XCSoar 7

the open-source glide computer

User Manual

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For XCSoar version 7.46.1
https://xcsoar.org

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Preface

Warnings and precautions

IT IS THE USER'S RESPONSIBILITY TO USE THIS SOFTWARE PRUDENTLY. THIS SOFTWARE IS INTENDED TO BE USED ONLY AS A NAVIGATION AID AND MUST NOT BE USED FOR ANY PURPOSE REQUIRING PRECISE MEASUREMENT OF DIRECTION, DISTANCE, LOCATION, OR TOPOGRAPHY. THIS SOFTWARE SHOULD NOT BE USED AS AN AID TO DETERMINE GROUND PROXIMITY FOR AIRCRAFT NAVIGATION. THIS SOFTWARE SHOULD NOT BE USED AS A TRAFFIC COLLISION AVOIDANCE SYSTEM.

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1 Introduction

This document is a pilot's manual for XCSoar, an open-source glide computer originally developed for handheld devices. The audience is assumed to have a sound knowledge of the fundamental theory of flight for gliders, and at least a basic working knowledge of cross-country soaring.

Updates to the XCSoar software may result in some of this manual being out of date. You should read the release notes distributed with the software to keep track of changes. Updates to the manual and software are available from

https://xcsoar.org

1.1 Organization of this manual

This manual most notably is written in order to get the XCSoar user started quickly *as well as* support his deep understanding of all the features, concepts and tactics introduced. At all times, the authors made their effort for doing this from a pilot's perspective (and honestly hope for having succeeded).

The authors highly encourage you to take your time reading the entire manual chapter by chapter (with exception of the reference chapters InfoBoxes and Configuration). Feel assured, the time you will have spent will pay off as a manifold in understanding. On your way reading you might feel blue once in a while. That is why the authors introduced some blueish things: links and icons.

Figure 1.1: Icons configuration, reminder, gesture, warning

Warning. The icon warning is used, whenever things shall be followed strictly. Not following will cause unexpected results, total dysfunction, or even danger to life. Proceed only, if warning understood.

DU

Gesture. A swipe gesture input is available using devices with a touch screen to invoke a menu or function amongst others. In this example, DU stands for moving your fingertip down, then up, (in straight lines) on the screen.

Specific Gesture. Whenever the manual's authors kept up with XC-

Soar's rapid development process in writing, a specific icon is provided, depicting the movements.

Reminder. This icon tags a tip, trick, things you might remind after having read corresponding sections and so on.

Configuration see... The icon depicting two craftsman's tools refers to an in-depth description of items being mentioned and how to configure them. The numbers beside the icon refer to a specific chapter / section of this manual's reference chapters 12 and 13, in this case referring to section 13.7.

¡pǝɹʇuǝʌuI ƃuıʎuI ʍɥılsʇ sʃɐunɐɯ ƃuıpɐǝɹ ɯoɹɟ doʇS

Read at home, *configure* on the ground, safely. Having perceived this (inverted) warning as an example, you are ready to proceed.

Referring to the second exemplary case of the icon "configuration" to the left, the icon points towards chapter 1, (this chapter), section 1.6, "Using XCSoar safely" underneath, which could be understood as a "how to configure yourself". It is up to you whether to jump to an in depth discussion and go back or just proceed. If reading this manual electronically, clicking the number will let you jump to the requested cross -reference. Use the go-to "back" (or similar) function of your particular browser to proceed with the chapter you jumped from.

The numbers are printed in blue as are the icons introduced, signalling "help available". And so are other Universal Resource Locators, underlying blue text. Clicking on text like `https://github.com/XCSoar/XCSoar/discussions` will open your world wide web browser or mailer to get in touch with other resources or knowledgeable people respectively.

The remainder of this chapter "Introduction" is about getting you prepared for XCSoar, how to raise your level of understanding and maintain your skills. Chapter 11 "Quickstart" might be the next waypoint after 2 "Installation" for the urgent user. Feel free to cut short, but do not resume too sadly when reading chapter by chapter, following:

Chapter 3 introduces the user interface concepts and gives an overview of the display .

Chapter 4 describes the moving map part of the display in greater detail and describes how the software can assist in general navigation. Chapter 5 describes how cross-country tasks are specified and flown, and presents some of the analysis tools available to pilots to help improve their performance. Chapter 6 goes into further detail on the glide computer functions as it is important for pilots to be aware of how the computer performs its calculations.

Chapter 7 describes how the computer can interface to variometers and other air data sensors, and how it uses these measurements to provide various models of the atmosphere, in particular on winds and thermal

convection. Chapter 8 describes how XCSoar can assist in managing flight in special use airspace and the FLARM collision awareness system. Chapter 10 deals with systems integration and systems diagnostics, the integration of XCSoar with communications devices and with airframe switches.

The remainder of the manual contains mainly reference material. Chapter 12 lists the types of information that can be displayed in the grid of InfoBoxes next to the map display. The configuration of the software is described in detail in Chapter 13. The formats of the various data files that program uses, as well as where to obtain them from and how to edit them, is described in Chapter 14.

Finally, a short history and discussion of XCSoar's development process is presented in Chapter 15.

1.2 Notes

Screenshots

Throughout this manual are several screenshots of XCSoar. These are taken from the program running on a variety of hardware platforms and possibly even different versions. Each platform and version may have different screen resolutions, layouts and fonts, and so there may be slight differences in the appearance of the display. Most of the screenshots in this manual are taken of XCSoar running in landscape orientation.

1.3 Platforms

Android Devices : XCSoar runs on Android 6.0 or newer. Many phones and tablets have a built-in GPS, a barometric pressure sensor, and an accelerometer (G-load) that XCSoar can use.

iOS : XCSoar runs on iPhone and iPad. Install it from the Apple App Store. Many of these devices have a barometric pressure sensor that XCSoar can use when present.

eBookreader : XCSoar runs on several Kobo eReader devices.

Windows PC : It is possible to run XCSoar on an ordinary computer with the Windows operating system. This setup can be used for training yourself in using XCSoar. A simulation mode is included in XCSoar as well as a IGC replay function, that can be used when not connected to a valid GPS source.

macOS : XCSoar runs on Apple Mac computers. Install it from the Apple App Store or from the XCSoar website.

Unix/Linux PC : XCSoar runs on Unix/Linux.

1.4 Technical support

Troubleshooting

A small team of dedicated developers produces XCSoar. Although we are happy to help with the use of our software, we cannot teach you about basics of modern information technology. If you have a question about XCSoar in particular not found in this manual please get in touch on GitHub Discussions:

https://github.com/XCSoar/XCSoar/discussions

To begin with communication, join the XCSoar forum at:

https://forum.xcsoar.org

If your concern appears not already addressed, post it or email us:

xcsoar-user@lists.sourceforge.net

Any frequent questions will be added to this document. You may also find it useful to subscribe to the XCSoar users mailing list so you will be kept up to date with latest developments.

If all of this does not help, you probably discovered a bug.

Feedback

Like any complex software program, XCSoar may be subject to software bugs, so if you find any, please report them to the XCSoar developers by using our bug tracker portal at:

https://github.com/XCSoar/XCSoar/issues

or by sending an email to

xcsoar-devel@lists.sourceforge.net

XCSoar logs many valuable things in a logfile `xcsoar.log` in the `XCSoarData` directory. The logfile can be appended to the bug ticket in order to help XCSoar developers determine the cause of possible problems. If you like the idea of doing some more, get involved:

https://github.com/XCSoar/XCSoar

Updates

You should periodically visit the XCSoar website to check for program updates. The installation procedure in the following chapter can typically be repeated in order to upgrade the software. All user configuration settings and data files will be preserved during the reinstallation/upgrade.

It is also recommended to periodically check for updates to data files, particularly Special Use Airspace, which may be subject to change by the national civil aviation authority.

1.5 Training

For the safety of yourself and others, pilots using XCSoar are advised to train themselves in using XCSoar on the ground and become familiar with its interface and features prior to flight.

Using XCSoar on the PC

The PC versions of XCSoar may be used to become familiar with XCSoar's interface and functionality in the comfort of one's home. All files and configuration used by this version are identical to the embedded versions, so it can be helpful to try out customisations on the PC version before using them in flight.

The PC versions can also be connected to external devices and operate just as the embedded versions do. Suggested uses include:

- Connect the PC to a FLARM device to use XCSoar as a ground station display of FLARM-equipped traffic.
- Connect the PC to an intelligent variometer such as Vega to test configuration settings of the variometer.

Using XCSoar with a flight simulator

A good way to learn how to use XCSoar is to connect the smartphone device to a PC running a flight simulator that can output NMEA sentences to the serial port. Suitable simulators include Condor and X-Plane.

The benefit of this form of training is that XCSoar can be used in FLY mode, so it behaves exactly as if you were really flying, and you can get a good feel for how the program works while you are flying the simulator.

1.6 Using XCSoar safely

The use of an interactive system like XCSoar in flight carries with it certain risks due to the potential distraction of the pilot from maintaining situational awareness and eyes outside the cockpit.

The philosophy guiding the design and development of the software is to try to reduce this distraction by minimising the need for user interactions as much as possible, and by presenting information in a clear fashion able to be interpreted at a glance.

Pilots using XCSoar must take responsibility for using the system safely. Good practice in the use of XCSoar includes:

- Becoming familiar with the system thoroughly through training on the ground.
- Performing clearing turns before interacting with XCSoar in flight in order to ensure there is no collision risk with other traffic.

- Setting up the system to take advantage of automatic functions and input events so that user interactions can be minimised. If you find yourself mechanically performing certain interactions frequently, ask yourself (or other XCSoar users) if the software can be made to do these interactions for you.

2 Installation

2.1 To run XCSoar

you need to obtain the following:

- a device to run XCSoar on
- XCSoar
- a GPS receiver
- a waypoint file
- an airspace file (optional)
- a map file (optional)

2.2 ! Before you go out flying the first time with XCSoar !

After having installed XCSoar successfully, you might use it instantly. XCSoar will launch with a ready-to-use pre-configuration. But be aware, that up to this point your new toy will give you a moving map display only. *Don't trust the computations.* You have to tell XCSoar which plane you are flying in advance. This is done by specifying your plane's data as are polar, weight and some other data. However it's always a good idea to study the manual and become familiar with XCSoar at home.

2.3 How to get the most from XCSoar

In order to achieve your maximum benefit from XCSoar, you are kindly asked to do some more after having installed the software and downloaded some data files. "Some more" includes personal and plane data as well as configuration of just a few features. Unless you are willing to tweak everything XCSoar provides, this could be done in a rather short time. Necessary steps are summarized in an *XCSoar Checklist*, given in the next section.

If you are planning to arrange a system with several components engaged in, this manual will give you valuable advice on both, how to set up things and how to use them.

If you are a pilot in a hurry, the authors suggest to change to the short form manual `XCSoar-in-a-Flash` going through the *XCSoar Checklist* step by step. The short form manual is available on https://xcsoar.org/docs/#manual.

2.4 XCSoar Checklist

Bring XCSoar into play

- get hardware and install XCSoar
- get appropriate data files of your flight district
- tell XCSoar which data files to use
- tell XCSoar about the glider's polar & weight
- possibly connect to instruments
- finish setup and familiarize
- mount hardware
- add items listed underneath to your checklists
- make "home"

Conduct preflight check, including

- setup polar and weight
- setup wind and flight parameters (MC, bugs, QNH)
- possibly setup a task

Conduct start check, including

- Check wind and flight setup once more

Fly, enjoy

Conduct after flight check

- Download flight logs from logger, upload to skylines and OLC
- Gather statistical data of flight.

2.5 Compatibility

Devices for running XCSoar

XCSoar runs on the following platforms:

- Android mobile phones and tablets with Android 6.0 or newer
- iPhone and iPad (iOS)
- eReader Kobo
- Windows
- Linux
- macOS

GPS, Logger, Vario

XCSoar is compatible with any GPS emitting NMEA data. Most modern Android and iOS devices have a built-in GPS. Many of those phones and tablets also have a barometric pressure sensor; XCSoar uses it for altitude when no better external altimeter is connected. On Android, XCSoar also uses the phone's accelerometer as a G-sensor (load factor). For several reasons it is still favorable to connect to one or more external devices:

- a specialized GPS receiver gains much better reception providing much better data for measures and calculations
- an airspeed indicator allows quick and exact wind estimates without circling
- a vario improves the thermal assistant
- a task can be declared to an IGC logger, and after landing, the flight log can be downloaded
- some varios allow synchronising the MacCready setting with XCSoar
- FLARM (and even ADS-B input) provide informations and states of others around you (and of course FLARM gives you collision detection)

Supported external devices and features

Supported:	-Features			-Stream Data				
NMEA Device	Declaration	Remote ctrl.	Download	Airspeed	Vario	Baro. altitude	Wind	G-Sensor
Borgelt B50		√		√	√	√		
CAI 302	√	√	√	√	√	√	√	√
CAI GPS Nav								
Condor				√	√	√	√	
Digifly Leonardo				√	√	√	√	
EW Logger	√					√		
EW microRecorder	√					√		
FLARM	√		√			√		
Flymaster F1					√	√		
Flytec 5030				√	√			
ILEC SN10					√	√	√	
IMI ERIXX	√		√					
LX20, Colibri	√		√			√		
LXNAV Nano	√		√					
LXNAV V7		√		√	√			
LX Navigation Eos57	√	√	√	√	√	√	√	
PosiGraph	√					√		
Triadis Altair (pro)	√					√		
Triadis Vega		√		√	√	√		√
Vaulter		√		√	√	√	√	√
Volkslogger	√		√			√		
Westerboer VW1150		√		√	√	√		
XCVario		√		√	√	√	√	√
Zander / SDI		√		√	√	√	√	

Modern Android devices typically have no serial port. Those can either use Bluetooth or the Android IOIO board. To use Bluetooth, you need to connect the external device to a Bluetooth-to-Serial adapter, such as the K6-Bt or the SoarTronic-BT1/2.

2.6 Software installation

The software is available as a free download from the XCSoar website https://xcsoar.org. This section describes which file should be downloaded, and how to install it.

On Android

Obtain XCSoar from Google's Android market, or install the `apk` file manually. Copy the data files on the SD card in the directory `XCSoarData`.

On a Kobo Mini

The Kobo Mini is a cheap e-book reader. It has a black and white e-paper screen with excellent sunlight readability.

Before you begin: back up the internal SD card. The XCSoar installer may break the Kobo, though unlikely. You can always recover the Kobo from a software failure, but only if you have access to a backup.

To install XCSoar, connect the Kobo to your PC via USB. The Kobo exposes a mass storage device to your PC; open it and create a directory called `.kobo` (note the leading dot). Download the file `KoboRoot.tgz` from the XCSoar website into that directory (https://xcsoar.org/hardware/). Unplug the Kobo and reboot it (switch it off completely, and switch it on again). You will see the message "Updating", and after a few minutes, the Kobo shows a menu that allows you to launch XCSoar or the Kobo e-book reader software.

To copy data files (maps, waypoints, ...) to the Kobo, launch the original Kobo software ("Nickel") and connect the Kobo to your PC again. Copy the files into a directory called `XCSoarData` at the top level.

Alternatively data files may be downloaded via XCSoar's file manager, after having invoked a WLAN connection just before launching XCSoar.

Hacking the Kobo

After installing XCSoar on the Kobo, the new boot script checks for a script called `XCSoarData/kobo/init.sh` and executes it. If you know what you're doing, you can use this script to do things at boot time, for example launch `inetd` (for `telnet` access).

When you launch `Nickel` (the original e-book firmware), the new boot script also checks for a script in `XCSoarData/kobo/` named `init_nickel.sh` and executes it. Again, if you know what you're doing, you can use this script to do things before `Nickel` is fully started, for example send commands to your attached vario (to shut it down, to cut the volume, etc...).

The Power Off Screen

While powered off, XCSoar shows a log of your most recent flights on the screen. Additionally, if present, it shows the contents of the file `XCSoarData/kobo/poweroff.txt` at the bottom. This file can contain arbitrary text, e.g. contact/owner/emergency information.

On iOS

Install XCSoar from the Apple App Store. Data files are stored in `Documents/XCSoarData` and can be copied with the Files app (or

iTunes file sharing).

On macOS

Install XCSoar from the Apple App Store, or download the macOS package from the XCSoar website. Data files go in `XCSoarData` in your home folder.

On a Windows PC

Two Windows builds are available:

- **64-bit** (target "WIN64OPENGL"): the recommended version. Run the installer, or use the `.zip` file for a manual install. Supports high-DPI displays, GPU acceleration, and matches the Unix and Android versions in features and visuals.
- **32-bit** (target "WIN32OPENGL"): same as the 64-bit build for 32-bit Windows; installer or `.zip` available.

The version is visible in Windows file properties of `XCSoar.exe` and the installer.

On Unix/Linux

The file downloaded is `xcsoar_XXX.deb`, where `XXX` includes the version number and platform, e.g. `xcsoar_6.0.4_i386.deb`. This is a Debian package and can be installed using

```
sudo dpkg -i xcsoar_XXX.deb.
```

Use `dpkg-query -L xcsoar` to see where the executable and other files are installed. The package adds an XCSoar entry to the desktop menu. Additional data files must be placed in the directory `~/.xcsoar`. If `~/.xcsoar` does not exist, it will be created the first time that `xcsoar` is run.

On Raspberry Pi and Cubieboard

Install the Debian package as described above. However, unlike on "regular" Linux, XCSoar will not use X11. Instead, it runs full-screen on the Linux console.

On the Raspberry Pi 4 and later, Raspberry Pi OS already enables the VC4 display driver. In `/boot/firmware/config.txt` (on older images, `/boot/config.txt`) the line is:

```
dtoverlay=vc4-kms-v3d
```

Leave that line as it is. XCSoar draws through this driver. Do not add a second line, `dtoverlay=vc4-fkms-v3d`: the two overlays together stop the Pi from booting. If the file still has `dtoverlay=vc4-fkms-v3d`, edit that existing line so it reads `dtoverlay=vc4-kms-v3d`. Do not add another overlay line.

XCSoar requires access to your input devices (`/dev/input/event*`). By default, only `root` is granted access. To override this, create a udev configuration file, e.g. `/etc/udev/rules.d/99-input.rules`:

```
KERNEL=="event*", NAME="input/%k", MODE="660", GROUP="input"
```

Create the group `input` and make your user a member:

```
groupadd input
adduser pi input
```

2.7 Data files

To be able to use XCSoar's advanced features, additional data files, such as terrain, topography, special use airspace, waypoints etc. are needed. The files that can be used with XCSoar are described in Chapter 14.

All data files should be copied into the directory `XCSoarData`. This directory must be in a specific place so that XCSoar knows where to look for data files:

Windows PC : `XCSoarData` is in your personal folder ("`My Documents`")

macOS : `XCSoarData` is in your home folder.

iOS : `XCSoarData` is in the app's Documents folder, accessible via the Files app.

Unix/Linux : The directory is called `.xcsoar` in the user's home directory.

Android Devices : `XCSoarData` is on the SD card.

XCSoar will generate a number of additional files at run time. These will be placed in the `XCSoarData` directory (Windows, macOS, iOS, and Android devices), or the `.xcsoar` directory (Unix/Linux PC). From the first run, XCSoar will create and maintain the files `user.cup` (user-edited waypoints), `Default.tsk` (Default Task), `default.prf` (configuration settings), `xcsoar.log`, plus three directories: `cache`, `config` and `logs`. Additional files may be created/modified while XCSoar is running, such as task files (`*.tsk`) and flight logs.

2.8 Running XCSoar

Two modes are available inside the XCSoar application:

FLY : This mode is used when actually flying. The simulator is disabled and serial communications are active.

SIM : This starts XCSoar in simulator mode, no serial communications are attempted.

Quitting from this prompt leaves the profile file unchanged, including when XCSoar was started with `-profile=...`.

XCSoar PC version

The program can be run by opening the explorer window, finding the directory that has the XCSoar.exe executable, and double clicking on that program file.

Command-line options may use either one or two dashes where listed below (e.g. `-h` and `--help`). `-h`/`--help` prints the option list and exits; `-version`/`--version` prints version and licence text and exits. Invalid options print a brief usage reminder on standard error.

The program command line options allows the screen orientation of the display to be defined:

-portrait : The screen is 480 pixels wide, 640 pixels high.

-square : The screen is 480 pixels wide, 480 pixels high.

-landscape : The screen is 640 pixels wide, 480 pixels high. This is the usual setting. If you don't specify this parameter the landscape version will be loaded automatically.

-small : Draws the screen at half size. This is useful for using XCSoar in conjunction with flight simulators e.g. Condor.

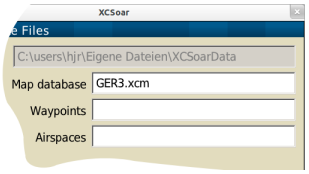
To change the screen orientation, it is convenient to create a shortcut to the program, then right click on the shortcut icon and click on "Shortcut". In the field "Target" add one of the desired options listed above.

XCSoar Unix/Linux PC version

Run `xcsoar` from a command line, or create a shortcut on the desktop. The location of the executable file may be found using `which xcsoar`. Only landscape mode is supported for now.

Useful options include `-datapath=...` for the data directory, `-profile=...` to load a profile file, `-simulator` or `-fly` when available to skip the startup mode prompt, and geometry switches such as `-portrait`, `-square`, and `-small`. The window cannot be resized below 320×240 pixels, or 240×320 when it is taller than it is wide. On desktop Unix/macOS builds, `-replay=PATH` may load flight replay data.

Loading data files



The first time that XCSoar is run, it does not automatically load the data files that you placed in the `XCSoarData` directory. To tell XCSoar which files to load, double click/tap the map (the large, blank white part with the glider symbol in the center), choose the menu Config 2 (click/tap it twice), then select the item System . The Configuration screen should be displayed: The first page allows you to choose the map, waypoint and airspace files, by clicking/tapping on the text boxes. Many other features of XCSoar may be configured

here. These are described in detail in Chapter 13. Once completed, XCSoar reloads those files; from now on, the data files will be loaded automatically at run time.

Start-up and user profiles

When XCSoar starts up, it will check for existing profiles. If multiple profiles are detected it will display a small window asking you which profile to load. To proceed, choose the desired profile and press Enter. If no profile is chosen the settings from the last session are loaded again. Profiles can be useful for example in the following cases:

- Different pilots
- Competition versus casual flying
- Flying in different locations
- Different planes (with different polars)

Profiles also might be understood as preserving a backup of a certain configuration. Virtually every of XCSoar's settings is stored in a profile file with extension `.prf`. Once you are happy with all your settings, make two copies of your profile file. One carrying extension `.prf`, the second copy carrying extension `.bak`. Whereas the `.prf` file will show up on startup and reflect all of your changes made whilst XCSoar is running for the next startup, the file `.bak` will keep the settings, you judged being worth it to preserve. As an example you might create a set of files as is:

- `buddiesinArcus.prf`
- `buddiesinArcus.bak`
- `johninKa6atwonderland.prf`
- `johninKa6atwonderland.bak`

SIM mode

XCSoar comes with a simple interface allowing for conducting a simulated flight. Depending on the hardware platform, there are different methods for altering values of bearing, speed, and height. Simulation is intended for your first familiarization with XCSoar in action. If you like the idea simulating a more realistic thing at home, you should acquire a "true" soaring simulator, to be connected to XCSoar.

On the map screen, clicking/touching the glider symbol with touchscreen or mouse and dragging causes the glider to move in the direction of the drag, the speed being proportional to the length of the drag.

With buttons, the aircraft speed, altitude and direction may be changed using the InfoBoxes. The following may not be available in total on every hardware platform, but on any of the platforms XCSoar supports, a full set of inputs needed for simulation purposes is possible.

Tap an InfoBox to open its panel. The aircraft altitude can be adjusted by tapping the GPS altitude InfoBox [Alt GPS] . That opens the altitude panel. The airspeed and the glider's track can be adjusted by tapping [V Gnd] or [Track] . That opens a panel with controls for speed and direction.

Other controls, buttons and menus work the same as in FLY mode.

Splash screen

When XCSoar starts up, shuts down, or loads large files, such as airspace, waypoints, terrain, etc., a progress screen is presented while the data is being loaded. This screen has a progress bar which indicates the data loading activity, and a short line of text describing the action that is being performed.

This screen also displays the software version information.

Exiting the program

XCSoar is shut down from the menu. The menu can be opened by double-clicking on the map.

[QUIT]

For PC versions, XCSoar can also be shut down by clicking the close icon on the XCSoar window.

3 User Interface

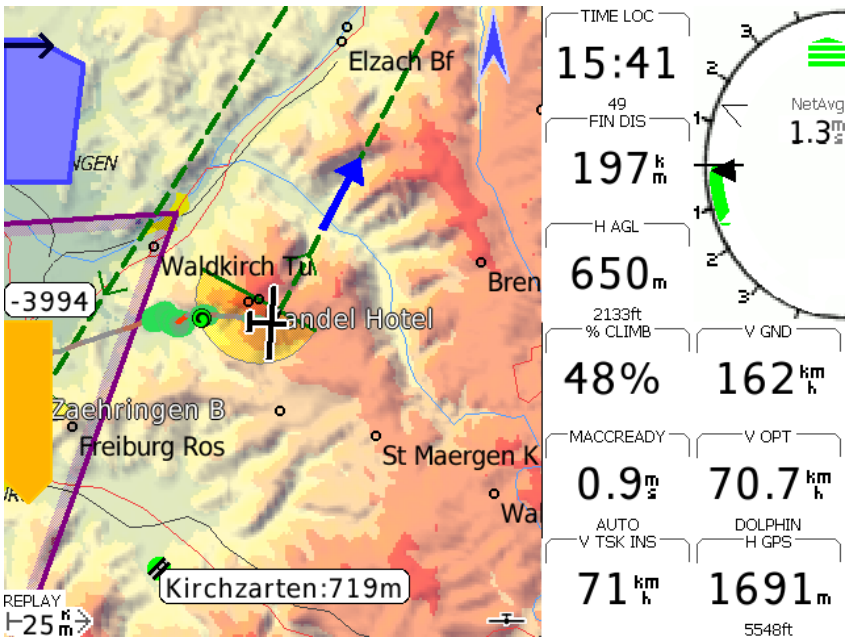


Figure 3.1: Typical XCSoar main screen layout

This chapter describes the fundamental user interface concepts used by XCSoar, and is intended as an overview. The *main screen* covers much of the information needed during normal flight. Typically, the main screen is composed of the moving map and InfoBoxes. For several reasons - not being the scope of an introduction - you have a choice of using several main screens in-flight, named *screen pages*.

Screen pages are easily accessed by a horizontal swipe gesture just like turning pages of a book or button push, depending on the hardware you use. With screen pages you are enabled to compose several main screens to be used advantageously in different situations in-flight. Simply speaking, you are enabled to use appropriate information in different *use cases*, to be accessed quite simply and fast.

Whenever actual situations are worthy of grabbing the pilot's attention, an *overlay* is put in front of the main screen. This happens especially when urgent reaction by the pilot is required as are the situation of a possible collision or an entering of a restricted airspace expected to happen soon.

Evidently, menu buttons and menu screens are overlays too, and there are many more. As a result, the elements put on each other form a display stack with the main screen representing the base of it. More detailed descriptions are given in following chapters.

3.1 Display elements

Main screen and screen pages

Every screen page out of XCSoar's screen pages' ensemble is composed of several parts:

Main area : The bulk of the screen typically is dedicated to the GPS moving map display. Various symbols relating to glide computer information are overlaid the map area. Icons and text may appear along the lower edge of the screen to indicate status of connected devices, flight modes etc. Following the development process of XCSoar there is an increasing number of items that may be chosen for display in the main area, which are gauges, FLARM Radar, Thermal Assistant and Horizon.

InfoBoxes : A grid of data values is displayed usually either along the top and bottom of the screen (portrait display) or to the left and right of the screen (landscape display). These so-called InfoBoxes display data from the GPS and other input devices as well as data calculated by XCSoar. Further, InfoBoxes can even display gauges and certain graphs.

Bottom area : At the bottom of the screen, XCSoar is able to draw a cross-section of terrain and airspaces in the direction of your heading.

Overlays

Gauges : Gauges provide instrumentation displays. All gauges are optional and some may only have meaningful information displayed when XCSoar is connected to a supported instrument. The FLARM radar and the thermal assistant are gauges: each is drawn at a fixed screen position. The thermal assistant can be shown when XCSoar enters circling mode. The FLARM radar can be shown when traffic is detected. The final glide bar, the vario bar and the thermal band are map overlays, configured under Map Display / Overlays. The needle vario belongs to an InfoBox layout.

Button labels and menus : Hardware buttons on the device running XCSoar can be used to bring up and navigate smaller on-screen menus that are typically laid out such that menu items can be selected by pressing the button adjacent to the item. If the device has a touch screen, the menu items can be selected by touching them. These buttons are drawn in black text on a grey background.

Status messages : Text is displayed over the screen in status message boxes. This text is used to present detailed information to the pilot when certain events occur.

Dialogue windows : Larger dialogue windows, usually containing graphics and buttons, are used to present detailed data to the pilot regarding waypoint details, statistics and analysis etc.

Main menu :
The main menu is accessible by double tapping the map area as well as through gesture. If the menu buttons are not pressed after a specified time, they disappear again so as to not obscure the map area.

Classic vario gauge

As said above, gauges might be displayed in different ways, either as an InfoBox, overlay, or even in the main area. The traditional variometer gauge is different. This needle-style gauge is invoked permanently by choosing an InfoBox layout including the variometer on the right side of the other InfoBoxes.

3.2 Interaction

There are several ways to interact with XCSoar:

- Touching certain map elements
- Touching InfoBoxes and on-screen menu buttons
- 'Gesturing', by e.g. drawing a dash from the left to the right on the screen (see Section 3.12 below).
- 'Dragging' the screen (touching the screen and moving before releasing).
- Pressing application buttons on the device.
- Pressing the cursor keys on the device.
- Pressing keys or switches on an instrument connected to XCSoar.

Depending on the particular hardware used with XCSoar, not all of these methods of interaction are possible and there may be different numbers or assignments of buttons.

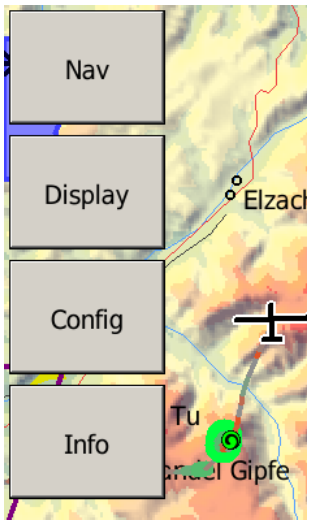
For the PC version of XCSoar, clicking the mouse over an item is equivalent to touching it.

On Linux, choosing Quit also offers controls for the system actions which are available without authentication, such as restarting or powering off the device. These controls are also available on Kobo. Cancel is the default choice. After choosing an action, XCSoar saves its state and closes its devices before asking the operating system to perform the action. Other platforms continue to show only the normal confirmation for quitting XCSoar.

3.3 The main button menu

The button menu is a set of buttons drawn on the screen and activated by touch or hardware button presses. Using buttons and the button menu is the primary way the user interacts with XCSoar.

Interface basics



The menu is organised into four different groups of functions, usually in the form of a hierarchy. The specific menu layout depends on the hardware button configurations and platform, and may also be customised by the user.

XCSoar can also accept input from external keyboards, game-pads, joysticks, stick grip switches etc. A wide variety of functions can be assigned to these inputs.

On the PC version, these mode buttons are activated by the 1, 2, 3 and 4 keys. The 6, 7, 8, 9 and 0 keys correspond to the horizontal strip of buttons.

If the user doesn't interact with the computer for some time, the menu will close automatically. This menu time-out is configurable. The escape key on PC can also be used to close the current menu.

Menu buttons appear greyed out if the corresponding function is not available. For example, the "Waypoint list" function will appear grey if there are no waypoints loaded.

Several menu button labels have dynamic text based on context, in order to make it clearer as to what happens when the button is pressed. The convention is used that a button's label describes what will happen when the button is pressed. For example, if the button says MC Auto , then pressing the button will turn on 'Auto MacCready', and the button label will then change to MC Manual . In the menu list described below, generic labels are used.

Menu function groups

This section describes the default layout of the menu system on all platforms. The functions performed by each button are explained more fully in following chapters.

For the PC version, the keys 1, 2, 3 and 4 activate the corresponding menu. The following menu item list has on the left side of most of the menu buttons links to the respective section. Follow them to get to all related details.

3.4 Menu item overview

Navigation menu

Nav 1/2	Task	Previous Turnpoint	Next Turnpoint	Waypoint List	Alternates
see	5	5.9	5.9	5.4	5.11
Nav 2/2	Task Abort	Mark Drop	Pilot Event	Target	
see	5.11	4.9	4.10	5.3	

You should not start using XCSoar without knowing about the 'Alternates' feature. Any 'Task' related item in the navigation menu is used for planned cross country flight and certainly the second step.

Display menu

Display 1/2	Zoom In	Zoom Out	Zoom Auto	Info Cruise/...	Pan On
see	4.3	4.3	4.3	3.6	4.4
Display 2/2	Labels All/...	Trail Full/...	Terrain On/Off	Topo. On/Off	Airspace On/Off
see	4.7	4.8	4.7	4.7	4.7

Most of the display menu items are available on gestures, or special key short-cuts of your device. Once you are familiar with XCSoar you probably will use those menu items less frequently.

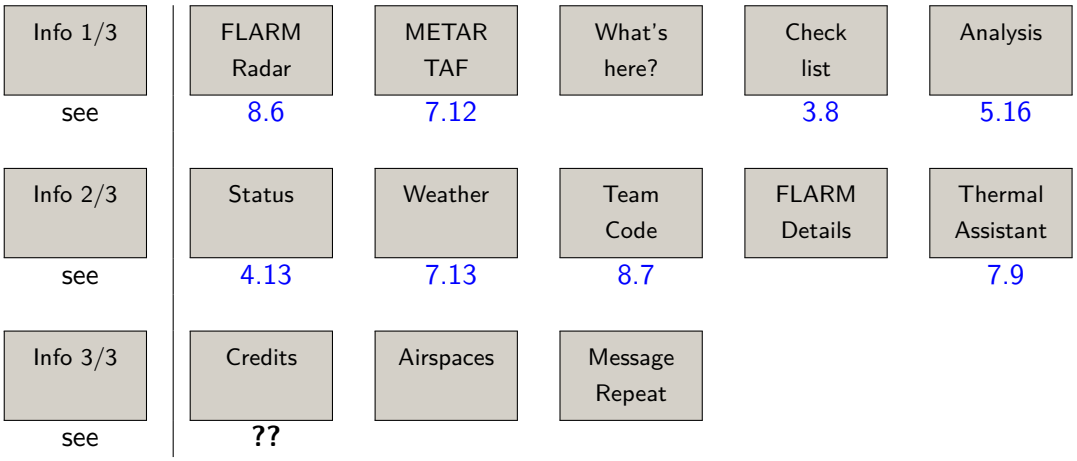
Configuration menu

Config 1/3	MacCready +	MacCready −	MacCready Auto	Flight	Wind
see	6.7	6.7	6.14	6.5	7.6
Config 2/3	System	Plane	Devices	File Manager	Replay
see	13	6.4	13.34		5.15
Config 3/3	Logger Start	Raw Logger	Airspace	Vega	Profiles
see	5.15	5.15	8.4		

The configuration menu is typically part of the ground interaction with XCSoar. You are not expected to spend much time in-flight with tweaking the configuration, except you manually adjust wind or

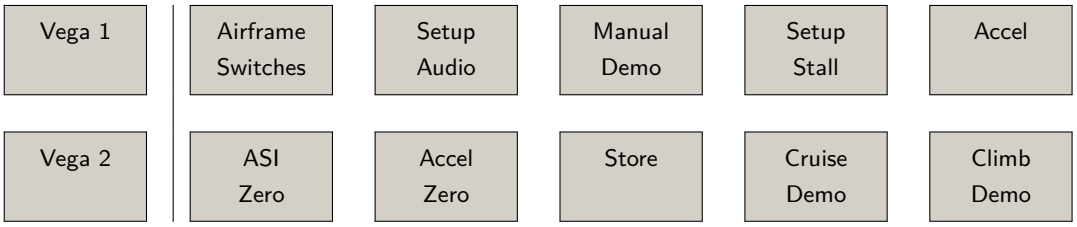
MacCready settings. The 'Vega' item gives control over the Vega intelligent variometer. This comprises a sub-menu.

Information menu



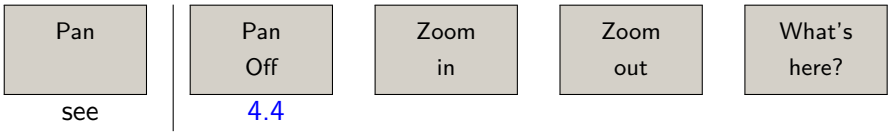
The information menu is always a good address, when not only a clue on how to set MacCready is requested, but rather more elaborate help on a larger scope tactical decision on your flight is requested.

The Vega variometer sub-menu of the configuration menu



The functions in this sub-menu require the Vega intelligent variometer. The menu can only be accessed if 'Vega' is selected as the connected device.

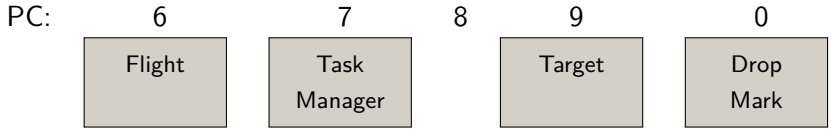
The pan mode sub-menu of the Display menu



This sub-menu unfortunately overlays the full-screen map view of the pan mode. Its functions are quite evident, although the menu could be replaced by multi-touch technology or knobs. Besides the essential 'exit pan mode' function the 'What's here?' button offers brilliant access to the variety of information of the map.

3.5 Default menu buttons

When no menu is active, (so-called default mode), the horizontal row of buttons perform the following functions (from left to right):



For all other versions in the default mode, the cursor keys perform the following functions:

Up key : Zoom in

Down key : Zoom out

Left key : Drop marker

Right key : Toggle through normal/aux. InfoBoxes and full-screen

Enter : Clear status message or suppress FLARM gauge if open and no warning active

Dynamic menu labels

Certain menu items have dynamic labels to make it clearer what happens when the menu item is selected. Furthermore, items that are not available are greyed out to indicate that selecting the menu item will not do anything.

The convention used for dynamic menu labels is for the labels to display the action that will be performed once the menu item is selected. For example "Lights On" will turn the lights on, and the menu will be updated to display "Lights Off", which would then if pressed turn the lights off. This convention is used throughout XCSoar.

A selection of key dynamic menu items is presented below:

Next Turnpoint : Greyed out if the task is cleared, or if the active turnpoint is the finish. If the currently active turnpoint is the turnpoint prior to the finish, this displays "Waypoint finish".

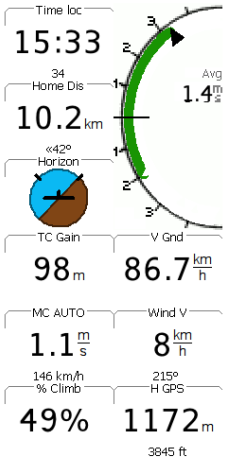
Previous Turnpoint : Greyed out if the task is cleared, or if the active turnpoint is the start and there are no multiple start points. If there are multiple start points and the active turnpoint is the start, then this displays "Cycle start" to allow selection between the various start points. If the active turnpoint is the first turnpoint after the start, this displays "Waypoint Start".

Labels All : This will turn on all labels available on the map. There are more options to only show a reduced set of labels like "Labels Task", thus not cluttering the screen too much.

Target : Greyed out if the task is cleared or in task abort.

3.6 InfoBoxes and screen pages

The information displayed in the InfoBox fields can be selected from a wide variety of options (listed in Chapter 12). These fields can also be used to change for example the MacCready setting.



The specific number and layout of the InfoBox grid depends on the screen orientation and the device's display size.

For a 320x240 display in portrait mode, there are four InfoBoxes above and four InfoBoxes below the map display.

A typical landscape layout has 9 InfoBoxes and the variometer gauge to the right of the map display. For larger displays up to 24 InfoBoxes may be displayed simultaneously.

In order to gain clarity, the less InfoBoxes you choose to be displayed at once, the faster your reading will be. On the other hand, there are much too many InfoBox options a pilot would hardly reject. The number of possible InfoBox options already exceeded one hundred. That is why XCSoar offers two ways of managing even more options than InfoBoxes count.

Depending on your flight's state, whether you are circling or cruising, you can let XCSoar change the content of each single InfoBox. As an example you might change the display of the actual average climb whilst circling to speed to fly when cruising. The switch is derived automatically by entering different *flight modes* (see section 6.1) executing a switch to another *InfoBox set*.

Further, you can use screen pages to change InfoBox content manually, by assigning different InfoBox sets to different pages (see following section).

To gain access to automatic switching InfoBoxes dependent on the flight mode, just let XCSoar run with its pre-configured setup from installation. To set up your personal version of InfoBoxes go through the following procedure.

InfoBox geometry : Choose a basic InfoBox geometry or layout. This basic layout is maintained through any changes in-flight, affecting InfoBox content only.

13.21

Choose InfoBox set "Auto" : Configure at least one screen page with the choice of InfoBoxes "Auto". As can be seen on the corresponding configuration screen, there are more screen pages pre-defined. These others are not needed to gain automatic switches by flight mode. They are for *manually* turning through the screens defined by pages.

13.22

Define InfoBox sets : Put together the InfoBox content you want to be displayed in three InfoBox sets called "Circling", "Cruise", and "FinalGlide" respectively.

13.20

Screen pages with different InfoBox sets

XCSoar allows the pilot to define various sets of InfoBoxes that are appropriate for "normal" states of flight. Assuming circling, cruising, or final glide as normal, XCSoar can switch corresponding InfoBox sets automatically.

As you might imagine, there are countless cases, you wished you had another ensemble of information displayed at once. For all of these more or less special situations you can define up to eight screen pages, reflecting the actual *use case*. Just to draw a brief sketch of the possibilities introduced by the concept of screen pages, a few use cases are given.

Familiarisation : Especially if you are a beginner, you might study computed values in-flight in advance of placing them in your "normal" InfoBox ensemble - just to get familiar with the reading. To do so, create a new InfoBox named "test" to be placed on an additional screen page brought in. In any case you can go back to the screen you know by "turning a page"

Competition : If you are a pilot scratching the edge, you might want to gain benefit of XCSoar's numerous task- and competition-related computations. In order to get them related to the competition's phases, you might like the idea of defining two special use cases with pages for the phase before start, another one for whilst racing. If you are in search of a specific value to be displayed, give it a try in chapter 12 "InfoBox Reference". There is a big chance you will find it.

On the ground : As a manager on duty you might use a screen page, showing the "FLARM Radar" solely. This might happen on a PC screen running XCSoar being connected to a FLARM receiver.

Whatever you would like to display, take into account the use case and screen pages concept.

To go through the various screen pages, use gesture left/right (touchscreen), or via menu button in menu Display 1/2 , showing a dynamic label, changing accordingly to the screenpage's content to show up next:

Display 1/2 ▷ Info Circling ▷ Info Cruise ▷ Info FinalGlide ▷ Info ...

After each page change, a page indicator with one dot per configured screen page appears for about two seconds at the bottom centre of the map. The filled dot marks the current page and thus shows its position among all configured pages. The indicator does not appear if only one page is configured.

Modifying InfoBox content

A short press on an InfoBox (a tap or a click, lifting before the box fills) runs that InfoBox's action. Some open a small dialogue, some open another screen, and some do nothing. A short press of Enter does the same thing when the InfoBox is selected.

Press and hold until the box fills, then lift, to arrange the InfoBoxes. Hold Enter until the box fills, then release, to do the same. That is described in section 3.6.

With a keyboard, Tab selects an InfoBox. The cursor keys then move to the InfoBox in that direction on the screen: left to the one on the left, and likewise for right, up, and down. When the map is showing and no dialogue or menu is open, Escape selects the first InfoBox. Escape on an InfoBox returns to the map.

Examples of InfoBoxes that open a dialogue include the MacCready setting, wind, and QNH.

Rearranging InfoBoxes

Press and hold an InfoBox past a tap; it fills from the bottom. Lift while it is full to enter the arrange mode with that InfoBox selected, or slide off to cancel. The '*Arrange InfoBoxes*' item of the Quick Menu opens the same mode without picking a box up. The screen uses the same backdrop as the InfoBox set dialog, with the map still showing through, and every InfoBox is replaced by a card showing only its number and its caption. On Android the backdrop still covers the screen. The cards, the description and the buttons stay clear of the screen edge, the camera cutout and the system bars, and below the area that opens the notification shade, so a drag stays in XCSoar. The InfoBox Sets editor uses the same layout. The InfoBoxes on the map stay where they are.

A tap on a card explains what that InfoBox shows. Drag it onto another one to exchange the two; the InfoBox which makes way slides over into the slot the dragged one has left. Hold still and the card fills from the bottom; lift to open the list of all available InfoBoxes, or slide off to cancel. Once the card follows the finger, holding no longer opens the list. A second finger on the screen aborts the drag.

Without a touch-screen the cursor keys and a remote stick select an InfoBox. A short Enter takes the selected InfoBox, the cursor keys then move it, and Enter puts it down again. Hold Enter until the card fills, then release, to open the list of available InfoBoxes, the same as holding a card. While a card is taken, Enter puts it down and the card does not fill. Putting an InfoBox down without having moved it opens that list too. Tab leaves the cards and reaches the Help and Close buttons; so does a cursor step toward them (down on a portrait page, left on a landscape one).

'*Help*' explains how an InfoBox is moved and how it is replaced. '*Close*' leaves the mode and keeps the new order, and so does the timeout after the same time as the menu; the Escape key leaves the mode and restores the order the page had before.

The InfoBox sets are composed in the same view. The dialog buttons copy a set, paste it into another one, and choose that set's geometry

(see Section 13.20).

Changing InfoBox sets

An entire set of InfoBox can be composed by the '*Setup System*' configuration dialogues on the '*Look / InfoBox Modes*' and '*Look / InfoBox Pages*' 13.20 setup page. The dialogues give a wide variety to set up the look and feel of the XCSoar pages.

3.7 Status messages

Status messages appear over the map area to present text for a short period of time. The message disappears after the time period has elapsed, and different types of message have different periods. Additionally, status messages can be made to disappear by acknowledging the message. Acknowledgement is achieved by either pressing the enter key, touching the status message (on touch-screen devices) or clicking the screen (mouse enabled devices).

Additional user buttons may be assigned to a status message repeat function, which brings up the last message again.

Typical status messages include:

- Airspace queries
- Airspace warnings
- User interface events (e.g. changing display modes)
- Glide computer events (e.g. take-off, turning waypoints)

Note that status messages do not appear while a dialogue is on screen, the messages are buffered and displayed as soon as the dialogue is exited.

3.8 Dialogue windows

XCSoar contains several dialogue windows that can be activated to bring up additional information and are also used for more complex interactions with the user, such as editing tasks and configuring settings.

Some dialogues simply display information, and require no user input. Other dialogues contain data fields that can be modified or buttons that can be pressed. Message dialogues adjust their text and controls when the application window or display orientation changes. Use the left/right arrow keys to move between buttons in the same row, and the up/down arrow keys to move to the closest button in the row above or below. On narrow screens where buttons form a single column, use up/down. At an edge, the selection stays on the current button. Enter activates the selected button; on a PC, Tab cycles through the buttons.

In other dialogues, a cursor appears over the active button or data field. Pressing the up/down arrow keys, the cursor will cycle through the next or previous items. For list items and scrollable text, the up/down arrow key moves the cursor up or down the list or text, and the left/right arrow keys move the cursor up or down by one page in long lists.

For PDAs and PC versions, list items can be selected by touching the item (or left-clicking with the mouse). Once a list item is selected, another touch (left click) is equivalent to pressing the enter key.

Pressing the right/left arrow keys, the data field value under the cursor can be modified. Pressing the enter key activates the button or makes a selection from a list.

Dialogues are typically started from the button menu.

Many of the dialogue windows have multiple pages of information and are controlled in a consistent fashion. Press the [<] or [>] buttons to select the next or previous page of the dialogue and the [Close] button to make the dialogue disappear. The [<] button is unavailable on the first page.

The escape key on a PC can also be used to close dialogues.

The user must close the dialogue to return to the map view. When a dialogue has been opened, the main button menu is disabled until the dialogue is closed.

In some dialogues, items that are not relevant or valid (such as AAT details when flying a non-AAT task) are not displayed.

A summary of the major dialogues is presented below.

Flight setup : Used to modify the polar of the glider both before and during flight, as well as to set the QNH pressure

Wind : Used to modify or adjust the estimated wind magnitude and direction

Waypoint details : Describes a waypoint in detail and has navigation functions such as 'GoTo' and 'Insert in Task'

Waypoint list : Used to select a waypoint from the waypoint database

Task manager : Used to create, modify and view cross country tasks

Analysis : Shows several pages of analysis and statistics about the flight

Status : The status dialogues give summaries of the situation of the aircraft, system, task, start and times

Configuration : Allows XCSoar and certain connected devices to be configured

Airspace filter : Controls enabling and disabling the display and warnings of each airspace class

Team code : Allows transfer of coordinates between FLARM team mates via a code

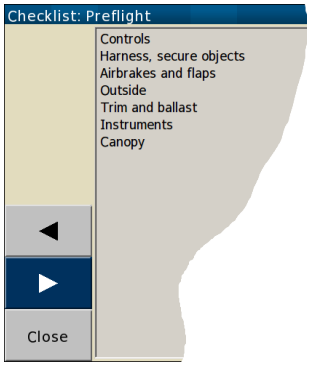
Devices : Selection of various external devices (e.g. smart variometers, FLARM, etc.).

Setup Plane : Easy reconfiguration of the plane-dependent settings (e.g. polar, competition ID, etc.) by choosing from a list of previously-created plane profiles.

Data Management : Provides file downloads, import, backup and flight export. The Export Flights list scans IGC files in the background and adds detected takeoff, landing and duration information as it becomes available. A line under the list shows how many IGC files have a detected launch and landing, and their total time as hours:minutes. It keeps updating while files are still being scanned. WeGlide Upload opens that list with only IGC files. The Upload Flight button sends the highlighted flight.

These dialogues are described in later chapters, with the exception of the check-list, status and text entry dialogues, which are described below.

Check-list (dialogue example)



The checklist dialogue can display several pages of user-defined free text. Typically this is used for check-lists. It can be accessed via the menu.

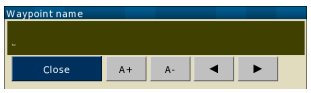
Info 1/3 ▷ Check List

These check-lists may include: daily inspection, preflight, out-landing, pre-landing, radio procedures, and aircraft rigging and de-rigging instructions. Since the check-lists may be long, the up/down keys may be used to scroll through the text. Clicking the [<] and [>] buttons selects the previous/next checklist. Tapping the text of a checkbox line toggles it. A link on that line, such as a VHF frequency, still opens the link. Checkbox ticks stay until you leave XCSoar or choose a different checklist file. Editing a page's text clears its saved ticks.

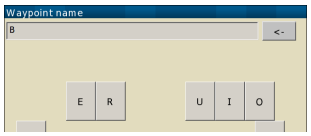
Text entry

A text entry dialogue is used for entering text. This is used for team code entry, setting file names, waypoint editing, as well as entering other configuration options, such as pilot name for the logger.

Two ways of entering text are provided.



To enter text in 'high score style', use the A+/A- buttons to adjust the character under the cursor (underlined character). Clicking the [<] and [>] buttons move the cursor left/right.



To enter text with the touch screen keyboard, press the letters of choice one after the other. In some dialogues (e.g. waypoint editing) only the next letters matching to an entry in the database will be shown. For deleting the last letter use the [<-] button. The [Clear] button deletes all input.

Press [Ok] to validate, or [Cancel] to exit.

3.9 Acoustic alert and sound feedback

XCSoar generates sounds for different events, and can be configured to have custom sounds for any event. See Section 14.13 for details on customisation.

When XCSoar is connected to the Vega intelligent variometer, it sends commands to Vega's speech system, to give verbal clues and warnings such as:

- Final glide through terrain
- Approaching/passing a task waypoint
- Airspace warnings

The XCSoar user interface also can connect sound feedback to the completion of any command like:

- Marker dropped

3.10 Screen visuals

Certain aspects of the look of items on the screen can be adjusted. The most noticeable of these is whether to display InfoBoxes and gauges in white on black (called inverse colours) or black on white.

3.11 Help system

A help system provides descriptive text for properties in most dialogues.

3.12 Interfacing with gestures

As of version 6.0, XCSoar supports so-called 'gestures'.

To use this feature hold down the finger on the touch-screen (or mouse button at the PC), draw a certain figure and release the touch-screen / mouse button. Depending on the figure that was drawn a certain function is activated. While you draw, XCSoar shows the path as a red line with a soft shadow. The line is slightly transparent while the figure drawn so far is not a known gesture. Once it is, a label at the top of the map names what the gesture does, for example "Zoom in" or "Analysis"; it changes as you continue drawing, and what it names happens when you lift the finger. With haptic feedback enabled, a light

tick tells you that the figure has turned into another known gesture, for example from "Analysis" to "Pan"; lifting the finger to run the gesture gives a stronger one.

A specific gesture is defined by movements of the finger or the cursor in the four directions Up, Down, Left and Right. This means if you drag your finger down and afterwards to the right over the screen, the gesture "DR" is detected, which stands for "Down-Right". It will bring up the waypoint list. The manual indicates an available gesture as shown here on the left side of the text body. Both the blue hand and pictogram of the movement are used to indicate a specific gesture, in this case move down then to the right. A list of generally available gestures is shown below.

Most common or basic gestures:

DU, denoting a check mark: Show main menu

U: Zoom in

D: Zoom out

L: Turn screen page pro-grade (Normal, Aux., Full-screen...)

R: Turn screen page retrograde (Normal, Full-screen...)

URDL, denoting a P: **P**an-mode. Might also be invoked by moving two fingers on the screen. On touchscreens that report both finger positions (Android, iOS, Linux Wayland), pinching zooms the map about the point between the fingers, and twisting rotates it temporarily. A two-finger drag or twist enters pan mode, and the temporary rotation is held until pan mode is left; a pinch that only zooms keeps following the aircraft. The north arrow (compass) in the top right corner of the map is a button: tapping it in pan mode resets a rotated map back to north-up, while outside pan mode it cycles through the available map orientations, briefly showing the newly selected mode. The tap only changes the orientation setting of the currently active flight mode: while circling it cycles the circling orientation, otherwise the cruise orientation. On a dedicated *Map (north-up)* page the orientation is fixed; the compass is not shown there and tapping it is therefore unavailable.

More gestures available:

DR, denoting an L: Show the Select Waypoint dialogue similar to menu item Waypoint **L**ist

RD, denoting a T: opens the **T**ask Manager

DL: show the Alternates List

UD: enables Auto-Zoom

ULDR: opens the Quick Menu

Sophisticated dialogues:

LDR, denoting a C: Show the **C**hecklist.

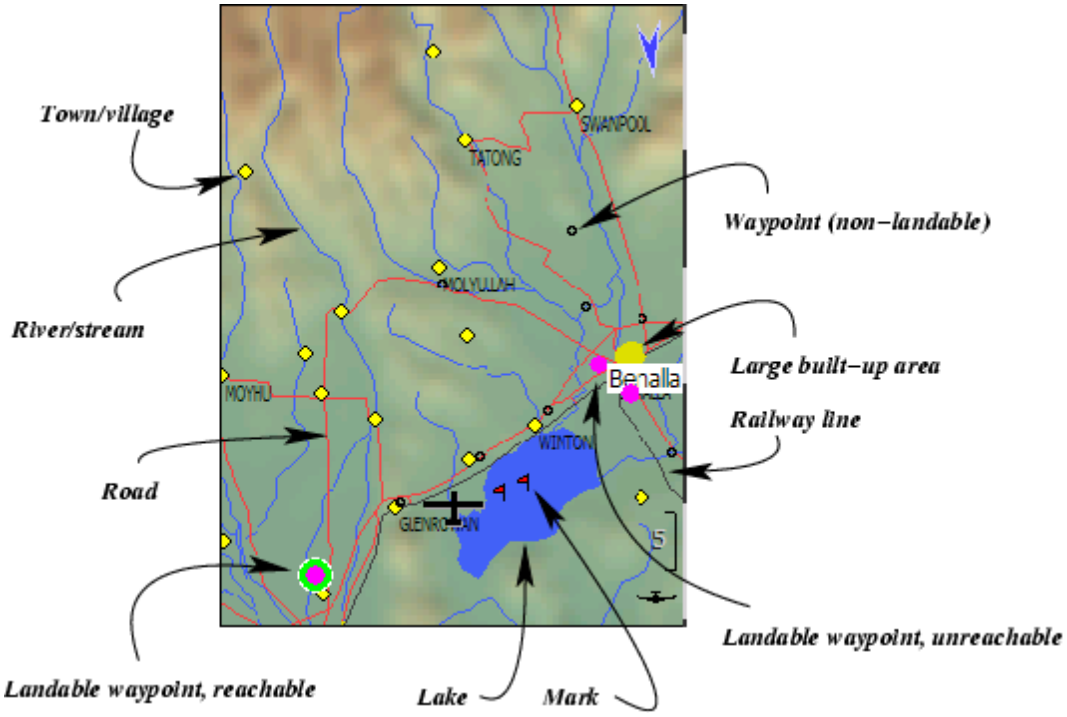
URD, denoting an A: Show the **A**nalysis dialogue.

LDRDL, denoting an S: Open the **S**tatus dialogue

4 Navigation

This chapter describes the moving map display as an aid to navigation, and also describes some of the task and glide related overlays on the map display.

4.1 Map display elements



The moving map shows:

1. Glider, wind indicator, thermal profile, final glide indicator
2. Terrain, relief and hight of the terrain
3. Topography, rivers, roads, towns
4. Waypoints, airports, landables
5. The active task, observation zones, turnpoints
6. The bearing (or route[1]) to the next waypoint, heading
7. Airspaces
8. Markers, thermals history, snail trail

[1] The line to the next waypoint may be a *route*, as described in Section 4.14.

9. Glide range[2]

The map is drawn in a projected coordinate system (not latitude and longitude), and the scale can be changed (zooming in and out), as well as panned. All navigation functions take the curvature of the Earth into account.

4.2 Glider symbol, map orientation

The glider symbol shows the position of the glider on the map. The orientation of the glider indicates the estimated heading of the glider.

13.7

The map is oriented in one of three ways: North up, Track up, or Target up. Configuration settings can be used to specify a different map orientation when in circling mode. This is useful to prevent disorientation when looking at the map while circling. Target-up when circling makes it easy to determine which direction to exit the thermal.

When Track or Target-up is used in circling mode, the glider symbol is centred on the screen, even if the symbol position is configured differently. In cruise mode the Track and the Target-up orientation allows the glider symbol to be positioned (e.g.) 20% from the bottom of the screen, giving a good view of the map ahead of the glider. This position is adjustable in the configuration settings.

13.7

4.3 Zoom and map scale

To change the scale of the map, depending on the hardware you use:

1. Tap/click on a blank part of the map to highlight the map if it is not already selected. Then use mouse wheel, or the device up/down key to either zoom in or out.
2. Android devices have the +/- rocker that let you change the zoom (it usually allows for adjusting the sound volume). It may be difficult to access during a flight, when the device in on a generic mount.

3. You can also gesture to change the zoom level. Gesture Up (see left) zooms in, Down zooms out.
4. Or select the function from the menu.

Display 1 ▷ Zoom In and Zoom Out

The map scale is displayed in the lower left corner of the moving map display. The indicated distance is measured from the left to the right border of the map display. The current InfoBox panel is named beside it: Circling, Cruise or FinalGlide, or the name you gave that panel. A weather-overlay page shows its own title here instead.

[2] The glide range is also referred to as the *reach*, as described in Section 4.12.

Compaq Aero Users. If you enable the Compaq Aero Game Keys (On the Q-menu) the centre two front buttons become the up/down keys.

Circling Zoom

13.7

There is a facility to have two zoom settings; one when the glider is in circling mode, and one in the cruise or final mode. This is the '*Circling zoom*' option in the configuration settings. By default, the circling zoom is set to about 2.5 km - 5.0 km, depending on the display size. When the user zooms in or out, it affects the current mode's zoom setting only, so when leaving the mode the previous mode's zoom setting is used. If '*Circling Zoom*' is not enabled, there is only a single zoom level. This leads to different zoom levels being preserved to be managed manually, independent of the following Auto Zoom settings.

Auto Zoom

Display 1 ▷ Zoom Auto

Auto Zoom automatically zooms in when approaching a waypoint to keep the waypoint at a reasonable screen distance. When *Auto Zoom* is active, 'AUTO' appears next to the map scale.

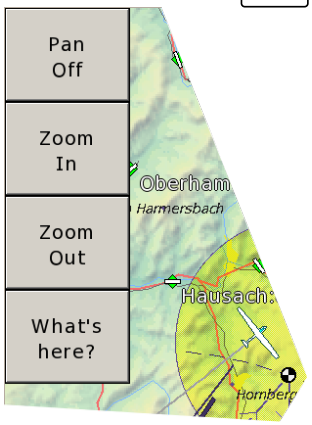
To invoke Auto Zoom use the gesture or menu path depicted to the left. Switching back to manual zoom is simply done by using the same menu path or just zooming manually, no matter whether done via menu or gesture.

When a waypoint changes (automatically, via the task selector, or by manually switching waypoints), *Auto Zoom* adjusts the zoom level automatically so that the next waypoint is visible on the map.

During circling, if a thermal has been detected, then the map is centred about the thermal or part-way such that the glider is still visible.

4.4 Panning the map

Display 1 ▷ Pan On



A pan mode allows the user to explore areas beyond the glider. This is particularly useful when task planning.

1. Enable pan mode by button menu or by gesture. The gesture for this is moving your fingertip up, right, down, left, supposed to form a "P".
2. The map can then be panned by dragging the screen or using the cursor keys.
3. When done, pan mode has to be disabled manually, by pressing '*Pan Off*' from the special sub-menu of buttons in pan mode.

When pan is active, the letters 'PAN' appears next to the map scale. While panning the location of the focus stays in the middle of the display under the cross hairs.

Despite the focus under the cross-hairs the map still offers the '*What's here?*' feature just by touching any position on the map (presuming a touch-screen).

4.5 Waypoints

Waypoints are displayed with different symbols and different options for waypoint label content depending on the waypoint type; the major distinction being landable and non-landable waypoints.

Landables

13.10

Landable waypoint symbols are drawn as shown below. There are three icon sets available for landable waypoints.

Icon set	Landable field	Marginal	Reachable	Airfield	Marginal	Reachable
Purple Circle						
B/W						
Traffic lights						

The *marginal* icons are drawn for those waypoints which are principally in the reach, but it is not possible to approach them directly. E.g. a mountain prohibits a direct approach. A landable outside that reach, but still reachable in a straight glide at best glide, is drawn in orange on the map and in the Alternates list. In the traffic-lights style, orange is already a straight reach that terrain blocks, so best glide is light red.

13.10

Waypoints are optionally labelled according to one of several abbreviation schemes and visibility.

On top of this, landable waypoints can be displayed in more detail. If '*Detailed landables*' is switched on, you get additional information encoded in the appearance of its icon.

1. Landable fields get a square-shaped icon despite what is shown in the table. The square is drawn like a diamond standing on one corner. Airfields stay with the circle shape, so that they become easy to distinguish.
2. All icon sets, including the 'Purple Circle' icon set, get the runway turned into their actual direction. The runway direction has to be available in the waypoint data. E.g. the SeeYou waypoint file format (`.cup`) does include this information.

Extra Data in Landables Labels

13.13

In XCSoar's default configuration, estimated arrival height is shown in the labels next to symbols for reachable landable waypoints. This is one of XCSoar's most powerful features. The displayed arrival height is the arrival height above the configured safety 'Arrival height' (a user setting on the 'Glide Computer / Safety Factors' configuration page). The arrival height calculation takes several things into account, including glider performance (polar), MacCready setting (MC), and wind. Given all the user-configurable options that go into this calculation, unless you fully understand the glide computer's concepts, it's recommended that you use XCSoar's default configuration. Even then, don't assume these calculations are perfect! The pilot should always interpret and understand the values shown and watch their trends over time.

13.10

The 'Arrival height' setting on the 'Map Display / Waypoints' configuration page controls the display of this arrival height and gives other options (e.g., none, arrival height that accounts for any needed detours around terrain, required glide ratio, and certain combinations of these options).

The displayed glide ratio to a waypoint is simply the glider's distance from the waypoint divided by how high the glider is above the minimum desired arrival height, which is the waypoint elevation plus the the configured safety 'Arrival height'. Nothing else is taken into account - no polar, no MacCready setting, no wind - just simple geometry.

13.4

In the default configuration, XCSoar only shows this extra data (arrival height, in the default configuration) for *reachable* waypoints; but if a glide ratio option is chosen, glide ratio will be shown even for *un*reachable waypoints. Also, if a waypoint file is configured as the 'Watched waypoints' file (selected on the 'Site Files / Site Files' configuration page), even arrival height will be displayed for unreachable waypoints (if an 'Arrival height' option including arrival height is selected).

Which is better, arrival height or glide ratio? This is a common topic of discussion among glider pilots. Glide ratio is a more trustworthy value, since it's calculated based on simpler, more trustworthy values; but arrival height more precisely tells you what you really want to know: how high you'll be when you get there. Also, you don't have to watch arrival height as much to look for a trend. With glide ratio, you often need to watch for the trend to see whether you'll make it. Since wind causes your achieved glide ratio relative to the ground to vary with wind speed, wind direction, and flight direction; it's tough to know at any given time what glide ratio relative to the ground you can expect to *achieve*. Maybe you're headed to a landing place where you'd really like to arrive higher than your configured safety 'Arrival height'. If all you see is glide ratio, the most you can know is simply

whether you'll arrive *above* or *below* your configured safety 'Arrival height' - but not *by how much*. In another scenario, maybe all you see is arrival height and it's positive but decreasing slowly as you fly toward the landing place. It would be difficult to figure out whether it's trending downward too quickly for a safe arrival. With glide ratio, though, you could much more easily answer this question. If glide ratio is holding steady or trending down (i.e., to a steeper glide), it looks like you'll make it. More could be said on this subject, but since there are cases when glide ratio is better and cases when arrival height is better, maybe showing *both* is the best option... and is an option XCSoar offers!

Non-Landables

As far as your waypoint file contains information on the nature of the non-landable waypoints, the map will then display specific icons accordingly. Figure 4.1 contains a collection of the currently supported map icons.

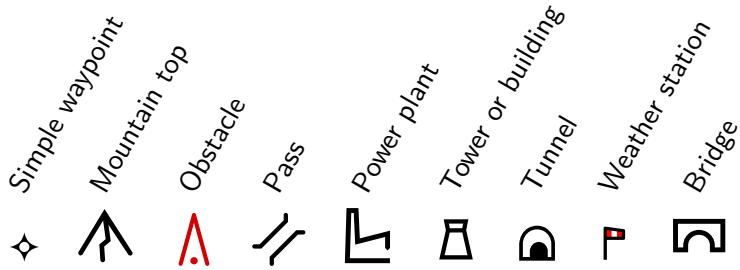


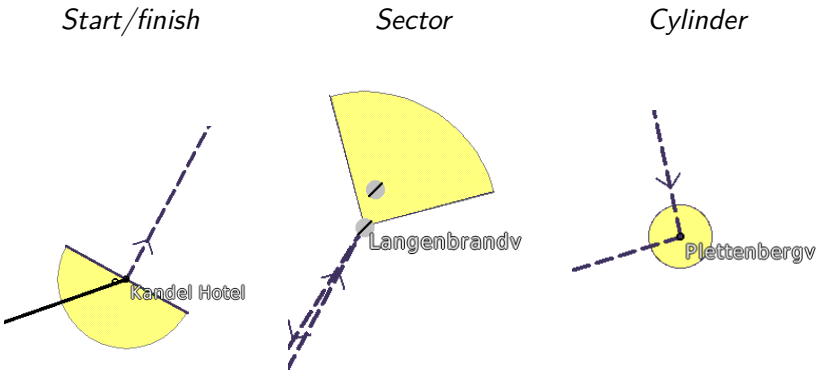
Figure 4.1: non-landables

4.6 Active task

The active task course is drawn on the map as a blue (dashed) line.

Assigned area tasks also show the turn point sectors or areas as a yellow shaded region. Circles are always drawn around start and finish points, lines are only drawn if the start/finish points are of line type. Task observation sectors are drawn as circle segments.

At all times a thick black line is drawn from the glider to the next waypoint in the task. This line may be the direct path to the waypoint, or may be a *route* path clearing terrain and airspace obstacles, described in further detail in Section 4.14.



4.7 Terrain and Topography

The following topographical features are drawn on the map:

- Major roads, shown as red lines
- Rivers, shown as blue lines
- Large water bodies (lakes), shown as blue areas
- Large cities, shown as yellow areas
- Small population areas, shown as yellow diamonds

Cities and small population areas are labeled in italics.

Terrain is coloured according to elevation, and optionally shaded by sun, or wind direction. Invalid terrain, or terrain below sea level is coloured blue.

Display 2 ▷ Terrain On/Off

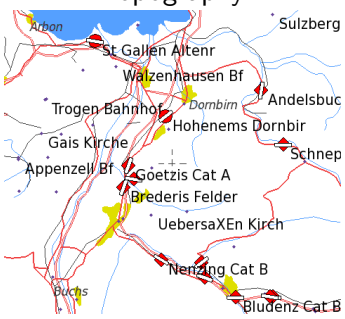
Terrain is shaded to improve visibility. The default shading is set up so that the virtual lighting position is the wind bearing, thus brighter areas are on the upwind side of hills and dark areas in the lee of the hill. Support for a sun ephemeris is also implemented. If the slope shading is set to 'Sun', the brightness of a slope follows the day time in a very natural way. The amount of shading and overall terrain brightness is configurable.

Display 2 ▷ Topo. On/Off

13.9

Both terrain and topography display can be switched on or off from the menu.

Topography



Terrain

If the terrain data is not available (or terrain display is turned off), the background colour of the map window is white. All terrain below mean sea level is coloured blue. If you are flying outside the terrain region, the background colour will be white.

Map labels

Display 2 ▷ Labels None

The screen can be de-cluttered, turning off the display of all waypoint labels by toggling the '*Labels*' menu.

Other options for display decluttering include:

Labels Task & Airfields

Shows labels for the waypoints in the active task and any airfields (based on the waypoint attributes in the waypoints file). Other waypoints are shown but not labeled.

Labels All

Shows labels for all waypoints.

Labels Task & Landables

Shows labels for the waypoints in the active task and any landable fields (based on the waypoint attributes in the waypoints file). Other waypoints are shown but not labeled.

Labels Task

Shows labels only for waypoints in the active task

13.10

Note that in all cases, the label format is configurable in the '*Waypoint Display*' configuration menu.

4.8 Trail

An optional 'snail trail' is drawn on the map showing the glider's path history. The colour and thickness of the trail depends on the altitude or on the variometer value.

If Vega or an intelligent variometer is connected with Netto output, the Netto vario value is used; hence the colours and thickness of the trail indicates the air-mass vertical movement rather than the glider's vertical movement.

13.6

The snail trail display can be toggled between *Off*, a *Short* trail (about ten minutes), a *Long* trail (about one hour) or a *Full* trail which

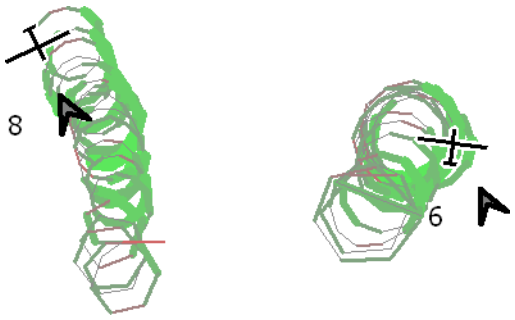
Display 2 ▷ Trail Full

displays the entire flight. This can be performed permanently through the configuration settings or temporarily by the menu.

Note that for all of these modes, the snail trail is short in circling mode in order to reduce screen clutter.

In order to assist centring thermals in the presence of wind, the snail trail can be artificially drifted with the wind as it is displayed (this is drift compensation). In this way, the snail trail is referenced to the prevailing wind rather than referenced to the ground. Since thermals drift with the wind also, the drifted trails give a better indication of where the glider has been relative to the thermals.

An example of this is illustrated below. Note that when trail drift compensation is active (right picture), the glider appears to be circling in a column rather than an elongated spiral (left picture).



13.6

Config 1 ▷ Wind

Enabling trail drift compensation is performed through the configuration settings. The compensation is only performed whilst in circling mode; the display of the trail in cruise mode is unaffected. This can also be performed from the wind settings dialogue.

The trail drift display is useful also to show more clearly when thermals are cranked due to wind shear.

13.6

The trail width can optionally be scaled according to the variometer display.

4.9 Markers

Nav 2 ▷ Mark Drop

Markers are shown as small flags (a) on the map. The markers can be dropped manually, by pressing a button, or automatically. An example use of automatic markers is to drop markers when entering circling mode, as a simple way of showing all thermals encountered.

Markers are not preserved after XCSoar is exited, however the location of all marks are appended to the file `xcsoar-marks.txt`.

4.10 Pilot Event

A Pilot Event (PEV) system allows pilots to mark particular times during a flight, such when inside a Turn Point Observation Zone (TP

Nav 2 ▷ Pilot Event

13.18

OZ). Also, when configured, it allows to initiate a special *Pilot Event* task start protocol[3].

When pressed, XCSoar will internally track the window open and close times, according to configuration defined in Task Rules (See 5.6): start window will open after *PEV start wait time* minutes and will be open for *PEV start window* minutes. The start open/close countdown will be displayed in the *Start open* and *Start reach* infoboxes. Make sure to have one/both visible to effectively calculate your start.

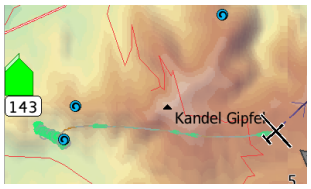
Also, *Pilot Event* will be announced to connected devices, allowing loggers to register it without pilot pressing the physical button on the logger device itself. This might be useful when logger is located outside of pilot reach (e.g. behind the panel). It is recommended to check on your device's manual whether it supports external PEV declaration -some older loggers may not-.

In order to start a task when *Pilot Event Start* is used, press the *Pilot Event* button, wait for *PEV start wait time* and then cross the start line within *PEV start window* minutes.

It may be useful to have *Start open* and/or *Start reach* InfoBoxes visible to effectively use the *PEV Start* procedure.

Note that the start window created by pressing the *Pilot Event* is "soft", as it is only informative to the pilot via the infoboxes mentioned above. XCSoar will still compute a valid start if one is performed outside of the PEV window -just like it would be scored in a competition-. In contrast, the task settings *Start open/close time* in 5.6 define a "hard" window, outside of which a start will not be computed.

4.11 Thermals



While climbing in thermals, a marker is automatically generated showing the thermal location on screen. The positions of the last 20 thermals are stored until the end of the flight. This thermal history is accessible through the map element functions in the same way as markers or waypoints.

4.12 Glide range line

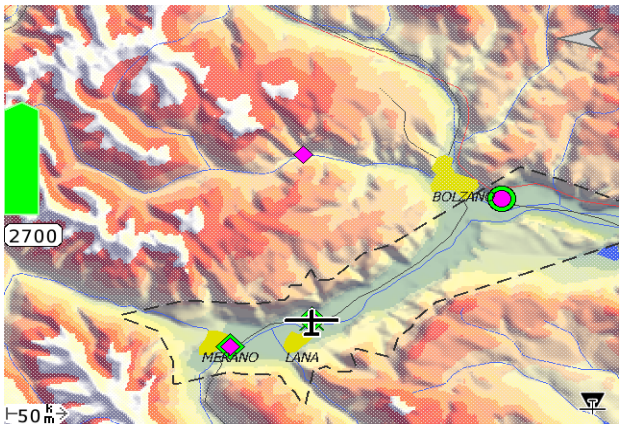
A reachable glide 'footprint' is displayed on the map as a dashed line, indicating where the glider would descend through the terrain clearance height (terrain reach). Reach display can also show a working line: how far the glider can fly and still arrive at typical thermal-base height from this flight. The reach shows clearance tracks extending in all directions, optionally including paths around terrain obstructions.

[3] PEV start procedure may be used in competitions to reduce mass starts, gaggles and following.

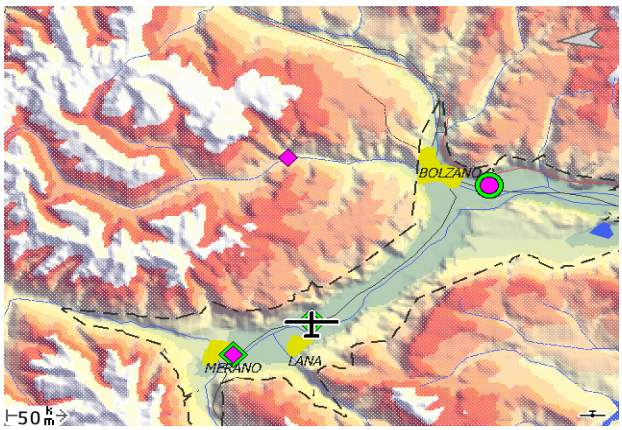
This feature is useful in assessing range with respect to topography when searching low for lift, and when flying in mountainous areas.

13.12 Reach calculations may be configured to two levels of detail:

Straight line : If turning reach is disabled, then the reach shows the furthest distance the glider can fly in final glide in all directions without turning. This reach appears as a closed ring around the glider.



Turning : If turning reach is enabled, then the reach shows the greatest area the glider can reach in all directions, even allowing turns around obstructions.[4] The reach area appears as a closed ring around the glider but may also include holes indicating mountain peaks that the glider cannot reach without further climb.



13.12 The display can be configured to additionally blur the unreachable area outside the glide range. The final glide path is checked for whether the glider clears terrain along the path by the terrain clearance height (see Section 6.9). If clearance is not attained, a red cross appears on the map at the point where the violation occurs. If a target is defined the calculation is done along the straight path to the target. If no target is defined the calculation is done along the current heading.

[4] The maximum number of turns is set to three, and no turns may be greater than 90 degrees.

If reach is enabled, then the reachability of landable waypoints is used by the abort task mode, alternate landable option lists and display of landable waypoints on the map.

Note that task calculations are otherwise unaffected by reach calculations — for example, altitudes required as shown in the final glide bar or task data as displayed in InfoBoxes do not take reach into account.

Furthermore, terrain reach is used for the footprint, landable waypoint colours, abort mode and the Alternates list. The MacCready used in these calculations is configurable:

13.12

Task MC : The live task MacCready (the same value as speed-to-fly).

Safety MC : A separate MacCready for conservative reach. Default is 3.2 m/s, about 25:1 on the default LS-8 polar. Higher values treat fewer fields as reachable. The Safety MC speed is not limited by maximum cruise speed. Speed-to-fly still stops at maximum cruise speed.

The working line always uses Task MC. Alternate InfoBoxes and the waypoint Alt. diff. Safety MC figure always use Safety MC, even if Reach polar is Task MC.

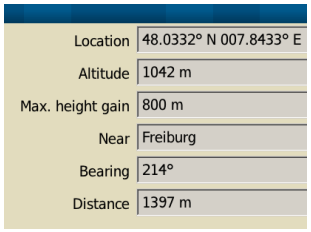
4.13 Status tabs '*Flight*' and '*Time*'

The status dialogue is a multi-tabular dialogue giving overview information on the flight, system, task, rules and times. These are information, and hence cannot be modified by the user. It is accessed via the gesture "S", or with the button menu.

Left - Down - Right - Down - Left

Info 2 ▷ Status

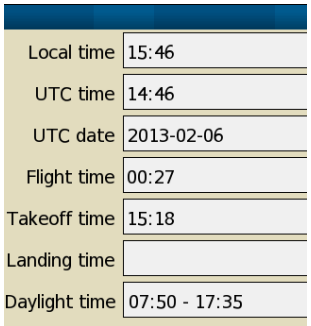
Flight



Select the tabular page '*Flight*'. The flight status dialogue shows the status of the aircraft's locality. It shows the location of the aircraft, the maximum height gain, and nearest waypoint it's bearing and distance.

You may find this function useful when you need to report your location to others.

Times



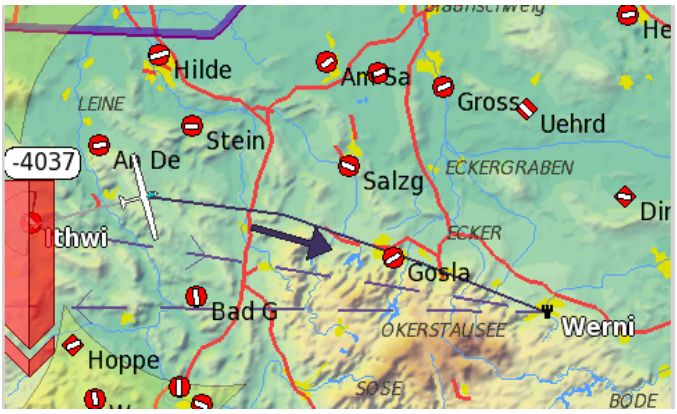
Select the tabular page '*Times*'. It shows the local time, UTC time and date, flight duration, takeoff and landing time, and the local sunrise and sunset times.

Note that the values in the Status dialogue are static once the particular dialogue page is displayed. That is, position, times, etc. do not update while the page is displayed. To see the updated values, it

is necessary to select a different tabular, then return to the previous dialogue to see the new values.

4.14 Route

XCSoar can plan paths around terrain and airspace obstacles in three dimensions from the aircraft to the destination. Such a path is known as a route. The height of the destination is the arrival height for final waypoints, or may be higher for intermediate waypoints, as dictated by the task system as required to complete the task. Route planning functions in normal ordered task mode, abort mode and goto mode.



Routes take into account the glider polar performance and are calculated to be optimal in the sense of minimum time. By default, route calculation is disabled, and can be enabled for terrain only or terrain and airspace avoidance.

13.12 13.13

Terrain is avoided vertically by the terrain safety height,with no additional lateral clearance imposed. Valid routes may result in the aircraft arriving at the destination higher than the minimum height — such as can occur when the destination is just beyond a steep mountain.

Airspace is avoided horizontally by a buffer of approximately 250 m, with no additional vertical clearance imposed. Valid routes may fly below or above airspace.

If MacCready is positive, then climbs are optionally allowed in the computed routes. The top of the climb may be limited to 500 m above the higher of the start and destination ceiling, or increased to the ceiling defined by the thermal ceiling. Climbs above the higher of the start and destination altitude are penalised by a slower climb rate than the actual MacCready value.

13.12

Some approximations and limitations of the route planning system are as follows:

- Where climbs are necessary (and permitted) to reach the destination, the climbs are assumed to occur at the start of the route.

- Climb-cruise segments are assumed to occur at constant altitude, equivalent to many small climbs distributed along the path.
- Individual turns between path segments greater than 90 degrees are not permitted.
- Failures of the solver result in the route reverting to direct flight from the aircraft location to the destination.

5 Cross Country Tasks

XCSoar provides a full task management system, in which tasks can be edited prior to flight and, when undertaking casual cross-country flying, modified during flight. Waypoints are advanced automatically or may be cycled through manually. Many of XCSoar's computations relate to either turnpoints or the finish waypoint. Unless a "true" task is defined, XCSoar will provide a "go home" function, with many of the task related functions referring to the location of takeoff. This chapter also describes the use of IGC loggers with XCSoar.

There are three task modes available:

Ordered task : This is the natural cross-country task type, in which the task consists of a start point, zero or more waypoints, and a finish point. The task points are to be flown in order.

Goto task : Flight to a single destination.

Abort task : Provides options to fly to the nearest landing points.

Note that in goto and abort modes, the ordered task is retained and may be resumed later, preserving any statistics about achievement in the task.

Automatic goto

If no ordered task is defined, then on takeoff, a goto task is automatically established with the takeoff point as the destination, or the nearest airfield if it was close to the takeoff point.

Whether or not a task is defined, the takeoff point is always generated and appears in the waypoint list for later reference or use.

After having defined an ordered task for the very first time, the automatic "goto takeoff" function is skipped. To resume a simple task, use goto.

5.1 Goto tasks

Goto tasks may be established by selecting a waypoint from the map, the waypoint list, or any other mechanism e.g. the alternates dialogue, and select GoTo . In goto task mode, selecting Nav 2 ▷ Task Resume resumes the ordered task (if any).

If the Goto destination has no known elevation, bearing and distance are still shown. Arrival height, the required glide ratio, time estimates and the final-glide bar are left blank. The point is not treated as being at sea level.

5.2 Editing tasks

You can edit tasks in several ways. Some methods are more useful for editing prior to flight, and others allow tasks to be modified whilst in flight for casual cross-country touring. Tasks can be saved to files and reloaded later, and can be transferred between any XCSoar platform (Android, iOS, Windows, Linux, macOS…).

It is also possible to save a 'default' task and have this task loaded automatically upon start-up of XCSoar. One application of this is to set up a default task with one waypoint being the home — this means that XCSoar is then programmed for final glide back to home, which is useful for casual cross-country touring.

The main ways of setting tasks are the following:

- Using the task editor dialogue
- Selecting waypoints from the map and adding them to the task from the airfields/ waypoint details dialogue
- Loading the task from a file

Loading a task from file may be useful in competition or casual cross-country flying in groups, as one person can distribute the task file to others, thereby saving effort on editing the task severalfold. If no task is present at startup, a task is created automatically, containing one waypoint takeoff as "goto home".

XCSoar saves the current task when shutting down and loads it at startup, thereby allowing the task to be entered early in the day, then the device running XCSoar can be turned off until flight time.

Task waypoints are preserved even if the waypoint file is changed. This means, if you save a task, then change the waypoint file, then load the task again, new waypoints are generated for any waypoints that are missing in the new waypoint file.

5.3 Waypoint Information

The waypoint info dialogue describes a waypoint in detail and has navigation functions such as GoTo, insert, append to the task, or set the waypoint as the new home. This may be accessed in several ways:

or menu Nav 1/2 ▷ Task , highlight a waypoint, then tap the highlighted waypoint again to display the task point dialogue, then push Details .

or menu Nav 1/2 ▷ Alternates to show the details of the landables nearest to the aircraft.

or menu Nav 1/2 ▷ Waypoint List , highlight and select a waypoint to show its details.

or menu Display 1/2 ▷ Pan On to put the map into pan mode, pan

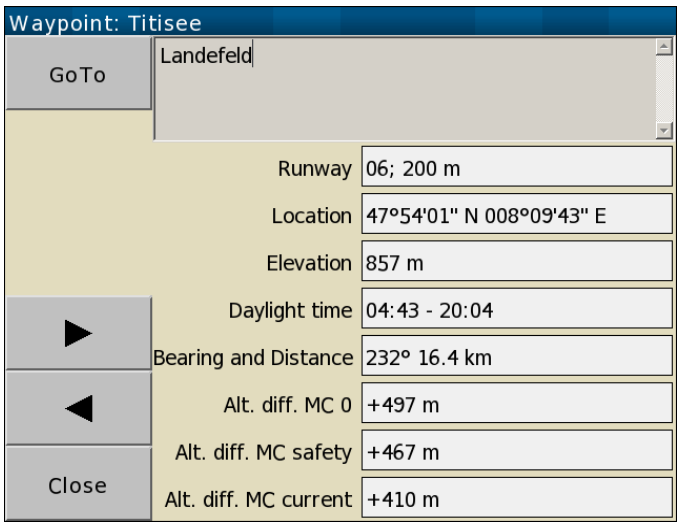
to the desired waypoint, touch its name or the waypoint symbol.

Info 1/3 ▷ What's here? to show the item list under the cross-hair, or your index finger on the map.

The airfields or waypoint details dialogue contains two major pages (accessed via the > and < buttons). Depending on the availability of further details of the waypoint they will by shown on extra pages.

Waypoint details

This page contains text giving the name of the waypoint, the waypoint's GPS coordinates, elevation, radio frequency and runway information (if this information is in the waypoint file), local daylight time, bearing and distance to the waypoint, and the altitude differences required to reach the waypoint as described below. In addition, there is a button GoTo to directly initiate navigating to this waypoint. The button cancels the current task.



As mentioned above, the Waypoint info dialogue also shows three forms of altitude difference (additional altitude required to reach the waypoint at the safety height) for the corresponding waypoint:

Alt diff MC 0 : Altitude difference at MC setting of 0

Alt diff Safety MC : Altitude difference at Safety MC. This always uses Safety MC, even if Reach polar is Task MC.

Alt diff Task MC : Altitude difference at the live Task MC, the same value as speed-to-fly.

From the main Waypoint Info screen, you can access the second page by using the > and < buttons in the bottom left corner of the page. Depending of the type and number of details available for a waypoint, other pages could be available.

Task actions menu

This page contains a column of buttons allowing various actions to be performed:

Replace in task : replaces the active waypoint in the task with the selected waypoint.

Insert in task : inserts the selected waypoint before the active waypoint in the task.

Append to task : adds the selected waypoint to the end of the task.

Remove from task : removes the selected waypoint from the task. Note that this option is only visible if the selected waypoint is included in the active task.

Set as new home : sets the waypoint as the home airfield.

Pan to waypoint : switches to pan mode and pans to that waypoint.

Set Active Frequency :

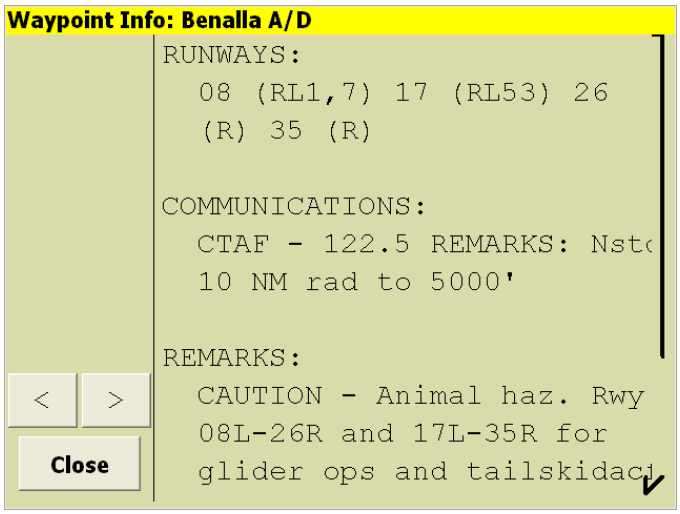
Set Standby Frequency :

Edit : allows to change the various attributes of the selected waypoint

It is a good idea to set your home waypoint from the airfields or waypoint details dialogue. This causes XCSoar to start up at the home location regardless of whether a GPS fix is received. If no home is set, then XCSoar starts in the centre of the terrain map.

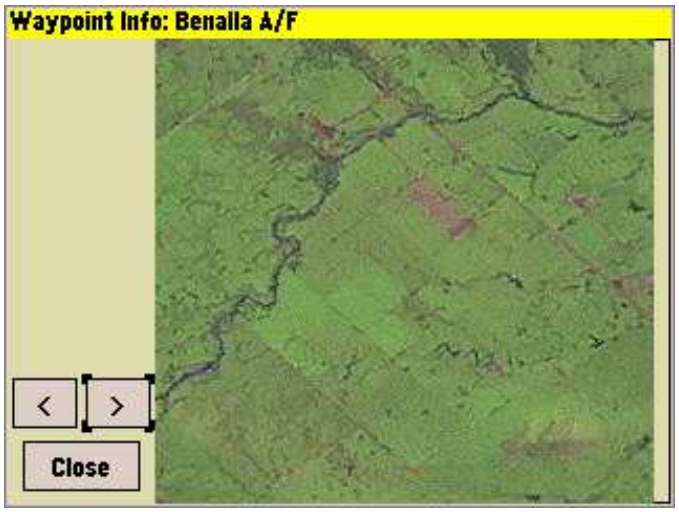
Airfield information

This page may contain relevant text from the en-route supplement about the airfield, including runways, radio frequencies, traffic patterns, contacts. See Section 14.5.



Waypoint details image

This page shows a satellite image of the waypoint.



How to set up the detailed waypoint information read Section 14.5.

5.4 Waypoint selector dialogue

Nav 1/2 ▷ Waypoint List

The waypoint selector is a dialogue that allows waypoints to be easily selected from a potentially large database.

Invoking the selector brings up a filtering dialogue screen with a set of optional filters on the left side of the page, and a list of waypoints on the right, matching all of the filtering conditions set. There are several filters available, which may be used together, individually or not at all.

Name : Selects waypoints, starting with the string typed.

Distance : Filters out waypoints farther than a specified distance from the aircraft.

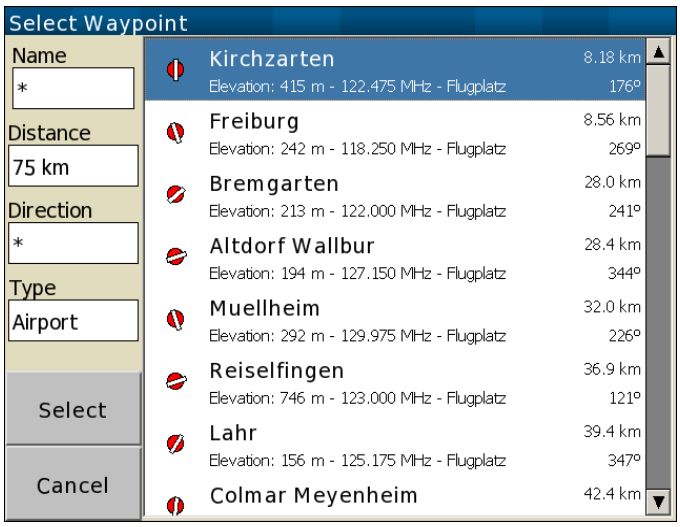
Direction : Filters out waypoints that are not in a specified direction from the aircraft. An additional special direction "HDG(xx°)" ("HDG" stands for "heading") filters waypoints within 30 degrees to either side of the heading of the glider. This allows the pilot to point the glider at a group of waypoints and quickly find them.

Type : Filters out waypoints that are not of the specified type (Landable point, Airport, Turnpoint, etc.) or that appear in the specified File 1 or File 2 (primary or secondary waypoint file respectively), or in recently-used files. Recently Used lists the waypoints whose details were opened or which were selected as Goto target, the most recent first.

The filters are kept when the selector is opened again. Waypoint selections from other dialogues do not change them.

The Left-Up gesture opens the same dialogue with the title Recently used waypoints. It lists the same waypoints as the type *Recently Used*, and all filters only search these waypoints, not the whole waypoint database. For example, Type Airport shows the recently used airports.

When filtering by name and type, the list of matching waypoints is sorted by name. When (in addition) filtering by distance or direction, the list of matching waypoints is sorted by distance.



The list can be scrolled if there is more than one screen full of matching waypoints. To scroll through the list, simply drag with the finger, or move to the bottom (or top) of the list with the cursor.

Selecting an item will result in different behaviour depending on what function opened the waypoint selector. In typical use it brings up the airfields or waypoint details dialogue for the selected waypoint.

5.5 Task manager

Nav 1/2 ▷ Task

The task manager is used to edit, view, load, save to file, and declare cross country tasks.

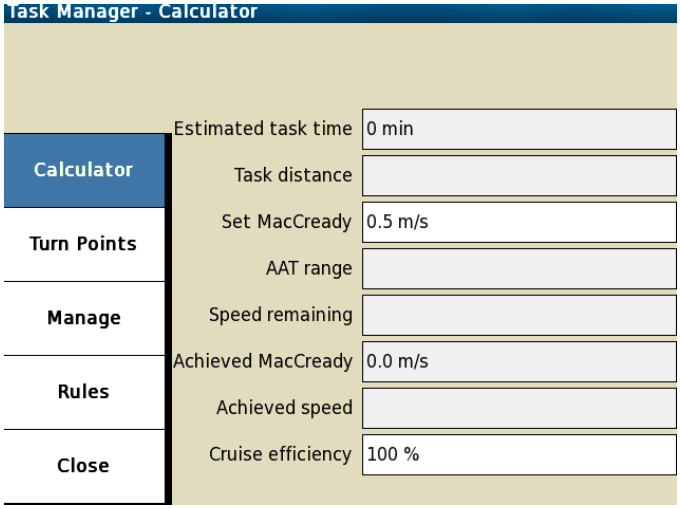
The primary page is a calculator. It shows various calculations related to the active task, as described in detail below. In addition, there are buttons for invoking dialogues Turn Points , Manage , WeGlide and Rules , as well as a button to Close the task manager.

Task calculator dialog

Calculator

The task calculator dialogue allows the pilot to see the effect of various changes to the task on final performance.

In flight the Task Calculator might also be accessed from the Analysis pages. With pages Task, Climb, and Task Speed a button Task Calc comes up, that directly changes to the Task Calculator screen.



Estimated task time : This field displays the estimated total time on task to complete the task at the provided MacCready setting.

Remaining task time : This field displays the time remaining to complete the task.

Task distance : This field displays the total task distance.

Remaining distance : This field displays the remaining distance to complete the task.

Speed estimated : This field displays the estimated average cross-country speed for the task as of task completion, assuming flying the rest of the task at the provided MacCready setting.

Speed average :

Set MacCready : Allows the user to adjust the MacCready value and see the effect it has on the estimated task time.

AAT range : Allows the user to adjust the targets within the remaining AAT areas, to see the effect it has on estimated task time and task distance.

Speed remaining : This field displays the estimated speed for the remainder of the task at the provided MacCready setting.

Achieved MacCready : This field displays the achieved MacCready value.

Achieved speed : This field displays the achieved speed

Cruise efficiency : 100 % indicates perfect MacCready performance, greater than 100 % indicates better than MacCready performance is achieved through flying in streets. Less than 100 % is appropriate if you fly considerably off-track. This value estimates your cruise efficiency according to the current flight history with the set MC value. Calculation begins after task is started.

See Section 6.12 for more details on task speed and achieved MacCready calculations.

On closing the dialogue the entered MacCready value is used as the MacCready setting. If the Cancel button is pushed, the MacCready setting is unaffected.

The Target button, for AAT tasks, adjusts the range (increases or decreases) so that the estimated task time exceeds the assigned task time by less than five minutes. The range is adjusted target-wise. In typical use, all targets are set to "auto" that means the pilot does not have to manually adjust the range to find the course for arrival at the assigned task time, thereby reducing pilot workload.

Turn Points

Turn Points

This page displays an ordered list of the points in the current active task. If there are no waypoints in the active task, there will be only an option to "Add Turnpoint." By highlighting (tapping) the "Add Turnpoint" function, then tapping in the highlighted region, the waypoint selector is displayed, as described above. Highlighting a waypoint from the list and then tapping on the highlighted region adds the waypoint to the task.

Manage

Manage

This page allows for invoking all operations needed to create new or manage already defined tasks.

New Task — Clears the current task and resets the task rules to the default values.

Declare — If an external logger is connected, this will allow uploading the active task to the logger and declaring it.

Browse — Displays a list of all the saved tasks, allowing the pilot to load a previously saved task. Note that this option will overwrite the current active task.

Save — Saves the current active task. Upon tapping the Save button the pilot will be prompted to enter a file name for the task to be saved.

Show QR Code — Shows the current task as a QR code that another XCSoar can scan, with the swift in the centre. A saved task shows its name under the code. An unsaved task is labelled "XCSoar task". The code is the XCSoar task, so a start line, a sector, a keyhole and the task rules are kept. A task that is too large for that code is shown as a SeeYou CUP code when the zones can be described that way: lines, cylinders, sectors and the common BGA areas. When that also does not fit, and every zone is a cylinder, it is shown as an XCTrack code. An empty task is not shown.

Scan QR Code — On Android, opens the camera and imports an XCSoar, SeeYou or XCTrack task QR code into this task manager. The phone camera can open any of these codes and start XCSoar when it is not already running.

WeGlide

WeGlide — This page loads tasks from WeGlide. Each list button opens the WeGlide settings when WeGlide is switched off or the pilot id and date of birth are missing.

Download Declaration — Downloads the task declared on WeGlide and loads it into the task manager.

My Tasks — Lists the tasks of the configured pilot.

Declared Tasks — Lists tasks declared on WeGlide.

Competitions Today — Lists today's competition tasks.

Recent Scores — Lists tasks from recent scores.

Scan QR Code — On Android, opens the camera and imports the QR code WeGlide shows for a task. That code is an XCTrack task.

Choosing a task from one of those lists loads it into the task manager.

Rules

Rules — The values in the menu depend on the task type selected. Clicking any existing value will bring up another menu allowing the pilot to select a different value for this rule. Task types are discussed in more detail below.

Also, tapping on the Rules button again after it is highlighted allows toggling between a "thumbnail" view of the task map and a larger view of the task.

5.6 Task types

XCSoar currently defines three different task types: Racing, AAT, and FAI badges/records.

A brief description of the task types is included below, but this manual does not intend to rephrase FAI rules or contest task types. The reader is encouraged to become thoroughly familiar with each task type by referring to contest rules or FAI rules, which are available at http://www.fai.org.

Racing

(also known as an "assigned task"). The racing task involves flight around each specified turnpoint in the specified order. Selecting the

racing task type allows the pilot to enter the following parameters (note that if the option "FAI start/arrival tasks" is "On", only part of these options is available) :

Arm start manually : If set to "On", some extra buttons are presented in order to let you Arm start as well as Disarm start in menu Nav 1/2 , controlling the detection of the start condition.

Navigate to nearest point : If set to "On", XCSoar aims at the nearest point of the start and finish zone instead of the point which makes the task shortest. See Section 5.7.

Start open time : This is the time when the start zone opens.

Start close time : This is the time when the start zone closes.

Start max. speed : This is the maximum speed allowed in the start observation zone. This should be set to 0 if there is no limit.

Start max. height : This is the maximum height above the start height reference (AGL or MSL) at which a task can be started. Type the height (up to 30,000 in the current altitude unit), or set it to 0 for no limit.

Start height ref. : This specifies whether the maximum start height is referenced to ground level of the start point ("AGL") or Mean Sea Level ("MSL")

Finish min. height : This is the minimum height based on the finish reference (AGL or MSL) at which a task can be finished. Type the height (up to 30,000 in the current altitude unit), or set it to 0 for no limit.

Finish height ref. : This specifies whether the minimum finish height is referenced to ground level of the finish point ("AGL") or Mean Sea Level ("MSL")

PEV start wait time : This specifies an interval in minutes between the pilot presses the *Pilot Event* (see 4.10) button and start window opens. If set to 0, the start will open immediately after *Pilot Event* button is pressed.

PEV start window : This specifies an interval in minutes during which the start window remains open when *Pilot Event* (see 4.10) start procedure is used. If set to 0, the start window, once opened, remains open forever.

Assigned area task (AAT) and Modified area task (MAT)

(also known as "Turn Area Task", or TAT). This is a task through assigned areas (restricted to cylinder or sector observation zones). A minimum task time applies. Rules options for this task type include:

AAT min. time : This is the required minimum time for the task. Refer to contest rules or consult an expert for penalties associated with finishing prior to the minimum time.

Other rules : All other rules stay the same as in case of task type "racing".

FAI badges/records

The selection of this type of task allows to define the value of the following field:

FAI start/finish rules : If set to "On", only the type of start, and the start and end times might be set. If set to "Off", all other racing task rules might be altered from the FAI standard.

Once the appropriate task type has been selected and start and finish rules have been defined as described above, it is necessary to define the properties of each waypoint in the task.

Once selected, waypoints can be moved with the Up and Down arrows. The first waypoing is automatically set as a start point, and the last as an arrival point.

5.7 Turn Points' task rules

Turn Points

The Turn Points dialogue brings up the list of waypoints in the task. If no waypoint is already defined, this screen will show an empty list. With (add Turnpoint) , up and down arrows, and Make Finish an ordered list of waypoints is created. Waypoints can be start point, turnpoint, or finish point. Highlighting any waypoint on the list and either tapping it again or touching the Edit Point button brings up the waypoint definition. Touching Change type will bring up a menu of the various task point types available. Definitions of each point type are given below.

A variety of task rules may be used when specifying tasks, including the common FAI triangles and Assigned Area Tasks (AAT). Many aspects of the rules can also be customised.

Starting and finishing lines are centred on their associated waypoint and aligned perpendicular to the next and previous waypoints respectively.

Sector turn-points are 90-degree segments aligned to the bisection of the previous and next waypoints, as commonly used in FAI tasks. There is also support for British BGA, and German DAeC sectors.

Start point types

The conditions to be met for a valid start depend on the type of start:

Start Cylinder : When the glider leaves the cylinder area.

Start Line : When the glider crosses the start line.

Turnpoint types

The conditions to be met for a valid turnpoint pass depend on its type:

FAI Sector : When the glider has entered the observation zone (OZ), defined by a segment and radial distance from the waypoint. The segment is defined by a 90-degree arc centred about the bisector of inbound and outbound legs, with a distance of 20 km.

Keyhole Sector (DAeC 0.5/10 sector) : When the glider has entered the observation zone, defined by a segment and radial distance from the waypoint. The segment is defined by a 90 degree arc centred about the bisector of inbound and outbound legs, with a distance of 10 km. The observation zone also includes a cylinder of 500 m.

BGA Fixed Course Sector : When the glider has entered the observation zone defined by a segment and radial distance from the waypoint. The segment is defined by a 90-degree arc centred about the bisector of inbound and outbound legs, with a distance of 20 km. The observation zone also includes a cylinder of 500 m (British rules).

BGA Enhanced Option Fixed Course Sector : When the glider has entered the observation zone defined by a segment and radial distance from the waypoint. The segment is defined by a 180-degree arc centred about the bisector of inbound and outbound legs, with a distance of 10 km. The observation zone also includes a cylinder of 500 m (British rules).

Turnpoint Cylinder : When the glider has entered the observation zone defined by a radial distance from the waypoint.

Symmetric Sector : A Symmetric Sector of a circle with a custom radius and angle. The sector is centred about the middle of the inbound and outbound legs.

Area Cylinder (AAT) :

Area Sector (AAT) : When the glider has entered the observation zone defined by the radial distance from the waypoint, and segment for sector areas.

Finish point types

Task completion depends on the finish type:

FAI finish quadrant : A 90 degree sector with a radius of one kilometer. Cross edge to finish.

Finish line : When the glider crosses the finish line.

Finish cylinder : When the glider enters the cylinder area.

Automatic advancement is triggered whenever a condition is met. To start an AAT, mixed task, or Racing task the start has to be armed before.

Competition rules may be defined in a profile file for distribution to a group of pilots or task-setters, so all competitors are playing by the same rules!

Additional task rules for valid starts and finishes may also be specified. Starts may have a defined maximum altitude above ground, and a maximum speed. Finishes may have a minimum altitude above ground. These parameters are defined in the page "Default Task Rules" in the configuration settings in Config ▷ Task in the panels "Task Rules" and "Turnpoint Types". For non-AAT tasks, an option is available to set the minimum finish altitude according to the FAI rule, whereby the minimum finish altitude is above 1000 meters below the start altitude.

13.18

The page "Task Rules" also carries the option "Navigate to nearest point", which is "Off" by default. Normally XCSoar aims at the point of the start and finish zone which makes the task shortest; on a line that is its centre or one of its ends. While the option is set, it aims at the nearest point of the zone instead, which moves as the glider moves, so the distance, the estimated time and the arrival height describe the place the glider is going to cross. The bearing line on the map, the airspace warnings along the leg and the waypoint sent to devices which receive the next waypoint (for example a CAI L-Nav or an LX160) follow that point too. Task distance, its optimisation and scoring are unchanged. A sector is left alone, and so is a cylinder the glider is already inside, where the nearest point of the rim is the wrong way out. On a start cylinder the distance and the estimates therefore change once as the glider enters it.

The arrival height is measured against the elevation of the waypoint, which is not necessarily the elevation under the nearest point.

The option is stored in the task. The "Task Rules" page sets the default for new tasks and for a task read from a file which carries no such attribute; the "Rules" page of the task manager changes the task in use.

5.8 Start a task

One the waypoints (start, turn points with their special features, finish) and task rules defined, there are two things to do:

- In the panel "Manage", press on Save to save the task by giving it a name. If you have just modified an existing task, you can either give it the same or give it another name (to create a new task based on an already-existing one).
- Press on the item Close of the task manager. After the creations and changes done, the displayed windows may differ. You can choose between Close to use the task you have just modified or created. The button Revert Changes allows to discard the changes and continue with the task that was previously

loaded. If you have created and saved a new task, it will not be most: you could find it later on in you list of saved tasks. However, the activated task would have been erased from the working memory. You will have to reload the task that you wish to do.

Si you push on Close , the task is started (activated).

5.9 Advancing and restarting tasks

At all times one waypoint in the task is designated as the active waypoint. The active waypoint is used for calculation and display of navigation information, that is, the pilot is directed to fly towards the active waypoint (also referred to as the "next waypoint" in the description of InfoBoxes as in Chapter 12).

During flight a continuous display of the bearing to the next waypoint is shown.

The altitude required to complete the task is calculated for the route starting from the glider's actual position going through the task's turnpoints to the final waypoint.

Changing the active waypoint is performed automatically, or may be performed manually. The start point of racing tasks, and AAT task points, are special cases that require the task point to be "armed" before the system will automatically advance to the next task point once that point is reached. All other task points will automatically advance to the next point as soon as the last point was reached.

For non-racing tasks, no user interaction is required to advance through the task — the system will automatically advance as each task point is achieved. The user may still manually advance or retreat the active task point by selecting the menu items Nav ▷ Previous turnpoint and Nav ▷ Next turnpoint respectively.

The menu items Previous turnpoint and Next turnpoint show dynamic labels that indicate the action that will be performed upon selecting the item.

For task points requiring arming, Next Turnpoint becomes Arm turn if the turn is not armed; if it is armed, then it becomes Next Turnpoint allowing for manual advance. Previous Turnpoint changes to Disarm turn if the turn is armed and vice versa. Similarly, for racing tasks these menu items update for arming start points. If the Next Turnpoint is the Finish Turnpoint , the menu label changes accordingly.

Status messages are given for task points requiring arming, when inside the observation sector, as reminders to arm the turn when the pilot is ready to advance to the next waypoint. For starting, a warning is given that the glider is in the start cylinder or behind the start line, as a reminder to "arm" if necessary.

For PC with touchscreen, the user may manually cycle through the waypoints by highlighting the waypoint and by pushing the up or down cursor key.

See Section 5.7 for details on observation rules.

If a user has cycled through the waypoint manually, this does not mean that the glider has successfully passed the waypoint! However, this facility is useful to force a task restart or to skip a waypoint when flying a casual cross-country task.

Tasks can be restarted simply by manually cycling back through the waypoints to the start.

In all modes, if the glider re-enters the start zone or crosses the start of the previous start, the task will be automatically restarted.

When selecting [Previous turnpoint], the trigger that detects auto-advance for that waypoint is cleared; meaning that the task manager expects the aircraft to fly to that observation zone (OZ) again before continuing the task. The pilot may still select [Next turnpoint] to advance to the next task waypoint.

A system beep and message is given on task/waypoint advance. The messages are given when the system advances the task waypoint automatically or, in manually arm mode, when the system is armed and the aircraft is in sector:

Task start : appears when the aircraft has crossed the start line or exited the start sector. This can be repeated any time.

Next turnpoint : appears when the aircraft has entered the observation sector for turnpoints. Turns with variable target advance as soon as [Arm Turn] is pushed. For the manual arm mode, if the aircraft has already entered the observation sector and left, pushing arm will cause the task manager to expect, that the turn is intended to approach another time.

Task finish : appears when the aircraft has crossed the finish line or entered the finish cylinder. This occurs in both advance modes.

5.10 Alternate starts

The task system allows alternate start sectors to be defined:

[Nav 1/2] ▷ [Task] ▷ [Turn Points] select start point, [Edit Point] ▷ [Enable Alternate Starts]

On the start point edit page of the Task Manager turn on the [Enable Alternate Starts] property. Another screen is brought up for defining an alternate start point. If alternate start points have been defined before, label [Enable Alternate Starts] changes to [Edit Alternates]. After selecting "Add Alternate Start" and touching [Relocate] the "Select Waypoint" filtering dialogue is invoked.

Having set up several alternate start points, the "next waypoint" scheme again will be extended. Before detection of a valid start and having armed start manually, the menu buttons stepping through all the waypoints will show label Next Start .

Summarizing, all dynamic menu labels in menu Nav 1/2 show commands to be executed for selecting waypoints and conditions either consecutively or in reverse order.

5.11 Abort/resume the task and Alternates

If atmospheric conditions change for the worse, you may make the judgement that it will be impossible to complete the task. In this situation, XCSoar can be instructed to "abort" the task, and it will then help you reach a safe landing site. An ordered task can be aborted in different ways. Either it is done by selecting a waypoint and execute the goto command or by invoking the abort mode. In either case, the ordered task might be resumed.

Task Abort

Nav 2/2 ▷ Task Abort

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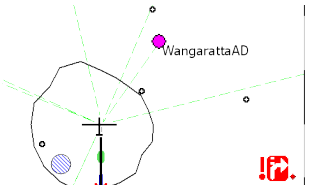
Invoking the abort mode forces XCSoar to enter a special case of the final glide mode. For a discussion on flight modes refer to Section 6.1. In this flight mode the configuration option Reach polar determines whether waypoint arrival heights in abort mode use the live Task MC or Safety MC. Default is Safety MC. Abort does not change XCSoar's MacCready ring; speed-to-fly stays on Task MC. The MacCready InfoBox shows Safety MC, with the glide ratio at that setting in place of speed-to-fly, and up and down adjust Safety MC for this flight. The saved Safety MC setting is left unchanged. If Task MC is higher than Safety MC, that lower value is sent to connected devices, and Task MC is sent back when abort ends. Safety MC reach is not limited by maximum cruise speed.



With invoking abort mode the cross-country task is disabled. On the map radials are drawn pointing to the nearest landables to instantly support the pilot's decision. As is during the whole flight, the group of nearby landables is maintained permanently. Radials and nearest landables may change dynamically when in abort mode, so that at any time several landing options are presented and any of these may be selected as the active waypoint. Even if no landable is in reach, the radials are drawn. If conditions improve, the task can be resumed by selecting the same menu button that aborted the task, now denoting Resume Task . The active waypoint, prior to aborting the task, is then restored along with all the other task details.

Alternates

Nav 1/2 ▷ Alternates

Alternates are maintained throughout the flight, reflecting good airmenship by always keeping an eye on possible alternates. Up to ten

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landing options are maintained. They are filtered by the configured "alternates mode" criteria (Simple, Task, or Home). Choosing Task or Home puts some bias on the presentation of alternates to the heading, you were taking whilst still task oriented. Landable colours and arrival altitude use the same terrain reach as the map, including turns around obstacles when Reach mode is Turning. A field the reach calculation cannot make, but that a straight glide at best glide still can, is drawn in orange on the map and in this list. In the traffic-lights style that colour is light red, because orange is already the straight reach. The Alternate InfoBoxes use the same orange. A field without an elevation is not marked. The arrival altitude stays the reach value, which can be below zero.

As is with every waypoint list, additional information might be called by tapping Details before deciding which final to go. Select a waypoint from the list and push Goto .

The Alternate 1 / Alternate 2 InfoBoxes and their variants can be used either in **AUTO** mode or in **MANUAL** mode. AUTO is the default and shows the best automatically selected alternates. Tap Select as Alternate to pin a reachable field from the list onto that InfoBox (MANUAL). This manual selection is runtime-only: it is not saved when XCSoar is restarted, and it remains active until the pilot chooses another field or taps Alternate Mode: Auto to return the slot to AUTO.

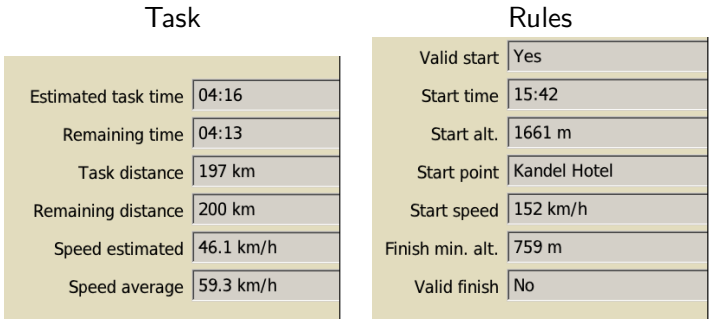
Although the items on the alternate list obey different rules they interact in the same way with the current task. Choosing a target from the alternates list aborts the task; once the conditions get better the resuming of the task is doable by the already mentioned button.

5.12 Task status

Info 2 ▷ Status

The status dialogue gives a summary of important task information. It can be useful to give a good overview of the task status while freeing up InfoBoxes for other purposes. The status dialogue can be referred to in order to confirm that a valid start was detected, as well as the progress against the task. The status dialogue can be invoked by menu or gesture left down right down left, denoting an S. The status tabs 'Task' and 'Rules' are of interest.

The task tab shows the AAT times, distances achieved and remaining and the task speeds. The rules tab shows the validity of start/finish according to the task rules.



5.13 Assigned Area Tasks

AAT targets

A *target* is a point within an AAT area that the pilot intends to fly to. These targets can be moved within the AAT areas so the pilot can adjust the effective distance of the task. Targets may be set on the ground, during task planning, and modified during flight.

When flying an AAT task, the navigation system directs the glider to the target, and statistics like distance to waypoint are also relative to the target rather than the waypoint of the AAT area itself.

Automatic task waypoint advancement does not trigger when entering an AAT area solely. The pilot has to arm the turn manually to advance to the next turn. When arming the AAT turn while flying through the OZ also the task optimiser is triggered to capture the realized AAT target and bring the target optimisation for the rest of the task up to date. See Section 5.9 for details.

Manually moving targets

In order to make the specification of targets more straightforward, their location is defined by a range parameter that determines how far from the minimum to maximum possible distance the target is. This is expressed as a percentage. For example, with range set to 100%, the target is located to give the maximum overall task distance. With range set to -100%, the target is located to give the minimum overall task distance.

Zero range yields a nominal task distance: for sectors the target is half way along the bisector radial; for cylinders the target is in the center of the cylinder.

The task calculator dialogue (see Section 5.5), shows the average percentage over all turns in the AAT Range field. The targets can be individually modified from the target dialogue of the task calculator.

AAT targets and the Task Calculator

The typical use of targets in flying AAT is as follows:

Config. 1/3 ▷ Flight
Config. 1/3 ▷ Wind

- Set the expected MacCready, bugs/ballast and wind settings for the flight using the dialogues and .
- Define the task as normal from the task editor.
- Based on the pilot's judgement of how good the weather is, and whether some areas are likely to be more or less difficult than others, targets may be set individually for each turn-point in the target view. The ETE field in the target view compared to the assigned minimum time is shown as Delta T to check if the planned task is efficient and long enough.
- During flight, if situations change, such as changed MacCready setting or wind, the task calculator can be brought up to show the estimated task time, again allowing comparison to the assigned minimum time.
- If the pilot decides to extend or shorten the flight, all the remaining targets can be modified from the task calculator.

The task calculator therefore allows the pilot to make (and help to answer) 'what if?' questions, for example:

- What will happen if the conditions improve? The MacCready setting can be increased and the pilot can see if there is sufficient adjustment to targets in order to be able to extend the planned task.
- What will happen if the conditions deteriorate? The MacCready setting can be decreased and the pilot can see how much the task can be shortened and still finish the task later than the assigned minimum time.
- What will happen if I leave the AAT area now? By pressing Arm turn the take over of the current position into the optimization can be forced. The repositioning of subsequent turns can be reviewed in the task calculation dialogue.

Target projection

XCSoar continually analyses the path of the glider through AAT sectors to find the points in previous AAT sectors through which the achieved scoreable distance will be greatest. Internally, the program moves the targets for previous AAT sectors, which are then the optimal targets.

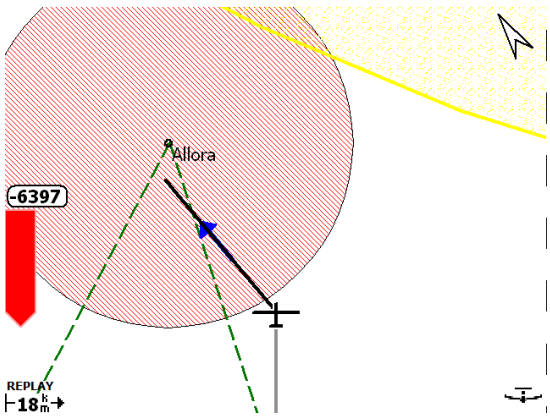
In certain conditions, targets for the current AAT sector may be moved automatically:

- When inside an AAT sector, the target in that sector is moved to a line projecting from the previous sector's target through the aircraft, at the same distance from the previous sector's target to the target prior to entering the sector. The effect of this is to allow pilots to choose to enter an AAT sector in a different

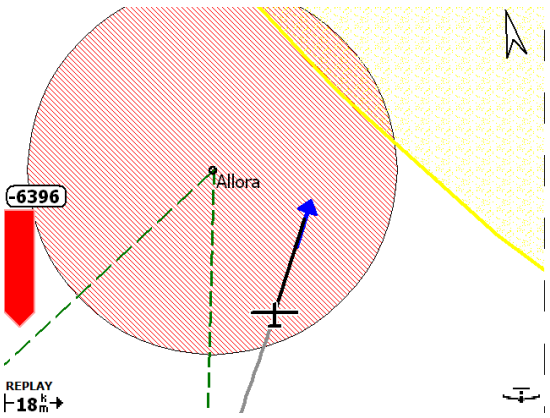
direction or offset from the direct line from the previous target to the current target.

- While the aircraft is in the AAT sector and the distance from the previous target to the aircraft is greater than the distance from the previous target to the current target, the target is moved further along the projected line from the previous target to the aircraft, just beyond the aircraft. Hence, the black track line will not be visible but the blue optimal track arrow will point along this projected direction.

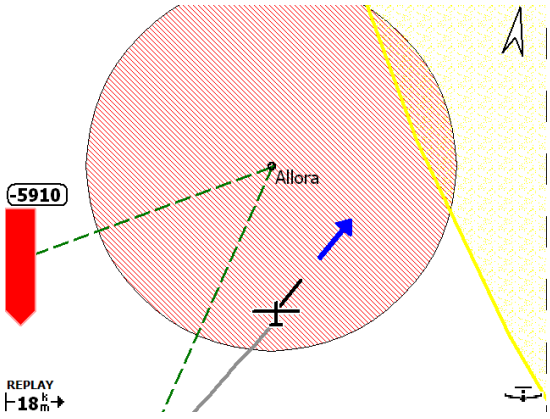
A worked example is provided in the following figures to illustrate how targets move during a flight and to show how XCSoar determines the maximum scored path.



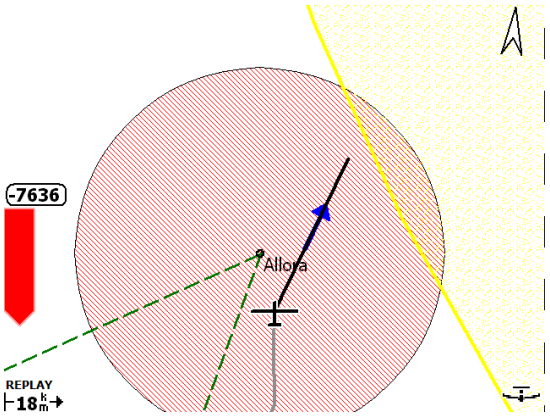
Outside sector
Target (-20%) is on bisector



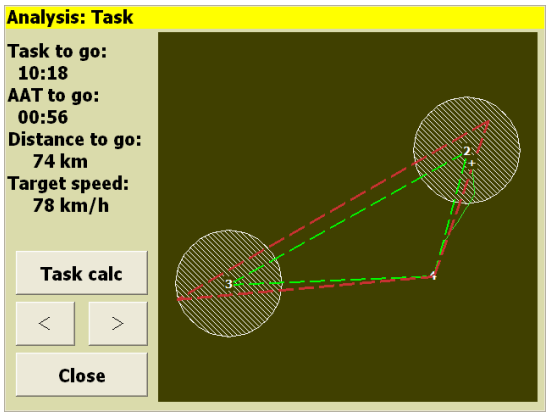
Inside sector
Target moved along track line



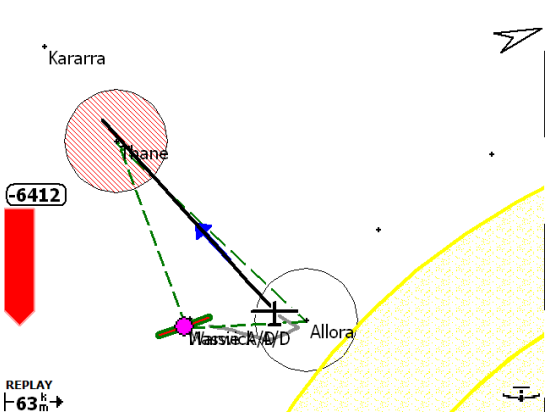
User decreased range
Target (-80%) moved along track line



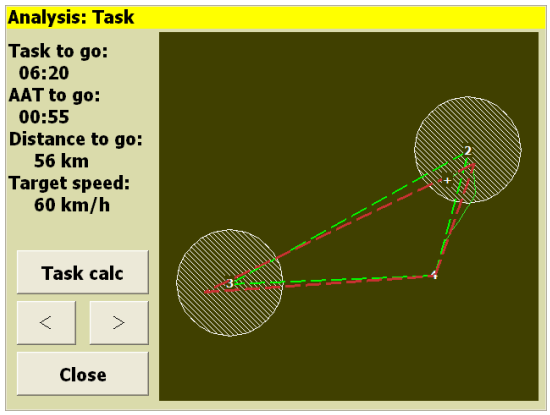
User increased range
Target (80%) moved along track



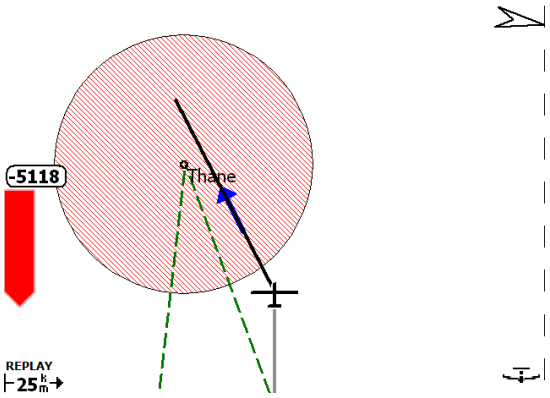
Analysis (task page)
Path around active target



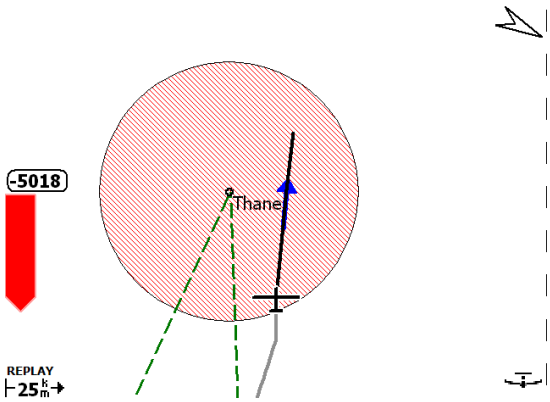
Next waypoint
"Arm Turn" pressed



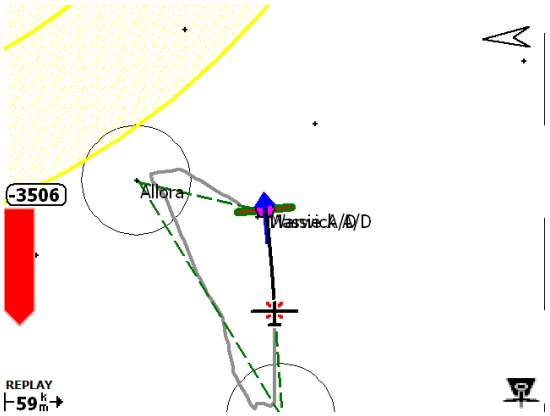
Analysis (task page)
Best scored target found



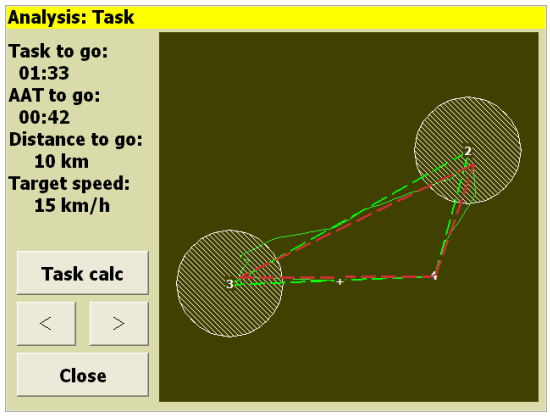
Approaching next area
Target (60%) is on bisector



Inside sector
Target (60%) moved along track line



Next waypoint
"Arm Turn" pressed



Analysis (task page)
Best scored targets found

5.14 Contest

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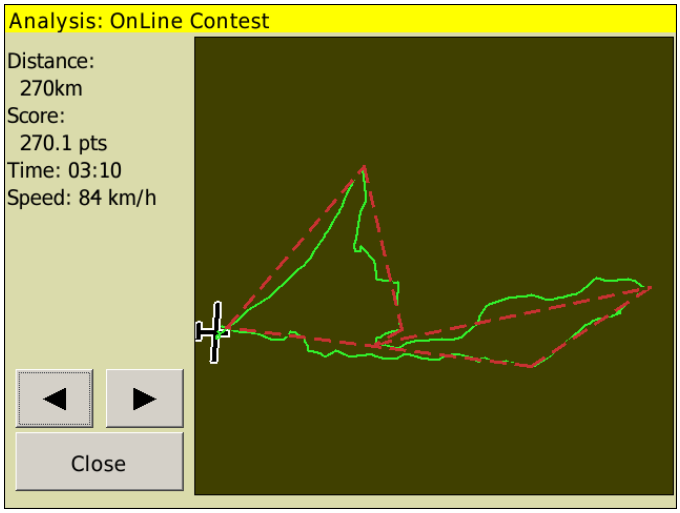
The analysis dialogue contains a page "Contest" which can be used to show the optimal path and estimated score. The configuration settings (task rules page) allows the selection of which set of rules to be used for the selected contest (like OLC or WeGlide) optimisation.

The optimization is done continuously in the background and can be retrieved at any time. The analysis page shows a graphical overview of the optimisation result besides distance and score. An InfoBox is available which gives the instant selected contest distance and score as well.



When flying for contests, either AAT or non-AAT tasks may still be used to manage the flight navigation. During flight, the computer will optimise the current flight with respect to the selected contest rules.

In the contest analysis page, the aircraft track is shown as a thin green line, the optimal path is shown as a thick red line.

The score and computed optimal distance is approximate.

When the aircraft has landed, the displayed result is not updated anymore.

5.15 Logger

A flight logger conforming to the IGC file specification can be used to record flights.

Several flight loggers are accessible via XCSoar:

- A software-based logger. All versions of XCSoar have this functionality. The logger conforms to the IGC standard but is not certified.

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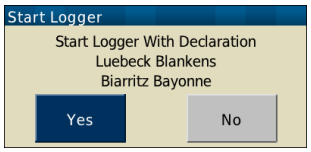
- XCSoar can also send declarations to some external logger devices. For this to work, the device must be specified in the 'Devices' section of the configuration settings.
- For some of the numerous logger devices XCSoar can download IGC files. This is convenient especially for logger devices which are not that easily removable from the glider.

Setup

For a complete matrix of the supported logger features see Section 2.5. The configuration is described in detail in Section 13.28. Details to the log files can be found in Section 14.10.

Logger activation



The logger can be turned on and off automatically or manually. For para-glider XCSoar provides the option to only start the logger automatically. Thus a very slow and close to the terrain flight won't automatically stop logging the flight. If you choose the auto start only logger you have to stop the logger manually. To turn the logger on (or off) manually, select from the menu:

Config 3 ▷ Logger Start

When the internal software logger is active, a small 'green status led' in the lower right corner of the map area flashes once per second.

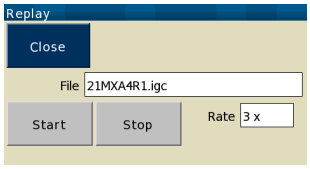
By default, XCSoar is set up to automatically start and stop the internal software flight logger when it detects the aircraft is flying and when it has landed, respectively. Only when the logger is manually started does it ask if the flight is to be declared; when automatically starting it automatically declares the current task. In simulation mode the logger does not get activated automatically.

If a task has been declared, then subsequent attempts at modifying the task result in a warning message asking to confirm whether the action is to be taken and invalidate the declaration. This is intended to make it harder to accidentally modify the task resulting in a failed declared task.

The XCSoar software logger, when started, checks for 500 kB of free space on the file storage. If there is insufficient space, it will automatically delete IGC files, oldest first, in order to free up 500kB. It does not ask the user for confirmation before performing this operation.

The internal software logger buffers data so that when it starts (automatically or manually) up to 60 seconds of data prior to starting is recorded. This means that the software logger now adequately captures the full take-off.

Logger replay



Flight logs in the IGC format generated by XCSoar or other loggers can be replayed. The logger replay dialogue can be accessed via the menu:

Config 2 ▷ Replay

During replay, the word 'REPLAY' appears at the lower left corner of the screen. During replay, the program behaves as if real GPS updates are being received by a GPS.The logger replay dialogue does not need to be open during replay.

To start a log replay, first select the file to load, and then select the Start button. The file selector lists IGC and NMEA logs. IGC files show detected takeoff, landing and duration as the list is scanned. The number of IGC files with a detected launch and landing, and their total time as hours:minutes, are shown under the list. Leave the file blank, or choose Demo, to run the demo. The replay can be performed in accelerated time by changing the time scale from 1x to a higher number, and paused by setting the time scale to zero. High time scales can result in degraded performance of the wind estimation and other statistics/analysis routines.

Stop the log by pressing Stop . Once a log is started, further presses of the Start has the effect of restarting the replay.

After a log file has been replayed, it is recommended to reset the device before flight, in order to ensure that XCSoar's internal statistics are properly reset.

When operating XCSoar in FLY mode, the replay is disabled (stopped) if the real GPS receiver detects that the aircraft is moving.

The logger replay works best with high sampling rate log files; a 6 second interval or less works fine.

Error analysis logger

For the pure reason of tracking down error prone behaviour of XCSoar there is a 'Raw Logger'. In case you are able to reproduce an error you can activate the raw log file creation by:

Config 3 ▷ Raw Logger

Developers will appreciate very much any detailed error description including a log file like this. It really facilitates the root cause analysis and saves time to fix an error.

5.16 Flight analysis

Up - Right - Down

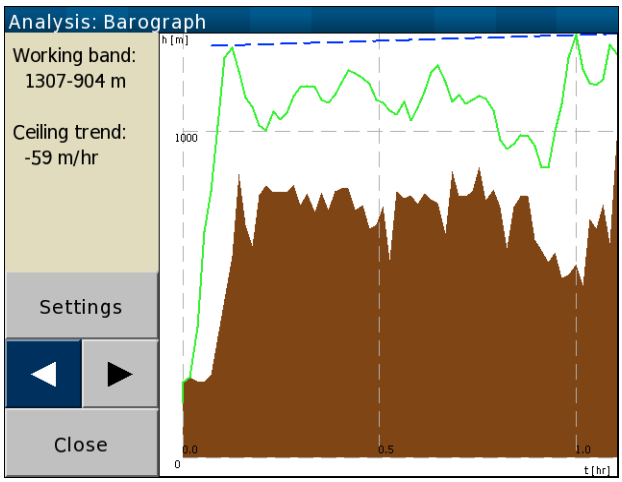
The analysis dialogue is very useful in planning and conducting cross-country flights. It is accessed via the menu:

Info 1 ▷ Analysis

Several pages are of interest:

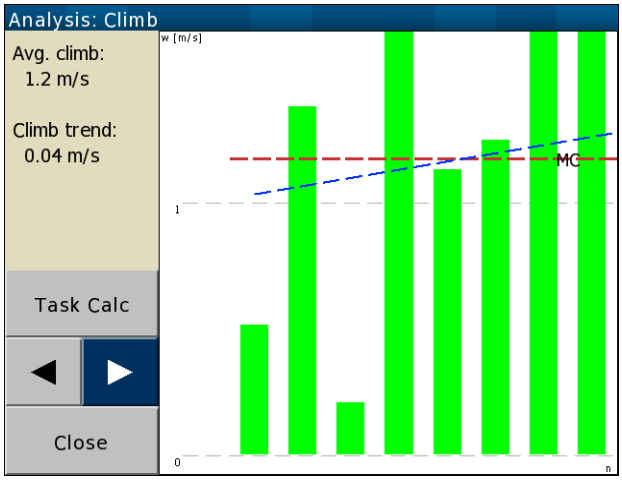
Barograph : Shows a graph of the history of the altitude of the glider. Statistics are used to estimate the thermal working band (average base and ceiling of climbs) and to estimate how the ceiling is changing over time. The base and ceiling lines are drawn on the barograph.

The 'Settings' button opens the flight settings dialogue, allowing to alter the values of ballast, bugs, QNH and maximum temperature.



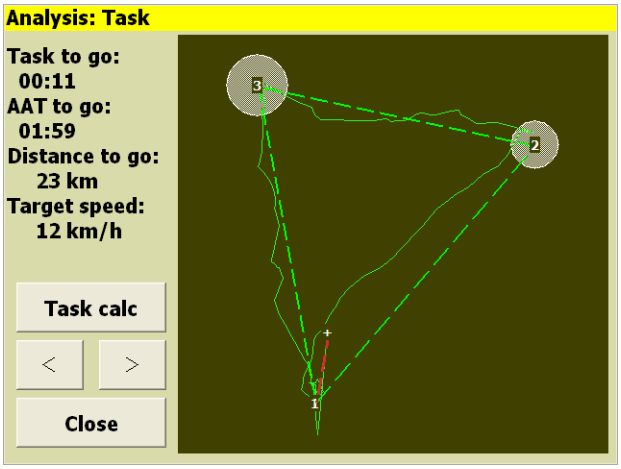
Climb history : Shows a bar chart of the average climb rate achieved during each climb. Statistics are used to estimate the overall average climb rate, and to estimate how this average is changing over time. The current MacCready setting is drawn on the bar chart as a thick red dashed line, and the climb rate trend is drawn on the chart as a blue line.

The "Task Calc" button opens the task calculator, (e.g. to adjust the MC value).



Task : This page shows an overview of the entire task. The main task line is drawn in thick dashed green, AAT areas are shaded. For AAT tasks, the path from the aircraft around the remaining targets within AAT areas is shown in red. The aircraft track is shown as a thin green line.

The 'Task Calc' button opens the task calculator, (e.g. to adjust the AAT task range or MC value).



5.17 Sunlight and time

A sun ephemeris computes the time of sunrise and sunset, which is displayed in the Aircraft Status dialogue (see Section 4.13). Note that local terrain and atmospheric conditions may result in poor visibility before the displayed sunset time.

For PDA systems, the clock is adjusted for daylight saving time according to the settings in the operating system.

If the expected arrival time at the final waypoint in the task is past sunset, a status message warning is issued.

6 Glide Computer

This chapter focuses on how XCSoar's glide computer works and is recommended reading so you understand the specific details of calculations being performed and how to use the software properly. It assumes a basic knowledge of cross-country soaring, but is suitable reading for competition pilots as well as pilots engaging in casual cross-country touring.

6.1 Flight modes

In order to reduce the pilot's workload, XCSoar is enabled to do different things depending on the actual flight's state. XCSoar can do this without in-flight interaction of the pilot. The differences are reflected by different displays, calculations, and flight information amongst others. The four states used by XCSoar are called *flight modes*, which are

- Cruise mode
- Circling mode
- Final glide mode
- Abort mode

XCSoar automatically detects the difference between circling flight and cruising flight. Circling is enabled when the glider turns (typically three quarters of a turn). After about 30 seconds of straight line flight the software will switch from circling to cruise mode. Hence, the switch is based on a simple condition.

It is also possible to have circling mode switched based on an external input (e.g. from a pilot-operated switch).

Final glide becomes active when the glider is above final glide path with respect to the given navigational task and safety margins. The required altitude depends most importantly on the adjusted MC value, but also the ground clearance is considered. On entering a thermal while in final glide mode for gaining some extra safety margin XCSoar will switch to the circling mode and back to the final glide mode, once the thermal is left again and the final glide condition is still met (i.e. the glider is still above the final glide path, considering MC setting and terrain).

As an example, a powerful feature to be driven by flight modes is the switch between different MacCready settings strategies. If you decided to let XCSoar manage the setting automatically it will maintain a

value based on past thermals worked out successfully until final glide. Instantly MacCready is set to achieve minimal arrival time or what you set up for final glide (see Section 6.14). Hence the switch to final glide mode is based on a set of sophisticated computed tactical conditions.

13.11

You might force XCSoar to enter final glide mode by skipping all remaining turnpoints, if for example conditions get worse and you decided to just go home.

Abort mode is invoked manually to give you full control in case of emergency via menu. No automatics — you decide. The abort mode might be understood technically as a special final glide mode with concurrent support for multiple optional targets. However, in practice the abort mode simply supports your urgent decision where and how to go finally (see Section 5.11). In this case, a safety MacCready value is set. Hence the switch to abort mode is based on the pilot's cognition.

13.13

Due to the fact that the different flight modes typically are reflected in differing things being displayed, the frequent XCSoar user might get used to some kind of watching a 'display mode'. This is just the default *perceived* after having installed XCSoar without having done some advanced configuration. As holds true for almost everything within XCSoar, the display's behavior might be changed, adding value for the advanced user. But altering things in XCSoar does not influence the conditions for entering a flight mode, they do not change.

In order to take full advantage of the flight modes concept, XCSoar will *always* show you, which mode is active. A small symbol is drawn on the lower right corner of the map area to indicate which flight mode the computer is in:

(a) (b) (c) (d)

Cruise (a) : The glider is not circling and there is either no task active, or the task waypoint is not the finish point.

Circling (b) : The glider is circling (though it may not be climbing).

Final glide (c) : The glider is not circling and the active waypoint is the final one in the task.

Abort (d) : This manually-triggered mode indicates the immediate landing options to the user. (See Section 5.11)

The concept of different flight modes enables much more to be automated:

13.22

- The InfoBoxes may be set up differently for each flight mode. (See Section 3.6)

13.7

- Change zoom level between circling and other flight modes (this

is called 'circling zoom', see Section 4.3).

13.23

- Switch the vario gauge's reading between Vario (gross climb rate) whilst thermalling and airmass lift around you (net) whilst cruising (see Section 7.1).

13.15

- When in circling mode, invoke the 'thermal assistant', a small polar diagram depicting the updraft over circular course (see Section 7.9).

13.6

- Switch to a so-called drift compensation, drawing a wind-compensated trail of the circles you fly to better depict wind shear (see Section 4.8).

Take notice, that this list is just an excerpt from an entirety of switchable items. You will find numerous dependencies conducted by the actual flight mode, whilst further reading this manual. Please pay attention to it, because the flight mode concept is one of XCSoar's fundamental basics. Another very basic scheme deals with how to structure information to be displayed together. This information is grouped in *screen pages*. Further details are given in Section 3.6 "InfoBoxes and screen pages".

13.22

6.2 MacCready setting

The MacCready setting may be adjusted several ways:

- For touchscreen/mouse devices, select the MacCready InfoBox field, then use the up and down arrow keys.
- When connected to a supported intelligent variometer, adjusting the MacCready setting on the variometer will change the setting in XCSoar according to the devices synchronisation configuration (see Section 13.34)

In addition, an automatic MacCready mode is available as described in Section 6.14.

6.3 Thermal next leg equivalent

The T Next Leg InfoBox shows the climb on the next task leg that gives the same average cross-country speed as flying the current leg at the MacCready setting. The calculation uses the glide polar and the headwind component on each remaining track. The box is blank when there is no valid next leg, no wind, or no polar. The comment shows "no wind" when wind is not available.

Compared with the MacCready setting:

- A lower value means the next leg is easier (typically a turn from into-wind to downwind). Weaker thermals after the turn can still match the present average speed.

- A higher value means the next leg is harder (typically a turn into wind). Extra height before the turn, and less selective thermalling afterwards, help hold the present average.
- A similar value means the wind on both legs is comparable.

This is not a MacCready setting. MacCready remains the expected lift; T Next Leg only translates that performance onto the next track.

6.4 Glide polar

Config 2/3 ▷ Plane

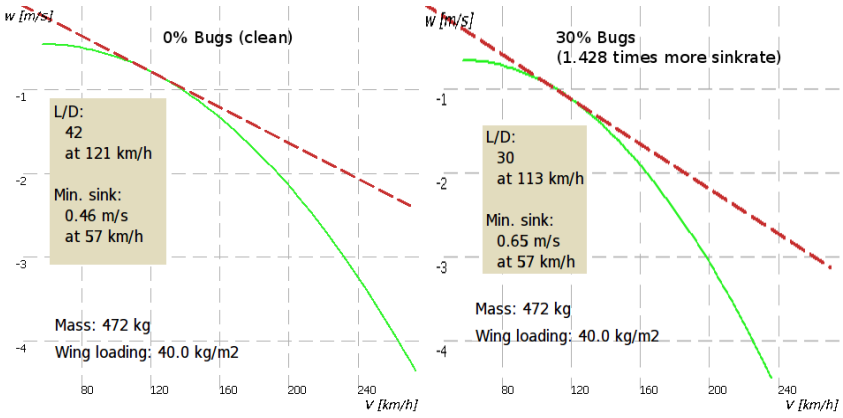
13.33

The glide polar specifications of a wide selection of glider types, representing major classes of gliders, are built into XCSoar. If your glider type is not listed, these may be used as an approximation if no better glide polar can be found. However, for most accurate results, it is advisable to use the correct glide polar for your particular aircraft type. Besides the aircraft type, the correct overall mass of the glider is important for accurate results. The preflight check of your tactical glide computer certainly includes a check of the correct settings for water ballast, with regard to the configured dry mass. Because XCSoar does not offer a setting for the pilots weight you are free to include the latter to the dry mass setting, or the water ballast setting.

On top of the polar and mass configuration the glide polar is adjustable in flight to take into account performance degradation due to bugs or rain droplets.

The build-up of bugs on the wing's leading edge, as well as rain droplets on the wing, affect the aerodynamic performance. It is the pilot's responsibility to judge and update the bugs value during flight. The bugs value is expressed as a percentage of degradation compared to the clean glider's performance. For example, at 0% bugs value, the glider performs as a clean glider, and at 50% bugs value, the glider's sink rate is doubled when compared to a clean glider. The calculation scales linearly in-between.

Info 1 ▷ Analysis



Knowing all this, a meaningful setting for a worst-case bug polluted wing could scale down the polar by 30%. Some experimentation may be required to determine appropriate settings for bugs, because the

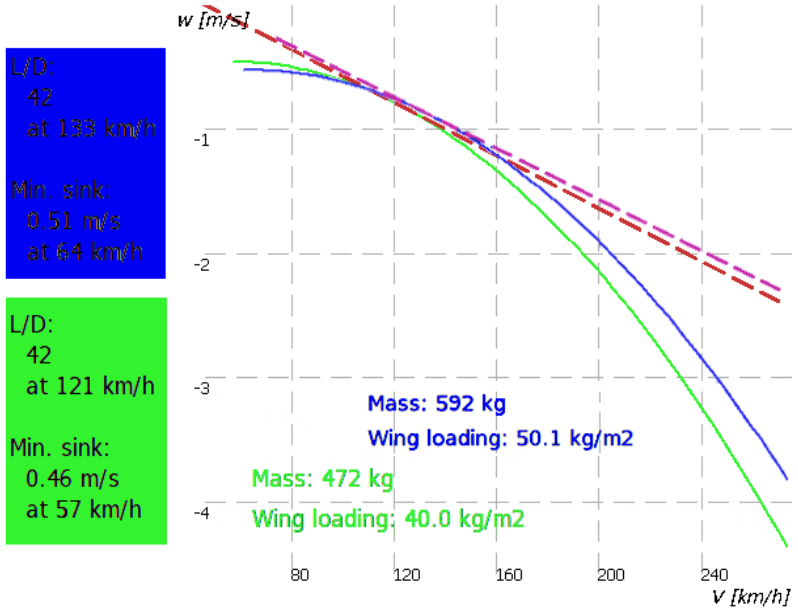
performance degradation experienced by different glider types may be different.

Alternatively, you can enable the "Auto bugs" feature which adds 1% to the bugs setting after each full hour of flying. This feature is set via

Config 1 ▷ System ▷ Glide Computer ▷ Safety Factors ▷ Auto bugs

The ballast is set in litres of water. Depending on the specifically set dry mass of the glider, this may optionally include a weight margin to provide for different pilot weights. When flying with no ballast, a heavy pilot may set a ballast value of perhaps 15 l so that the polar is appropriately adjusted for the increased cockpit weight.

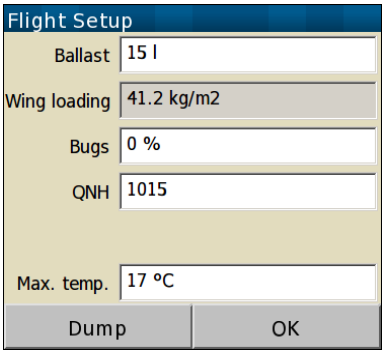
Info 1 ▷ Analysis



6.5 Flight setup dialogue

Config 1 ▷ Flight

Use the flight settings dialogue to modify the all up weight of the glider both before and during flight, as well as to set the QNH pressure.



The 'bugs' setting determines the amount the polar is degraded due to contamination during a long flight. A 'bugs' setting of 0% will cause the software to use the clean polar. A 'bugs' setting of 50% will degrade the polar and effectively double the sink rate for a given airspeed.

The ballast setting is used to modify the polar to account for any water ballast carried during the flight. Ballast is shown in litres, and should be set to correspond to the correct water ballast added before flight. The ballast setting modifies the polar to account for the indicated load of water ballast. The wing loading in this dialogue is red while the all-up weight is above the plane's MTOW.

Use this dialogue both before and during the flight to record the mean sea level atmospheric pressure, also known as QNH pressure. The software uses the values entered to convert airspace flight levels into altitudes. If connected to a supported intelligent variometer with an altimeter, the altitude is updated on this dialogue as the QNH pressure is adjusted. This makes it easy to set the QNH pressure if the airfield elevation is known.

The maximum forecast ground temperature is used by the convection forecast algorithm (see Section 7.10) in its determination of estimated convection height and cloud base.

XCSoar can fill this field from the forecast published by the Deutscher Wetterdienst, so that it reflects the day rather than whatever it was last set to. The lookup is off until it is switched on with Config 1 ▷ System ▷ Weather ▷ Flugwetter (pc_met) ▷ Max. temp. from forecast, next to the pc_met account details. It contacts the Deutscher Wetterdienst on its own, so it is the pilot's to enable; it needs no account of its own.

Once it is on, opening the dialogue starts the lookup in the background: the dialogue appears at once with the value it had, and the field changes only if an answer arrives. The station nearest the aircraft is used, which requires a GPS fix, and the forecast is fetched once a day and then kept, so opening the dialogue again costs nothing.

Where there is no network the attempt is abandoned after a few seconds and the field simply keeps its value; nothing is reported, because the lookup was not asked for.

The element read is **TX**, which the Deutscher Wetterdienst defines as the highest air temperature over the twelve hours before the timestep. The entry stamped 18:00 UTC therefore covers the daylight half of the day – the half a convection estimate is about. It is deliberately not the highest of the hourly temperatures: a statistical forecast states each element in its own right, and sampling the hourly series reads a degree or more low, which is a few hundred feet of estimated cloud base.

While a forecast is in effect the field states the value with the source beside it, 18.6 °C DWD MOSMIX , and cannot be edited – a number nobody typed should not look like one somebody did. To enter a temperature by hand, switch the lookup off.

What the number buys is only visible once the glider has climbed. The estimate compares the dry adiabat from this ground temperature against the outside air temperature the probe measures on the way up, so before the aircraft has sampled the layer there is nothing to compare and neither the ceiling nor the cloud base is reported. The ceiling needs an outside temperature probe; the cloud base needs a humidity probe as well. Both appear on the temperature trace page of the Analysis dialogue (Section 7.10).

The station catalogue covers about 5600 stations worldwide, roughly half of them in Germany and three quarters in Europe. Outside Europe the nearest station may be some distance away, and over mountainous terrain a station in a valley can read warmer than the airfield.

It is possible to configure XCSoar to display the basic settings dialogue when it starts up.

On system startup, after the GPS has acquired lock, and if a barometric altitude source is connected (e.g. Vega, AltairPro, FLARM, or the built-in barometer on Android and iOS), the QNH is automatically adjusted. This adjustment sets the QNH such that the barometric altitude equals the terrain altitude.

The QNH is only updated if the aircraft is on the ground for more than 10 seconds, so that if XCSoar is restarted during flight, QNH will not be adjusted. The update also only occurs if the terrain database is valid at the current aircraft location.

6.6 Speed command display

When used in conjunction with an intelligent variometer that produces indicated airspeed measurements, a speed command chevron is drawn on the right side of the map display. If the glider is flying slower than the optimal speed, the chevrons are red and point downwards. If the glider is flying faster than the optimal speed, the chevrons are green and point upwards. If the speed is approximately optimal, no chevrons are drawn.

Depending on the configuration, speed command chevrons can be displayed on the right side of the map area, or on the variometer gauge.

6.7 Speed to fly

XCSoar continuously calculates two types of speed to fly:

MacCready speed : The best speed to fly in cruise for the current MacCready setting, in still air. When MacCready is 0 and a task or Goto is active, the speed is adjusted for wind so the glide over the ground toward the waypoint is as good as it can be. Into a headwind the command is faster than the polar's still-air best glide, because less time is then spent in the headwind; with a tailwind it is slower. The final-glide symbol does not turn this adjustment on. With MacCready above 0, during cruise between thermals, wind is not used: the polar is flown in the air mass.

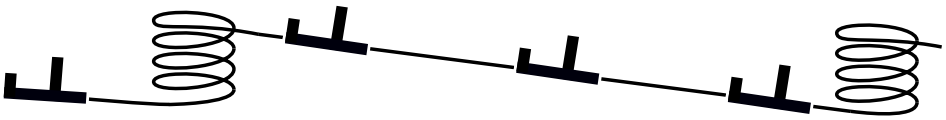
Dolphin speed : The instantaneous best speed to fly in rising or descending air. Wind is used on the same rule: only when MacCready is 0 and a task or Goto is active.

The best L/D speed on the polar chart is the still-air figure for the current MacCready setting. Speed-to-fly matches it when the wind is zero, or when there is no task or Goto. At MacCready 0 with a headwind it is higher.

The user can specify a maximum maneuvering speed in the configuration settings, which limits the speed-to-fly in MacCready calculations to realistic values.

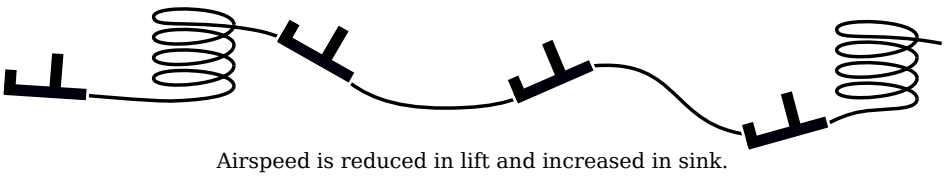
Different pilots have personal preferences as to whether they prefer to fly in so-called 'block MacCready' style, in which they fly constant speed between thermals according to the MacCready speed; or to fly in 'dolphin' style, in which they fly at varying speeds according to the continuously changing Dolphin speed value.

Block Speed to Fly



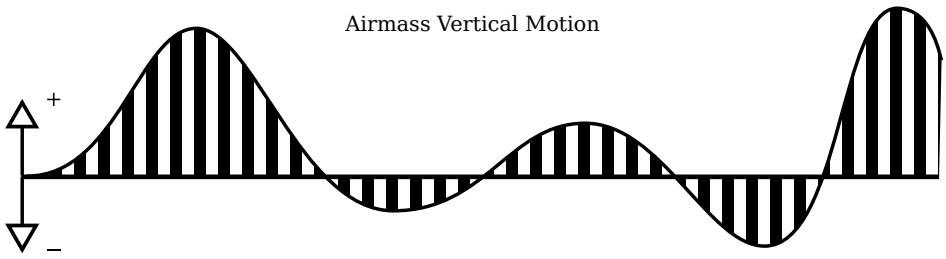
A constant airspeed is maintained regardless of lift/sink.

Dolphin Speed to Fly



Airspeed is reduced in lift and increased in sink.

Airmass Vertical Motion



A configuration option 'Block speed to fly' (see Section 13.11) can be used to specify whether dolphin or block speed to fly is used. The InfoBox 'V Opt' shows the optimum speed according to whichever mode is selected. When connected to the Vega intelligent variometer, the speed command sounds are based on this optimum speed value.

6.8 Speed to fly with risk

The speed to fly system can be compensated for risk, in which the MacCready setting used for calculating the speed to fly (in both Block or Dolphin modes) is reduced as the glider gets low.

Many pilots typically wind down the MC as they get low — this feature performs this automatically. The theory governing how this is implemented in XCSoar is based loosely on the paper by John Cochrane, "MacCready Theory with Uncertain Lift and Limited Altitude", *Technical Soaring*, 23 (3) (July 1999) 88–96.

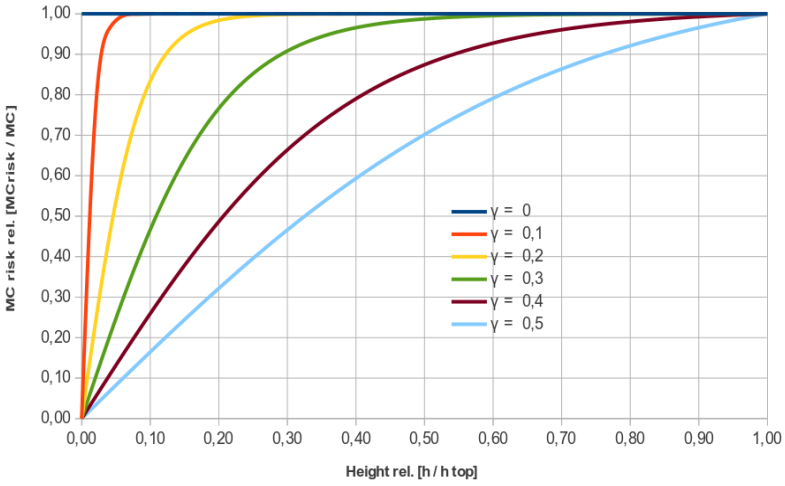
https://www.johnhcochrane.com/s/newmcred.pdf

A configuration parameter γ ('STF risk factor', in the configuration settings under page 'Glide Computer') controls how the risk MC value is calculated. The γ factor determines the fraction of the current MacCready setting as a function of the height fraction. The height fraction used in this calculation is the ratio of the height above terrain (h) to the height of the maximum climb above the terrain (h_{top}, this will usually be close to cloudbase). The γ setting thus represents the fraction of the total available climb (cloudbase minus terrain) at which you would wish to abandon the task and begin to prepare for a landout. Thus, low γ values indicate a higher tolerance for landout risk than higher values of γ.

For the default value, $\gamma = 0.0$, there is no compensation — the risk MC is the same as the MC setting. For $\gamma = 1.0$, the risk MC is scaled linearly with the height fraction h/h_{top}. For intermediate values of γ, the risk MC varies smoothly with the height fraction, such that the risk MC is small only when low.

Low values of γ are best when pilots do not want to slow down as they get low (but risk out-landing); high values of γ can be used for very cautious pilots but will result in lower average speeds.

A value of $\gamma = 0.3$ is recommended.



6.9 Safety heights

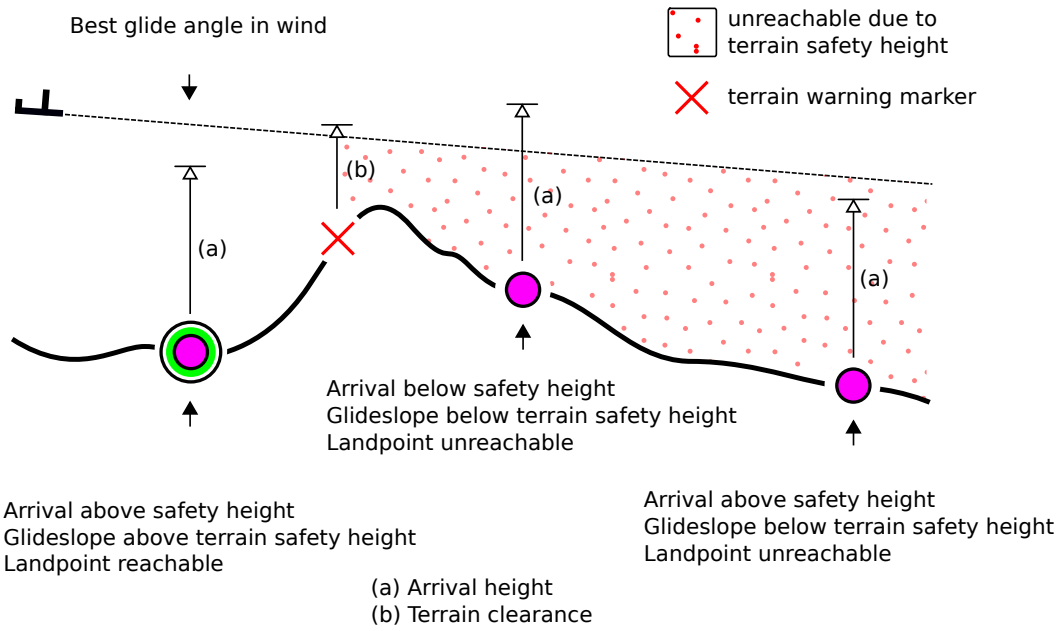
Three safety heights are defined to provide a degree of safety margin in glide computer calculations.

The safety heights are:

Arrival height (a) : This is the elevation above ground at which the glider is required to arrive at least. Typically, you want to include height for a safe landing circuit, plus some safety margin for hazardous vertical/horizontal air movements and resulting errors of computed route and speed. This value is used in final glide calculations as well as the determination and display of reachable landable fields.

Terrain clearance (b) : This is the elevation above ground, below which any computed glide path is considered to provide inadequate clearance to the terrain. The terrain clearance value affects the glide range display, and if the final glide at any point dips below the terrain clearance elevation above ground, a warning marker (large red cross) is drawn on the screen. If the terrain elevation model is invalid or out of range, then the glide range display and the terrain warning marker is disabled.

Break-off height (c) : This is the elevation above ground, below which it is recommended for pilots to consider the cross-country task failed and to concentrate on finding a suitable field to land in. Currently, this break-off height does not affect XCSoar in any way but it is referenced in the manual.



These may be set to zero but this is highly discouraged since all glide computers, instruments and data sources (such as terrain elevation models) are subject to some degree of error and the atmosphere through which the glider flies is also unpredictable.

XCSoar determines the elevation above sea level of any turn point or landing point either from the waypoint file, or if no height is specified in the waypoint file, from the terrain file.

The estimated arrival altitude displayed next to landable waypoints uses the Reach polar (Safety MC by default). Reach polar can be set to Task MC instead. Safety MC defaults to 3.2 m/s, about 25:1 on the default LS-8 polar.

Landable fields are only marked as reachable if the estimated arrival elevation above ground is above the arrival altitude safety height, and the glide path does not intersect the terrain clearance safety elevation.

At all times, if the final glide through terrain marker (a red cross) is displayed on the screen, then the glider must climb in order to safely reach the destination.

When calculating the arrival heights of landable fields (for map display purposes and in abort mode), Reach polar selects Task MC or Safety MC. Safety MC is 3.2 m/s by default (about 25:1 on the default LS-8 polar). Larger values make the arrival height calculation more conservative. The Safety MC speed is not limited by maximum cruise speed. Speed-to-fly still stops at maximum cruise speed.

6.10 Final glide calculator

The final glide calculator uses many sources of information when determining the altitude required to reach your goal or the next waypoint. These are:

- The glider's polar data;
- The wind speed and direction;
- The distance and bearing of the goal or waypoint;
- The MacCready setting;
- The altitude of the waypoint or goal;
- A user specified safety margin (arrival height and terrain clearance).
- The glider's total energy if XCSoar is connected to an instrument with an air speed indicator.

From the parameters shown above, two altitudes are derived.

Altitude required : This calculation is the total altitude required for the glider to reach the goal plus any user safety margin.

Altitude difference : This calculation is the altitude required to glide to the goal plus any safety arrival altitude plus the altitude of the goal, minus the altitude above mean sea level of the glider. The result represents either your height above glide slope, or your arrival height at goal. If no goal altitude is provided in the turn-point file, XCSoar will use the terrain file altitude at the goal.

The final glide calculation is extended to calculate the altitudes required and difference to complete the entire task. This capability is sometimes referred to as final glide around multiple turn points. The altitude difference to complete the task is displayed continuously as an arrow and in numeric form on the left-hand side of the map area of the screen.

The altitude required is adjusted for energy, compensating for the fact that the kinetic energy of the glider can be converted to height (potential energy). The kinetic energy that is convertible to height is calculated from the difference in the true airspeed to the true airspeed for best glide. This compensation is most accurate when airspeed data is available to XCSoar, otherwise the true airspeed is estimated from the wind speed and ground speed.

6.11 Display of required altitude difference

On the left side of the map display, a box displays the calculated altitude difference required for the glider to complete the task, or reach the final waypoint. If the glider is above the minimum altitude

required, a green arrow bar is drawn above the box indicating the amount of excess height.

If the glider is below the minimum altitude required, a red arrow bar is drawn below the box indicating the amount of height deficit. If, however, there are landable waypoints within glide range, but the glider is below the minimum altitude required to complete the task, the bar is coloured amber.

Above *Below*

The scale of the final glide bar is $+/-$ 500 meters.
A bar beyond this scale is indicated by a chopped-off tip.

The meaning of the height shown is affected by the 'Predict wind drift' setting (see Section 13.11).

Dual altitude required bars

The final glide bar has been extended to show the effect of MacCready setting on the altitude difference to complete the task. The display shows with a brighter split arrow the *altitude difference calculated at zero MacCready*, as well as the usual arrow that displays the altitude difference calculated at the current MacCready setting.

The number shown in the box next to the final glide bar still shows the altitude difference at the current MacCready setting.

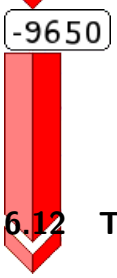
Examples of the appearance in various configurations with the additional *MC*$= 0$ bar display is shown below:

Above final glide : (current MC$= 0.7$) Here the display shows that at the current MacCready setting, the aircraft is above final glide (filled arrow). The split arrow shows the additional excess height.

Below/above final glide : (e.g. MC$= 1.8$) Here the display shows that at the current MacCready setting, the aircraft is below final glide (filled amber arrow). The split green arrow shows that at MC$= 0$, the aircraft is above final glide.

In this situation, if the glider is climbing, the pilot can assess whether to leave the thermal early and commence a final glide descent at a reduced MacCready setting; or continue to climb. It is useful to switch on the auto MacCready setting as this will automatically adjust the MacCready value to the optimal value — and then it is simple for the pilot to compare the achieved lift rate with the MacCready value. When the achieved lift rate drops below the MacCready value, the thermal should be left.

Below final glide : (e.g. MC= 2.5 and with less height) Here the display shows that at the current MacCready setting, the aircraft is below final glide (filled red arrow). The tip of the red arrow is chopped off to show that the altitude undercut the 500 meter limit the arrow can scale on. The split slightly brighter red arrow shows that by reducing the MacCready setting to zero, the aircraft still is far from final glide.



Below final glide : Here the display shows that at the current MacCready setting, the aircraft is below final glide (red arrow). The split brighter red arrow shows that even at MC= 0 the aircraft is well below final glide.

6.12 Task speed estimation

Some of XCSoar's internal calculations make use of estimates of the time required to reach each waypoint in the task. This information is used in some InfoBox displays, Assigned Area Task calculations, and sunset warnings.

The glide computer assumes the glider's average cross-country speed is equal to that achievable under classic MacCready theory taking wind into account, with the current MacCready setting. This method is used for estimating arrival times and task finish time. The T Next Leg InfoBox applies the same idea to the next task leg (Section 6.3).

The following task speed measures are defined:

Task speed achieved : This is the task speed to date, compensated for altitude differences from the task start altitude.

Task speed average : This is the task speed to date compensated for altitude required to complete the task.

Task speed remaining : This is the task speed estimated for the remainder of the task according to MacCready theory.

Task speed estimated : This is the task speed estimated for the entire task, start to finish, assuming flying the remainder of the task according to MacCready theory.

Task speed instantaneous : This is the instantaneous estimated speed along the task. When climbing at a rate equal to the MacCready setting, this number will be similar to *Task speed remaining*. When climbing more slowly than this or cruising in a direction other than directly toward the active waypoint, this number will be lower than *Task speed remaining*. In cruise at the optimum speed directly toward the active waypoint in air that has no vertical motion, this number will be similar to *Task speed remaining*.

This measure, available as an InfoBox, is useful as a continuous indicator of cross-country performance. It is not used in any internal calculations.

For an assigned area task (AAT), the positions of any remaining targets with the *Optimized* box checked are automatically adjusted (if room for such adjustment is available) to give an estimated total task time of five minutes more than the task's *AAT min. time*.

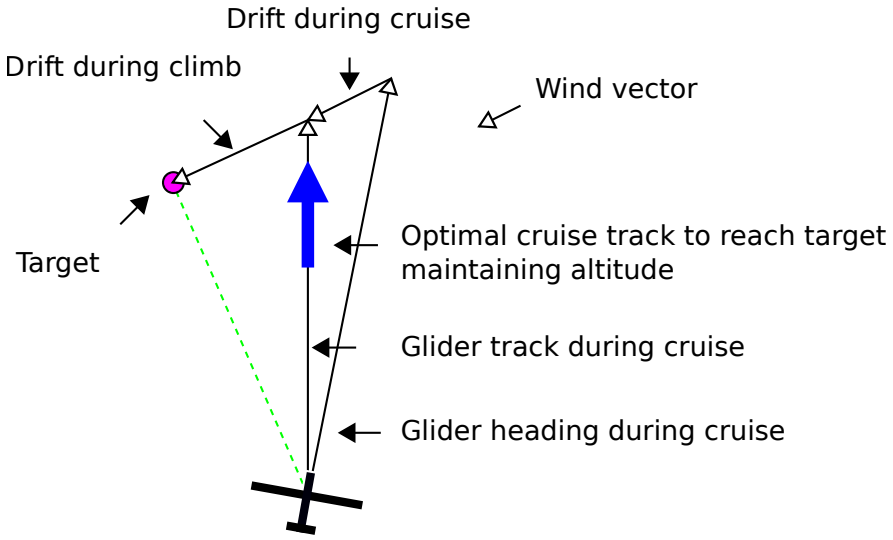
Also, a measure called *Achieved MacCready* is calculated. This is computed by finding the MacCready setting that under classical MacCready flight would produce the same task speed as has been achieved so far. This value is higher than the actual MacCready setting when the glider has climbed faster than the actual MacCready setting or when the glider has flown in cloud streets, for example. *Achieved MacCready* is shown in the *Status* dialogue's *Task* tab but is not available as an InfoBox.

An "achieved" task speed includes compensation for the glider's net change in altitude so far. For example, two gliders flying the same task can have different "achieved" task speeds even if they have both flown the exact same distance in the exact same amount of time. The higher-altitude glider will have a greater "achieved" task speed. In fact, a glider that has flown *less* distance in the same amount of time could have a greater "achieved" task speed if its altitude is enough higher than that of the farther-ahead glider.

While flying an AAT, task speed measures may change relatively quickly when the glider is inside a turn area or when AAT range or target location is adjusted by the pilot. This is due to changes in *task distance achieved* and *task distance remaining* when such events occur.

6.13 Optimal cruise track

In order to help reduce the cross-track error when flying between non-final waypoints, XCSoar calculates an adjustment to the cruise track, called the 'optimal cruise track'. This track is adjusted so that it compensates for the wind drift incurred when circling, and as such it needs to estimate the proportion of time spent circling according to classical MacCready theory.



The optimal cruise track is displayed on the map area as a large blue arrow, and it recommends the glider steers so that the glider's track is lined up with the blue arrow during cruise. For example, if the display is oriented 'Track-Up', then steer so the blue arrow points directly up.

The glide computer accounts for wind drift during circling to provide an 'optimal cruise track' vector, which indicates the track the glider should follow during cruise such that it will arrive at the waypoint in minimum time. This vector is displayed on the map as a blue arrow. When the wind is negligible, or when the computer is in final glide mode, this arrow will point along the black line that indicates the track to the next waypoint.

The calculation and display of optimal cruise track is a unique feature of XCSoar. Commonly, when cruising between thermals, glide navigation systems direct the glider to steer so that the glider's track points directly at the target. Ideally, the glider's track is collinear with the line from the previous to next waypoint, such that the cross-track error is small and hence the glider travels the minimum distance between waypoints.

However, because the glider usually has to stop cruising in order to climb in lift, whilst circling the glider drifts downwind and therefore the cross track error can increase. After several cycles of cruise-climb, the overall track becomes curved.

For the case where the final waypoint is active and one is above final glide, circling is not necessary so this simple scheme is optimal.

6.14 Auto MacCready

XCSoar can adjust the MacCready ring setting automatically to relieve the workload on the pilot. Two methods of updating the MacCready

ring setting are available:

Final glide : During final glide, MacCready is adjusted in order to arrive at the finishing point in minimum time. For OLC Sprint tasks, the MacCready is adjusted in order to cover the greatest distance in the remaining time and reach the finish height.

Trending average climb : When not in final glide, MacCready is adjusted to the trending average climb rate based on all thermals.

Additionally, both methods may be used, so that before reaching final glide, the MacCready setting is adjusted to the average climb rate, and during final glide it adjusts the setting to give minimum time to arrival.

The method that is used is defined in the configuration settings dialogue as the field "Auto MC Mode". The default setting is "Both".

When Auto MacCready is enabled, the MacCready InfoBox displays 'MC auto' instead of 'MC manual'; and the MacCready indicator in the variometer gauge displays 'AutoMC' instead of 'MC'. To benefit the most from the automatic MC adjustment XCSoar propagates the MC value to the connected intelligent variometer (if it supports).

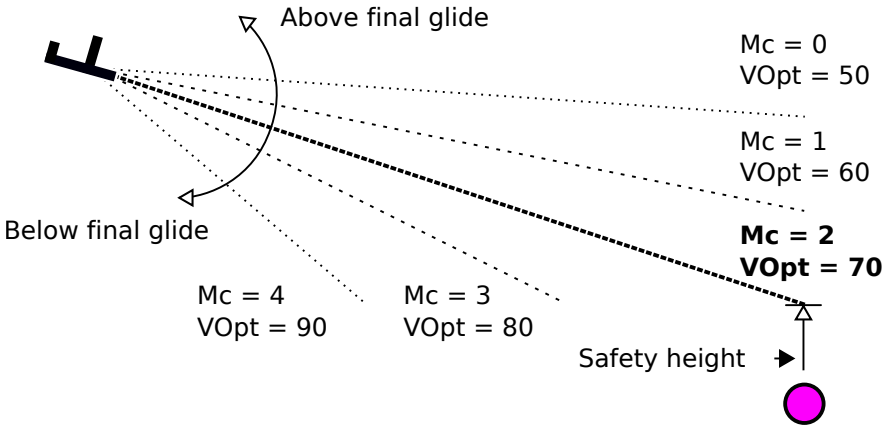
The Auto MacCready methods are described in further detail below.

Final glide

When above final glide altitude, the MacCready ring setting may be increased, resulting in a higher speed to be commanded. Because the ring setting has increased, this also increases the minimum strength of the thermal that would be efficient to stop and circle in.

Similarly, when below final glide altitude, the MacCready ring setting may be decreased, resulting in a lower speed to be commanded. Because the ring setting has decreased, the pilot may be prepared to stop and circle in weaker thermals.

Auto MacCready performs this adjustment automatically and continuously. Typically, it is meaningless to enable this mode before reaching final glide altitude, or nearly so, because early in the flight the glider will be very much below the final glide altitude and the Auto MacCready function would then drive the MacCready ring setting to zero.



Average climb

This method sets the MacCready to the average climb rate achieved across all thermals in the current flight. As such, it takes into account the time spent centering the thermal. The value is updated after leaving a thermal.

Since MacCready theory is optimal if the MacCready setting is the average climb rate of the next expected climb, this method may give sub-optimal performance (commanding speed too slow) if the conditions are improving; and similarly may be non-conservative if the conditions are deteriorating (commanding speed too high). Similarly, if the pilot continues to climb in weak thermals, this will reduce the average and may therefore encourage the pilot to continue to select weak thermals.

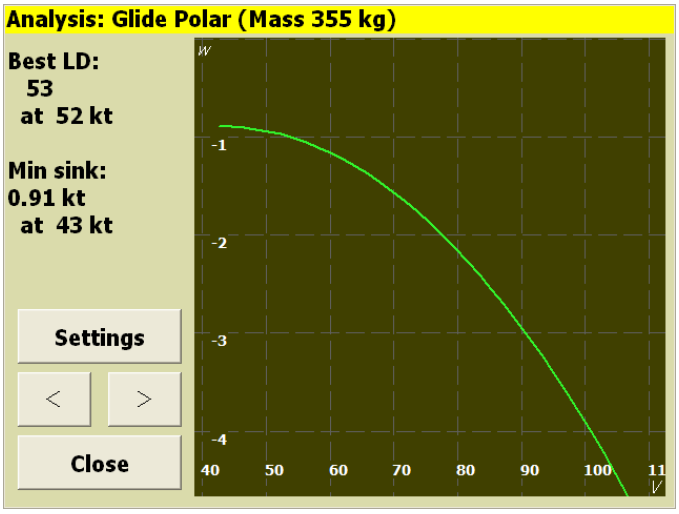
As a result of these limitations, the pilot should be aware of how the system operates and adjust his decision-making accordingly.

6.15 Analysis dialogue

Info 1 ▷ Analysis

The analysis dialogue can be used to check the glide polar.

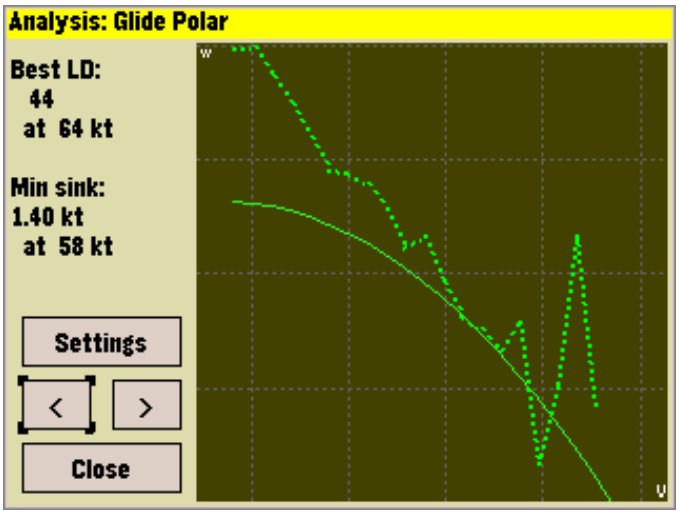
The polar page shows a graph of the glide polar at the current bugs and ballast setting. It also shows the L/D and the speed at which it occurs for the current MacCready setting, that MacCready value, and the minimum sink and the speed at which it occurs. The L/D and its speed change when MacCready changes. The current aircraft all up weight is displayed in the title.



In this dialogue page, the 'Settings' button opens the flight settings dialogue (e.g. to adjust the bugs/ballast).

The glide polar page of the analysis dialogue shows the average total energy sink rate at each speed achieved in flight, when connected to a supported intelligent variometer (e.g. Vega). This facility allows pilots to perform test flights in stable atmospheric conditions, such as on calm days with no wind, and inspect the measured glide polar. By comparing the measured glide polar with the model glide polar, this enables investigation of whether the glider is being flown optimally with respect to flap settings and also to investigate the benefits of performance optimisation such as sealing control surfaces, etc.

Data is collected only when in cruise mode and at G loading between 0.9 and 1.1; so pilots performing test flights should attempt to fly smoothly with wings level.



6.16 Flight notifications

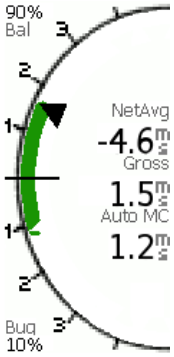
Notifications, appearing as status messages, appear when the following conditions are detected:

- Estimated task time too early for AAT
- Estimated arrival at finish past sunset
- Significant wind change
- Transition to above/below final glide

7 Atmosphere and Instruments

XCSoar maintains an internal model of the atmosphere based on statistics gathered from the flight path and other connected devices. These statistics and measurements are approximate and the weather can on some days change rapidly. The pilot should at all times keep observing the weather. In particular, when out-landing in fields, the pilot should look for indicators on the ground to confirm wind strength and direction.

7.1 Variometer



13.23

A needle-dial style display shows the variometer measurements. The gross variometer reading drives the main arrow on the dial, and in the centre of the dial the instantaneous measurement is shown as text. Additionally, speed command arrows (chevrons) appear above or below the gross variometer measurement. Chevrons pointing up indicate slowing down is recommended. Chevrons pointing down indicates that speeding up is recommended.

When the averager value is displayed, the value shown is the average gross climb rate over the previous 30 seconds when in circling mode, and the netto (airmass) vertical speed over the previous 30 seconds when in cruise mode. While circling, that figure is red when it is less than half the risk MacCready, the same as the TC 30s InfoBox.

The average value can also be displayed as an optional additional needle (caret). The vario gauge is customisable as to what is displayed along with the gross value etc. Under those figures, STF or Var follows the audio vario: speed-to-fly or the variometer. Tap the gauge to open the flight setup, as with the Ballast InfoBox. Sliding off before lifting does not open it.

When an intelligent variometer is connected to XCSoar, the needle displays data from the instrument; otherwise it produces variometer estimates based on GPS vertical speed, which is slow and uncompensated for aircraft total energy.

The MacCready value, bugs and ballast, optimum speed to fly and wind data are transferred between XCSoar and supported external intelligent variometers. In the ideal setup, both XCSoar and the variometer have a consistent perspective on the flight at all times; and that by adjusting the MacCready setting on one device should be kept in sync with the other, by the software and to not require additional input from the pilot.

Pilots abuse the device synchronisation (see Section 13.34) for various reasons. You may have different MacCready settings on PDA and intelligent vario to cross-check the results. You may do computations with different ballast settings and cross-check the results. You may choose on one of the devices manually a different wind setting and cross-check the results, etc.

A list of supported variometers is maintained in Section 2.5.

For Vega: A small icon displaying a circling glider is displayed when the variometer is in climb audio mode.

7.2 Audio Variometer

In addition to the variometer display XCSoar provides an acoustic variometer which transfers the variometer measurements into sounds. The audio variometer is for now only available on Android devices. For proper performance connect your device to a barometric sensor or use the internal one of your Android or iOS device if it has one. The audio vario is enabled and configured in Setup / Audio.

7.3 Air data inputs

Where additional aircraft dynamics or air mass data are provided by an intelligent variometer, XCSoar can often make use of it or display it in a separate InfoBox. Key sensor measurements that XCSoar uses include:

Gross total energy variometer : (rate of change of the total energy of the aircraft) Used for display, and for calculation of netto variometer.

Netto variometer : (estimated vertical velocity of the air mass at the aircraft) Used to for display, and to colour the snail trail so that it may effectively show areas of lift and sink.

Aircraft acceleration : (load factor) Used for netto variometer calculations where an external netto variometer is not provided. On Android, XCSoar uses the phone's accelerometer when no external G-sensor is connected. With *Built-in IMU* set to *Not aligned*, the sign is ignored, because a negative value means the top of the phone points down.

Barometric altitude : Used for display

Indicated airspeed : Used for display, in compensating final glide calculations for aircraft kinetic energy, and in netto variometer calculation where an external netto variometer is not provided.

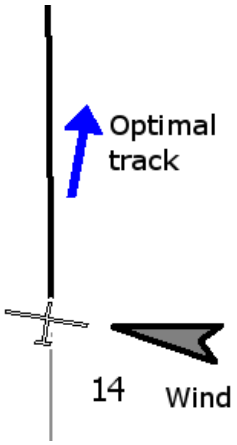
Air density : Used for calculating true airspeed from indicated airspeed.

7.4 Wind display

A continuous display of wind strength and direction is provided on the map. The wind information is derived from the gliders wind drift during thermal flight (climb mode).

The wind direction and speed are displayed as a wind vector on the moving map display and optionally in numeric form in the data display fields. The length of the vector indicates the wind magnitude, and this magnitude is also displayed near the wind vector.

The wind data is one of many data sources used to calculate final glide information. It is possible to manually adjust the wind used in all calculations.



7.5 Wind estimation

XCSoar offers two ways of estimating wind during flight.

Circling : This method uses GPS position fixes to estimate the wind based on drift, typically while thermalling; and is available on all XCSoar installations. To improve wind calculations, airspeed and rotation rate measurements are also used, if available.

Zigzag : This method uses GPS position fixes and true airspeed measurements to estimate the wind, typically during cruise. It is only available where XCSoar is connected to an intelligent variometer that outputs true airspeed.

The wind magnitude and direction can also be adjusted manually from the wind settings dialogue (see below).

Statistics are gathered so that winds are recorded at different altitudes and times. When the glider's altitude changes significantly, the statistics are consulted to determine the best estimate of the wind based on previous measurements.

For PC with touchscreens, you can also do this by highlighting the wind InfoBox and using the cursor keys (up and down increase and decrease the magnitude, left and right rotate the wind direction).

13.14

The configuration settings dialogue allows control of which estimation method is used for wind updates, via the field 'Auto Wind':

- Manual
- Circling
- Zigzag
- Both (Zigzag and Circling)

When wind estimates change significantly, a status message notification of this is issued.

Circling wind algorithm

XCSoar estimates the wind magnitude and direction when circling. It does this using a sophisticated algorithm that incrementally improves the wind estimate from completed turns. Poor quality turns, where the bank angle changes significantly, are rejected or have minimal impact on the overall wind estimate. The best turns are those with constant bank angle. If values from the airspeed measurement are available, i.e., a corresponding instrument is connected, speed variations during circling are compensated for. If a gyroscope (IMU sensor) is connected, changes in bank angle and changes in turn rate can be detected, and the circles in question will be excluded from the wind calculation.

Estimates are only obtained if the average GPS fix rate is better than one every two seconds. This results in improved fidelity of estimates in the presence of GPS dropouts.

Zigzag algorithm

For aircraft fitted with intelligent variometers connected to XCSoar, a so-called 'zigzag' wind estimation algorithm is available. With this algorithm, the wind estimate can be updated continuously during long glides without circling.

This allows the wind estimate to be updated during cruise while the aircraft performs a zigzag manoeuvre. No specific manoeuvre is required, in many cases the estimate will be updated as the aircraft's heading changes naturally as the pilot hunts for lift. In general, however, the technique requires the aircraft heading to change over 40 degrees.

If the wind changes significantly while in straight flight, the zigzag algorithm is used to update the wind estimate even if the aircraft's heading does not change much. This provides greater accuracy in long final glides.

Wind estimates are updated when a large difference between the estimated ground speed and the true ground speed are detected even without much zigzag manoeuvring.

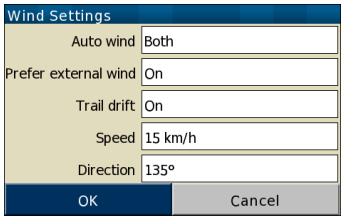
Compass algorithm

For aircraft fitted with intelligent variometers and digital compasses connected to XCSoar, a wind estimation algorithm making use of magnetic heading and airspeed is being developed. This provides another method of updating the wind estimate during cruise and does not require zigzag manoeuvres.

7.6 Wind settings dialogue

Config 1 ▷ Wind

The wind dialogue allows the initial estimate of the wind speed and direction to be entered, usually prior to flight.



At any time during flight, the pilot can make corrections to the wind estimate by entering the correction in the wind settings dialogue. Once the dialogue gets closed, the internal estimate is ignored until a new internal estimate is obtained from the circling or zigzag algorithm.

The automatic wind algorithm may also be switched on or off (or between modes) in this dialogue. See Section 7.5 for details on these algorithms.

The compensation of wind drift of the snail trail can also be switched on or off in this dialogue. See Section 4.8 for details on how this affects the display of the snail trail.

7.7 Thermal profile

Statistics on climb rates in thermals are collected and displayed in a thermal band meter. This is shown above the final glide difference bar on the left side of the map display. It is not shown when the glider is above final glide.

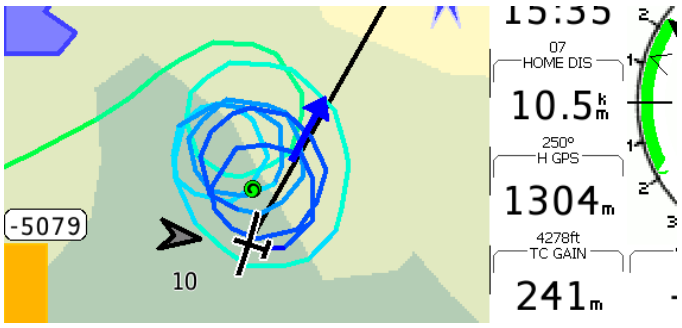
The thermal band meter shows a graph, where the vertical axis is height above the break-off height (Section 6.9), and is scaled according to the maximum altitude achieved. The horizontal axis is the average climb rate achieved at a particular altitude band. The horizontal axis is scaled according to the MacCready setting, and an arrow indicating this setting, and the glider's current altitude is overlaid on the shaded area. This scaling and arrow makes it easy to see how the pilot's MacCready setting compares with achieved thermals and to plan the desired working height band.

When cruising between thermals, the vertical position of the arrow, indicating the glider's height relative to the thermal band, can be used

as a reference to suggest how urgent it is to find the next thermal. As the arrow approaches the bottom of the band, then the glider is nearing the break-off height and the pilot should consider taking even a weak thermal.

7.8 Thermal locator

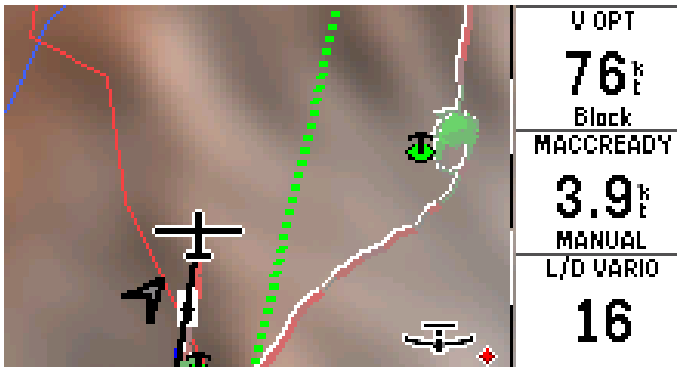
An algorithm estimates the centre of the lift when circling. The thermal marker symbol is a green circle with a spiral.



The thermal locator marks the location of the last 20 thermals on the map with the thermal symbol during cruise.

This location is calculated to compensate for the thermal drift at the glider's altitude. This means that internally XCSoar remembers the location of the thermal source on the ground. In other words, if you leave a thermal at the top and later return at low altitude, the position on the map shows the predicted location of the thermal at that low altitude (which is further upwind than the top).

If the wind changes and the thermal source is still active, its position on the map reflects the wind change; that is, the thermal at altitude will be projected downwind at the new wind estimate.

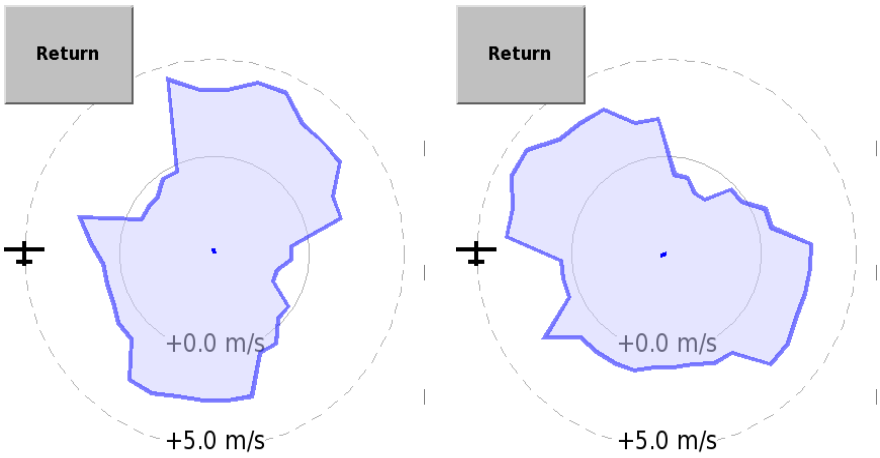


7.9 Thermal assistant

13.15

The thermal assistant is a graphical aid to maximise the exploitation of the given thermal updraft. If it is configured "On" the small polar diagram is mapped to the lower left corner of the screen. A single tap on the small diagram enlarges it to a full-screen view.

The polar diagram shows the climb rate over the circular course of the glider. The screen-shots show a right circle, where the glider position is fixed to the left side, and the polar distribution of the climb rate is shown relatively to the current glider position.



The two screen-shots are taken in a few seconds sequence to demonstrate the practical usage of the rotating climb diagram. A simple recipe to optimise the climb rate according to the assistant would be to follow these two steps repeatedly:

1. : At the moment, the maximum peak on the polar diagram passes the top of the display; that is a quarter of the circle before you reach that part again: Open the circle a bit to displace the circle centre in the direction of the strongest climb rate.

2. : At the moment, the maximum peak on the polar diagram passes the gliders position; the vario should show the maximal climb rate: Narrow the circle as much as possible to centre the thermal updraft at its maximum.

It must be said, that the interpretation of the thermal assistant always relays on the specific lag of the connected sensor and PDA itself. A successful updraft optimisation will thus depend on a bit of training to take the lag into account.

7.10 Convection forecast

If the glider is equipped with an outside temperature and humidity probe, a simple convection forecast system estimates the convection ceiling and the cloud base. The humidity probe is optional and is mainly required for estimating cloud base.

Prior to takeoff or during flight the pilot can modify the maximum forecast temperature on the ground, by adjusting the value in the "Forecast Temperature" InfoBox.

The forecast convection ceiling is determined by the altitude at which the atmospheric temperature equals the maximum forecast temperature on the ground, cooled adiabatically as it rises according to the dry adiabatic lapse rate. Typically, the glider will not climb as far as the convection ceiling and so the measured values are extrapolated to find the ceiling. The dry adiabat starts at the elevation of the ground where the sounding began, taken from the terrain file at the first measurement after take-off, or from the take-off altitude without one. If the atmosphere is stable, no ceiling is found and the analysis page shows "—" in its place.

The maximum forecast temperature on the ground is entered using the flight settings dialogue described in Section 6.5.

The forecast cloud base is determined by the altitude at which the dew point intersects the maximum forecast temperature on the ground, cooled adiabatically as it rises according to the dry adiabatic lapse rate. If no clouds are forecast, no cloud base is found and the analysis page shows "—" in its place.

7.11 Analysis dialogue

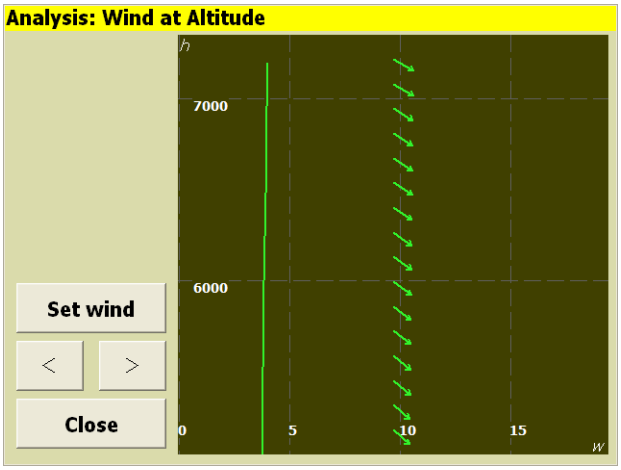
The analysis dialogue is used to see several aspects of the atmosphere.

Info 1 ▷ Analysis

Several pages of interest:

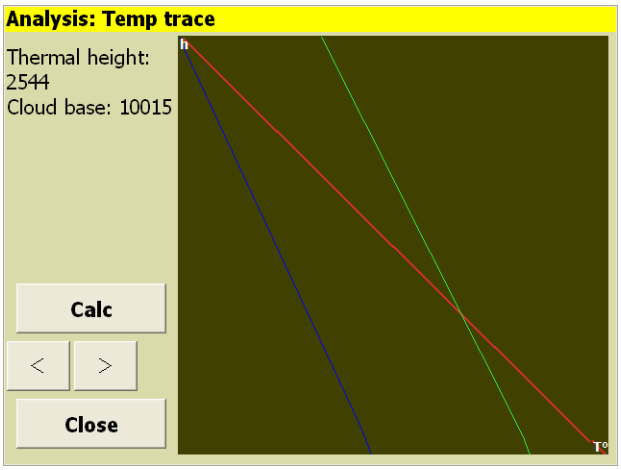
Wind at altitude : This shows a graph of the wind speed versus altitude, and shows the wind vector at several altitudes.

The 'Set wind' button opens the wind settings dialogue (e.g. to manually set the wind).



Temperature trace : This page is only available if a supported instrument is connected to XCSoar that produces outside air temperature and humidity. The chart shows the variation of dry air temperature, dew point temperature and outside air temperature with alti-

tude. The convection forecast is summarised as the estimated thermal convection altitude and estimated cloud base.



The climb history and barograph pages, described in Section 5.16, are also useful to determine trends in the soaring conditions.

7.12 Weather, METAR / TAF

Info ▷ Weather

If the hardware hosting XCSoar is able to connect to the internet, weather reports and forecasts can be downloaded. Present actual informations available are depicted by a little flag, pinned to the waypoint of the reporting station. To set up reports and forecasts, invoke the METAR and TAF dialogue. With Add a filtering screen for ICAO codes comes up. After typing and pushing OK another station is added to the list. Accessing the information is either possible via selecting an airport and pushing Details on the same screen or by touching the map invoking the "Map elements at this location" dialogue. The dialogue will show airports, airspaces……and weather data. If the flags are missing on the map, no actual information is available. Invoke the info dialogue and touch Update .

7.13 Weather forecast, RASP

Regional Atmospheric Soaring Prediction (RASP) is intended to provide detailed graphical weather forecasts for soaring purposes. For further details the pilot is invited to consult http://www.drjack.info on how RASP forecasts work, from where they are available, and their use and limitations. RASP forecasts use a specialized forecast model with a particular focus on boundary layer (BL) meteorology and convective processes.

You can find a list of available RASP forecasts at http://www.drjack.info/RASP. These are provided by various independent soaring and paragliding enthusiasts. Please note that some of these links provide data in-season only, and only some of these providers make data available in XCSoar format.

You can either install RASP data files yourself, or use XCSoar's built-in automatic download for many regions worldwide via the 'Site Files / Site Files' configuration page, 13.4, or the *Update* button in Info → Weather → RASP. In that RASP panel, *Auto update* (on by default) also refreshes an out-of-date or missing file when you open a RASP map page or when auto time has no data; turn it off for offline use.

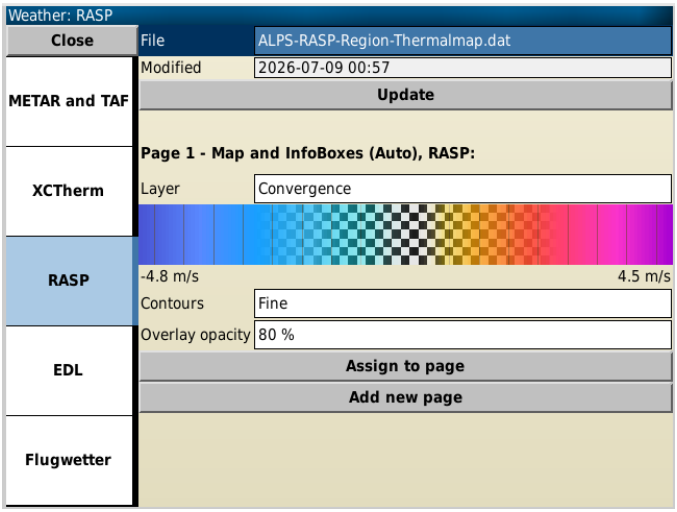
The files have `.dat` extension and the information is shown as colour-coded terrain overlays on the map.

Make sure that terrain display is set to "on".

Info ▷ Weather Setup

The main configuration dialog for RASP is in the weather setup via menu RASP . You select the RASP data file to display, and the data field to be shown. After choosing the the configuration, use Assign to page to assign that configuration to the current map page.

Alternatively, you can control which pages show weather data and how weather display is controlled via the page configuration (Section 13.22): Set *Map overlay* to *RASP*, choose the *RASP layer* for that page, and optionally set the *Bottom area* to *Weather controls* for in-flight forecast time control. This allows configuration of several pages quickly.



When the bottom *Weather controls* panel is visible, *Auto advance* follows the current local time. Turn it off to select a fixed forecast time. When entering a page with RASP overlay for the first time, XCSoar selects the next forecast time in the RASP file at or after the current time.

When a field is not available in the RASP file, the background is left blank. The current field name is displayed in the lower left corner of the screen whenever RASP data is displayed.

Info ▷ Weather Setup

RASP display configuration parameters are in the RASP tab in .

Global options are:

File : Shows the currently selected RASP data file and allows selection and download of other RASP data files.

Modified : Shows the last modification date of the currently selected RASP data file.

Update : Attempts to download the latest version of the currently selected RASP data file. This is available for RASP data files that were downloaded from the XCSoar repository. THe download is in the background, the data will automatically update once it is completed.

Layer : Selects the RASP data field to display on the currently active map page, indicated above the layer field.

Colormap : Below the layer selector, a colormap preview is shown for the currently selected RASP data field, with the scale given in the currently selected units.

Contours : Allows activation/deactivation of contour lines in the weather data, as well as the density of the contour lines.

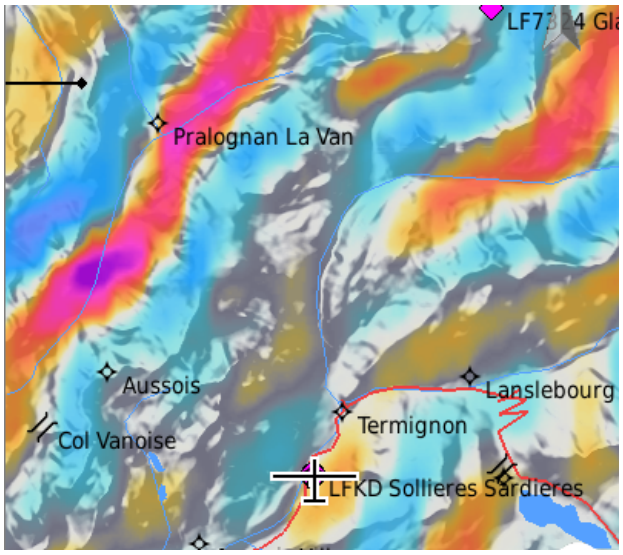
Opacity : Allows adjustment of the opacity of the weather overlay. Some weather layers are global and do not have a transparency channel, such as the surface temperature. This setting allows to make them partially transparent to enable the underlying terrain to shine through.
For RASP layers with their own transparency souch as wave lift or cloud cover, this setting only reduces opacity, it never overrides the transparency of that layer.

Assign to page : Assigns the currently selected RASP configuration to the currently active map page.

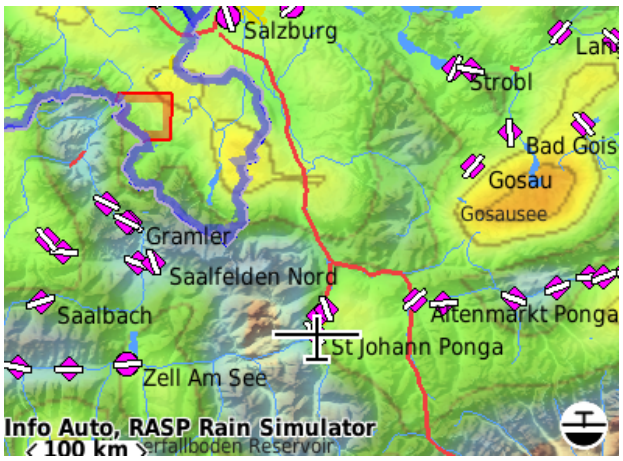
Add page : Creates a new map page with the currently selected RASP configuration after the currently active page.

The available fields can vary by data source. Some examples include:

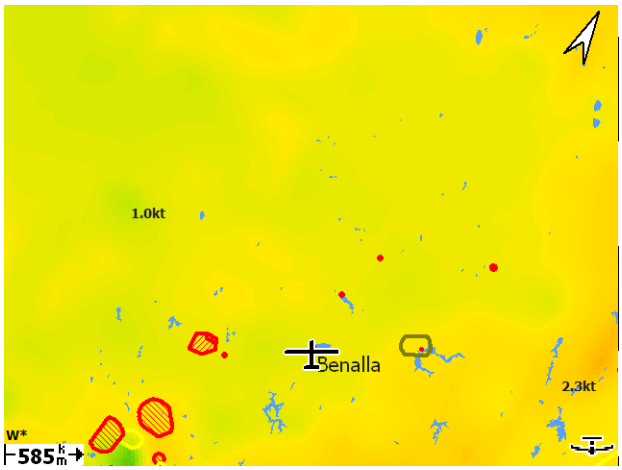
Wave : Vertical velocity of the air mass at the given altitude.



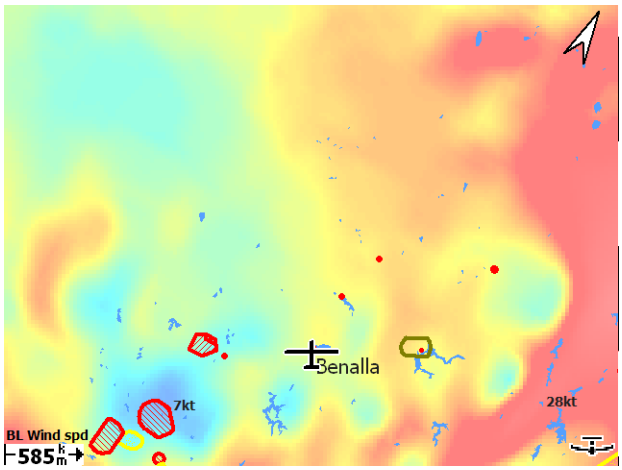
Rain : Predicted preciptation rate integrated over the forecast step interval (typically 15 minutes or 1 hour).



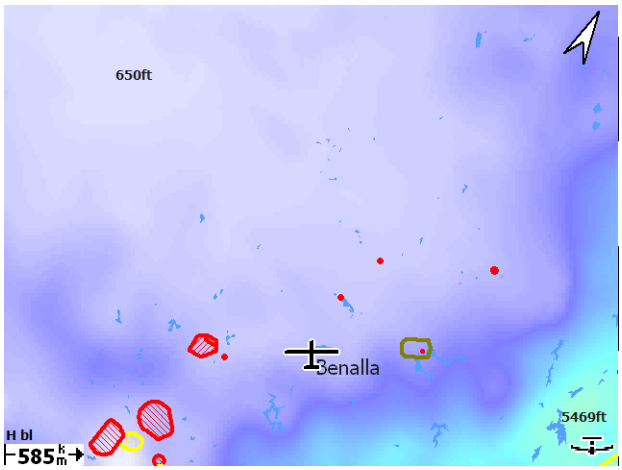
W* : Average dry thermal updraft strength near mid-BL height. Subtract glider descent rate to get average vario reading for cloudless thermals. Updraft strengths will be stronger than this forecast if convective clouds are present, since cloud condensation adds buoyancy aloft (i.e. this neglects “cloudsuck”). This value depends upon both the surface heating and the BL depth.



BL wind spd : The speed and direction of the vector-averaged wind in the boundary layer.This prediction can be unreliable if there is large wind shear through the BL.



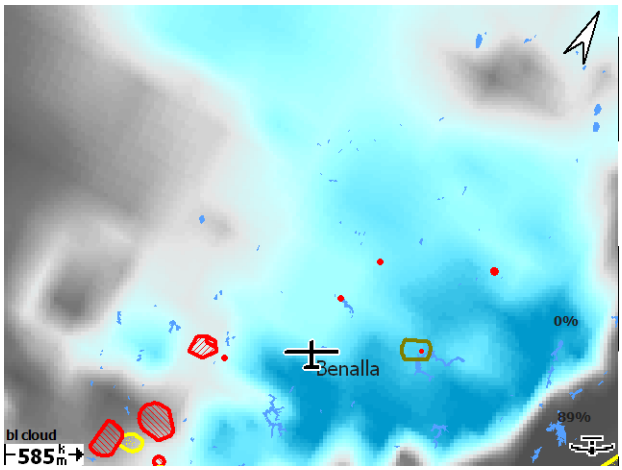
H bl : Altitude of the top of the mixing layer, which for thermal convection is the average top of a dry thermal. Over flat terrain, maximum thermalling heights will be lower due to the glider descent rate and other factors. In the presence of clouds (which release additional buoyancy aloft, creating "cloudsuck") the updraft top will be above this forecast, but the maximum thermalling height will then be limited by the cloud base. Further, when the mixing results from shear turbulence rather than thermal mixing this parameter is not useful for glider flying.



dwcrit : This parameter estimates the height above ground at which the average dry updraft strength drops below 225 fpm (1.1 m/s). This is expected to give better quantitative numbers for the maximum cloudless thermalling height than the BL Top altitude, especially when mixing results from vertical wind shear rather than thermals. (Note: the present assumptions tend to underpredict the max. thermalling height for dry conditions) In the presence of clouds the maximum thermalling height may instead be limited by the cloud base.

hwcrit : Same as *dwcrit*, but giving the altitude instead of the height at which the average dry updraft strength drops below 225 fpm.

bl cloud : This parameter provides an additional means of evaluating the formation of clouds within the BL, and might be used either in conjunction with or instead of the other cloud prediction parameters. It assumes a very simple relationship between cloud cover percentage and the maximum relative humidity within the BL.The cloud base altitude is not predicted, but is expected to be below the BL top altitude.



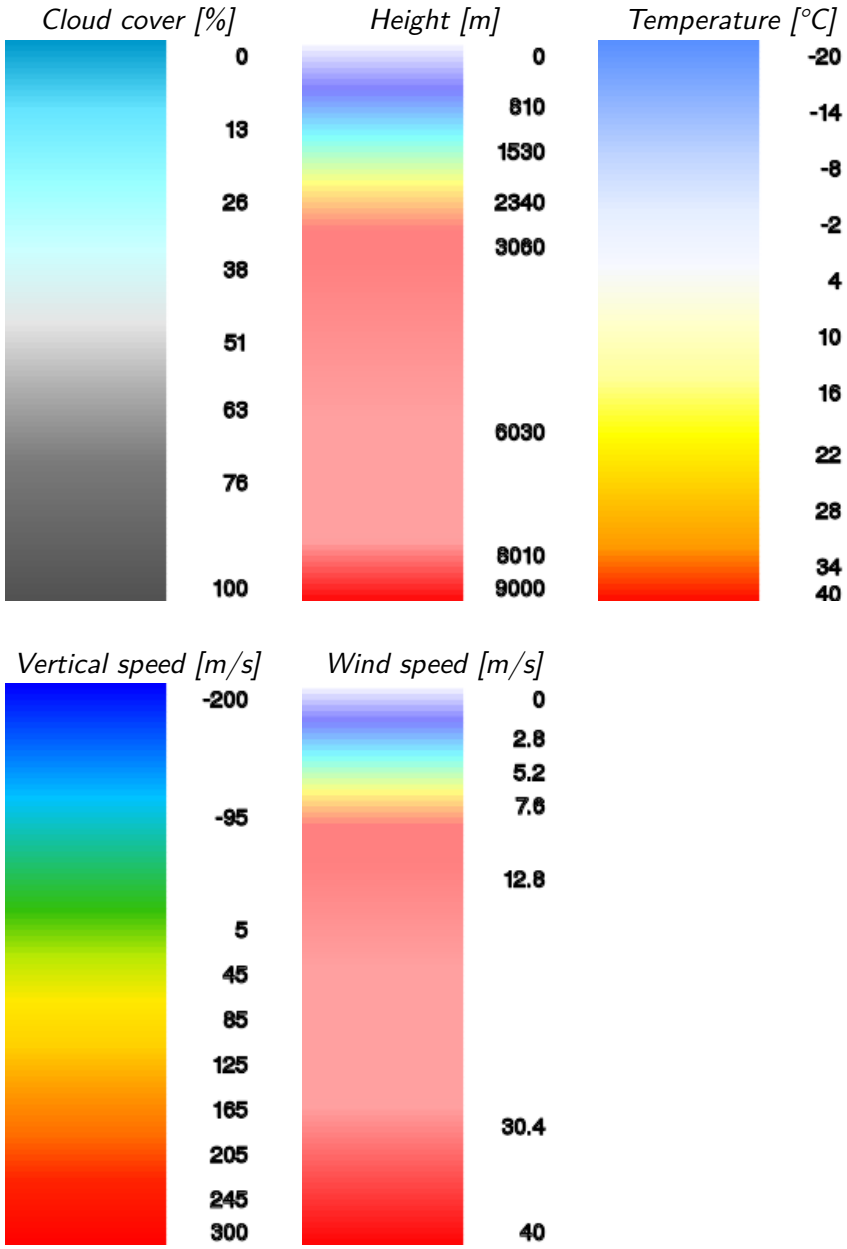
Sfc temp : The temperature at a height of 2 m above ground level. This can be compared to observed surface temperatures as an in-

dication of model simulation accuracy; e.g. if observed surface temperatures are significantly below those forecast, then soaring conditions will be poorer than forecast.

wblmaxmin : Maximum grid-area-averaged extensive upward or downward motion within the BL as created by horizontal wind convergence. Positive convergence is associated with local small-scale convergence lines. Negative convergence (divergence) produces subsiding vertical motion, creating low-level inversions which limit thermalling heights.

blcwbase : This parameter estimates the altitude of the cumulus cloud base.

The colour schemes used in rendering the RASP contours are illustrated in the table below.



7.14 Weather forecast, EDL Soaring

XCSoar can display wave-oriented weather overlays provided by the public EDL Soaring MBTiles service at https://www.edl-soaring.com/mbtiles/. XCSoar downloads the tiles on demand from EDL Soaring's public extraction service and stores them locally as `.mbtiles` files in the weather cache.

Before using EDL, enable *EDL Weather Page* in the system configuration under *System setup / Weather* (requires an OpenGL build with

HTTP support).

Info ▷ Weather

Tiles are cached locally. Open the EDL tab in or the EDL section in *System setup / Weather* to manage the cache:

Cached day : Show which UTC days are already stored in the local cache. A day is marked *Complete* when all 24 forecast hours and all five EDL levels are available locally, otherwise it is marked *Partial*.

Precache day : Download all 24 hours and all five EDL levels for the selected UTC day. This is intended for pre-flight preparation, so that the EDL data remains available when internet connectivity is lost in flight.

Clean other days : Keep only the selected cached UTC day and delete the other locally cached EDL days.

Configure a map page in the page configuration dialogue (Section 13.22): set *Main area* to *Map* (or *Map (north-up)*), *Map overlay* to *EDL*, and *Bottom area* to *Weather controls*. The in-flight bottom panel provides:

Auto advance : When enabled, XCSoar follows the next UTC forecast hour and selects the lowest isobar above the current aircraft altitude. Forecast and level selectors are disabled while auto advance is active.

Forecast : Select the forecast hour to display. XCSoar shows this time in local time for the pilot's convenience, but requests the data from the EDL service in UTC because the remote service expects UTC timestamps.

Level : Select one of the supported pressure levels. The EDL source provides the fixed isobars 500, 600, 700, 800 and 900 hPa. XCSoar also shows the approximate altitude corresponding to each isobar in the current pressure setting.

Entering a page with EDL overlay resets the display to the next UTC forecast hour and enables auto advance. The overlay legend in the upper right corner shows the active local forecast hour, the selected pressure level and its approximate altitude.

The same EDL overlay can be enabled on any map page by setting *Map overlay* to *EDL* in the page configuration.

The EDL source is intended for wave flying and provides rendered image tiles rather than raw meteorological grids. XCSoar therefore uses the EDL imagery as a map overlay and does not expose additional model parameters beyond the forecast hour and the fixed isobar levels published by the EDL service.

7.15 Rain radar

XCSoar can draw the European weather radar composite on the map. The data comes from EUMETNET's OPERA programme, is published under CC BY 4.0 and needs no account and no subscription.

Info ▷ Weather

The layer is listed as *Radar (EUMETNET OPERA)* on the "Overlay" page of the Info menu. Select it and press Use ; Disable switches it off again.

Selecting it draws the part of the newest composite covering the area the map is currently showing, so pan and zoom the map first and select the layer afterwards. Update fetches a fresh image for the area now visible. A new composite is published every five minutes.

13.22

A map page can also carry the radar permanently: set *Map overlay* to *Rain radar* in . The picture is then fetched in the background whenever the page is shown, without a progress dialog interrupting the flight.

It arrives in pieces, nearest first. XCSoar divides the area around the aircraft into a block of tiles and fetches them in rings growing outwards from underneath the glider, so on a slow or intermittent connection the weather you are flying into is drawn before the distant weather is. Each tile stays on the map on its own: flying on fetches only the tiles that come into range, and panning or zooming keeps whatever still fits.

This is also what keeps the feature affordable. The composite is one file of about five megabytes covering the continent, but it is tiled and carries a pyramid of reduced-resolution copies, and the server serves byte ranges, so XCSoar reads its index and then only those tiles it actually needs, at the resolution the map is drawn at. At the scales one flies at that is between two and three per cent of the file – typically a hundred and fifty kilobytes for the whole block, and about a hundred for the first tile, the one under the aircraft. Zoomed out far enough to see half the continent it is more, because more ground is being asked for.

While such a page is open, XCSoar watches how old the picture is. XCSoar asks for a frame seven minutes old, because one takes four to six minutes to reach the server after it is measured; frames are renewed every five minutes, so what is on the map is between seven and twelve minutes old. Once a frame passes twenty minutes it is removed from the map *before* a replacement is fetched, so a failing or slow connection can never leave a stale echo on display. If the replacement then fails to arrive, a warning says so; that warning offers to stop appearing, and can be switched back on with *Warn when radar expires* on the *Look / Language, Input* configuration page (Section 13.27).

The colours are the classes the Deutscher Wetterdienst uses for its own radar images, from cyan for the weakest echo through green,

yellow and orange to red and violet for the heaviest, so the picture reads the way German pilots are used to. Areas the radar network does not reach are left transparent rather than shaded, because the map underneath should stay visible.

Coverage reaches from the Azores to northern Scandinavia and from Iceland to eastern Europe; nineteen national weather services contribute.

Note that this feature requires and uses an internet connection.

This is not the radar of the *pc_met* dialogue (Section 7.17): those are the Deutscher Wetterdienst's own radar images, shown as pictures with the aircraft marked on them, and need a subscription.

7.16 Satellite imagery

XCSoar can draw Meteosat imagery underneath the moving map, so that terrain, airspace and the task are read on top of the cloud picture, at the map's own scale and orientation.

The imagery comes from EUMETView, EUMETSAT's public web map service. It needs no account and no subscription: the rendered products are CC BY 4.0, and the service declares neither fees nor access constraints. This is the same Meteosat data the Deutscher Wetterdienst sells on in its *pc_met* satellite images, taken one step earlier in the chain, and for the Meteosat Third Generation layers at a finer sampling than *pc_met* carries at all.

13.22

To switch it on, set *Map overlay* to *Satellite* in and choose a product under *Satellite layer*. Each page keeps its own choice, so one page can carry visible light and another infrared.

The products offered are:

European HRV RGB : the closest counterpart to the *pc_met vis_hrv* images, and the default.

Visible 0.6 µm (MTG) : the Third Generation imager at its finest solar sampling, about twice as detailed as the previous generation's high resolution channel.

Infrared 10.5 µm (MTG) : cloud top temperature, which works at night.

True colour (MTG) : and **Geo colour (MTG)**, composites that read like a photograph.

Rapid scan natural colour : renewed every five minutes rather than every ten, over Europe.

The imagery is fetched as a block of five by five tiles centred on the aircraft. At the scales a glider is flown at, a tile is about twenty-five kilometres across, so the block reaches at least fifty kilometres in every direction.

The tiles are requested *nearest first*: the one the glider is over, then the ring around it, then the next ring outwards. This is deliberate, because a glider's mobile connection is usually slow and often absent. The tile under the aircraft is about three kilobytes and is on the map almost at once; after nine tiles, some thirty kilobytes, the picture already covers the area a glider can reach, and the full block costs about eighty. If the connection dies part way through, what remains on the map is a complete picture of the ground that matters most, rather than a half-drawn one.

Only one tile is requested at a time. Stacking requests on a thin link makes every tile arrive late instead of the nearest one arriving early.

The tiles sit on the standard map tile grid, so flying on does not throw the picture away: when the aircraft crosses into the next tile, the tiles the new block shares with the old one stay exactly where they are and only the ones that have come into range are fetched. Panning fetches nothing at all.

Zooming the map *in* fetches nothing either — the satellite has no finer detail to give, so a closer look would only spend data enlarging what is already on the screen. Zooming *out* past what the block covers does move it to a coarser grid, so that the imagery keeps covering the map instead of shrinking to the middle of it. Each step is a halving, so an ordinary change of scale does not move it, and the coarsest grid spans a couple of thousand kilometres.

A frame is not on the server the moment it is taken; the delay runs from about thirteen minutes on the rapid scan product to half an hour on the slower composites, and XCSoar waits accordingly rather than asking for a picture that does not exist yet. EUMETView answers a request for a frame it does not have with an error rather than an older picture, so this margin is measured rather than guessed. As with the radar, a frame that grows too old for its layer is taken off the map before a replacement is requested, so a failing connection cannot leave yesterday's weather on display.

EUMETSAT's data policy requires the source to be named wherever the imagery is shown. XCSoar carries the attribution in the overlay's label, which the map shows when the image is tapped.

Note that this feature requires and uses an internet connection.

7.17 pc_met, Deutscher Wetterdienst

German weather service "Deutscher Wetterdienst" provides several useful meteorological images for XCSoar users. To use it, you need a (paid) account with their *pc_met* product.

Note that this feature requires and uses an internet connection. This may be expensive, depending on your mobile data plan.

To enable the feature, enter your *pc_met* credentials in XCSoar's system configuration. There are two username/password pairs: the first is for DWD's web services (on www.flugwetter.de), and the other is the FTP password (on ftp.pcmet.de).

Info ▷ Weather

During preflight check and during the flight, you can check weather forecasts and live weather data in the Info menu. Below "Overlay", you can choose layers for the map window. "pc_met" is a collection of live images which are usually displayed on the DWD web site www.flugwetter.de.

In the radar images ("Radar"), the satellite images ("Satellitenbilder") and in "Sat Rad Blitz", XCSoar draws the aircraft symbol at your current GPS position, as long as you are inside the map section shown by the image. Without a fix, or outside that section, the image is shown unchanged. The symbol is updated while the image is open, and it follows the zoom and pan of the image viewer. Note that these images use the polar stereographic projection of the DWD, in which the meridians converge; north is straight up only along 10° East.

For radar and satellite imagery drawn on the moving map itself, without a subscription, see Sections 7.15 and 7.16.

8 Airspace, Traffic and Team Flying

A database of Special Use Airspace (SUA) can be loaded into XCSoar and used for both display of the airspace regions as well as detecting when the glider enters and leaves the regions.

A list of airspace files can be set in the configuration settings. See Section 13.4.

It is the user's responsibility to ensure that the SUA database (airspace file) is up-to-date.

Through a connected FLARM device, the glide computer can also display information relating to FLARM-equipped nearby traffic and obstacle threats.

A team code function allows teams of pilots to exchange their positions via radio in a short code, encoded and decoded by the computer.

8.1 Airspace display

Local special use airspace regions are drawn on the map as shaded areas with thick borders. The colour of the areas is specific to different airspace categories and may be configured by the user. Depending on the settings, the user may choose to display all airspaces, only airspaces below a certain altitude, only airspace within a particular height separation, or only airspace below the glider.

Airspace areas are filled with a transparent colour so terrain and topography remain visible. Where airspaces overlap, all borders are drawn. Fill padding is drawn inside the airspace boundary, keeping overlapping borders visible.

A small label on each airspace shows its ceiling and base. Labels can be switched on or off with Label visibility in the configuration settings. See Section 13.5. When two labels would cover each other they are moved so both remain readable.

Both the display and warning of airspace classes can be individually enabled or disabled by the user as described in Section 8.4.

The default colouring of Class C, D, E and F airspace is consistent with ICAO charts.

NOTAM airspace

XCSoar can download NOTAM affected areas and display them as airspace on the map. This function is intended for situational awareness only and does not replace a proper pre-flight NOTAM briefing.

NOTAM support is enabled in the system configuration under *Map Display / Airspace / NOTAM*. When enabled and a valid position and Internet connection are available, XCSoar downloads NOTAMs around the current position using the configured search radius. The downloaded NOTAMs are added to the normal airspace display and can be queried from the map like other airspaces. The details page shows NOTAM-specific information such as the NOTAM number, ICAO location, Q-code, validity period, altitude limits and text.

XCSoar keeps the downloaded data small. It stores the NOTAM cache in the data directory and reuses it while it is still valid for the current position, radius, API URL and refresh interval. If the aircraft moves outside the loaded area and Internet access is available, XCSoar loads a new area for the configured radius. Automatic updates are also performed from time to time according to the configured refresh interval. XCSoar requests incremental updates based on the NOTAMs already known instead of downloading all data again.

To avoid overloading the map and the pilot with low-value notices, NOTAM filters are enabled by default. The default settings hide:

- IFR-only NOTAMs,
- NOTAMs which are not currently effective,
- NOTAMs with an affected radius larger than 100 km, and
- NOTAMs with the Q-code prefixes `QA`, `QK`, `QN`, `QOL`, `QOA` and `QOBTT` (administrative, checklist, navigation-aid and obstacle-lighting or obstacle-administration notices).

The filters can be adjusted in the NOTAM configuration page. The settings page also shows how many loaded NOTAMs are filtered by each filter, and the List button can be used to review the current NOTAM list. Use Refresh to manually request a new download for the current position.

Incursion events

Three types of events are detected by XCSoar in relation to SUA:

Predicted incursion : This event is detected when the glider is estimated to be on a track that will result in entering the airspace at a set time in the future. The time is the airspace 'warning time' configuration setting.

The use of a long term average track in these calculations means that the system can still predict incursion even when drifting in the wind when circling.

Entering : This event occurs when the glider enters an airspace region.

Leaving : This event occurs when the glider leaves an airspace region.

In all cases, the boundary of the region is defined by maximum and minimum altitudes or flight levels, as specified in the airspace file.

Airspace warnings are still issued even if the incursion region is off-screen.

Where a barometric altitude source is available, it is used preferentially to GPS altitude in detecting airspace incursions. This makes the system conform to normal conventions of having airspace violations based on QNH-adjusted altitude.

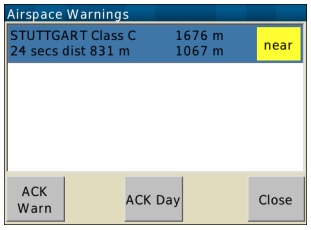
8.2 Airspace warnings

The concept of airspace warnings in gradual levels is introduced:

None : Aircraft is outside and distant from airspace.

Near : Aircraft is predicted to penetrate the airspace and is close to doing so.

Inside : Aircraft is inside airspace.



At all times XCSoar monitors the aircraft relative to all airspace and maintains warning levels for each. The airspace warnings are still filtered according to the airspace filter preferences; such that certain categories of airspace may be effectively disabled. The sequence of events when entering an airspace results typically in two warnings: when near (level 1), and when inside (level 2).

Whenever the warning level increases (above level 0) for any airspace, the airspace warning dialogue appears, and XCSoar says "Airspace near.", "Airspace above." or "Airspace inside." "Airspace above." is used when the airspace is overhead and there is no horizontal distance. "Airspace near." and "Airspace above." have a short pause between the two words. When there are no more airspace regions at warning levels above 0, the dialogue disappears automatically.

Airspace warning dialogue

The airspace warning dialogue contains a list of up to 4 individual warnings. The list items status background is coloured red if the glider is inside, and yellow if near. If the warning is acknowledged, the text is greyed out.

Each list item occupies two rows, and includes the following details:

```
<NAME and Class>                <TOP>   <Position>
<Time and distance if outside> <BASE>
```

The values in the list are continuously updated. An example follows:

```
Bern TMA Class D                 FL100      near
35 sec horizontal dist 1300      1750m
```

This means that the aircraft is 1300 m horizontally separated from the Class D airspace 'Bern TMA', with a base of 1750 m and ceiling at FL100.

Another example:

Bern CTRgld Class C	1350m SFC	inside

This means that the aircraft is inside the Class C airspace 'Bern CTRgld', with base of terrain surface and ceiling at 1350 m.

If there are airspace warnings any time the airspace warning dialogue is shown you get the details to an airspace by touching it.

Airspace warning acknowledgement

When the warning dialogue is visible and an airspace warning is active, it is possible to close the warning dialogue without acknowledging the warning. Depending on the hardware used you may press ESC (on PC) or the Close button.

When one or more warnings are visible in the airspace warning dialogue, a warning can be acknowledged by pressing one of the buttons along the bottom of the dialogue.

The meanings of the acknowledgement buttons are as follows:

ACK Warn : Acknowledge the current warning level. A new warning will appear only if the warning level increases.

ACK Space : Acknowledge all current and future warning levels from this particular airspace region while the aircraft is within 2.5 km horizontal separation and 500 m vertical separation.

ACK Day : Acknowledge all current and future warning levels from this particular airspace region for the rest of the flight (specifically, until XCSoar is restarted).

Enable : Cancels an acknowledgement of the airspace, to reactivate all warnings from this space.

Close : Closes the airspace warning dialogue, without acknowledging airspace. The dialogue will re-open automatically if the airspace warning level increases.

Note that not all acknowledgement buttons may be visible for all warning levels. In particular, if inside SUA, you do not have the option to Acknowledge the Warning (ACK Warn), since it is at this point no longer warning of an impending airspace incursion, but in fact stating that you are currently inside the airspace.

The general guidelines for using the dialogue are:

- Don't acknowledge a warning if you intend to or must avoid the airspace

- The spoken alert occurs when the warning level increases, and is repeated while the warning remains if Repetitive sound is enabled.
- The warning system is designed to allow circling near an airspace without over-stressing the pilot with extraneous warnings.

When an airspace region is acknowledged, the region is drawn as an outline only.

When the aircraft is predicted to enter an SUA region, or it actually enters an SUA region, a warning is raised, presented as an audio alert and a status message describing the type of airspace warning, and some SUA details (including class of airspace, base and ceiling altitude or flight level).

Acknowledged warnings will repeat after a certain time specified as the 'Acknowledge time' in the configuration settings.

Airspace warning acknowledgements apply to individual SUA regions. If, for example, a glider enters airspace A and the pilot acknowledges the warning, and shortly thereafter is predicted to enter airspace B, an airspace warning for SUA region B will be raised.

If you want acknowledged airspace warnings to not be repeated, set a very large value for the configuration setting 'Acknowledge time'.

Airspace warnings are automatically cleared when both the current glider's position as well as the estimated future track are clear of the airspace.

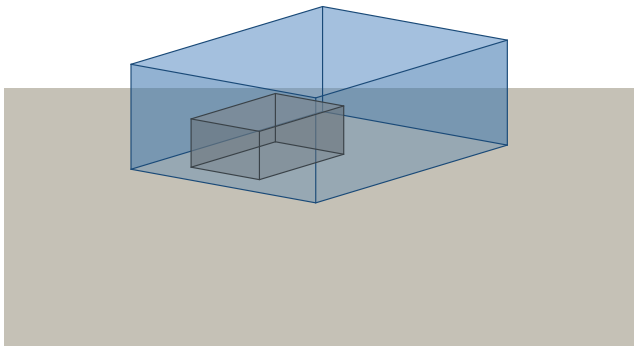
Simultaneous airspace warnings can occur if the aircraft (or its estimated future track) penetrates multiple airspace regions.

8.3 Airspace Clearances

Airspace clearance is a status that can be granted to an airspace region to indicate that the pilot has received ATC clearance, or is otherwise permitted, to operate inside it. It is distinct from the *acknowledge* function: acknowledging an airspace suppresses warnings for an airspace the pilot wishes to *avoid*, whereas granting clearance marks an airspace the pilot is *allowed to enter*.

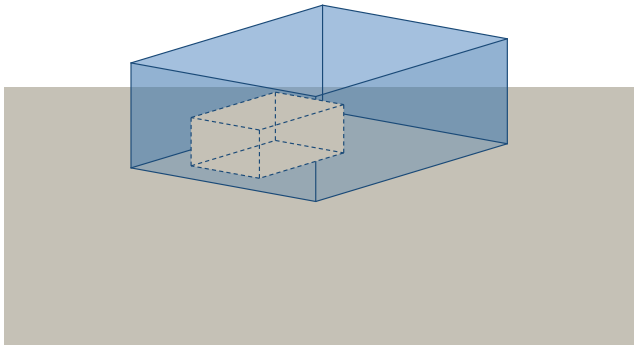
Concept

The typical use case is a glider sector or club operating area situated inside a larger restricted airspace (e.g. a CTR or TMA). The glider sector has a lower ceiling than the surrounding restricted zone, so the pilot is permitted to fly within the sector but must stay below the ceiling and within its horizontal boundaries.



The large blue restricted airspace slab with the grey glider sector (lower ceiling) situated in one corner.

Once the pilot grants clearance on the outer (larger) airspace, XCSoar computes the volume that remains *outside* the cleared area and treats only that volume as restricted for warning purposes. Warnings that would arise solely because the aircraft is inside the cleared sector—and nowhere else—are suppressed. While you are inside the cleared airspace, another you are already under goes quiet too when it has no boundary ahead. A boundary still ahead keeps warning, including a climb that reaches the top of the cleared airspace within the warning time.



Warning volume after clearance: only the blue L-shaped remainder (outside the cleared sector) triggers warnings. The dashed outline shows the cleared sector boundary.

Effect on warnings

The clearance suppression is applied in two passes after the normal warning computation:

Inside warnings : If the aircraft is physically inside a cleared airspace and also inside a second, non-cleared airspace, the inside warning for the second airspace is suppressed provided the aircraft's position is fully covered by the cleared volume.

Approach warnings : If the predicted flight path enters a non-cleared airspace but the portion of the path that triggers the warning lies entirely within a cleared airspace, the approach warning is suppressed.

Warnings are *not* suppressed when the aircraft is approaching the boundary of the cleared airspace from the inside toward a restricted zone beyond it. For example, if the pilot climbs toward the ceiling of the glider sector, XCSoar will still warn when the predicted track exits the sector ceiling into the surrounding restricted airspace.

Granting and revoking clearance

Clearance is granted and revoked through the airspace details dialogue, which is accessible in two ways:

- Tap the airspace region on the map, select it from the map item list and press Details .
- Open the airspace selection dialogue (Info. 3 ▷ Airspace), locate the airspace and press Details .

The details dialogue contains a Set Clearance button. Pressing it grants clearance for the selected airspace for the remainder of the flight session (until XCSoar is restarted). A cleared region shows a green **Cleared** badge in the map item list, the airspace list and the airspace warnings, whether the aircraft is inside it or not. When clearance is already active, the button label changes to Revoke Clearance and pressing it removes the clearance immediately.

Clearance is granted per individual airspace region, not per class. To cover a glider sector you must open the details for that specific sector, not for the surrounding restricted space.

Per-class clearance permission

Not every airspace class is appropriate for clearance. Granting clearance on a very large region—such as a Flight Information Region (FIR) or UIR—would suppress warnings across an enormous area and is rarely the pilot's intent. XCSoar therefore has a per-class *clearance permitted* flag.

This flag is configured in the Airspace Filter dialogue (Section 8.4). The filter list now shows three checkbox columns: **Show**, **Warn**, and **Clrnc**. The **Clrnc** column controls whether clearance may be granted for that airspace class. When the box is unchecked, the Set Clearance button in the details dialogue is disabled for all airspaces of that class.

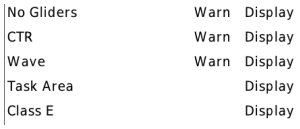
By default, clearance is permitted for most classes and disabled for information regions (FIR, UIR, FIS Sector) where it serves no practical purpose.

Granting clearance on a large airspace such as a FIR will suppress warnings for all overlapping airspace within that region. Use this function only for well-defined, smaller areas where you have explicit permission to fly.

8.4 Airspace query and details

For touchscreen/mouse devices, when an airspace region is visible on the map area, it may be queried by touching the region on the map. The map item list will appear and give you an overview of the waypoints, airspaces, etc. below your finger tip, or mouse pointer. SUAs are listed with similar details as provided when an actual warning is raised. The query returns all airspace regions when overlapping airspace is visible at the query location. Selecting the SUA on the list and pressing Details or the enter key displays all airspace details.

Airspace filter dialogue



The Airspace Filter dialogue allows warnings, display and clearance permission to be enabled or disabled for each class of airspace.

This may be accessed several ways:

- From the main menu Info. 3 ▷ Airspace .
- Or at the system configuration page for airspaces, press the Filter button.

The list shows one row per airspace class with three checkbox columns:

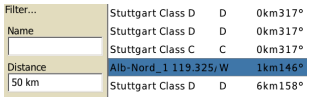
Show : Controls whether the class is drawn on the map.

Warn : Controls whether approach and inside warnings are generated.

Clrnc : Controls whether the Set Clearance function is available for airspaces of this class. See Section 8.3 for details.

To use the dialogue, tap or click a checkbox to toggle it directly, or move up or down the list and press the enter key to cycle the **Show** column.

Airspace selection dialogue



Pressing the Lookup button brings up the airspace select dialogue. This functions similarly to the waypoint lookup dialogue, and allows search based on name, distance, direction, and type (class).

Once an airspace item has been located, you have the chance to acknowledge it for the day. That acknowledgement also covers a surrounding airspace you are already under, and it remains until you re-

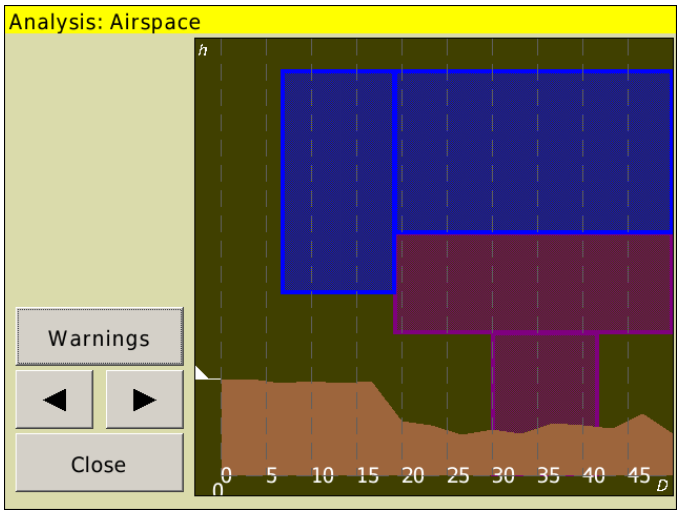
enable the item. From the airspace management dialogue it is possible to re-enable it again.

8.5 Analysis dialogue

Info 1 ▷ Analysis

The analysis dialogue contains a page showing a cross-section of the airspace.

The display shows along the horizontal direction, the distance from the glider out to 50 km in the direction of the glider's track; along the vertical direction is altitude. The altitude of the glider is indicated by a white arrow. This page is useful to help visualise complex layering of airspace.



The "Warnings" button opens the airspace warning dialogue if close to airspace.

8.6 FLARM traffic

If connected to a FLARM device, FLARM traffic is displayed on the map area. Each FLARM aircraft received is drawn as a dashed red disk.

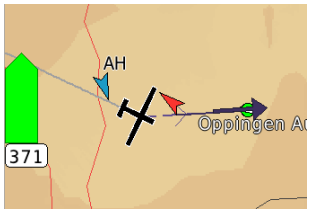
Do not use XCSoar for collision avoidance, as FLARM audio devices are much more suitable in assisting the pilot to be aware of traffic.

Note that unless one is circling, the usual zoom level is such that FLARM traffic will not be easily distinguished. When one is circling, the zoom level might be appropriate, but continuous direction change and the typical latency of a PDA makes the map display a poor aid at helping to locate the traffic.

FLARM map display

The FLARM targets on the map are drawn as red coloured arrow heads to indicate the direction the FLARM target is heading, as well as the

13.6



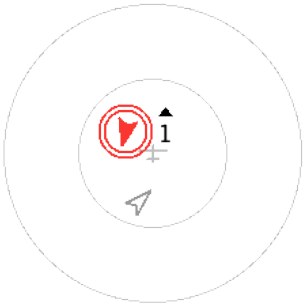
collision risk. Note that these arrow heads are oriented according to the display orientation. For example, if the orientation is track-up, then the arrows show the relative track bearing of the target to the aircraft. If the orientation is north-up, then the arrows show the absolute track bearing of the target.

Display on the map FLARM of aircraft registration or pilot name is made possible via a look-up of the ICAO aircraft ID of FLARM traffic in a file. See Section 14.11 for details on this file format. Aircraft with the FLARM privacy flag set will not have any identification displayed.

FLARM radar

To remedy this situation, when FLARM traffic is received, XCSoar shows a small radar-style view of the FLARM traffic from the perspective of the aircraft. The FLARM traffic is displayed in identical style, except that the threatening traffic is emphasized with one or two red circles around the arrow head icon. The display corner used for the small radar view can be configured.

13.16



This FLARM display is oriented track-up and a small glider icon clearly shows that the display is oriented as such. The scale of the display is linear up to maximum distance of 2000 m. On the background there are two rings; the first is a 1000 m radius and the second is 2000 m. Traffic farther away than 2000 m is drawn at the 2000 m ring. When traffic is farther than 4000 m away, the small radar view disappears.

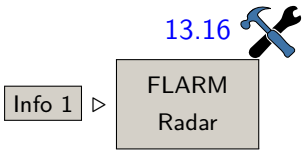
All the FLARM displays shows FLARM traffic in colours according to the threat level, or team and dialogue status. The traffic is coloured:

- No color for level 0, no threat.
- Yellow for level 1, warning.
- Red for level 2 and 3, alert.
- Green for the team mate.
- Blue is the selected target.

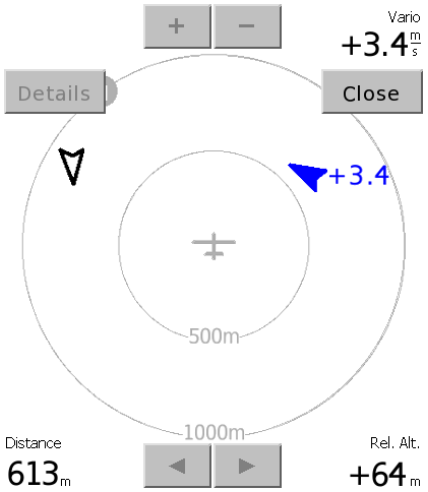
For every target above threat level 1 the rough relative height is shown. The supplied figure is the absolute height difference rounded by 100. A small triangle indicates that the target is higher or lower than you. The example radar shows a target approximately 100 m (for metric altitude) higher.

The FLARM radar-like display, when enabled, can be suppressed when visible by pressing the enter button. If the FLARM radar is suppressed, pressing the enter button again cancels the suppression and the radar is shown again. When new traffic appears in the radar, or if the FLARM issues a collision warning, the suppression is canceled.

FLARM Traffic dialogue



Once FLARM has reported traffic and the small radar-style view of the FLARM traffic gets activated you can tap on the FLARM radar to enlarge the view to fullscreen size. The fullscreen FLARM display offers all available information about the FLARM traffic and depending on the setup it closes by itself, when all traffic has gone.



Only a few controls are on the dialogue, from top down:

North up : If checked the radar screen is oriented North up, if not the orientation is Track up.

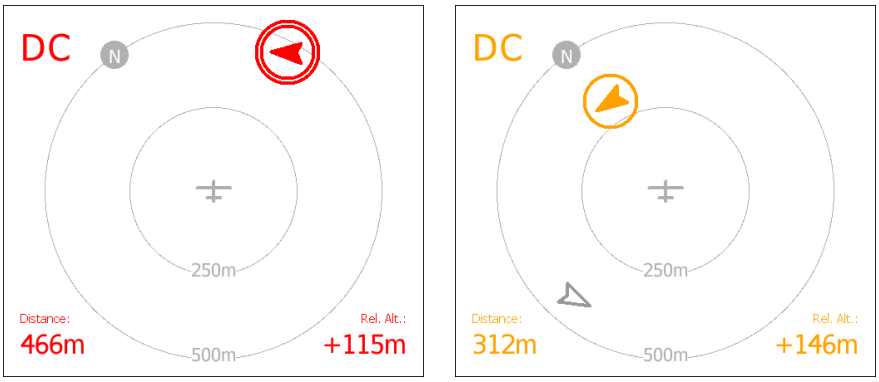
A. Zoom : Automatic zoom scales the radar screen so that the targets are perfectly visible. If not checked, the screen must be zoomed manually. The Up-Down gesture activates the automatic zoom.

Avg/Alt : The button toggles in-between average vario and altitude displayed next to the target.

Details : Through the button a separate dialogue with all details to the selected target is accessed.

+/- : Manually change the zoom from 500 m to 10 km radar range. The zoom gestures also apply here.

◁/▷ : Select the previous or next target on the radar, gestures work in the same manner.



The three screenshots are taken in a sequence and demonstrate a typical near pass of e.g. two FLARM equipped gliders. The extra information is colour-coded in the already mentioned way. In the four corners of the radar screen is additional info to the selected target displayed:

Top left : If available the FLARM ID of the selected target.

Top right : Vario of the target, derived from the consecutive altitude messages.

Bottom left : The distance to the target.

Bottom right : The relative height of the target.

From the first to the second FLARM snapshot about 15 seconds elapsed. The selected blue target was climbing at 3.4 m/s and did not have a relative course recognised as a threat. Then in the meantime the 'DC' has turned more to the left, became an alerting threat and is now displayed red. The FLARM radar switched the zoom from 1000 m to 500 m. In snapshot three the continuously climbing target becomes classified to threat level 1, gets coloured yellow and seems to no longer be a threat.

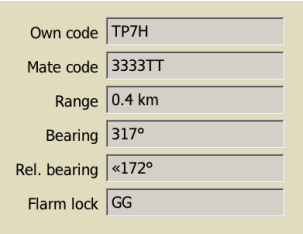
8.7 Team flying

Team code is a system to allow pilots flying within a team to communicate their position to each other in a concise and accurate manner. The principle of the system is that each pilot uses their computer to determine a 5 digit code which describes their position relative to a common waypoint. The pilots call each other reporting these codes, and entering the codes into the computer allows their mates to be located accurately by the computer.

Info 2 ▷ Team Code

To use the team code, all pilots in the team should select a waypoint to be used as the reference. This is all done on the team code dialogue. The reference waypoint is set via the Set WP button. Select a waypoint from the lookup dialogue and it will be the team reference.

During flight, the pilot can read out his 'Own code' from the team code dialogue to his team mate, in order to report his position. When the



FLARM ID lookup

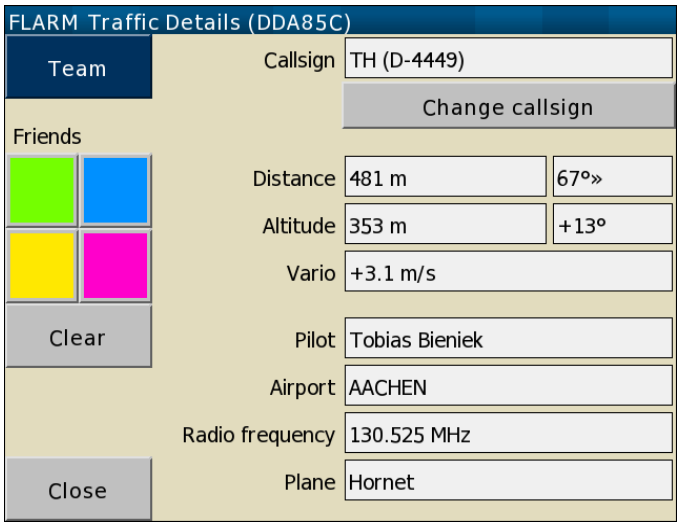
pilot hears a code report from a team mate, he presses the Set Code button to open the text entry dialogue to allow entry of the mate's code.

After entering the mate's code, the relative distance and bearing to the mate is calculated and updated in the dialogue.

XCSoar also supports the encrypted team codes from the FlarmNet initiative. The Flarm Lock button allows you to access the FlarmNet database as well as XCSoar's database for FLARM to find a team mate. A simple lookup for a competition ID delivers potentially the desired FLARM identity. Selecting the desired data base entry from the found items allows you to 'lock' your buddy from afar. See Section 14.11 for where to find the FlarmNet database etc. explained in detail.

Info 2 ▷ FLARM Details

Similar functionality provides the FLARM details dialogue. It also lets you search through the competition ID's in the data base and shows the details on it.



Click your buddy

Even if XCSoar can 'lock' only one team mate by reference waypoint, it handles any number of 'friends' with a known FLARM ID. Chances are high your buddy is not registered in any database. But in any case you get closer to your flying colleague, just pick the details from the FLARM radar screen, choose a colour and XCSoar will identify this FLARM response in the future as your buddy.

9 Integration

9.1 Building an XCSoar system

Integration is bringing together all things and actions in an entity for building a *system* providing desired functionality. Things needed are hardware components, software, database files, configuration, power supply e.a. and glue components. As you might have expected, this chapter deals with integration of XCSoar, with the components of interest:

- Hardware XCSoar runs on: Android, iOS, Windows, Linux, macOS, Kobo...
- XCSoar software
- Flight information databases: terrain, waypoint, weather, polar, FlarmNet, airfield details...
- Instruments: barometer, vario, FLARM, logger, horizon...
- Backup components: second XCSoar unit
- Mounting
- Configuration: XCSoar internally and connections with
- User training

No system ever runs without using some components providing no primary function of interest, but some "glue", holding things together. Most likely your XCSoar system needs one ore more of these glue components as are: Cabling as well as data, signal, and power *converter* and signal *multiplexer*.

Finally, there are things, a pilot may not think of when doing integration work. However, if you want to get the max from your XCSoar system, allow for optimal interaction with other systems via *interfaces*.

- Remote tracking server (skylines) / Cellular network reception and coverage
- GPS satellite network / GPS reception
- Remote database servers / data translator
- XCSoar.org / contact channels as given in chapter introduction

So now, it is time to end with systems theory and dive into reality. With countless valuable system setups possible, just a few examples of XCSoar systems are given. This is meant as a starting point for the keen pilot. This manual in no way represents a full-fledged integration

guide. The five examples described will follow the path of integrating more components, starting with a "basic" system, consisting of one single piece of hardware only.

9.2 Exemplary XCSoar system setups

Due to the fact that this manual is not intended as an advertising publication, several components terms used in the following stand for a class of devices. For gathering information on hardware products, please consult XCSoar's website https://xcsoar.org/hardware/, XCSoar's forum https://forum.xcsoar.org or ask google. With terms *emphasized* you are already equipped with keywords for invoking a search and discover tour.

XCSoar Basic

Setup

Handheld with XCSoar and a built in GPS receiver and basic data stock, provided by XCSoar website and the national agency of your country, providing airspace data.

Functionality:

An XCSoar basic setup will give you an almost perfect moving map with a great basic flight information system (FIS) functionality. The glide computer will give you flight-related tactical *and* statistical data if polar configuration is correct. Please note that realtime computations of actual climb or sink rate may suffer drastically from poor GPS reception, as built-in GPS receivers often are cheap add-ons in a mobile device's budget. In any case, please give it a try in the air. Some of these cheap GPS receiver add-ons come with bad GPS antennas and sometimes are heavily dependent on local information of your cellular network provider. This dual mode locating function is called aGPS - assisted GPS. As mobile network coverage gets worse up in the air, your devices location fix follows. If your mobile device shows stable reception, you achieved a good one.

Application

XCSoar basic is the utmost club-friendly setup out of all. With no additional hardware needed, you own a valuable system with no intrusion into club gliders necessary. A basic system might be helpful if all of your club mates are rather conventionally oriented or if you are a parachutist with very little instrument space.

XCSoar Classic

Setup

An XCSoar classic system is a basic system plus a *FLARM* connection. As long as the family of FLARM and FLARM-like hardware uses serial communication ports, a first piece of glue hardware appears necessary in many cases. There are several pieces of hardware available, converting signals from FLARM's serial port to either USB or even Bluetooth radio link.

Functionality

As you might have expected, FLARM itself gives you a collision detection system. Added integration value first of all might be a rock-steady GPS reception. With precise GPS fixes, XCSoar's actual readings improve a lot. Still, reception is heavily dependent on the pilot's mounting of the GPS antenna. Place it in a definite professional manner and verify reception.

Further added value of FLARM devices is giving you an air pressure measurement. This enables XCSoar to compute QNH height. It is much more precise than height derived from the GPS calculations due to the fact that GPS height is the value with the worst precision out of all publicly available GPS measures. Uncertainty in height is around 50 m.

Additionally, XCSoar takes the position data of others around you from FLARM and draws "FLARM targets" on your moving map. Displaying climb rates of others, a classic XCSoar system aids in team flying. As long as reception is good, you do not have to call your mates whether their efforts in thermals are worth it or just for asking where they actually are. Last but not least, FLARM can bring in an IGC-approved logger. You will need this to participate in several contests, as the logger has been approved and sealed.

Application

An XCSoar classic system also is club-glider friendly. If your club-gliders are equipped with a plug, intended for managing or downloading from FLARM devices, you can connect with almost no intrusion in the glider's instrumentation structure. Whatever you are willing to integrate in your XCSoar system, said functionalities of a classic system turn out to own a very good value / integration effort ratio.

XCSoar Classic+

Setup

Bring in an additional *ADS-B* receiver. With rapid market penetration of FLARM, a very welcome collision detection coverage in the glider

scene is achieved already. However, this is not the case with powered aircraft. If you want to have motorized targets to be depicted on your moving map, consider an ADS-B receiver on your integration list. Integrating a FLARM and an ADS-B receiver is a first example for integrating two sources of data. Possibly you need a multiplexer in case your hardware XCSoar runs on has only one communication port. Either purchase a hardware multiplexer or use Bluetooth functionality. Most smartphones come with a Bluetooth built-in multiplex functionality. Another way is to achieve a *Power FLARM* device, already equipped with a multiplexer for both FLARM and ADS-B data.

Functionality

ADS-B stands for Automatic Dependent Surveillance - Broadcast. This radar based system broadcasts position of equipped aircraft even if they are not pinged by ground primary radar. If you plan to use such a device, please plan to do a careful system setup too. As long as you are not interested in commercial aircraft travelling in upper flight levels, you probably need no information about them on your map. Also, radar transponders are made as long range systems. Simply set up several filters in your system in order not to crowd your moving map.

Application

Increased situation awareness support. However, many pilots judge ADS-B being information overkill as do many representatives of ground control organisations. *Please* take your time when reading discussions on ADS-B usage in gliders *before* purchasing hardware. Technically speaking ADS-B is brilliant as is FLARM.

XCSoar Tactic

Setup

Integrate an electronic variometer with your classic system, an *eVario*. Since an eVario is expected to be a second piece of hardware to be connected, you might need a data multiplexer for connecting both FLARM and eVario to your XCSoar hosting hardware. Take your time studying the hardware features of your eVario of interest. There are some devices selling which bring with them a multiplexer for merging GPS and other data from FLARM with their own measurements presented on an output. Additionally a voltage converting power supply might be included on that output port, ready for supplying a "data plus power package" for your XCSoar hardware.

Functionality

XCSoar's tactical computations will give you valuable estimates of positions in reach, provide heading, bearing and sophisticated information on times needed to reach waypoints and much more... With the

actual wind vector being a very important value which those computations rely on, an eVario will greatly improve XCSoar's wind estimates by turning the "value" wind estimate to an actual wind "measurement" value (although the wind vector remains an estimate). Obviously, an eVario also will give you precision actual lift/sink measurements.

With all tactical computations being dependent on your actual estimates of MacCready and polar degradation, you might find synchronising your input to both, eVario and XCSoar useful. It is just a matter of setting up things to do so.

Application

Get the best tactical data in flight a glider pilot can get. :-))

XCSoar Competition

Setup

Put additional data files in your tactical system such as tasks and waypoint databases, amongst others. To input various file formats it might be necessary to involve a data converter. Additionally you might set up extra screen pages, covering competition related measures.

In case, a competition hosting / umbrella organisation alters task rules, there is a chance that something turns out to be done by XCSoar's developers. Suddenly facing a newly introduced crude task rule, you develop awareness of a need for developer's support urgently. At that moment the XCSoar organisation is perceived as being an important part of your XCSoar system.

Please input any *important* information to the XCSoar community promptly. All the developers will do their best keeping up with changes as are competition rules for example. But please keep in mind, XCSoar is an open source project, performed by *volunteers*. The earlier you provide information on changes, the better your chances in gaining support from the XCSoar community. Nevertheless, all said holds true for commercial suppliers as well.

Functionality

The task files put in will ensure you are equipped with precise task data. No error-prone manual input.

The additional screen pages will give you InfoBox readings, related to several phases of the competition. Just to give you a clue, the InfoBox "Start open / close countdown" appears to be useless in all day flying situations? Put it on a screen page other than your standard ensemble.

Application

No comment.

XCSoar Reference / Developer

Setup

Put in either component, not yet mentioned in your XCSoar setup. Please be aware, that the XCSoar project is targeting the best support of VFR type soaring possible. With inputting other functionality, you probably enter a space of ongoing experiments having attracted some attention in the XCSoar community. Especially when integrating an *AHRS* (Attitude Heading Reference System) system: You are handling non-certified components. *ALL THINGS, JUST EVERYTHING* you do with XCSoar software is at your own risk. With focusing on setups up to the tactical class of systems, the XCSoar community pays lot of attention to providing stable code (software). With some integration issues being rather exotic, you leave the field of primary focus. There might be too few users for providing a secure testing base for exotic features. Although, all the times XCSoar's code itself is maintained for stability as long as you are involving *released* code.

Functionality

Although not being the focus of every XCSoar user, you should follow the development process in order to get an up to date survey on additional functionality. There is a chance it might pay off. Just to give a few examples:

- With an AHRS type device you are able to use an artificial horizon.
- RASP data are for lee wave pilots
- Additional airspace files, focusing on *glider* pilot's needs.
- Hardware command input devices, provided by enthusiastic hardware developers (there even were few cases, pilots involved gamepad hardware!)
- About possible future things: New components classes to be integrated under discussion might be transceivers, motor management, transponders etc. (as of January, 2014)

Application

Whenever you think of a new killer feature to be integrated or just want it all, set up a Reference / Developer XCSoar system. Additionally, feel deeply encouraged to test software previews or alpha/beta versions after having gained experience with XCSoar's behavior. Help improve stability of software updates / upgrades, or provide some new code. In other words:

Think of the XCSoar project as being part of your passion for gliding and contribute. Please do not only follow this passion by soaring. Get involved in XCSoar's development process and discover the power and beauty of the open-source credo. Doing so you will discover a close congeniality. A Reference / Development system is a worthy tool to become a member of the project.

10 Avionics and Airframe

This chapter discusses XCSoar as a subsystem of the aircraft. It covers the integration of XCSoar with external devices, including GPS, switches and sensors, and aircraft radio transceivers and other devices. Integration with FLARM is covered in Chapter 8, and integration with variometers is covered in Chapter 7.

10.1 Battery life

Most modern PDAs are designed for short sporadic use and so do not have a very good battery capacity when considering the duration of cross-country soaring flights. It is recommended that the PDA be powered externally, via an appropriate voltage converter connected to the glider battery. This installation should be performed by appropriately qualified personnel, and should contain a fuse and a manual isolation switch.

The greatest cause of power drain by the PDA is the LCD back-light, however domestic PDAs are not particularly bright so they may need to have the back-light up full. However, for EFIS systems, it is recommended to use the lowest back-light settings that are comfortable.

When operating PDAs under internal battery, XCSoar detects a low battery condition and allows the operating system to shut down and preserve the memory. In addition, it can be set up to blank the screen after a period of inactivity, so that it can reduce the power consumption. When the screen is blanked, pressing one of the hardware buttons on the PDA activates the screen again. When a status message is issued by the system, the screen becomes activated.

Another way to help conserve battery power is to reduce the computational load by turning off certain features. Drawing terrain and long snail trails contribute significantly to the CPU load.

For other embedded platforms, a Battery InfoBox is available that displays the available battery life remaining, as well as the charge state (AC on–charging, or AC Off–operating off internal battery power).

10.2 GPS connection

XCSoar requires a 3D GPS fix for its navigation functions.

GPS status

GPS status icons and text may appear on the bottom edge of the map display to indicate:

(a) (b)

Waiting for GPS fix (a) : Better reception or additional time to search for satellites is required. The GPS may have a 2D fix. The aircraft symbol disappears while there is no 3D fix.

GPS not connected (b) : No communication with the GPS is received. This indicates an error in the comm port settings or the GPS device may be disconnected or switched off.

When the GPS is not connected for more than one minute, XCSoar automatically attempts to restart communication with the device and will then resume waiting. This method has shown to provide the most reliable way of recovering from communication errors.

XCSoar can handle multiple GPS sources and it uses them to provide redundancy. The sources are configured on the System Configuration screen, on the page entitled "Devices". Device A is the primary GPS data source and Device B is the secondary source.

During operation, if the primary GPS source drops out, XCSoar will use the GPS data from the secondary source. If both sources have valid fixes, the secondary source is ignored. For this reason, it is recommended to have the GPS source with the best antenna or most reliable operation as the primary source (i.e. Device A).

GPS altitude

Some older GPS units (and some new ones) do not output altitude relative to mean sea level, rather they output elevation with respect to the WGS84 ellipsoid. XCSoar detects when this occurs and applies the ellipsoid to geoid offset according to an internal tabulated data at two degree spacing. This is not required for FLARM units, which correctly output MSL altitude.

10.3 Switch inputs

XCSoar supports monitoring of switches and sensors connected to the host computer, for the purpose of providing situational awareness feedback, alerts, or as general-purpose user-interface input devices. Several mechanisms are available for interfacing to switches and sensors:

Serial device : Certain intelligent variometers such as Triadis Engineering's Vega have multiple airframe switches and pass this information on to the PDA or EFIS as special NMEA sentences.

Bluetooth device : Many devices support wireless connection to a Bluetooth Game-Pad device that has several buttons. This is more suited to user-interface input devices than airframe monitoring.

A custom 'input events' file determines how switch and sensor inputs are processed.

A standard set of airframe inputs are defined as:

- Airbrake
- Flap position (positive/landing flap, neutral, negative/reflex)
- Landing gear

This set is expected to expand to include engine and fuel monitoring.

Other logical inputs from Vega include computed quantities relating to specific airframe alerts and aircraft operating envelope warnings, for example "airbrake extended and gear retracted".

Refer to the Vega documentation for more details on switch inputs and how they may be used.

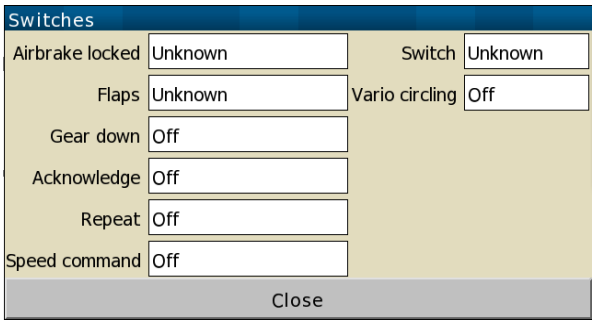
10.4 Vega switch dialogue

Config 3 ▷ Vega

Airframe Switches

A dialogue displaying switch states for the Vega variometer is available from the menu.

This dialogue is updated in real-time, allowing the pilot to check the correct functioning of switches during daily inspection tests or before takeoff.



10.5 Slave mode

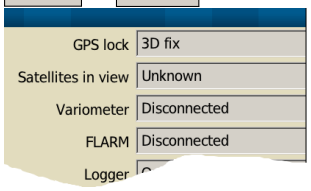
A device type in the configuration settings, "NMEA Out" is defined for use in joining two systems in a master-slave mode. In the master, the second com device can be set to NMEA Out, and all data received in the first com device (as well as outgoing data) will be sent to the slave.

As an example where two devices are being connected together, in the slave, the first com device can then be set to "Vega" and this system

receives all data as if it came from the Master's GPS and connected instruments (Vega, FLARM etc).

10.6 System status

Info 2 ▷ Status



The system status dialogue is used primarily as a systems check, to see how the glide computer and the connected devices are performing. This is accessed via the menu and then selecting the tabular **System**.

All dynamic values (e.g. battery voltage, number of satellites in view) are updated continuously.

10.7 Multiple devices

You can configure multiple external devices, connected at the same time (few PDAs have two serial ports, but Bluetooth can handle any number of concurrent connections).

When both provide a valid GPS fix, the first one (i.e. Device A) is chosen by XCSoar, and the second GPS fix is ignored. As soon as the first device fails, XCSoar switches to the second one automatically, until the first one recovers.

The same is true for values such as barometric altitude (QNH), pressure altitude (QNE), logger altitude (IGC), vario and airspeed: XCSoar prefers the first device, and uses the second device only for values that are not received from the first one. Static pressure and pressure altitude are one ambient pressure: XCSoar uses the form sent by the first device and ignores the other form from a later device. Traffic (FLARM) from every device that reports it is used.

Example: Device A is a CAI 302, and Device B is a FLARM. That gives you the best of both: XCSoar has airspeed, vario and traffic data.

10.8 Managing external devices

Config 1 ▷ Devices

The device management dialogue can be accessed from the configuration menu. It shows a list of configured external devices, and it lists what information they provide.

13.34

The button "Reconnect" attempts to reconnect to the selected device. XCSoar reconnects to a failed device periodically, but sometimes, it might be desirable to trigger that manually.

The button "Flight download" is only available with supported IGC loggers (see Section 2.5 for a list). Upon clicking, XCSoar retrieves a list of flights, and asks you to select one. Each entry shows the date and the start and end time of the flight; the end time is left out when the logger did not record it, as an LXNAV S10 does for most flights. The IGC file will be downloaded to the "`logs`" directory inside

`XCSoarData`. A flight download shows the flight name, the connected device, and the driver on separate lines above the progress bar. Inside the bar it shows the percentage complete, the amount received against the total, the transfer speed, and an estimate of the time remaining. From an LXNAV logger on a BLE port, such as the Nano 3, XCSoar downloads the file in blocks with a checksum each and a checksum over the whole file, and requests a damaged block again. A serial port or classic Bluetooth reads the flight line by line, as does a BLE logger that does not support the block transfer. A PowerFLARM Flex or Fusion does not give out its flight log on the data connection. Join the device Wi-Fi (shown on the Hub screen) and use Flight download; XCSoar reads the flights from there.

The button "Manage" is enabled when a Vega or a CAI 302 is connected. It provides access to special features of these devices, such as clearing the CAI 302 flight memory, which is needed sometimes to work around a Cambridge firmware bug.

For a FLARM, "Manage" shows the device type, ID and versions, and offers Setup, Reboot and Simulation. On a PowerFLARM, "Range statistics" shows the mean distance at which the FLARM has received other aircraft, as a plot seen from above with the direction of flight up: one sector per direction, separately for each of its two radio channels ("Antenna" A and B). A sector drawn as an outline only has fewer than 50 data points behind it and is not yet meaningful, as FLARM recommends; a missing sector has no data at all. The dashed line is the minimum range FLARM asks for: 2 nm ahead and 1 nm to the sides and behind, which gives a warning 15 seconds before two aircraft at 250 kt each would meet. A measured sector that does not reach it is drawn in orange, and "Below minimum range" counts these sectors out of all measured ones; check the antenna installation if there are any. "Range setting" is the distance beyond which the FLARM reports no aircraft at all; when it is within the plot, it is drawn as a dashed black circle, since the FLARM cannot measure beyond it. The statistics build up over many flights. "Reset" clears them, for example after a change to the antennas.

Any other FLARM, such as a Classic FLARM, keeps no such statistics. For these, "Range statistics" shows an estimate that XCSoar collects itself, across flights, from the traffic the FLARM reports while flying. Each contact with another FLARM aircraft counts once in every sector it passed, with the largest distance it was received at there, by its direction relative to the own ground track; a contact ends when the aircraft has not been reported for 30 seconds. Counting each contact once keeps an aircraft that stays close for a long time, in the same thermal for example, from outweighing all others. A sector shows the mean of the larger half of these distances, and the line across it the largest distance received. The smaller half is left out: an aircraft that never got far away says nothing about the range. A sector needs 50 contacts before it counts as measured. ADS-B targets and aircraft

in stealth or no-tracking mode do not count. The estimate is saved every 10 minutes in flight, on landing and when XCSoar exits. It is not FLARM's own measurement: it depends on how much traffic there was and how far away, and the FLARM reports nothing beyond its "Range setting". "Reset" clears the estimate, for example after a change to the antenna.

11 Quickstart

This chapter provides instructions for using XCSoar in typical cross-country tasks. It is separated into simple scenarios to demonstrate how to use key features. It assumes the configuration options have already been set up to the user's preferences.

These instructions are intended to provide a simple step-by-step guide to flying tasks of varying levels of complexity but are not intended to demonstrate all the features of XCSoar. Furthermore, the system can be used productively in ways other than as described here.

11.1 Local flight

In this scenario, the pilot intends to fly locally or a casual cross-country task where navigation to pre-determined waypoints is not required.

Prior to takeoff

1. Turn on the device.
2. Open the Flight Setup dialogue and adjust the bugs and ballast as required. Set the maximum forecast temperature. Close the dialogue.
3. Open the Task Edit dialogue, and create a blank task by pressing New .
4. Select "Touring" as task type.
5. Once the task is created, move the cursor to the "add waypoint" item and press enter. Select the start waypoint from the list, e.g. first item is the home base, and press enter. Press close or escape.
6. Select another one "add waypoint", and enter the same waypoint as finish point.
7. Now the task contains one waypoint to home.

In-flight

1. At the appropriate times, set the MacCready manually from the menu, task calculator or from the variometer.
2. Change the bugs/ballast settings as required.
3. At any time, the glider can reach home when the altitude difference bar is a green arrow pointing upwards.

4. Optionally, activate MC Auto when ready to return home. If the MacCready mode was set to "Final Glide" or "Both", then the system will command the optimal speed to return home.

After landing

1. The Status dialogue shows the elapsed flight time.
2. The analysis dialogue can be used to analyse or review the flight.
3. The IGC logger replay can be used to replay the flight.
4. These actions may be performed after turning the device off and on again.

11.2 FAI Task

In this scenario, the pilot intends to fly a triangle FAI task with a single start sector and automatic waypoint advance.

Prior to takeoff

1. Turn on the device.
2. Open the Flight Setup dialogue and adjust the bugs and ballast as required. Set the maximum forecast temperature. Close the dialogue.
3. Open the Task Edit dialogue, and create a blank task by pressing New . Select "FAI triangle" as task type.
4. Move the cursor to the "add waypoint" item and press enter. Set the start and sector type and select the desired waypoint from the list and press enter. Once finished, press close.
5. Move the cursor to the "add waypoint" item again and press enter. Select the waypoint from the list and press enter. This will add the first waypoint to the task.
6. Repeat the procedure for the second waypoint. A good idea to find the right second turn is to filter the waypoint list by bearing ($+120°$) and the proper distance of the triangles edge. The filter references to the first waypoint of our triangle.
7. Repeat the last step as required for an additional waypoint. The last waypoint is the finish waypoint.
8. The task is now entered. You may declare it and send the task to a connected logger device.

In-flight

1. The current waypoint will advance automatically as the pilot flies through the observation zones.

2. After the task is started, the Status dialogue can be opened to verify a valid start was detected. "Valid Start" should be tagged as true, The start time can be reviewed, the start height is saved and the min. finish hight according given rules is shown.
3. At all times the black track arrow will point at the next waypoint. The blue arrow will point at the direction the glider should track when in cruise.
4. If Zoom Auto is activated, the map will automatically zoom in as task waypoints are approached.
5. At the appropriate times, adjust the MacCready by the menu, the task calculator or the connected variometer; or activate MC Auto . If the MacCready mode was set to 'Final Glide' or 'Both', then the system will command the optimal speed to return home; and the MacCready value will be set to the minimum climb rate at which it is beneficial to continue to climb.
6. Change the bugs/ballast settings as required.
7. Refer to the Analysis dialogue as required.
8. Refer to the Status dialogue as required. This shows the start time, elapsed time on task, estimated arrival time, average task speed etc.
9. At any time, when the altitude difference bar is a green arrow pointing upwards the glider can finish the task.

After landing

As described in Section 11.1.

11.3 AAT Task, Manual Arm

In this scenario, the pilot intends to fly a triangle AAT task, and will manually arm the waypoint advance system.

Prior to takeoff

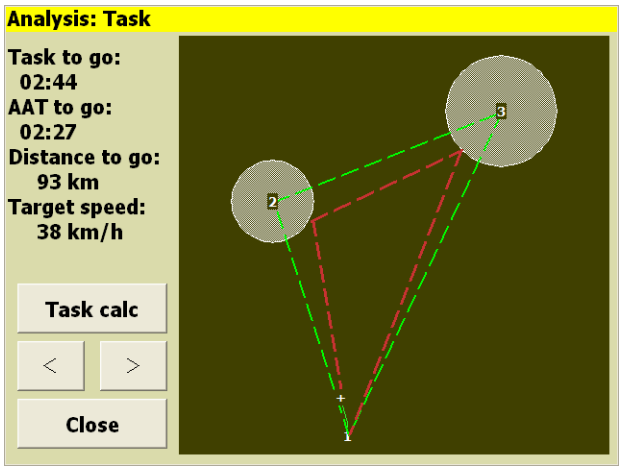
1. Turn on the device.
2. Open the Flight Setup dialogue and adjust the bugs and ballast as required. Set the maximum forecast temperature. Close the dialogue.
3. Open the Task Edit dialogue, and create a blank task by pressing New . Select "AAT" as task type.
4. Once the task is created, move the cursor to the 'add waypoint' item and press enter. Add waypoints in the already described way.

5. The AAT requires additional input to the kind and size of the observation zone. Adjust AAT sector parameters for this waypoint and press close or escape.
6. Repeat the last two steps as required for additional waypoints. The last waypoint is the finish waypoint.
7. The AAT task is now entered. Open the Properties dialogue and set the given task time.
8. The estimated elapsed time to complete the task with different MacCready settings can be explored from the Task Calc dialogue. Adjusting the MacCready value and see what "AAT Range" setting is suggested by XCSoar.

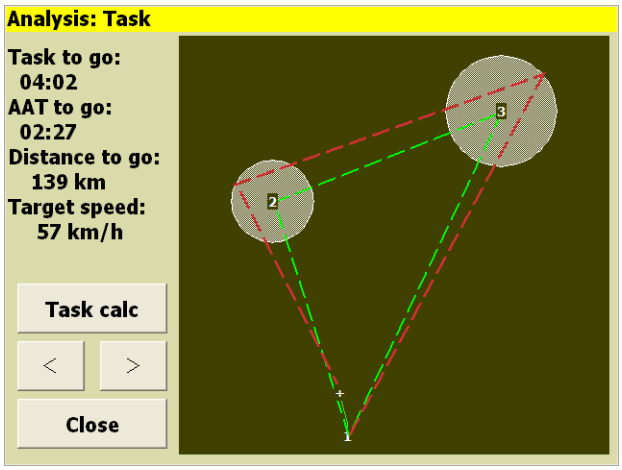
In-flight

1. When the pilot is ready to start the task, press the Arm Start button. The current waypoint will then advance automatically once, as the pilot flies through the start sector. After this occurs, the advance trigger is disarmed.
2. In order to re-start, the pilot needs to manually revert to the Start Turnpoint and again press the Arm Start button prior to flying through the start sector again.
3. After the task is started, the Status dialogue can be opened to verify a valid start was detected. If the start time is given, the start was detected and legal according to the task start rules specified in the configuration. Otherwise it will display "INVALID".
4. During flight, the estimated elapsed time to complete the task with different MacCready settings can be explored from the Task Calc dialogue. Once a decision is made to extend or reduce the AAT range this can be done by manually manipulating the Target . This allows the pilot to effectively increase or decrease the task distance and estimate the effect on AAT time.

   The figure below shows the course around the targets at range set to -100%.



The figure below shows the course around the targets at range set to 100%.



5. At all times the black track arrow will point at the next target. The target is the location within the AAT sector at the range specified in the Task Calc dialogue. The blue arrow will point at the direction the glider should track when in cruise.

6. When the pilot is within or approaching an AAT sector and is ready to advance to the next waypoint, press the Arm Turn button. The current waypoint will then advance automatically once, if the pilot is inside the observation zone. After this occurs, the advance trigger is disarmed.

7. If Auto Zoom is activated, the map will automatically zoom in as task waypoints are approached.

8. At the appropriate times, adjust the MacCready by the menu, the task calculator or the connected variometer; or activate MC Auto . If the MacCready mode was set to 'Final Glide' or 'Both', then the system will command the optimal speed to return home; and the MacCready value will be set to the minimum climb rate at which it is beneficial to continue to climb.

9. Change the bugs/ballast settings as required.
10. Refer to the Analysis dialogue as required.
11. Refer to the Status dialogue as required. This shows the start time, elapsed time on task, estimated arrival time, average task speed etc.

After landing

As described in Section 11.1.

12 InfoBox Reference

InfoBox data types are grouped into logical categories.

All InfoBoxes display their data in user-specified units. Whenever the content is invalid, the displayed value will be '– – –'. This happens, for example, when no terrain elevation is found for the 'Terrain Elevation' InfoBox, or in the same way for a derived InfoBox like 'Height AGL'.

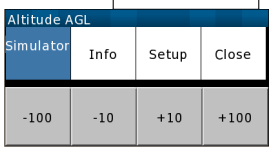
Some of the InfoBox contents are modifiable complex values like 'MC setting', or 'Wind'. Most of those values are now accessible through an InfoBox dialogue. It is a short cut to quickly change the most often accessed items. An InfoBox dialogue is opened by tapping the InfoBox (or pressing Enter when it is selected). A long press opens the arrange mode.

In the following description of the InfoBox types, the first title is as it appears in the InfoBox configuration dialogue box, the second title is the label used in the InfoBox title.

12.1 Altitude

Altitude GPS

Alt GPS



Altitude above mean sea level reported by the GPS. Tap or Enter opens the altitude panel. In simulation mode that panel can change this altitude.[1]

Barometric altitude

Alt Baro

Barometric altitude obtained from a device equipped with pressure sensor.[1]

Altitude (Auto)

Alt <auto>

Barometric altitude obtained from a device equipped with a pressure sensor or the GPS altitude if the barometric altitude is not available.

Height AGL

H AGL

Navigation altitude minus the terrain elevation obtained from the terrain file. The value is coloured red when the glider is below the terrain safety clearance height.[1]

Terrain elevation

Terr Elev

Elevation of the terrain above mean sea level obtained from the terrain file at the current GPS location.

Height above take-off

H T/O

Height based on an automatic take-off reference elevation (like a QFE reference).[1]

Flight level

Flight Level

Pressure Altitude given as Flight Level. If barometric altitude is not available, FL is calculated from GPS altitude, given that the correct QNH is set. In case the FL is calculated from the GPS altitude, the FL label is coloured red.[1]

QNH

QNH

Current QNH pressure setting. The line below the pressure shows the barometric altitude when a pressure sensor is available. Tap the InfoBox to open the setup panel and adjust QNH.[1]

Barogram

Barogram

Trace of altitude during flight.

12.2 Aircraft state

Speed ground

V GND

Ground speed measured by the GPS. In simulation mode, tap or Enter opens a panel that changes the speed and the track.

Track

Track

Magnetic track reported by the GPS. In simulation mode, tap or Enter opens the same panel as Speed ground.

Airspeed IAS

V IAS

Indicated Airspeed reported by a supported external intelligent vario.

G load

G

Magnitude of G loading reported by a supported external intelligent vario. This value is negative for pitch-down manoeuvres. On Android, with *Built-in IMU* set to *Not aligned*, the sign is ignored.

Blood Oxygen

SpO2

Blood oxygen saturation in percent from a Bluetooth pulse oximeter on Android. At 90% and above the value uses the normal text colour, from 85% to 89% it is amber, and below 85% it is red. After 30 seconds the comment line shows the age of the reading. The value is cleared after three minutes.

Ballast

Ballast

Water ballast on board, in litres. The comment shows the resulting wing loading (for example in kg/m^2) if the wing area of the polar is known. That comment is red while the all-up weight is above the plane's MTOW. While ballast is being dumped, the value is blue. Tap the InfoBox to open the flight setup and change the ballast.

[1] In simulator mode an additional dialogue is available to change the value of the InfoBox.

Bearing Difference

Brng. D

Difference between the glider's track bearing, to the bearing of the next waypoint, or for AAT tasks, to the bearing to the target within the AAT sector. GPS navigation is based on the track bearing across the ground, and this track bearing may differ from the glider's heading when there is wind present. Chevrons point to the direction the glider needs to alter course to correct the bearing difference, that is, so that the glider's course made good is pointing directly at the next waypoint. This bearing takes into account the curvature of the Earth.

Airspeed TAS

V TAS

True Airspeed reported by a supported external intelligent vario. The value is blue when it is estimated from ground speed and wind.

Attitude indicator

Horizon

Attitude indicator (artificial horizon) display calculated from flight-path, supplemented with acceleration and variometer data if available.

12.3 Glide ratio

GR instantaneous

GR Inst

Instantaneous glide ratio over ground, given by the ground speed divided by the vertical speed (GPS speed) over the last 20 seconds. Negative values indicate climbing cruise. If the vertical speed is close to zero, the displayed value is '- - -'.

GR cruise

GR Cruise

Distance from the top of the last thermal, divided by the altitude lost since the top of the last thermal. Negative values indicate climbing cruise (height gain since leaving the last thermal). If the vertical speed is close to zero, the displayed value is '- - -'.

Final GR

Fin GR

Required glide ratio over ground to finish the task, given by the distance to go divided by the height required to arrive at the safety arrival height. This is no adjusted total energy possible.

Next GR

WP GR

Required glide ratio over ground to reach the next waypoint, given by the distance to next waypoint divided by the height required to arrive at the safety arrival height. Negative values indicate a climb is necessary to reach the waypoint. If the height required is close to zero, the displayed value is '- - -'.

L/D vario

L/D Vario

Instantaneous lift/drag ratio, given by the indicated airspeed divided by the total energy vertical speed, when connected to an intelligent variometer. Negative values indicate climbing cruise. If the total energy vario speed is close to zero, the displayed value is '- - -'.

GR average

GR Avg

Distance made in the configured period of time, divided by the altitude lost since then. Negative values are shown as '⁀⁀⁀' and indicate climbing cruise (height gain). Over 200 of GR the value is shown as '+++'. You can configure the period of averaging. Suggested values are 60, 90 or 120. Lower values will be closer to GR inst., and higher values will be closer to GR cruise. Notice that the distance is *not* the straight line between your old and current position, it's exactly the distance you have made even in a zigzag glide. This value is not calculated while circling.

12.4 Variometer

Last Thermal Average

TL Avg

Total altitude gain/loss in the last thermal divided by the time spent circling. The seconds in smaller font reflect the time spent circling.

Last thermal gain

TL Gain

Total altitude gain/loss in the last thermal.

Last thermal duration

TL duration

Time spent circling in the last thermal. The number in smaller font reflects the overall climb rate for the last thermal.

Thermal climb, last 30 s

TC 30s

30 second rolling average climb rate based of the reported GPS altitude, or vario if available. The value is red when it is less than half the risk MacCready.

Thermal average

TC Avg

Altitude gained/lost in the current thermal, divided by time spent thermalling.

Thermal gain

TC Gain

Altitude gained/lost in the current thermal.

Vario

Vario

Instantaneous vertical speed, as reported by the GPS, or the intelligent vario total energy vario value if connected to one.

Netto vario

Netto

Instantaneous vertical speed of air-mass, equal to vario value less the glider's estimated sink rate. Best used if airspeed, accelerometers and vario are connected, otherwise calculations are based on GPS measurements and wind estimates.

Vario trace

Vario Trace

Trace of vertical speed, as reported by the GPS, or the intelligent vario total energy vario value if connected to one.

Netto vario trace

Netto Trace

Trace of vertical speed of air-mass, equal to vario value less the glider's estimated sink rate.

Thermal climb trace

TC Trace

Trace of average climb rate each turn in circling, based of the reported GPS altitude, or vario if available.

Thermal average over all

T Avg

Time-average climb rate in all thermals.

Climb band

Climb Band

Graph of average circling climb rate (horizontal axis) as a function of altitude (vertical axis).

Thermal assistant

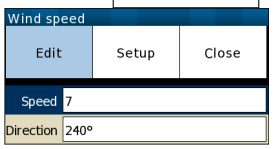
Thermal

Circular thermal assistant that shows the lift distribution over each part of the circle.

12.5 Atmosphere

Wind arrow

Wind



Wind vector estimated by XCSoar. Tap or Enter opens the wind settings.

Wind bearing

Wind

Wind bearing incl. wind speed, estimated by XCSoar. Tap or Enter opens the wind settings.

Wind speed

Wind

Wind speed incl. wind direction, estimated by XCSoar. Tap or Enter opens the wind settings.

Wind, head component

Head Wind

Current head wind component. Head wind is calculated from TAS and GPS ground speed if airspeed is available from external device. Otherwise the estimated wind is used for the calculation.

Wind, head component (simplified)

Head Wind *

Current head wind component. The simplified head wind is calculated by subtracting GPS ground speed from the TAS if airspeed is available from external device.

Outside air temperature

OAT

Outside air temperature measured by a probe if supported by a connected intelligent variometer.

Relative humidity

Rel Hum

Relative humidity of the air in percent as measured by a probe if supported by a connected intelligent variometer.

Forecast temperature

Max Temp

Forecast temperature of the ground at the home airfield, used in estimating convection height and cloud base in conjunction with outside air temperature and relative humidity probe. Tap or Enter opens the flight setup page, where this temperature is set.

12.6 MacCready

MacCready Setting

MC <mode>

Current MacCready setting, current MacCready mode (manual or auto), and recommended speed-to-fly. At MacCready 0, with a task or Goto active, that speed is adjusted for wind toward the waypoint and need not match the polar's still-air best glide. With MacCready above 0, wind is not used. Tap or Enter opens a dialogue to change the value and to switch Auto MacCready. In task abort the title and the value are Safety MC, and the comment is the still-air glide ratio at that MacCready, written as a ratio such as 25:1, instead of speed-to-fly. The dialogue adjusts Safety MC for this flight and leaves the saved setting unchanged. If Task MC is higher than that Safety MC, the lower value is sent to connected devices. A lower Task MC is left unchanged. Leaving abort sends Task MC back when it had been replaced.

Speed MacCready

V MC

MacCready speed-to-fly for optimal flight to the next waypoint. In cruise flight mode, this speed-to-fly is calculated for maintaining altitude. In final glide mode, this speed-to-fly is calculated for descent. At MacCready 0, with a task or Goto active, this speed is adjusted for wind toward the waypoint and need not match the polar's still-air best glide. With MacCready above 0, wind is not used.

Percentage climb

% Climb

Percentage of time spent in climb mode. These statistics are reset upon starting the task.

Speed dolphin

V opt.

Instantaneous MacCready speed-to-fly, making use of netto vario calculations to determine dolphin cruise speed on the glider's current bearing. In cruise flight mode, this speed-to-fly is calculated for maintaining altitude. In final glide mode, this speed-to-fly is calculated for descent. In climb mode, this switches to the speed for minimum sink at the current load factor (if an accelerometer is connected). When 'Block' mode speed to fly is selected, this InfoBox displays the MacCready speed. At MacCready 0, with a task or Goto active, this speed is adjusted for wind toward the waypoint and need not match the polar's still-air best glide. With MacCready above 0, wind is not used.

Thermal next leg equivalent

T Next Leg

Climb on the next task leg that gives the same average cross-country speed as flying the current leg at the MacCready setting, using the polar and the headwind on each track. The box is invalid when there is no next leg, wind, or polar. The comment shows "no wind" when wind is not available. See Section 6.3.

Task cruise efficiency

Cruise Eff

Efficiency of cruise. 100 indicates perfect MacCready performance. This value estimates your cruise efficiency according to the current flight history with the set MC value. Calculation begins after task is started.

12.7 Navigation

Next Bearing

Bearing

True bearing of the next waypoint. For AAT tasks, this is the true bearing to the target within the AAT sector.

Next radial

Radial

True bearing from the next waypoint to your position.

Next distance

WP Dist

Distance to the currently selected waypoint. For AAT tasks, this is the distance to the target within the AAT sector.

Speed VMG

V VMG

Velocity made good towards the next waypoint: the component of the ground speed along the bearing to it, that is the rate at which the distance is shrinking. It equals the ground speed when tracking straight at the waypoint, falls to zero at right angles to it and becomes negative when flying away. It shows what leaving the direct course for better lift costs in progress along the leg: a high ground speed well off track can result in less progress than a slower speed flown straight at the waypoint. For AAT tasks, the target within the AAT sector is used.

Next altitude difference

WP AltD

Arrival altitude at the next waypoint relative to the safety arrival height. For AAT tasks, the target within the AAT sector is used.

Next MC0 altitude difference

WP MC0 AltD

Arrival altitude at the next waypoint with MC 0 setting relative to the safety arrival height. For AAT tasks, the target within the AAT sector is used.

Next altitude arrival

WP AltA

Absolute arrival altitude at the next waypoint in final glide. For AAT tasks, the target within the AAT sector is used.

Next altitude required

WP AltR

Altitude required to reach the next turn point. For AAT tasks, the target within the AAT sector is used.

Final altitude difference

Fin AltD

Arrival altitude at the final task turn point relative to the safety arrival height.

Final altitude required

Fin AltR

Additional altitude required to finish the task.

Final distance

Final Dist

Distance to finish around remaining turn points.

Distance home

Home Dist

Distance to the home waypoint.

Home altitude difference

Home AltD

Arrival altitude at the home waypoint relative to the safety arrival height.

Home

Home

Displays the home waypoint name, arrival altitude difference relative to the safety arrival height, and distance to the home waypoint. Tap to select or change the home waypoint.

Active Waypoint

Active WP

Displays the active waypoint name, arrival altitude difference relative to the safety arrival height, and distance. The active waypoint is the next task waypoint when an ordered task is loaded, or the Goto waypoint otherwise. Tap to choose a different waypoint: when a task is loaded, selecting a task waypoint advances the active task point to that leg; without a task, the selection becomes the new Goto. If a task is loaded and you select a non-task waypoint from the list, the selection becomes the new Goto.

Previous Waypoint

Prev WP

Displays the waypoint name, arrival altitude difference relative to the safety arrival height, and distance for the task waypoint before the active leg. While on the first leg (no prior point) the start waypoint is shown instead. Tap to choose a different waypoint to display: with an ordered task loaded the popup is prepopulated with task waypoints; without a task the full waypoint list is shown. The selection is informational only — it never advances the task and never sets a Goto. The override is sticky across leg advances. With a task loaded, tap again and choose "Resume auto tracking" at the top of the list to return to automatic tracking of the task.

12.8 Competition and assigned area tasks

Speed task average

V Task Avg

Average cross-country speed while on current task, not compensated for altitude.

Speed task instantaneous

V Task Inst

Instantaneous cross-country speed while on current task, compensated for altitude. Equivalent to instantaneous Pirker cross-country speed.

Speed task achieved

V Task Ach

Achieved cross-country speed while on current task, compensated for altitude. Equivalent to Pirker cross-country speed remaining.

Speed task estimated

V Task Est

Estimated average cross-country speed for current task as of task completion, assuming performance of ideal MacCready cruise/climb cycle.

AAT time

AAT Time

'Assigned Area Task' time remaining. Goes red when time remaining has expired.

AAT delta time

AAT dT

Difference between estimated task time and AAT minimum time. Coloured red if negative (expected arrival too early), or blue if in sector and can turn now with estimated arrival time greater than AAT time plus 5 minutes.

AAT max. distance

AAT Dmax

'Assigned Area Task' maximum distance possible for remainder of task.

AAT min. distance

AA Dmin

'Assigned Area Task' minimum distance possible for remainder of task.

AAT speed max. distance

AAT Vmax

'Assigned Area Task' average speed achievable if flying maximum possible distance remaining in minimum AAT time.

AAT speed min. distance

AAT Vmin

'Assigned Area Task' average speed achievable if flying minimum possible distance remaining in minimum AAT time.

AAT distance around target

AAT Dtgt

'Assigned Area Task' distance around target points for remainder of task.

AAT speed around target

AAT Vtgt

'Assigned Area Task' average speed achievable around target points remaining in minimum AAT time.

Contest distance

Cont Dist

Instantaneous evaluation of the flown distance according to the configured contest rule set.

Task progress

Progress

Clock-like display of distance remaining along task, showing achieved task points.

Start open/close countdown

Start open

Shows the time left until the start point opens or closes. If the *PEV Start Procedure* (4.10) is in use, time relative to the PEV window is displayed. Else, the task defined *Start open/close time* (5.6) are used.

tart open/close countdown at reaching

Start reach

Shows the time left until the start point opens or closes, compared to the calculated time to reach it. If the *PEV Start Procedure* (4.10) is in use, time relative to the PEV window is displayed. Else, the task defined *Start open/close time* (5.6) are used.

12.9 Waypoint

Next waypoint

Next WP

Name of the currently selected turn point. Tap or Enter opens the waypoint details.

Flight Duration

Flt Duration

Time elapsed since take-off was detected.

Time local

Time loc

GPS time expressed in local time zone.

Time UTC

Time UTC

GPS time expressed in UTC.

Task time to go

Fin ETE

Estimated time required to complete task, assuming performance of ideal MacCready cruise/climb cycle.

Task time to go (ground speed)

Fin ETE VMG

Estimated time required to complete task, assuming current ground speed is maintained.

Next time to go

WP ETE

Estimated time required to reach next waypoint, assuming performance of ideal MacCready cruise/climb cycle.

Next time to go (ground speed)

WP ETE VMG

Estimated time required to reach next waypoint, assuming current ground speed is maintained.

Task arrival time

Fin ETA

Estimated arrival local time at task completion, assuming performance of ideal MacCready cruise/climb cycle.

Next arrival time

WP ETA

Estimated arrival local time at next waypoint, assuming performance of ideal MacCready cruise/climb cycle.

Task req. total height trend

RH Trend

Trend (or neg. of the variation) of the total required height to complete the task.

Time under max. start height

Start Height

Contiguous period the ship has been below the task start max. height.

12.10 Team code

Team code

Team Code

Current Team code for this aircraft. Use this to report to other team members. The last team aircraft code entered is displayed underneath.

Team bearing

Team Brng

Bearing to the team aircraft location at the last team code report.

Team bearing difference

Team BrngD

Relative bearing to the team aircraft location at the last reported team code.

Team range

Team Dist

Range to the team aircraft location at the last reported team code.

12.11 Device status

Battery voltage/percent

Battery

Percentage of device battery remaining (where applicable) and status/voltage of external power supply.

CPU load

CPU

CPU load consumed by XCSoar averaged over 5 seconds.

12.12 Alternates

Alternate 1 / Alternate 2 and their GR / AltD variants may either display the best automatic alternate (AUTO, default) or a manually selected alternate chosen from the alternates list during flight. Manual selections are runtime-only and remain active until changed again or switched back to AUTO. Blue means the safety polar still arrives with no further climb. Orange means that glide misses, but a straight glide at best glide still arrives. A field without an elevation is not marked orange. Red means best glide misses too, or there is no solution. In AUTO mode the default colour means further climb is required. In MANUAL mode that case is red.

Alternate 1

Altn 1

Name and bearing to the best alternate landing location.

Alternate 2

Altn 2

Name and bearing to the second-best alternate landing location.

Alternate 1 GR

Altn 1 GR

Geometric gradient to the arrival height above the best alternate landing location. This is not adjusted for total energy.

Alternate 2 GR

Altn 2 GR

Geometric gradient to the arrival height above the second-best alternate landing location. This is not adjusted for total energy.

Alternate 1 altitude difference

Altn 1 AltD

Arrival altitude at the best alternate landing location relative to the safety arrival height.

Alternate 2 altitude difference

Altn 2 AltD

Arrival altitude at the second-best alternate landing location relative to the safety arrival height.

12.13 Obstacles

Nearest airspace horizontal

Near AS H

Horizontal distance to the nearest airspace.

Nearest airspace vertical

Near AS V

Vertical distance to the nearest airspace. A positive value means the airspace is above you, and negative means the airspace is below you.

Terrain collision

Terr Coll

Distance to the next terrain collision along the current task leg. At this location, the altitude will be below the configured terrain clearance altitude.

Fixed text

Text

Title, value and comment entered by the pilot. Assign this InfoBox in the InfoBox set editor, then tap it on the map and choose Setup. Leave a line empty to hide it. The Shaded InfoBox border style draws a grey bar behind the title whenever the title is not empty, so a title consisting of a single space shows that bar without any text.

12.14 Radio

Active radio frequency

Act Freq

Currently active radio frequency.

Standby radio frequency

Stby Freq

Currently standby radio frequency.

13 Configuration

XCSoar is a highly configurable glide computer and can be customised to suit a wide variety of preferences and user requirements. The entire configuration is saved in a so-called profile file, reflecting all configuration settings. Whenever a configuration is judged being worthy, a backup of the profile file is advisable (see Section 2.8. This chapter describes the configuration settings and options.

13.1 Scope of configuration

There are several ways XCSoar can be customised:

- Modifying configuration settings. This is the sort of configuration most likely to be performed by users; and this is given the greatest attention in this document.
- Changing the language, or even just to change the wording of text in the user interface.
- Changing the button assignments and button menus. This allows the content and structure of the button menu to be changed.
- Changing or adding actions performed when glide computer events take place.
- Defining how long status messages appear and sounds play when those messages occur.

13.2 Modifying settings

There is a large set of configuration settings that may be customised from the settings dialogues accessible from the menu:

Config 2/3 ▷ System : Invokes the main configuration dialogue for rather static settings. It is in no way intended to be accessed during flight.

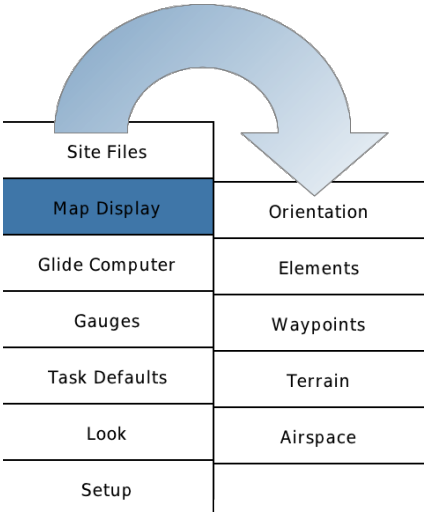
Config 2/3 ▷ Plane : Dialogue for specifying the plane's data, with polar and wing loading representing the most important ones. This dialogue is to be included in the preflight check if the XCSoar base system is used in different planes.

Config 2/3 ▷ Devices : Configuration of devices connected to XCSoar. Although being a system setup dialogue, there might be rare occasions where this dialogue is required in-flight. Whenever connections to devices are lost, this dialogue might be used to reconnect. This dialogue neither was nor will be intended for use in-flight. Unfortunately, buggy operating systems of host hardware create a demand for it occasionally.

13.3 Configure System

Config 2/3 ▷ System

The system configuration can be accessed through a two layer structured menu or just sequentially through the back and forward buttons.

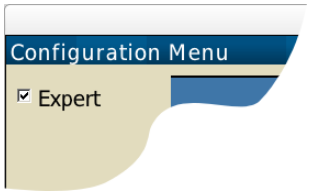


You are strongly discouraged from changing these settings during flight. All changes to the settings should be performed on the ground so that their desired effect on the programs behaviour can be verified.

The settings dialogue contains several pages. Once changes have been made, click Close on the screen to close the dialogue and return to the configuration menu. Another button press leads back to the normal map mode.

Once you are happy with your configuration settings, save the profile file and make a backup so that you can later restore the settings if your PDA's memory is accidentally erased.

See Chapter 14 for a description of the data formats of files referred to in the settings. Where no file is to be used, the field can be left blank. File name fields in forms show files that match a file extension filter. This makes it much easier to find and select the correct file.



The main configuration dialogue (Setup System) can be run in Basic or Expert user level, via a selectable field on the left of the dialogue. When in Basic mode, many of the less commonly used and advanced configuration settings are hidden. In the descriptions below, all of the parameters marked with an asterisk are only visible in expert user level.

13.4 Site Files / Site Files

The dialogue specifies most of the important files that must be configured when flying at a new site.

XCSoar data path : The location for all of your XCSoar data on your hard drive, SD card, or the PDA's static memory.

Map Database : The name of the map file (XCM) containing digital elevation terrain data, topography, and optionally waypoints, airspace etc. A good prepared database file covers all the needs for this page.

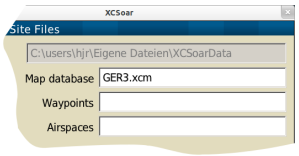
Waypoints : List of waypoint files. If left blank, waypoints are loaded from the map file (if available).

Watched waypoints* : List of waypoint files containing waypoints for which arrival height is always displayed in map labels, even when unreachable. Useful for waypoints such as known reliable thermal sources (e.g., power plants) or mountain passes.

Airspaces : List of active airspace files that can be selected and used simultaneously. If left blank, airspaces are loaded from the map file (if available).

Airfields or Waypoint details* : The airfields file may contain extracts from Enroute Supplements or other contributed information about individual airfields.

User repositories* : List of user repository URLs, separated by the character '|'. The URL for each repository must point to the repository's manifest file. The content listed in that manifest is then included in the file download selectors. The manifest needs to use the same format as that of the XCSoar repository (See https://github.com/XCSoar/xcsoar-data-content).



Multiple airspace and waypoint files can be selected to be used simultaneously. The Download button on a file field opens the repository. Each row shows the file name and, on a second line, the description. Tick one or more files and press Download to fetch them one after another. Nothing ticked downloads the highlighted file. Countries limits the list to the ticked countries and is remembered. Search matches the name and the description and lasts until XCSoar exits.

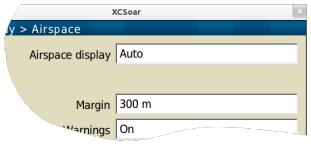
The XCM map database concept is the current way to setup a site to fly. XCSoar releases prior to v6.4 required each to be separate files and to be specified separately (as the '*Terrain file*' and '*Topography file*' respectively). This option has been dropped in favor to the XCM map database with XCSoar release v6.4.

The XCM map file, however, contains all these files: Terrain, topography and optionally waypoints and airspaces. If the latter are contained, the e.g. '*Primary waypoint file*' may be left blank and the system will load waypoints from the map file. However, the user can still specify other files and they will be used instead of the data in the map file.

See Section 14.2 for more details on map files.

13.5 Map Display / Airspace

This page is used to determine how the airspace information is displayed and how warnings are issued.



Airspace display : Controls how airspace display and warnings are filtered based on altitude. The airspace filter dialogue also allows filtering of display and warnings independently for each airspace class.
All on: All the airspace information is displayed at the same time.
Clip: Only airspace below a user determined altitude is shown.
Auto: Only airspace at the current altitude plus or minus a user definable margin is shown.
All below: Like auto plus every airspace below the glider is shown.

Label visibility* : Shows the ceiling and base of each airspace on the map.
None: No labels.
All: A label on every displayed airspace.

Clip altitude : For clip mode, this is the altitude below which airspace is displayed.

Margin : For auto and all below airspace mode, this is the height above/below which airspace is included.

Warnings : Determines whether warnings are enabled or disabled.

Warning time* : This is the time before an incursion is estimated at which the system will warn the pilot.

Acknowledge time* : This is the time period in which an acknowledged airspace warning will not be repeated.

Use black outline* : Draws a black outline around each airspace.

Airspace fill mode* : Specifies the mode for filling the airspace area.
Fill all: Transparently fills the airspace colour over the whole area.
Fill padding: Draws a solid outline with a half transparent border around the airspace.
Default: This selects the best performing option for your hardware. In fact it favours '*Fill padding*'.

This page also has Colours and Filter buttons which can be used to review or change the colours used by each airspace class, and whether each airspace class will be filtered out of warnings and/or display.

Colours

This function is used to determine the colours used to draw each class of airspaces.

First select the airspace class you wish to change. Then select the colour you wish the selected airspace class to be drawn in.

Filters

The filter function is described in Section 8.4. The filter dialogue includes a **Clrnc** (clearance) column that controls which airspace classes may be granted clearance by the pilot. See Section 8.3.

NOTAM

This page configures downloading and display of NOTAM affected areas. NOTAMs are shown as airspaces on the map and are intended for situational awareness only; they do not replace a proper NOTAM briefing. See Section 8.1.

NOTAM Support : Enables downloading and display of NOTAMs from aviation authorities.

API URL : Base URL of the NOTAM proxy API.

Search Radius : Radius around the current location for which NOTAMs are downloaded. If the aircraft moves outside the loaded area and Internet access is available, XCSoar downloads NOTAMs for the new area.

Auto-Refresh (minutes) : Time interval for automatic NOTAM updates. Set this to 0 to disable automatic refresh and use manual refresh only.

Show IFR-Only NOTAMs : Includes NOTAMs marked as IFR-only traffic. This is disabled by default.

Show Only Currently Effective : Hides NOTAMs which are not effective at the current time. This is enabled by default.

Maximum NOTAM Radius : Hides NOTAMs whose affected radius is larger than this value. Set this to 0 to disable the radius filter. The default is 100 km.

Hidden Q-Codes : Space-separated list of Q-code prefixes to hide. Prefixes are matched case-insensitively. The default list is `QA QK QN QOL QOA QOBTT`, hiding administrative, checklist, navigation-aid and obstacle-lighting or obstacle-administration notices.

The read-only rows below the filter settings show how many loaded NOTAMs are currently filtered by each filter. The Refresh button saves the current settings and requests a new download for the current position. The List button opens the current NOTAM list for review.

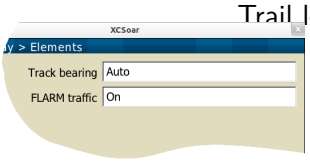
13.6 Map Display / Elements

This page provides options relating to screen elements overlayed to the map display.

Ground track : Display the ground track (ground track projection) on the map. The setting "Auto" displays the ground track only if there is a significant difference to plane heading.

Turn back marker : Show a green triangle on the map along the current track. It marks the furthest point from which the active task waypoint or Goto target can still be reached with the current altitude and conditions, and is drawn only in cruise while that target is reachable.

FLARM traffic : This enables the display of FLARM traffic on the map.



Trail length* : Determines whether and how long a snail trail is drawn behind the glider.
Off: No trail is drawn.
Long: A long trail is drawn (approx 60 minutes).
Short: A short trail is drawn (approx 10 minutes).
Full: A trail for the entire flight is drawn.

Trail drift* : Determines whether the snail trail is drifted with the wind when displayed in circling mode. Off by default. Switched Off, the snail trail stays uncompensated for wind drift. In circling this also applies to the projected track curve: On keeps it relative to the air mass; Off includes wind. The setting stays available when Trail length is Off.

Trail type* : Sets the type of the snail trail display.
Vario #1: Within lift areas lines get displayed green and thicker, while sinking lines are shown brown and thin. Zero lift is presented as a grey line.
Vario #1 (with dots): The same colour scheme as the previous, but with dotted lines while sinking.
Vario #2 (default): The climb colour for this scheme is orange to red, sinking is displayed as light blue to dark blue. Zero lift is presented as a yellow line.
Vario #2 (with dots): The same colour scheme as the previous, but with dotted lines while sinking.
Altitude: The colour scheme corresponds to the altitude.

Trail scaled* : If set to ON the snail trail width is scaled according to the vario signal.

Detour cost markers* : If enabled this displays in cruise flight some figures projected in front of the nose of the glider icon. This is the additional distance in percent if you fly up the position of the figure and after that again straight towards the target, compared to the straight distance to target.

Aircraft symbol* : Sets the symbol used for the aircraft.
Simple: Simplified line graphics, a black glider shape with white contours.
Simple (large): Enlarged simple graphics for better visibility on a small display.
Detailed: Rendered aircraft graphics.
HangGlider: Simplified hang glider as line graphics, white with black contours.

ParaGlider: Simplified para glider as line graphics, white with black contours.

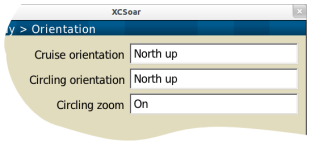
Wind arrow* : Determines the way the wind arrow is drawn on the map.
Off: No wind arrow is drawn.
Arrow head: Draws an arrow head only.
Full arrow: Draws an arrow head with a dashed arrow line.

FAI triangle areas : Whether to show FAI triangle areas on the map.

13.7 Map Display / Orientation

This page let you specify the favoured map orientation and view.

Cruise/Circling orientation : This determines how the screen is rotated with the glider, depending on it's current display mode.
Track up: The moving map display will be rotated so the glider's track is oriented up. The north arrow symbol points to true north. The glider symbol may be shown rotated according to the computed heading of the glider taking wind into account.
Heading up: The moving map display will be rotated so the glider's heading is oriented up.
North up: The moving map display will always be orientated true north to south and the glider icon will be rotated to show its course (corrected for wind).
Target up: The moving map display will be rotated so the current target direction is oriented up.
Wind up The moving map display will be rotated so the wind is always oriented top-down (might be useful for wave flying).



Circling zoom : This determines whether separate zoom levels will be maintained for circling and cruise modes. If enabled, then the map will zoom in automatically when entering circling mode and zoom out automatically when leaving circling mode.

Map shift reference : The direction according to the map will be displaced in order to present a meaningful map section.
None: Disable any adjustment.
Track: Use a recent average of the ground track as basis.
Target: Use the current target waypoint as basis.

Glider position offset : Defines the location of the glider drawn on the screen in percent from the screen edge.

Max. auto zoom distance : The upper limit for auto zoom distance.

13.8 Map Display / Overlays

The final glide bar, the vario bar and the thermal band are drawn on the map. They stay at the edge of the map area.

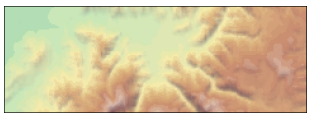
Thermal band : Enables the display of the thermal profile (climb band) overlay on the map.

Final glide bar* : If set to **On** the final glide bar is always shown. If set to **Auto** it is shown when approaching the final glide possibility. **Off** hides it.

Final glide bar MC0* : If set to ON the final glide bar will show a second arrow indicating the required altitude to reach the final waypoint at MC zero. Hidden while the final glide bar is off.

Vario bar* : Shows the vario bar on the map.

13.9 Map Display / Terrain



This page sets how terrain and topography is drawn on the map window. The effect of the changed terrain settings are directly visible at the small preview below.

Terrain display : Draws digital elevation terrain on the map.

Topography display : Draws topographical features (roads, rivers, lakes etc.) on the map.

Terrain colours : Defines the colour ramp used in terrain rendering. Various schemes are available, which works best for you will depend on how mountainous your region is.

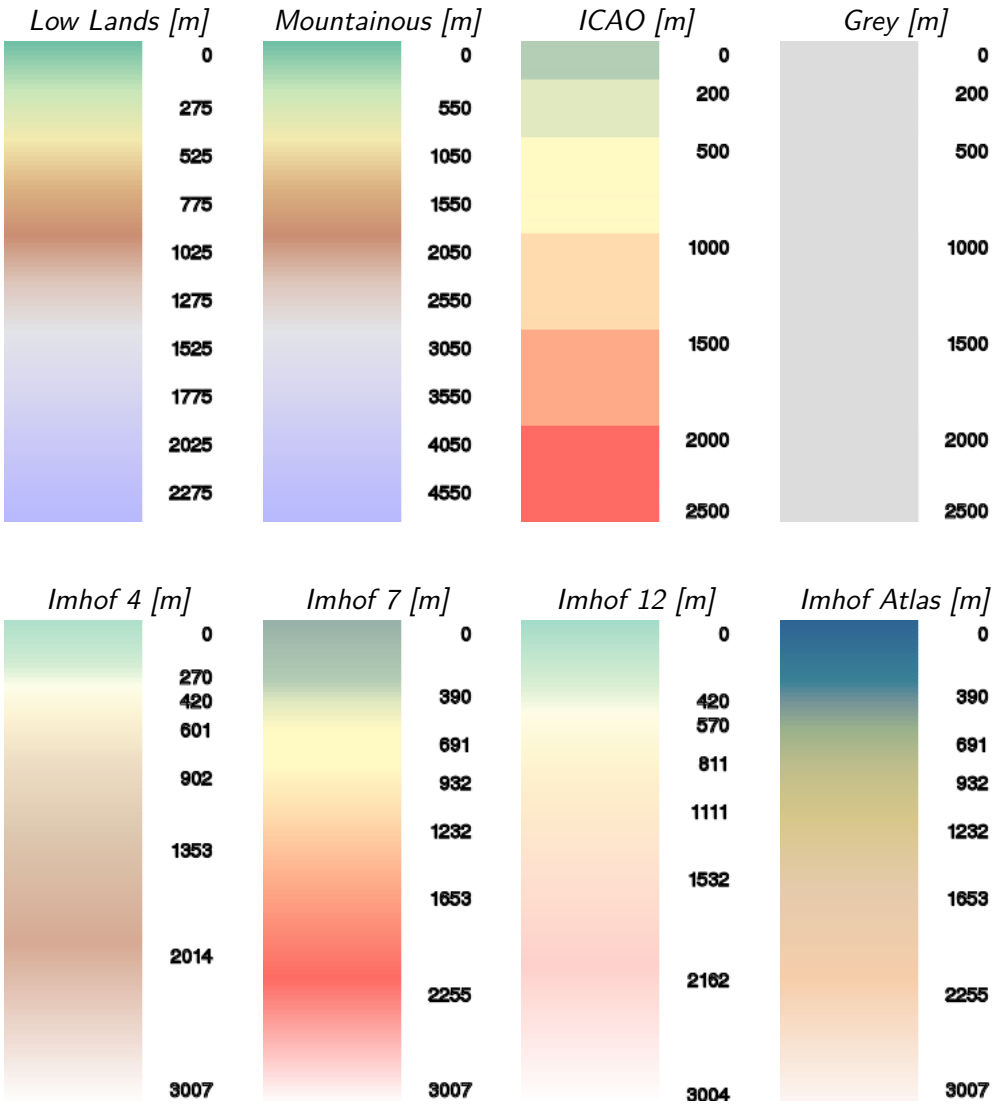
Slope shading* : The terrain can be shaded to indicate slopes and other terrain features. The illumination direction for the shading can be either: geographically fixed from the north-west, screen-relative fixed from the top left, or the shading can be according to the actual current sun position. In addition, the illumination can be set to indicate the wind direction, with upwind slopes bright, and downwind slopes shaded.

Terrain contrast* : Defines the amount of Phong shading in the terrain rendering. Use large values to emphasise terrain slope, smaller values if flying in steep mountains.

Terrain brightness* : Defines the brightness (whiteness) of the terrain rendering. This controls the average illumination of the terrain.

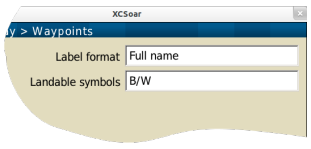
Contours* : Draws contour lines on the terrain. Two groups of modes are available. The adaptive modes (**Mountains**, **Highlands**, **Lowlands**, **Superfine**) set a base line density that is automatically scaled with the zoom level to avoid over-cluttering at small scales. **Mountains** is for areas with steep slopes, with a 256 m base spacing; the other adaptive modes provide progressively smaller spacing and higher line density. The fixed modes (**Fixed 256 m**, **Fixed 128 m**, **Fixed 64 m**) use a constant contour spacing regardless of zoom level.

The available terrain colour schemes are illustrated in the table below.



13.10 Map Display / Waypoints

This page provides options for how waypoints are displayed on the map.



Label format : This setting determines the label format displayed with each waypoint. There are four different format options.
Full name: The full name of each waypoint is displayed.
First word of name: Only the first word (up to the first space) of the waypoint name is displayed.
First 3 letters: The first 3 letters of the waypoint name are displayed.
First 5 letters: The first 5 letters of the waypoint name are displayed.
None: No name is displayed with the waypoint.

Waypoint label visibility* : Controls which waypoints are displayed with names and arrival altitudes on the map:

All: All waypoint labels will be displayed.
Task waypoints and landables: All waypoints part of a task and all landables will be displayed.
Task waypoints: All waypoints part of a task will be displayed.
None: No waypoint labels will be displayed.

Arrival height* : This setting allows arrival height and/or required glide ratio to also be shown in labels for landable waypoints. See Section 4.5 for more information.
None: Neither arrival height nor required glide ratio is displayed.
Straight glide: Straight glide arrival height (no terrain is considered). (default option)
Terrain avoidance glide: Arrival height considering any detour needed to avoid terrain.
Straight & terrain glide: Both arrival heights.
Required glide ratio: Glide ratio over the ground required to reach the waypoint.
Required GR & terrain glide: Both required glide ratio and terrain avoidance glide arrival height.

For any option including terrain avoidance glide arrival height, the 'Reach mode' setting (on the 'Glide Computer / Route' configuration page, 13.12) must be set to 'Turning'.

Glide ratio will be shown whenever the aircraft is higher than the waypoint regardless of how shallow the glide is and regardless of which configured waypoint file contains the waypoint. Negative straight glide arrival heights, however, will only be shown for waypoints in the 'Watched waypoints' file (selected on the 'Site Files / Site Files' configuration page, 13.4). Negative *terrain avoidance* arrival heights will never be shown for any waypoints.

Also, if the 'Straight & terrain glide' option is selected and only one arrival height (a positive one) is shown for a waypoint (e.g., 'Moontown:100m'), either no detour around terrain is needed or there's interfering terrain and no possible detour will get you to the waypoint at an acceptable height (the configured safety 'Arrival height' (13.13) above the ground at the waypoint). These are two *very different situations* safety-wise! Use other clues, like the reach line or the waypoint appearance (e.g., color), to determine which is the case in this scenario. Both arrival altitudes will be shown only if there's a detour that will get you there at an acceptable height but a direct route is blocked by terrain. For example, 'Moontown:200/50m' means (1) you could reach Moontown 200m above the minimum acceptable height if not for terrain that's in your way but (2) there's a detour that will get you there 50m above the minimum acceptable height. So in this case, you must detour, and the detour will cost you 150m (compared to if there were no terrain in your way).

Label style* : Labels for landables can be shown on a rounded rectangle with

white background, or with outlined letters.

Waypoint icon size : Size of waypoint symbols on the map as a percentage of the built-in artwork. List dialogs keep a fixed row icon size.

Landable symbols : Three styles are available: Purple circles (WinPilot style), a high contrast style with icons, and icons with a traffic light colour scheme. See Section 4.5 for details.

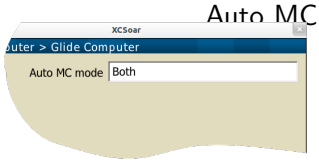
Detailed landables* : Enabling details on landables displays instead of fixed icons variable information like runway length and heading.

Landable size* : A percentage to select the size landables are displayed on the map.

Scale runway length* : Enabling this option will display for detailed landables additionally a scaled runway length based on real length.

13.11 Glide Computer / Glide Computer

This page allows glide computer algorithms to be configured.



Auto MC mode : This option defines which auto MacCready algorithm is used. For more details see Section 6.14.
Final glide: Final glide adjusts MC for fastest arrival.
Trending average climb: Sets MC to the trending average climb rate based on all climbs.
Both: Uses trending average during task, then fastest arrival when in final glide mode.

Block speed to fly* : If enabled, the command speed in cruise is set to the MacCready speed to fly in no vertical air-mass movement. If disabled, the command speed in cruise is set to the dolphin speed to fly, equivalent to the MacCready speed with vertical air-mass movement.

Nav. by baro altitude* : When enabled and if connected to a barometric altimeter, barometric altitude is used for all navigation functions. Otherwise GPS altitude is used.

Speed command switch* : How XCSoar uses the variometer's cruise/climb report. Off by default.

Off : XCSoar decides circling from the turn. The variometer report is not used.

Flight mode : While flying, the variometer's cruise/climb report is the flight mode. Cruise ends the climb and restarts the average. Climb starts a new thermal. Final glide can still appear in cruise. On a Vega this is the circling output. A profile that had *Flap forces cruise* enabled loads as this choice.

Display mode : The page changes and the flight mode does not. Cruise shows the cruise page, including while turning, and hides

final glide. Climb shows the vario page. On a Vega this is the speed-command switch. This choice does not run during a replay.

GR Average period* : Average efficiency is always calculated in real-time. Here you can decide on how many seconds of flight this calculation must be done. The real distance covered second by second in this period is divided by the final difference of altitude. So if for example you go and return back to the same point after 2 minutes, and you have set 2 minutes as period, average GR will consider the total distance covered in those two minutes, and not the distance between your position 2 minutes before and your current position, that in this case could be almost zero! Normally for gliders a good value is 90-120 seconds, and for paragliders 15 seconds. Lower values will give as a result pretty much the same as GR Instant, while higher values will look like GR Cruise. Other commercial instruments and software use 2 minutes.

Predict wind drift* : Accounts for drifting with the wind while circling to gain any altitude needed to reach final glide path altitude. On by default. This affects any displayed altitude difference (e.g., the final glide bar and altitude difference InfoBoxes). For upwind destinations, it makes the displayed altitude difference more negative; for downwind destinations, it makes it less negative (less climbing needed). The assumed circling climb rate equals the current MacCready setting (MC). If the current MC is zero, no circling is assumed, and the value shown is the same as if 'Predict wind drift' were 'Off'.

13.12 Glide Computer / Route

This page allows control over glide reach calculations and route optimisations.

Route mode : This controls which types of obstacles are used in route planning. Please have a look at Section 4.14 for a detailed description.

Route climb* : When enabled and MC is positive, route planning allows climbs between the aircraft location and destination.

Route ceiling* : When enabled, route planning climbs are limited to ceiling defined by greater of current aircraft altitude plus 500 m and the thermal ceiling. If disabled, climbs are unlimited.

Reach mode : How calculations are performed of the reach of the glider with respect to terrain.
Off: Disables map reach (terrain line and shade). Abort, alternates and landable arrival still use the Reach polar.
Straight: The reach is from straight line paths from the glider. Landable colours and the Alternates list use this reach.

Turning: The reach is calculated allowing turns around terrain obstacles. Landable colours and the Alternates list use this reach.

Reach polar* : Which MacCready is used for terrain reach, landable colours, abort and the Alternates list. This still applies when Reach mode is Off. The working line always uses Task MC. Alternate InfoBoxes and waypoint Alt. diff. Safety MC always use Safety MC.
Task MC: Uses task MacCready value.
Safety MC: Uses safety MacCready value.

Reach display : How the glide reach is drawn on the map. Terrain reach uses the Reach polar down to the ground. Working reach is how far you can glide and still arrive at typical thermal-base height from this flight; it always uses Task MC.
Off: No reach overlay on the map.
Terrain line: How far you can glide to the ground. Uses the Reach polar.
Terrain shade: Shades the map beyond glide to the ground. Uses the Reach polar.
Working line: How far you can glide and still arrive at typical thermal-base height from this flight. Always uses Task MC.
Working line, terrain line: Working line to typical thermal-base height using Task MC, plus terrain line to the ground using the Reach polar.
Working line, terrain shade: Working line to typical thermal-base height using Task MC, plus shade beyond the ground using the Reach polar.

13.13 Glide Computer / Safety Factors

This page allows the safety heights and behaviour for the alternates mode to be defined.

Arrival height : The height above terrain that the glider should arrive at for a safe landing.

Terrain height : The height above terrain that the glider must clear during final glide.
See Section 6.9 for more details on the meanings of the safety heights.

Alternates mode : Determines sorting of alternates in the alternates dialogue and in abort mode.
Simple: Reachable airfields are listed first (nearest at top), then outlanding sites (nearest at top).
Task: Reachable airfields are listed first (smallest detour to the active turnpoint at top), then outlanding sites.

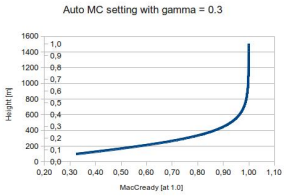
Home: Reachable airfields are listed first (smallest detour toward home at top), then outlanding sites.

Polar degradation* : A permanent polar degradation. 0% means no degradation, 50% indicates the glider's sink rate is doubled.

Startup Task MC : The MacCready used at startup for speed-to-fly and task calculations. Changing it here also sets the live MacCready. Terrain reach, landable colours, abort and the Alternates list follow Reach polar, not this value unless Reach polar is Task MC. The setting and the live MacCready run from 0 to 5 m/s. Default is 0.5 m/s.

Safety MC* : The MacCready used for terrain reach, landable colours, abort and the Alternates list when Reach polar is Safety MC. Alternate InfoBoxes and waypoint Alt. diff. Safety MC always use this value. The Safety MC speed is not limited by maximum cruise speed. Speed-to-fly still stops at maximum cruise speed. The GR at that setting is shown beside the value, written as 25:1. Higher values treat fewer fields as reachable. The setting runs from 0 to 10 m/s. Default is 3.2 m/s, about 25:1 on the default LS-8 polar. Adjusting Safety MC from the MacCready InfoBox during abort changes it for that flight and leaves this saved value unchanged.

STF risk factor* :



The STF risk factor reduces the MacCready setting used to calculate speed to fly as the glider gets low, in order to compensate for risk. Set to 0.0 for no compensation, 1.0 scales MC linearly with height (with reference to height of the maximum climb). If considered, 0.3 is recommended. See Section 6.8 for more details.

13.14 Glide Computer / Wind

This page sets the base for wind computations.

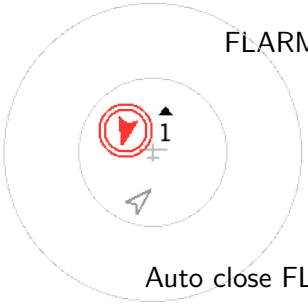
Auto wind : This allows switching on or off the automatic wind algorithm.
Manual: When the algorithm is switched off, the pilot is responsible for setting the wind estimate.
Circling: Circling mode requires only a GPS source.
ZigZag: ZigZag requires an intelligent vario with airspeed output.
Both: Uses Circling and ZigZag.

Prefere external wind : If enabled, the wind vector received from external devices overrides XCSoar's internal wind calculation.

13.15 Gauges / Thermal Assistant

Thermal assistant : Enables the display of the Thermal Assistant and selects its position on the screen.

13.16 Gauges / Traffic



FLARM radar : Enables the traffic radar and chooses its position on the main screen, or **Off** to hide it. The track bearing of the target relative to the track bearing of the aircraft is displayed as an arrow head, and a triangle pointing up or down shows the relative altitude of the target relative to you.

Auto close FLARM* : This will close the FLARM radar view when all FLARM traffic has gone.

Spoken alerts : Speaks the collision alarms of FLARM in English: the urgency (*Traffic*, *Traffic important*, *Traffic urgent*), the clock position of the intruder and whether it is *above*, *below* or *level*. A level intruder is less than about 8 degrees above or below you. A non-directional intruder (PCAS, Mode-S) gets no clock position. An alarm is spoken when it starts and whenever it becomes more urgent; while it persists, a new clock or vertical position is spoken at most every five seconds. Obstacle and alert zone alarms are not spoken: the FLARM device still beeps for them, as it does for every alarm. Off by default. The button *Test spoken alert* below plays "Traffic urgent! Twelve o'clock. Above.", so you can check the voice and the volume on the ground; a checklist line can play it too (`xcsoar://sound/test`, see section 3.8). It plays nothing while FLARM reports a collision alarm.

In all FLARM environments, the colour of the target indicates the threat level.

13.17 Task / Scoring

Contest : Determines the rules used to optimise for the selected contest paths.
OLC FAI: Conforms to FAI triangle rule. Three turns and common start and finish. For tasks longer than 500 km, no leg less than 25% or larger than 45%; otherwise no leg less than 28% of total. Finish height must not be lower than start height less 1000 m.
OLC Classic: Up to seven points including start and finish, finish height must not be lower than start height less 1000 m.
OLC League: A contest on top of the classic task optimisation, cutting a 2 hours segment over max. 3 of the turns. Finish height must not be below start height.
OLC Plus: A combination of Classic and FAI rules. 30% of the FAI score are added to the Classic score.
DMSt: Deutsche Meisterschaft im Streckensegelflug.
XContest:
DHV-XC:
SIS-AT:

FFVV NetCoupe: The FFVV NetCoupe '*libre*' competition.
WeGlide FREE: WeGlide combines multiple scoring systems in the WeGlide Free contest. The free score is a combination of the free distance score and the area bonus. For the area bonus, the scoring program determines the largest FAI triangle and the largest Out I& Return distance that can be fitted into the flight route.
WeGlide O&R: A start point, one turn point and a finish point are chosen from the flight path such that the distance between the start point and the turn point is maximized.

Predict Contest : If enabled, then the next task point is included in the score calculation, assuming that you will reach it.

13.18 Task / Task Rules

Task rules may be defined to limit valid starts according to competition rules.

Start max. speed : Maximum speed allowed in start observation zone. Set to 0 for no limit.

Start max. speed margin* : Maximum speed above maximum start speed to tolerate. Set to 0 for no tolerance.

Start max. height : Maximum height above ground while starting the task. Type the height (up to 30,000 in the current altitude unit), or set it to 0 for no limit.

Start max. height margin* : Maximum height above maximum start height to tolerate. Set to 0 for no tolerance.

Start height ref. : Reference used for start max. height rule.
MSL: Reference is altitude above mean sea level.
AGL: Reference is the height above the start point.

Finish min. height : Minimum height based on finish height reference (AGL or MSL) while finishing the task. Type the height (up to 30,000 in the current altitude unit), or set it to 0 for no limit.

Finish height ref. : Reference used for finish min. height rule, correspondingly to the start rule height reference.

PEV start wait time* : The default interval in minutes between the pilot presses the *Pilot Event* (see 4.10) button and start window opens. If set to 0, the start will open immediately after *Pilot Event* button is pressed.

PEV start window* : The default interval in minutes during which the start window remains open when *Pilot Event* (see 4.10) start procedure is used. If set to 0, the start window, once opened, remains open forever.

13.19 Task / Turnpoint Types

This page allows to set default turnpoint types used by the task editor. All options are well described for the task manager in Chapter 5.

13.20 Look / InfoBox Modes (or InfoBox Sets)

This page shows and let you customise the available InfoBox sets.

Circling, Cruise, ... : There are three predefined InfoBox sets (Circling, Cruise, Final Glide). Additionally you can define up to five more InfoBox sets and name them as you want. By default they are named AUX-1, AUX-2, and so on.
Selecting one of the sets starts a dialogue which provides all means to name and compose an InfoBox set up to your needs.

Use final glide mode : Controls whether the "final glide" InfoBox mode should be used on "auto" pages.

InfoBox Set Customisation

The dialogue shows the set the way it is laid out on the screen: every InfoBox is a card with its number and its caption, and the set is composed by moving these cards around, exactly as on the map (see Section 3.6).

Rename : Sets the name of the currently customized InfoBox set. The button starts the text input dialogue of XCSoar. Only the sets you have made yourself can be renamed.

InfoBox geometry : The layout used while this set is active. *Inherit from global settings* uses the geometry chosen under Look / Layout. Choosing another geometry lays the cards out again.

Help : Explains how an InfoBox is moved and how it is replaced.

Copy Set : Remembers all InfoBoxes of this set.

Paste Set : Replaces the InfoBoxes of another set with them.

See Section 12 for a description of the InfoBox types and their meanings.

To change the content of an InfoBox in the set, long-press its card. Without a touch-screen, press Enter twice without moving the selected InfoBox. The InfoBoxes are numbered; the location of the InfoBoxes depends on the screen layout. The tables below show the InfoBox enumeration scheme for the landscape and portrait screen layout.

1	7
2	8
3	9
4	10
5	11
6	12

1	2	3	4
5	6	7	8

13.21 Look / Layout

This page once more details the appearance of the graphical user interface of XCSoar.

Text size : Scales all UI text. At 100%, type follows the display density. InfoBox fonts follow it, and do not grow past the box. Menus, dialogues and status messages stop growing once the type would no longer fit the screen.

Viewing distance : **Auto** shrinks type when the short edge is under 3.2 inches (a phone held close). **Handheld** always uses that closer size. **Panel** keeps full-size type for a screen read at arm's length. Kobo devices start on **Handheld**.

InfoBox geometry : A list of possible InfoBox layouts. Do some trials to find the best for your screen size. The preceding number refer to the total number of InfoBoxes of this geometry.

Tab dialogue style : Determines whether tabbed dialogues use text or icons. **Icons** is the default.

Message display* : Defines the alignment of the status message box, either **Center** or in the **TopLeft** corner.

Dialogue size* : Determines the display size of dialogues.

Inverse InfoBoxes* : If **On**, the InfoBoxes are white on black, otherwise black on white.

Colour InfoBoxes* : If **On**, certain InfoBoxes will have coloured text. For example, the active waypoint InfoBox will turn blue when the glider is above final glide.

InfoBox border* : Two styles for InfoBox borders are available.
Box: Draws boxes around each InfoBox.
Tab: Draws a tab at the top of the InfoBox across the title.

13.22 Look / InfoBox Pages (or just Pages)

This page allows the definition of the screen page ensemble. A typical setup will contain three pages, the expert can pile up to eight possible pages. On a landscape screen, Add, Delete, and the move buttons are in the sidebar.

A page is more or less a composition of map and InfoBox set. There are five predefined pages for circling, cruise, final glide, a map only page and a page with automatic InfoBox set activation depending on your flight mode.

Additionally you can choose from up to five more pages that are composed from map and your custom InfoBox sets.

Page 1..3 : Select what you feel is appropriate for you to appear on page 1,2,3 etc. Selecting "- - -" will make the page inactive.

Page 4..8* : Experts can configure up to eight pages in the already described manner.

When editing a page, the following options are available for map pages:

Main area : The primary content of the page, for example *Map* or *Map (north-up)*.

InfoBoxes : Which InfoBox set is shown alongside the main area.

Bottom area : Optional panel below the main area. Select *Weather controls* to show in-flight RASP, EDL, or XC Therm forecast controls when the page uses a weather overlay.

Map overlay : Optional weather overlay drawn on map pages: *None*, *RASP*, *EDL*, *XC Therm*, *Rain radar*, or *Satellite*. RASP requires a loaded RASP file; EDL and XC Therm require network-capable builds with the respective weather provider configured. *Rain radar* draws the EUMETNET OPERA composite (Section 7.15) and *Satellite* draws Meteosat imagery from EUMETView (Section 7.16); neither needs an account, only an internet connection.

Satellite layer : When *Map overlay* is *Satellite*, selects which EUMETView product this page draws.

Layer / Level : When *Map overlay* is *RASP*, selects which RASP field is displayed on this page. When the overlay is *EDL*, selects the pressure level (altitude band): *Auto* follows aircraft altitude when the page is opened; a fixed level is restored each time the page is selected. The label and choices change with the selected overlay.

13.23 Look / Vario

This page configures the analog vario. It is part of an InfoBox layout that includes a vario, not a separate gauge on the map. The readouts are on by default. The averager needle is off. The thermal averager needle is on and replaces the live vario needle. Under the average, gross, and MacCready figures, STF or Var shows the audio vario cue. STF is speed-to-fly. Var is the variometer. Automatic mode uses STF in cruise and Var while circling, and stays on Var in cruise when speed-to-fly input is not available. Manual mode keeps the selected cue.

Speed arrows : Whether to show the speed command on the vario gauge. It is a vertical bar in the same colours as the climb and sink band: up to command slow down, down to command speed up. Shown in speed-to-fly mode, not while circling, when true airspeed is available. Within about 8 kt of the speed-to-fly target, no bar

is drawn. At full deflection the bar reaches the top or bottom of the scale.

Show average : Whether to show the average climb rate. In cruise mode, this switches to showing the average net airmass rate. While circling, the figure is red when it is less than half the risk MacCready, the same as the Thermal climb, last 30 s InfoBox. Cruise keeps the plain text colour.

Show MacCready : Whether to show the MacCready setting. The figure is green when manual, blue when automatic, and orange for Safety MC in task abort, the same colours as the MacCready InfoBox. In task abort the figure is Safety MC. An arrow in that colour marks the same value on the outside of the scale.

Show gross : Whether to show the gross vario value.

Averager needle : If true, the vario gauge will display a hollow averager needle. During cruise, this needle displays the average net value. During circling, this needle displays the average gross value.

Show bugs* : Whether to show the bugs percentage.

Show ballast* : Whether to show the ballast percentage.

Thermal Averager needle* : If true, the vario gauge will display a thermal averager needle instead of the current climb-rate needle. During cruise, this needle displays the last thermal average net value. During circling, this needle displays the average net value.

13.24 Services / LiveTrack24

The '*LiveTrack24*' protocol is used e.g. by the tracking portal on http://www.livetrack24.com. Please consult the web pages of the service provider listed under 'Server' for details on this setup.

Enable : Switch this **On** to enable the live stream of your position to '*LiveTrack24*'.

Tracking Interval : The time interval for which one position is sent to the tracking service.

Vehicle Type : Type of vehicle used.

Server : The service's web address to stream your position to. There is currently a choice of some predefined.

Username : If you created an account you can enter those credentials here. Otherwise the track will be logged as '*guest*' and thus be anonymous.

Password : The password to your tracking account.

13.25 Services / SkyLines

'*Live*'-Tracking means using a GPS to determine your position and a mobile network to send this position in real-time to a server, other people can see your exact position and track presented in a map just in time. The tracking option needs the capability to connect to mobile networking as offered by your glide computer.

'*SkyLines*' is a spin-off project from XCSoar itself; for details on this service have a look at https://skylines.aero.

Enable : Switch this **On** to enable the live stream of your position to '*SkyLines*'.

Tracking Interval : The time interval for which one position is sent to the tracking service. '*SkyLines*' implements a very lean protocol, so that even a 30 sec. interval does not exhaust a plain GPRS connection (ca. 12 kbit/sec).

Key : Create a key on the page https://skylines.aero/tracking/info and enter it here, to identify your positions at the tracking service.

13.26 Setup / Audio

Master volume and the audio variometer.

Master Volume : The overall audio output volume.

Audio Vario : Enable/Disable the audio variometer. The other audio vario settings on this page are hidden while it is off.

Vario Volume : Set the volume of the variometer sounds.

Mode switching : Stay in manual audio mode, or switch automatically between Vario in circling and speed-to-fly in cruise.

Enable Deadband : Enable/Disable the mute for audio output when the current lift is in a certain range around zero. Deadband min. lift and Deadband max. lift are hidden while this is off.

Min. Frequency* : The tone frequency that is played at maximum sink rate.

Zero Frequency* : The tone frequency that is played at zero climb rate.

Max. Frequency* : The tone frequency that is played at maximum climb rate.

Deadband min. lift* : If the deadband feature is enabled the vario will play sounds when the climb rate is below this threshold.

Deadband max. lift* : If the deadband feature is enabled the vario will play sounds when the climb rate is above this threshold.

13.27 Setup / Language, Input

This page allows to customise the way the user controls and interacts with XCSoar.

Events* : The Input Events file defines the menu system and how XCSoar responds to button presses and events from external devices.

Language : The language options selects translations for English texts to other languages. Select **English** for a native interface, **Automatic** to localise XCSoar according to the system settings; or you may select one of the two character language short cuts directly.

Status message* : The status message file can be used to define sounds to be played when certain events occur, and how long various status messages will appear on screen.

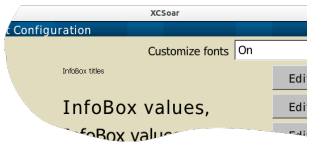
Menu timeout* : This determines how long menus will appear on screen if the user does not make any button presses or interacts with the computer.

Text Input Style* : Determines which style for text entries is used. See Section 3.8 for further information on textual input.
HighScore Style: For entering text you have to change the underlined character to the relevant letter.
Keyboard: Uses the on-screen keyboard for entering text.
Default: Uses the default input style for your platform.

Haptic feedback* : Let you switch on or off the vibration when the device accepts a finger press. Available on Android and iOS.

Press the Fonts button to adjust the fonts XCSoar uses.

Font Configuration



This page enables customisation of fonts in various fields of the program.

Once the customisation is enabled, the Edit buttons allow to change some parameters (font face, height, bold and italic) of the chosen font.

If customisation is disabled, default fonts will be used.

13.28 Setup / Logger

The internal software logger has adjustable time steps, separate for cruise and circling modes. Typically the circling time step is set to a smaller value than cruise in order to give good quality flight logs for replay purposes.

Pilot name : This is the pilot name used in the internal software logger declaration.

Time step cruise* : This is the time interval between logged points when not circling.

Time step circling* : This is the time interval between logged points when circling.

Auto logger* : Enables the automatic starting and stopping of the logger on takeoff and landing respectively. Disable when flying paragliders to prevent the low ground speeds from triggering the automatic logger.

NMEA logger* : Enable the NMEA logger on startup? If this option is disabled, the NMEA logger can still be started manually. On Android and iOS, the built-in satellite receiver is written to that log as GPRMC and GPGGA sentences when the logger is running and at least four satellites are in use.

Log book* : Logs each start and landing.

Logger ID : This is the logger registration.

13.29 Setup / Units

This page allows you to set the units preferences used in all displays, InfoBoxes, dialogues and input fields. For most users hopefully one of the presets will match the needs. The presets include unit sets for **American**, **Australian**, **British**, and **European**.

Separate selections are available for all items. Once you changed a given preset it will be referenced as 'Custom' set and will also be stored in your profile.

Aircraft/Wind speed* : Units used for airspeed and ground speed: mph, knots, km/h. A separate unit is available for task speeds.

Distance* : Units used for horizontal distances e.g. range to waypoint, distance to go: sm, nm, km.

Lift* : Units used for vertical speeds (variometer): knots, m/s, ft/min.

Altitude* : Units used for altitude and heights: ft, m.

Temperature* : Units used for temperature: °C, °F.

Task speed* : Units used for task speed: mph, knots, km/h.

Pressure* : Units used for pressures: hPa, mb, inHg.

Lat./Lon.* : Units, or better formats used for latitude and longitude. Supported are several 'degree/minutes/seconds' formats, respectively their decimal fraction, and the UTM WGS 84 format.

13.30 Setup / Screen

This page configures the physical screen: technology, resolution, orientation, brightness, and (where drawn by XCSoar) the mouse cursor.

Display type* : Select the display technology. E-ink modes disable kinetic and smooth scrolling for slow refresh screens, and draw text without anti-aliasing (the same 1-bit glyphs as on Kobo). Terrain is drawn at full detail immediately, without a coarse preview. Map updates are capped the same way as on the Kobo: calculations at 900 ms and sensor merge at 450 ms. Text size follows the same density and Text size setting as an LCD; only rasterisation changes.

Display resolution* : Used to adapt line widths, font size, landable size and more. Leave this on automatic unless the type is clearly the wrong size.

Display orientation : Rotate the display on devices that support it.

Screen brightness : Adjust the screen brightness, where the platform allows it.

Full screen : Let XCSoar use the whole screen, including the areas behind the system bars and the display cutout (the "notch"). The map always fills it completely; *Stretch InfoBox area* decides which edges the InfoBoxes, gauges, map overlays and the menu may reach. Only available on Android and iOS.

Stretch InfoBox area* : The InfoBox area is the part of the screen that is available to the InfoBoxes, gauges, map overlays and the menu. Selecting this entry opens a picker in which you choose the screen edges on which the InfoBox area is stretched out to the screen border, so that they reach the very edge there. Edges you leave unstretched stay clear of the display cutout and of the space the system bars occupy, including the home indicator while full screen hides it. Rounded corners stay clear on unstretched edges. Dialogues always stay inside the safe area. The Fly/Simulator start screen may fill the screen with its background; Quit, Fly, Simulator and the version stay in the safe area. Hidden while *Full screen* is off.

System status bar : Whether the system status bar with the clock and the battery level stays visible.
Auto: Show it unless the InfoBox area is stretched to the top screen edge.
Visible: Always show it, even in full screen mode.
Hidden: Never show it.
While the status bar is visible, the InfoBoxes keep clear of the top screen edge, because they cannot be drawn behind it. Only available on iOS.

Cursor zoom : Control the size of the cursor. Default is 1. Only available if the cursor is drawn by XCSoar.

Invert cursor color : Use a black cursor. Default is **Off** (white cursor). Only available if the cursor is drawn by XCSoar.

13.31 Setup / Time

Set the local time offset with respect to UTC.

Local time source : Selects where XCSoar gets the offset between UTC and local time from:

- Automatic : The offset is taken from the time zone configured in the operating system and is kept up to date, so it follows daylight saving time changes and travelling to another time zone. This option is not available on Kobo, because those devices have no time zone setting at all.
- Time zone : The offset is calculated from the time zone selected below. A time zone includes the daylight saving time rules, which means XCSoar applies the transitions on its own; the setting does not have to be corrected twice a year.
- Manual UTC offset : The fixed offset entered below is used. It has to be corrected manually whenever daylight saving time begins or ends. This option is offered in expert mode only, unless it is the one in use.

Time zone : The time zone of the airfield you are flying at, e.g. 'Europe/Berlin'. It is only editable while the local time source is 'Time zone'.

Manual UTC offset : The field allows the UTC local time offset to be specified. It is only editable while the local time source is 'Manual UTC offset', and it keeps the value you entered while another source is selected.

Local time : The local time is displayed below in order to make it easier to verify the correct offset has been entered, followed by the UTC offset which is currently in effect. Offsets to the quarter-hour may be set.

Use GPS time* : This option, if enabled sets the clock of the computer to the GPS time once a fix is set. This is only necessary if your computer does not have a real-time clock with battery backup or your computer frequently runs out of battery power or otherwise loses time.

13.32 Setup / System Tools

On supported Linux versions, this page shows installed maintenance tools, their origin and a short description. It is hidden when no supported tools are available and is unavailable in SDL versions. Tools cannot start while flying.

Read the preparation instructions, then press Start or Back . Harmless information reports may start directly. Output remains visible with *Complete* or *Failed* when finished. Nonprinting controls are removed; line breaks and tabs are kept. Cancelling allows the job and its child

processes ten seconds to clean up before sending a forced-stop request and returning to XCSoar, even if the job remains blocked by the system. Unread output may then be discarded. For exclusive tools such as touchscreen calibration, XCSoar saves its state, closes, and restarts with the result. These tools require support from the flight computer's system image.

Install personal commands in `tools` below the active data folder. Pair `system-info.tool` with either `system-info` or `system-info.sh`; if both executables exist, the command is hidden. Scripts need an interpreter line (for example `#!/bin/sh`) and executable permissions. A minimal descriptor for an information report is:

```
name=Storage information
description=Show available disk space
instructions=This command does not change settings.
mode=job
confirmation=none
```

Use `confirmation=none` only for harmless information reports. The folder and files must belong to XCSoar's user, without symlinks or world write access. Group write is allowed for XCSoar's effective group; its members are trusted to modify commands. Parent folders must also prevent replacement by users outside that group. Trusted personal commands override system tools with the same ID; an overflowing personal catalogue is ignored. Commands run as XCSoar's user, including root if applicable, and must not have setuid/setgid bits. Install only commands you trust. Data backups preserve executable permissions; review restored commands before running them.

13.33 Configure Plane

Config 2/3 ▷ Plane

This dialogue allows the glide polar to be defined. For a large variety of glider types XCSoar provides a predefined glide polar, they could be modified if needed, or you can load your own polar from a file. The file format is based on the WinPilot polar file format (see Section 14.6).

To configure the glide computer to the performance of a glider type start with the selection of a type from the List . Choose Import when you want to load an external polar file. Customise the three V/W points defining the parabola curve and the reference weight to your needs. Be aware that namely those four items are of crucial importance for every glide performance relevant computation of XCSoar. Export your efforts to a file: always a good idea.

Polar V/W : Three pairs of corresponding horizontal and vertical speed of the glider. A good choice for the point triplet is one at the top most area of the polar, the second at a still very curved area and the third far out where the curvature seems to disappear.

Reference mass : Reference weight at which the given polar is valid.

Dry mass : The complete weight of the rigged glider including the pilots weight except the loaded water ballast. In the absence of a configurable pilot weight XCSoar expects you to include your own weight to the dry mass. Editing Empty mass on the active plane sends it to a device whose Sync. to device setting is on. Selecting a different plane sends that plane's whole polar when Polar sync is Send, and leaves the vario's polar unchanged when Polar sync is Receive.

Wing area : Optional specification of the wing area of the glider type. When Polar sync is Send, the wing loading written to the vario is the reference mass divided by this area.

Max. Cruise Speed : Optional upper limit for MacCready speed-to-fly (including final glide). Prevents the glide computer from commanding unrealistically high cruise speeds. A typical choice is the rough-air / green-arc limit from the flight manual.

Handicap : The handicap factor used for the On-Line Contest scoring.

MTOW : Optional maximum takeoff weight of the glider. Set to zero if it is not known. While the glider is heavier than this, the wing loading is shown in red. It does not change when the pilot weight changes. Editing it on the active plane, or selecting another plane that has one, sends it to a device whose Sync. to device setting is on. Zero is not sent.

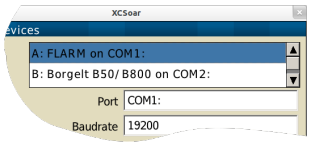
Max. ballast : Optional the amount of water ballast XCSoar refers to as 100% ballast. Set to zero if it does not apply.

Dump time : The time in seconds needed for dumping full ballast.

13.34 Configure Devices

Config 2/3 ▷ Devices

The Devices page is used to specify the ports used to communicate with the GPS and other serial devices. The default settings are COM1 and 4800 bits per second. When connected to the Vega intelligent variometer, the settings should be COM1 and 38400.



Four devices can be configured (device A through D). One, for example, can be connected to a GPS and another to a second device such as a variometer. If there is no further device, set the unused ports to 'Disabled'. XCSoar will then ignore those ports.

COM ports 0 to 10 may be used, including a TCP/IP connection. Which COM port is appropriate for you depends on what brand of PDA you use, and the communications medium (serial cable, Bluetooth, virtual COM port, SD card or CF based GPS, internal GPS). Detailing the various options for different devices is beyond the scope of this document. If you have trouble identifying which COM port to set, please refer to the XCSoar website and mailing lists.

Port : This setting maps an existing interface (port) of your glide computer to one of the available slots A to D. On Android, Bluetooth LE devices appear as *BLE port* (a serial UART used by varios such as BlueFly) or *BLE sensor* (heart-rate monitors, pulse oximeters, SensBox, and engine sensors). A BlueFly Vario must be selected as *BLE port* with the BlueFly driver; *BLE sensor* cannot carry its serial protocol. *Engine Type* appears only for an engine-sensor BLE device (ignition scaling); heart-rate bands do not show it. A Xiaomi Smart Band talks GATT on a random LE address; XCSoar follows that live device. Enable *Heart rate broadcast* and leave the Xiaomi app (and a second XCSoar copy) disconnected so the standard heart-rate service is free. A pulse oximeter is selected as *BLE sensor* as well. The Blood Oxygen InfoBox shows its saturation. The Devices list shows *Heart Rate*, *Blood Oxygen*, *Pressure*, *Temperature*, and *Relative humidity* among the other sensor flags, and *Battery=N%* when remaining charge is known, including BLE sensors that expose the standard heart-rate, Pulse Oximeter, Environmental Sensing, and Battery services. XCSoar uses the first device that supplies each value (device A before B, and so on). Winning sensor flags such as *GPS fix*, *Baro* (QNH height), *QNE* (pressure altitude), and *Alt IGC* (the altitude written to the IGC log) are drawn in bold; the same flag that is not bold on a later device is present but ignored. *Baro*, *QNE*, and *Alt IGC* are separate values, so one device can supply QNH height while another supplies pressure altitude or the logger altitude. *Pressure* (static pressure) and *QNE* are the same ambient pressure, so only the earlier of those two is bold. *Bad GPS* is shown in red on a colour display, or in bold on e-paper, when the device sends GPS sentences without a valid fix. *Battery=N%* is shown in red on a colour display, or in bold on e-paper, when remaining charge is below 10 percent. The *FLARM* flag is shown while that device is sending updates. *GDL90* is shown while the connection is alive. Traffic from every such device is used. The *Help* button on the Devices list repeats this.

Baudrate : Set this to the communication speed of the connected device.

TCP Port : This setting is useful to e.g. connect to the Condor flight simulator and do some XCSoar training in winter time.

Bulk baud rate : The baud rate used for bulk transfers, such as task declaration or flight download. The item is visible for those devices that support the feature.

Driver : The specific type of device can be selected from a list in order to enable support for devices with proprietary protocols or special functions.

Sync. from device* : This option lets you configure if XCSoar should use settings like the MacCready value, bugs and ballast from the device.

Sync. to device* : This option lets you configure if XCSoar should send settings like the MacCready value, bugs and ballast to the device.

XCSoar uses an NMEA sentence only when its checksum matches. A device that sends invalid checksums cannot be used as it is.

14 Data Files

Data files used by XCSoar fall into two categories:

Flight data files : These files contain data relating to the aircraft type, airspace and maps, waypoints etc. These are the files that are most likely to be modified or set by normal users.

Program data files : These files contain data relating to the 'look and feel' of the program, button assignments, input events.

This chapter focuses on flight data files; see the *XCSoar Advanced Configuration Guide* for details on program data files.

14.1 File management

File names must correspond to the name extensions specified below. It is good practice to make sure that the file names are recognisable so that when making configuration changes there is less risk of confusion between different files and different file types.

Terrain and topography files are accessed continuously while XCSoar is running, so they should be located on reasonably fast storage. Modern memory cards usually meet the required performance.

All data files should be copied into the directory `XCSoarData`. See Chapter 2 for where that directory lives on each platform.

If unsure, just start the newly installed XCSoar and it creates the `XCSoarData` directory at the right place.

14.2 Map Database

A map database (extension `.xcm`) contains terrain, topography and optional contents like waypoints and airspaces.

Terrain is a raster digital elevation model represented as an array of elevations in meters on a latitude/longitude grid. The internal file format is GeoJPEG2000.

The topography is vector data such as roads, railway lines, large built-up areas (cities), miscellaneous populated areas (towns and villages), lakes and rivers. The topography is stored in ESRI Shape files which are generated from OpenStreetMap.

Map files can be downloaded from the XCSoar web site:

https://xcsoar.org/download/maps/

To generate a custom map database with different settings and bounds, you may use the map generator:

https://mapgen.xcsoar.org/

As far as waypoints or airspaces are included in the map database XCSoar defaults to them. An e.g. separately configured waypoint file will replace all the waypoints given by the map database.

14.3 Waypoints

XCSoar understands the following waypoint file formats:

- WinPilot/Cambridge (`.dat`)
- SeeYou (`.cup`)
- Zander (`.wpz`)
- OziExplorer (`.wpt`)
- GPSDump/FS, GEO and UTM (`.wpt`)

Files are available from the Soaring Turn-points section of the Soaring Server[1]: http://soaringweb.org/TP

Several commercial and freely distributable programs exist for converting between different waypoint formats.

If the elevation field of a waypoint is empty, XCSoar takes the waypoint elevation from the terrain, as soon as the terrain file has been loaded, and again whenever another terrain file is loaded. A waypoint outside of the terrain has no elevation, and no arrival altitude is calculated for it. An elevation of zero in the waypoint file means sea level.

14.4 Airspace

XCSoar supports airspace files (extension `.txt`) using a sub set of the widely distributed OpenAir format, as well as the Tim Newport-Pearce file format (extension `.sua`). Files are available from the Special Use Airspace section of the soaring web site:

http://soaringweb.org/Airspace

The following is the list of supported airspace types: Class A-G, Prohibited, Danger Areas, Restricted, Task Area, CTR, No Gliders, Wave, Transponder Mandatory, and Other. All other airspace types will be drawn as type "Other". In addition to the OpenAir standard the 'AF' or 'AR' command is recognized as the airspace radio frequency. Ie. Since 2018, Naviter proposes the following change 'AF 999.999' (find 'Additional OpenAir fields' here - http://www.winpilot.com/UsersGuide/UserAirspace.asp)

[1] Mirrors to this website exist, google search for "worldwide soaring turnpoint exchange" if the main server is inaccessible.

14.5 Airfields or Waypoint details

The airfields or waypoint details file (extension `.txt`) is a simple text format file containing entries for each waypoint (especially airfield), marked in square brackets, followed by the text to be displayed on the Waypoint Details Dialogue for that particular waypoint. The text should have a narrow margin because the airfields or waypoint details dialogue cannot currently handle word wrapping.

The text may also specify images for airfields or waypoints. To show an image directly in XCSoar use `image=` followed by the file name (this is currently not supported on PC/Windows). Be sure to avoid any additional whitespaces around the equal sign or in front of the keyword. Which files are supported depends on your operating system and the applications that are installed. Android supports JPEG files and other file types, others mostly BMP images. one or several images can be shown. The file name is relative to the XCSoar data directory, also for waypoints loaded from a `.cupx` file. For those, a section in this file replaces the pictures the archive carries for that waypoint, even if it lists no image; only a file name that also exists in the archive is still taken from the archive.

The text may also specify any document specific to airfields or waypoints using `file=` followed by the file name. Such document won't be loaded directly in XCSoar but will be loaded by external app. Any arbitrary file is supported. PDF files, for example, will be loaded by your PDF reader.

The names of airfields used in the file must correspond exactly to the names in the waypoints file, with the exception that converting to uppercase is allowed.

The XCSoar website provides airfield details files for several countries and includes tools to convert from various Enroute Supplement sources to this file format.

Users are free to edit these files to add their own notes for airfields that may not otherwise be included in the Enroute Supplement sources.

An example (extract from the Australian airfields file):

```
[BENALLA]
RUNWAYS:
  08 (RL1,7) 17 (RL53) 26
  (R) 35 (R)

COMMUNICATIONS:
  CTAF - 122.5 REMARKS: Nstd
  10 NM rad to 5000'

REMARKS:
  CAUTION - Animal haz. Rwy
```

```
  08L-26R and 17L-35R for
  glider ops and tailskidacft
  only, SR-SS. TFC PAT - Rgt
  circuits Rwy 08R-26L. NS
  ABTMT - Rwy 17R-35L fly wide

ICAO: YBLA

file=Benalla.pdf
image=Benalla_sat.bmp
image=Benalla_pic.bmp

[GROOTE EYLANDT]
Blah blah blah blah
...
```

14.6 Glide polar

Many polars of common gliders are built into XCSoar. If your glider model is not listed, you can use a polar file in the WinPilot polar format (extension `.plr`).

The WinPilot and XCSoar websites provide several glide polar files. Files for other gliders may be created upon request to the XCSoar team.

The format of the file is simple. Lines beginning with * are ignored and so may be used to document how the polar was calculated or if there are restrictions on its use. Other than comments, the file must contain a single row of numbers separated with commas.

The WinPilot polar format defines eight fields:

- Mass dry gross weight in kg: this is the weight of the glider plus a 'standard' pilot without ballast.
- Max water ballast in liters (kg).
- Speed in km/h for first measurement point, (usually minimum sink speed).
- Sink rate in m/s for first measurement point.
- Speed in km/h for second measurement point, (usually best glide speed).
- Sink rate in m/s for second measurement point.
- Speed in km/h for third measurement point, (usually a high cruise speed).
- Sink rate in m/s for third measurement point.

XCSoar optionally accepts two further fields after those eight (not part of the WinPilot format):

- The wing area in m^2 to allow the wing load computation (could be zero if unknown).
- The max. cruise speed in m/s. XCSoar uses this as an upper limit for MacCready speed-to-fly (including final glide), so the computer does not command unrealistically high cruise speeds. It corresponds to the plane setting "Max. Cruise Speed". A typical choice is the rough-air / green-arc limit from the flight manual.

An example, for the LS-3 glider, is given below:

```
*LS-3 WinPilot POLAR file: MassDryGross[kg],
*  MaxWaterBallast[liters], Speed1[km/h], Sink1[m/s],
*  Speed2, Sink2, Speed3, Sink3
373, 121, 74.1, -0.65, 102.0, -0.67, 167.0, -1.85
```

Don't be too optimistic when entering your polar data. It is all too easy to set your LD too high and you will rapidly see yourself undershooting on final glide.

14.7 Profiles

Profile files (extension `.prf`) can be used to store configuration settings used by XCSoar. The format is a simple text file containing `<label>=<value>` pairs. Certain values are text strings delimited by double quotes, for example:

```
PilotName="Baron Richtoffen"
```

All other values are numeric, including ones that represent boolean values (true$=1$, false$=0$), for example:

```
StartDistance=1000
```

All values that have physical dimensions are expressed in SI units (meters, meters/second, seconds etc).

When a profile file is saved, it contains all configuration settings. Profile files may be edited with a text editor to produce a smaller set of configuration settings that can be given to other pilots to load.

When a profile file is loaded, only the settings present in that file overwrite the configuration settings in XCSoar; all other settings are unaffected.

The default profile file is generated automatically when configuration settings are changed or when the program exits; this has the file name `default.prf`.

The easiest way to create a new profile is to copy a previous one, such as the default profile. Copy the file, give it a logical name, and then when XCSoar starts next time the new profile can be selected and customised through the configuration settings dialogues.

14.8 Checklist

The checklist file (`xcsoar-checklist.txt`) uses a similar format to the airfield details file. Each page in the checklist is preceded by the name of the list in square brackets. Multiple pages can be defined (up to 32).

An example (extract):

```
[Preflight]
Controls
Harness, secure objects
Airbrakes and flaps
Outside
Trim and ballast
Instruments
Canopy

[Derigging]
Remove tape from wings and tail
...
```

14.9 Tasks

Task files (extension `.tsk`) are stored in XCSoar's own XML format, whereas SeeYou tasks can also be loaded from file (extension `.cup`). The task file format is documented for developers and authors of converters at https://xcsoar.readthedocs.io/en/latest/task_file.html.

14.10 Flight logs

The software flight logger generates IGC files (extension `.igc`) according to the long naming convention described in the FAI document *Technical Specification for IGC-Approved GNSS Flight Recorders*. The GPS line of its header (`HFGPS`) names the device that supplies the GPS fix when the logger starts: the first device in the Devices list that delivers a position, the one whose GPS flag is shown in bold. If another device takes over the GPS fix during the flight, the file notes it in a comment line after the first fix from that device, for example `LXCS132015GPS:B FLARM` (UTC time 13:20:15, new source device B with the FLARM driver); the header line itself cannot change.

Log-files are stored in the 'logs' subdirectory of the XCSoarData directory. These files can be imported into other programs for analysis after flight.

14.11 FLARM Identification

The FLARM identification file `xcsoar-flarm.txt` defines a table of aircraft registrations or pilot names against the ICAO IDs that are

optionally broadcast by FLARM equipped aircraft. These names are displayed on the map next to FLARM traffic symbols, for matching ICAO IDs.

The format of this file is a list of entries, one for each aircraft, of the form *icao id*=*name*, where *icao id* is the six-digit hex value of the ICAO aircraft ID, and *name* is free text (limited to 20 characters), describing the aircraft and/or pilot name. Short names are preferred in order to reduce clutter on the map display.

Example:

```
DD8F12=WUS
DA8B06=Chuck Yeager
```

Currently this file is limited to a maximum of 200 entries.

Additionally the FlarmNet file `data.fln` is supported. It contains all the FLARM identifications distributed by the FlarmNet community. The file can be downloaded from the web site:

http://www.flarmnet.org

The file must reside in the XCSoarData directory.

14.12 Input events

The input event file (extension `.xci`) is a plain text file designed to control the input and events in your glide computer.

You do not require access to the source code or understanding of programming to write your own input event files but you do require some advanced understanding of XCSoar and of gliding.

Some reasons why you might like to use xci:

- Modify the layout of button labels
- Support a new set or layout of buttons (organiser hardware buttons)
- Support an external device such as a Bluetooth keyboard or gamepad
- Customise any button/key event
- Do multiple events from one key or glide computer triggered process

For more information on editing or writing your own input event file the *XCSoar Developer Manual* is a good starting point.

14.13 Status

Status files are text of the form *label*=*value*, arranged in blocks of text where each block corresponds to an individual status message. These

are delimited by double spaces. Each block can contain the following fields:

key : This is the text of the status message.

sound : Location of a WAV audio file to play when the status message appears. This is optional.

delay : Duration in milliseconds the status message is to be displayed. This is optional.

hide : A boolean (yes/no) that dictates whether the message is to be hidden (that is, not displayed).

Example:

```
key=Simulation\r\nNothing is real!
sound=\My Documents\XCSoarData\Start_Real.wav
delay=1500

key=Task started
delay=1500
hide=yes
```

15 History and Development

15.1 Product history

XCSoar started as a commercial product developed by Mike Roberts (UK), where it enjoyed a successful share of the market for several years and going though several releases, the last being **Version 2**. Personal reasons prevented him from being able to continue supporting the product and so in late 2004 he announced the licensing of the source code to the GNU public license, as XCSoar **Version 3**. A support website on Yahoo Groups was set up and the open source project started to gain interest and input by developers.

In March 2005 the program was substantially enhanced and this resulted in **Version 4.0** being released. By this time, coordination of the various development efforts on the source code became difficult and time-consuming, so it was decided to move the project to SourceForge, whereby all the software work could be managed by a concurrent version management system.

In July 2005, **Version 4.2** was released which addressed some compatibility issues that were experienced with certain PDA and GPS hardware configurations.

In September 2005, **Version 4.5** was released. This contained major enhancements to the user interface including the introduction of the 'input event' system and language translation files.

In April 2006, **Version 4.7** was released to Altair customers. This contained stability and performance enhancements as well as many bug fixes; and a new method for handling dialogues based on XML files.

In September 2006, **Version 5.0** was released on all platforms, Altair, PC, PDA. This version contains many improvements and new features and is based on extensive testing in flight and in simulation.

In September 2007, **Version 5.1.2** was released on all platforms, Altair, PC, PDA. This version contains many improvements and new features and is based on extensive testing in flight and in simulation. Major improvements include a new map file format incorporating JPG2000 compression, online contest support, additional supported devices, FLARM radar screen, and overall improved stability, reliability and accuracy of task calculations. Many feature requests from users have been incorporated into this release.

In February 2008, **Version 5.1.6** was released. This contained numerous bugfixes and user interface enhancements, notably expanding the RASP and AAT functionality.

In March 2009, **Version 5.2.2** was released. As well as user interface improvements, several major features were introduced: IGC files were digitally signed for validation in online contests such as OLC. PNA navigation devices were supported for the first time. FLARM was integrated with the map display with support for the FlarmNet ID database. Developers could now easily compile XCSoar from Linux desktop computers.

In August 2009, **Version 5.2.4** was released with internal fixes and enhancements.

In December 2010, **Version 6.0** was released. Following an extensive rewrite of much of the program, many stability and performance enhancements were made and startup times were dramatically reduced. A great many features were added including a vastly expanded task engine and editor, AAT support, new FLARM and thermal-assistant displays. Many new languages were introduced, and new translations could now be easily generated by users.

Significantly, the rewrite allowed XCSoar to run on UNIX-like systems and Android devices, and the use of modern compiling tools enhanced the performance of the program on the current generation of devices.

In March 2011, **Version 6.0.7b** was released, the first release to officially support Android.

Early 2013: With **Version 6.4.5.** first results of a German and French manual translation got published on the XCSoarhome page.

February 2012: XCSoar**is world champion** in Argentina! Tobias did an interview with Santi on IRC.

April 2013: **Version 6.6** was released. Six years after starting the version 6 rework of the XCSoarengine the final outcome becomes visible on user interface level. A remarkable pile of usability convenience condensed the XCSoarvalue, including the cross section map view.

May 2013: The Android XCSoarinstallation counter for the stable release crossed the 30,000 mark.

15.2 Get involved

The success of the project is the result of many kinds of contributions. You do not have to be a software developer to help.

In general, there are perhaps five major ways of contributing, other than working on the software itself:

Give feedback : Ideas, suggestions, bug reports, encouragement and constructive criticism are all very welcome and helpful.

Setup suggestions : Because XCSoar is so configurable, we rely to some extent on users to think about how they would like the program to be set up. Selection of InfoBox layouts, button menus and button assignments require some design thought, and making these available to the developers and other users will help us provide good default settings.

Data integrity : Airspace and waypoint files need to be kept up to date, and it often takes people with local knowledge to do this.

Promotion : The more users the software has, the better the product will be. As more people use the software and give feedback, bugs are found more easily and improvements can occur at a greater pace. You can help here, for example, by showing the software to others and by conducting demonstration and training sessions in your club.

Documentation : Naturally, the manual is always outdated, and we need help with maintaining it.

15.3 Open source philosophy

There are several benefits to having software like XCSoar open source.

- Firstly, it is free so pilots can try out the software at no cost and decide if it is suitable for their needs; and pilots are free to copy the program onto whatever device, PC or EFIS they like without charge.
- You have access to the source code so you are free to change the software or use pieces of it in new free programs.
- Having the source code available on the Internet means that it is subject to wide scrutiny and therefore bugs are easily and quickly fixed.
- A large group of developers are available to help in troubleshooting and quickly implement new features upon request.
- Open source software under the GNU public license cannot at a later date be made closed-source; so by using this software you will not be locked in to unspecified software costs in the future.

The full terms of the licensing agreement for XCSoar is given in Appendix A.

The development of XCSoar since its open source release has been entirely a volunteer effort. This does not preclude individual developers or organisations from offering commercial support services. The spirit of the project however suggests that in such cases the commercial services are encouraged to produce some flow-on benefit back to the wider community of users.

15.4 Development process

We try to incorporate new features as quickly as possible. This has to be balanced by the needs to not change substantially the interface without appropriate warnings so users that upgrade do not get a shock. This means that when we introduced the new button menu system in version 4.5, it was necessary to also distribute a file that allowed users to have the buttons assigned to their 'legacy' function.

XCSoar, being used in flight, is a special kind of software because it can be regarded as 'mission-critical', and is a real-time system. This has placed a very high emphasis on developers to perform a great deal of testing before releasing changes to the public.

Flight testing is certainly the best sort of test, but we have also been able to conduct the bulk of testing by using XCSoar in a car, and more recently, by replaying IGC flight logs.

In general, we don't want the program to crash or hang, ever, and if it does so during testing, then whatever bug caused the problem has to be fixed as top priority.

The software developers all keep in contact with each other through the SourceForge developer's mailing list

xcsoar-devel@lists.sourceforge.net

We try to coordinate our activities to avoid conflict and duplicated effort, and to work together as a team. If you would like to get involved in the software development, send the developers an email.

15.5 User base

Who is using XCSoar? Good question, and hard to answer. Since no-one pays for the product — most people download the program anonymously — it is hard for anyone to keep track of how many users are out there.

Statistics from the main website indicate there has been an average of approximately twenty downloads per day between June 2005 and June 2006, and eighty downloads per day between June 2006 and September 2007. Looking at how many people download the terrain and topography data packs from the website indicates that it is used in many countries and in nearly every continent.

XCSoar is used by a wide cross section of pilots, including early post-solo through to experienced competition pilots. There are many 'arm-chair' pilots who use XCSoar with gliding simulators, such as Condor.

Appendix A GNU General Public License

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Version 2, June 1991

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