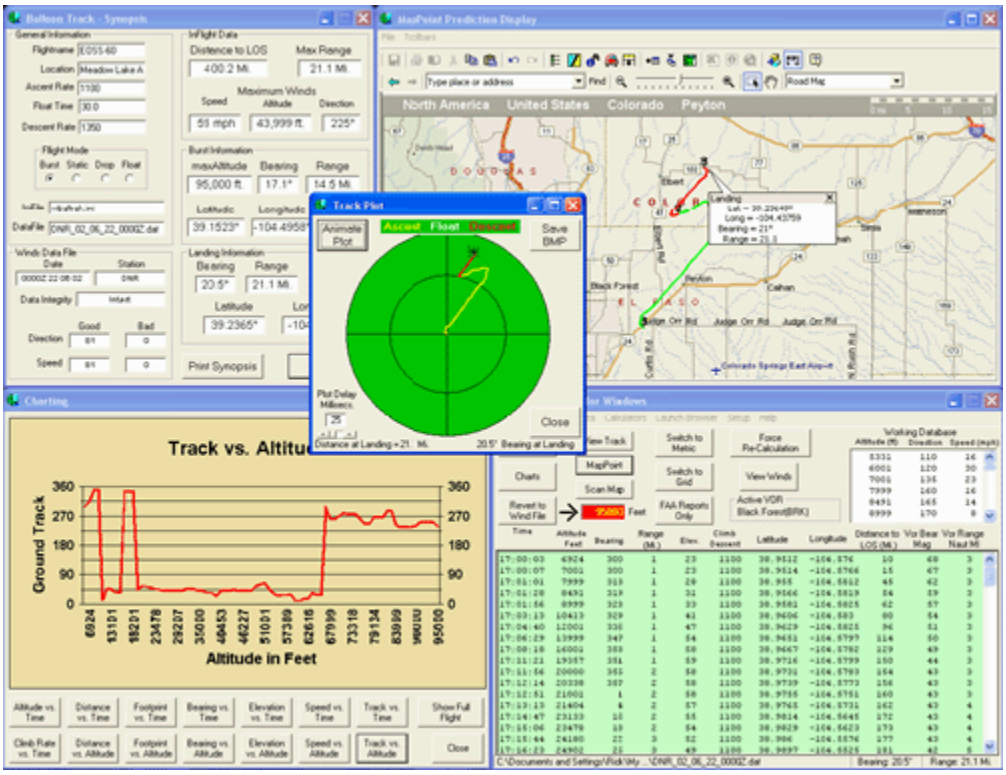
Balloon Track for Windows

Manual



Prediction work flow

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Introduction

During the first few years of its release Balloon Track for Windows was primarily used by individuals who were intimately familiar with BALLTRAK.BAS, the Basic Program written by Bill Brown, WB8ELK. Because of this, many of the program's features were easily recognized by those savvy individuals.

However, in recent times it has come to my attention that more and more, individuals brand new to high altitude balloon flight were using the program.

I have always tried to make the home web site of Balloon Track for Windows a living manual evolving with the program. Now I believe it is time to release at least a general guide to the program's operation for first time users.

That is the purpose of this manual.

It does not purport to be a guide to the mystical rites of balloon flight prediction. It just tells how the program should be operated to generate something of value.

I would also like to mention that the core algorithms within Balloon Track for Windows are almost exactly the original code written by Bill Brown, WB8ELK. Bill gave his permission to incorporate those algorithms prior to the first release of Balloon Track for Windows and I am eternally grateful for his initial work in this area, and his permission to shamelessly steal his code. Thanks Bill, you really are the "Father of Amateur High Altitude Ballooning" in the amateur radio community, as dubbed by the attendees of the Great Plains Super Launch in July of 2002!

This manual was created while Balloon Track for Windows Version 1.8.2 was in development

Obtain the Program

Balloon Track for Windows is available at the Edge of Space Sciences (EOSS) web site, http://www.eoss.org/wbaltrak/.

There are almost always two versions of the program available for download, a "Full Installation" and a "Lite" version.

Visual Basic programs are most often comprised of three different modules. They are:

1) The basic code the programmer writes and compiles into an executable (EXE) file.

2) Associated OCX or perhaps DLL files that are required to make the program run.

3) The Visual Basic Runtime files all VB programs require.

Balloon Track for Windows is just such a program. Therefore, it is necessary to obtain the required modules associated with the program to ensure proper operation.

The Visual Basic Runtime files are available from a link on the download page that redirects you to a Microsoft web page where they are available. If you don't have these files it is recommended you download and install them first.

The "Full Installation" file is a standard installation program. It contains everything needed to run Balloon Track for Windows. It will also create a folder in the "C:\Program Files" hierarchy to host the program and install the modules in their proper locations as well as modify the Windows Registry to make Windows aware of these new modules.

Once you have downloaded the "Full Installation" future upgrades may be possible by only downloading the "Lite" version of the program. This is dependant on the fact that no new modules have been added to Balloon Track for Windows. If some major change has added new modules to the program then the download page will indicate that a new "Full Installation" will be required to ensure proper program operation.

Installation

The "Full Installation" Version of the Program

Once you have downloaded the zip file containing the full installation, unzip the file in any empty folder on your system. The folder does not actually have to be empty, however it makes it easier to delete the installation files once the program has been installed properly.

Run Setup.EXE.

During the course of the installation routine you can select any folder for installation of the program files. I would suggest you acquiesce to the installer's suggestions as all mention of the "home" location of the program here and on the web site for Balloon Track for Windows will always be referring to the "Program Files" location.

When the install routine finishes it will notify you of a complete and successful install. This means the program and all of its associated parts have been successfully placed on your system. You can now remove the install files from your system. I usually keep the zip files for installs handy for future use, however I always get rid of all the "chaff" that results in the expansion of that file. In the case of Balloon Track for Windows's installer, that currently contains the following files:

- Setup.exe
- Setup.lst
- Wbaltrak.cab

Erase them, by all means.

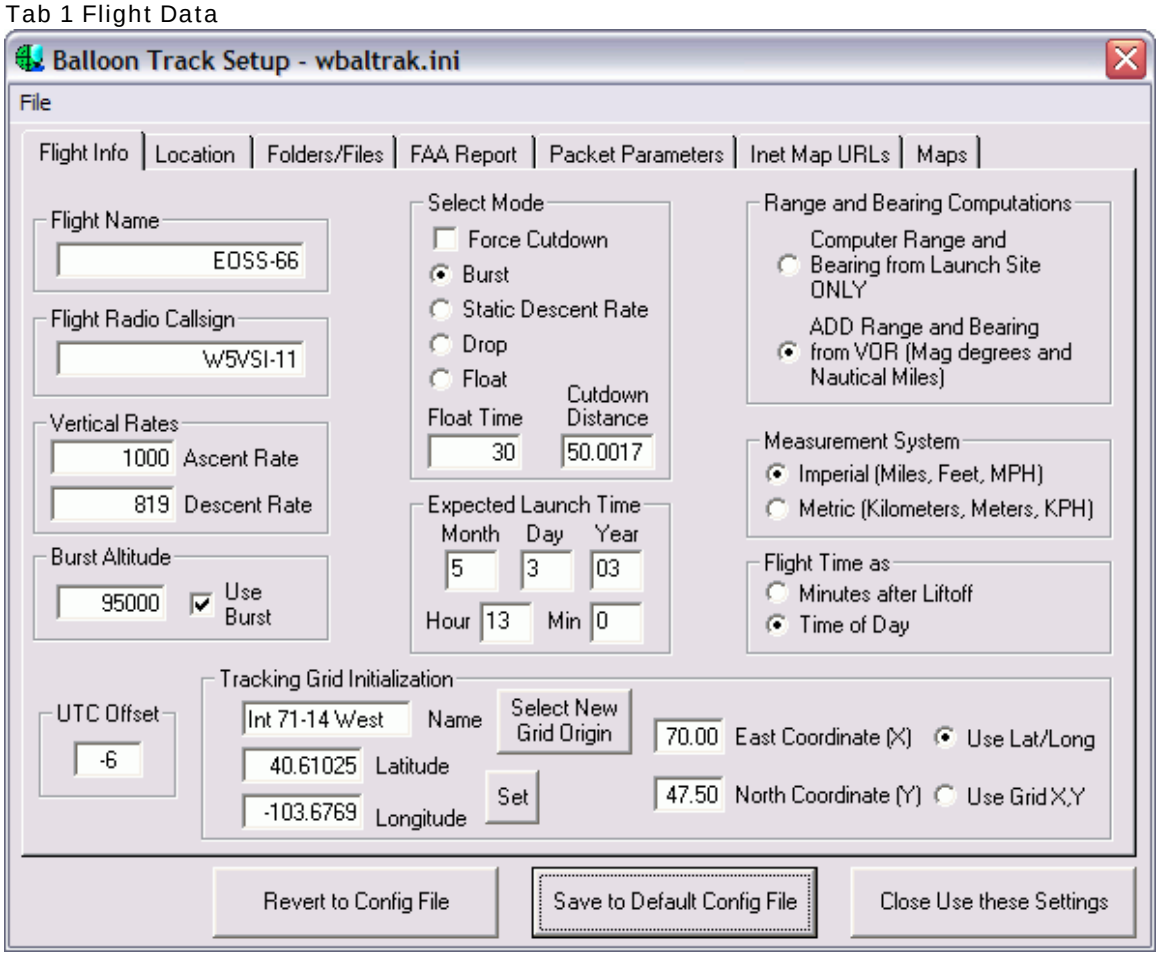
Installing the "Lite" Version

If you have previously downloaded the "Full Installation" and properly installed it on your system and are upgrading by downloading the "Lite" version, then simply unzip the file. You should find wbaltrak.exe and on rare occasions a readme.txt file. Copy them both to the Home Folder of Balloon Track for Windows, which is usually C:\Program Files\Balloon Track\Balloon Track\. That's it.

Setup

The first step in running Balloon Track for Windows is to go to the setup screen and fill in several of the various parameters. I will describe each aspect of the Setup Screen and note required fields for each tab.

Tab 1 Flight Data



Flight Data Required Fields

- You should enter a flight name. It is used on most printouts and displays.
- The Flight Radio Callsign is used primarily on the Packet Terminal screen. It is not required, but if you have a radio aboard the balloon transmitting packet, I'd recommend you fill it in.
- Vertical Rates are required. Otherwise, Balloon Track for Windows wouldn't know what to do.
- Burst altitude is optional. I have it entered and enabled for every flight.

- Float Time is required only if you select the Float mode.
- Cut down distance is only required if you check Force Cutdown.
- Tracking Grid Initialization and all its fields are optional.

Menu Options

The "File" menu allows you to load and save initialization files that contain all the data set on this window. Whenever the program starts it first reads wbaltrak.ini, however you can select any INI file from the file menu. This allows for multiple configurations.

The Buttons

"Revert to Config File" reloads whatever INI file is displayed in the title bar (in the example shot above, "wbaltrak.ini").

"Save to Default Config" saves the settings for each tab of the Setup Window to the INI file displayed in the title bar.

"Close Use These Settings" only saves the changes you've made in memory, it does not update the INI file. So you can quickly change parameters and see how they affect the flight without having those changes carry over to the next time you run Balloon Track for Windows.

Tab 1 Field Descriptions

Flight Name – This name will appear in various printouts and saved files

Flight Radio Callsign – This callsign will be used in the communications area of the program as a suggested callsign to track. You can always override it there if you wish.

Vertical rates – the Feet per Minute (or Meters per Minute if you're in Metric) of the ascent and descent rates. The descent rate should be the rate at which your payload would descend under its parachute at sea level.

Latitude and Longitude information is entered in many areas of Balloon Track for Windows.

West Longitudes are entered as NEGATIVE numbers.

Southern Latitudes are entered as NEGATIVE numbers.

Burst Altitude – If you plan to either cut away your payload or allow your balloon to burst you can enter an altitude here in feet and place a checkmark in the "Use Burst" box. When Balloon Track for Windows makes its calculations it will always assume this altitude as the maximum altitude. If you do not enter an altitude or do not place a check mark in the box then Balloon Track for Windows will calculate the touchdown based on the entire wind data file you imported.

UTC Offset – enter the difference in time From UTC to your location. In the USA it is always a negative number. For reference, during Eastern Standard Time the difference between EST and UTC is negative 5 (-5) hours. Balloon Track for Windows uses this information when constructing information where it has to fabricate UTC time from your system clock. Which brings up a proviso, if you system is set to UTC then the offset is zero (0).

Select Mode – There are basically 4 modes of operation to generate a prediction.

1) Burst Mode – In this mode the balloon ascends steadily until it reaches a set altitude. Then it either bursts, or the payload is cut away and descent begins immediately. This is the most common mode of operation among the community of Balloon Track for Windows users.

2) Static Descent Rate Mode – An unusual mode. It assumes that the descent rate will be constant. In a normal flight when the balloon bursts or payload is cut away it plummets to the ground at a high rate of speed. As the air becomes denser, the parachute slows the payload down. In a static descent mode, the balloon descends at a continuous speed. This is usually accomplished by suspending the payloads beneath two balloons. One of the balloons burst. The remaining balloon does not have enough lift capacity to continue ascent, so that balloon and the payload begin a controlled descent using the helium lift capability of the remaining balloon to retard the descent speed. So, in a normal flight when you enter 1000 fpm for the descent speed, a balloon might actually start descent from 100,000 feet at around 10,000 fpm. Then it would continuously slow its rate if descent as the parachute works against the denser atmosphere at lower altitudes. In the Static Descent model, the balloon would begin its descent from 100,000 feet at 1000 fpm and continue to the ground at that constant velocity.

3) Drop Mode – very infrequently used mode. Edge of Space Sciences recovery teams were requested to be ready for a situation were a balloon would launched from a location west of us and allowed to float at high altitude until it arrived over Colorado. The EOSS recovery team would then cut it down. Drop mode allows for the calculation of a landing location by computing only the descent phase of the flight.

4) Float Mode – Zero pressure or Super Pressure balloons reach an altitude where their ascent rate goes to. However, these types of balloons do not burst. So, they just float. Using this mode you check the float box and enter a "Float Time" in the entry box below. The program will calculate an ascent prediction to the float altitude, then it will calculate where the balloon will travel during the elapsed time of the float and from that location the program will proceed to calculate the descent profile.

Forced Cut Down - I added this option so that it would be possible calculate a new, and lower burst/cut down altitude it in the event we had a very slow ascent rate which could easily turn a standard flight into a much longer (in both time and distance) flight. Forced cut down allows you to control the distance traveled by a balloon. Place a check mark in this box, and fill out the "Cut down distance" at the bottom of the modes box. The instant the balloon is predicted to travel beyond that distance a forced cut down is assumed and the descent phase of the flight is calculated. By examining the results of the prediction, you can determine the altitude you must cut down your payload to land at the approximate distance from launch that you indicated in the "Cut Down Distance" box.

Expected Launch Time – When producing a prediction, Balloon Track for Windows can display each record for the prediction in elapsed minutes from the launch or as an actual time of day, if you fill in the time and date parameters. It is possible to generate an Automatic Position

Reporting System (APRS) and or a GPS file from a prediction. These file formats require time stamps.

Range and Bearing – Balloon Track for Windows always produces range and bearing from the launch site. However, the FAA wanted reports on the balloon's expected flight path in relation to nearby VOR (VHF Omni-directional Range navigation system). If you select the range and bearing from launch site that's all that is computed. If you elect to add the VOR data then those computations will be made and added to the main screen display. You must have a VOR station entered on the next tab of the Setup Screen for this to work properly.

Measurement System – While about 95% of the users of Balloon Track for Windows are United States of America residents, some users are from more civilized climes and utilize the much superior metric system of measurements. So, the program works in either format.

Flight Time – Select either elapsed minutes after launch or an actual time of day. If you select the "Time of Day" mode, the program will use the time information you entered above to calculate the launch time and add the subsequent elapsed time to that launch for each time mark.

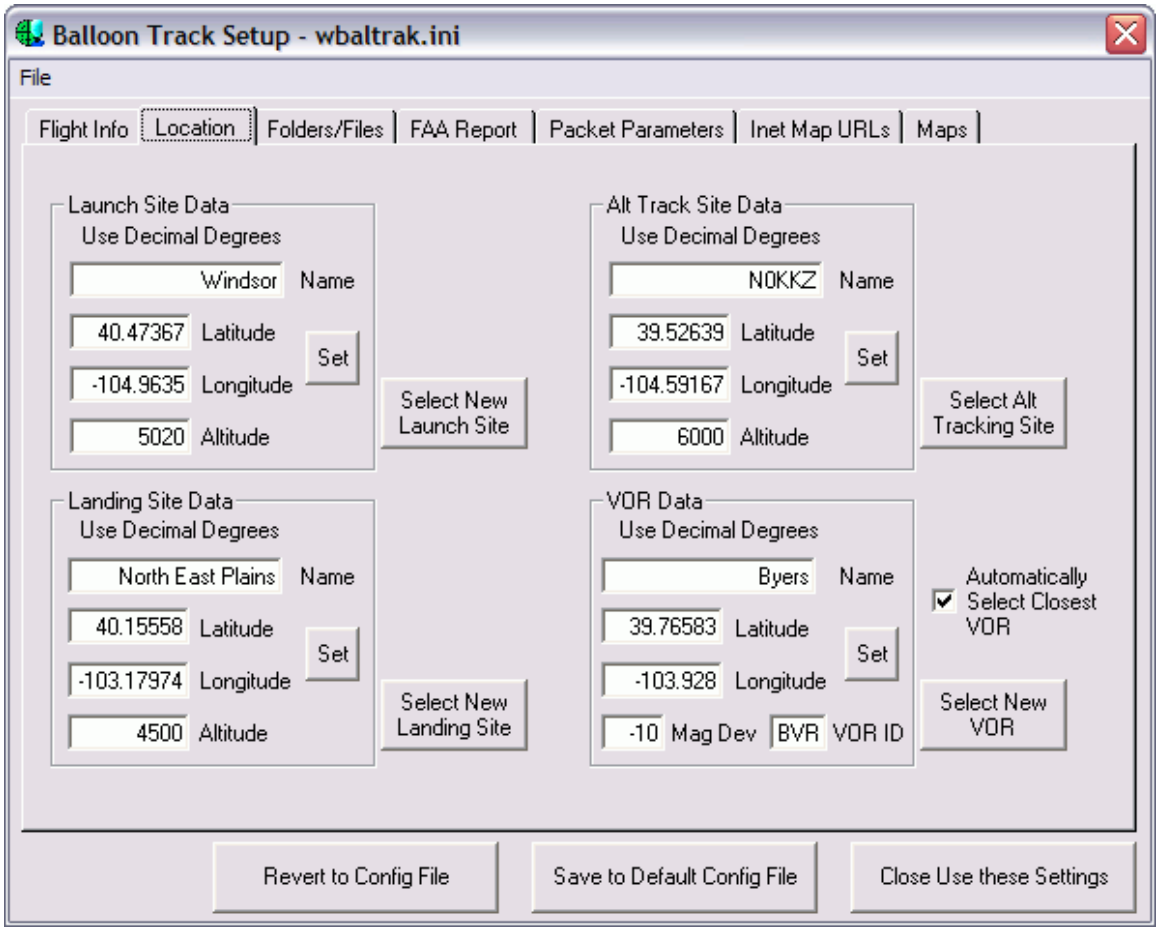
Tracking Grid Initialization – Enter the X, Y coordinates for any pre-established grid reference point, add the latitude and longitude for that point and Balloon Track for Windows can output location information in the Grid X, Y coordinate system

This is probably only of use to EOSS. We have created a system whereby we place a grid on a map and reference each tracking team member as well as the balloon on this grid system. The grid is a rectangle 90 miles wide by 70 miles high. The grid is available at the EOSS web page. It's printed on an overhead transparency which is then taped to a map it is scaled to interact with. It makes reporting bearings very quick and easy. A station need only say "This is station bravo, 26 comma 32, 240 degrees true NØKKZ out". They have told the tracking and recovery coordinator they are 26 miles east and 32 miles north of the origin of the grid and that they have determined that the RF signal from the balloon is coming from 240 degrees true. The T&R coordinator has a map in front of him and can very quickly locate the reporting stations position and draw the vector on the map. We also have a special spread sheet program that does all this "automatically". The operator enters the information for each reporting station and after all stations have reported the spreadsheet's code will compute the triangulation of every station pair. Then it will weight each result with respect to how closely it agrees with other stations and it will finally come up with a composite location for the balloon based on all this information.

One note here about those buttons in the Grid Initialization area … You could manually just type in a location and a lat/long. If you don't know the decimal value of a degrees minutes, and seconds lat/long you could press SET and a dialog box will open allowing you to enter a lat/long pair in any form, degrees and decimal minutes or degrees, minutes and decimal seconds. You could for that matter enter decimal degrees, but then you wouldn't need to come to this "Set" dialog box. **HOWEVER, I STRONGLY RECOMEND** that you press the "Select New Grid Origin" button. This opens up a dialog box which will allow you to select the grid origin from all the previously entered origin points. You can also add new origin points and edit old ones. I recommend this because you may find yourself frequently using the same locations on your grid and this makes it that much easier to bring back that old location. All this does is add the name of

a grid coordinate and its latitude and longitude. You must supply new X, Y coordinates each time you set up the Grid Initialization section.

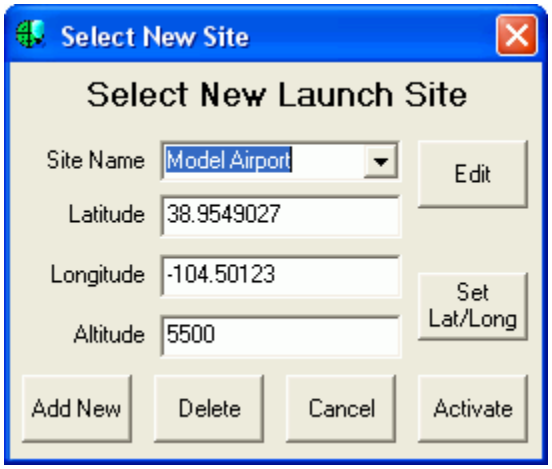
Tab 2 Location Data



Location Data required fields

- If you do not require latitude/longitude information for your prediction and if you do not plan to use any of the mapping capabilities of Balloon Track for Windows then, there's nothing required. However, if you do want to map the course of the balloon either via MapPoint or by exporting a file that can be read by an APRS program or DeLorme's Street Atlas, then you must, at a minimum, enter the "Launch Site Data".

As with the entry of information for the Grid Initialization on the previous tab, I strongly recommend you click on the "Select New xxx Site" button and either choose a previously entered location or add a new location. That entry screen looks like this:



If this is the first time you are entering in a site, click on the Add New button. Fill out the data. The caption on the button labeled Edit, above, will change to save when you click on Add New. When you are finished filling out the record, hit save.

In this way these sites are saved and will be available instantly without having to refer to maps to get coordinate information. For instance, in the screen shot showing all the Site Locations, the Launch Site is Windsor. If I wanted to change it to the Model Airport I just click on activate in the Select New Site dialog box and it replaces Meadow Lake on the setup screen. This makes changing locations a lot easier once you have you major sites identified and entered into the program.

Launch Site Data

You should give your launch site a name. This name will appear in several different printouts and saved data files. The latitude and longitude information is obvious. Perhaps not so obvious is that all degrees West (western hemisphere) should be entered in negative numbers. That altitude is obvious but it is also important. Several factors are affected by this entry. The winds as received on the surface of the location where your source weather data may be at a different altitude than where you are launching from. Balloon Track for Windows uses the winds that it finds for your launch altitude as the first wind record. It ignores all the wind data below this initial launch altitude. The program also calculates the Radio Horizon or Loss of Signal (LOS) range above this altitude during the ascent phase of the flight.

Alt Track Site Data

In real time mode you can track the balloon and the program will report various types of information. One type is range, bearing and elevation from the launch site. If you enter data into the "Alt Track Site Data" box, you can see this information generated for another station. This option at this location may be a bit of a throw back. I've added the ability to have four alternate stations. When you open that screen from the Packet Terminal (you'll learn about all this later) you can edit, and delete these stations.

Landing Site Data

The latitude and longitude aren't all that important unless you plan to use some of the special calculators in Balloon Track. However, the altitude is important. As in the ascent phase of the prediction, the descent phase uses the winds as imported down to the landing site altitude. If this altitude is different from the launch altitude (say much lower) then the balloon will remain in the air longer, it will pass through wind layers that the ascent phase did not. In other words, the final touchdown will be affected to some degree. Also, during the descent phase of the flight the LOS range is computed above the landing point altitude.

If you enter no Landing Site Data, the program assumes the information for the landing site is the same as that of the launch site.

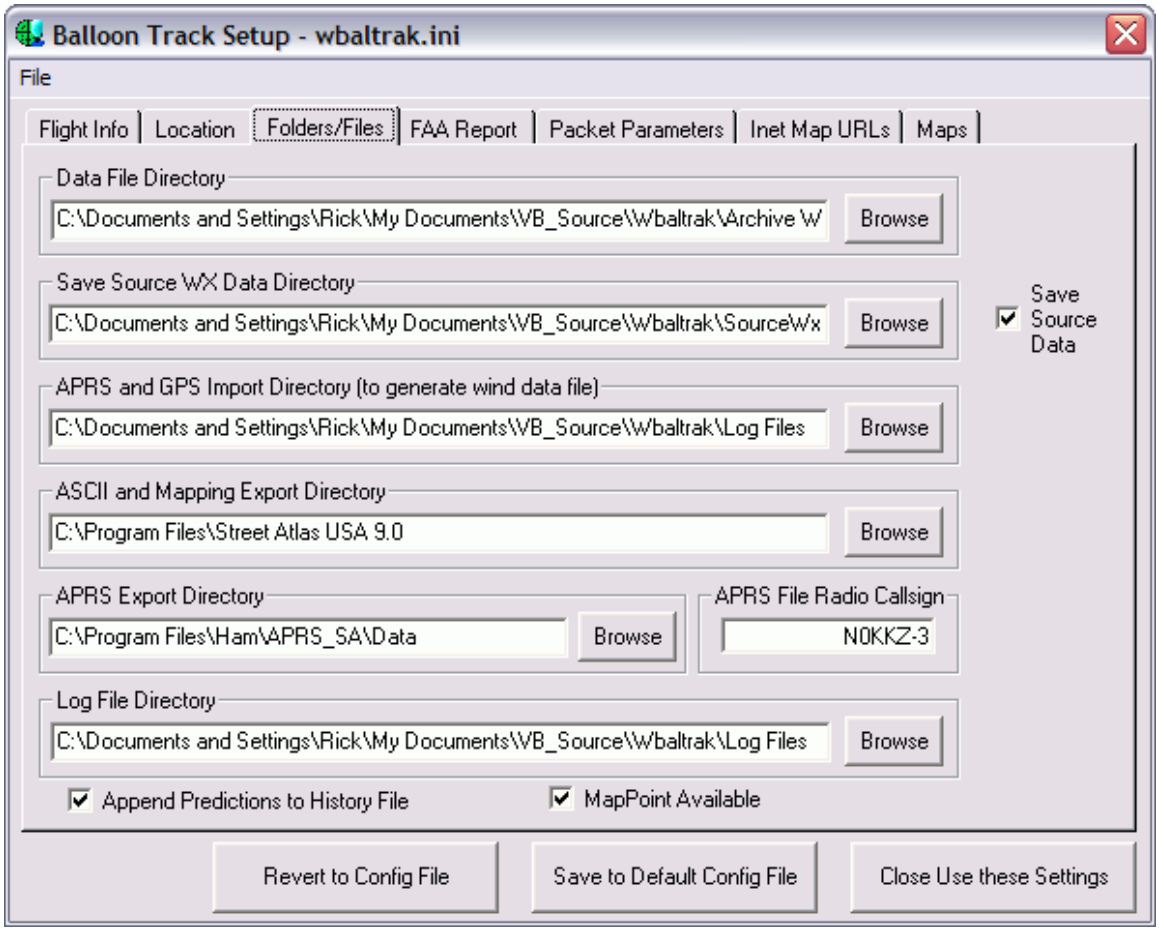
VOR Data

If you wish to generate range and bearing from a VOR station to the balloon then the program needs to know two things. Where the VOR is and what the magnetic offset (declination, variation). The altitude of the VOR station is unimportant. That field as displayed above is relabeled to Magnetic Offset. VOR bearings and ranges are always given in Magnetic Degrees and Nautical Miles. You should also enter the VOR ID. This field only appears on the Select New xxx Location window when you select VOR.

Note the "Automatically Select Closest VOR" checkbox. If you have entered several different VORs into the VOR database via the Select New VOR Location box, then (if you check this option) the program will check for the closest VOR each time it computes a record when running a prediction and use the closest VOR for the range and bearing information. You can see this illustrated on the Main Screen capture in the Basic Operation section of this manual.

If you do NOT check this option then the VOR that appears on the Locations Tab will be used exclusively.

Tab 3 Folders/Files



Folders/Files required fields

- Strictly speaking, nothing is required.

The idea here is to help keep you better organized. If you make no entries for these folders the program defaults to its own home folder as the location where all these files may be found or saved.

The Data File Directory is the folder/directory location where, if you select [File/Open] from the program's main screen, the dialog box will first point to. If you wish to load a data file from some other folder, you can easily navigate there from this dialog box.

The Save Wx Source Directory is a folder where you imported wx file will be copied to for archive purposes. You must also place a checkmark in the box "Save Source Data". The file is renamed to the same name as the Balloon Track Data file. However instead of the DAT file extension, it has a TXT file extension. Examples:

- DNR_02_08_17_1200Z.dat – Balloon Track Data File
- DNR_02_08_17_1200Zc.txt – Raw Text Weather Data File received over the net

Hey, those names aren't identical there's a "c" appended the to the raw text filename. In the event that you run multiple predictions from different data sources, but they all generate the same Balloon Track Data File Name, then the program adds an incremental letter to the end of the archived source weather data file to ensure that different source files do not overwrite each other.

APRS or GPS Import File Directory is a default location where the program expects to find either APRS or GPS formatted data in a text file that can be imported and used as a source to generate a wind data file. This is usually the data directory of an APRS program, but you can point it anywhere. You may be using a HyperTerm with your TNC and that may be the source of your data. It's up to you.

ASCII and Mapping Export Directory is the location where exports for different mapping programs will end up. I point mine to the DeLorme Street Atlas directory.

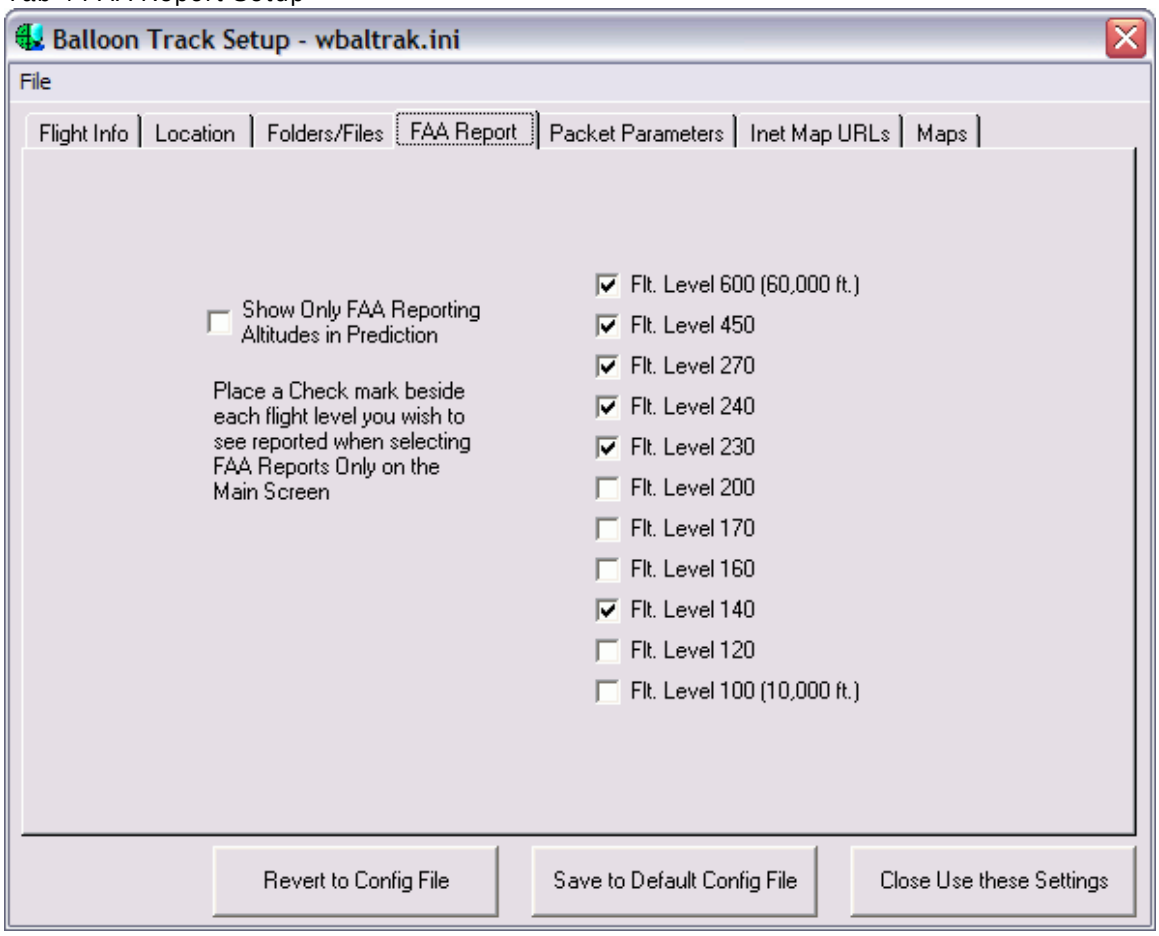
APRS Export Directory usually points back to the data directory of some APRS program. You can export an APRS formatted prediction file and then load that prediction into the APRS program as a reference to make comparisons with the predicted and actual flight tracks during a flight.

APRS File Radio Callsign – Place a callsign in this box and when the program exports APRS or GPS packet formatted data, that callsign will be used as the sending station id.

Log file directory is a location for several different files. Primarily, if you are in the packet terminal screen and select any type of logging, the log files generated end up in this folder. If you use MapPoint, whenever the MapPoint screen is closed, a PTM file is generated (a snapshot of the map in a MapPoint proprietary format that you can click on and open). If you are in the prediction part of the program, the file is called LastPredictMap.PTM, if you're in the packet terminal mode tracking a flight then, LastTrackMap.PTM. If you put a checkmark in "Append Predictions to History File" then the file predhist.csv will be created and updated with information about each prediction you create using Balloon Track for Windows. There are some other types of files which end up here. I'll cover them when we get to that part of the program.

"Append Predictions to History File" didn't I just cover that in the last paragraph?

Tab 4 FAA Report Setup



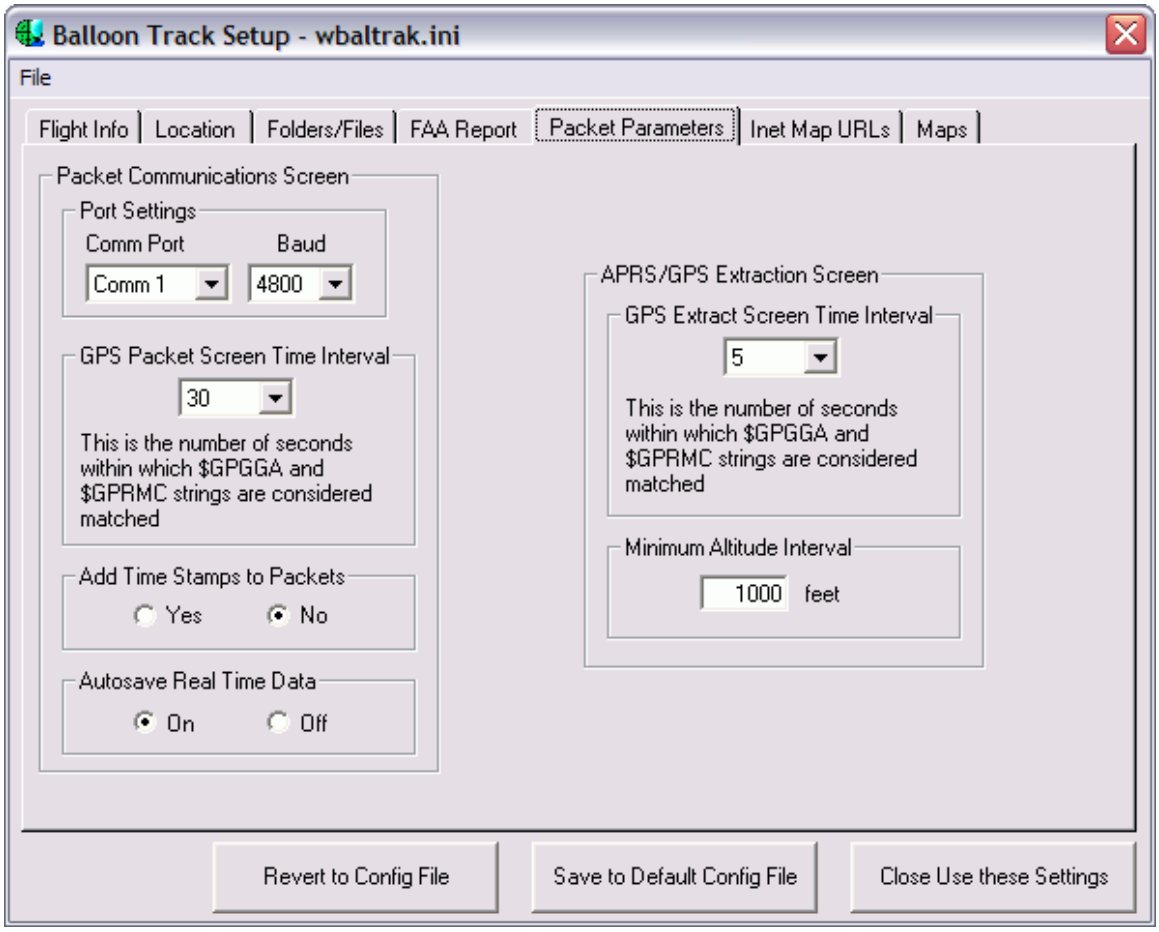
FAA Report Setup required fields

- None.

If you are reporting flight predictions to the FAA, they are interested in where the balloon will penetrate various altitudes. Your morning RAOB flight might have conveniently gathered data exactly at an FAA reporting altitude, then again and most probably, it didn't. So, prior to flight, find out what altitude levels the FAA controllers want. Place a check mark beside that flight level on this screen.

When you look at the Main Program window you will see a button labeled "FAA reports only" Press that button, the prediction is rerun and each reporting altitude is added to the prediction. The results of this prediction only show the FAA required reporting altitudes both on the ascent and descent phases of the flight.

Tab 5 Packet Parameters



Packet Parameters required fields

- If you plan to use Balloon Track for Windows to track a flight using a TNC then you must set the baud rate and com port correctly. The program assumes 8 data bits and 1 stop bit.

One strange possibility. Perhaps you are running Balloon Track for Windows on a computer with NO comm. port and wish to run simulations on the packet terminal screen. If you set a comm. port and baud rate and open the terminal screen the program crashes. So, WHAT to do?

Click the down arrow for the comm port and select "No Comm". Now you can open the terminal and run simulations.

The rest is simple and confusing. My fault and I apologize.

GPS Packet Screen Time Interval

On several screens where real time information is being displayed, Balloon Track for Windows attempts to show lots of information for a particular moment in time. Sometimes the data needed to fill out these displays arrives at different times in separate packets. You can set the number of seconds for an interval which you consider acceptable for associating data. For instance a packet

arrives at 15:01:15 containing an altitude of 6,780 feet. At 15:01:40 a packet arrives containing a course of 245 degrees and a speed of 32 miles per hour. Using the above 30 second interval, the program would display all this data as related to the most recently arrived data time stamp even though the data actually arrived 25 seconds apart. Here's a more detailed explanation:

The GPS strings $GPGGA and $GPRMC contain complementary information. While they both show the time, latitude and longitude, each string carries different data from there on out. GGA has altitude, RMC has course and speed. There are other differences. Ok, so, let's say you got a GGA and an RMC with identical time stamps. Well then you would know that at a certain time the balloon was at a certain altitude moving over a certain course at a certain speed. Got it? Both strings match in time so all the data in one is directly linked (in time) to each other.

Now, suppose there was 5 seconds difference between the strings and the GGA came in first. Well, we'd know that the RMC string arrived 5 seconds later by the time stamp. What we would not know is at exactly what altitude all the data associated with the RMC string occurred. But with a difference in time of only 5 seconds, we'd probably just assume (in high altitude ballooning anyway) that there wasn't a significant difference and we would associate the data under one timestamp as all being concurrent.

Ok now things start to get difficult. As the interval between the two strings of data become longer and longer, the accuracy of the data becomes more and more suspect when it is combined into one record. It is of course absolutely no problem if records are generated in which only valid data are written but sometimes balloon track wants to know "everything" in a single record so it can calculate changes between records.

Add Time Strings to Packets

In the event the packets you are receiving do NOT have built in time stamps, Balloon Track for Windows can add them. The program uses the time set to your system clock. I would recommend you do not add these unless necessary as it makes packet file analysis more difficult for other programs. Balloon Track for Windows can recognize this time stamp and work around it when parsing files.

Autosave Real Time Data

The "Flight Analysis" part of the program depends on a data file created from received data during the flight. I strongly recommend you leave this set to "ON". The program will then automatically always save this data when you open the "Flight Analysis" window. More details about this are available in the section of the manual which deals exclusively with "Flight Analysis".

APRS/GPS Extraction Screen

This option relates to the "Process Packet File" part of the program. It works with data extracted from an incoming telemetry data file.

It's the same as above. However, it is strongly recommended that you tighten up the allowable interval to avoid creating false data file. This may not be much of a concern any more. This doesn't apply to any type of data that has at least one record that contains all of the following: an accurate time stamp generated from a GPS device, an altitude and a lat/long pair. The GPS string

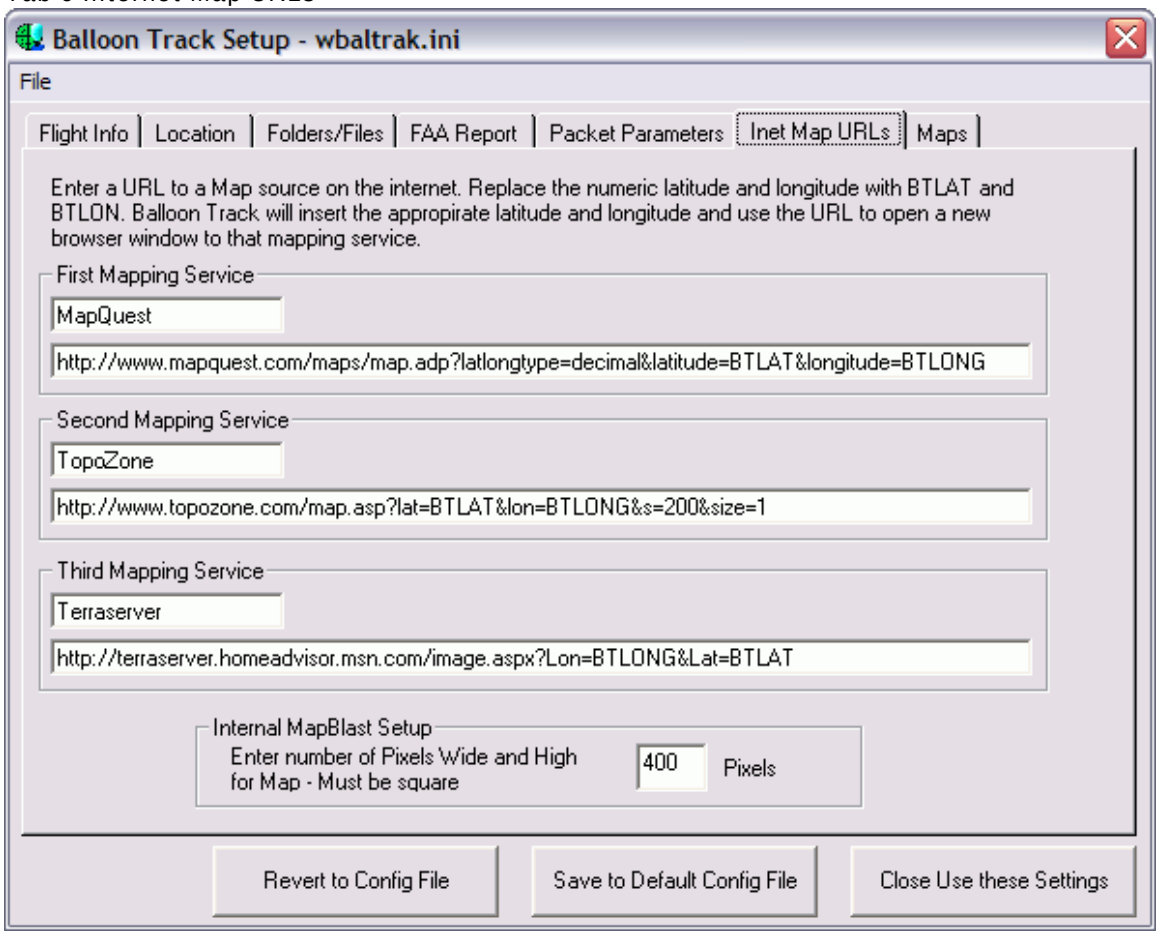
$GPGGA has all this. Balloon Track does not need the course and speed in the RMC sentence so it ignores it. Really the only meaningful purpose for this interval is an obsolete type of data string we used at EOSS. I'll have to update this soon.

Minimum Altitude Interval

This option relates to the "Process Packet File" part of the program. It works with data extracted from an incoming telemetry data file.

When you open a log file to extract data to create either a Balloon Track for Windows data file or a spread sheet file of that data, you can specify a minimum altitude interval. Suppose the data file contains data for every 5 seconds, this may generate false wind direction and speed data. Data coming in this fast would also generate around 1200 records for a flight from Sea Level to 100,000 feet. This amount of data can now just barely be handled by the arrays within the program, but it isn't really desirable or necessary. Instead you could specify you only wanted to act on records that were at least 500 or perhaps 1000 feet apart in altitude. In this way you would allow a significant amount of time to pass so that a more meaningful computation of wind speed and direction for that altitude layer was possible. If you are extracting data to a spread sheet, you might set this number much lower as you are probably interested in getting every data report into the spread sheet. If you set the interval to one foot, you should probably get each and every data record in the input file converted to spreadsheet format.

Tab 6 Internet Map URLs



Internet Map URLs Required Fields

- None

Enter the name of an internet site that will take a URL with latitude and longitude coordinates in it and then enter the URL for that service.

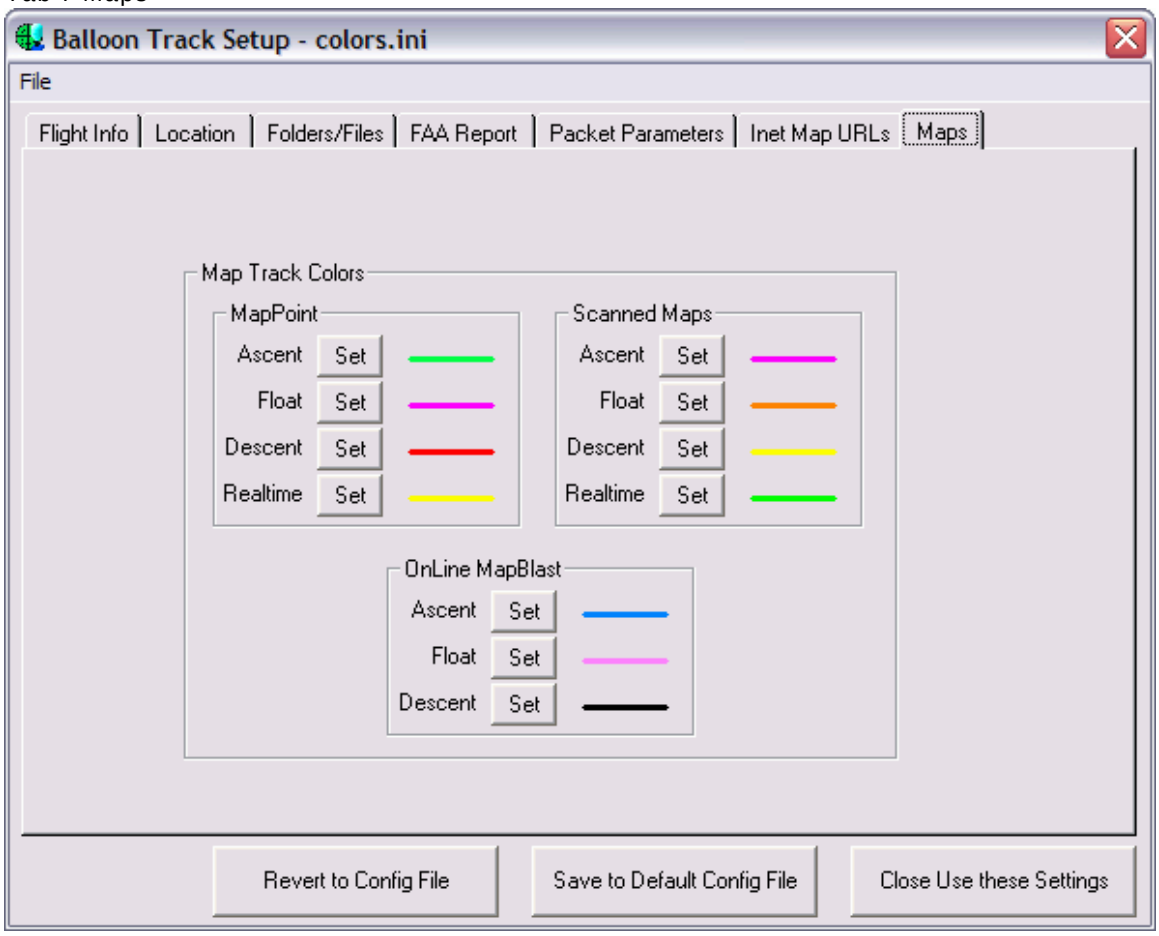
Where the latitude should appear in the URL substitute BTLAT.

Where the longitude should appear in the URL substitute BTLONG.

When you run a prediction you can then click on the Inet Mapping menu choice and select one of the services. Your browser will launch the URL substituting the appropriate latitude and longitude for BTLAT and BTLONG and that service will return a map of the appropriate latitude and longitude. On the main screen this will be the predicted touchdown point. On the Packet Terminal screen it will be the last received latitude and longitude processed for the Target Callsign.

Enter the size of the maps obtained directly from MapBlast for use with the Internal mapping option discussed in the Main Screen Menu options section.

Tab 7 Maps

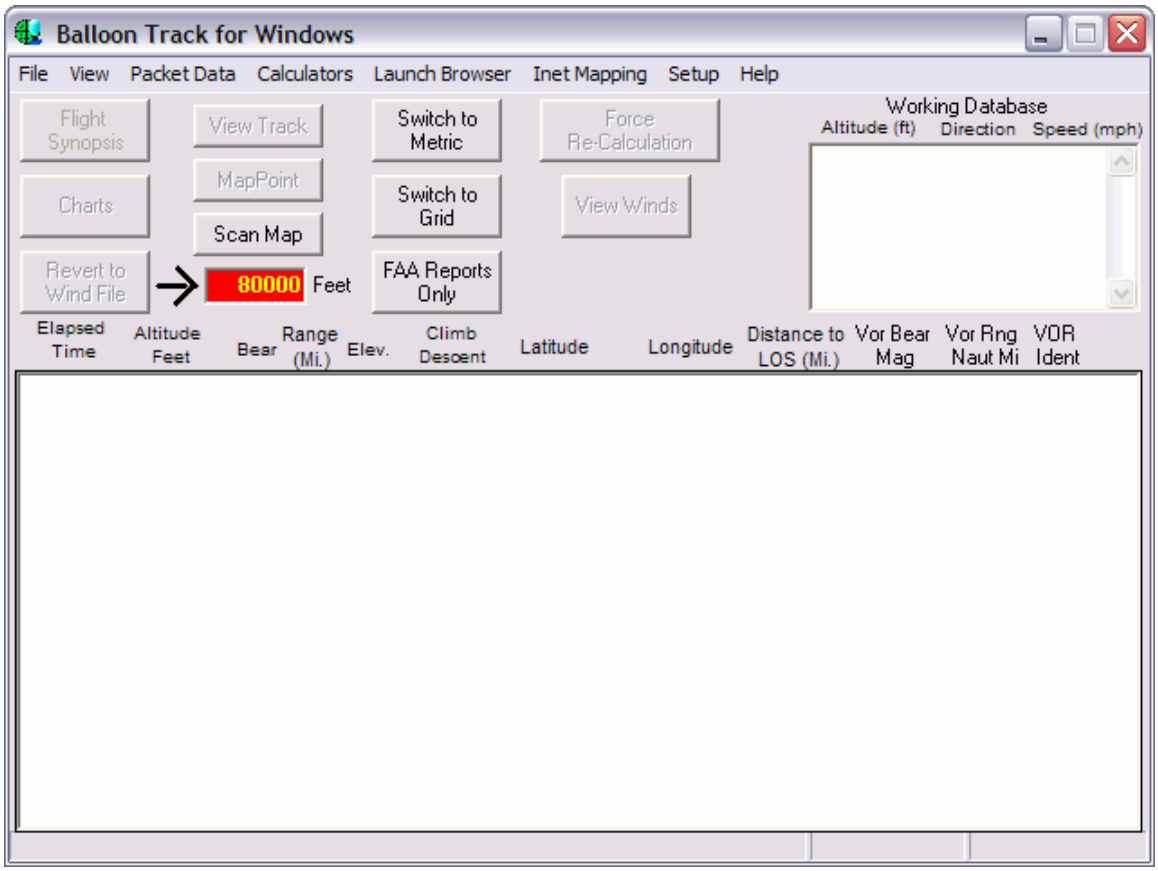


There are no required settings here.

Click “Set” and pick a color for that phase of the flight on each individual mapping module

Basic Operation

When you first launch Balloon Track for Windows, this is the screen displayed. What do you do now? Well if it is your very first run of the program, select [Setup] from the menu and then return to the previous section of the manual and follow the directions. Assuming you have set your initial parameters correctly you are now ready to run a prediction.



Get Some Data

The first thing you need is some data to work with. So, click on [Launch Browser/Internet Exlporer] and this dialog will open:

Assuming you have an active internet connection, clicking on one of these 5 buttons will launch your browser and direct it to the page indicated on the button. By the way, you can right click on any button and quickly change the Caption of the button and the URL your browser is directed towards.

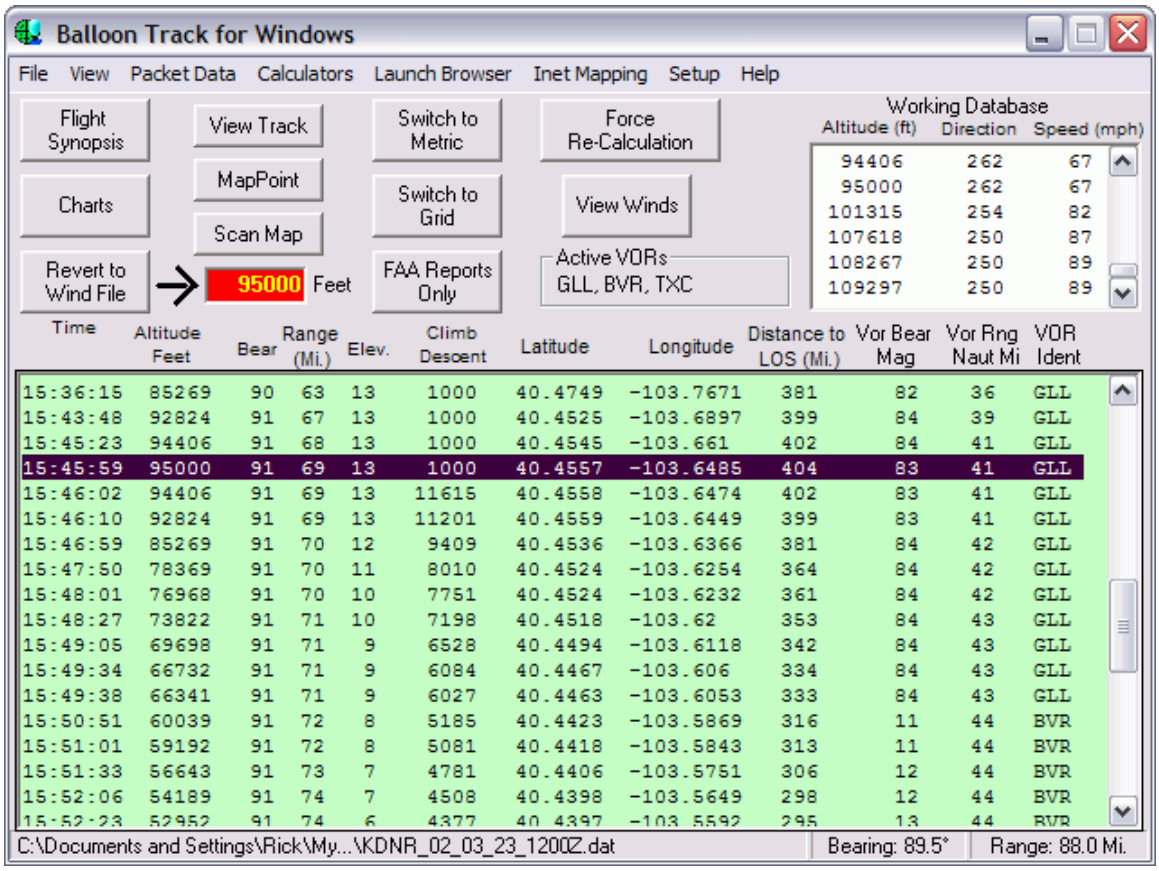
Since each upper atmosphere site is different, I'll let you figure out how to navigate to the page where the text of the upper air data is located. Once you have that page on your browser screen, select [File/Save As] in your browser and save the web page as plain text with a distinctive name. I usually use the RAOB site name, DEN.TXT.

Close your browser.

Import Data – Run Prediction

On Balloon Track for Windows's main menu select [File/Open] and select the file you just saved. If it is one of the several import formats Balloon Track for Windows supports, then it will automatically be parsed, and a suggested filename for the Balloon Track Data file will be given. Click OK to accept the name or change the filename to whatever you wish.

The program will then automatically use that "winds aloft" data to create a flight prediction.



The program then fills out three areas of the main screen. The Working data base shows the wind data for each altitude, the large box below shows the predicted position for the balloon at each altitude record in the data file, and the status bar along the bottom of the window shows the data file Balloon Track for Windows is using, the bearing and range to touchdown. That's it. You are finished.

Main Screen Data Fields

Time – This field shows either the elapsed time of the flight in minutes or the time of day. This is determined by selecting one option or the other on the "Flight Data" section of the setup screen.

Altitude – Displays the altitude for each record in the prediction. It will be in either feet or meters as determined by the measurement system selected on this screen or on the "Flight Data" section of the setup screen.

Bear – the bearing from the launch site to the balloon in degrees azimuth. Zero (0) being north, 90 east, 180 south and 270 west.

Range – The distance to the balloon from the launch site. It will be in either miles or kilometers as determined by the measurement system selected on this screen or on the "Flight Data" section of the setup screen.

Elev. – The number of degrees above the horizon where the balloon is located relative to the launch site.

Climb/Descent – The rate at which the balloon is ascending or descending. It will be in either feet or meters as determined by the measurement system selected on this screen or on the "Flight Data" section of the setup screen.

Latitude – If you have set a home latitude then this is the latitude of the balloon for this prediction record.

Longitude – If you have set a home longitude then this is the longitude of the balloon for this prediction record.

While not shown, the Latitude and Longitude can be replaced by the Grid X and Grid Y positions. If you have entered a grid initialization on the "Flight Data" section of the Setup screen then the number of miles east (Grid X) and the number of miles north (Grid Y) will be displayed.

Distance to LOS – The distance from the point directly below the balloon to the horizon. As the balloon ascends, the horizon will recede. This is a good indication of how far VHF and above radio signals will travel. It will be in either miles or kilometers as determined by the measurement system selected on this screen or on the "Flight Data" section of the setup screen.

VOR Bear Mag – The magnetic bearing in degrees azimuth from the selected (Locations section of the Setup Screen) VOR.

VOR Rng Naut Mi – Distance from the VOR to the point on the earth directly beneath the balloon. (NOT Slant Range).

VOR Ident[1] – The 3 letter ID of the VOR being used for the previous calculations. If you have selected the "Automatically Select Closest VOR" option on the Locations section of the Setup screen.

[1] Note the change of VOR ident in the above screen capture. This occurred because "Automatically Select Closest VOR" was checked on the Locations tab of the Setup screen.

Some notes on Burst Altitude

You will note that you can enter a "Forced Burst" altitude on both the main screen of the program and also on the Setup Screen.

If you have entered this altitude and selected "Forced Burst" that button on the main screen will be relabeled to "Revert to Wind File" as is shown above.

Note that the background color of the data output by the program is Green. There are three possible background colors and they all indicate something about the prediction.

WHITE = A prediction using ALL of the information in the Wind Data file and nothing else. If the wind file goes up to 53,210 feet then the prediction goes up to 53,210 feet and a burst and descent is simulated.

GREEN = A prediction using PART of the wind data file. Suppose you have a data file that begins at launch altitude and extends to 110,000 feet. Further suppose you have set the burst altitude for the prediction to 95,000 feet. Balloon Track for Windows is using only part of the data file. Green is the background color because Balloon Track is sure that it is not "making up" any data and only using information supplied in the data file.

RED = A prediction using ALL of the wind data file and Balloon Track for Windows FABRICATING additional data to cover altitudes ABOVE where the wind data file ended. In this case, suppose you only have data to 90,000 feet. But you expect the balloon to burst at 95,000 feet. Balloon Track for Windows will use what ever data was available at the highest altitude and extend that data to your burst altitude. Since Balloon Track for Windows is making up wind data it warns you with a red background. In the above example practically speaking no big errors would accumulate since so little altitude was gained with fabricated data. But suppose your data ended at 54,000 feet and you projected that last information to your burst altitude of 95,000 feet. Almost certainly, your prediction would be significantly in error.

Be aware of the background colors and check your input data if you see a red background when you expected a white or green one. You may have downloaded an incomplete data file and be generating a somewhat suspect prediction. I regularly see "red" and I check and see that some type of prediction data ended below my expected burst altitude. As long as I'm close, I'm happy. But if too great a distance in altitude is being covered between my last known data and the expected burst altitude I know to lower the probability of accuracy for the prediction.

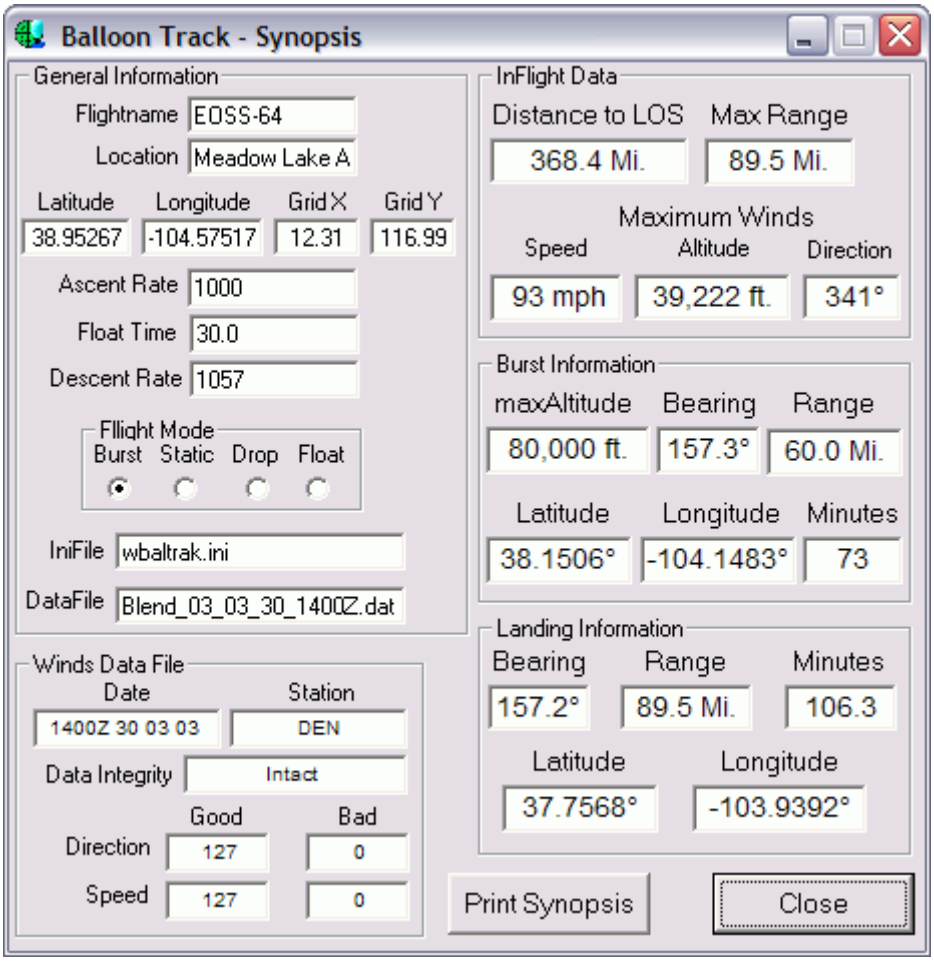
Main Window Controls

First, I will cover all the buttons available on the Main Window of Balloon Track for Windows. Then we'll tackle all the menu options.

Main Window Buttons

Flight Synopsis

The flight synopsis looks like this:



This screen gives you details about various aspects of the flight. Everything should be fairly obvious, however a couple of notes.

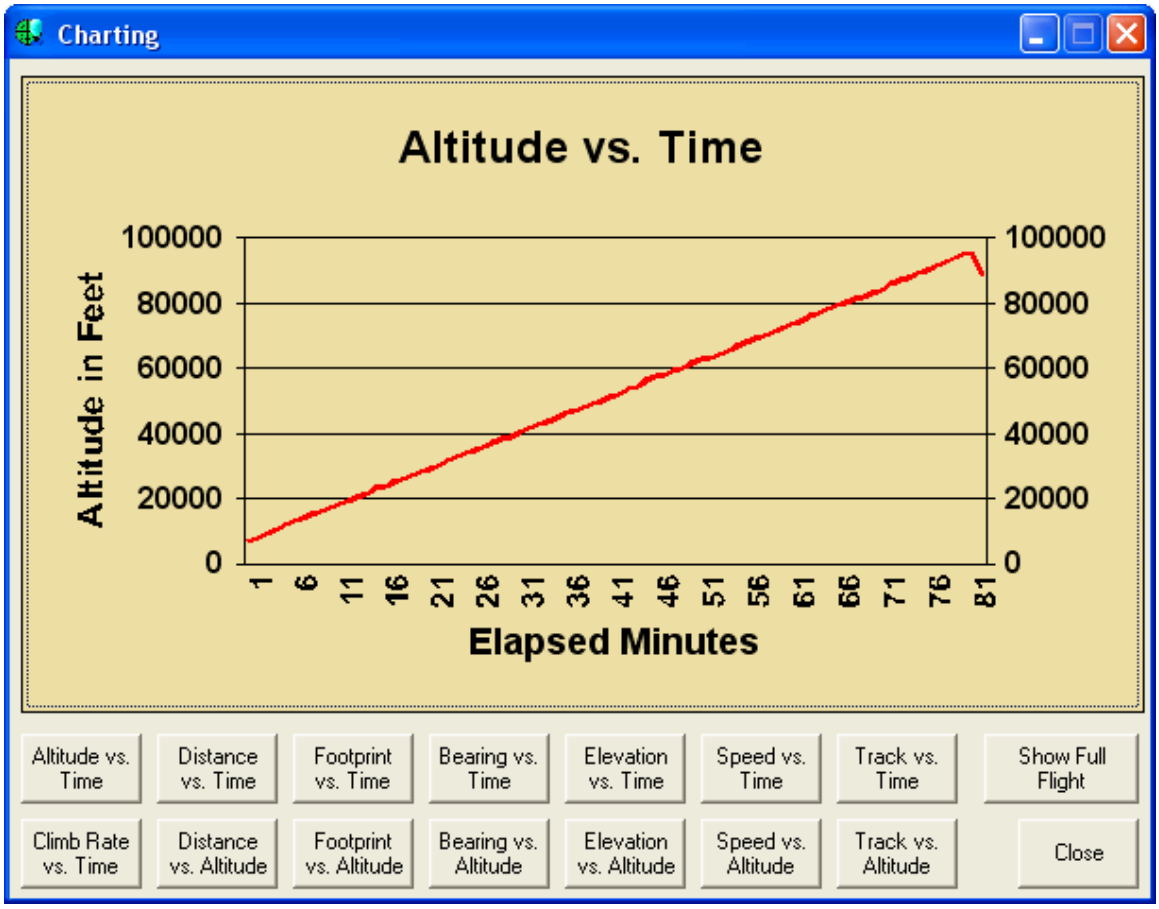
The Distance to LOS is NOT the size of the footprint. Rather, it is the distance from the balloon's ground position at maximum altitude to the horizon. It is approximate and does not account for topographic obstructions and radio propagation characteristics of the transmitter you are using. It's essentially the visual distance to the horizon. Radio coverage may be slightly greater.

If you have the program set to give coordinates in latitude and longitude the window will appear as above. If you switch to the Grid mode, the lat/long above would be relabeled to GirdX and GridY and those coordinates would be given.

If you click on Print Synopsis only this data will be printed. The record by record data for the entire flight will not be printed.

Charts

Pressing this button displays this window.



Initially this charting window opens with Altitude vs. Time and will only graph the ascent phase of the flight. Click on any of the buttons and that data will be charted.

Revert to Wind File/Select Burst Altitude

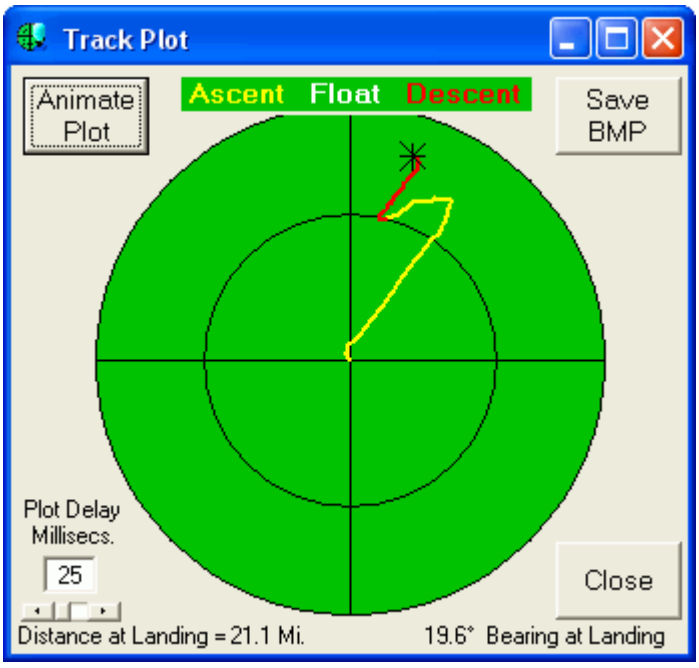
If Burst Altitude is active, the button label reads "Revert to Wind File". If the program is using the entire wind data file then the label reads "Select Burst Altitude".

If you have a burst altitude entered and selected to be used (from the Setup Screen) you can click this button and that burst altitude will be ignored and the full wind data file will be processed. If the winds extend above that burst altitude you will see a prediction based on the full wind file to that maximum altitude. If the winds end below the indicated burst altitude then the prediction will be based only on those lower winds.

A note about using a Selected Burst Altitude. If the winds in the data file end at some altitude BELOW the burst altitude, Balloon Track for Windows will use the last wind record from that lower altitude to fill in the missing data up to the burst altitude. This will result in a slightly inaccurate prediction. The inaccuracy will increase depending on just how far the balloon has to ascend from that last "real" altitude record. If the wind data runs out at 39,000 feet and the balloon is set to burst at 100,000 feet. The program will assume that the winds present at 39K feet form a monolithic block all the way up to 100K. This will invariable result in a wildly inaccurate prediction. Conversely, if the wind data ends at 95K feet and the balloon ascends to 100K, then the prediction will likely be pretty accurate. The background of the prediction window will be colored red to indicate a warning. If the wind data file extends to altitudes higher than the selected burst altitude then the background is colored green to indicate that the entire wind data is not being used but the prediction is based entirely on observed winds and is not fabricating wind data to generate a prediction.

View Track

Click this and the original track display is shown:



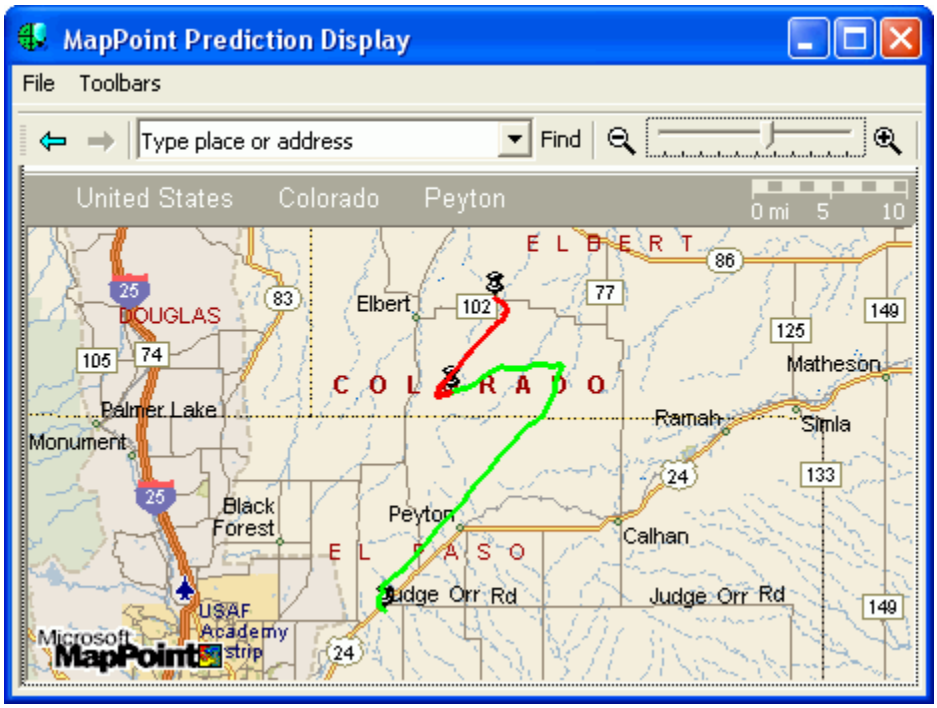
You can save a BMP of this screen, click the animate and you'll see the line drawn slowly on the map. The speed of the animation is controlled by the Plot Delay in the lower left. The range and

bearing at touchdown are displayed at the bottom of the screen. This display is totally independent of latitude and longitude.

MapPoint

If you have Microsoft MapPoint installed this button appears. If you do not have MapPoint the button is not displayed.

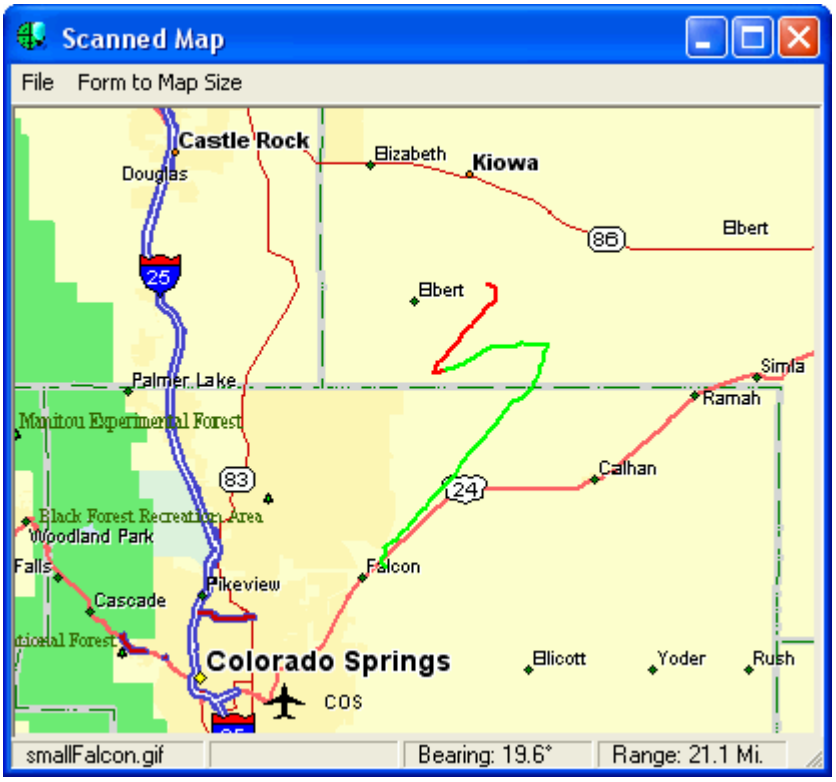
If you have MapPoint and run a prediction and press the button this is what you will see:



Notice that the shape of the track is the same as displayed on the simple View Track button, however, assuming you entered the launch location for the balloon, MapPoint can draw this track over the terrain it will actually traverse. The green section of the track is the ascent phase of the flight. If there was a float element, that part of the track would be colored white. The descent phase of the flight is the red colored line. Note the three pushpins. There is one for the launch location, one for the burst location and one for touchdown. Double click on any of these pushpins and data about that location will be displayed.

Scan Map

Pressing Scan Map will display the track on a map you have scanned into your system.



The accuracy of a scanned map depends on the projection method used to create the source map. Mercator is best. Any projection other than this results in distortion in the track. The green section of the track is the ascent phase of the flight. If there was a float element, that part of the track would be colored white. The descent phase of the flight is the red colored line. See Appendix E on how to acquire and setup a scanned map.

Switch to Metric

Should convert all measurement unites into meters/kilometers. When in metric operation, the caption on the button changes to "Switch to Imperial".

Switch to Grid

Changed the Latitude/Longitude output to the EOSS style Grid positions (so many miles east of the origin = X, so many miles north of the origin = Y). When in Grid operation the caption on the button reads "Switch to Lat/Long".

FAA Reports Only

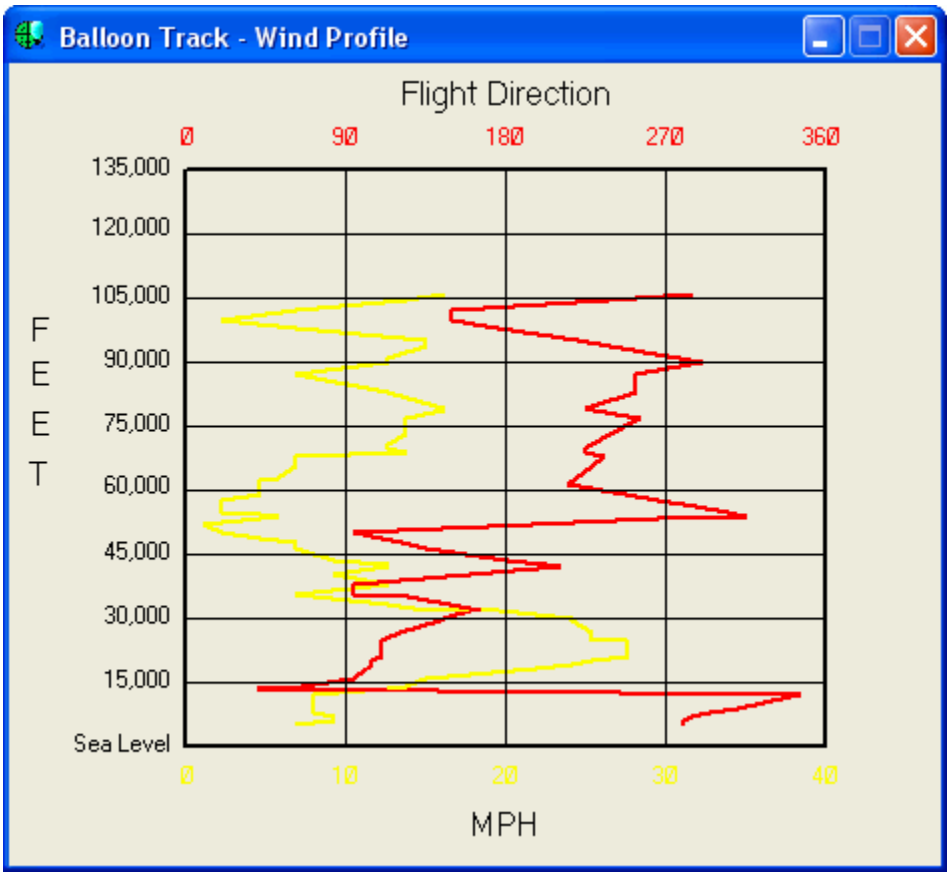
As referred to in the Setup discussion above, shows only those records for altitudes the FAA is concerned about for your flight. The full prediction is run, the results are filtered to show only these values. When active the caption on the button reads "Skip FAA Reports"

Force Re-Calculation

In most circumstances, when you change something in Balloon Track for Windows that affects the prediction, the program detects this and re-computes. However, one thing you might do, change the burst altitude on the main screen. If you do, you need to force the re-calculation.

View Wind

I should probably just dump this, but, it's the original chart that I manually assemble from the wind data. The info on the Charts screen is more informative.



Main Window Menu Options

The main window has several menu choices.

File Menu

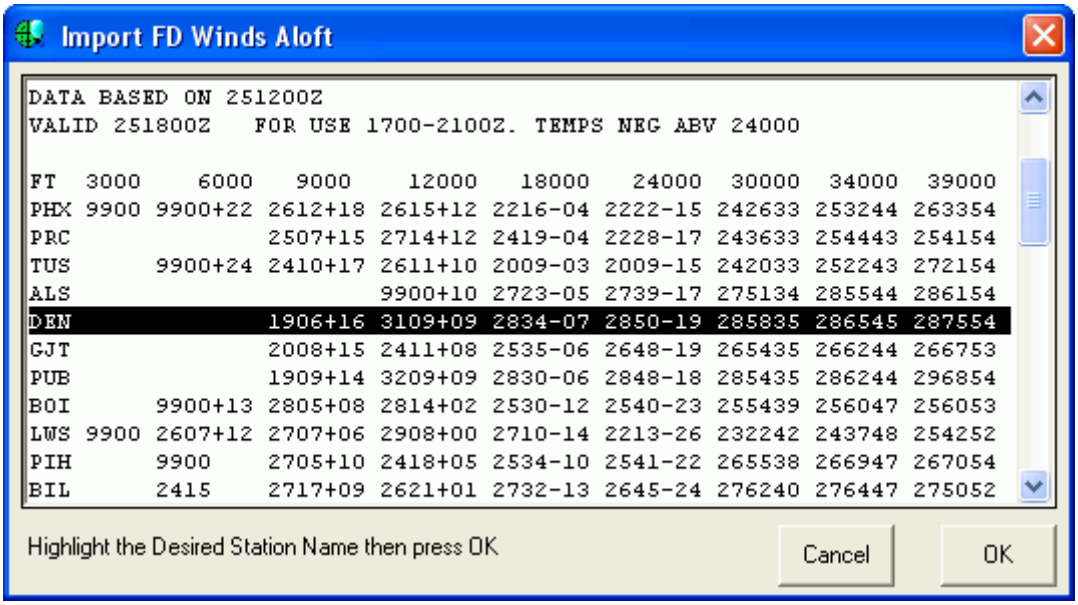
[File/Open]
Select this option to open any wind file. It can be in any recognized format. If it is a recognized import data format, then it will be parsed and the data will be saved to the Balloon Track for Windows data file you name.

[File/Open Blender]
Sometimes you can **not** obtain a full wind data file for the entire atmosphere. Either the NWS RAOB flight was aborted or data was not fully received. Here is how I handle this problem.

On the days running up to the flight I get a morning RAOB report. I also get a predicted wind data file for the actual day of the flight (see Appendix C). Upper level winds (those above the troposphere) are usually pretty stable over days, sometimes even weeks. So, on flight day when the morning RAOB flight data is incomplete, I go to the FAA and get the Winds and Temperature Aloft Forecast "FD" report. It is available at:

http://aviationweather.noaa.gov/awc/aviation_weather_center.html

I save the file for my area. When I try to open it in Balloon Track for Windows the program recognizes the format and pops open this dialog:



This file contains many reports for my region. But, I am only interested in DENver. So, I highlight that line (incidentally, as long as you start the highlighting at DEN you could go on highlighting to the bottom of the page. The program will only use the line where the highlighting begins). Balloon Track for Windows decodes that data. If you look at the dialog above you might get some idea of what's happening. But, most important, the wind data stops at 39,000 feet

altitude. So, what am I going to do? Well, instead of just opening the "FD" file, I can select the [File/Open Blender] option. I'll be prompted for two filenames. Pick the "FD" data for the lower level winds, and the most recent complete RAOB file (hopefully yesterdays) for the high level winds. Balloon Track for Windows will compile the two files into one data file, giving precedence to the low level winds. When they run out (39,000 ft in this case) Balloon Track for Windows will go to the high altitude wind file and use the data from that source to "flesh out" the remaining winds at high altitude.

The Blender will blend any two files as long as Balloon Track for Windows recognizes the format of the imported data.

[File/Export]
Export opens up to several sub-menus (detailed instructions in the appendix)

1) APRS – a format that can be read by just about any APRS program. Select this option and a screen opens allowing you to customize what information is exported to the APRS file.

2) Comma Delimited – All the data displayed on the main window is written to a comma delimited format. You should be able to import this into any spread sheet program.

3) GPS File – Creates a file containing GPS strings that "mimic" the predicted flight path of the balloon. Select this option and a screen opens allowing you to customize what information is exported to the GPS file.

4) Ozi Explorer – I don't have this program, but a user requested it and forwarded on the formatting so … Select this option and a screen opens allowing you to customize what information is exported to the OZI files.

5) Street Atlas – Exports a standard Lat/Long file which DeLorme's Street Atlas can import and display. Select this option and a screen opens allowing you to customize what information is exported to the SA file.

[File/Print]
Several reports can be printed.

1) Flight Prediction – The complete data as displayed on the main window with the synopsis data included.

2) Flight Synopsis – Just the data available from the synopsis screen.

3) Data File - The wind data file in columns (speed of winds converted to KPH or MPH) instead of Knots. Slightly more human friendly than the raw wind data file.

[File/Exit]
Program shutdown. Clicking on any of the other traditional Windows shut down hotspots will work equally well. You know, the X in the upper right hand corner of every window. Or click on the icon in the upper right hand corner and select close from the menu that appears.

View Menu

[View/Data File]
Displays the data file currently being used.

[View/Import]
Displays the source raw weather data file (if you have opened one for this prediction run). If you just load a data file, there is no source import file and you'll see a dialog informing you of that.

[View/Flight Data File]
If you have run a prediction and PRINTED out that prediction, then the program will open up that text file and let you look at it. This data file is not automatically generated and only exists if you print it to a file from the [File/Print/Flight Prediction] selection. If you select this option and haven't printed out a prediction to a file then a dialog will open informing you of that.

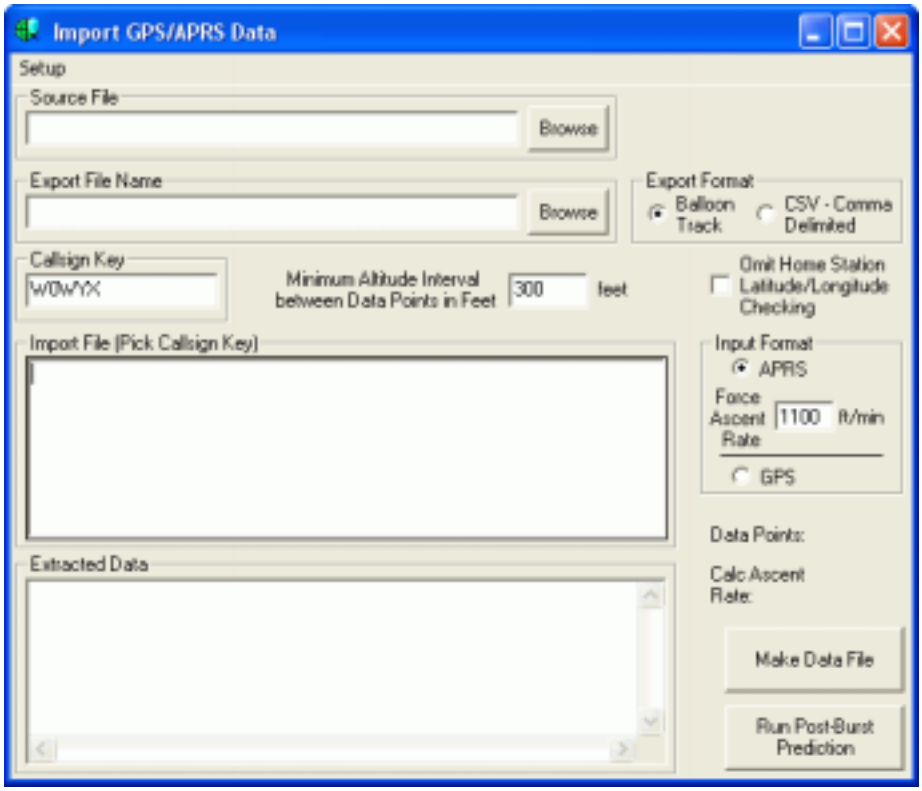
[View/Export Files]
As above, if you exported a file from the current prediction, then you can view that text file. There are menu choices for each export type. If an export of a particular type has not been run then a dialog will open informing you of that.

[View/Text File]
Opens a dialog box where you can select any text file for viewing.

Packet Data Menu

[Packet Data/Packet Terminal]
Balloon Track for Windows has a built in packet radio terminal program. It is designed strictly for balloon flight tracking and shouldn't be used for much else. Because of the depth of capabilities of this area of the program, I'll leave the instructions for its use to a separate section.

[Packet Data/Process Packet File]
When you select this option a new screen appears:



This screen allows you to import an APRS or GPS data file captured during a flight and create either a Balloon Track for Windows Data file or a comma delimited spread sheet file.

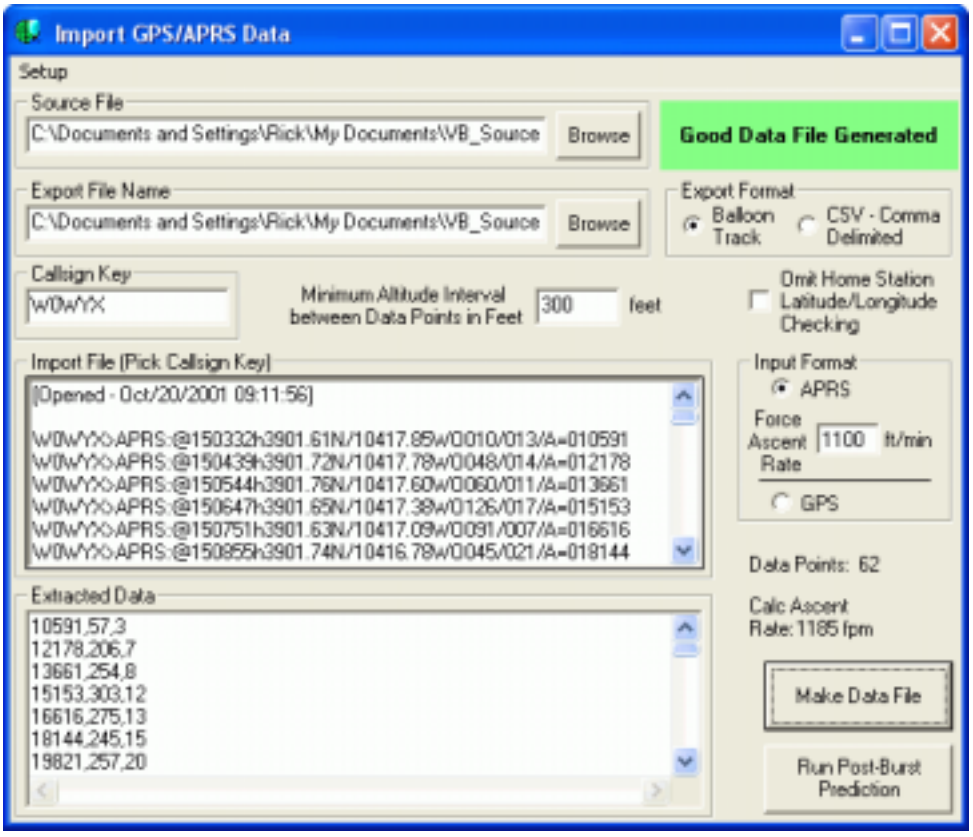
Click on the browse buttons to select the import and export file names. When you select an import/source file the program will attempt to determine the type of file you have loaded. If it sees lots of APRS strings for the callsign key it will assume that format, if it finds lots of GPS strings, it will assume that format. You can override whatever the program sets. The program also attempts to determine the Callsign Key. First it assumes that the "Flight Radio Callsign" as set on the setup screen is the target. However, if upon opening the file it finds that callsign is outnumbered by some other callsign, it will "adopt" the more prolific callsign as the target. Once again, you can set this target callsign manually after specifying the Import/Source file. Once the Import/Source file has been examined the text display box marked "Import File – Pick Callsign Key" will show this file. The "Pick Callsign Key" is there because you can highlight and copy any callsign (or any text for that matter) and paste it into the Callsign Key box above. The "Force Ascent Rate" for was when we were dealing with APRS data that had no time stamps. Using that

rate, an interval would be calculated for the time that had passed between packets. And this time was used to generate speed values for the wind layer. If a file being processed has time stamps associated with altitude then the forced ascent rate is ignored.

Next select the type of output you want in the Export Format Dialog. Balloon Track files will only include data from the ascent phase of the source data file. If you select CSV, the program will extract data for the entire file (both ascent and descent phases).

Select the minimum altitude interval. If you are creating a Balloon Track for Windows Data file and your payload beacons out more often than once a minute, you should probably set 1000 feet as the minimum interval. This allows more time to pass between calculations and thus gives a better average wind direction and speed for the altitude layer being computed. If you are generating a CSV file, set this at a very low figure to capture all data in the input file to a comma delimited export file.

If you are making a Balloon Track for Windows data file and want to immediately run a prediction based on this data click the "Run Post Burst Prediction" button. If you just want to create the data file, click that button. The result of the processing will appear in the window labeled "Extracted Data"

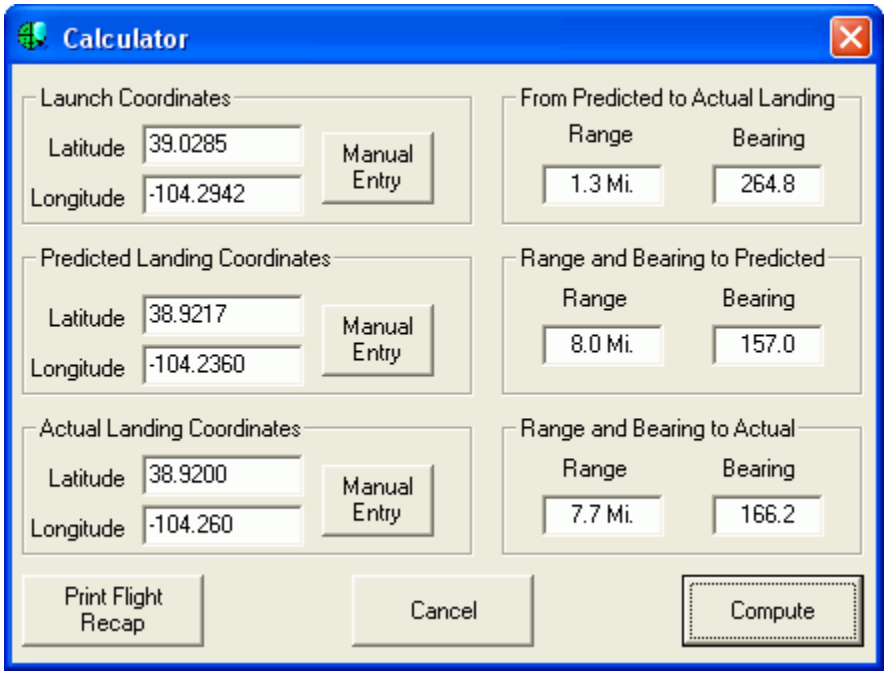


Above, an example of an APRS file converted into a Balloon Track for Windows data file.

Calculators

Balloon Track for Windows has several calculators built into it.

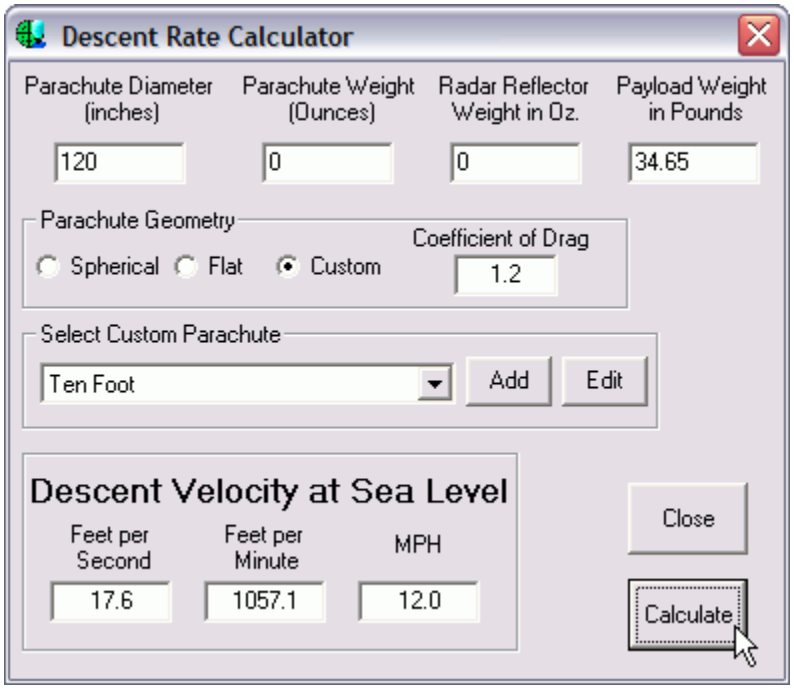
[Calculators/Actual vs. Predicted]



After a flight has concluded you can rerun the original prediction, then select this menu item and a calculator will open. The launch location and predicted landing location will be filled out. Enter the actual landing location as reported by your recovery team and the program will compute a new range and bearing from the predicted landing to the actual landing, it will restate the range and bearing of the prediction and it will give the actual range and bearing from the launch site to the real landing site.

Pressing "Print Flight Recap" will print a page almost identical to the printing of a Synopsis. However, it will also include the actual data computed on this screen.

[Calculators/Descent Profiler]

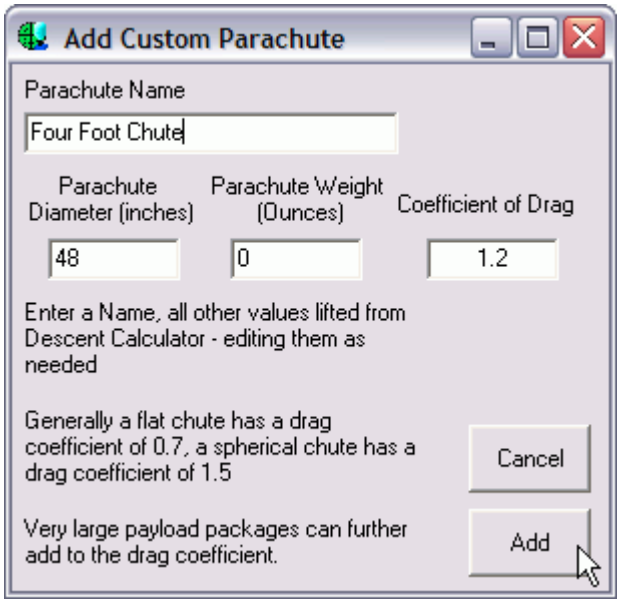


The descent profiler will estimate the descent rate at SEA LEVEL for your system.

Fill out all the values in the first row of the window.

Next select the Parachute Geometry. If you select Spherical a default coefficient of drag of 1.5 will be used. If you select Flat a default drag of 0.7 will be used. You can also select Custom and enter any coefficient of drag you wish.

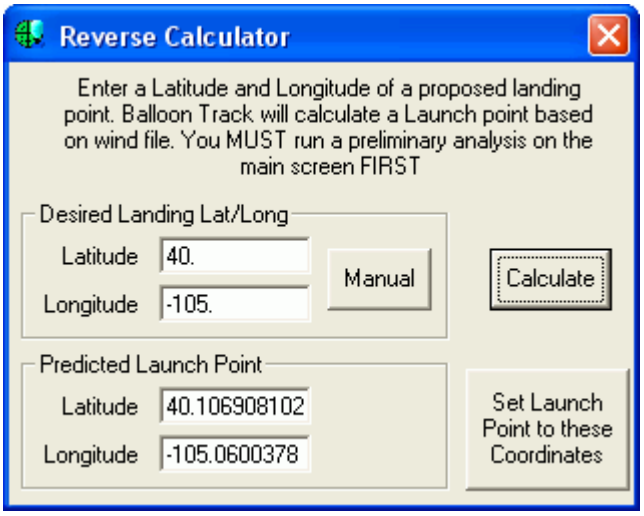
If you regularly use the same parachute you can click the Add button and the following screen will appear.



Enter in a distinctive name and the values for this chute. Click add and the parachute will be added to your database of custom chutes, the form will close and the data will be displayed on the Descent Profile screen.

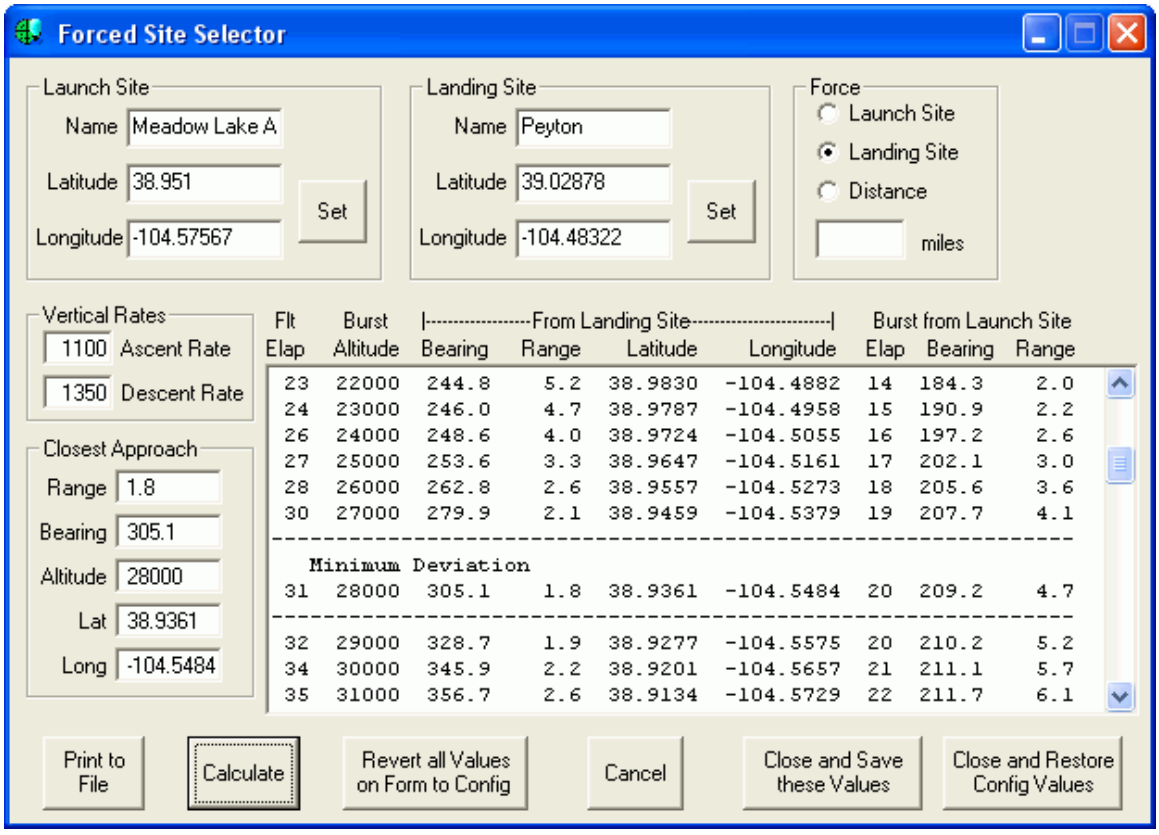
Now press “Calculate” and the descent velocity will be displayed. This is the descent rate you should enter on the Setup Page. Balloon Track for Windows will automatically adjust the descent rate for atmospheric pressure so that initial descent rates at 100,000 feet will come in around 10,000 fpm and slowly reduce to the rate indicated on this screen as the payloads approach sea level altitude.

[Calculators/Reverse Calculator]



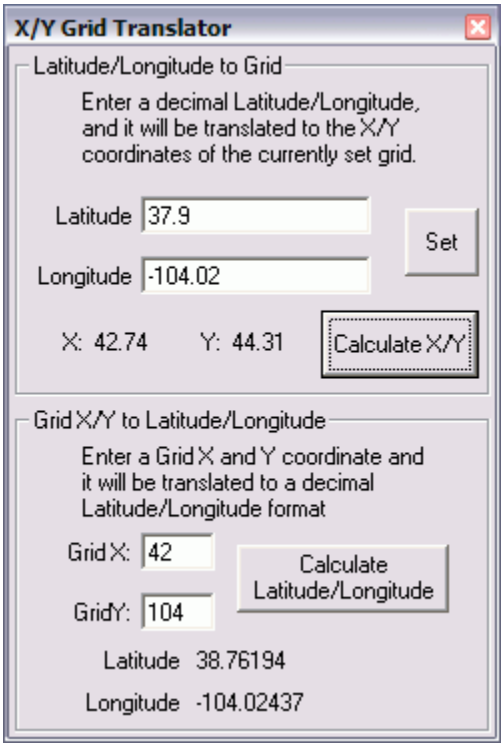
After you run a prediction, Balloon Track for Windows knows the range and bearing from launch to landing. This calculator simply plots a reverse range and bearing from an intended landing site and gives the latitude/longitude coordinates for a launch site that will result in a landing at your desired location.

[Calculators/Forced Site Selector]



Suppose you wanted to land as close as possible to a given location. Using this somewhat experimental calculator, Balloon Track for Windows runs the prediction recursively for an altitude gain of 1000 feet added to the burst altitude starting at the first whole increment of 1000 feet above the launch site. In the example given above, there are predictions for where the balloon would land for bursts at 7,000 feet, 8,000 feet, 9,000 feet and so on until the scope of those results appears above. With each calculation, the distance from the predicted touchdown is compared with all other results. The flight whose burst altitude forces the payload to land closest to the "Forced" landing site is highlighted in the text display and that data is displayed in the info box to the left. This is just a toy. We've never had to use it, but it may come in handy someday.

[Calculators/ Calculate Grid X/Y for Lat/Long]

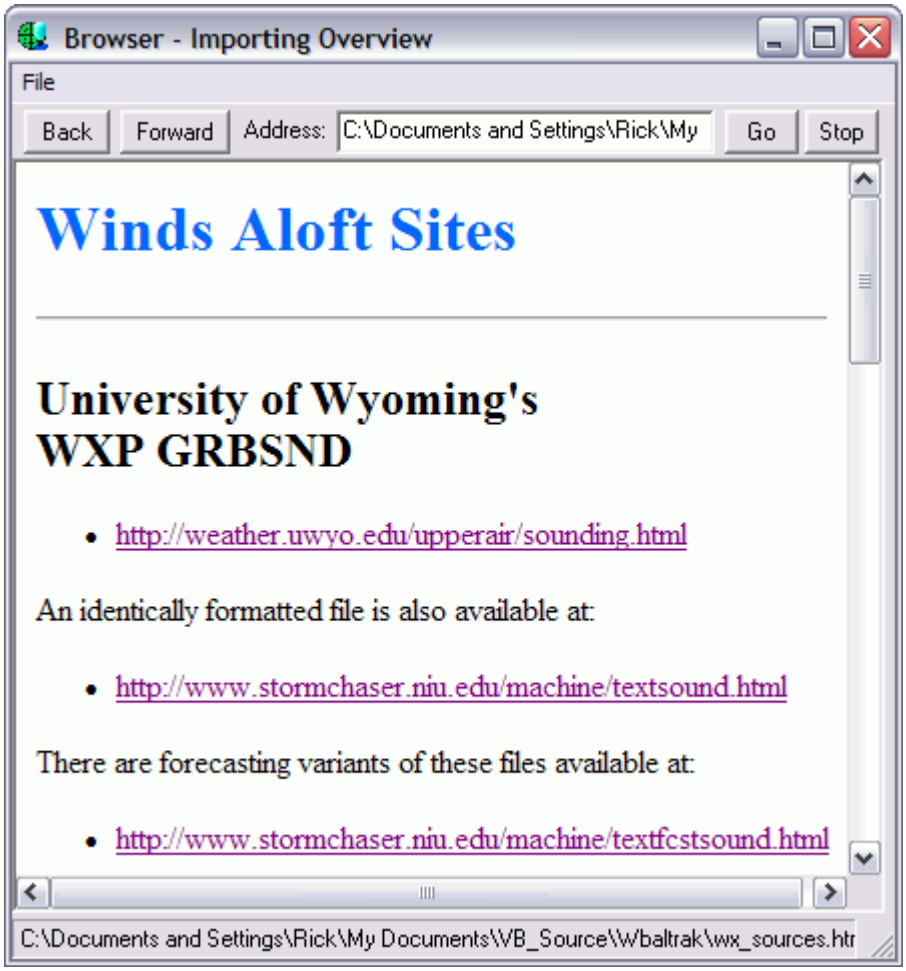


This is another feature that is probably only useful to EOSS, however, it calculates the Grid X/Y coordinates for any latitude/longitude pair entered.

Launch Browser

Launch Internal Browser

There is a very simple browser built into Balloon Track for Windows. Select this option and it launches

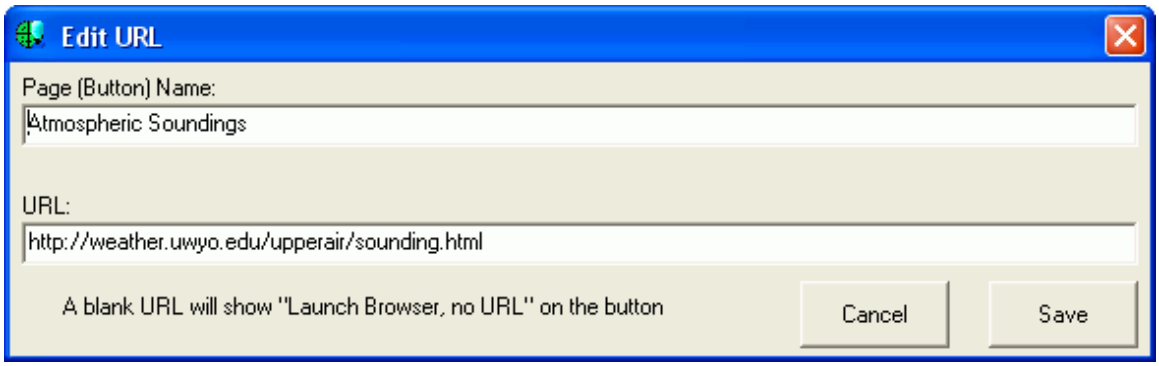


Internet Explorer

When you select this option the following dialog box appears:

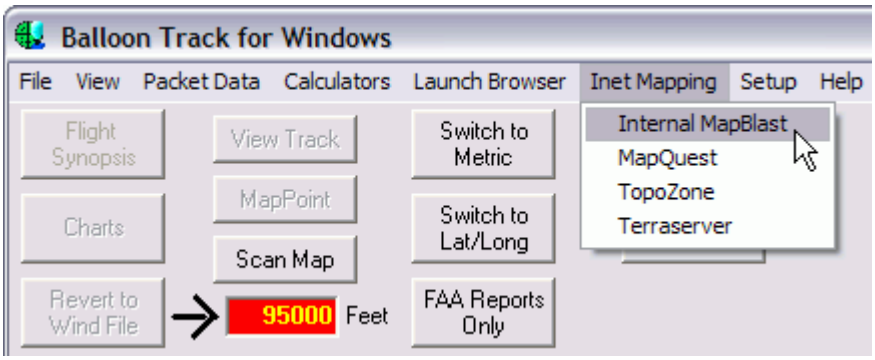
If you click on any of these buttons, your browser is launched and directed to the URL associated with the caption on the button.

If you right click on a button this dialog box appears:



You can cut and paste into this dialog and thus change the behavior of the browser button above.

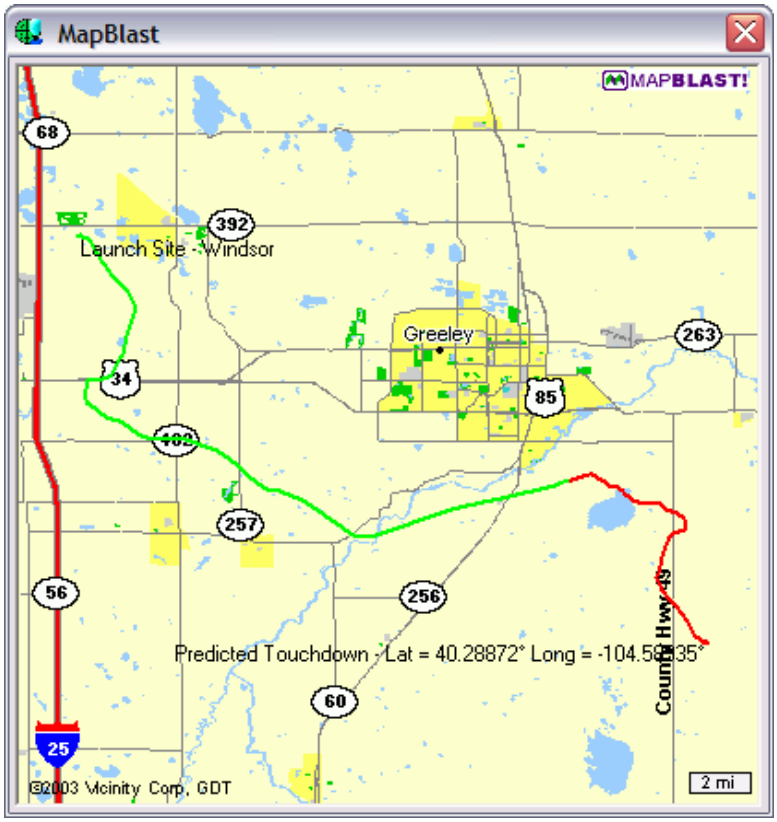
Inet Mapping



Click on Inet Mapping and a pop down menu appears that includes all the services you entered on the Inet Mapping tab of the Setup Screen. Also available is the Internal MapBlast map.

For the Browser based maps the current predicted touchdown point will be mapped using that service.

For the Internal MapBlast map, the full prediction will be plotted on top of a map obtained live over the internet. Naturally, you must have an active internet connection.



Setup

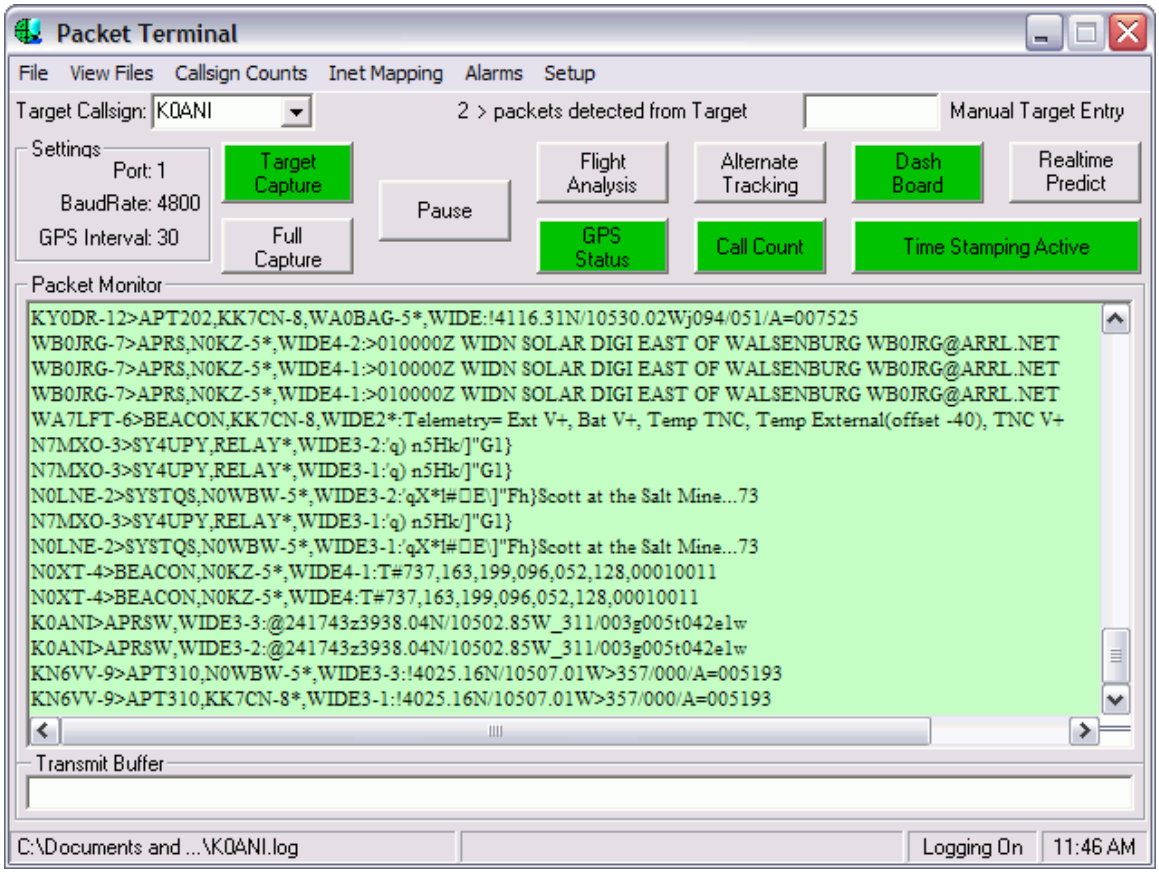
No sense it being redundant, check out the opening section of the manual for a description of the Setup screen and its features.

Help

Originally there was a standard Windows Help file for Balloon Track for Windows however, it became too onerous to maintain. A five minute coding change might conceivably take an hour or more to account for in the help file. Of course, the help file generator I was using was freeware and decidedly quirky. If I ever get the nerve to spend $800+ for a decent help generator, I may tackle this end of the program. In the meantime, that's why I'm sitting here typing the manual. So individuals may have at least some minimum guidance.

Packet Terminal

The packet terminal deserves its own section of this manual as it is a little complicated and offers many functions. Basically, when you select this menu option a new window opens:



In this section of the manual, I'll deal first with the Menu Selections possible on this screen. Then I'll explain what those several buttons across the top of the window accomplish.

The first thing you should do is ensure that the "Target Callsign" is correctly entered. If it is NOT then all the flight data will not be processed by the program on the various tracking modules (Flight Analysis, Alternate Tracking, Dashboard, Flight Records, etc.).

Menus

[File/Save]
This option opens onto a sub-menu where you can elect to:

[File/Save/Autosave Real Time Data] – This option refers to the data file that is created and maintained by the "Flight Analysis" routines (button) of the Packet Terminal. When you are watching a live flight, as long as you have the "Flight Analysis" window open, Balloon Track for Windows will maintain a data file containing all information received during the flight. You may

set a default behavior for this option on the setup screen (Packet Parameters). I recommend you set AutoSave to always be active. That way, you need not remember to activate it. More on this file when we get to "Push" the Flight Analysis button later.

There are two additional sub menus, [File/Save/Save Packets for Target Callsign] and [File/Save/Save All Packets]. They do pretty much what they say. Both of these options are also available from buttons on the Packet Terminal window.

[File/Open Simulation]
Selecting this option, Balloon Track for Windows will display a dialog box allowing you to pick a simulation file. It can be any text file that is formatted as a capture from your balloon would be formatted. Meaning, the file can contain APRS data or straight GPS data. However, it must be in packet data form, meaning the data must be preceded by an amateur radio callsign which can be used as a key to finding and extracting the data

When you initiate a simulation, the com port is closed and the program processes a text file one line at a time exactly as if it were receiving that text from a TNC via the com port. In this way, you can test the program operation, and get used to what will happen during a real flight without having to wait until a balloon actually flies. All of the various options available from the Packet Terminal window will function regardless of whether the system is processing a simulated flight or actually acquiring live data from an air borne balloon.

View Menu

The view menu opens to allow three selections.

[View/Real Time Log]

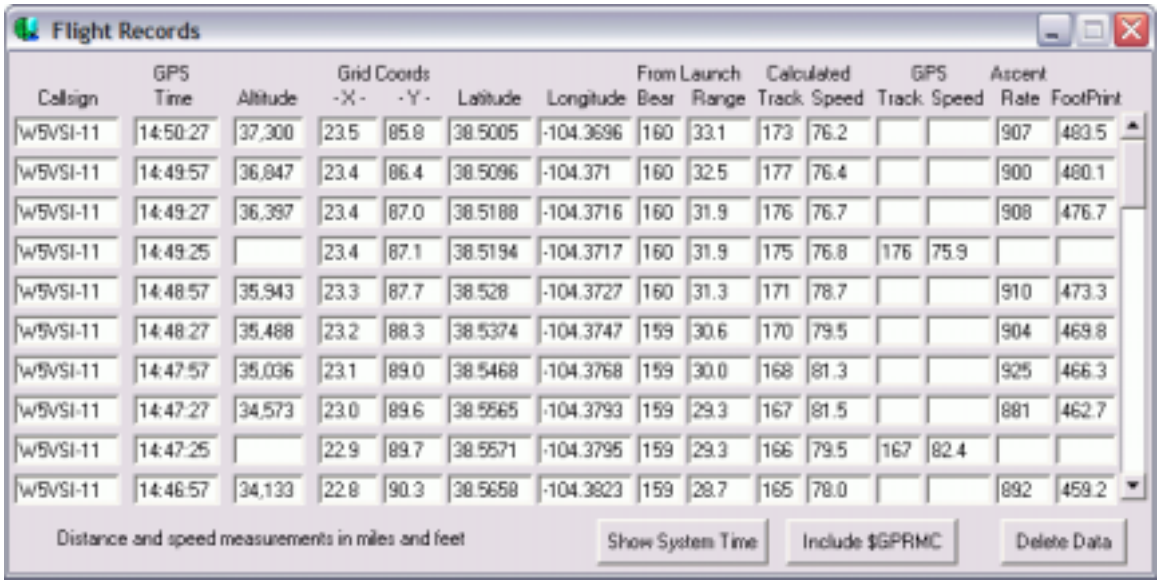
This is the log file that is used by the "Flight Analysis" part of the Packet Terminal. It is hard to decipher manually, but, being able to see it can help troubleshoot problems if the "Flight Analysis" doesn't seem to be working properly.

[View/Any Text File]

This option allows you to open any text file for viewing.

[View/Flight Records]

This opens a new window that looks like this:



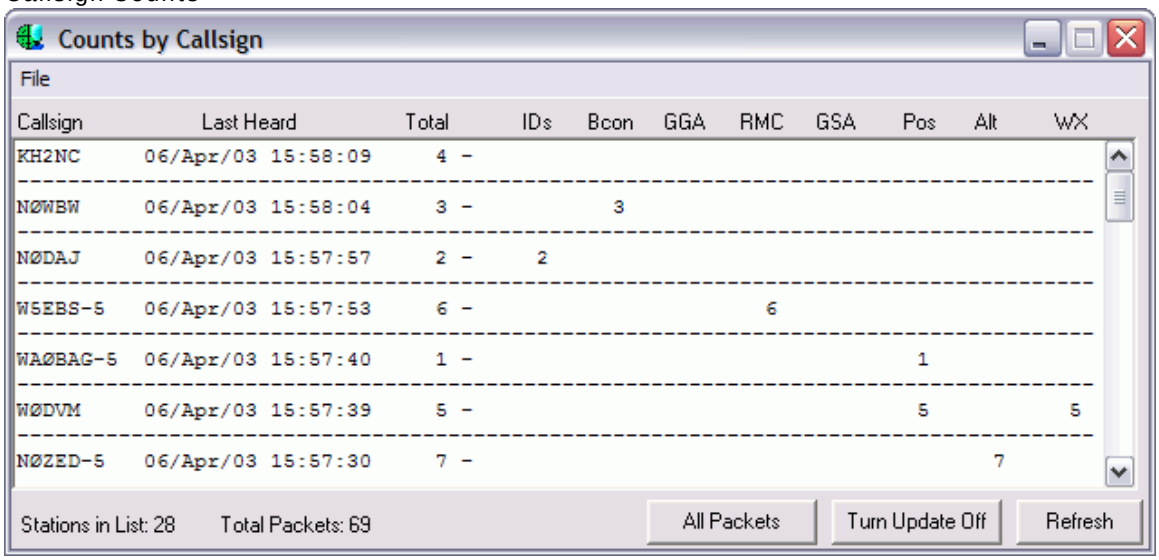
As each new packet is received from the balloon's APRS tracking beacon it is decoded and the data contained within that packet along with information derived by Balloon Track for Windows is displayed here. The source file for this data is ALWAYS open. So even if you forget to log data, it will be accumulated here as long as you have correctly identified the Target Callsign on the main Packet Terminal screen. The source file is a comma delimited text file that will load into any spread sheet. The fields GPS Time, Altitude, Latitude, Longitude and GPS Track and Speed are derived directly from the packets. The fields Callsign[2], System Time, Grid Coordinates X and Y, Range and Bearing from Launch, Calculated Track and Speed, the ascent rate and the footprint are all calculated by Balloon Track for Windows. You can elect to NOT include the $GPRMC data. However, selecting this option will have two different outcomes. When you are running a Simulation, the program will not save the $GPRMC data to the file from which this data is derived. In this way you can create a "clean" CSV file that has altitude data for each record in the data file. If you are receiving live packets then the behavior is slightly different. This display constantly records the $GPRMC data to its database file, however it filters that data out on the

[2] The callsign and system time fields toggle back and forth using the command button on the bottom of the window. However, both are present in the data file.

display. I did this for two reasons. When capturing live data, everything is important. When running a captured log file through the program in simulation mode, I enabled the complete deletion of the $GPRMC data in order to more easily make pretty graphs from various properties of the flight that relate directly to altitude.

Although I glossed over the use of this “Flight Records” display in simulation mode, I want to point out that it is a great way to get data post flight into a spread sheet format. I usually miss the first minute of a flight because I’m not at the launch site and have to wait for the balloon to rise over my local horizon. And for just the same reason, I usually lose the telemetry for the last 10 minutes of a flight as the balloon has traveled much further from me and goes over my horizon while still around 9,000 feet AGL. So, after a flight I get log files sent to me from many sources. I combine all these log files into a master telemetry file. Then, I run it in simulation through this screen and end up with a very nice spread sheet file of the flight.

Callsign Counts

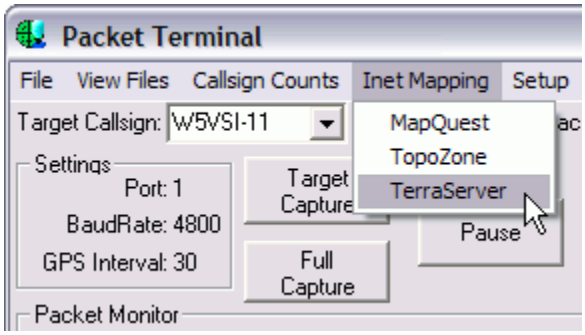


I designed this screen with the intention of having a quick overview of what stations could be heard on the frequency where the balloon is transmitting tracking data. I thought it might be of help in resolving possible conflicts of frequency usage. However, I've hardly ever opened it up during a flight. When we fly a mission expressly for the purpose of acting as a high altitude digipeater, this may come in handy.

All packets just means that the program counts each and every instance of a packet, including duplicate packets which are heard both directly at the receiving station (Balloon Track for Windows Computer) and through digipeater stations. If you click this button the caption changes to "Unique Packets". In that case a packet is only counted once even if it is digipeated dozens of times. However, there is the possibility that a packet might be exactly duplicated a minute or two later (fixed station position reports). So, there is a 15 second window associated with this duplicate packet window. When a packet is received, it is "memorized" by the program and the time it is received is associated with that packet. Then if subsequent identical packets arrive (minus any inconsistencies in the path) within the 15 second window of receipt of the first packet they are not counted. After 15 seconds pass, the "memorized" packet for each call sign is replaced with the next new packet from that station.

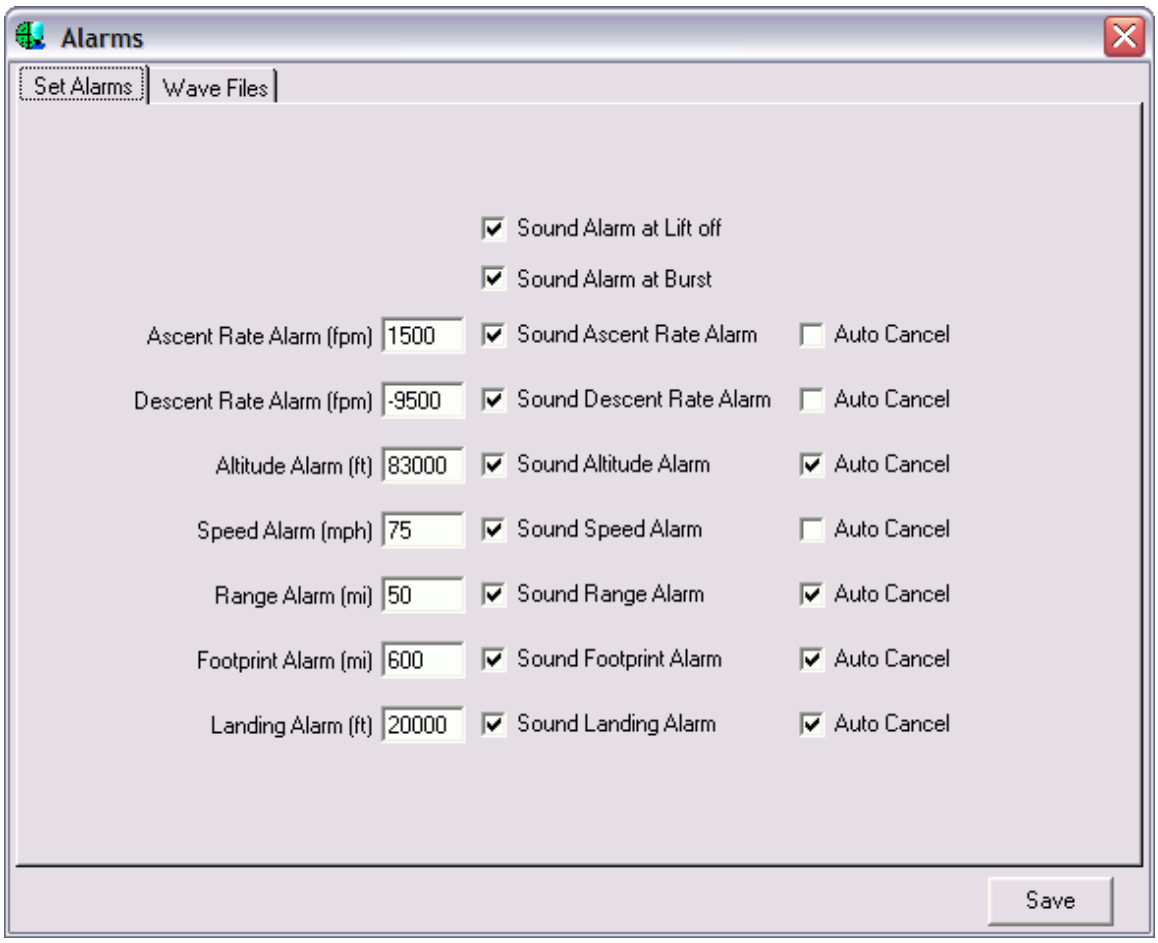
If you click "Turn Update Off" then the program will stop updating this screen. You can then refresh it any time manually by clicking "Refresh".

Inet Mapping



Click on Inet Mapping and a popdown menu appears that includes all the services you entered on the Inet Mapping tab of the Setup Screen. Click one and the last received latitude and longitude for the target callsign will be mapped using that service.

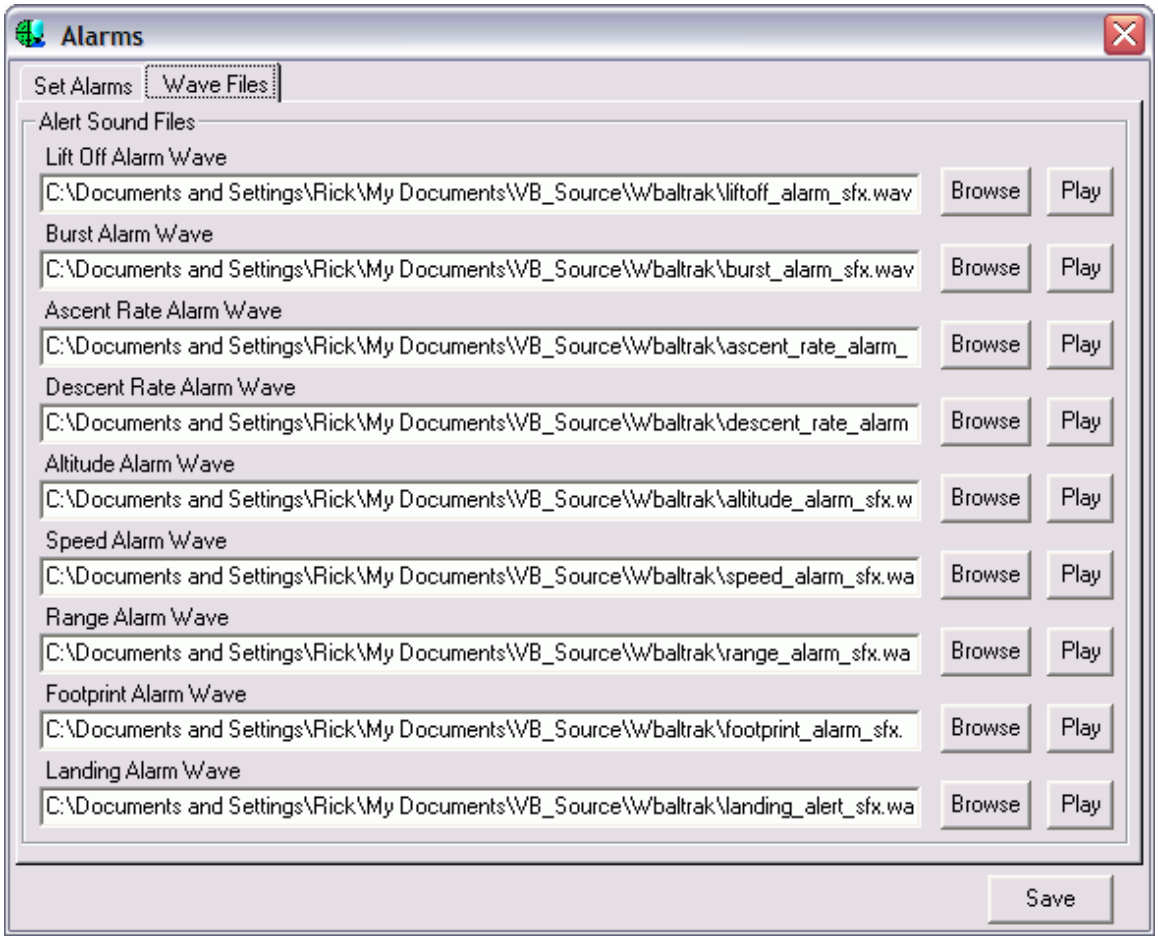
Alarms



Set various parameters which when exceeded will sound an alarm.

Check “Sound xxxx Alarm” to activate it.

Check Auto Cancel and after the first alert, the alarm will be deactivated. You can reactivate all alarms by re-opening this window from the Packet Terminal screen.



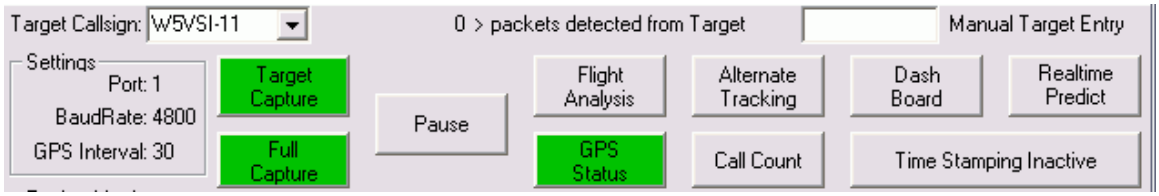
Set which wave files play for each alarm.

Setup

A shortcut to the setup screen from the packet terminal.

Buttons

Several of the buttons on the Packet Terminal Window duplicate functions available from the Menus. However, I wanted a quicker way to activate these features. That's why the duplication exists. When an option is active the button changes color from standard window background to green, as the "Target Capture", "Full Capture" and "GPS Status" buttons demonstrate below.



Target Capture

This opens a capture file that will save only those packets which are sent from the target callsign.

Full Capture

This opens a file that captures every packet received.

Pause

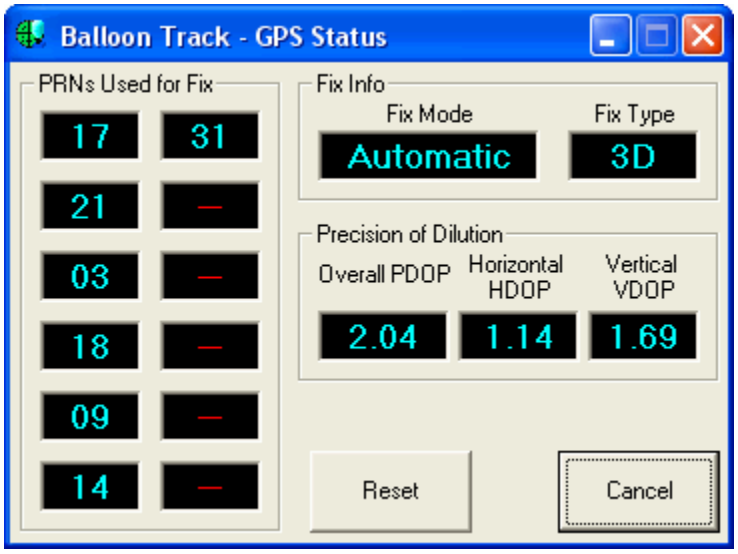
This temporarily closes the com port. My TNC buffers data when the com port is closed, so if I pause it for a few minutes then click this button again (its caption changes to Resume when you click it) to resume reception, the buffer of the TNC dumps all the data it has saved into Balloon Track for Windows. The program has no difficulty processing these buffered packets.

Flight Analysis

It's not all that complicated, but I'm going to cover that in the next section after all the buttons have been described.

GPS Status

Opens this window:

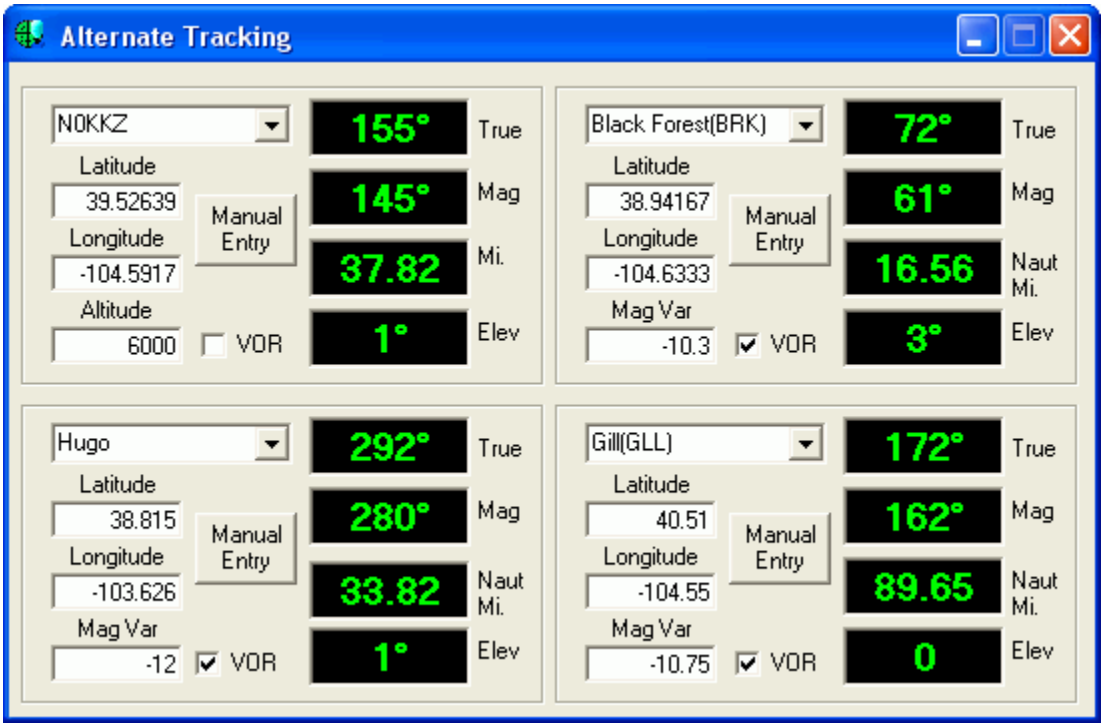


The numbers on the left are the GPS constellation satellite ID numbers currently being heard by the GPS receiver on board the balloon. Fix Mode could be Automatic or manual or none. Fix type could be 3D or 2D or None. The precision of dilution is an indication of the current level of accuracy. Go to a GPS web site for more info on all this. I added this in the early days of GPS so we could monitor the status of the GPS receiver on the balloon.

This data is ONLY available if you are transmitting NMEA strings from your balloon APRS station and you include the $GPGSA string, which provides all this info. If your payload is not transmitting this string, this display will remain blank.

Alternate Tracking

Balloon Track for Windows can give you range, bearing (both magnetic and true, and elevation (degrees above your local horizon) where the balloon can be seen from multiple locations.



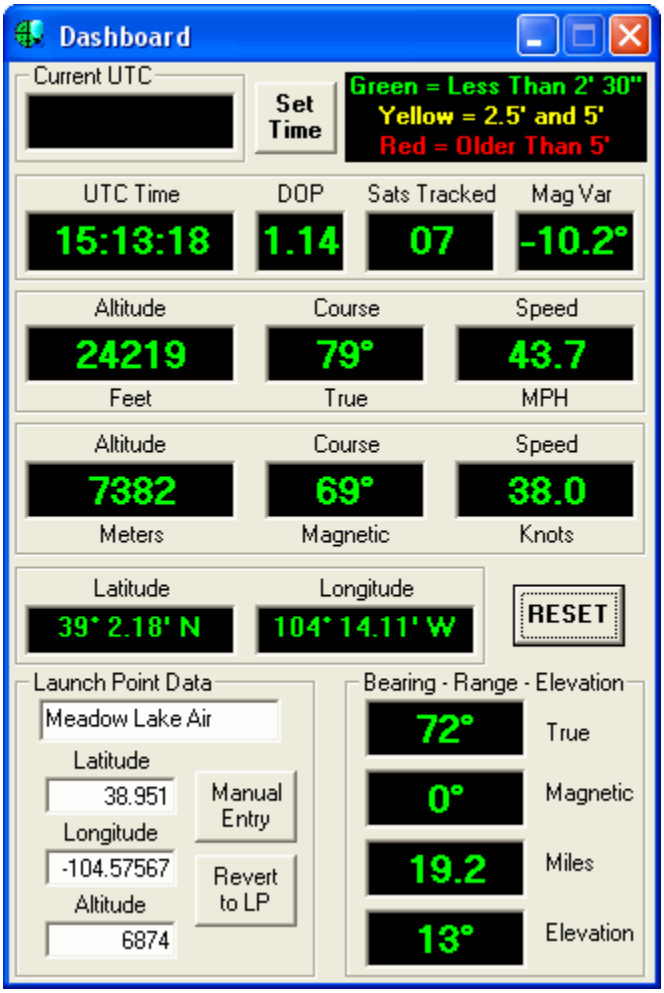
This information may be helpful in pointing directional antenna arrays, and it is also of use if you need to immediately convey a position report with respect to a VOR station to the FAA. You can manually enter in any location you choose. However, the program will refer back to the data you entered on the Setup Screen for various locations and combine them all into one list from which you can select an alternate tracking location.

Call Count

A button which performs the same function as selecting this option from the menu (discussed above).

Dashboard

The dashboard is the predecessor to the "Flight Analysis" window.



I leave it in because it offers a quick view of some information that isn't readily available from any other single display. Notice the legend in the upper right corner. When I captured this screen, the program was running in simulation mode and so, all data is considered current. However, during a live flight, the Current UTC time would be updated from your computer's system clock (adjusted by applying the UTC Offset entered on the Setup Screen). When the time stamps on the packets start getting aged, meaning no new packets have been received in a window between 2 minutes 30 seconds and 5 minutes, the green characters of all data are replaced by Yellow colored characters. Once the data is older than 5 minutes, the characters all turn red. This can come in handy if I'm across the room using another packet setup to view the balloon's track on a straight APRS program. I glance at this screen, see a bunch of red characters and note immediately that I haven't received a good packet in a long time. Something may be going haywire and I need to get on top of it soonest.

Realtime Predict

Real time predictions depend on data acquired by Balloon Track during the ascent phase of the balloon's flight.

Important!

Prior to flight clear the "Flight Records" database. On the Packet Terminal screen, click [View Files/Flight Data]. When the Flight Records screen opens up be sure to click the Delete data button.

Once the flight has commenced, do NOT clear this data again. If the program becomes unstable and crashes you can simply restart the program and open up the packet terminal and all new data received will be appended to the data you acquired prior to the crash.

At any time you can click on the "Realtime Predict" button. When you do, this is what transpires.

1.) The Program changes the home location (lat/long) to the position where highest altitude was recorded in the Flight Records database.

2.) It changes the mode of operation to "Drop". You can do this from the Setup screen for special flights but normally you would be running a burst or float type flight.

3.) It loads the data acquired during the ascent into the program.

4.) Based on that data the program runs the descent phase of the prediction from the latitude and longitude of the burst to the ground.

When you click the "Realtime Predict" button its caption changes to "Restore Config". If you click on that button then the program will:

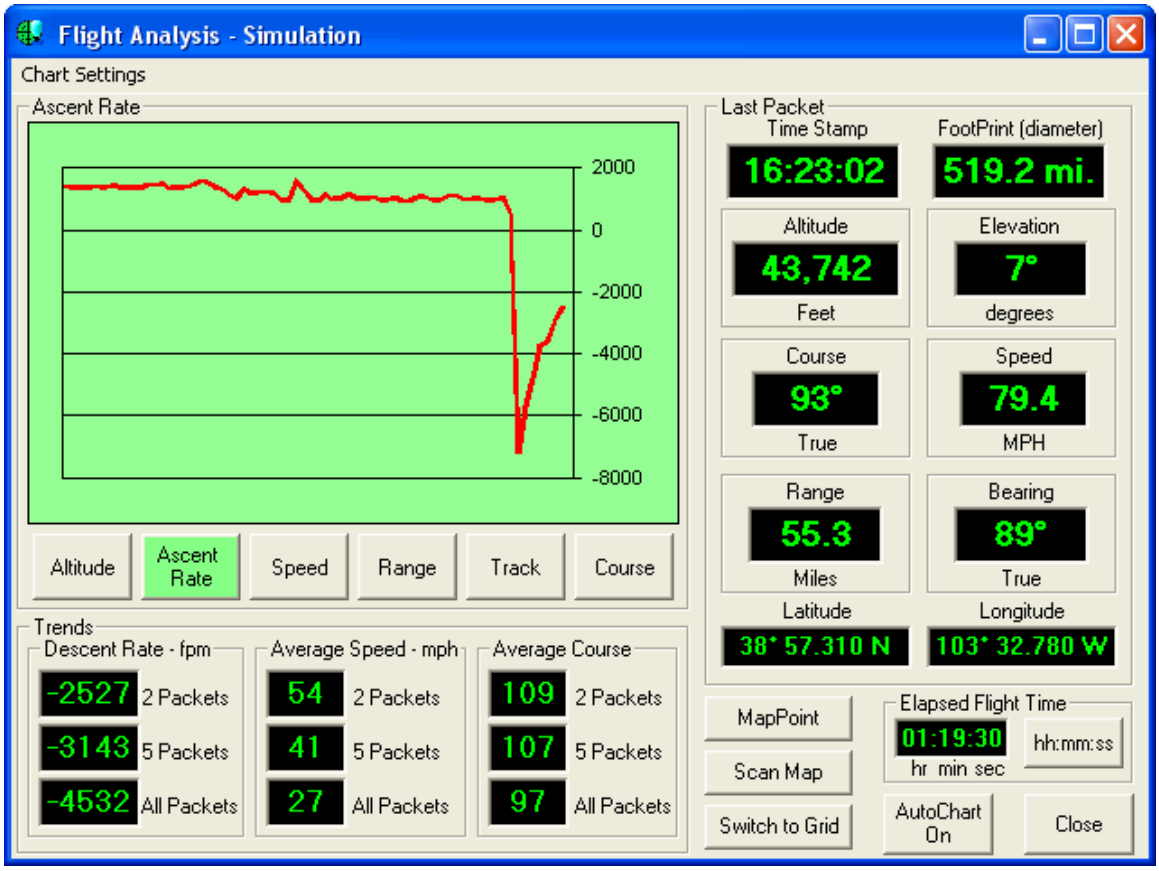
1.) Restore the original Home Location from your wbaltrak.ini file.

2.) Restore the original predicted winds database (if one was loaded prior to this real time prediction) you obtained over the net.

Time Stamping Inactive

Click this button and the caption changes to “Time Stamping Active” and the program adds a date and time string in front of every packet received. There is only ONE excuse to use this feature. You are flying a system that does not include a valid time stamp derived from the GPS data used to assemble the telemetry packets. Within EOSS we used to beacon out a packet that just had lat/long and altitude. Adding the time stamp, while live capturing the data, really helped improve the accuracy of the ascent rate and other derived data.

Flight Analysis



By pressing the "Flight Analysis" button on the Packet Terminal screen this window opens. However, and this is **VERY** important, first a dialog box pops up asking if you want to "Clear Data File". Get this down and get it **RIGHT!!** :-) Prior to a flight, clear the data file. However once a balloon is in the air **NEVER** clear the data file. Why? Prior to a flight you want to clean out any residual data from a previous flight or simulation. However, once a balloon has started transmitting data to this program, you want to preserve that data at all costs. Suppose the program crashes. It definitely does crash on occasion. Restart Balloon Track for Windows and click "Flight Analysis" on the Packet Terminal screen and **DO NOT** clear the data file. When this screen opens, the graphs will continue to display all the flight data from the beginning of the flight missing only the data contained in those packets you did not receive while the program was not running. So, before a flight clear the data file. In the middle of a flight **DO NOT CLEAR THE DATA FILE.**

This is the screen I most heavily rely on to keep me informed during a flight.

Click on any of the buttons below the graph and the program will graph that value. If you click on Chart Settings on the menu, you can change the interval the program uses to generate the graphs. Select 2 packets and the program will display a chart of the data that is generated between the last

two packets received. Select 5 packets and the program will compare and chart the data between the last packet received with the data received five packets ago. This tends to smooth out the data a little. Some options allow you to chart the current average of all packets. I usually set the program to chart between the last two packets and look below the chart to the Trends box to see what has been happening in the wider 5 packet and all packet windows.

In the Trends box all data is calculated from data received in the packets. For instance, the course isn't the current track as being reported by the GPS, it is the course as calculated between the previous and current latitude and longitude positions. The same is true for the Speed and Ascent/Descent rates.

The "Last Packet" Box to the left shows what is actually being reported in the last packet. In this box, the Speed and Course are those encoded in APRS strings directly from the NMEA GPRMC string.

Click on MapPoint and the program displays the current track of the balloon in that program's display. Click on Scan Map and your custom scanned map is displayed with the current track show on it. Both maps will automatically update when each new packet is received.

Click "Switch to Grid" and the program changes the current Latitude and Longitude reporting to the Grid X/Y reporting scheme as described earlier.

Well, that's all folks.

Thanks for using Balloon Track for Windows.

73 de NØKKZ

Appendix A - APRS Formats Supported

There are many different ways you can design an APRS telemetry string. Balloon Track for Windows has not been designed as an APRS program and does not purport to support each and every different format. Here are a few strings I have supported.

This first string is, in my opinion one of the best for ballooning because it is a fully compatible APRS string and it contains everything needed to track a balloon flight.

```
W0WYX>APRS:@164428h4029.84N/10427.34WO234/038/A=092748
```

- The leading 164428 is time and breaks out as 16:44:28 UTC. This is the time stamp from the on board GPS receiver associated with the position information in the NMEA sentence used to construct this data.
- Latitude: 40° 29.84' North
- Longitude: 104° 27.34' West
- The "O" following the "W" in the longitude is the symbol representing an icon for a balloon.
- 234 following the "O" balloon icon symbol is a 3 digit number representing the course as reported by the onboard GPS (true)
- 038 is speed in knots
- /A=092748 represents the altitude, in this case 92,748 feet above sea level

This string is identical to the one above but without the time stamp:

```
W0WYX>APRS:@4029.84N/10427.34WO234/038/A=092748
```

Another format just contains latitude, longitude and altitude:

```
W0WYX>APRS:!4029.84N/10427.34WO Alt = 92,748 Feet.
```

This string translates to:

- Latitude: 40° 29.84' North
- Longitude: 104° 27.34' West
- The "O" following the "W" in the longitude is the icon for a balloon.
- And altitude is obvious

Another Format supported.

```
W0WYX>APRS:@164054h4026.59N/10450.62WO095/041/ Alt = 20,729 Ft.
```

These last two APRS strings are proprietary and were designed to run in EOSS payloads. Most likely you will never see them in your group

Appendix B -
GPS Strings Supported

Balloon Track for Windows can parse some standard GPS NMEA sentences.

- $GPGGA
- $GPRMC
- $GPGSA

The $GPGGA string looks like this:

```
N0KKZ-3>GPSPO:$GPGGA,164733,4030.621,N,10423.588,W,1,08,1.0,17640.3,M,46.9,M,,*52
```

This string breaks out as:

- 16:47:33 UTC time
- 40° 30.621' North Latitude
- 104° 23.588' West Longitude
- 1 = fix quality and represents a GPS Fix
- 08 = Number of satellites tracked
- = Horizontal dilution of position
- 17640.3 = Altitude in meters
- 46.9,M = Height of geoid (mean sea level) above WGS84 ellipsoid
- (empty field) = time in seconds since last DGPS update
- (empty field) = DGPS station ID number
- *52 = mandatory checksum (this is calculated in case any programs verify the checksum)

The $GPRMC String looks like this:

```
N0KKZ-3>GPSPO:$GPRMC,164733,A,4030.621,N,10423.588,W,018.4,084.0,230101,010.5,E*67
```

This string breaks out as:

- 16:47:33 UTC time
- A = Navigation receiver warning A = OK, V = warning
- 40° 30.621' North Latitude
- 104° 23.588' West Longitude
- 018.4 = Speed over ground, Knots
- 084.0 = Course Made Good, True
- 230101 = Date of fix 23 January 2001

- 010.5,E = Magnetic variation 10.5 deg East
- *67 = mandatory checksum (this is calculated in case any programs verify the checksum)

The $GPGSA string, which is used to report on the data used by the GPS receiver to determine its position fix looks like this:

```
N0KKZ-3>GPSPO:$GPGSA,A,3,04,05,,09,12,,,24,,,,,2.5,1.3,2.1*39
```

This string breaks out as:

- A=Automatic
- 3 = 3D position fix
- All the numbers out to but not including 2.5 represent the satellite identification numbers that the GPS receiver is currently receiving and tracking and using to create position information
- 2.5 = The value of DOP (dilution of precision)
- 1.3 = The value of Horizontal dilution of precision (HDOP)
- 2.1 = The value of Vertical dilution of precision (VDOP)

DOP is an indication of the effect of satellite geometry on the accuracy of the fix.

Each of the example GPS strings are “addressed” to the unproto (unconnected) callsign of GPSPO. This is insignificant. The program need only find a valid callsign in the “from” position of the packet, above that is N0KKZ-3. The program then scans along until it finds the first colon. Then it starts parsing out the contents of the packet. So, you could have a $GPGSA string that looked like this:

```
N0KKZ-3>APRS:$GPGSA,A,3,04,05,,09,12,,,24,,,,,2.5,1.3,2.1*39
```

And the program would ignore the APRS addressee and still correctly identify the string and parse out the information contained within it.

Appendix C -
Internet Weather Data Sources

Importing Data (from the net)

There are several formats of winds aloft data out there. Naturally, you can only import data in a format that Balloon Track recognizes. I've built several decoder/importers for this. You need only go to one of these web sites and save the plain text of the data. Then using the [File/Open] command from the main screen point to the file you saved. Balloon Track will examine the file to determine its format, and if it is one of those below, it will import the data into the program and save it to Balloon Track's regular data format.

If you have a reliable weather source and want decoders included for it, send me the URL and instructions and I'll see what I can do. I'm working up to decoding the raw (coded) rawinsonde stuff.

Current Data

University of Wyoming's WXP GRBSND

The format I first found and used on the web is generated by a suite of programs called Weather Processor. The specific program that generates a decoded text file of the RAOB upper air data is called GRBSND. Balloon Track can read these files. They are available at:

http://weather.uwyo.edu/upperair/sounding.html

An identically formatted file is also available at:

http://www.stormchaser.niu.edu/machine/textsound.html

http://www.stormchaser.niu.edu/machine/textfcstsound.html

Unisys

Unisys provides access to the current upper air soundings using GRBSND. Go to:

http://weather.unisys.com/upper_air/skew/

Select the upper air reporting station from the map.

When the upper air data appears look for a link to TEXT in the menus at the top of the window. Click it and the decoded plain text data will be displayed. Save it as a text file.

Florida State University Program

A new source (and format) was recently provided to me at:

http://www.met.fsu.edu/CUDOS/cgi/ezuacode.html

The formatting is different from the above files, but all the data is there to 10 millibars so you should be able to get good predictions from this data.

Forecast Data

There are several models out there that will predict what the winds will look like at some time in the future. The windows of these models are from hours to days (up to 11 days). This type of data is very useful in the week prior to flight. You can start running real predictions for the actual flight day rather than just plot out the current winds aloft track prediction. There are a couple of sources.

National Weather Service

Winds and Temperatures Aloft (FD)

The most generic form and least helpful but a good addition is the NWS winds aloft forecast for Pilots. A good source for this file is located at:

http://www.awc-kc.noaa.gov/awc/awc-fd.html

This is the only "tricky" format and will require a little user intervention. Balloon Track will handle recognition of the file type, but when this format is being imported you need to specify which of the many reporting stations in the file you wish to be imported. See "File/Open Blender" for the details.

National Oceanic & Atmospheric Administration (NOAA)

Real-time Environmental Applications and Display sYstem (READY)

http://www.arl.noaa.gov/ready/cmet.html

Go to the above web site.

On the first page enter your location. If you know the WMO code for the nearest winds aloft station enter that. If you don't know this code, enter the latitude and longitude of your launch site. The site will automatically select the closest location.

On the next page are links to numerous products. You want, naturally, "Forecast Soundings". When you click on the down arrow in the selection box an number of forecast products are available.

I recommend you look at each one to determine the window of time they cover. Use whichever product just barely covers your launch date. For instance, if you are launching it two days, pick the product that only forecasts that far into the future. It will be more accurate than a product that deals in longer range forecasts.

The GFS model offers several different windows into the future. The longest is from 192 hours to 384 hours into the future (16 days!). Use one of these until you get within 288 hours of lift off. Then either switch to one of the shorter range GFS models or go on to the next model below.

The "Medium Range Forecast Model(MRF 191 km Global) will forecast into the future 288 hours(12 days). Use this one until you get within 3.5 days.

Then switch to the "Aviation Model (AVN 191 km over global). Use this model until you get to within 48 hours of launch.

Then switch to the "ETA Model (40 km Over US). Use this model until you are within 12 hours of launch.

The nested grid model also forecasts up to 48 hours into the future.

Then switch to the "Rapid Update Cycle (RUC 20 km over US). This model will take you right up to launch.

Some models only forecast winds to a maximum altitude in the 60K feet range. I would recommend you obtain actual winds aloft for your current time and add them to the "top" of the data for a pretty accurate prediction as those winds do not change much over the space of a few days. You can do this by using the [File/Open Blended] option as described in Basic Operations. However, this is only a general "rule". You may find that those winds do indeed change significantly so, just watch them closely if you are mixing real-time data with forecast data and be aware of any significant fluctuations in the high level winds. If they are moving around daily, you may want to take that into account.

Appendix D - Export Formats

Balloon Track for Windows can export to several different formats. These export files can be generated from the Main Window menu selection [File/Export]

APRS

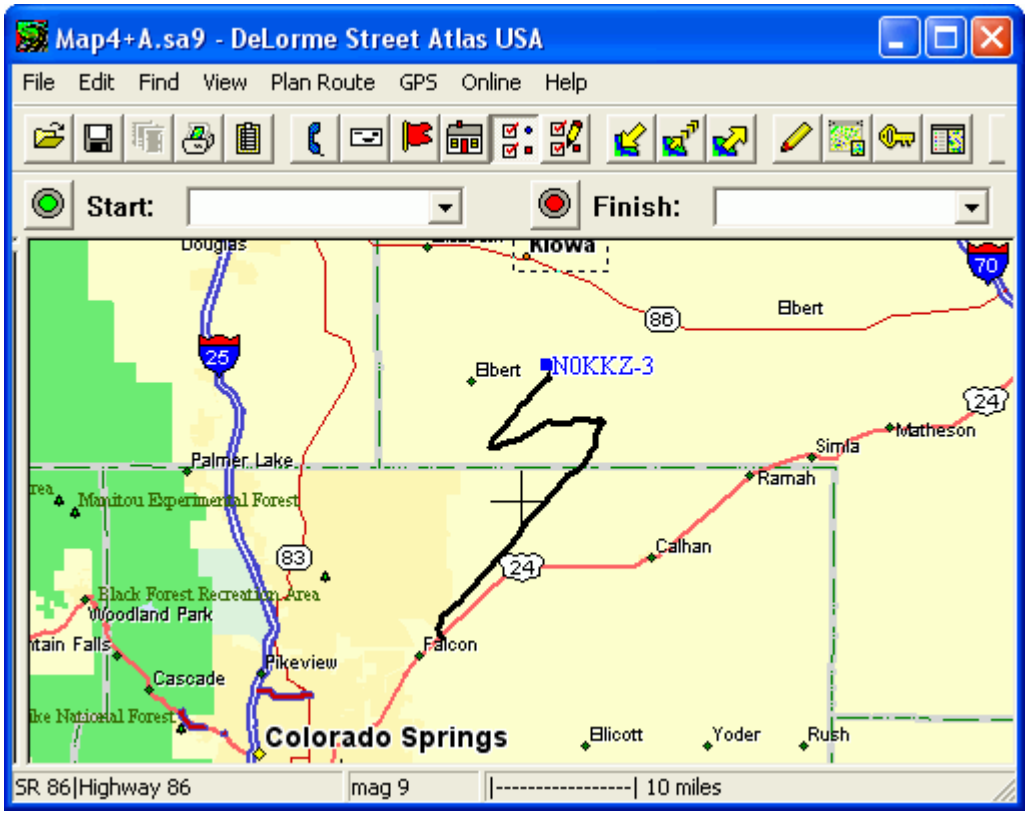
Selecting [File/Export/APRS] displays this dialog box.

The program will use whatever callsign you entered on the Setup screen (folders tab). However, you may change it to whatever you wish.

You can select the default Balloon Icon, or you can enter any icon number manually. For a description of all the symbols available check out the web page:

http://www.aprs.net/vm/DOS/SYMBOLS.HTM

In this example, I've exported the predicted track of the balloon (same data as used elsewhere in this manual) to an APRS file and loaded that file into APRS+SA by Brent Hildebrand. That program then produces this map in Delorme's Street Atlas:



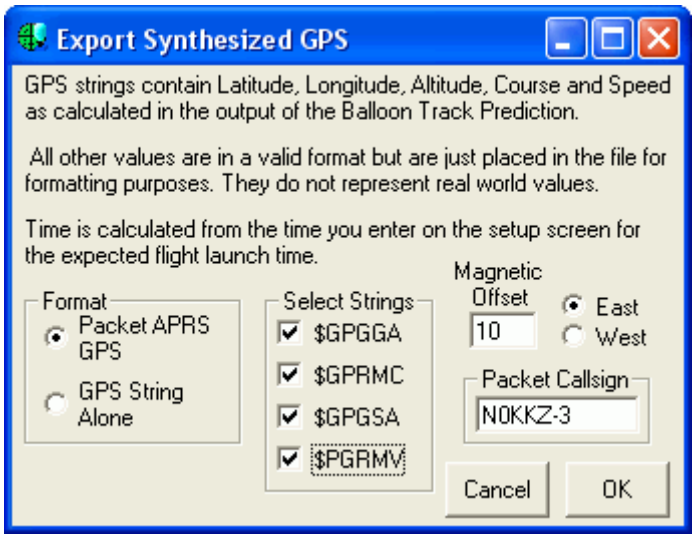
Comma Delimited

No dialog box opens other than the [File/SaveAs] box. The resulting file will contain the following data:

- Time UTC
- ElapsedTime
- Altitude(ft.)
- Course(true)
- Speed(knots)
- Bearing
- Range(mi.)
- Elevation
- Climb/Descent Rate(fpm)
- Latitude
- Longitude
- Footprint Radius(mi.)
- GridX(mi.)
- GridY(mi.)

Synthesized GPS Strings

Balloon Track for Windows can create "fake" GPS strings. By selecting [File/Export/GPS File] this dialog box will appear:



If you select the "Packet APRS GPS" format a callsign and UI path will be added to the beginning of each GPS string. If you select "GPS String Alone" the resulting file looks just like it came out of a NMEA capable GPS device. The $GPRMC string includes magnetic variation. So, to get it right, you'll need to manually enter it on this dialog box and specify if it is a west or east offset.

As on the APRS export dialog box, a packet callsign is suggested. It is the same one that you entered on the Folders tab of the setup screen. You may change it if you wish.

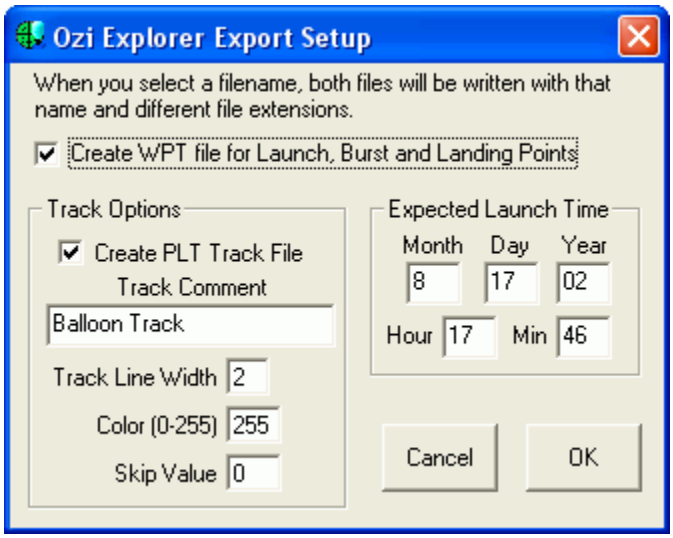
And you need to specify which strings you want to export. The strings are fully compliant with NMEA standards. The $GPGGA, $GPRMC and $PGRMV strings contain data about the predicted flight path as computed by the program.

The $PGRMV string is a Garmin proprietary format. It shows meters per second movement in three axes.

The $GPGSA string is completely fabricated, but if you use this string in telemetry, having it included may be of help. The program has 10 strings that contain various possibilities for a GSA string. These strings are picked at random for inclusion in the output file.

Ozi Explorer

By selecting [File/Export/Ozi Explorer] this dialog box will appear:

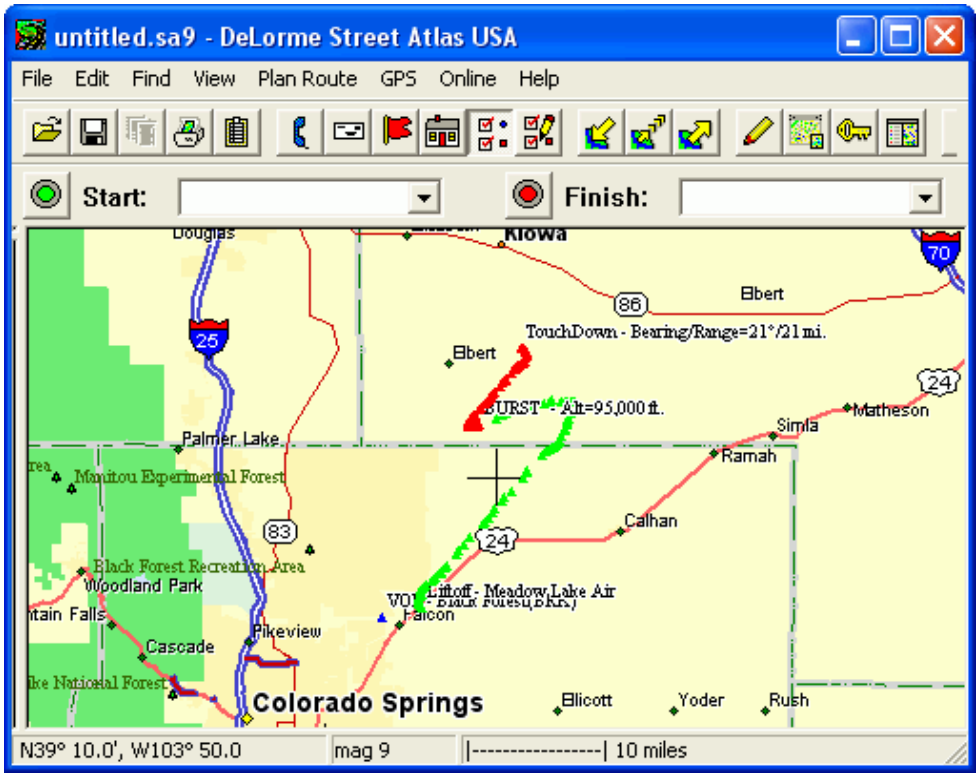


I don't have this program, but, I'm told I got the export routines right.

Delorme Street Atlas

By selecting [File/Export/Street Atlas] this dialog box will appear:

You can select an Icon shape and size, indicate what colors to use for the ascent and descent phases of the flight (white is always used for the float phase if a float is active). If you select one of the plot labels, the data will appear beside each and every plotted point on the map. This can be helpful, but mostly it makes for a totally cluttered display. If you do not select any Plot Labels then the program will label the liftoff, burst and landing points only as shown below:



Appendix E - Scanned Maps

Scanned maps may not be the best name for this option as you can import any graphic image, whether it's a scan, a digital picture or a screen capture of a map on the net.

Before doing anything else you need to obtain a map upon which you can plot. For this example, I've done a screen capture from Delorme's Street Atlas.

Here's a tip. Open some mapping source, web page, mapping program and while that screen is active, hold down the ALT key and press Print Scr. Only that window will be copied to the clip board.

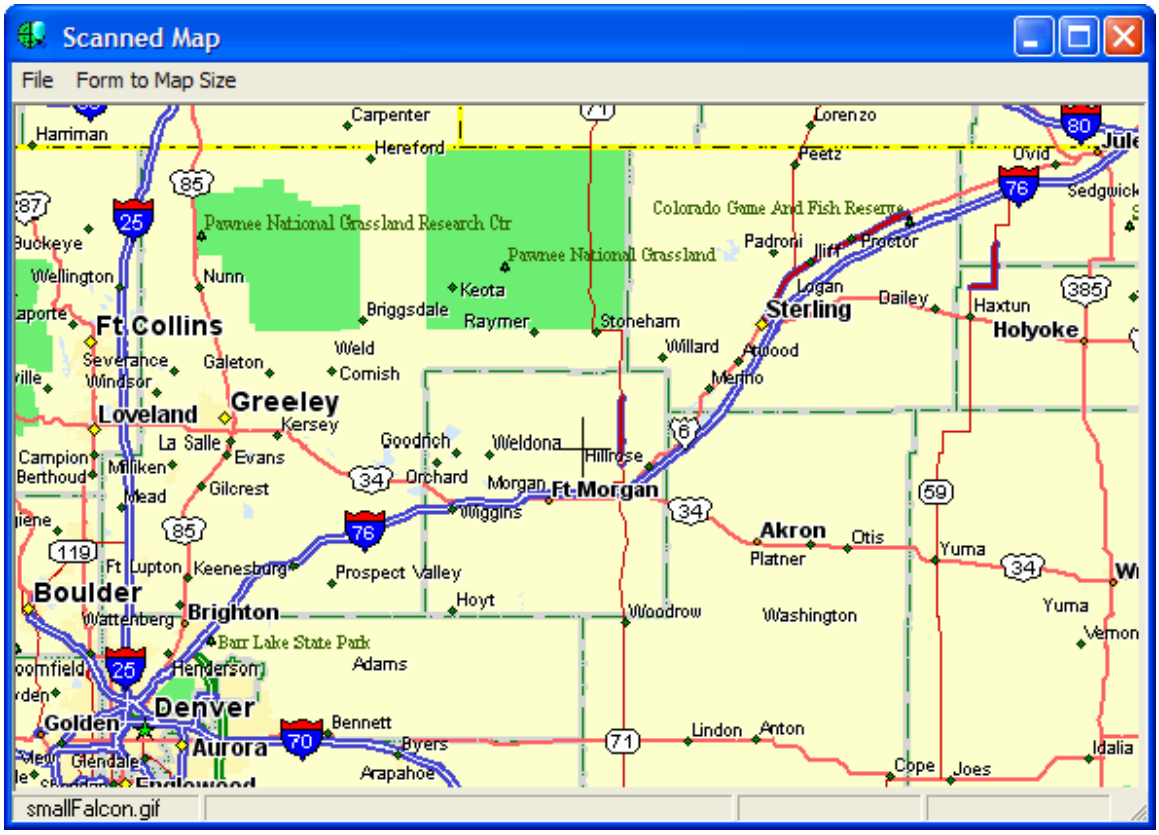
Next, you need to get that graphic into a file. Use your favorite image editor. If you don't have one then use Paint Brush (or Paint), it comes with every version of Windows and is found under [Start/Programs/Accessories]. Open that editor, select new file (many programs will automatically suggest a picture with dimensions the same as those of the image stored in your clip board. When that new file opens, click [Edit/Paste]. Now you have a graphic of that map you just screen captured. Use the cropping tool to remove all the extraneous information (Title bar, Menu, Status bar, window frame). Then, just save the picture as a JPG, GIF or BMP. Might as well use JPG or GIF and save some disk space.

Now, copy or move that picture into the home folder of Balloon Track for Windows, usually "C:\Program Files\Balloon Track\Balloon Track".

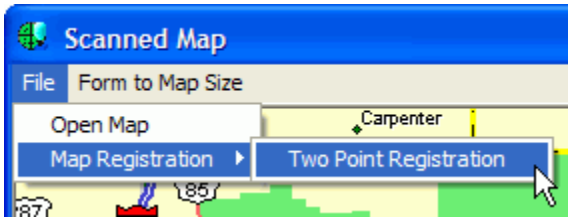
Now you are set to use this map in Balloon Track.

When you first click on the Scan Map button a blank screen will appear with a menu. Click [File/Open] and select the file you wish to use. Once you have selected a map, it will open each subsequent time you start the scan map screen.

I've opened a map of northeastern Colorado:



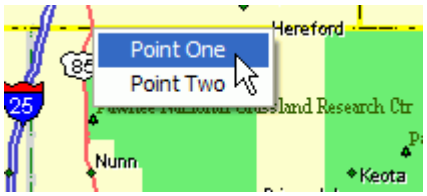
Now you have a pretty picture opened with Balloon Track but the program hasn't got a clue how to use it.



You need to register the map. So click on [File/Map Registration/Two Point Registration].

Now you must identify two points, preferably in opposite corners of the map where you will identify the latitude and longitude of those locations:

Move the cursor over the map and pick a distinctive location. Right click on it and the following popup menu appears. Click on the correct point.



Above I've selected the point in the North West corner of the map where Highway 85 crosses the border between Colorado and Wyoming. Note that the upper left corner of the popup menu "points" to this location. When I click "Point One" the program displays this dialog:

Enter the latitude and longitude for that point.

Next select a point in the opposite corner of the map. Because of screen capture limitations I couldn't really select the spot I would have used in real life, the intersection of 59 and 71 in the south east corner of the map, but I did want to show a nice graphic of the highlighting of "Point Two".

You know what to do, click and the Latitude Longitude entry screen pops up. Enter that info and you are all set. Balloon Track for Windows will create a file in the same folder as the map with the same filename. However the file extension will be .DAT. This file will contain the information

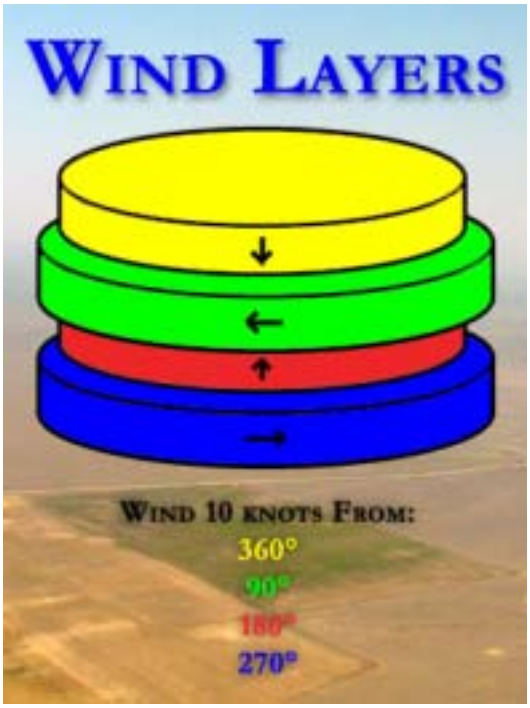
about these registration points. Next time you open this map, it will remember its settings and be pre-registered.

Now, just run a prediction and it will appear on the map.

Appendix F - How it Works

Balloon Track for Windows uses the winds aloft data to predict where a balloon will land after a flight. But, how does it work.

The concept is quite simple. The atmosphere is layered with winds moving in different directions at different speeds. For a simple example let's suppose the following:



In our imaginary atmosphere there are only 4 layers of wind.

The blue layer extends from the surface to 20,000 feet above sea level (ASL). In this layer the wind is coming from the west moving at 10 knots.

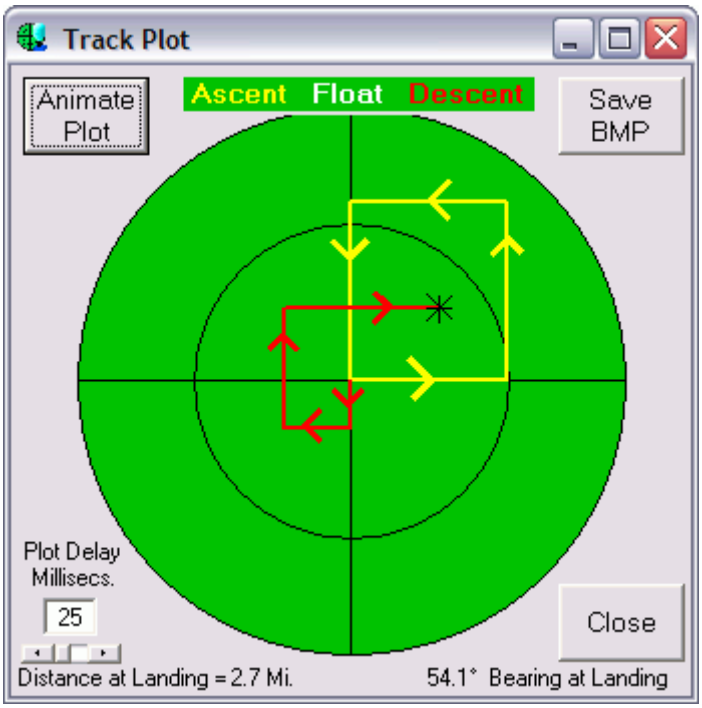
The red layer extends from 20,000 to 40,000 feet. The winds are coming from the south at 10 knots.

The green layer winds extend from 40,000 to 60,000 feet with the winds coming from the east at 10 knots.

And finally, the yellow layer extends from 60,000 to 80,000 feet with the winds coming from the north at 10 knots.

Balloon Track for Windows requires you input an ascent rate and a descent rate. For this example, we'll use an ascent rate of 1000 feet per minute and a descent rate of 1000 feet per minute. With this information combined with knowledge of the winds in those 4 layers it's a simple process to calculate where the balloon will land.

Here is the data Balloon Track for Windows generates:



Time	Alt	Bear Deg	Rng Mi.	EL. Deg	Vertical FPM	Latitude	Longitude	Dist. to LOS	Bearing Mag	Range NM	VOR ID
13:00:03	51	90	1	45	1000	40.4737	-104.9633	10	253	19	GLL
13:20:00	20000	90	4	45	1000	40.4736	-104.8905	190	251	16	GLL
13:40:00	40000	45	5	54	1000	40.5292	-104.8904	269	264	16	GLL
14:00:00	60000	360	4	71	1000	40.5292	-104.9635	330	263	19	GLL
14:20:00	80000	270	1	90	1000	40.4737	-104.9635	380	253	19	GLL
14:25:21	60000	180	1	85	3743	40.4588	-104.9635	330	250	19	GLL
14:33:58	40000	238	2	76	2320	40.4588	-104.9950	269	251	21	GLL
14:47:32	20000	314	2	59	1474	40.4965	-104.9950	190	257	20	GLL
15:07:32	1	54	3	-1	1000	40.4965	-104.9219	1	257	17	GLL

As you can see in the plot above, the balloon takes off from the center of the graph and heads east. Since the balloon is ascending at a rate of 1000 feet per minute, it takes 20 minutes to ascend to 20,000 feet. For the first 20 minutes the balloon is traveling east at a rate of 10 Knots. This means that the balloon will have traveled 3.333 nautical miles or 3.835 statute miles. The program rounds this off (in this printout only) to show the balloon at a bearing of 90° from the launch site at a distance of 4 statute miles. Then it travels 3.835 statute miles north, then the same distance west and the same distance south to arrive back at the launch point. But now it is at an altitude of

80,000 feet and the angle of elevation from the launch site to the balloon is 90° or looking straight up.

But, why isn't the descent path the same square shape and why doesn't the balloon return directly to the launch point.

Take a look at the descent rates in the data above. Although the payload system is estimated to descend at a rate of 1000 feet per minute at sea level, the actual descent rate in the rarefied upper atmosphere is much faster. With little atmospheric pressure for the parachute to work against, the payload descends at a very fast initial velocity. As the payload system descends to lower altitudes the atmospheric pressure increases and the descent rate decreases.

The payload system descends the first 20,000 feet from 80,000 feet to 60,000 feet and only travels 1 mile south of the launch site. When the payload turns west at 60,000 feet its descent rate has slowed somewhat and it travels further on this leg. Likewise with each subsequent layer of the atmosphere, the descent rate decreases and thus taking a longer amount of time to traverse the layer which gives the winds more time to move the payload a greater distance.

In reality things are much more complex. There are no discrete boundaries in the atmosphere. The winds in each layer not only move laterally they also have a vertical movement component. Because of this, no prediction made with Balloon Track for Windows can be really exact. However, a reasonably accurate prediction is possible with the program.