Aero Experiments

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Using a GPS in soaring flight

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1) Introduction

This article is primarily aimed at conveying some useful techniques I've developed while using a handheld-style GPS unit during flight in hang gliders, sailplanes, and airplanes. The focus will mainly be on soaring flight, but some items will also be relevant to powered flight. At times I'll use some particular Garmin GPS's as examples, solely because these happen to be the GPS units that I'm most familiar with.

For brevity we'll use the term "GPS" in this article to refer to the entire GPS receiver unit with the associated display screen, etc.

2) Using the map screen for cross-country flying, thermalling, and more

When a GPS's map screen is zoomed in far enough that individual thermalling circles are visible, this is quite valuable for judging wind speed and wind direction. For hang gliding, I find that the "300 foot" scale works well for this purpose. After several consecutive thermalling circles, the wind direction will be immediately obvious by the drift in the thermalling circles, and the wind speed can be judged by the degree to which the individual thermalling circles overlap. I find that by glancing at my GPS's map screen while thermalling, I can estimate the wind direction much faster and much more accurately than can my GPS-interfaced variometer, which only estimates the wind direction to the nearest 30 degrees, and sometimes suffers from errors of greater than 30 degrees, especially when I choose to fly without an airspeed probe. Especially in light winds, it's quite interesting how strongly and suddenly the wind direction can change with altitude during the course of a thermal climb. This will often be difficulty to detect purely from visual references, especially at high altitude. Judging the wind direction by glancing at the moving map screen of my GPS, with the scale zoomed in far enough to show the direction of the drift in the "breadcrumb" trail, is actually the number one way that I use my GPS in soaring flight.

When a pilot is in a thermal, he should not look too much at the GPS; he should instead concentrate almost entirely on the feel of the glider and the sensations of G-loading and the sound of the variometer. However, when a thermal is lost, it can often be found by flying upwind. This makes sense: the thermal column is tilted, and the glider has a downward velocity--the glider's inherent sink rate--in relation to the rising air in the thermal. If the glider flies uniform 360-degree turns with no wind correction, the glider often will eventually sink down through the slanted, downwind wall of the thermal. If the thermal is not found upwind, then the pilot may find it productive to keep an eye on the GPS map screen while setting up a brief search pattern (which may be as simple as a single wider circle), keeping in mind that the thermal will be drifting with the wind. Also, a new thermal can often be found by flying upwind along a line that exactly follows the drifting track of the earlier thermal, especially in situations where thermals are originating from well-defined sources or trigger areas.

I prefer to use the moving map screen in the "north up" mode rather than the "track up" mode. In the "track up" mode it is difficult to quickly judge which direction is north, which also makes it difficult to quickly estimate the direction of thermal drift. In "track up" mode there are also delays associated with the need to frequently redraw the map while circling. However, in the "north up" mode one sometimes does find oneself accidentally making course corrections in the wrong direction when flying southwards. This tendency will decrease with practice.

In a ridge-soaring situation, or during straight-line gliding or powered flight in air that is not too turbulent, the most accurate way to judge the wind direction is to let the aircraft fly exactly at trim in a very shallow bank, starting on a heading that will allow the nose to slowly pass through the estimated upwind direction. As the aircraft's heading slowly changes, note the precise direction of travel that yields the lowest ground speed. At this point the aircraft is travelling directly upwind. I often go through this procedure when flying in ridge lift or wave. Using the GPS to find the wind direction in this manner is especially helpful when searching for wave lift several miles downwind of a single mountain peak on a cloudless day. Since the wave will be confined to a narrow band extending directly downwind from the peak, and since the wave will not be present everywhere within this narrow band, it's very important to know the exact wind direction in this situation so that the search can remain focussed in the right area. To estimate the wind speed as well as the wind direction, at the point where the aircraft is travelling directly upwind, i.e. on the heading that yields the lowest groundspeed, the pilot should subtract the groundspeed from the measured, calculated, or estimated true airspeed. (Note that the flywheel airspeed probes commonly used by hang glider pilots measure true airspeed, while pitot tubes measure indicated airspeed. At high altitude, indicated airspeed is significantly lower than true airspeed.) For a more accurate estimate of windspeed, after finding the direction from which the wind is blowing, the pilot can then make a 180-degree turn and note the groundspeed while travelling in the reciprocal direction, which would be directly downwind. By subtracting the groundspeed obtained while travelling upwind from the groundspeed obtained while travelling downwind, and then dividing the result by 2, the wind speed can be determined, without any need to calculate or measure the true airspeed. Of course, in many soaring situations it's not really practical to spend much time flying in the downwind direction; the situation where I most frequently go through this procedure is when scouting for wave lift in a light airplane. This upwind-versus-downwind comparison technique can also be carried out during a series of steady 360-degree circles (e.g. when a glider is circling in a thermal), but with less accuracy, because the GPS might not happen to update the groundspeed display at the precise moments that the aircraft is pointing directly upwind or directly downwind. For all these techniques, a numerical readout of "speed" (groundspeed) is essential, and a numerical readout of “heading” (current direction of travel over the ground) is very helpful. Also, a pilot should know how to quickly calculate reciprocal azimuths in flight: add “2” to the “hundreds” digit of the original figure and then subtract “2” from the “tens” digit of the original figure. If that will yield a result greater than 360, then go back to the original figure and add “2” to the “tens” digit, and then subtract “2” from the “hundreds” digit. Example: if the original figure is 191, adding “2” to the tens digit yields 211, and then subtracting “2” from the hundreds digit yields 011. Pilots who have trouble with this at altitude are probably hypoxic, and should descend immediately!

When lift is stationary and the ground is distant--e.g. in wave--it is extremely valuable to mark waypoints wherever the lift is good, so that these places may be returned to easily even though there are no good nearby visual references. In the future, this real-time lift-mapping function will undoubtedly be automated on some of the more exotic variometer-GPS combinations, and perhaps this is already available. Of course, during a prolonged flight in a small area of ridge lift or wave, the “breadcrumb trail” or track line tends to build up quite heavily in the areas where the lift is good, which provides sort of a primitive automatic lift-mapping function, even if the user doesn’t go to the trouble of actually marking any waypoints in these areas.

It’s handy to have a large number of numerical display windows (plus the “navigation status” window) on the moving map screen of the GPS. We’ve already described ways that a pilot might use numerical displays of “speed” (groundspeed) and “heading” (current direction of travel over the ground) to judge the wind direction. Two other items that are very useful for soaring flight, and are also handy for planning long descents in a light plane, are the “current glide ratio” and “glide ratio to destination”. Two other items of interest are the “distance” to the destination waypoint, and the “bearing” to the destination waypoint (although this is also indicated graphically by the “bearing” line on the map screen, if present.) I configure my Garmin GPSmap 76S to display all 6 of these numerical data fields on the map screen, and I find this set-up to be ideal both for soaring flight in hang gliders and sailplanes, and for cross-country flight in a light airplane. The Garmin GPSmap 76S is a bit unusual in this respect—its large display screen and small numerical data fields allow the user to display a large number of numerical data fields on the map screen, while still leaving plenty of screen area for the map display itself. In fact, as many as 9 numerical data fields can be displayed on the map screen of the GPSmap 76S, while still leaving a reasonable amount of screen area for the actual map display. Most other GPS’s, including the newer GPSmap 76C/Cx/CS/CSx, are less capable in this regard. For more on this, see the related articles on this website entitled “More on the Garmin GPSmap 76S” and “Map screen size comparison of some handheld Garmin GPS units with numerical data fields enabled.”

I’ve noticed that many hang glider and paraglider pilots prefer to set their GPS’s to the compass-like display screen for cross-country flight. Perhaps they feel that this presentation is simpler to interpret than the map display screen. I find the map screen to be much more useful than any other screen. When optimally configured, the map screen contains all the information that is present on the compass-like display screen, and more.

I always set up the map screen of my GPS to include a “bearing” line which represents the direction to the target waypoint. The orientation of the little triangle-shaped “current position” icon represents the current ‘heading”, or when the magnetic compass function is disabled (as it always should be during flight), the current direction of travel over the ground. By aligning the tip of the “current position” icon with the “bearing” line, I can ensure that I am travelling directly toward the target waypoint, with the nose pointing at the correct “crab” angle, so that I maximize my velocity-made-good in the intended direction. This technique of aligning the map screen’s “heading” line (or the tip of the triangle-shaped “current position” icon) with the “bearing” line to the target waypoint is especially useful during flight at high altitudes, where there is little sense of relative motion over the ground and a pilot might otherwise be tempted to simply point the aircraft’s nose directly at the target waypoint. This technique is also especially useful during flight over a cloud deck, or at night, in a powered airplane.

3) Notes on "heading", "track", "bearing", and "course"

The terms "heading", "track", "bearing", and "course" are used in ways that vary from one GPS manufacturer to the next, and in some cases, from one model of GPS to the next. Be sure to understand exactly what these displays show on your own GPS unit.

It is important that GPS users understand that in the absence of a magnetic compass sensor, a GPS unit has no way of knowing the exact direction that the nose of the aircraft, or the nose of the GPS unit, is pointing. The satellite-derived GPS data only reveals the direction of travel over the ground. This can be quite different from the actual heading of the aircraft, especially in ridge-soaring situations.

If a particular GPS unit does include a magnetic compass sensor, it should be switched off before flight, because it is subject to the same banking-related errors that a conventional wet compass is subject to. Leaving the magnetic compass sensor switched on during flight will cause the GPS's "heading" displays to behave very erratically during turns. I've confirmed this to be true first-hand with in-flight experiments involving the Garmin Etrex Vista, Garmin GPSmap 76S, and Magellan Meridian Platinum GPS units. See the related article on this website entitled "Compass errors in flight" for more on this. Sometimes the magnetic compass sensor's on/off status is controlled by a set of interlocking speed and distance parameters. Do whatever is necessary to ensure that your GPS's magnetic compass sensor stays off in flight, even if your groundspeed happens to drop near zero momentarily. A GPS-driven heading display will naturally behave erratically whenever the groundspeed approaches zero, but in the context of a vehicle that turns by banking, the situation becomes even worse if the heading display is switching back forth between being driven from the GPS satellites and being driven from the magnetic compass sensor, or if the heading display is being driven entirely from the magnetic compass sensor. For notes on how to ensure that the magnetic compass display of the Garmin GPSmap 76S/CS/CSx or the Etrex Vista/Vista C/Cx remains switched off in flight, see the related articles on this website entitled "More on the Garmin GPSmap 76S" and "More on the Garmin Etrex Vista".

Nearly all GPS's do have a compass-like heading display screen, and the value displayed on the screen is usually called the "heading", but when the magnetic compass sensor is absent or inactive, this "heading" value actually reflects the direction of travel over the ground. Properly speaking this really ought not be called the "heading", but in this article we'll follow the convention of many GPS manufacturers and use the word "heading" to describe the direction of travel over the ground, at least in all cases where the magnetic compass sensor is inactive or absent. Since we'll also assume that the magnetic compass sensor is absent or inactive, for our purposes the term "heading" will mean the direction of travel over the ground.

Occasionally a GPS manufacturer will use the word "track" is used instead of the word "heading" to describe the direction of travel over the ground. Another suitable term for the direction of travel over the ground might perhaps be "course", but many GPS manufacturers use the word "course" to mean something entirely different, which we'll explore in more detail below.

Most GPS manufacturers use the word "bearing" to mean the direction to the target waypoint at any given moment, and we're following that convention in this article.

In virtually all soaring applications, the concept of a defined "course" line is meaningless. In my own flying, even in powered airplanes, when I want to fly toward a target waypoint, I generally want to take the most direct path from my present location, rather than returning to some pre-defined "course" line. Therefore I almost never allow my GPS to display any information relating to the "course", either as numerical data field or as a graphic display on the map screen or on the compass-like screen. But for clarity, we'll take a moment to define the concept of a "course" line, as used by the manufacturer in the context of the GPS units that I'm most familiar with (Garmin GPSmap 76 series and Etrex series.) At the moment that a "goto" function is activated on one of these GPS units, a "course" line is created, which is a fixed line in space, extending from the aircraft's location at that moment, to the target waypoint. As the aircraft continues to fly, the "bearing" to the target waypoint may change, but the "course" line remains fixed in place over the ground. If one of the numerical data fields has been configured to display the azimuth of the "course" line, this number will remain constant, until the navigation to the waypoint is discontinued or re-started with the same waypoint or with a different waypoint, at which point a new, fixed, "course" line will be created. On most GPS units (including the GPSmap 76C/Cx/CS/CSx) , the user must choose to display either a "bearing" line or a "course" line on the map screen; the GPSmap 76S is somewhat unusual in that can be configured to display both a "bearing" line and a "course" line on the map screen if the user wishes. On many GPS units the "distance off course" is one of the values that can be displayed in a numerical field or as part of a HSI-style display. Here are some examples of situations where a pilot of a powered aircraft may be interested in returning to a defined "course" line rather than simply aligning the current direction of travel over the ground with the bearing to the target waypoint: when flying at low altitude through mountainous areas, or when trying to stay in visual contact with a particular set of pre-selected checkpoints, or when flying along defined airways, or when flying instrument approaches. There is one specialized soaring application where I sometimes do use a "course" line: when I'm searching for wave lift behind a solitary mountain peak, I find it helpful to create a fixed reference line on the screen of my GPS that starts at the mountain peak and extends in the downwind direction. The best way to do this is to create a distant waypoint in the downwind direction and create a "route" that goes from this distant waypoint to the mountain peak. An alternate way to do this is to set the GPS map screen to show a "course" line rather than a "bearing" line, and activate a "goto" function at some moment when the aircraft lies directly downwind of, and preferably is rather distant from, the mountain peak. Either of these procedures will draw a fixed reference line on the map screen of the GPS.

4) "Current glide ratio" and "glide ratio to destination"

Some GPS's with barometric altimeters (pressure sensors) include "current glide ratio" and "glide ratio to destination" displays. These functions are quite useful. By comparing these two numbers, one can get a sense of whether the glider will reach the target with altitude to spare, or will not have enough altitude to reach the target.

The "current glide ratio" display on the pressure-sensor-equipped GPS's that I'm familiar with—namely the Garmin GPSmap 76S/CS/CSx, GPSmap 60CS/CSx, and Etrex Vista/Vista C/CX --is extremely responsive. This is a mixed blessing. In very smooth air, the effects of a change in airspeed can be seen almost instantly, after waiting just a few seconds for the aircraft's sink rate to stabilize. In turbulent air the display is so "twitchy" that it is not really very useful for fine-tuning the pilot's choice of speed-to-fly. It would be nice if the user could select for the "current glide ratio display" to be averaged over a slightly longer time interval on these GPS's, so that it would function more like the digital "current glide ratio" display on some GPS-compatible variometers like the Brauniger IQ Comp GPS. This would make the "current glide ratio" display slightly more useable for fine-tuning the pilot's choice of speed-to-fly. However, even in turbulent air, and even given the "twitchiness" in the "current glide ratio" displays of the GPS units mentioned above, a rough comparison of the "current glide ratio" with the "glide ratio to destination" will give a good idea of whether or not the glider is currently on a glide path that will reach the target destination with altitude to spare or fall short of the target destination, assuming that the current atmospheric conditions continue all the way to the target.

A "glide ratio to destination" display is always intrinsically much more stable than a "current glide ratio" display, because the "glide ratio to destination" function depends only on the glider's position in space relative to the target, not on the glider's horizontal and vertical velocities. The "glide ratio to destination" display is not dependent upon an accurate measurement of the glider's vertical speed at any given moment. An updraft or downdraft can produce a very large, immediate change in the "current glide ratio", but will only produce a gradual change in the "glide ratio to destination."

A long-term trend in the "glide ratio to destination" function gives a pilot some useful information. For example, in a sailplane, if a pilot sees the “glide ratio to destination” slowly scroll from “30” down to “25” over the course of several minutes, this indicates that the glider will overfly the target with altitude to spare, assuming that the current atmospheric conditions continue all the way to the target. Conversely, if the pilot sees the “glide ratio to destination” slowly scroll from “30” up to “35” over the course of several minutes, this indicates that the glider will run out of altitude before reaching the target, assuming that the current atmospheric conditions continue all the way to the target. For hang gliding and paragliding applications where glide ratios are often below 10:1 and can even drop to 5:1 or less when a strong headwind is present, a “tenths” digit in the “glide ratio to destination” display is very useful for helping a pilot to detect slow trends in the “glide ratio to destination” display. For example, if over a period of several minutes, the “glide ratio to destination” figure slowly scrolls from "4.8" to "4.7" to "4.6", this lets the pilot know that he will overfly the target with altitude to spare, assuming that the current atmospheric conditions continue all the way to the target. On the other hand, if over a period of several minutes, the “glide ratio to destination” figure slowly scrolls from "4.7" to "4.8" to "4.9", this lets the pilot know that he will not be able to reach the target, if the current atmospheric conditions continue all the way to the target. For hang gliding and paragliding applications, a “glide ratio to destination” display is significantly more useful if it has a “tenths” digit, than if it does not.

The “glide ratio to destination” display on the pressure-sensor-equipped GPS’s that I’m familiar with—namely the Garmin GPS units listed above--does not include a “tenths” digit. Perhaps in a future software update for these GPS units, Garmin will create a “tenths” digit for the “glide ratio to destination” function, at least in cases where the glide ratio to target has dropped below 10:1. In fact this would be my number one suggestion to Garmin for improving the functionality of their GPS’s for hang gliding and paragliding applications. One GPS unit whose “glide ratio to destination” display does include a “tenths” digit is the MLR SP24 XC VL.

Pilots may occasionally encounter a rather peculiar problem with the “current glide ratio” function on handheld Garmin GPS’s with barometric pressure sensors-- if the satellite reception is poor, the “vertical speed” display will scroll to zero and the “current glide ratio” display will scroll to infinity. For more, see the related article on this website entitled “Notes on the glide ratio functions of some Garmin GPS receivers with pressure sensors.” For most soaring applications, the satellite reception is good enough that this problem is rarely encountered.

At first glance it may seem redundant for a pilot to fly with both a GPS-interfaced variometer with glide ratio displays, and a pressure-sensor-equipped GPS unit that has its own independent glide ratio displays. But in actual practice it often happens that there is no way to make the vario alone, or the GPS alone, simultaneously display a useable, well-damped “current glide ratio” display that is somewhat useable even in moderately turbulent air, as well as a “glide ratio to destination” display that includes a “tenths” digit. For example the Brauniger IQ Comp GPS vario that I use for hang gliding has a digital "current glide ratio" display that is averaged over a long enough time period that it is somewhat useable even in rough air, and has a digital "glide ratio to destination" display that includes a "tenths" digit. It would be great to be able to see both of these displays at the same time. However, with this vario, these two displays are never both visible at the same time—if the attached GPS is in “goto” mode toward a waypoint that is coded in a manner that the vario can recognize, then the digital “glide ratio to target” display is visible, and in all other situations, the digital “current glide ratio” display is visible. (See the related article on this website entitled "An expanded manual for the Brauniger IQ Comp GPS variometer" for much more.) Therefore I find it useful to also display one or both of “current glide ratio” and “glide ratio to destination” values on my GPS, even though neither of these displays function quite as well as the equivalent displays on my variometer. If my vario could simultaneously display both of these digital glide ratio values, I would most likely be flying with a simpler GPS with no pressure sensor, especially since I never use the accompanying magnetic compass sensor.

Some handheld Garmin GPS’s without barometric pressure sensors—including the 96/96C/196/296/396 aviation series, as well as some general-purpose units like the Etrex Legend C--now also feature “current glide ratio” and “glide ratio to destination” displays. I'm not familiar with how well these features work for use in paragliders, hang gliders, sailplanes, and light airplanes. These features would be ideally suited for use in a high-speed aircraft with a pressurized cockpit. In a low-speed aircraft, at any reasonable glide angle the descent rate will be quite low and will need to be measured quite accurately to produce a useable "current glide ratio" display, so I'm a bit skeptical that GPS-derived altitude data would be suitable for this application. On the other hand, the "glide ratio to destination" display will not be particularly sensitive to small altitude errors, at least so long as the destination is still some distance away.

5) Mounting a GPS for hang gliding, polarization issues, protecting the display face

I've made a mount that attaches to the right down tube of my hang glider and holds both my vario and GPS. I prefer to mount my instruments on the right down tube of my hang glider rather than on the base bar, and I prefer to place the long axis of the instruments parallel to the horizon rather than perpendicular to the horizon. I find the map display and compass-like heading display on the GPS to be more intuitive to use in this orientation than if the instruments were mounted on the down tube in a more upright position.

I always wear polarized sunglasses in flight, because they darken the sky, so that distant clouds in the haze near the horizon and nearby patches of mist that mark the beginnings of new cumulus clouds all become much more visible. However, LCD screens are polarized, and there are some orientations where they are not visible when viewed through polarized sunglasses. The LCD screen on my vario (a Brauniger IQ Comp GPS) happens to be polarized in an orientation that is about 45 degrees off from the polarization of the screen of my GPS (either a Garmin Etrex Vista or a Garmin GPSmap 76S). However, the vario is tolerant of quite a wide range of viewing angles, so it turns out to be practical to mount the vario and the GPS parallel to each other. When the instruments are mounted on the right down tube of my hang glider, with their long axes horizontal as described above, I find that I don't have any problem viewing either screen through polarized sunglasses. The exact orientation of the polarization of LCD screens in GPS and variometers varies from one manufacturer to the next, and also sometimes varies among the various product lines offered by a given manufacturer. Also, some LCD displays are only visible through polarized sunglasses when they are viewed at the optimal orientation that yields the minimum interference between the glasses and the display, and other LCD displays remain visible through a much wider range of viewing angles. Before purchasing an expensive instrument mount, or before finalizing the design of a home-made mount, pilots who fly with polarized sunglasses should definitely check that all the instruments are visible when the pilot and instruments are all positioned in realistic in-flight attitudes.

For protection against scratches, I always cover the LCD screen of my GPS with a piece of wide, transparent tape, which I replace every few months. This keeps the screen in like-new condition, though the tape does slightly detract from the visibility of the screen.

To mount my GPS's, I simply drill a hole through the battery cover and pass a 6-32 bolt through the hole, with the head of the bolt trapped inside the battery cover. (I use as single bolt with my Etrex Vista and 2 bolts with my GPSmap 76S.) I then pass the bolt through a hole in a piece of sheet metal on my home-made vario/GPS mount, and fasten the GPS in place with a wing nut on the other side of the piece of sheet metal. This arrangement relies heavily on the fastener that keeps the battery cover closed—if this fastener were to fail, the battery cover would stay attached to the mount and the rest of the GPS unit would fall from the aircraft. However, I've never had any trouble of this nature.

6) Naming waypoints

I generally prefer not to use the coding system that is recognizable by my Brauniger IQ-Comp GPS variometer (6 digits in total, consisting of 3 letters followed by three numbers, coding for the altitude of the waypoint to the nearest 10 feet, e.g. "DOG180".) By not allowing my variometer to recognize that my GPS is locked onto a target waypoint, I ensure that the vario will continue to show me my time-averaged climb rate and my current glide ratio, instead of my glide ratio to destination. The pros and cons of this setup are explored in more detail in a related article on this website entitled "An expanded manual for the Brauniger IQ Comp variometer."

Many pilots will undoubtedly want to use waypoints that are configured in a format that their GPS-compatible variometer can recognize. At first glance this can appear to present a problem in a when a pilot downloads a set of pre-selected "official" waypoints at a contest. If a given day's task only involves a few waypoints, it is no problem for the pilot to use his GPS to quickly create a set up "dummy" waypoints, coded in whatever format he prefers, that lie only a feet away from their "official" counterparts. He can then build a route from the "dummy" waypoints and take advantage of all the glide-to-destination-related features of his variometer. If the contest will feature the style of task that allows pilots to choose their own goals in flight, then a bit more advance preparation will be needed to convert all the possible "official" waypoints into appropriately coded "dummy" waypoints.

For my own recreational flying, to facilitate quickly finding waypoints corresponding to hang glider launch sites, hang glider landing sites, and airports, I always use the prefixes "Y-", "Z-", and "AP-" in the names of waypoints representing these features, respectively. This ensures that all the hang glider launch and landing sites will appear in one single consecutive block when I'm scrolling through an alphabetical list of waypoints. This greatly speeds the process of finding a waypoint in flight.

When I'm coding waypoints in this manner, I also use the last 3 digits of the waypoint name as a numerical code for elevation, to the nearest 10 feet (e.g. "Z-ANDS001" for a hang gliding landing site named "Andersons" located at 10' above sea level). Neither my GPS nor my variometer pay any attention to this coding system, but it's nice to be able to quickly see the elevation of a given waypoint at a glance, without needing to call up the detailed waypoint data page.

Here's a trick that I've found to be useful--when I'm creating a waypoint that I'll know I'll want to paste into a permanent waypoint file at a later date, I add a text name to the three-digit numerical name suggested by the GPS. (E.g. the GPS suggests "025" and I change the name to "025DOGZ".) Later, when I download the waypoint set from the GPS to my computer, I know that the waypoints that are coded with three numerical digits followed by text are the ones I should pick out, rename, and copy to my permanent waypoint files. All other waypoints are presumed to be either of no particular lasting interest, or already part of my permanent waypoint file. This helps me avoid accidentally accumulating a bunch of "junk" waypoints into my permanent waypoint files.

7) Giving a location in an emergency

In a well-reasoned article entitled "Using the GPS as a Safety Tool", Peter Gray has discussed the best way to transmit location information by radio in an emergency, such as when a paraglider or hang glider pilot is descending by parachute over rugged terrain. Poor radio reception, and in an international competition or flying safari situation, even language barriers may come into play in such a situation. The author points out that there are significant advantages to transmitting one's distance and bearing to a waypoint that is known to all the pilots in the area (e.g. "Pine Mountain Launch is 272 degrees true from me, and 6.7 miles") rather than transmitting one's latitude and longitude. These advantages include: a bearing-and-range location is easier to understand, remember, and conceptualize, because it contains many fewer consecutive numbers. There is no ambiguity about the map datum that is in use (this is a non-trivial factor in some parts of the world) or the latitude/longitude format (degrees and minutes and decimal minutes, or something else?) that is in use. However, the waypoint should be relatively nearby (within 10 miles or so if the pilot will descend into thick forest) or there will be significant ambiguity due to the fact that most GPS receivers only display bearings to the nearest degree.

Therefore, in emergency, using the "find nearest waypoint" to select a waypoint that is known to other pilots in the area, and transmitting a bearing and range to that waypoint, might be more appropriate than scrolling to a screen that gives lat/lon information. In a non-contest situation where pilots are not flying with a shared list of waypoints, a nearby hang glider/paraglider launch area or landing zone might be a good choice for a reference feature, as it would likely be entered on the GPS's of most pilots in the area. A nearby small town might be an even better choice. Once a pilot has transmitted bearing and range information to a known feature, it is easy for anyone else with a GPS that contains the known feature to use the "measure distance" function to create a new waypoint, representing the pilot's location, at the appropriate bearing and distance from the known waypoint. Keep in mind that an addition or subtraction of 180 degrees will be required to find the reciprocal of the bearing originally transmitted by the pilot in distress.

It would be a good idea for a pilot to include the word "true" when transmitting bearing information in this manner, to emphasize that he has not set his GPS to read in terms of magnetic degrees rather than true degrees.

Pilots who envision describing their position in an emergency by giving the bearing and distance to a waypoint should practice this method in advance. With some GPS's (e.g. the Garmin GPSmap 76CS or Etrex Vista), simply calling up a list of nearest waypoints and moving the cursor onto the desired waypoint is all that is needed to see the continually-updated bearing-and-range to that waypoint. This can be done very quickly. With other GPS's (e.g. the Garmin GPSmap 76S), to see the bearing and distance to a waypoint, the user will actually need to initiate a "goto" function toward that waypoint, and will need to have a numerical data field on the map screen (or elsewhere) configured to show "bearing", and will need to have a second numerical data field on the map screen (or elsewhere) configured to show "distance."

For non-emergency situations where good communications are available and a pencil and paper are handy and everyone is using the same datum, it may be simplest to communicate positions in terms of a latitude and longitude. All GPS users should familiarize themselves with how to create a waypoint to match a given latitude and longitude. One way to do this is to simply create a waypoint at the present location, and then change the latitude and longitude to match the desired values.

8) The GPS as an emergency cloud-flying aid

It is possible to use a GPS unit as an emergency cloud-flying aid in certain conditions with certain types of aircraft, though this practice is quite dangerous and success is not by any means assured. (In other words, you might not survive; this technique is for emergency use only.) The heading display screen (with the magnetic compass sensor turned off) often gives a pilot the best chance at quickly detecting a small change in heading, which indicates that the wings are no longer level. However, on many handheld GPS units, the heading display screen is only updated about once per second, which will make the heading display jump around very erratically once a slow-flying aircraft like a hang glider or paraglider has developed an appreciable bank angle, along with the associated high rate of change in heading. In this situation, the pilot has a better chance of determining the direction of turn by looking at the curving track on the map screen, zoomed in to a fine scale. While hang gliding, I sometimes carry 2 GPS's so that I can have both the map screen and the heading display screen available in case of an inadvertent entry into clouds. (The Garmin Etrex Venture is a compact, inexpensive choice for a second GPS to show the heading display.)

Note that in high-wind ridge-soaring situations where an aircraft's groundspeed may approach zero, or where the aircraft may drift backwards, a GPS's heading indicator will behave extremely erratically. (Recall again that if the magnetic compass sensor is turned off, as it should be for all flight applications, or if there is no magnetic compass sensor, all the "heading"-related displays will actually show the aircraft's current path of travel over the ground.) If a pilot wants to get useable heading guidance from his GPS in this situation, he must increase his airspeed enough to maintain a good positive groundspeed.

My experience is that regardless of whether the heading display screen or the map screen is used, it is very difficult to use a GPS to keep the wings of a hang glider level in cloud. Eventually the glider is likely to end up in a steep spiral or some other uncontrolled maneuver. Obviously this is very hazardous: even if the glider does not collide with terrain, the glider may tumble or may overstress and fail due to excessive airspeed. (Again, in other words, you might not survive.) Paragliders have a much better chance of staying out of a spiral dive, since they are one of the few types of aircraft that are actually spirally stable rather than spirally unstable. However, since a paraglider experiences a low groundspeed when flying into even a moderate wind, a GPS will tend to be hypersensitive to small changes in the aircraft's actual heading when flying upwind. By the same token, the GPS will tend to be quite insensitive to small changes in heading when a paraglider is flying downwind. All this will make it very challenging to use the GPS to keep the glider pointed in a constant direction. The risks created by a pilot's failure to control his aircraft's heading are obvious, especially if terrain is near, or if there are large areas in the downwind direction where no safe landing would be possible.

Obviously, hang glider pilots who contemplate using their GPS's for guidance while "stuffing" the control bar to increase the sink rate to escape being "whited out" completely, or to regain visibility after being briefly "whited out", or to maintain a good positive groundspeed in a high-wind situation ridge-soaring situation, will need to mount the GPS in a position where it can be seen even when the control bar is "stuffed". Here is an extreme example of a mount that is optimized for easy viewing with the control bar "stuffed" (photo #1, #2, #3, pilot's-eye view). This GPS is mounted on a long carbon-fiber rod that fits into a socket on the base bar. The whole apparatus rests in a tube that is taped to one of the lower front wires for launch and landing and any other time that it is not needed. Here (photo #1, #2) is a less extreme example of a mount allows the GPS to be visible even when the control bar is well pulled-in.

One problem in the use of a GPS as an emergency blind-flying aid in a hang glider or paraglider is that it is almost impossible to find opportunities to safely, let alone legally, practice these skills in a realistic manner. In the world of "conventional" aviation no pilot would expect to successfully use the gyro instruments in cloud without any prior practice, and hang glider and paraglider pilots should employ an equally cautious attitude toward the prospects of successfully controlling a glider with only a GPS for guidance. Even taking into account the inherent spiral stability of paragliders and the inherent load-shedding characteristics of flex-wing hang gliders, the dangers inherent in loss of visual contact with the ground in either type of aircraft are very severe.

In a light airplane (Cessna 152), flying with the rudder pedals only and keeping my hands off the yoke, in smooth air, with the gyro instruments and compass hidden from my view, in cloud (with an IFR-rated check pilot in the other seat), I've found that it is possible to use the heading display screen on a handheld GPS unit like the Garmin GPSmap 76S or Etrex Vista to keep the aircraft out of a spiral dive. The resulting flight path didn't resemble anything like a straight line, but rather constituted a series of reversing gentle S-turns that slowly meandered in the intended direction of travel. I have some doubts that this would have worked at all in rough air, or with a more spirally unstable aircraft. Again, it's clear that this sort of thing is extremely hazardous and is only appropriate as a strategy of last resort: due to the large risk of a spiral dive followed by structural failure, I would never dream of intentionally carrying out this type of experiment in a "conventional" airplane or sailplane unless working gyro instruments were instantly available as a back-up.

For more strategies and more warnings pertaining to this topic, see the related article on this website entitled "Using a GPS as an emergency cloud flying aid in hang gliders, paragliders, and 'conventional' aircraft."

9) Additional links

For more GPS-related information, see the following articles on the Aeroexperiments website:

“More on the Garmin GPSmap 76S”

"More on the Garmin Etrex Vista"

“Map screen size comparison of some handheld Garmin GPS units with numerical data fields enabled.”

"Notes on the glide ratio functions of some Garmin GPS receivers with pressure sensors, including the GPSmap 76S/CS/CSX, GPSmap 60CS/CSX, and Etrex Vista/Vista C/Cx"

"Using a GPS as an emergency cloud flying aid in hang gliders, paragliders, and 'conventional' aircraft"

"Compass errors in flight"

"An expanded manual for the Brauniger IQ Comp GPS variometer"

And for still more GPS-related information, see the following links:

"Using the GPS as a Safety Tool" by Peter Gray