Airspace and navigation

IF YOU'RE USING ELECTRONIC NAVIGATION, YOU'D BETTER GET IT RIGHT. NEV ALMOND EXPLAINS

WHILST USE OF GPS INSTRUMENTATION HAS BEEN GROUND-BREAKING FOR US FREE-FLYERS, RELIANCE ON GPS DRIVEN INSTRUMENTATION FOR EVERY ASPECT OF NAVIGATION CAN LEAD US INTO A FALSE SENSE OF SECURITY. Without understanding how you are using *your* unique set-up could mean a breach of airspace when you innocently believe you are informed otherwise. This article summarises the key considerations of:

- Using the right airspace information (whether it be CAA paper maps or the electronic equivalent)
- Various instrumentation idiosyncrasies that could lead to you being misinformed

Airspace - paper maps

The paper maps issued by the CAA form the backbone of our ever-changing UK airspace definition. The change process doesn't work in clean calendar years; for the first few months we are still using a map from the prior year, then the 1:500,000 Southern England map is issued in early spring (e.g. March 5th for 2015), then a month or so later the Northern England Map is issued (e.g. April 2nd for 2015). Whilst most of us don't actively use paper maps any more, the map issue process demonstrates how the CAA rolls out change. It's also worth noting that the CAA doesn't provide electronic airspace definitions for us – just paper maps!

Electronic airspace definitions

If the CAA does not produce the maps, who does? It's mainly down to a few dedicated and proactive pilots who understand the underlying data required and have taken on the responsibility to do the task, but who don't (and shouldn't) take responsibility for its accuracy. This is a very important point, and hence it's down to all of us to check and verify what we use. In reality, key individuals (e.g. Pete Desmond, Tim Newport-Pearce) produce the regular 'base updates' of the airspace files, which are then checked by shortlist of dedicated helpers (e.g. Richard Bungay) to give the best chance of correctness. Such files are then uploaded to the worldwide resource SoaringWeb.org, which has airspace files (and much more) for most frequented countries where free-flying takes place.

As the process for airspace updates is driven by the issue of the CAA paper maps, consequently this means we need two or more updates of our electronic airspace each year. For example, in 2015 the last 2014 airspace file will be current for Jan/Feb, a new file is required on March 5th (Southern map update), and yet another new file on April 2nd (Northern update).

Additionally, we need to adhere to NOTAMS that the CAA issue. These are typically short-term and/or short notice airspace changes, ranging from big events like the Farnborough air show, to smaller events like, for example, a short aerobatic display at a fete. The CAA process has been unchanged for years, and they still issue NOTAMs in the form of text abbreviations and parameters and is almost unusable without a tool like Dave Massie's excellent www.notaminfo.com (our XC leagues contribute towards its hosting). Flying/instrument software such as XCSoar allows the temporary inclusion of a second airspace file for NOTAMS, which can be generated by freeware tools such as Jeff Goodenough's SPINE program. Again, checking of the information it outputs is crucial, especially for some of the more complex shapes which it sometimes struggles to reproduce (e.g. it had difficulty in reproducing the boundaries of the 2014 Fairford Air Tattoo).

It's also worth mentioning the idiosyncrasies of Free-Fall Parachuting Drop Zones (DZ). Whilst these are normally warning-only, the BHPA (and BGA) sensibly self-regulates and classes them as 'controlled' for the purposes of competition. Although free-flying through a DZ can't be controlled, frankly you'd be quite mad to consider it. Hence, if you fly through a DZ your XC league submission will be disqualified. Note that some clubs have procedures in place, typically whereby named members will check/notify when a specific DZ doesn't have any parachuting planned, and an exemption for the day then applies (e.g. Avon club and the Keevil drop zone near Westbury).

Navigation by instruments

There are two relevant instruments:

The GPS (primarily for Latitude, Longitude and GPS altitude)

The barometric altimeter (for barometric altitude, derived from air pressure)

To understand the implications of GPS vs. Barometric altitude, I recommend Mark Graham's excellent article that was published by XCMag back in 2011 and available at www.xcmag.com/2011/07/gps-versus-barometric-altitude-the-definitive-answer.

It's well worth the long read,

primarily to understand the differences, but also to understand the vagaries, potential points of failure, and what this would mean for you. If you are short on time, then reading the 12 bulleted conclusions on the last page, should, IMHO, be mandatory reading for any pilot who (i) wishes to say legal by keeping out of airspace, and (ii) wishes to not suffer an airspace infringement in a comp scored by GPS altitude (even though the 'real' flight track was actually legal).

During the last eight months I have tested over 120 Kobos; 20 with Blueflies (barometric altitude + GPS), and 100 GPS-only. I have tested these in conjunction with up to four Garmin GPSs (two Gekos and two 12s), and a Brauniger Comp IQ (as a reference for barometric altitude).

Whilst the results are not of a perfect scientific nature, or controlled as you would expect from say Garmin, they do represent in excess of 300 hours of use and with many actual/real results showing a repeatable pattern. Most useful has been the discovery of a localised 'poor signal area' (see sidebar below). This testing has given me a lot of comfort with how the instruments I use behave and perform. My approach is this:

Barometric altitude. This is my primary indicator of altitude

GPS altitude. Whilst visible I treat it as indicative only. There is typically 'some' error, which can get further exaggerated in poor signal areas. Whilst rare when flying it is nevertheless a possibility

2D position. The GPS position (i.e. Latitude/Longitude) is my primary indicator of position.

An important finding for me was the significant difference between 2D and 3D performance. 2D has proved to be bullet-proof, unlike the third dimension (GPS altitude) which, despite being indicative in general use, can go somewhat wayward in a poor signal area. This finding was quite comforting; unlike altitude we have no alternative for 2D position and we'd be back to our Mk 1 eyeball.

Despite barometric altitude being considered definitive, many comps still score using GPS altitude as it greatly simplifies the checking – imagine the admin overhead of checking if 150 pilots had each set their barometric altitude correctly! If comp organisers are scoring using GPS altitude, you'd be advised to use (i) barometric altitude to stay legal and (ii) GPS altitude to be compliant with the rules.

Our UK XCL organisers (John Stevenson (paragliding), and Phil Chettleburgh (hang gliding) take the sensible/practical approach of using a GPS trace as indicative, but if any boundary conditions require examination, barometric altitude is used. Which of course requires additional effort to confirm the take-off height to ensure QNH (true altitude) was correctly set at take-off.

We need to continually trial, check and verify to ensure we each understand our unique instrument set-up and how we are using them. A fitting example: XCSoar is very clever and once it has a positional fix from the GPS (i.e. Lat/Long), it then spends the next 20 seconds using the map data to automatically establish QNH to determine your height above sea level. This is very reliable when the locality doesn't undulate too much (XCSoar interpolates spot heights from a 90 metre grid), but if you are close to major undulations it could lead to an height error synonymous with the size of the undulation within the 90 metre grid.

Likewise, taking off immediately after GPS acquisition (and before QNH is established) will mean that XCSoar will fail to set QNH and your barometric altitude will be random.

Another example are various phone/tablet apps that may be making assumptions using 'location service', which can also introduce positional errors.

The point of these examples is to make sure you understand how your own combination of GPS, flight software and computer works (we now have hundreds of possible permutations) and let automation assist your flying but not rule it.

Poor signal areas

Whilst quite rare, it is possible to find weak GPS signal areas. I haven't encountered a poor signal area while flying for a few years. With hindsight, when I did it was probably more related to using instruments that were side mounted on an upright and hence sometimes pointing the GPS aerial downwards whilst thermalling; i.e. I had unwittingly introduced a poor signal scenario.

Extensive testing of Kobo/GPS units during my 26-mile car journey to work has led to the discovery of a natural/occasional poor signal area for two of the 26 miles. My poor signal has been confirmed with both (i) the 'Satellite view' displays on Garmin GPSs showing the satellite coverage sometimes dropping to just two or three, and (ii) the useful satellite predictor tool (at http://satpredictor.navcomtech.com/) which allows interrogation of GPS coverage for a given location [pictured below]. No doubt the presence of hills to one side, many large trees and buildings, and the car roof partially blocking reception all contribute too.

Repeated trialling in my (very useful) personal poor signal area has consistently corroborated the satpredictor tool, the Garmin GPS 'satellite coverage' view and, when experienced, significant GPS altitude errors start to creep in. The usual variance (from barometric altitude) of 50~150ft that I typically see can easily swing to discrepancies of 400~500ft. Meanwhile, multiple barometric units on the same journey consistently show a typical deviation of just 5~10 ft between each other – it does seem like that wedge of air above us is pretty consistent. This is all further corroborated later when inspecting the IGC files: the barometric trace is as expected and unbroken, and the GPS trace (both altitude types are recorded in an IGC file when both are available) is broken wherever the poor signal was evident during the live test.

So whilst GPS altitude seems to suffer in poor signal areas, I've been amazed by the robustness of the two-dimensional functions (e.g. position, direction, speed). A car is a great test bed as you have the road as a datum. With the map set to 'track up' and a winding/irregular route, if the map is constantly moving/adjusting to what you are actually seeing in front of you then the information is clearly good. Watching four units behaving identically under poor signal conditions, and having them behave exactly as you would expect is confidence-building. This applies to not just the absolute position (Lat/Long), but also for all 2D functions such as speed, direction, direction to waypoint, distance to waypoint, etc; they all mirror each other perfectly. To date, I haven't experienced a 2D error, whilst errors in the third dimension (GPS height) seem to be easily achieved (albeit only in my somewhat artificially-created poor signal area; I'm sure I'd get a different result by being 500ft AGL).

GPS satellite predictor tool