RASP demystified

I have found that pilots tend to fall into four categories with respect to RASP. There is the group (likely quite small among those that have been flying for some time) who have never heard of it. At the other end of the scale there are those, probably also relatively few in number, who are expert users. These words are not really for them. But I suspect that the vast majority of pilots fall into one of the middle two categories: either they have heard of RASP but consider it too scary and complicated to actually use, or they know of it and use it to plan flying days but only in a fairly limited way without exploiting its full potential. This article is written mainly to aid those in the middle two groups, to show you what RASP is capable of (bearing in mind the rather limited space available) and to help you to use it effectively in your day-to-day flying as the powerful forecasting tool that it is. You may find it helpful to have a computer nearby when you read this.

What is RASP and where can it be found?
First of all, then, what actually is RASP? Standing for Regional Atmospheric Soaring Prediction, it is a modification of a standard weather forecasting model to increase the resolution of the forecast over a limited area and to produce predictions of weather parameters of particular interest to glider pilots. It was originally developed by Dr John W. Glendening (Dr Jack), an American atmospheric scientist and glider pilot.

The UK version of RASP is run and maintained by Paul Scorer at Leeds Metropolitan University and can be found at the website http://rasp.inn.leedsmet.ac.uk/, with a duplicate server at http://rasp.stratus.org.uk/, which can be useful if one site has a problem. Globally, there are more than thirty RASP models around the world, which can be beneficial on flying trips abroad – the full list can be found here: http://www.drjack.info/RASP/index.html.

On the Leeds website mentioned above, the most usual way of viewing the forecasts is through the RASPtable link, although there is also a recent interface based around Google Maps which seems very useful. These both present data in the form of so-called BLIPMAPs (standing for Boundary Layer Information Prediction Maps). Forecast soundings are also available – these are vertical plots through the atmosphere at one point at a given time and can be useful for gauging the vertical extent of clouds and how wind changes with height, among other things.

How does RASP work?
Every day, the American National Weather Service runs a weather model known as GFS (Global Forecasting System) that covers the whole world. This works by taking observations of the real weather from wherever they're available, combining these with a previous forecast to give a best guess 'initial state of the atmosphere' in terms of wind, temperature, pressure etc. at points approximately 50 km apart around the globe (relatively poor resolution since the computing power needed to cover such a large area is huge), then doing lots of complicated calculations to advance this 'state of the atmosphere' at each point through the next few days.

RASP begins by downloading from GFS the forecast state of the atmosphere at a certain time to provide itself with starting conditions but, because RASP runs at a higher resolution than GFS, it does some modifications along the way to fill in the gaps between the GFS data points in a sensible way.

Based on these initial conditions, another weather model called WRF (for Weather Research and Forecasting) is used to produce a simulation of the weather to come for the next 12 hours (in the UK at least – other versions of RASP may vary). The output from this model is entirely numerical so the next stage is to convert it into graphical maps or forecast soundings. Finally, these charts are uploaded onto a remote web server to be looked at by interested pilots wherever they may be.

In terms of resolution for the UK sites, the RASP forecast for 'today' uses a grid of four-kilometre boxes and that for 'tomorrow', five kilometres. Every other day gets a forecast with 12-kilometre resolution and there is also a 12-kilometre run for 'today' using slightly more recent base conditions than the main four-kilometre run.

Why is RASP useful?

RASP, with its focus on soaring, is useful primarily for planning cross-country flights, although it is also instructive for local flying. Most hang gliding and paragliding takes place within the convective boundary layer, that is, the layer of the atmosphere that is in contact with the earth's surface, is influenced by surface effects on time scales of less than about an hour and is the layer in which thermals exist. RASP, used effectively, can give you a good idea of the structure of the boundary layer and how it changes with time and from place to place, enabling you to plan a flight that keeps you in the best conditions for as long as possible.

One of the advantages of RASP over the standard global models that power many other forecast websites (such as XCWeather) is its increased resolution. This is particularly noticeable when the local conditions are highly dependent on the terrain below (for example, in the mountains or around coasts). RASP's higher resolution allows it to model topography better than the global models do, thus taking more account of local effects. Additionally, and valuably, RASP predicts parameters that are not traditionally forecast, such as the thermal updraft velocity or the potential for over-development, saving the user the need to work these out for himself.

What can RASP do and how is it best used?

When you first look at the RASPtable viewer, you will be presented with a screen looking like Figure 1. On the left is a map of the UK showing, initially, the *Thermal Updraft Velocity* at midday on day 1, that is, today. Note that the north-south lines do not run vertically on the page – this is to fit as much as possible of the UK into a small area. The scale is below the map and can change from one hour to another, so it is not always enough to just look at the colours (although the colours are actually fixed for *Thermal Updraft Velocity*, as indicated by 'FIXED' at the end of the scale).
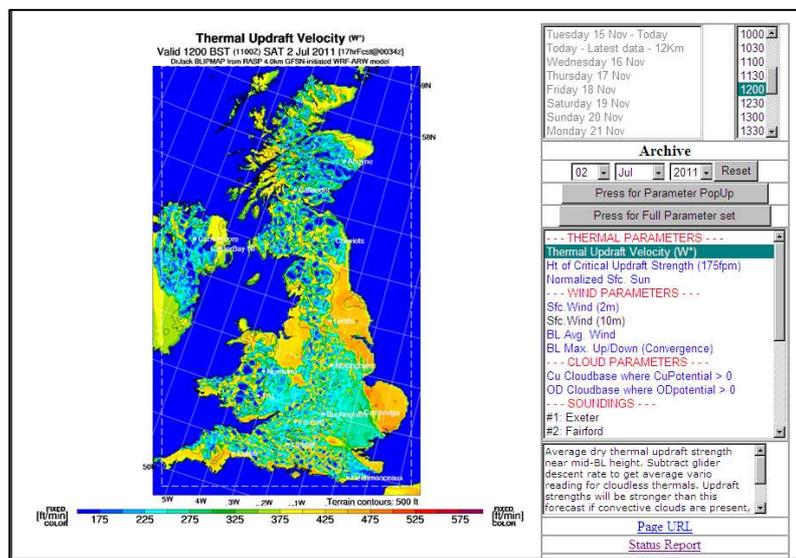

Figure 1

Clicking on the map advances it by half an hour, but clicking on any particular location while holding down the 'Ctrl' key gives you an exact value at that point. To the right of the map are a number of boxes, the topmost of which allows you to change the time and date you are looking at, or view archived maps from the past few months. Below this is a box with the available weather parameters, divided helpfully into categories. At first, this ju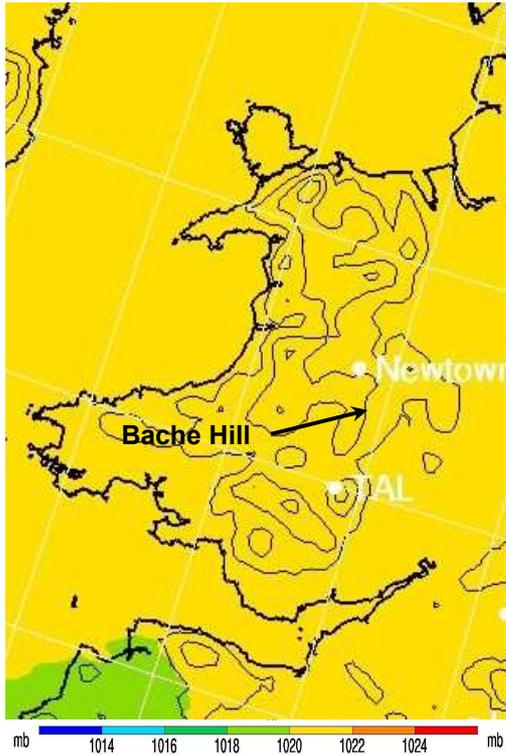st shows the most commonly used parameters but others can be found by clicking where it says 'Press for Full Parameter Set'. Finally, at the bottom of the page, there is a box giving some information about each parameter, for example, what it shows, how it is calculated or how it can be used in conjunction with other parameters.

This *Thermal Updraft Velocity* seems to be many people's favourite parameter so it may be helpful to point out that it takes into account neither the sink rate of your glider nor the effect of cloudsuck. You should bear this in mind if you are trying to use it to give actual values, although it is often better just to compare one region or time with another and try to figure out trends.
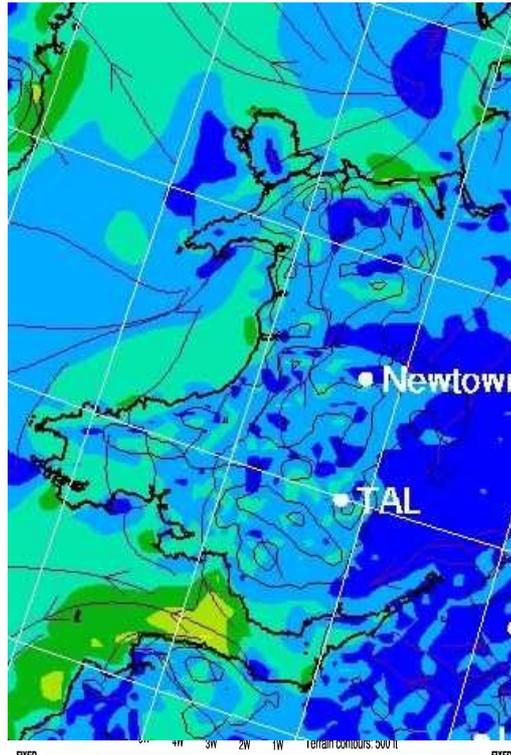
Figure 2 Mean Sea Level Pressure at midday

Figure 3 Surface Wind at midday

It is easiest to illustrate some of the other forecast parameters using an example. Figure 1 is taken from the 2nd July 2011, during the third round of the British Open Series in mid-Wales. This was the first of two days at Bache Hill and the one on which no-one got away. That day, pressure was relatively high with little variation across the country (Figure 2), with very light winds both at the surface (Figure 3) and throughout the boundary layer (Figure 4).
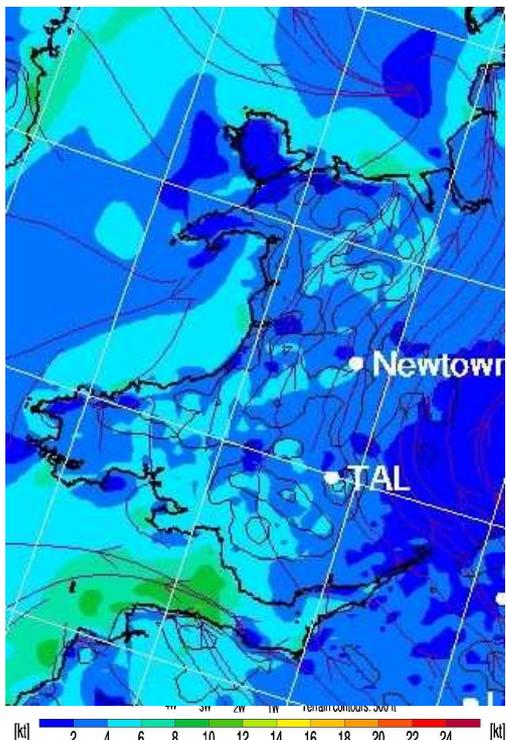

Figure 4 Boundary Layer Average Wind at midday

The *Boundary Layer Average Wind* is useful particularly on days where wind direction is constant with height. Where wind direction changes dramatically, the wind at one level can 'cancel out' the wind at another, leaving what looks like light winds on the map but is in fact quite strong winds with different directions at different levels. Not so in this case – winds were in fact light throughout the boundary layer.

The day started blue, as indicated by RASP's *Normalized Surface Sun* parameter (Figure 5), which aims to show the amount of solar radiation reaching the ground compared with what would be the case in the absence of cloud. Values in excess of 95% in mid-Wales at 0900 do indeed indicate an absence of cloud at this time. Incidentally, the dark pink and red colours tend to imply the presence of cirrus. This is also backed up by the *Cumulus Potential* parameter, which does just what the name suggests and evaluates the potential for cumulus formation based on the expected cloud depth. It is often best used in the form that shows *Cu Cloudbase where CuPotential>0*, as this shows not only where cumulus are probable but also what their

base is likely to be. At 0900 BST on the day in question, the *Cu Potential* was also indicating just a little low, early-morning cumulus around Bache Hill (Figure 6).
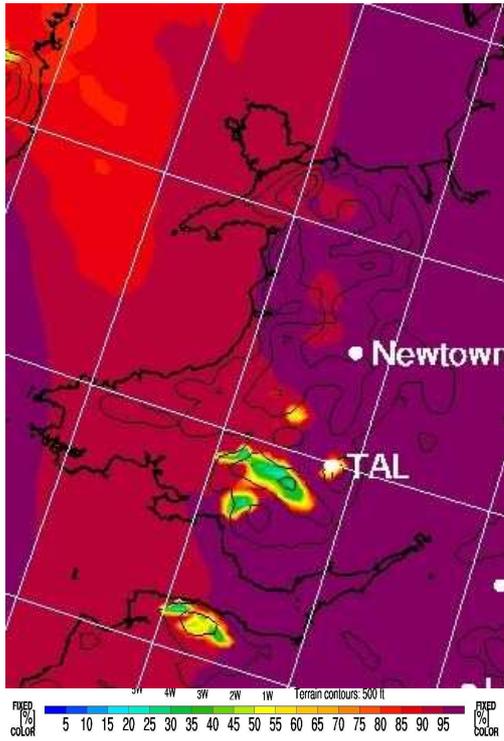

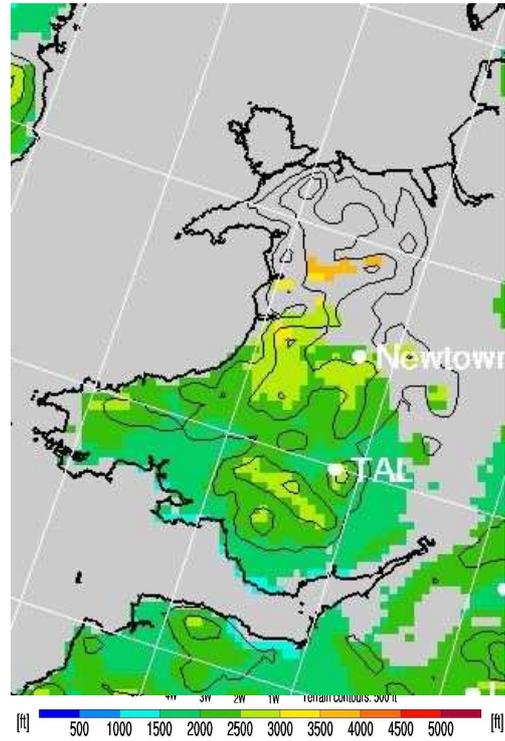**Figure 5 Normalized Surface Sun at 0900**

Figure 6 Cu Cloudbase where CuPotential>0 at 0900

Cumulus did develop later however, with the first clouds of the day forming just where you would expect them, over the hills. From there, with no wind to speak of, they spread out until, a few hours later, the sky was pretty much overcast. Now, we can look not only at the
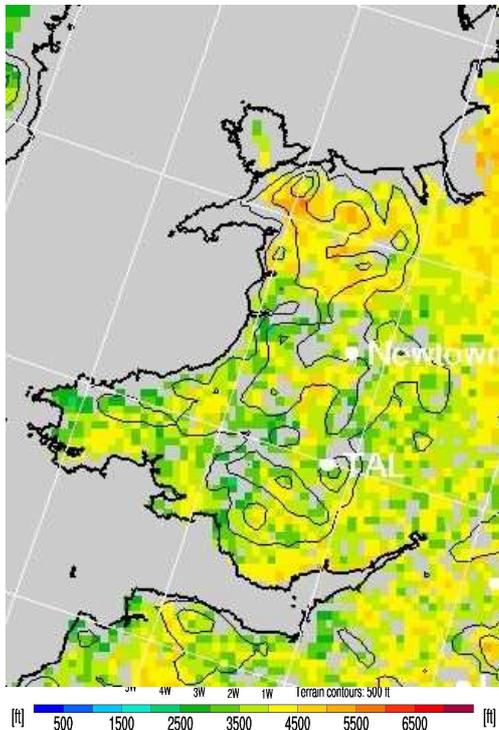

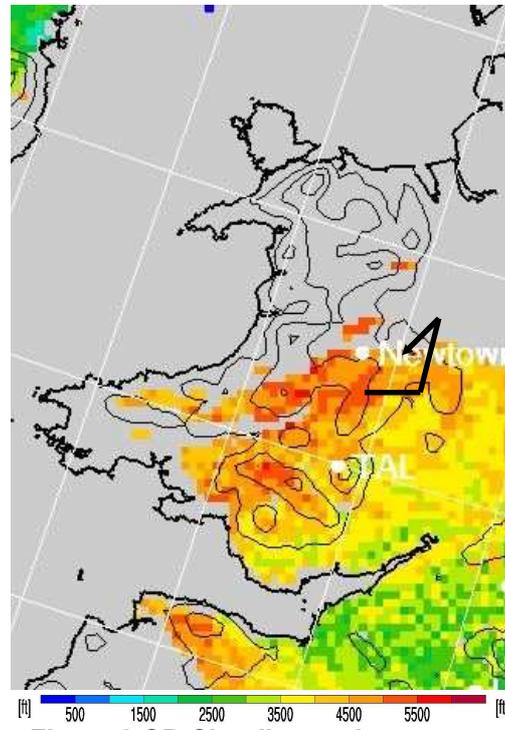**Figure 7 OD Cloudbase where ODPotential>0 at 1400**

Figure 8 OD Cloudbase where ODPotential>0 at 1200, 3rd July, showing approximate course

Cumulus Potential but also the *Overcast Development Potential*, again often easiest to use in the form *OD Cloudbase where ODPotential >0*. Figure 7 shows the *ODCloudbase* at 1400 BST.

Notice that it seems to indicate the presence of some gaps in the overcast. This was somewhat misleading on this occasion but a glance at the soundings from that day makes it clear that such gaps were unlikely. It might be worth pointing out that, in common with many other weather models, RASP's strong points are wind and thermal parameters, with cloud details tending to be less reliable.

It is interesting to compare this day with the following one, when a 97 km task was flown from Bache Hill in what initially appeared to be similar conditions. The main factors in the different outcome were an earlier start to beat the cloud, together with the fact that the over-development occurred a bit later and, at least initially, didn't spread as far north, as shown by the forecast cloud in Figure 8. The task was set towards the clearer air further north to take advantage of the better conditions there.
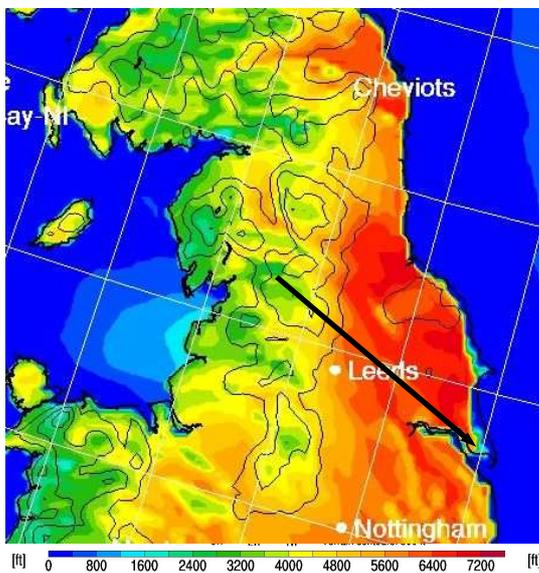
Figure 9 BL Depth at 1200, 31st May, with approximate course

Taking a different example, let's look at 31st May 2011, the final day of the BOS second round, which saw a 161 km task from Wether Fell in the Yorkshire Dales to Skeffling on the Lincolnshire coast. The weather situation was that of a ridge of high pressure following an earlier cold front, in many ways the classic set-up for cross-country flying, although slightly compromised by a band of cloudier conditions with showers around the start point. An alternative to the *Thermal Updraft Velocity* on RASP might be the *Boundary Layer Depth* parameter, since thermal strength is closely related to the depth of the boundary layer. The top of the boundary layer is the average top of blue thermals, although the achievable thermalling height will be lower due to the glider's sink rate.

Figure 9 shows the *BL Depth* at midday on 31st May, indicating an increase in the boundary layer depth in the Vale of York and the North York Moors compared with the Yorkshire Dales and implying stronger thermals here. Another feature of this day was the sea breeze that developed on the east coast – this can be seen on the map of *BL Max. Up/Down Motion* (Figure 10), which can be useful for picking out convergence lines, including those due to sea breeze fronts.
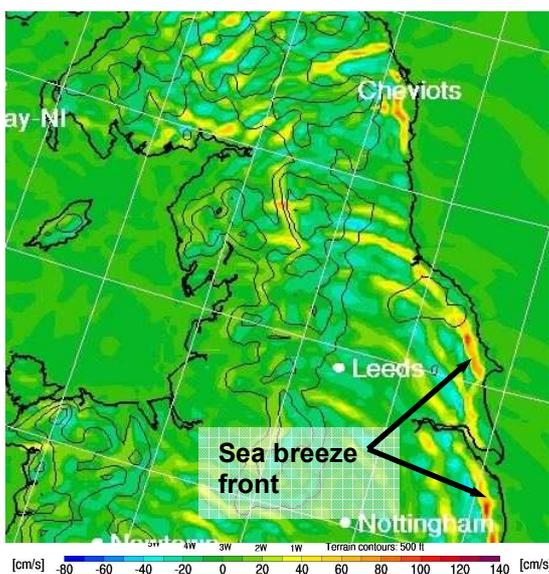
Figure 10 BL Max. Up/Down Motion at 1400, 31st May

Forecast soundings, as mentioned earlier, are useful for gauging the vertical structure of the atmosphere, in particular the detail of clouds and how wind and temperature change with height, both in and above the boundary layer. On RASP, a list of fifteen standard sites is given in the Parameters box but other points can be seen by clicking first where it says 'Press for SkewT PopUp', then holding down the 'Shift' key while clicking on the map.

These soundings are very powerful for forecasting when used with a bit of understanding. Although there is not room here to explain how they work and how to use them, I would encourage anyone with an interest in finding out more to work through the tutorial on soundings at http://www.weatherjackwx.co.uk/tutorials/tutorials-all.html, the parent website of which is also a useful source of links to all kinds of weather information.

This is necessarily only a brief introduction to what RASP is capable of. There is extra information and a number of other 'tools' on the RASP homepage, not least an even-higher resolution (1.4 km) map of the central part of the UK, intended to provide wave forecasts, wave being a phenomenon occurring on a scale that really benefits from higher-resolution modelling. The alternative Stratus site also produces graphs of conditions at a single location. For another view on how to interpret RASP data, Judith Mole's webcasts (http://www.judithmole.net/blog/?page_id=3205) include one on just that subject, which is worth a few minutes to listen to.

A few caveats.
As Dr Jack eloquently puts it on his website, "Remember folks, this is a model not a crystal ball". The real atmosphere is very complex and any model can be at best an approximation. It is worth getting into the habit of questioning model output. Ask yourself why RASP predicts a certain pattern – either it will be a real effect and by understanding it you have learnt something about the weather, or it will be a model error and you will thereby learn something about the model.

Be aware of how parameters relate to one another – for example, the boundary layer average wind is of little use when RASP is predicting the boundary layer to be only 30 feet deep, which it often does around coasts. Comparative predictions are usually better than absolute ones.

And finally, always remember that just because it looks realistic, it doesn't necessarily mean it's right. There's no substitute for experience and practise and it is when this experience is combined with model predictions that you end up with a really useful forecast.

Acknowledgements.
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