Ensembles tutorial

What are ensembles?

The ensemble forecasts, data, graphs and maps you see on netweather are taken from the Global Ensemble forecast model made and run by the NOAA. (the US weather office)This data model runs four times a day at 00.00, 06.00, 12.00 and 18.00 covering the entire globe. The official name for this ensemble model is the Global Ensemble Forecast System – or GEFS.

The ensembles run using the same initial data as the GFS (global forecast system) model but with a key difference – the model is run several times, each time with some slight changes to the original data. The reason for this is that weather forecasting models take a huge amount of data into them, and within this data there will always be some errors and inaccuracies, so by making changes to that data you can understand how those inaccuracies may affect the forecast. A control is also run, which is the data without any changes to it. By comparing the various outputs from each run of the model, you can also gauge a margin for error for each forecast timeslot, which is very useful for working out how likely the shown outcome is to happen. Each time the model is run with the slightly different data, the output it creates is known as a member.

At the current time, the NOAA run 15 different members each time they run the ensemble model – but this is being increased all the time, with an eventual target of more than 200 members! With so many members, it's impossible to give access to all of them as the amount of data would be huge, so here on netweather we show an indicative 10 members with the mean and spread data based on the full amount of members not just the 10 you can see seperately on the graphs etc.(we'll cover what the spread and mean data is later on).

Many leading agencies now believe that ensemble forecasting is the way forward for anything beyond 5 days – and sometimes even shorter.

So moving onto the output on netweather extra – which is probably the widest range of ensemble output you will see anywhere on the internet!

Graphs

These show all the members (plus the mean and control run) for a selected parameter across the full 384 hours the ensembles run out to.

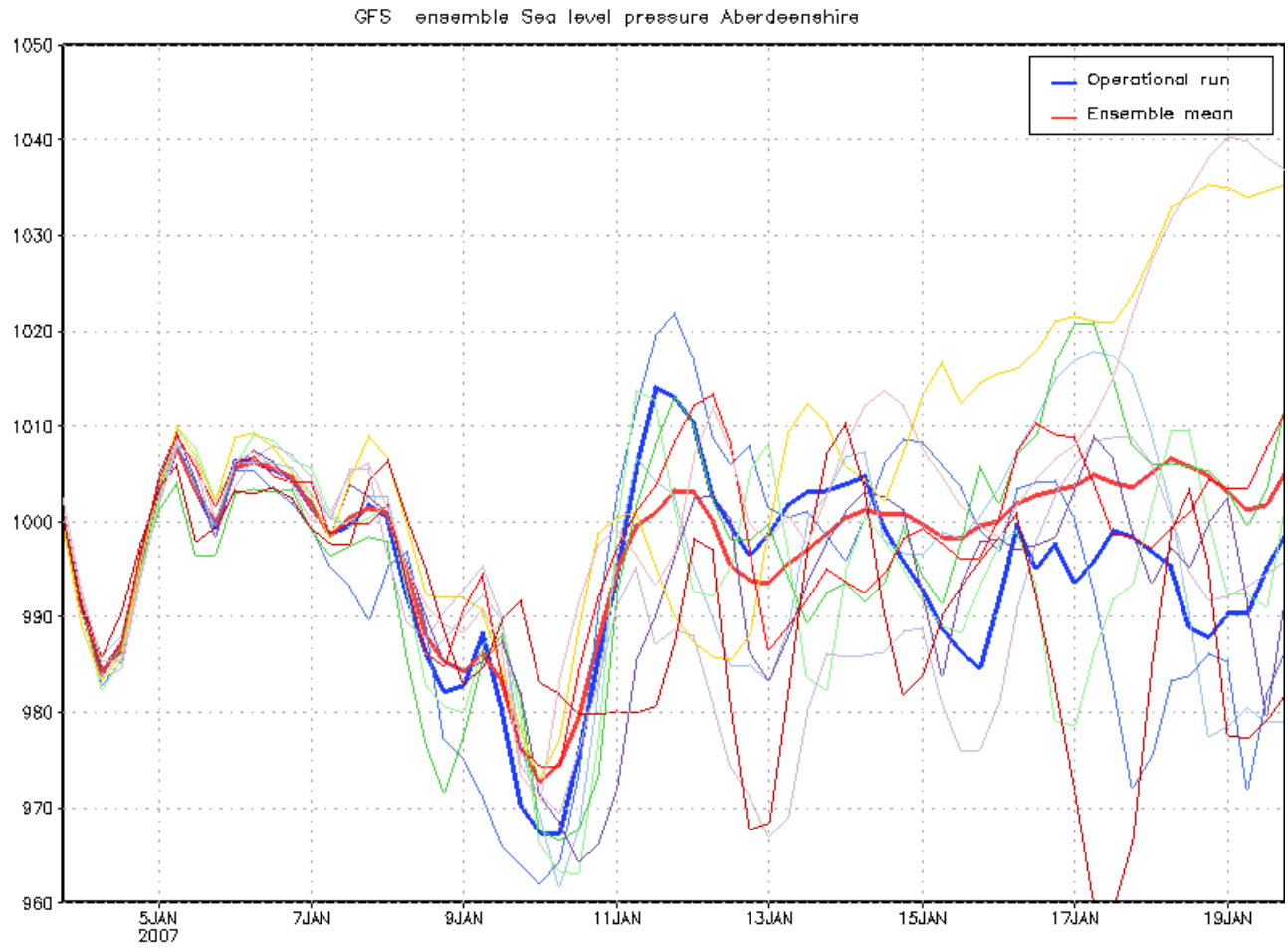
The graph below shows the Air pressure for Aberdeenshire. The control run is marked in bold blue and the mean (average) of all the different members is the boldened red one. The 10 other indicative member runs each have a different colour, but aren't bold.

The scale running horizontally is time – running out to 384 hours from when the model was run. The vertical left hand scale is the air pressure in millibars or hpa. As you can see, the

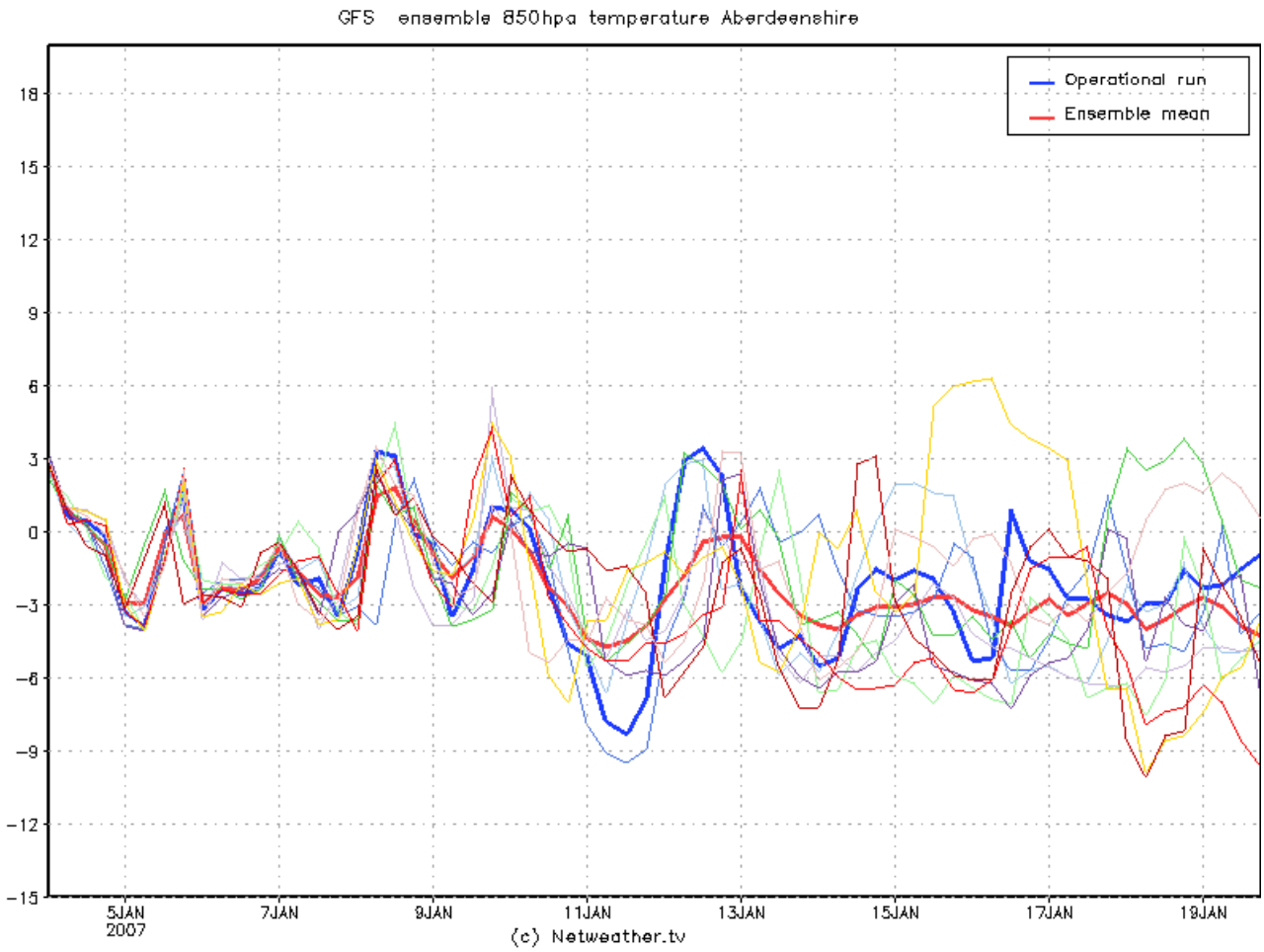
various lines are fairly close together at closer range – this is fairly normal, it is rare to see much disagreement between the mean, control and other members early in the run. The less dissagreement that there is, the more confidence you can have in the forecast.

Further into the run and the disagreement between the members becomes greater – this implies you should have less confidence in the forecast outcome but using the mean can give you a better guide. You can also see that the control run (blue, bold) is quite close to the mean throughout so has a better likelihood of being accurate.

Sometimes the control run will go off in a tangent and either be much higher or lower than the other runs and the mean, this is known as an outlier and can often mean that the control run is unlikely to be showing the actual outcome.



Below we have another example of another graph – this time the 850hpa temperatures (temperatures at around 1.5km up in the atmosphere – more information on this will be within the soon to be released (as of 05/01/07) model reading tutorial). Again the time runs horizontally and this time the tempature in degrees celcius runs vertically. Again on this particular graph, the control run follows the mean quite well – so some reasonable confidence on the forecast outcomes.

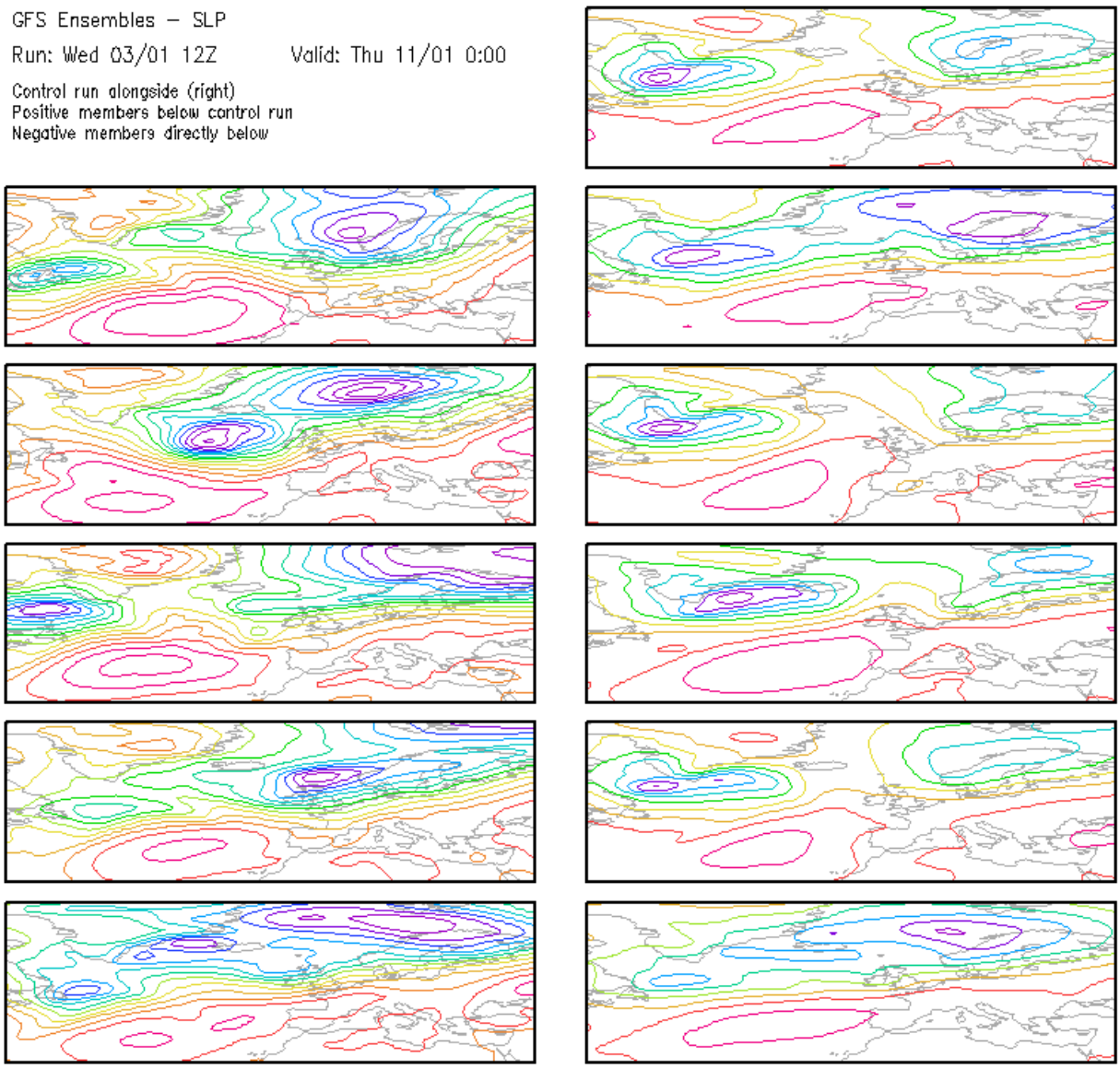


The graphs are great for looking at one location and the likely weather there, but what about a more general outlook? This is when we move onto the maps which are available..

Panel maps

These show each of the indicative members, plus the control run. Below is an example of this, showing the forecast air pressure for the North Atlantic and Europe 180 hours from the date and time the forecast was run. There is a panel map available for every 6 hour timeslot from the run time to 384 hours.

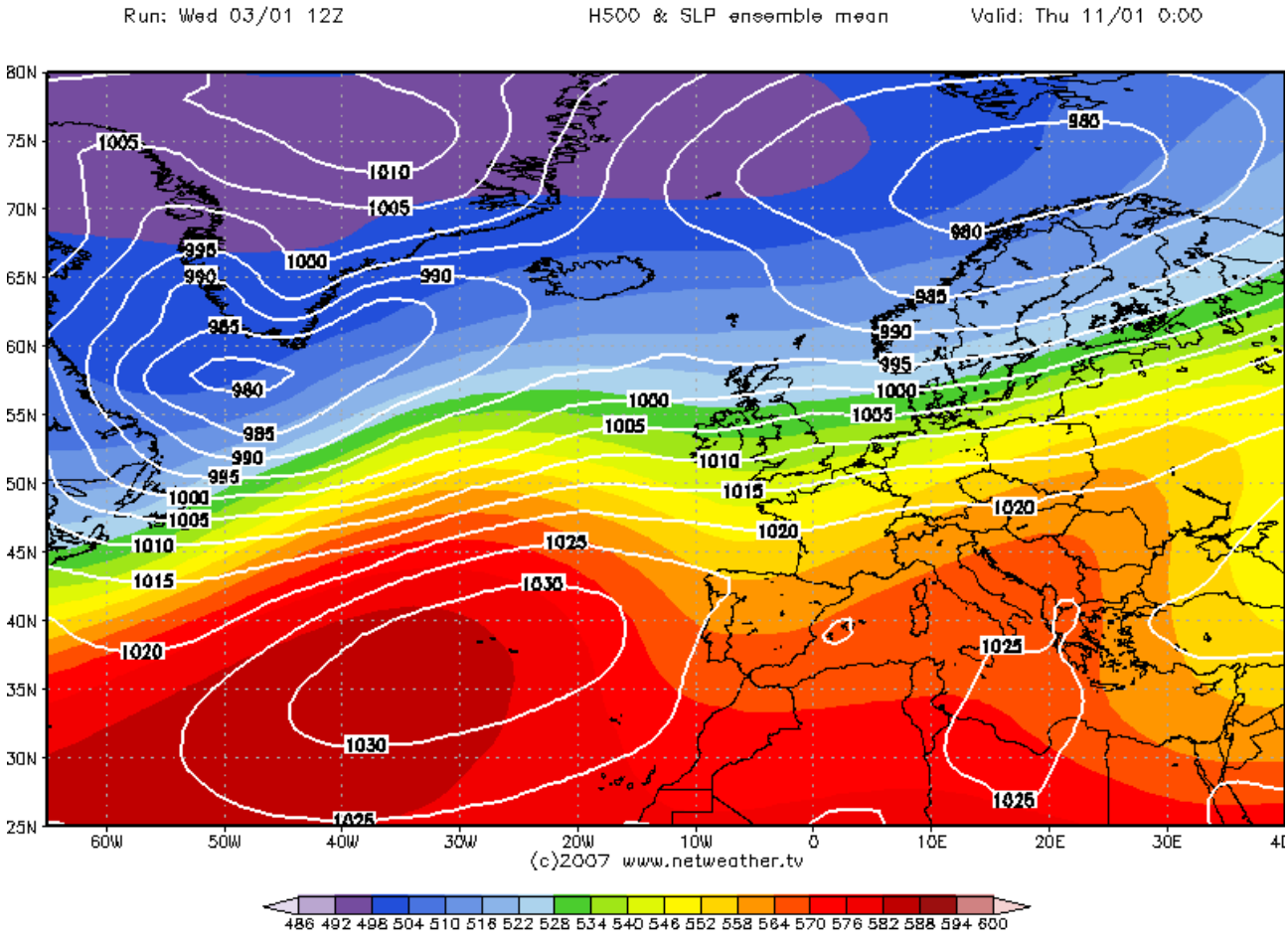
At 180 hours (7.5 days) we can generally expect the various members to be showing slightly (or even wildly) different outcomes, and the example below shows just that. The control run on this occasion shows high pressure to the southwest of the UK, ridging slightly over southern parts of Britain. Around 50% of the other members agree with this outcome in varying forms, while 50% tend to squash that high pressure further south. So not great confidence in the outcome on the control run.



Ensemble mean

The map showing the mean outcome is a very useful tool to use alongside these panel maps, as it effectively shows the average of the various members, so can give a very useful guide as to the most likely outcome.

The mean chart below is for the same time as the panel above, and show both sea level pressure and the 500hpa heights (for more information on these, see the model reading tutorial which will be available during January 2007). Comparing the air pressure with the various members above, it is close to being a half way house between the two most extreme outcomes from them – the high pressure isn't being squashed as far south as some members forecast, but is also not riding as far north as some members forecast either.



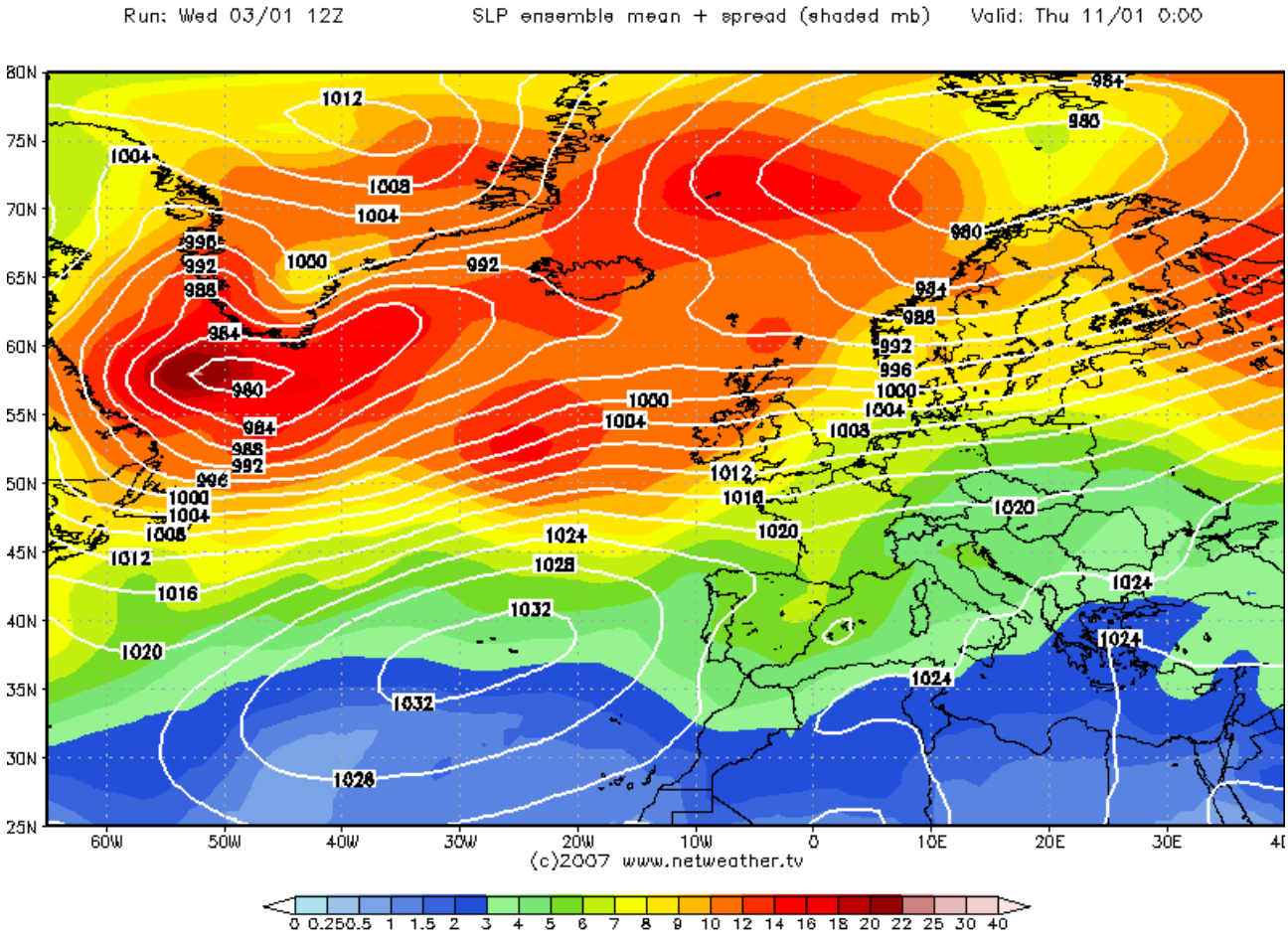
Using the mean ensemble results at longer range is well known to increase accuracy of the forecast, but this isn't the definitive answer (if only it were that simple!).

Spread

The next ingredient to add into the mix is the spread data (you may remember this was mentioned at the beginning). Spread data shows the difference from the highest to the lowest member. In the example below, we're using air pressure – so a spread value of 5 means that at that point in the map there is a potential margin for error on this run of 5hpa.

On the maps, the mean air pressure is shown by isobars (contour lines) and the spread by the shaded colouring. The first map below is showing the same period as the 2 maps above.

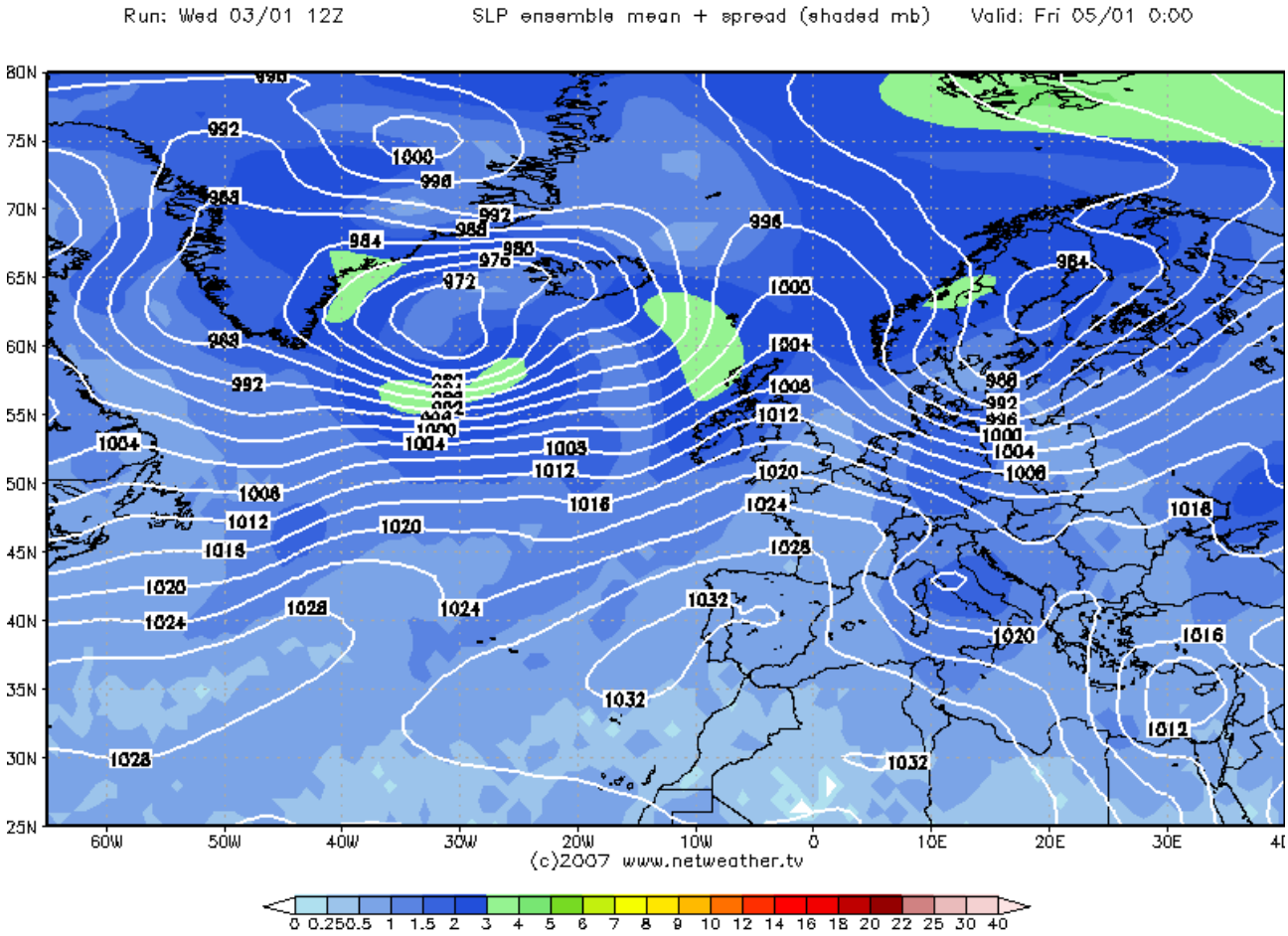
You can see that the brightest colours are on the northern half of this map, in areas where air pressure is lower. Often areas of low pressure are harder to forecast accurately – with depressions often moving fast, developing fast and generally being hard to forecast in terms of track, timing and intensity. Further south, where high pressure is settled, the certainty of the forecast inceases.



On the map below, this one at just 36 hours from the time of the run, you can see that confidence across the whole map is higher as the spread is lower: But even at this short range, around an area of low pressure there is increased spread and therefore more uncertainty as to the outcome.

It goes to show, that even at relatively short range, the nature of the weather, particularly in a location like the British Isles and North Atlantic, nothing is that certain.

This brings us nicely to the final tool from the ensembles and that is the spaghetti plot – this one is not much use at all at long range, but handy in picking out subtle differences at shorter range. More on this below.



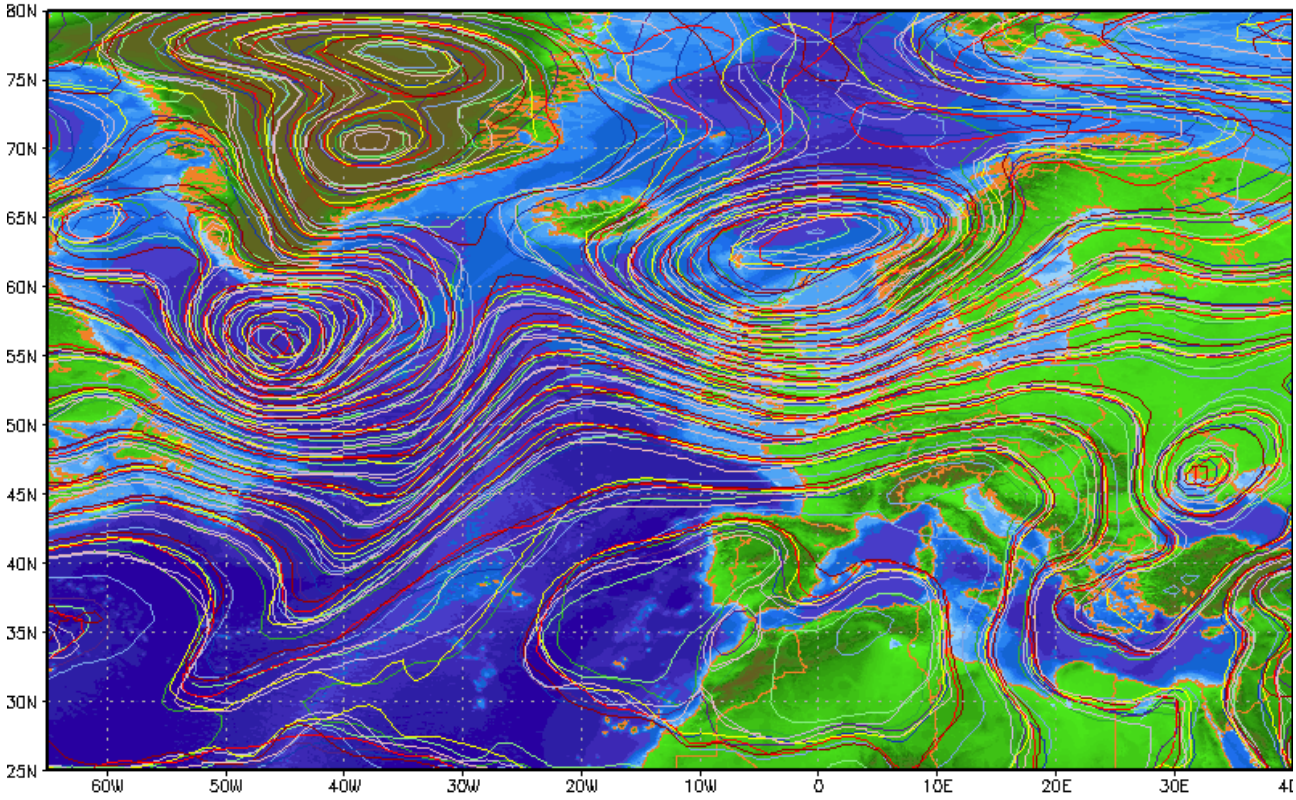
Spaghetti

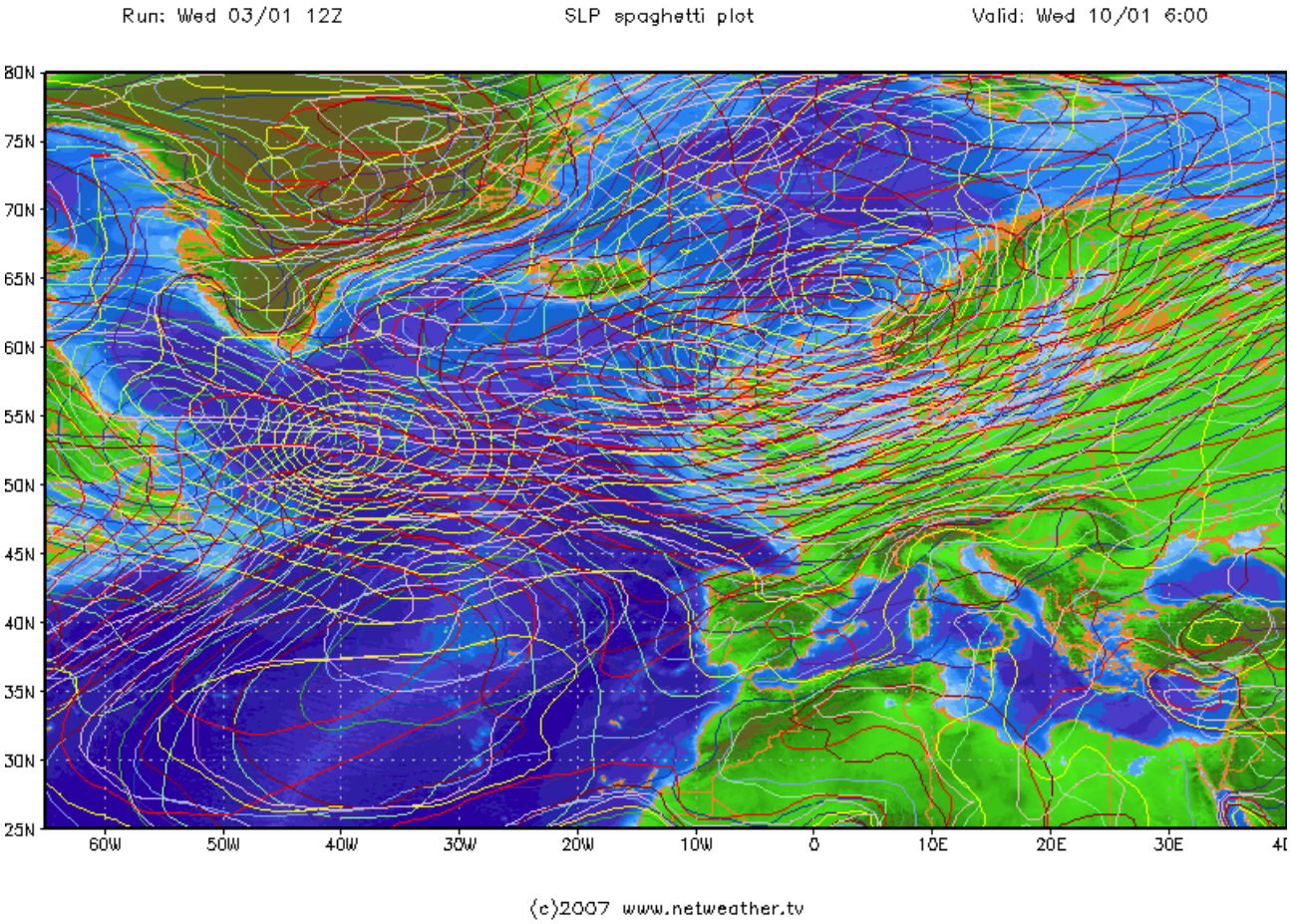
Spaghetti plots show each of the ensemble members with there own line – one map for every 6 hour timeslot, so you can see each member on one map. At shorter range (out to a max of 72 hours generally) this can be very handy indeed – showing small variations in the forecast outcome, allowing you to see all of the possible scenarios and setups. The map below showing an air pressure forecast for 12 hours in advance is a good example.

Notice how the two low pressure systems (one to the north of the UK and one off of the East coast of the USA) are drawn in generally the same place by all the members, but some have shme a little deeper than others, some in a slightly different location and some with a slightly different shape. On more zoomed in maps (as are available for the UK) you get an even better feel for things and will eventually see how the subtle changes shown here can make a large difference to the final outcome on the ground.

An example of these maps at longer range see the seond map below – a total mess, and pretty useless much of the time – best to ignore this type of map beyond 72 hours unless you're looking very deeply for a possible trend.

Run: Wed 03/01 12Z SLP spaghetti plot Valid: Thu 04/01 0:00





In conclusion, the ensembles are a fantastic forecasting tool – whereas the GFS alone can give great results and accurate forecasts at pretty long range, by using the ensembles alongside it, you can get a far more rounded outlook and see the probability of a forecast coming off. As well as this it can aid at shorter range when looking to nail down the finer details of a particular days weather.

For further reading and guidance on the ensembles and their uses, the NOAA (NCEP) training manual is available here:

http://www.hpc.ncep.noaa.gov/ensembletraining/

The Netweather team

If you have any queries regarding this tutorial – please feel free to contact us via the netweather website at:

www.netweather.tv

Look out for further new ensemble maps on nw extra over the coming days and weeks, plus part 2 of this guide which will look more in depth at using the ensembles for forecasting.