Forecast Jumpiness

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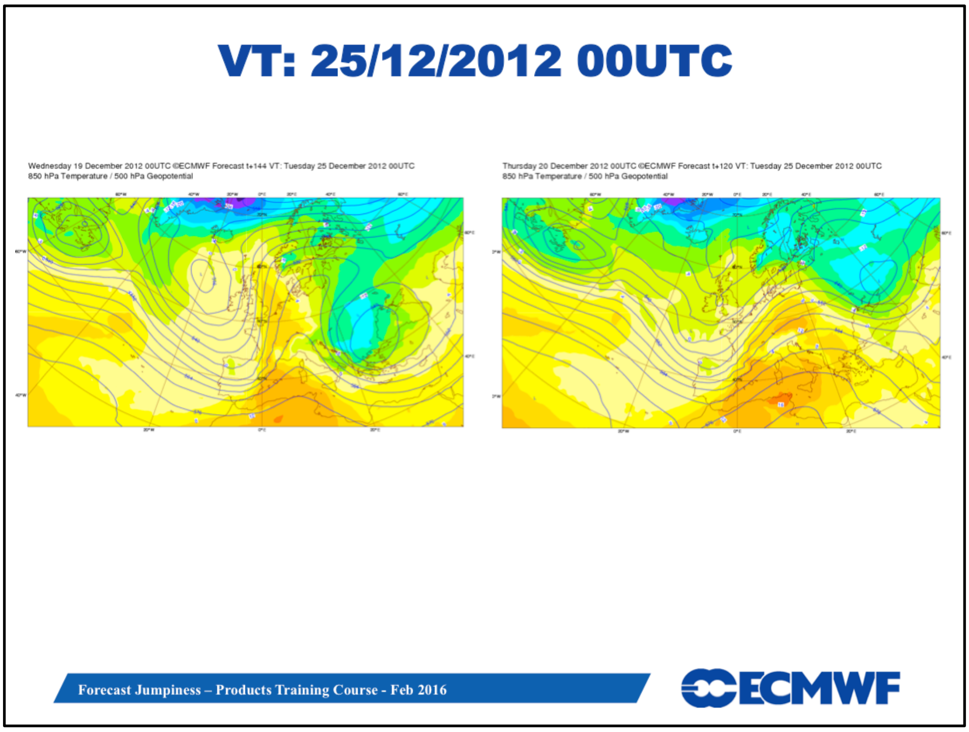
Thanks to Ervin Zsoter, Ivan Tsonevsky and David Richardson

Structure

- Example
- Related research results
- Summary

An Example

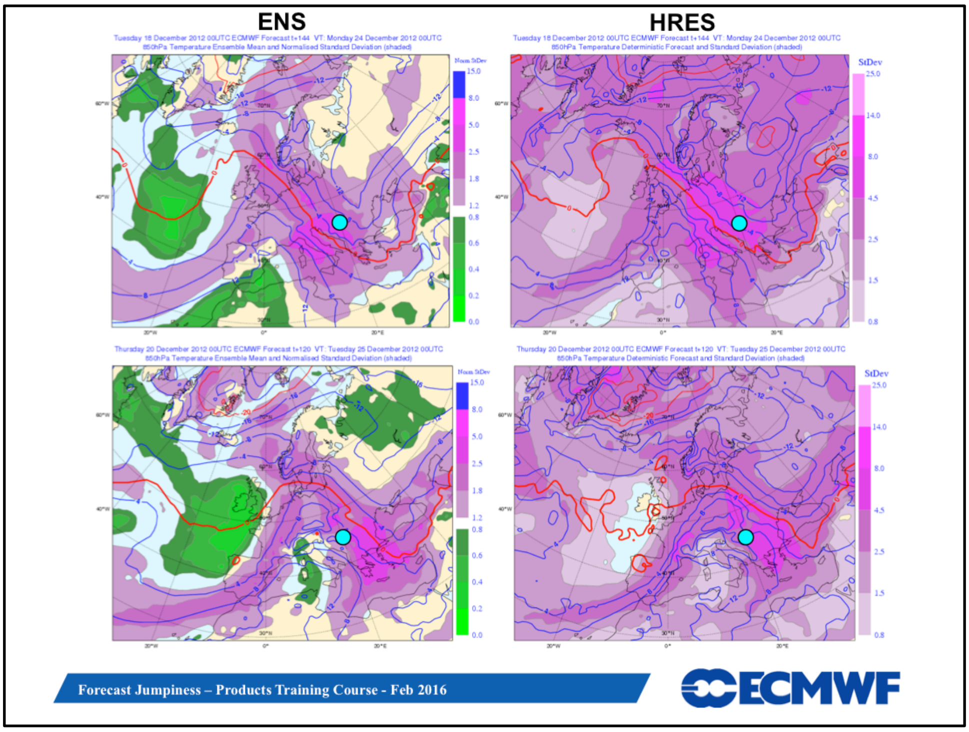
- Medium range forecasts for Belgrade
  - Christmas Day, 2012
- Jump in HRES and ENS, at the 5 to 6 day lead time



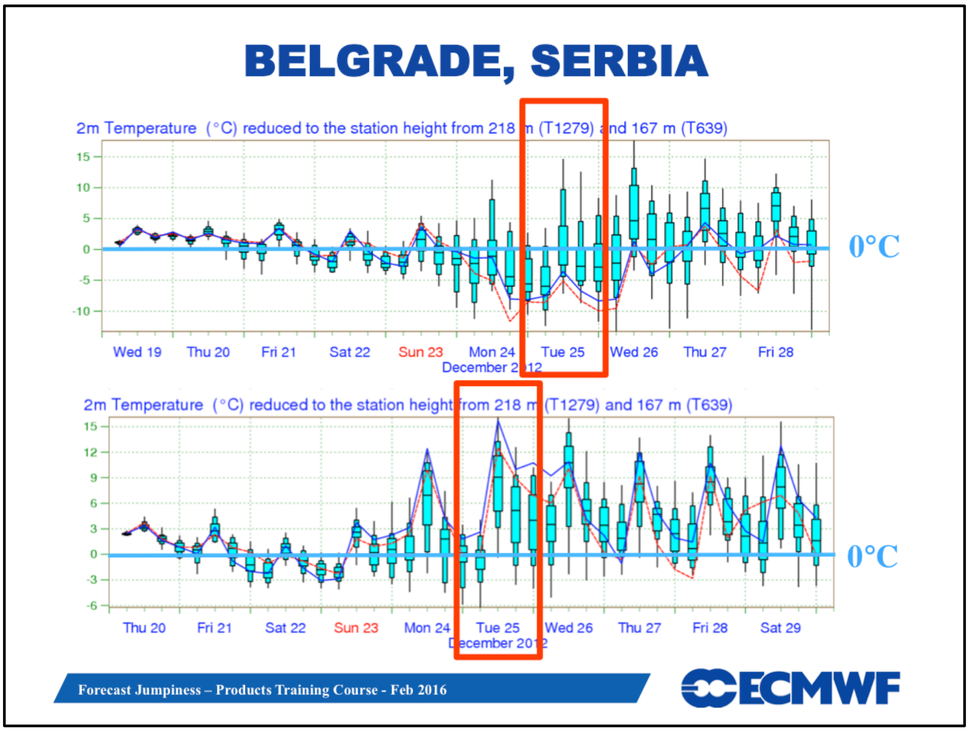
This is the example to be described:

Fields plotted, forecast base date and range.

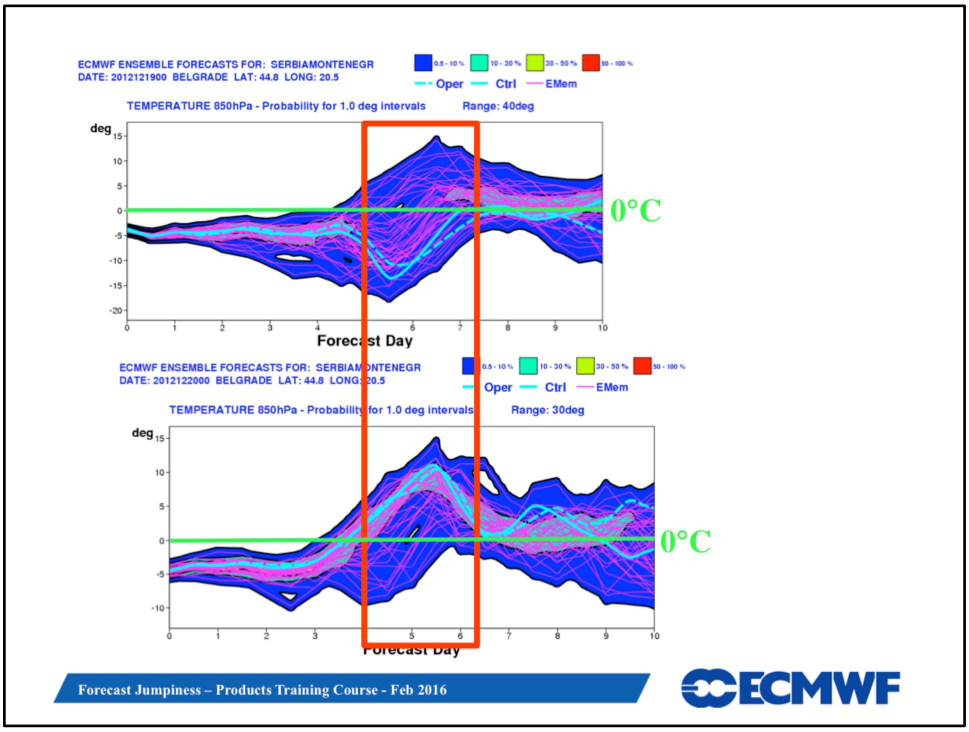
How do the two differ? To be noted is the change in the forecast from one plot to the other



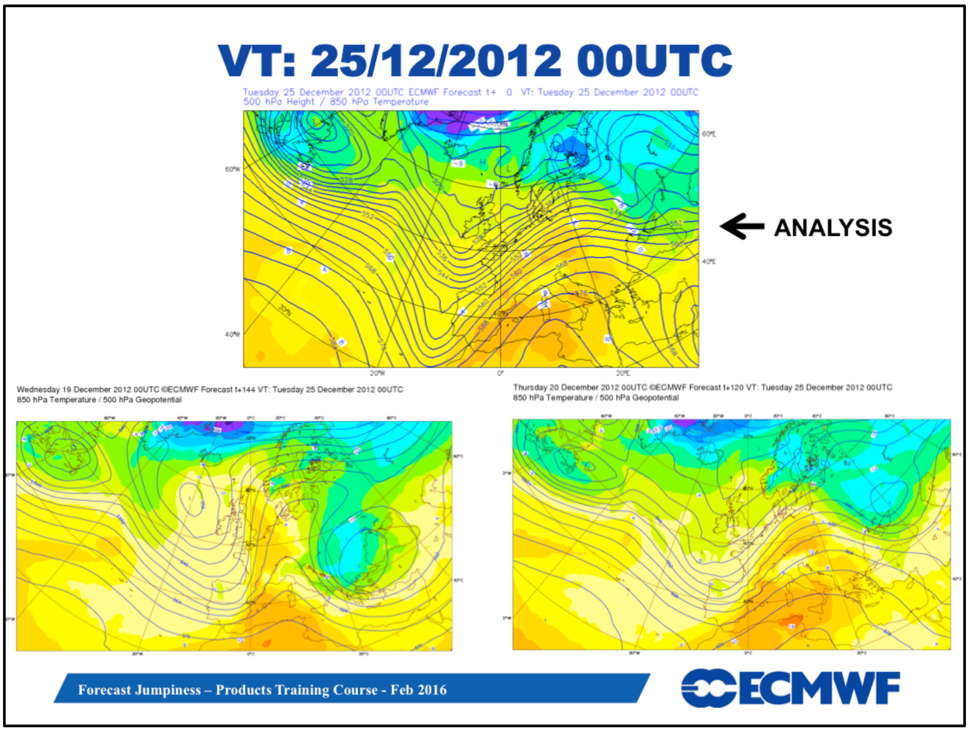
This are other products and also here the difference in the ENS mean on the left is quite remarkable between the two base dates (top and bottom) but interestingly the spread is quite large which indicated large uncertainty



This is a ENS meteogram which shows the temperature forecast (10 days) for Belgrade. The two boxes highlight the date of interest. Again here the two forecast are quite different, and the spread is quite large.

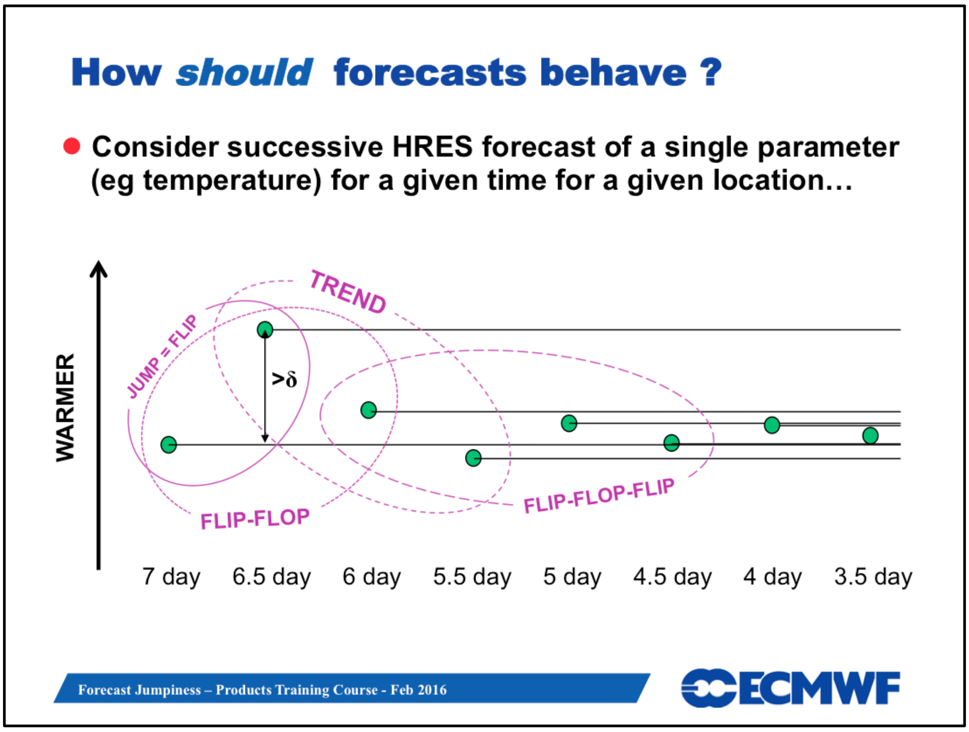


This is a plume for Belgrade (top and bottom are two forecasts (in the box the day of interest). Clearly the Control and HRES (two light blue lines) go from one solution quite cold (below zero) on the top plot to positive temperatures on the bottom plot.



The top is the analysis (proxy for truth) and the two bottom plots are those we have shown at the start.

This highlights the wrong solution



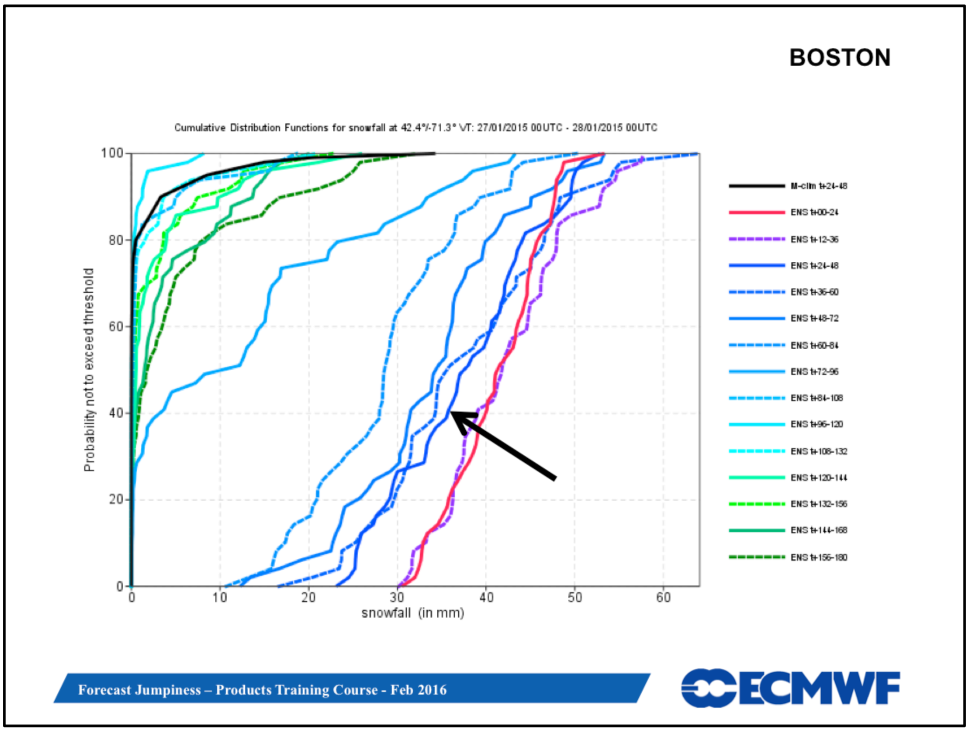
This slide explains the concept of flip-flop and trend

Relate the first 'jump' to the Serbia example

Dealing with jumps and trends…

- At the most basic level, given three consecutive forecasts:
  - “Flip-flops” will happen half the time
  - “Trends” will happen half the time

ECMWF

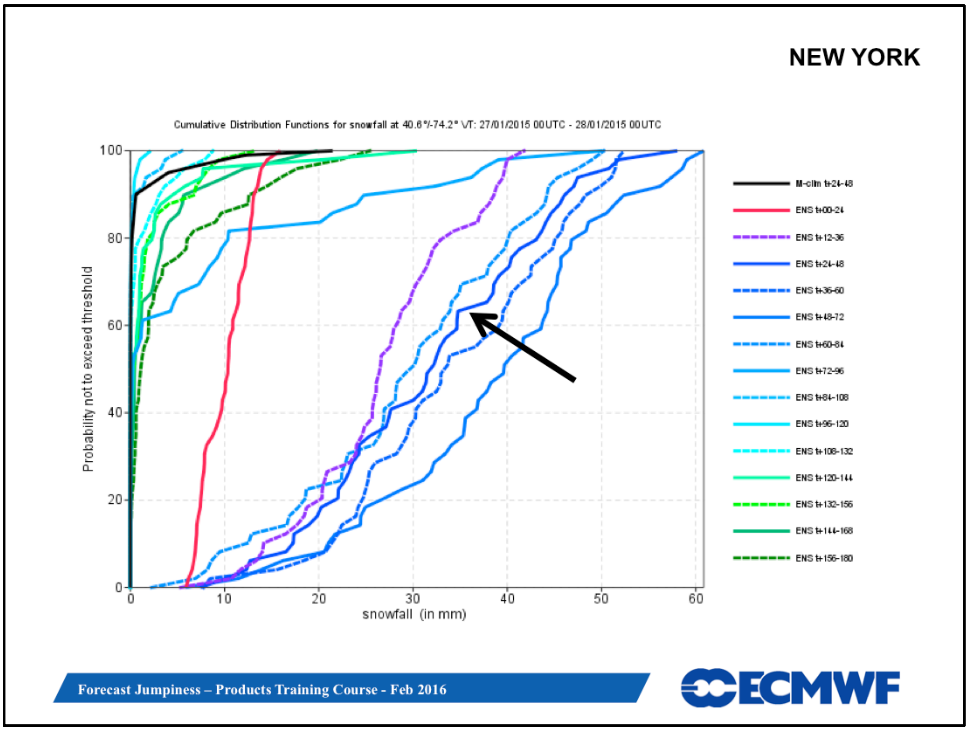


This is a CDF for different forecast ranges (in colour) and for the climate (black)

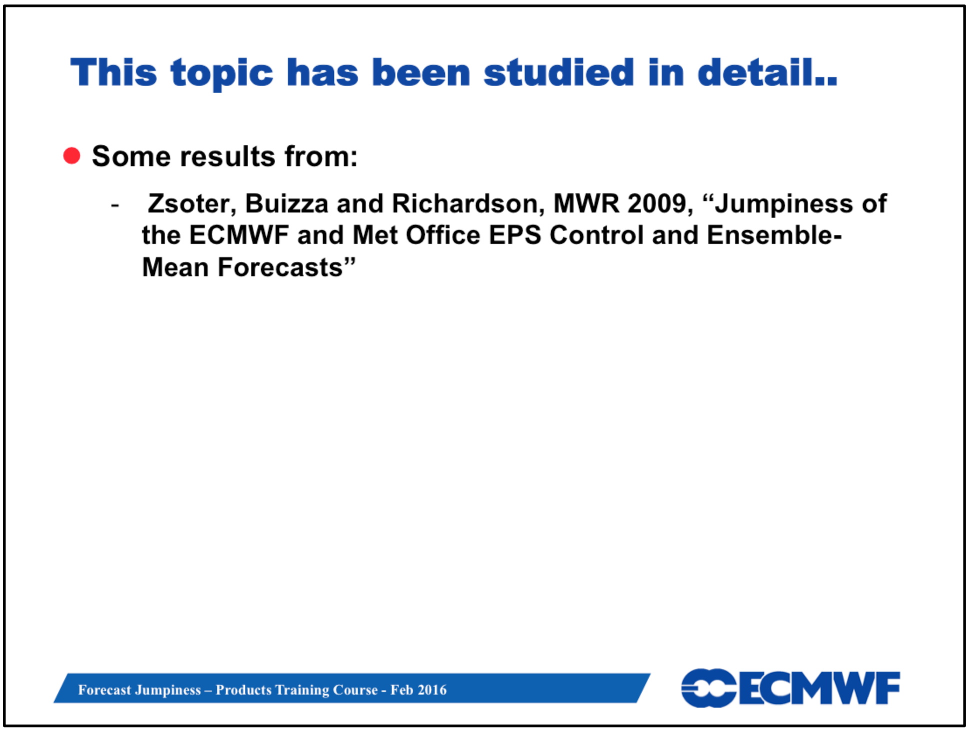
A CDF shows the whole ENS distribution at one point. One can deduce the probability of exceed a certain threshold, how confident the ensemble is and how consistent.

In this case the red line is quite vertical (compared to others in the plot) --→ ensemble is confident with small spread

The last few forecasts are reasonably close to each other indicating consistency



Compared to before the red line is neraly vertical (spread of values really small) and the lines are quite far apart indicating inconsistency between forecasts started with different base times



Make a quick summary of the study in bullet points

Lesson

- Make more use of the Ensemble distribution, rather than the Control (or HRES)
- Especially at longer lead times (say ≥ ~ 4 days)
- Forecasts will be less jumpy if the ensemble mean is sued
- Beware however that strong gradients are always weakened in the ensemble mean

- At short lead times the picture is more complicated..

An explanation

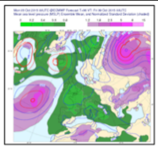
- The behaviour we see at both short and long ranges seems to be an inevitable (and necessary) consequence of ensemble design
- Perturbations, *positive and negative*, spread the ensemble forecasts either side of the Control early on, so any jumps in Control (and HRES) will likely be reflected in ENS also (at time zero ENS mean = Control)
- Later on in the forecast non-linearity becomes more important, and so the ENS members are less of a slave to the Control (and HRES): the ENS mean (with the usual caveats) result in a less jumpy and more reliable forecast, on average

Should we be more cautious about following a jumpy forecast ?

- From a psychological and customer perspective, we don't want to give out forecasts that jump around
- But at the same time it is likely that in absolute terms forecasts that *don't* get adjusted whenever there is a jump will average out to be more accurate in the long term
- Remember that, strictly, flip-flops occur half the time!
- We have seen that we should not extrapolate a trend, but nor should we revert back if we see a jump
- This is a difficult area, affected by customer perception…

- So is there any evidence to say that jumpiness means forecasts are likely to be less accurate?

Errors



- The average error of the ENS mean relates quite strongly to the absolute spread in the ensemble, as one would hope and expect. Larger spread implies larger errors, on average.
- However errors show only a very weak dependence on whether or not the ensemble mean forecast has been jumpy

So is there any evidence to say that jumpiness means forecasts are likely to be less accurate?

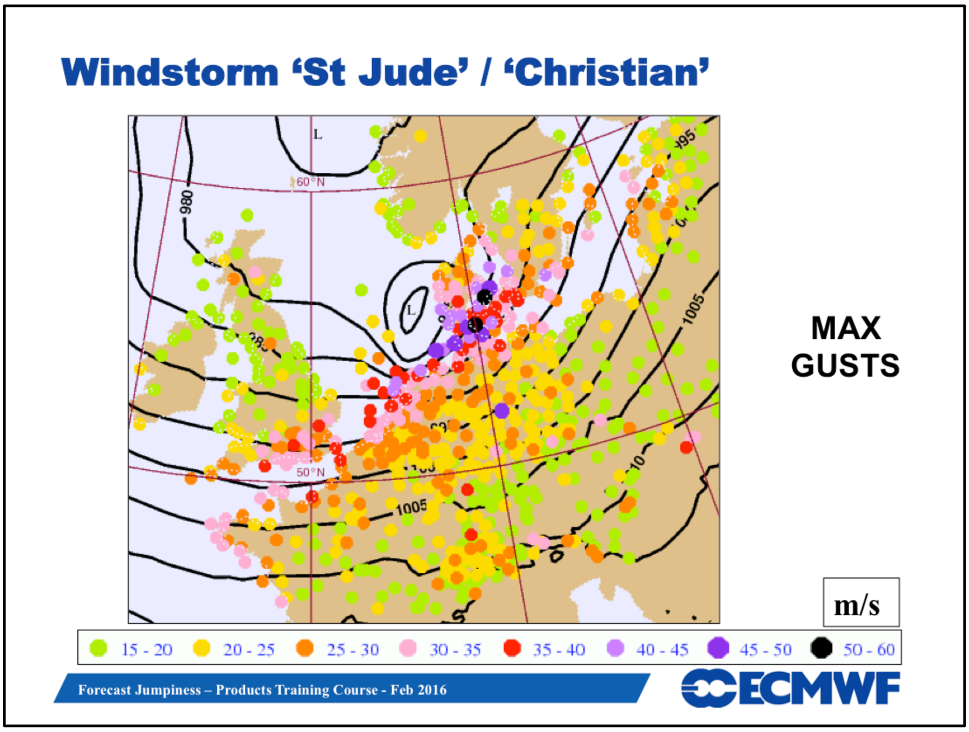
No, not really

?

Dynamical sensitivities = extra jumpiness?

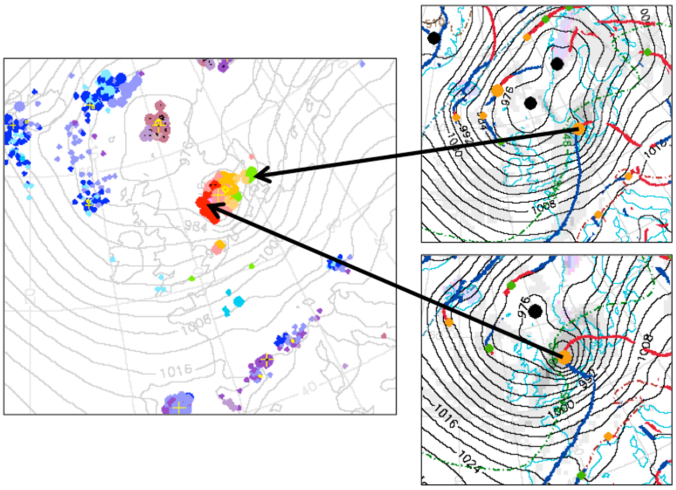
- Should we expect more jumps in potential severe weather situations, at *short lead times*, because of 'dynamical sensitivity' ?
- By dynamical sensitivity we mean 'finely balanced' situations, where slight changes can have a big impact:
  - eg – precise phasing of upper and lower levels needed for explosive cyclogenesis
  - eg – high precipitation intensities can turn rain into (surprise) snow, due to cooling through melting
- Illustrate, briefly, with a windstorm example (Christian, St Jude: 28 October 2013)

Further discussed in ECMWF Newsletter Spring 2014



This is another example where we observed a jump between one forecast and the next

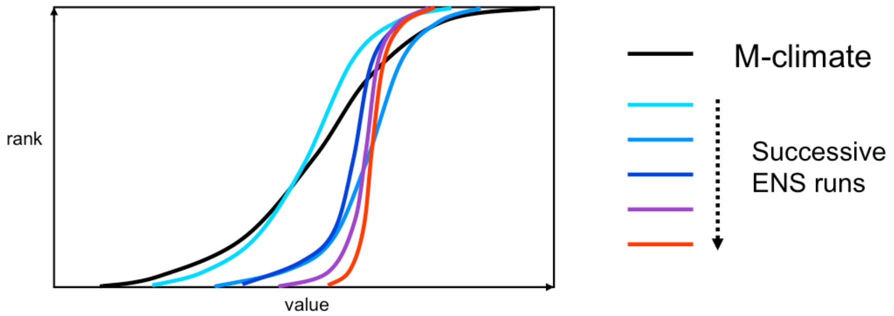
36h forecast for "Christian" – Valid 12UTC Oct 28th 2013



Large spread
=
Large uncertainty

Is this OK at short lead times ?

How ‘should’ CDFs behave in successive ENS runs?

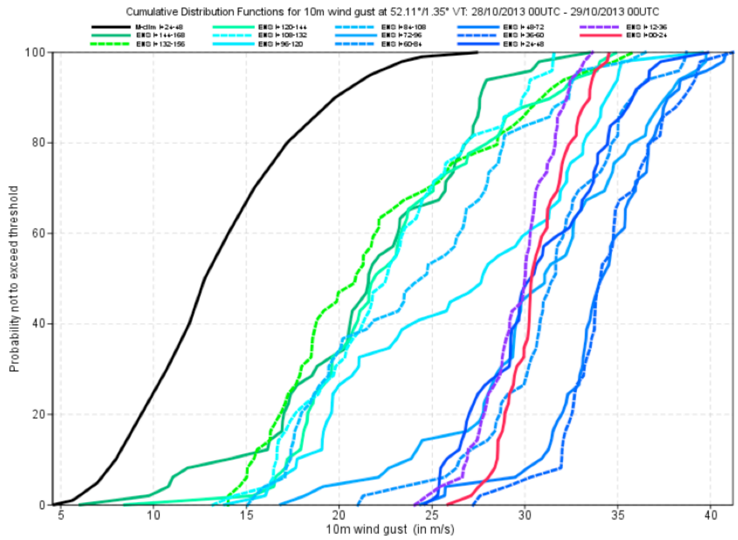


- At long lead times forecast CDF may be similar to the M-climate.
- Lateral variations in CDF position between successive runs should, mostly, become less (with time).
- CDF will tend to become steeper (with time), implying higher confidence.

ECMWF

Wind Gust CDFs - E England

OK!



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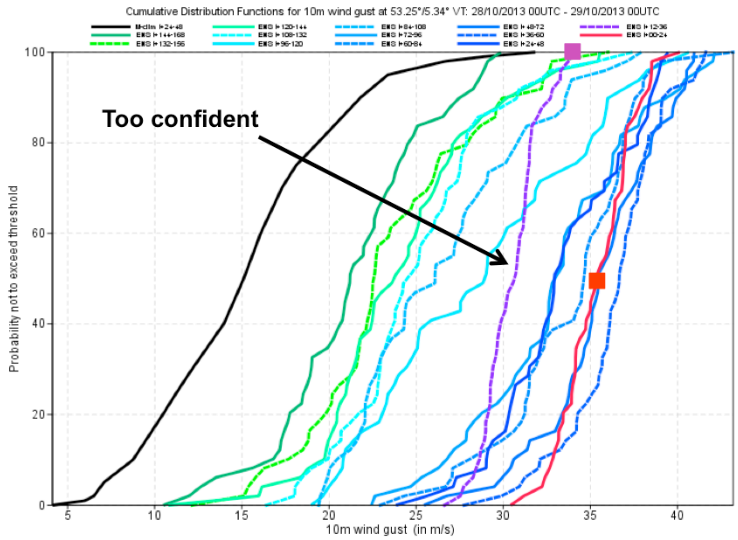
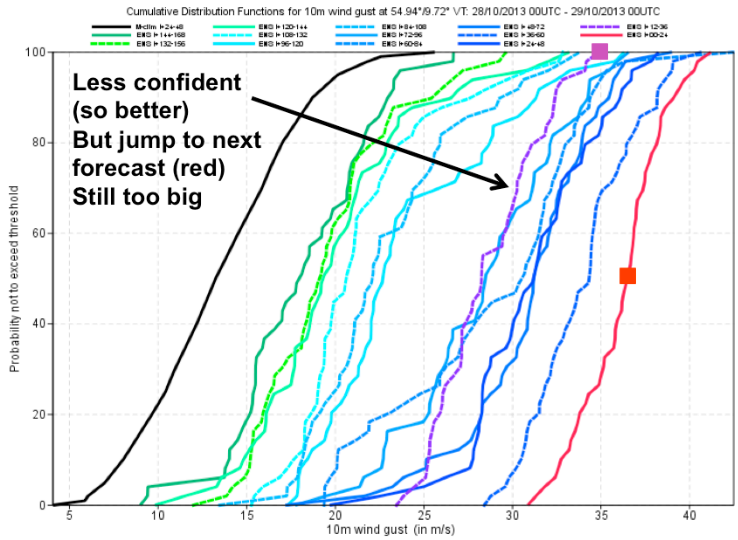
Wind Gust CDFs - Netherlands



ECMWF

Wind Gust CDFs - Denmark



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What can we learn?

- Spread was high (eg from Dalmatian chart, but also other measures)
  - So this highlights uncertainty

- BUT, from the CDFs, it seems that for this case the spread was probably not great enough (using a simple metric of “median > extreme of previous forecast”)

- The fine scale nature (sting jet?) and small lateral extent of the very strong winds was probably pushing the IFS to its limits!

Conclusions

- Jumpiness is not a good indicator of likely error, but spread is
- We have to expect some jumpiness, otherwise there would be something intrinsically wrong with the forecasting system
- There are however probably too many jumps, in general, which probably relates to a (slight) lack of spread in the ensemble system
- Customer aversion to jumpy forecasts is a very difficult hurdle to overcome; however following the ensemble mean pattern, particularly at longer ranges, will help
- Dynamical sensitivity – related for example to strong jets - can unfortunately increase jumpy behaviour at short ranges in severe weather situations – beware!