

# ECMWF Perspective – Storm Forecasts

Tim Hewson (+ the daily report analyst team\*)

ECMWF

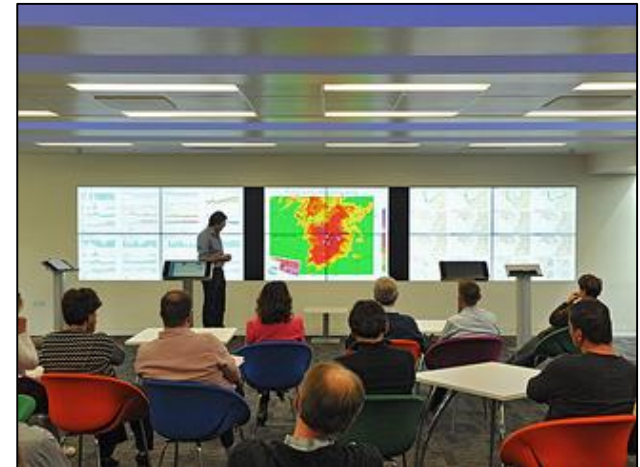
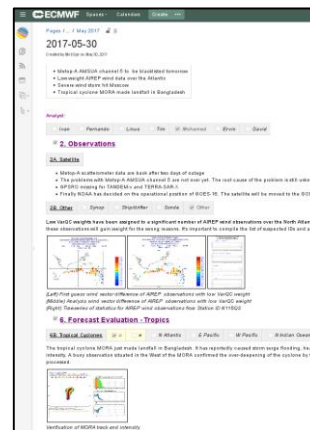
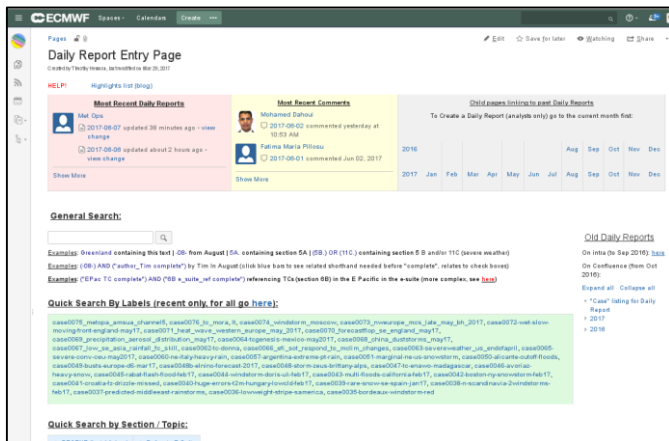
[tim.hewson@ecmwf.int](mailto:tim.hewson@ecmwf.int)

\* Ivan Tsonevsky, Fernando Prates, David Lavers,  
Ervin Zsoter, Linus Magnusson, Mohamed Dahoui



# Background

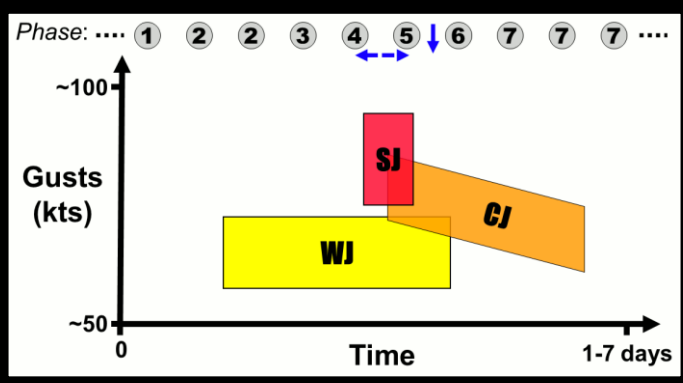
- ECMWF has a team of “duty analysts”
  - Work weekdays in the weather room pod
  - Focus on: model performance / analysis / severe weather events / etc
  - Respond to emails from users regarding model performance
  - “Daily report” put together each day
  - Culminates in a “weather discussion” for all of ECMWF each Fri afternoon
- One focal point is storms, of all types
- Here we present examples, primarily from daily reports
  - Further work / areas for improvement will be highlighted



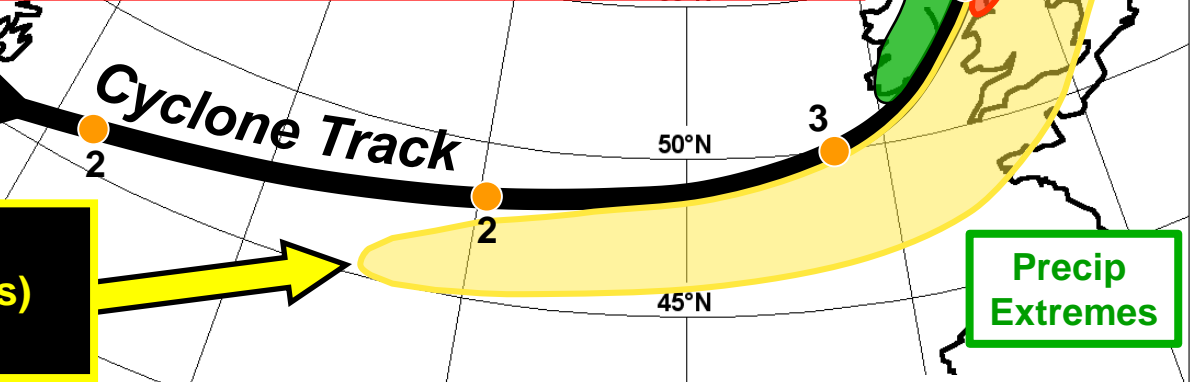
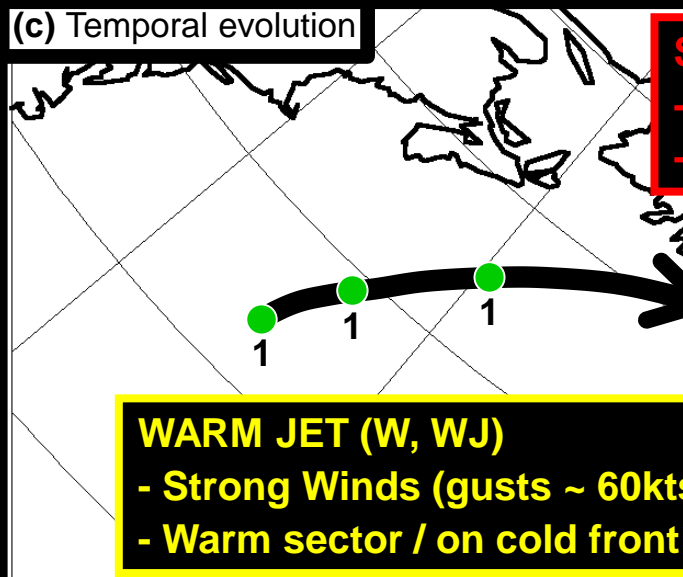
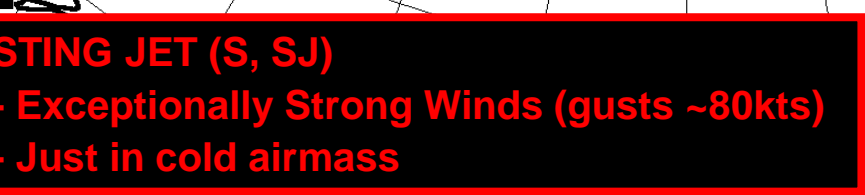
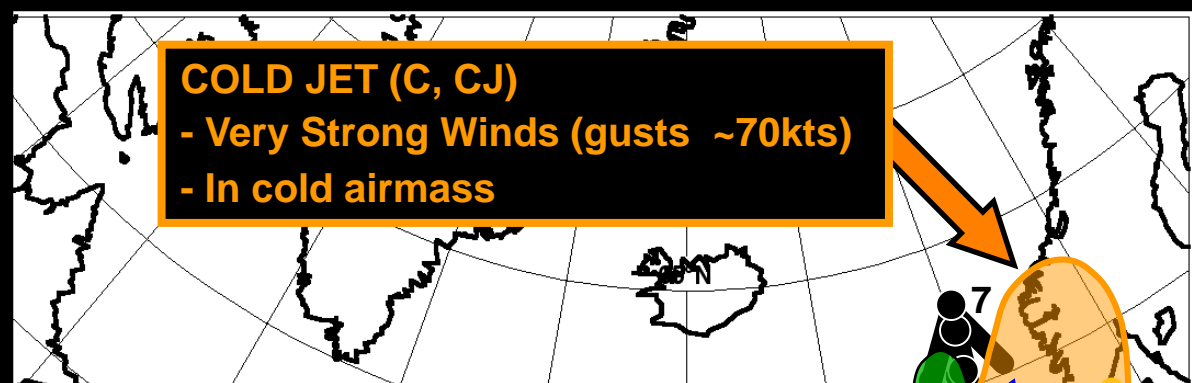
# Outline

- Cyclone development – conceptual model
  - Most (?) severe weather in the extra-tropics relates to cyclones / rapid cyclogenesis
- Windstorms
  - “Leiv” (France, Spain, 4 Feb 2017)
  - “Zeus” (France, 6 March 2017)
- Snowstorms
  - “Egon” (UK+.., 12 Jan 2017)
- Rainstorms
  - Middle East (mid Feb 2016)
  - Warm air rainstorms (Ireland +.., 15 May 2017)
- Convective Storms
  - Moscow storm (19 May 2017)
- Summary

# Windstorm Conceptual Model (Hewson and Neu, 2015, Tellus)

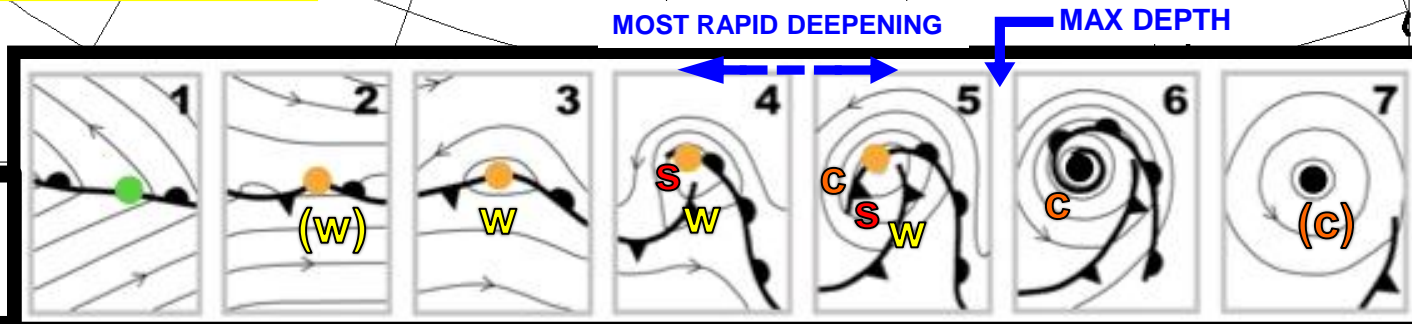


(c) Temporal evolution



(a) Track + footprints

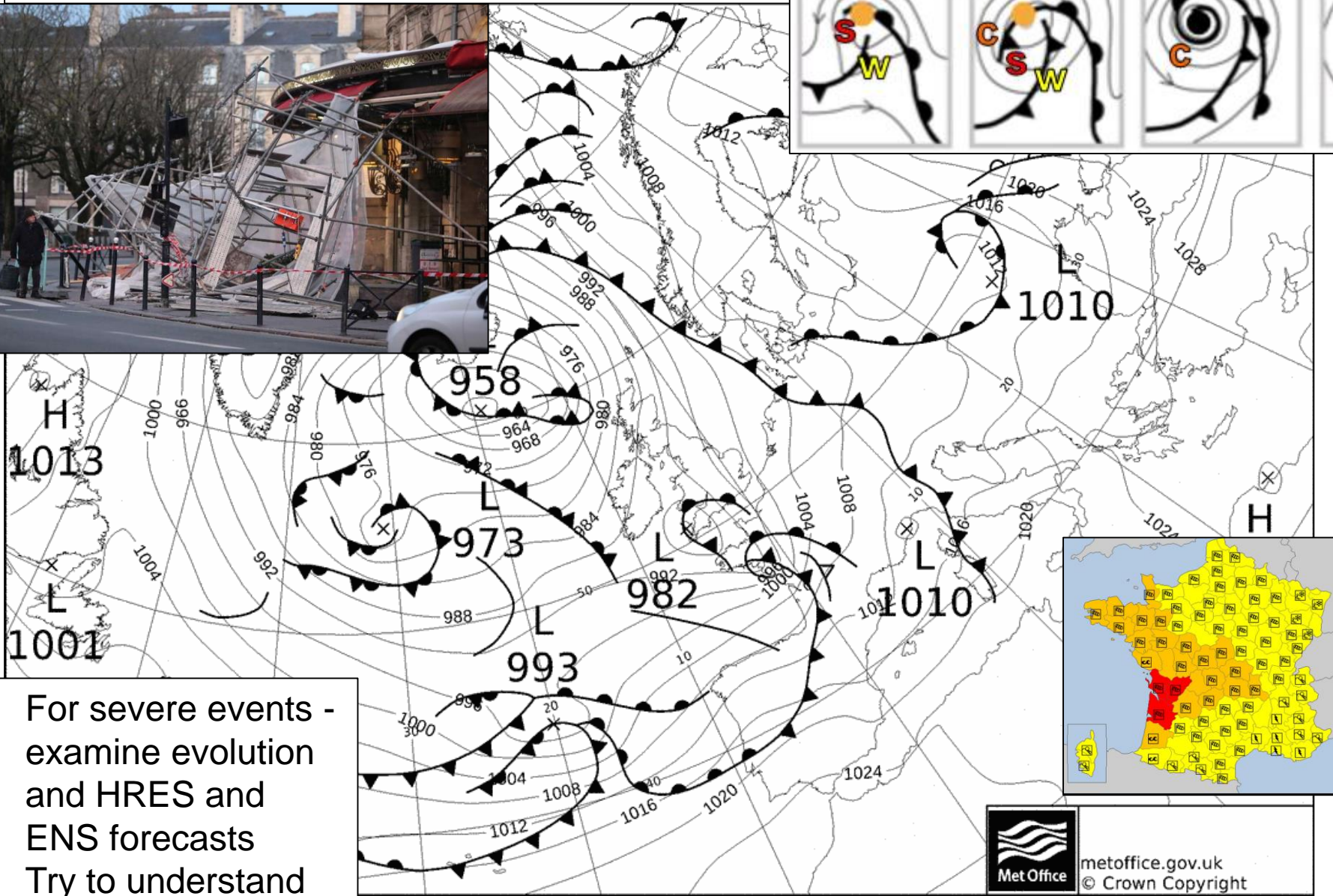
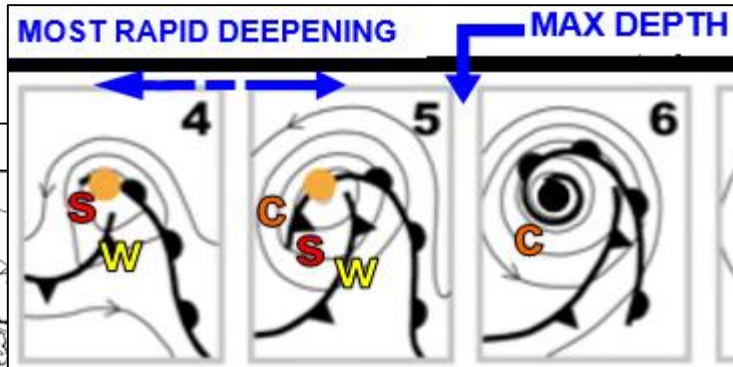
(b) Cyclone life-cycle phases:





# Windstorm "Leiv"

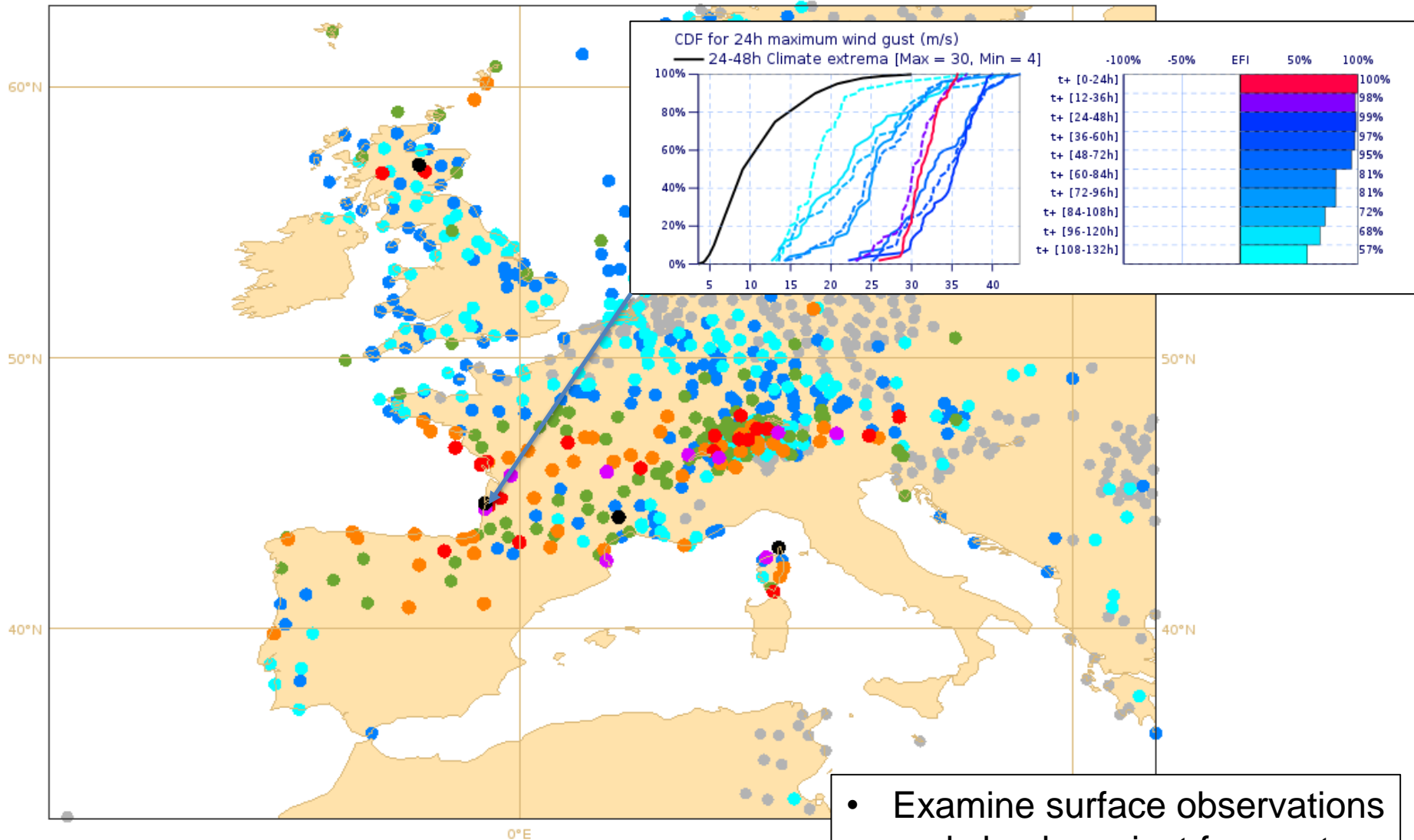
03-02-2017 12 UTC



- For severe events - examine evolution and HRES and ENS forecasts
- Try to understand



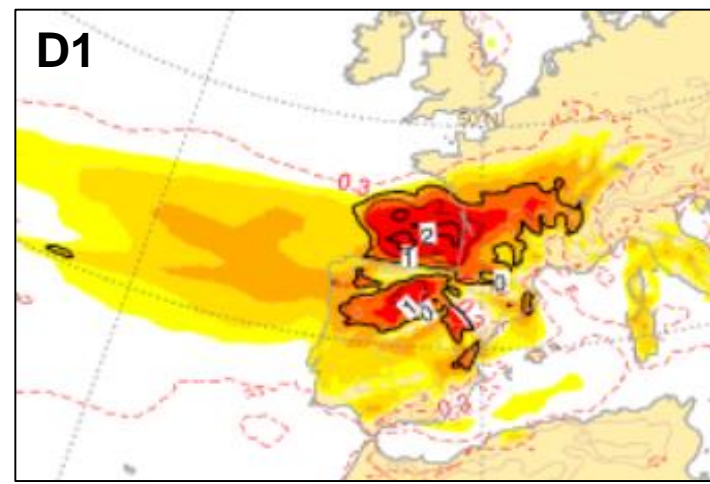
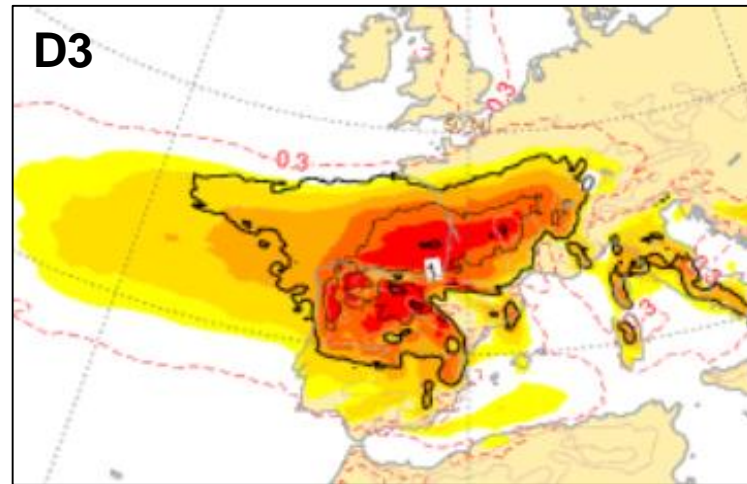
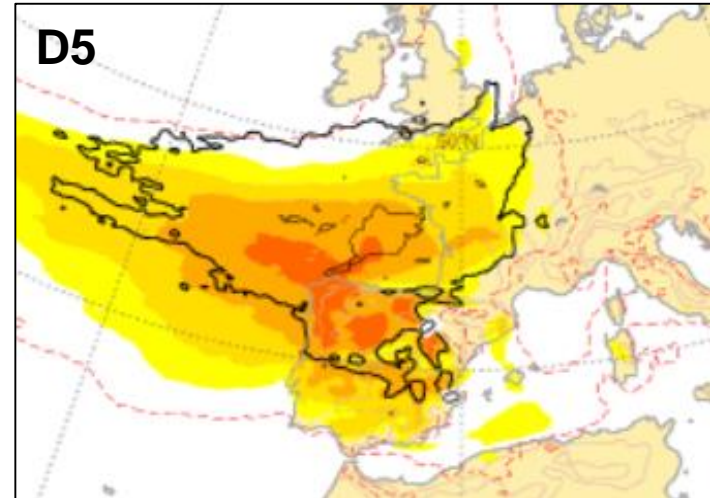
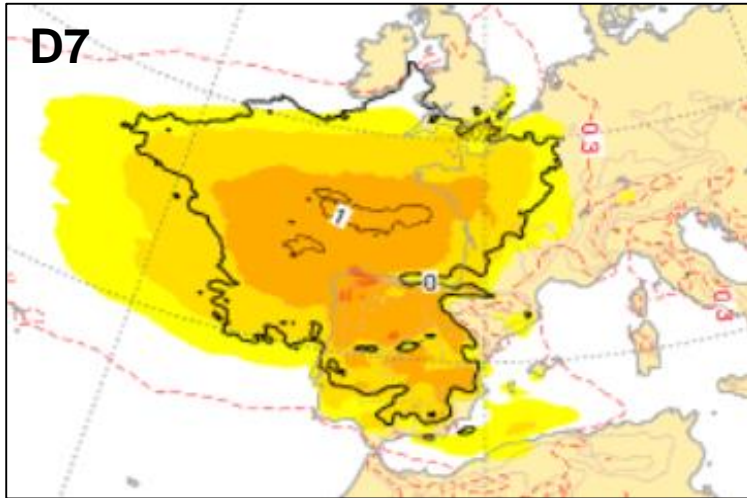
Maximum wind gust observations (m/s) 20170204 UTC - 20170205 UTC



- Examine surface observations and check against forecasts

# Max wind gust EFI/SOT

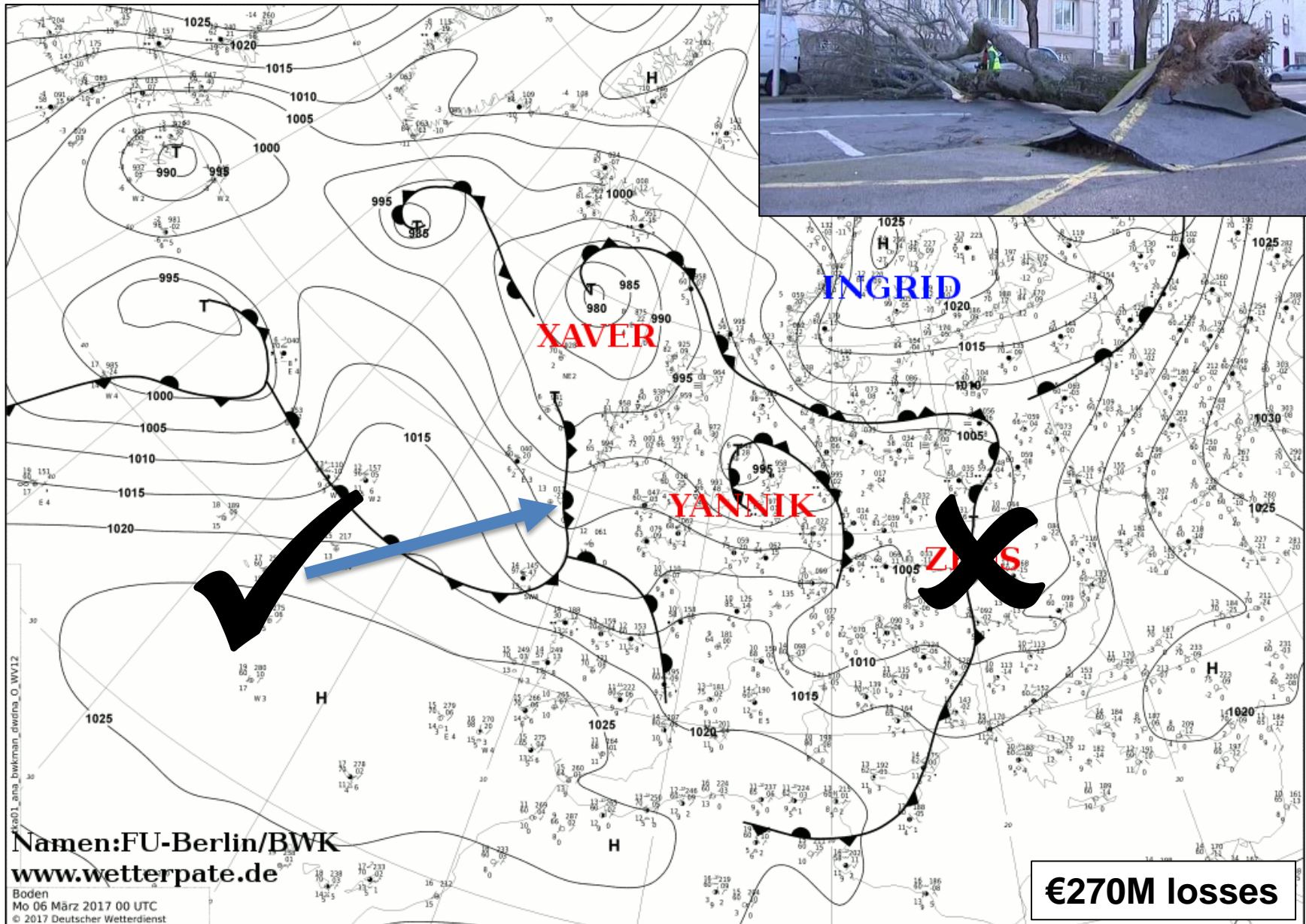
- See how the EFI/SOT did



CDFs, EFI and SOT behaved as we would hope for a major storm ☺



# Windstorm "Zeus" (not!)



Namen: FU-Berlin/BWK

[www.wetterpate.de](http://www.wetterpate.de)

Boden  
Mo 06 März 2017 00 UTC  
© 2017 Deutscher Wetterdienst

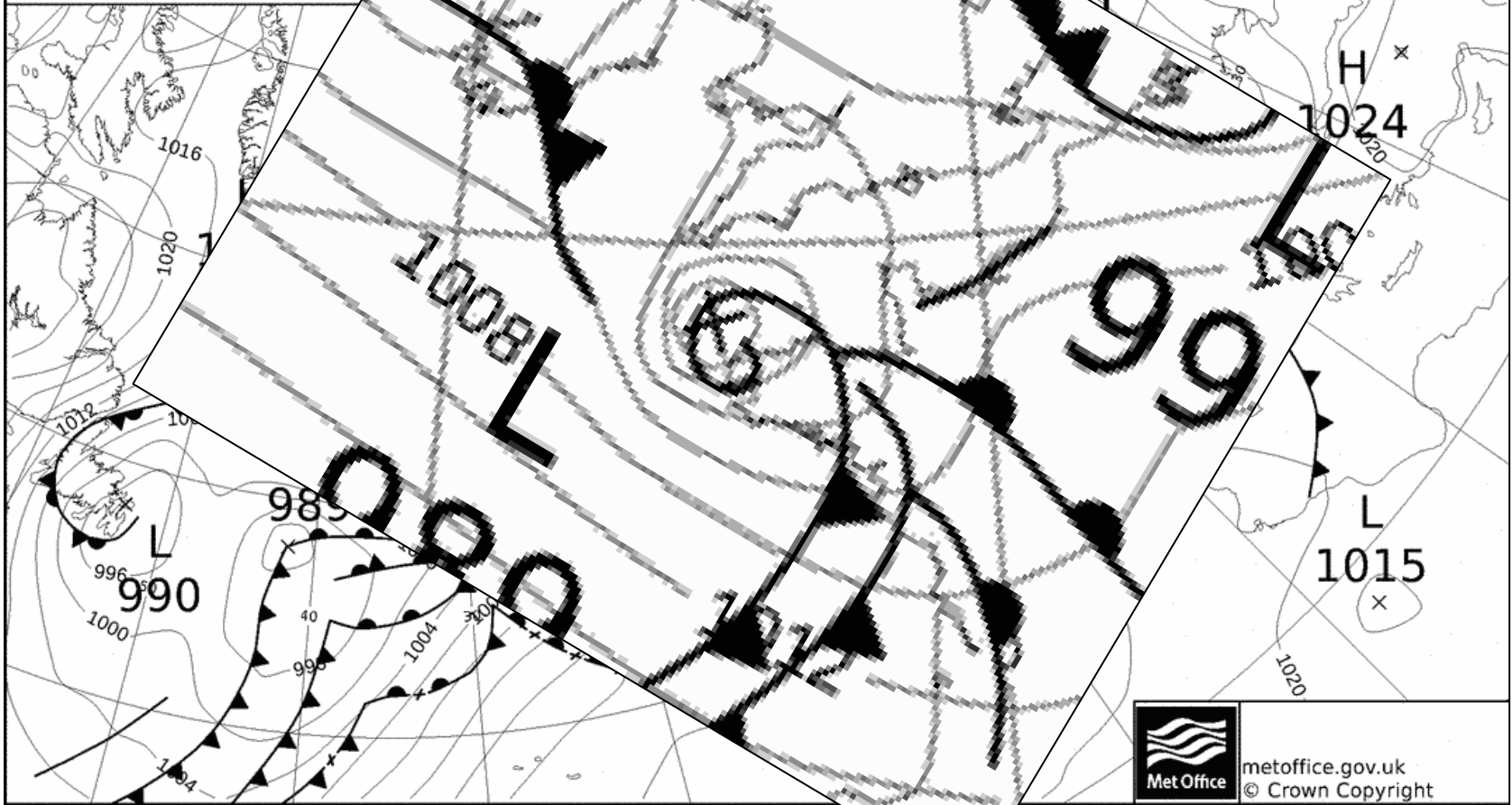
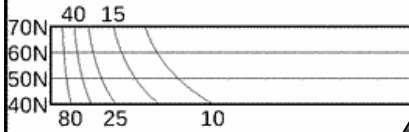


06-03-2017 06 UTC

Archived by [www.wetter3.de](http://www.wetter3.de)

Analysis chart valid 06 UTC MON 06 MAR 2017

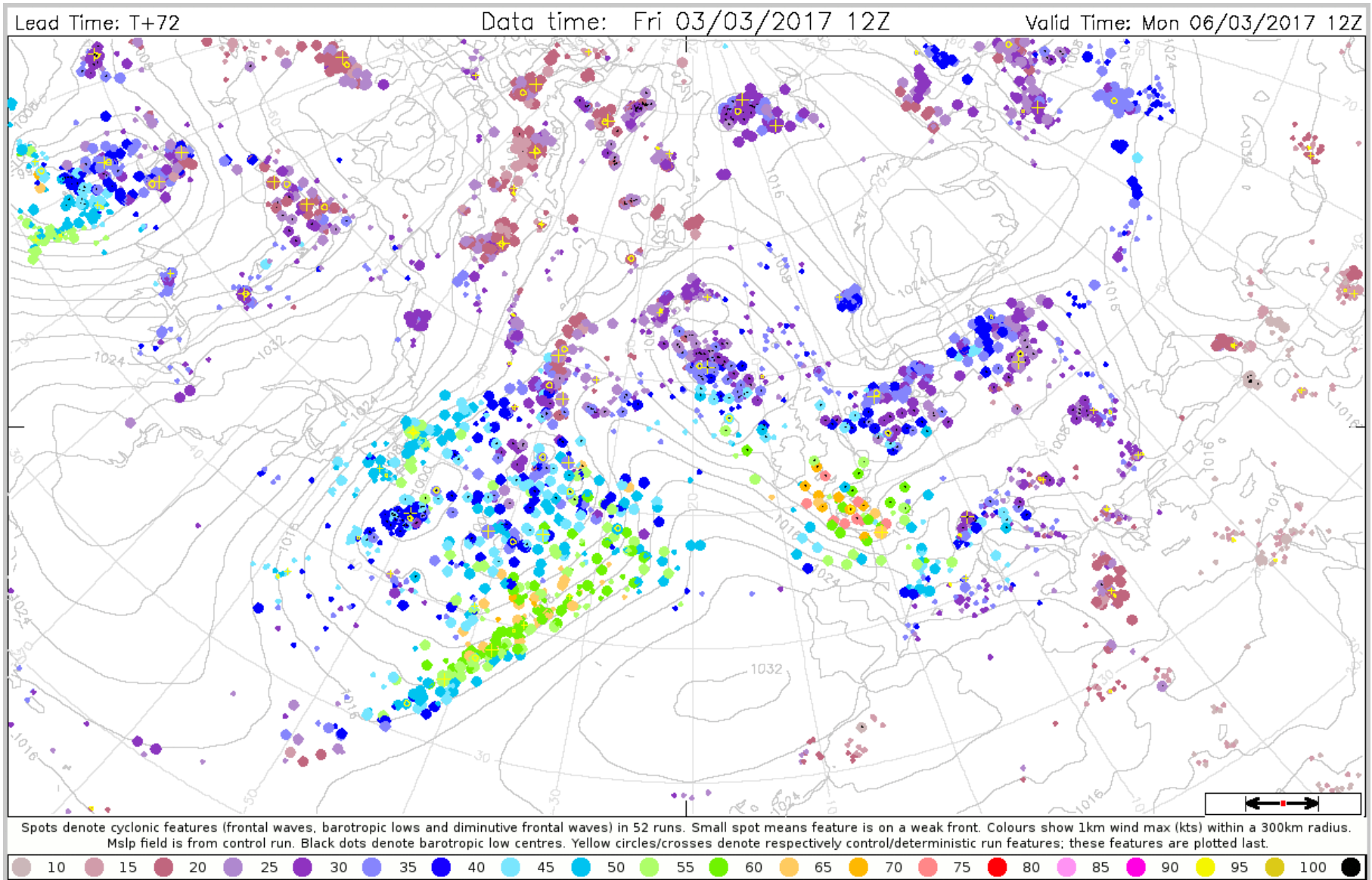
**Geostrophic wind scale**  
in kt for 4.0 hPa intervals



metoffice.gov.uk  
© Crown Copyright

- Study aspects of particular cases following enquiries from users (in this case Meteo-France)

# Dalmatian charts, coloured by max wind attribute

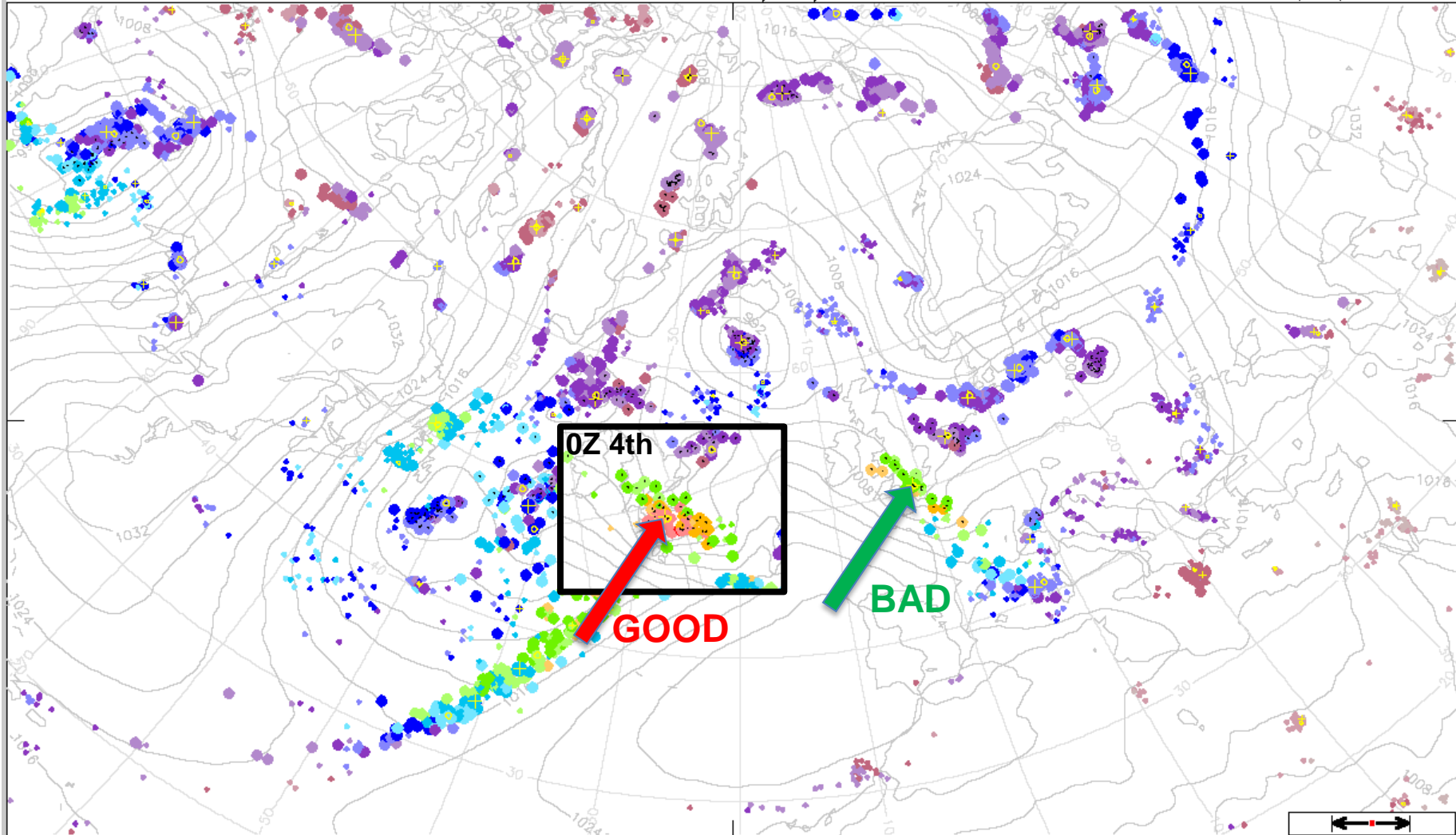


# “Poor” Forecasts from 0Z 5<sup>th</sup> March

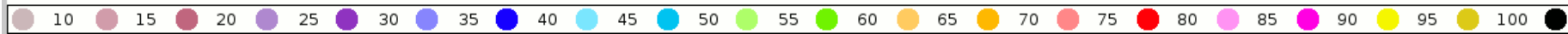
Lead Time: T+36

Data time: Sun 05/03/2017 00Z

Valid Time: Mon 06/03/2017 12Z

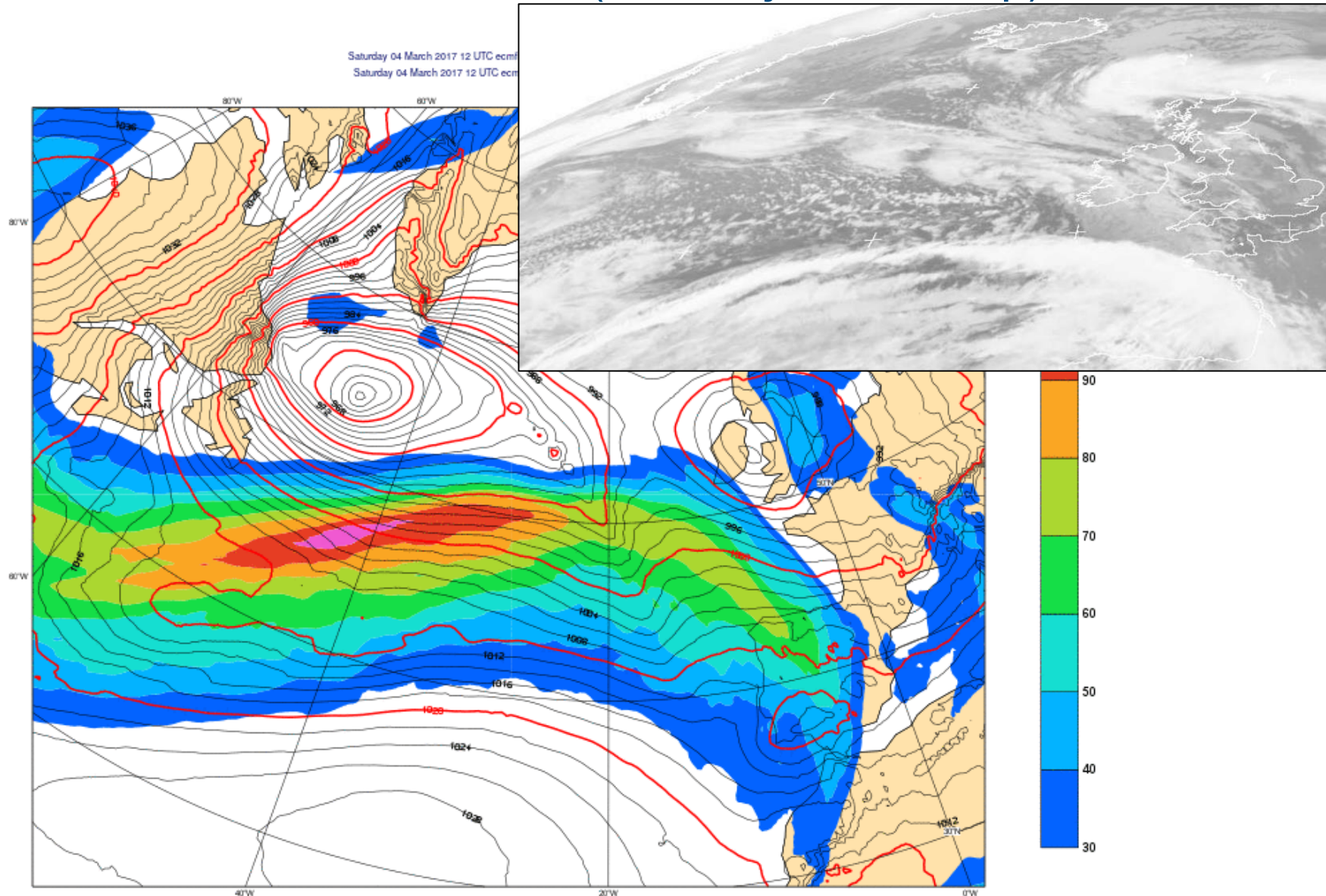


Spots denote cyclonic features (frontal waves, barotropic lows and diminutive frontal waves) in 52 runs. Small spot means feature is on a weak front. Colours show 1km wind max (kts) within a 300km radius. Mslp field is from control run. Black dots denote barotropic low centres. Yellow circles/crosses denote respectively control/deterministic run features; these features are plotted last.





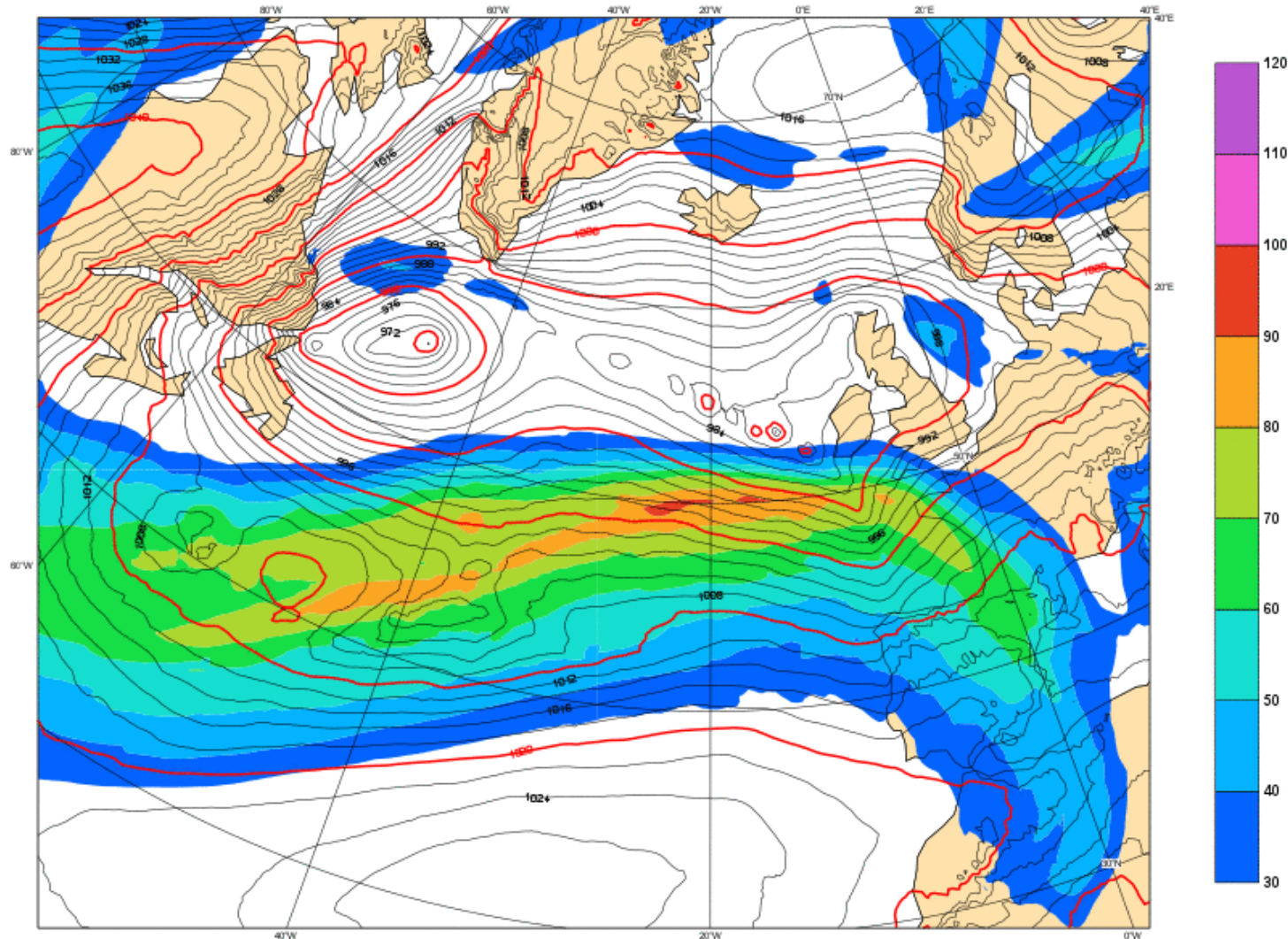
# Evolution in “Good” forecast (300mb jet and mslp)



Warm air cyclone crosses jet and develops further as left exit feature, with added input from latent heat release

# Evolution in “Bad” forecast (300mb jet and mslp)

Sunday 05 March 2017 00 UTC ecmf surface Mean sea level pressure  
Sunday 05 March 2017 00 UTC ecmf 300 hPa U component of wind

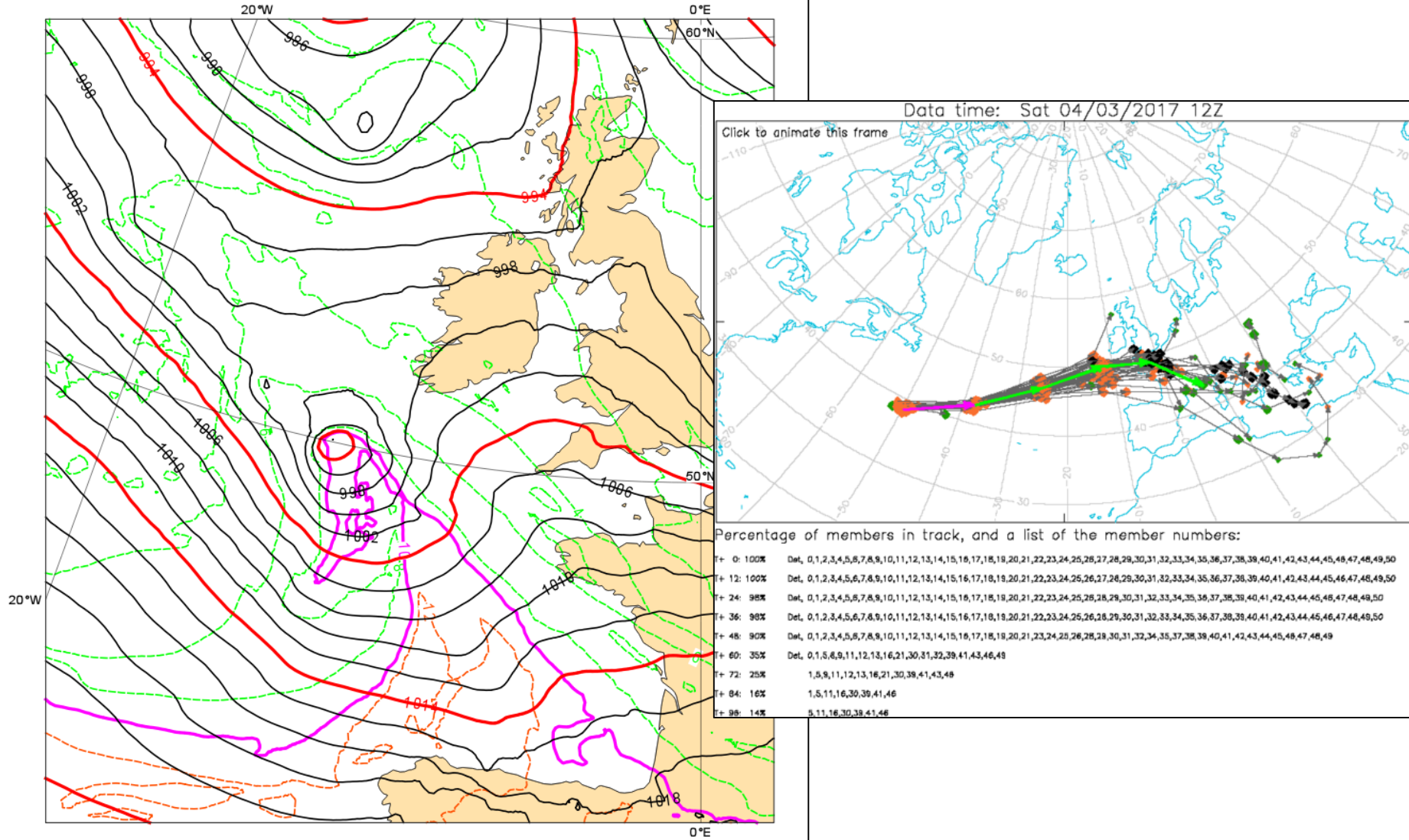


Cold air cyclone develops afresh, also as left exit feature, but with relatively small input from latent heat release



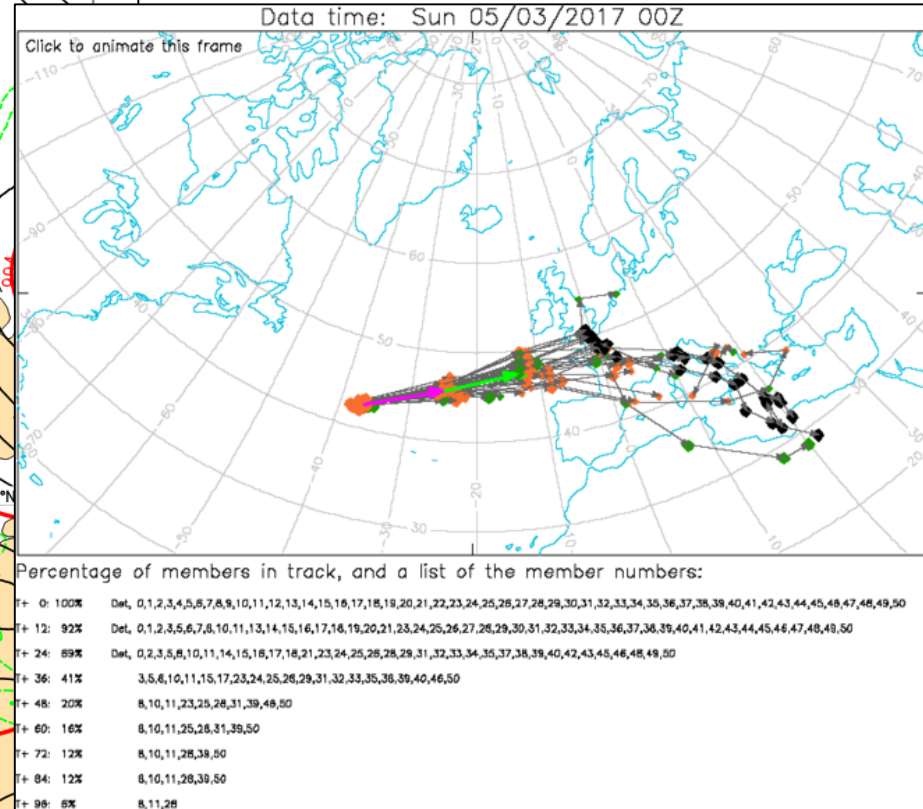
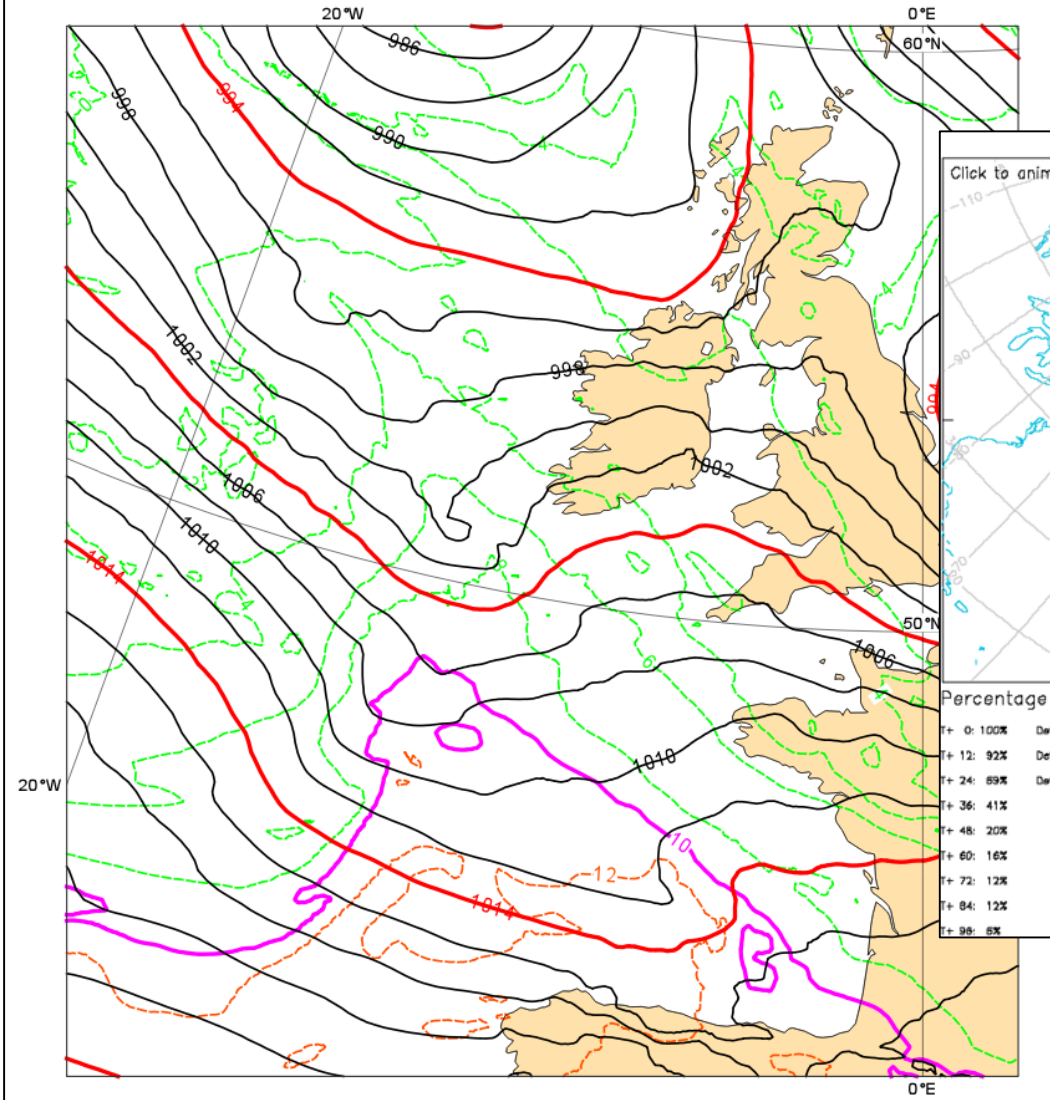
# Good

Saturday 04 March 2017 12 UTC ecmf t+36 VT:Monday 06 March 2017 00 UTC surface Mean sea level pressure  
Saturday 04 March 2017 12 UTC ecmf t+36 VT:Monday 06 March 2017 00 UTC 850 hPa Temperature



# Bad

Sunday 05 March 2017 00 UTC ecmf t+24 VT:Monday 06 March 2017 00 UTC surface Mean sea level pressure  
 Sunday 05 March 2017 00 UTC ecmf t+24 VT:Monday 06 March 2017 00 UTC 850 hPa Temperature



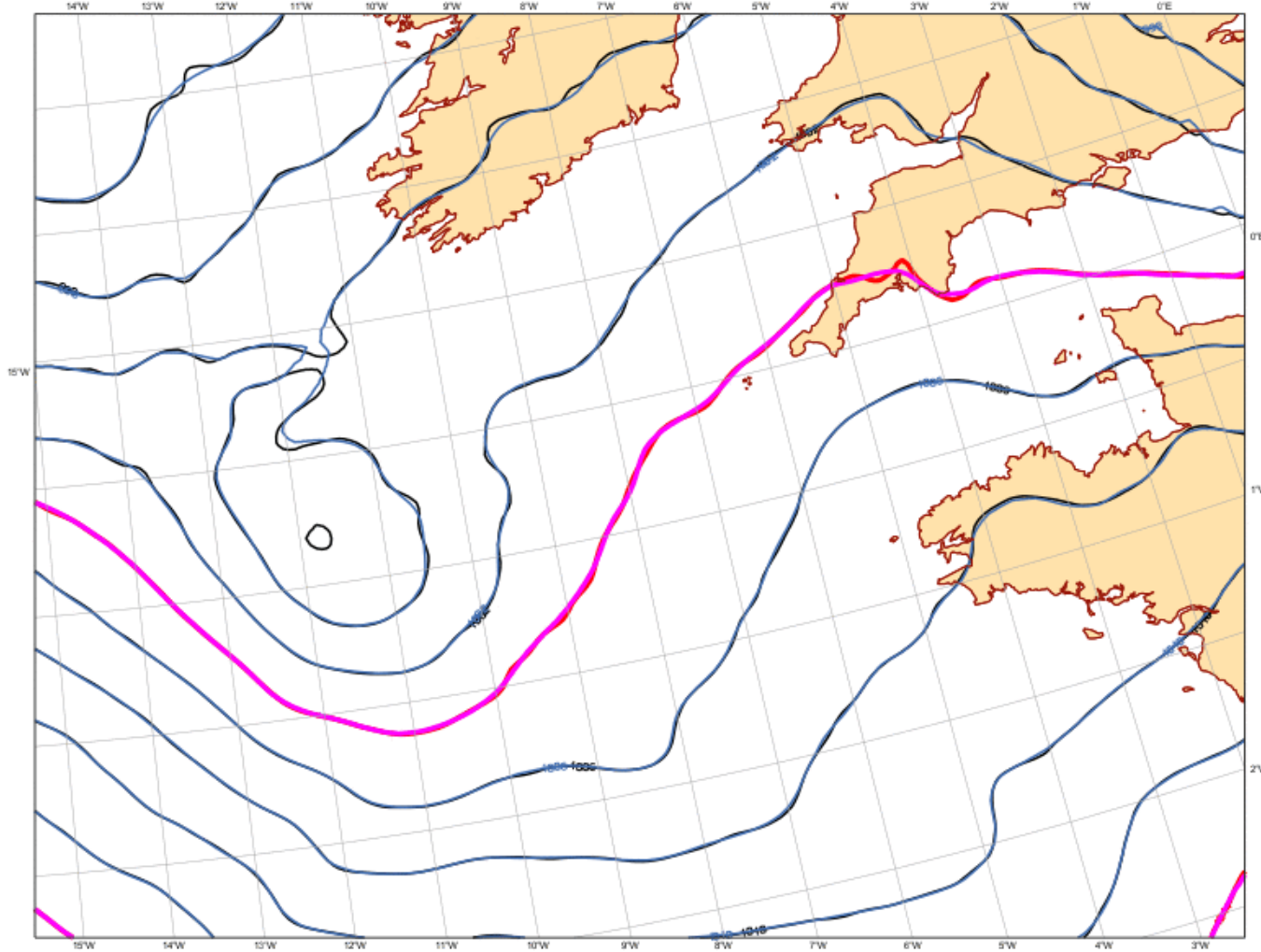


# What caused the “jump” ?

- Standard increment charts examined (1000mb and 200mb)
  - Values in N Atlantic larger than usual but hard to attribute changes
- Interactive ENS member selection:
  - Traced back the few good members in the “Bad” 00Z 5<sup>th</sup> forecasts
  - Unfortunately nothing clearly set these apart from the rest at data time
  - So detailed observation investigations will not provide concrete conclusions
- Need to look at full 3D structure of increments/jets/good members to understand
  - Complex! Seems to be very non-linear
  - New tools for 3D jet core identification now developed – may help
- Is there a resolution limitation (very small storm) ?...

# “Good” shorter range forecasts compared – HRES vs Control

Monday 06 March 2017 00 UTC ecmf surface Mean sea level pressure  
Monday 06 March 2017 00 UTC ecmf surface Mean sea level pressure

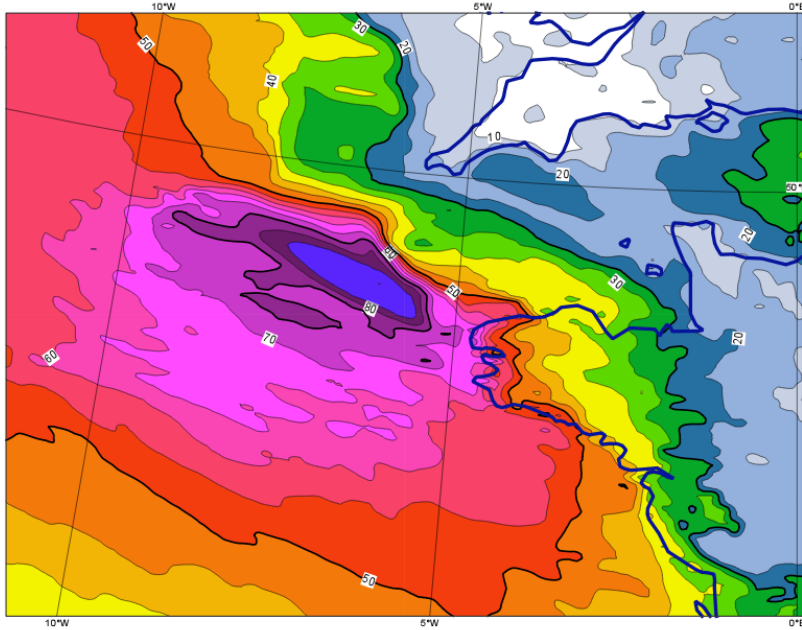


2mb interval

HRES has  
more rapid  
intensification

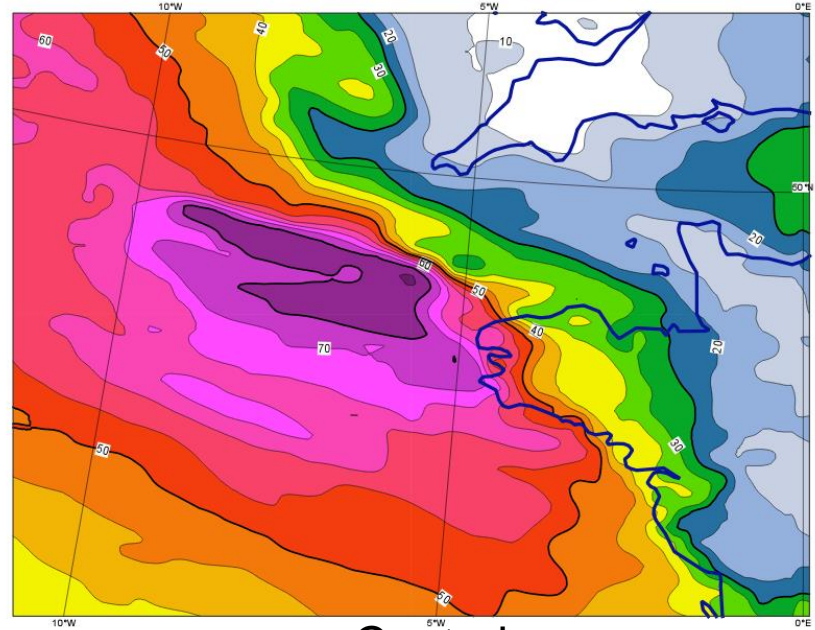
# Max Gusts T+3 to T+6

Monday 06 March 2017 00 UTC ecmf Forecast t+3 VT: Monday 06 March 2017 06 UTC surface 10 metre wind gust in the last 3 hours



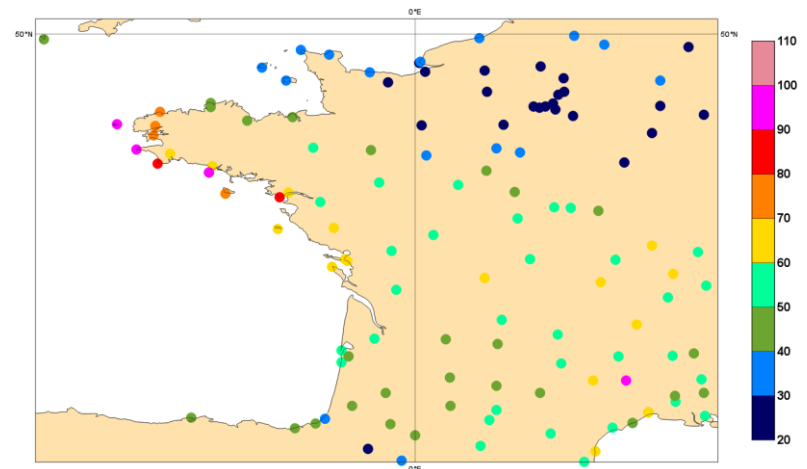
HRES

Monday 06 March 2017 00 UTC ecmf EPS Control Forecast t+3 VT: Monday 06 March 2017 06 UTC surface 10 metre wind gust in the last 3 hours



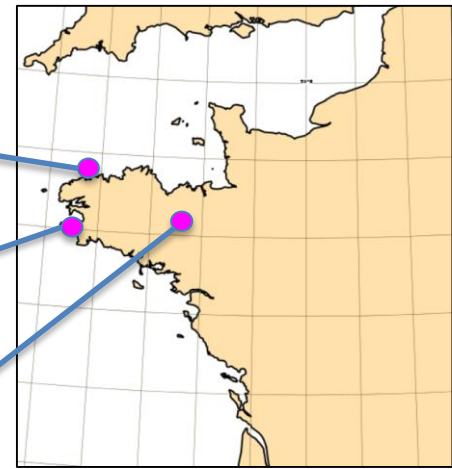
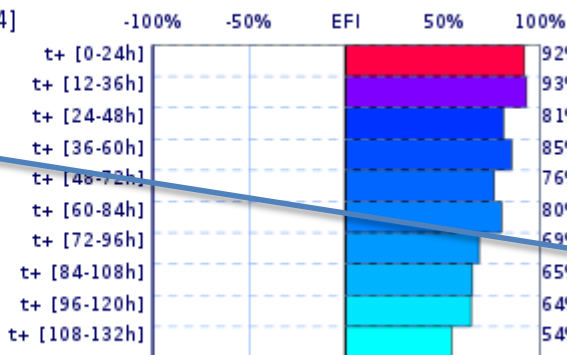
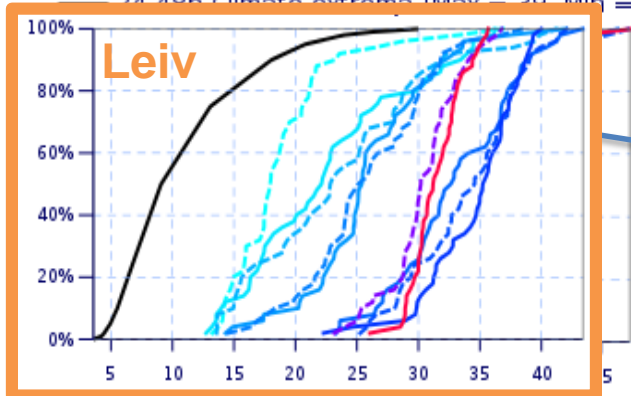
Control

Peak is 10kts stronger



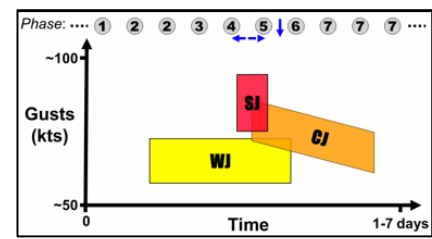
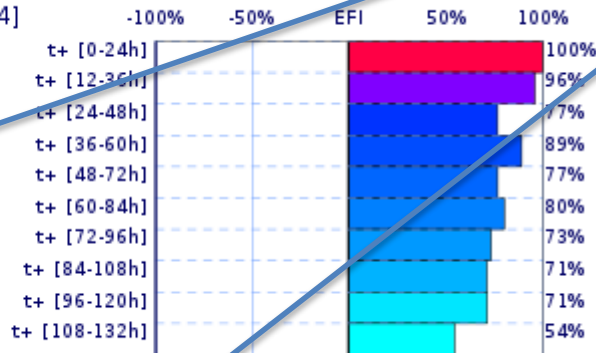
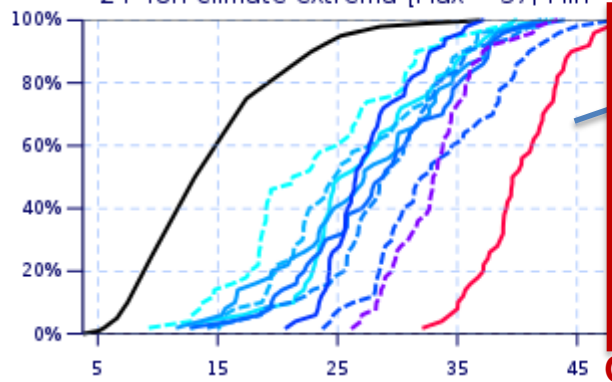
CDF for 24h maximum wind gust (m/s)

24-48h Climate extrema [Max = 29, Min = 4]



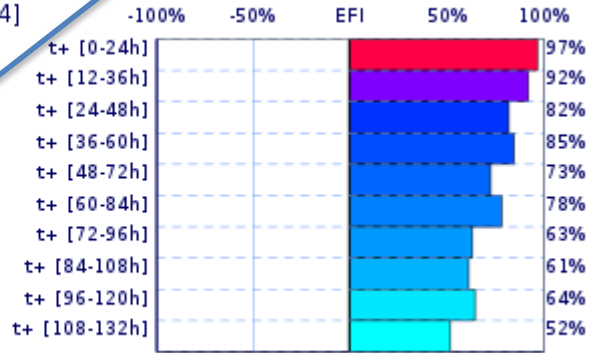
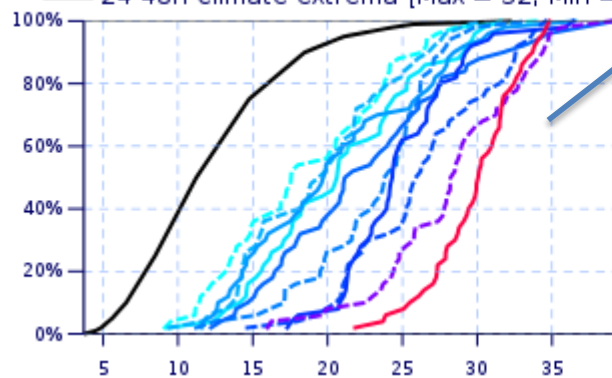
CDF for 24h maximum wind gust (m/s)

24-48h Climate extrema [Max = 37, Min = 4]



CDF for 24h maximum wind gust (m/s)

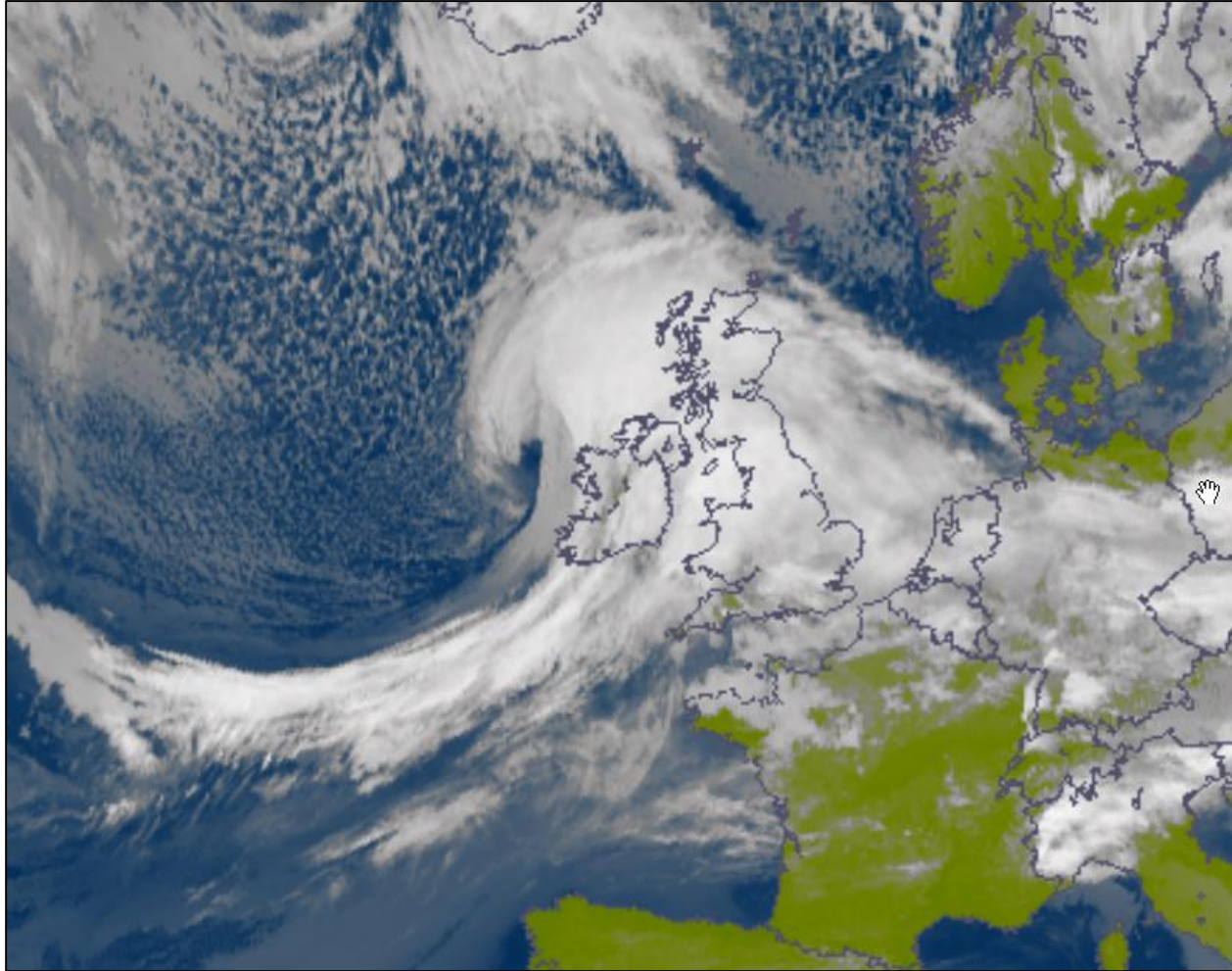
24-48h Climate extrema [Max = 32, Min = 4]



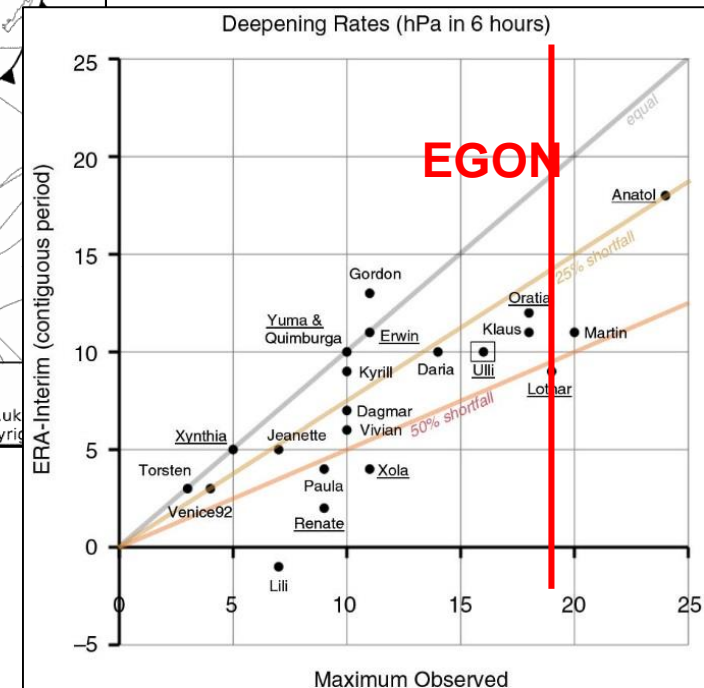
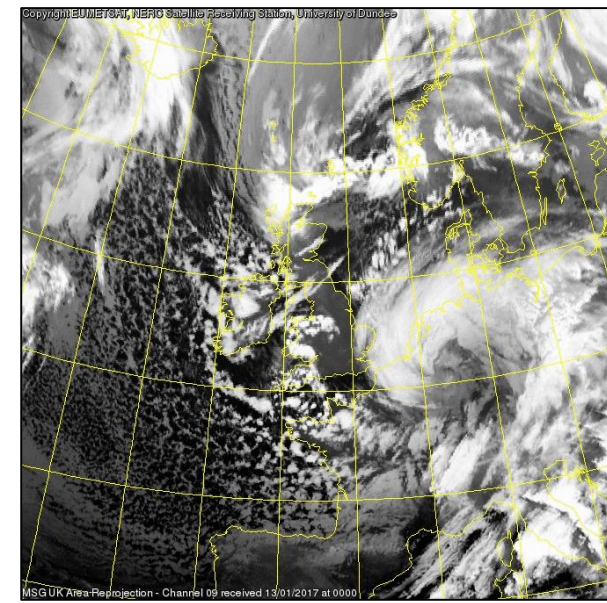
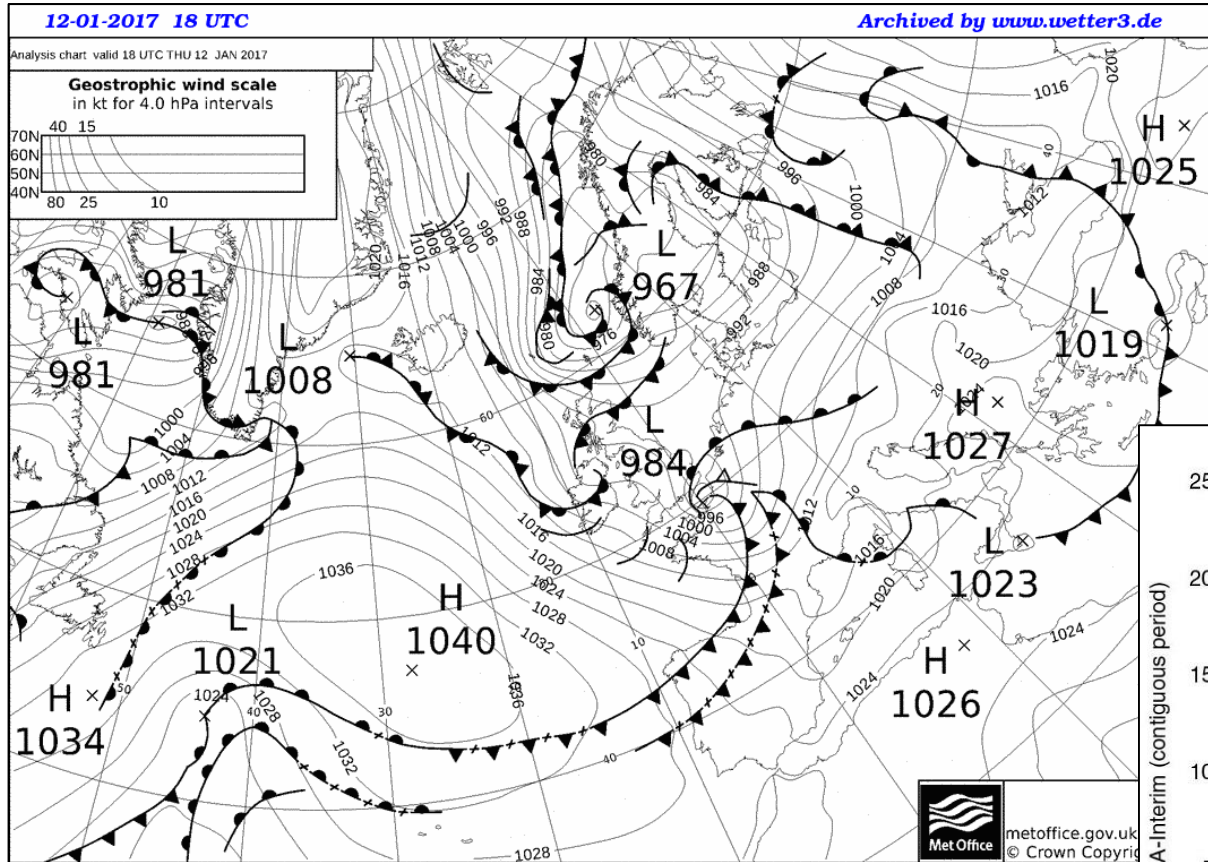
Given (1) small cyclone size, and (2) phase of development, correct prediction for specific regions was always going to be very difficult



- “Doris” also proved very problematic for ECMWF forecasts over Ireland
- This was in very much the same phase of cyclogenesis (with Sting Jet evidence)

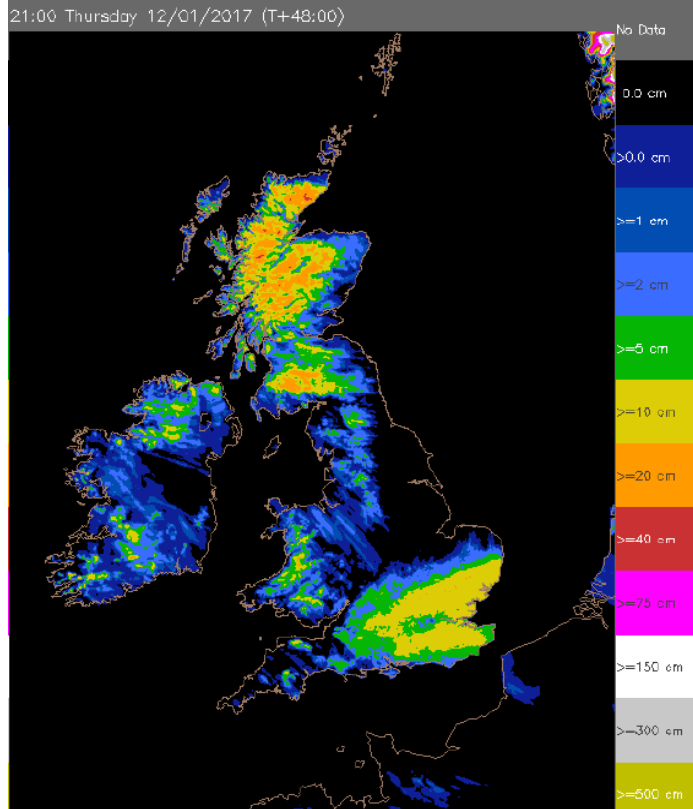


# Snowstorm "Egon"

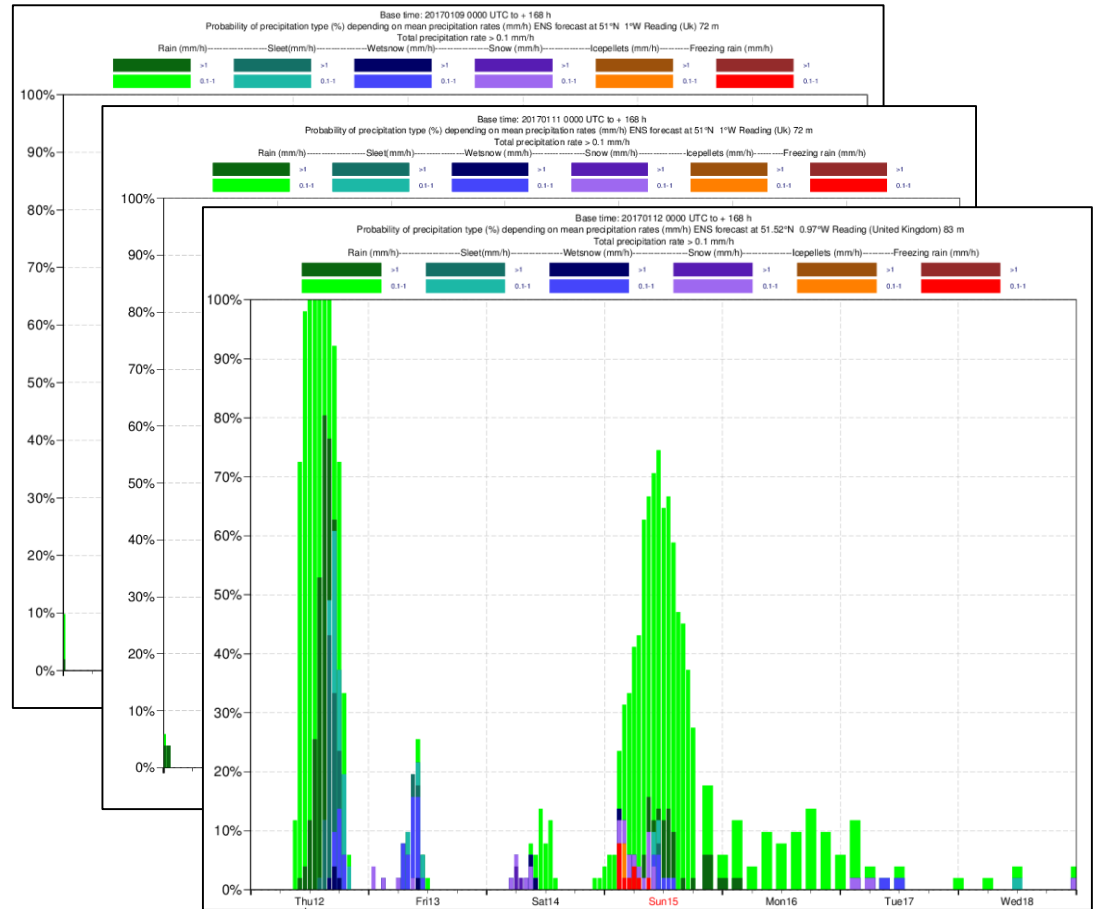


- Place storms in historical context

# Snowstorm "Egon"



## Reading Ppn Type



- Intercompare with other models
- Test new products



Thursday 12 January 2017 06 UTC ecmf t+12 VT: Thursday 12 January 2017 18 UTC surface Mean sea level pressure

Thursday 12 January 2017 18 UTC ecmf surface Mean sea level pressure

Thursday 12 January 2017 06 UTC ecmf t+12 VT: Thursday 12 January 2017 18 UTC surface Mean sea level pressure

Thursday 12 January 2017 18 UTC ecmf surface Mean sea level pressure

Thursday 12 January 2017 06 UTC ecmf t+12 VT: Thursday 12 January 2017 18 UTC surface Mean sea level pressure

Thursday 12 January 2017 18 UTC ecmf surface Mean sea level pressure

Thursday 12 January 2017 06 UTC ecmf t+12 VT: Thursday 12 January 2017 18 UTC surface Mean sea level pressure

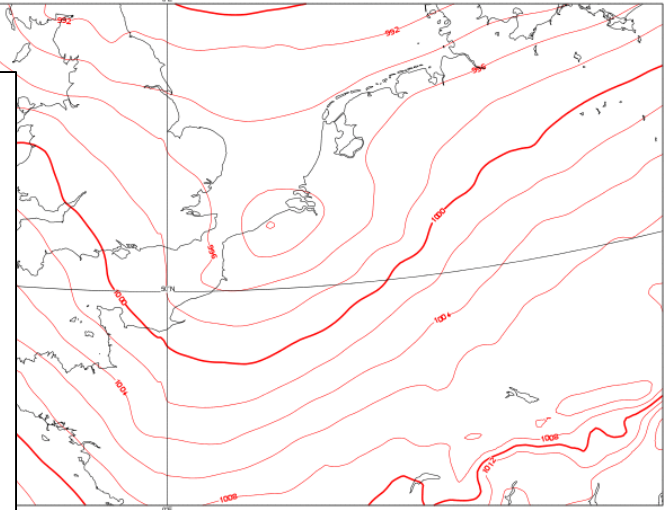
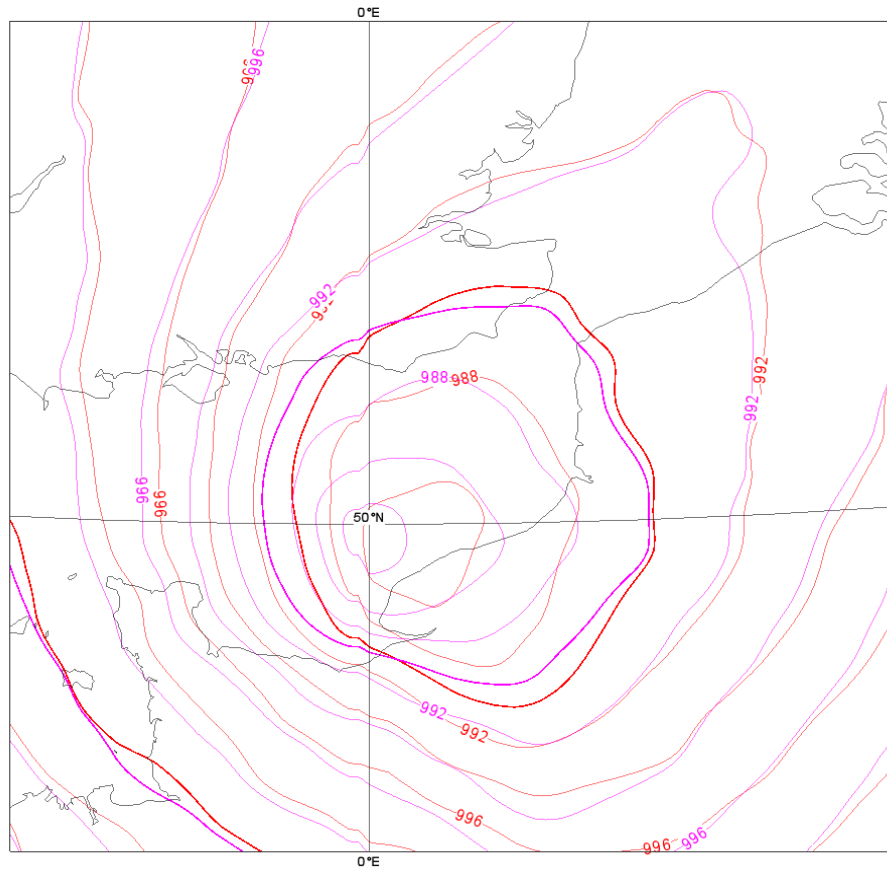
Thursday 12 January 2017 18 UTC ecmf surface Mean sea level pressure

Thursday 12 January 2017 06 UTC ecmf t+12 VT: Thursday 12 January 2017 18 UTC surface Mean sea level pressure

Thursday 12 January 2017 18 UTC ecmf surface Mean sea level pressure

Thursday 12 January 2017 06 UTC ecmf t+12 VT: Thursday 12 January 2017 18 UTC surface Mean sea level pressure

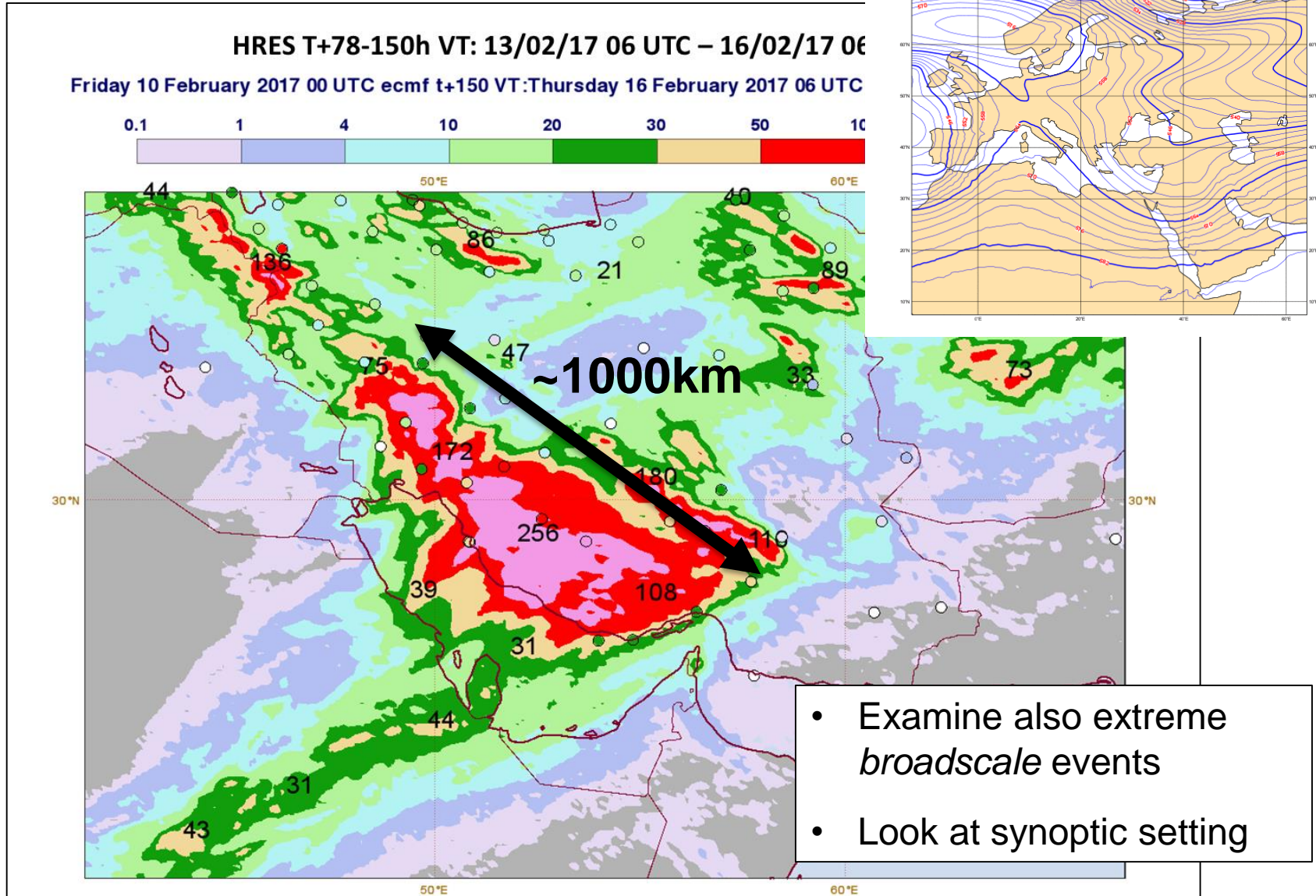
Wednesday 11 January 2017 06 UTC ecmf t+36 VT: Thursday 12 January 2017 18 UTC surface Mean sea level pressure



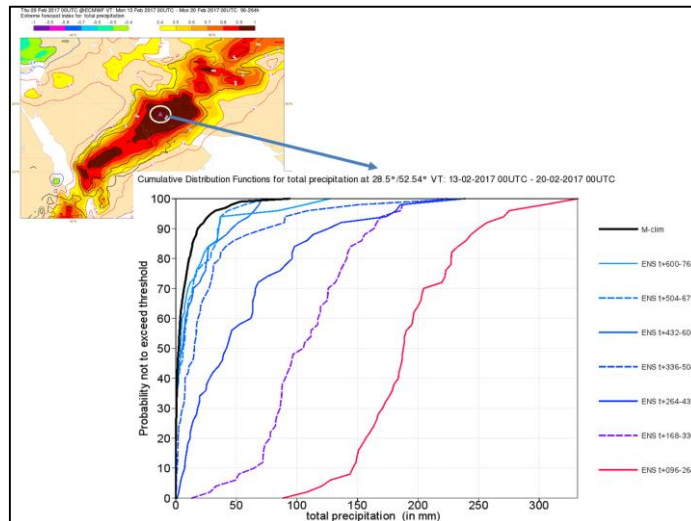
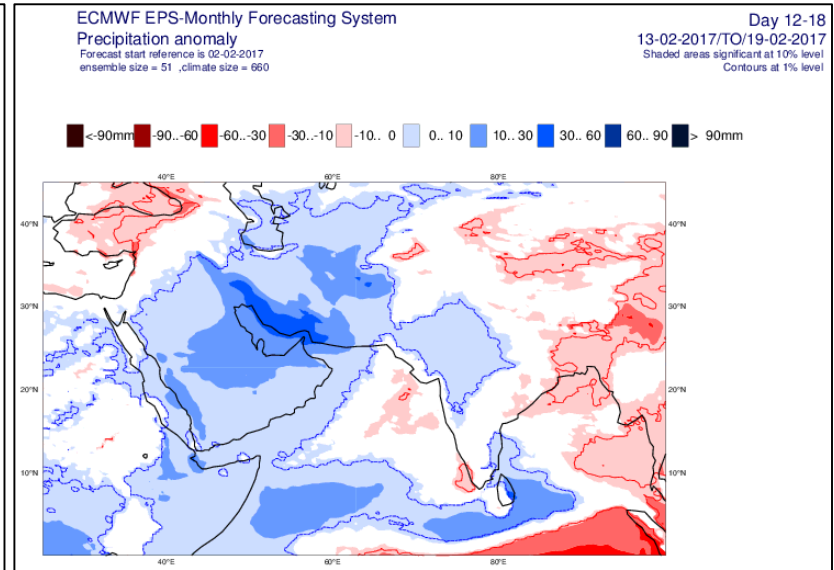
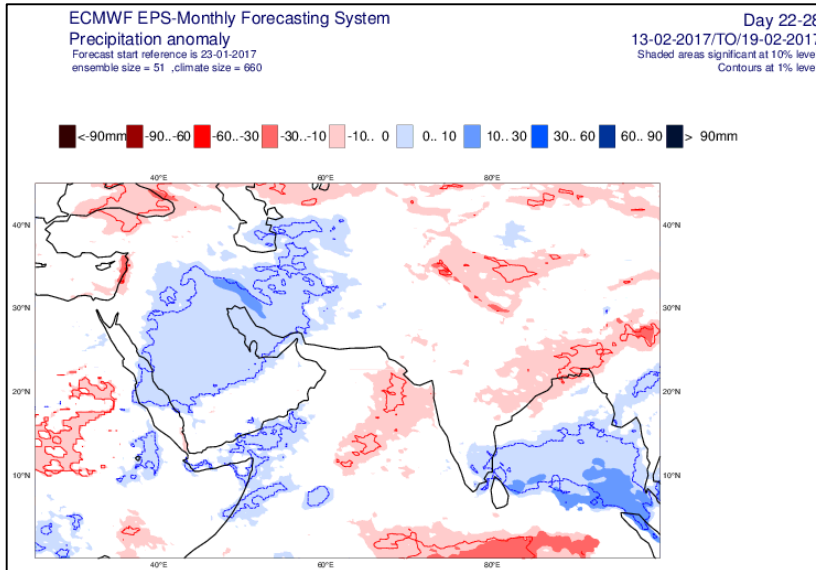
- Examine short range handling / DA issues
- Observation “rejections”



# Rainstorms – Middle East



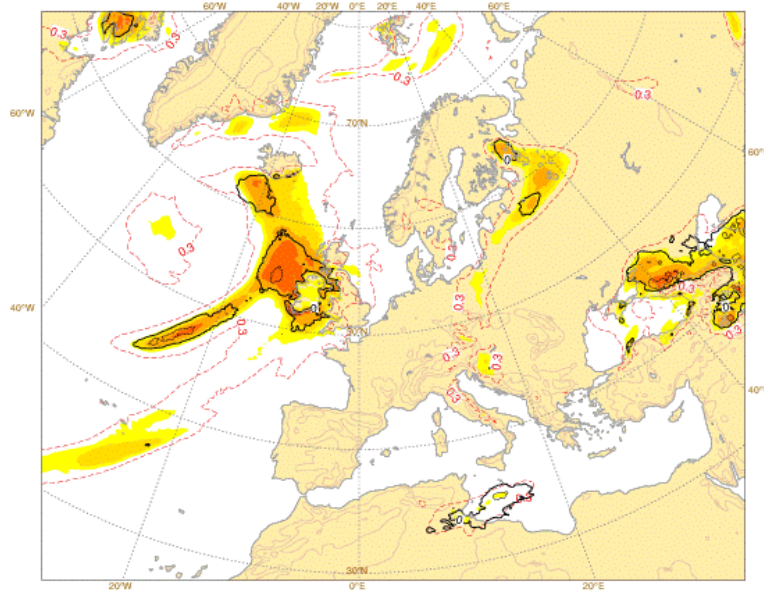
# Rainstorms – Middle East



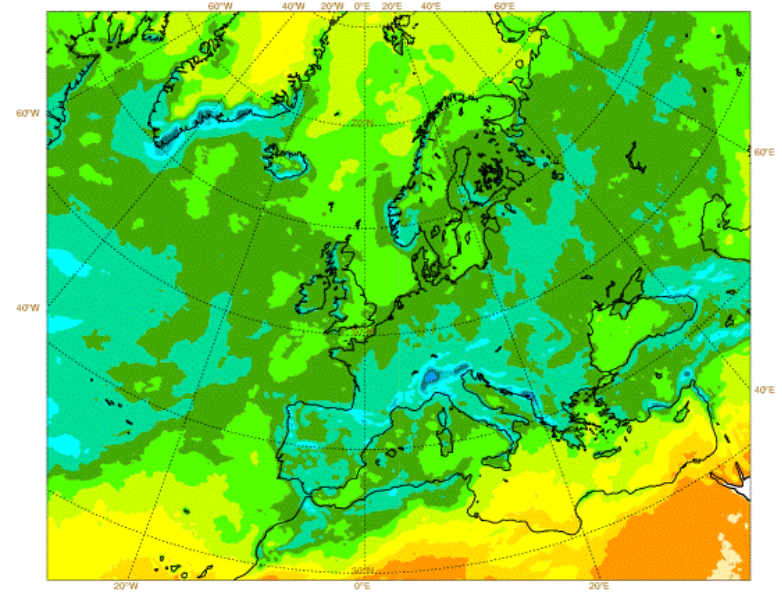
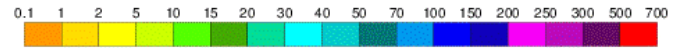
- Examine long range predictability (for broadscale events)
- Test out utility of possible new monthly products

# “Warm Air” rainstorms

Sun 14 May 2017 00UTC ©ECMWF t+24-48h VT: Mon 15 May 2017 00UTC - Tue 16 May 2017 00UTC  
Extreme forecast index and Shift of Tails (black contours 0,1,2,5,8) for total precipitation

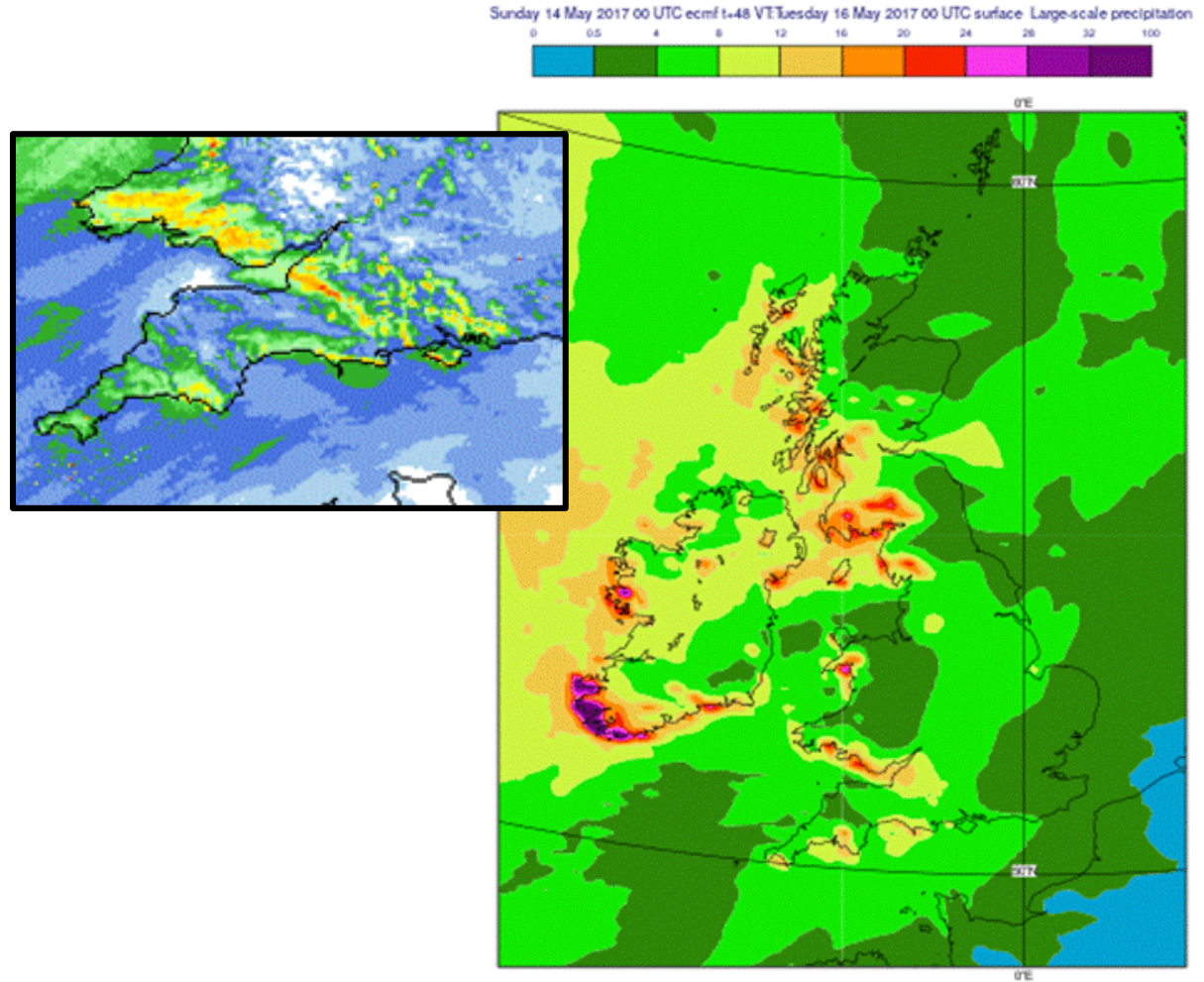


Thu 11 May 2017 00UTC ©ECMWF VT: Mon 15 May 2017 00UTC - Tue 16 May 2017 00UTC 24-48h  
total precipitation (in mm) Model climate Q99 (one in 100 occasions realises more than value shown)



- Examine strange behaviour in certain products

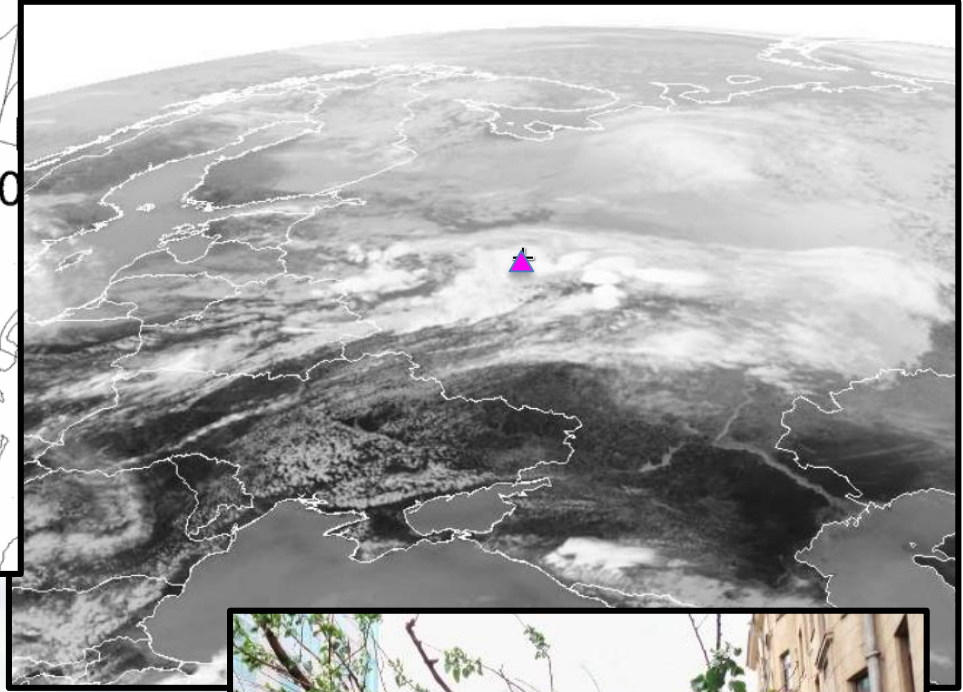
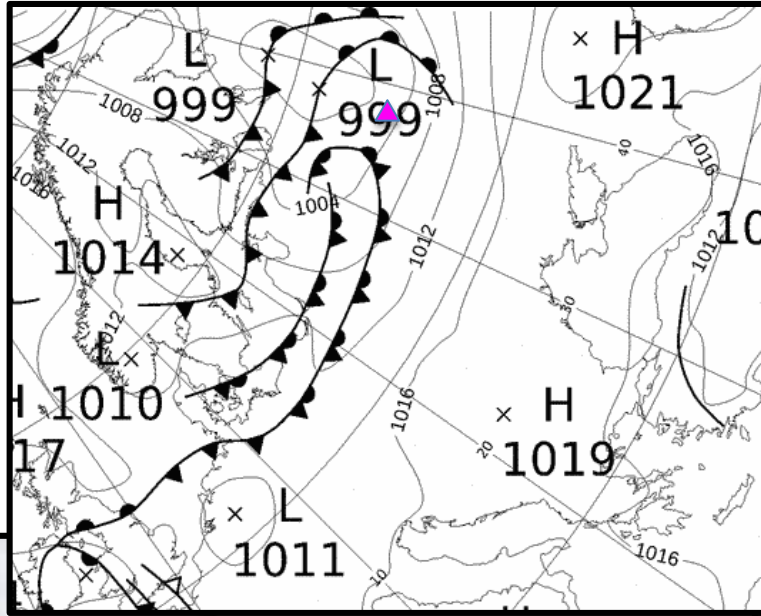




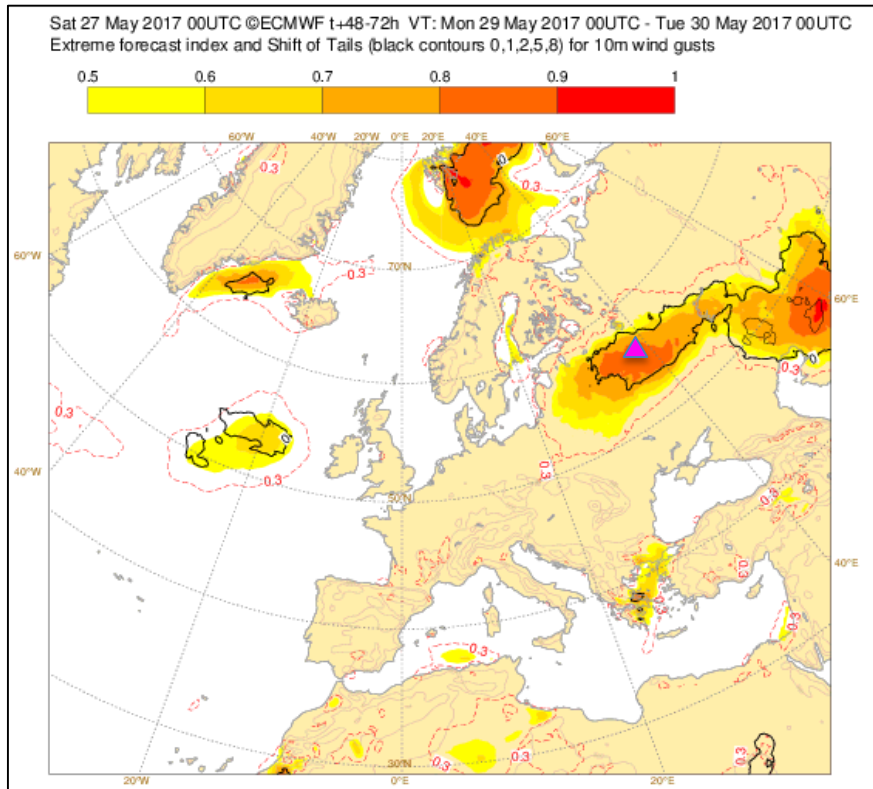
- Check parallel model cycle (e-suite)
- Liaise with RD
- Check how a future model cycle would handle situation



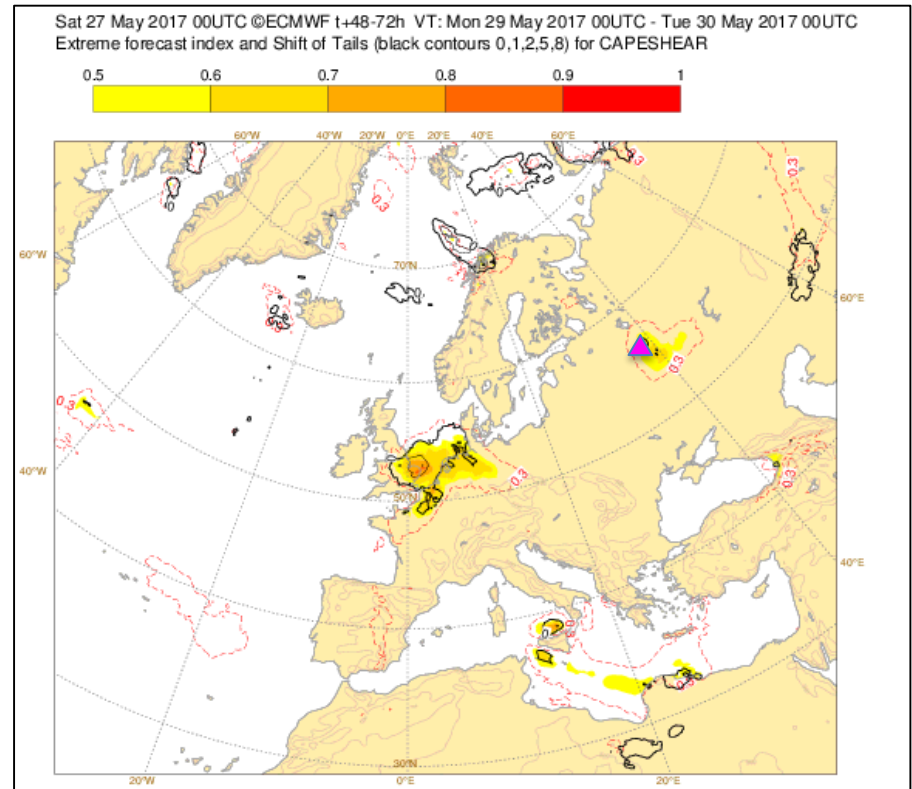
# Moscow convective Storm – 29 May



# Day 3 forecasts



EFI/SOT for Wind Gusts



EFI/SOT for "CAPESHEAR"

Indicates when convective gust enhancement /  
tornadoes / hail are possible

- Check media reports of extreme storms, & ESSL database
- Examine utility of current products for these events
- Consider improvements!

- The wind gust EFI, and model gust estimates, pointed to a very windy day
- The fact that the CAPESHEAR EFI was also large should suggest to the forecaster that extra factors could come into play and make the winds even more extreme...
  - Model forecasts were for Gusts of **~65-70 km/h**
  - Observed Gusts were **~110km/h**
- So the case illustrated nicely that special products developed by ECMWF can point to when extremes that the model cannot predict directly are more likely to happen
- But it also re-emphasised that CAPESHEAR can be further improved.. (interrogate all time steps, not just 6-hourly)

# Summary

- Examples repeatedly show that accurate prediction of extreme storm phenomena (wind/snow/rain) remains EXTRAORDINARILY DIFFICULT, even at short lead times, particularly when rapidly deepening cyclones are involved
- Conceptual models can help
- In spite of the above there are counter examples where the ECMWF IFS gave useful early warning of extreme phenomena 1, 2, 3 weeks in advance, usually broader-scale, which sometimes seem to almost defy logic (!)
- For convective situations the ECMWF IFS will not explicitly represent the damaging phenomena (large hail, tornadoes, gust fronts) but useful guidance on broadscale areas at risk is provided by other diagnostic, such as the CAPESHEAR EFI, can be provided many days in advance
- Work continues on improving our guidance for convective scale phenomena
- The work of the daily report analysts at ECMWF is pivotal in providing insights into the handling of storms (though we examine many other issues too!)
  - Feel free to contact us at [forecast\\_user@ecmwf.int](mailto:forecast_user@ecmwf.int)







