



# Systematic comparison between RALI observations and Arpege ensemble forecasts along the flights of the SAFIRE Falcon

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# Model simulations and outputs

## Arpege model (EPS):

- Resolution: T798 with stretching → 10km over France, 20km on Iceland
- Initial conditions: Arpege operational analysis
- Two convection schemes are compared (same as in Meryl's talk):

**B85: Bougeault (1985): closure in humidity, use in operational NWP version.**

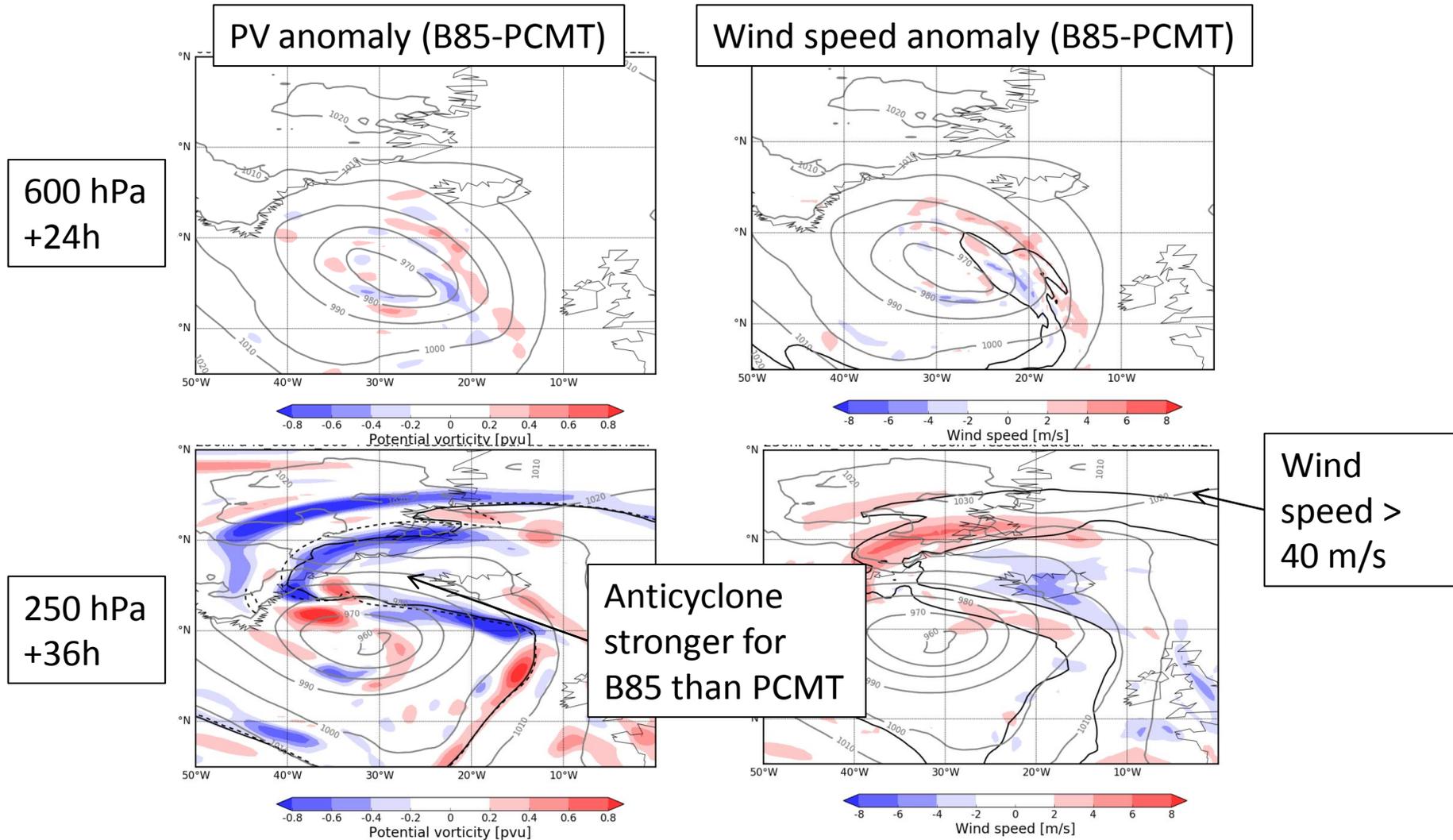
**PCMT: « Prognostic Condensates Microphysics and Transport »**

**Piriou et al. (2007); closure in CAPE, use in Arpege climate version.**

## Output:

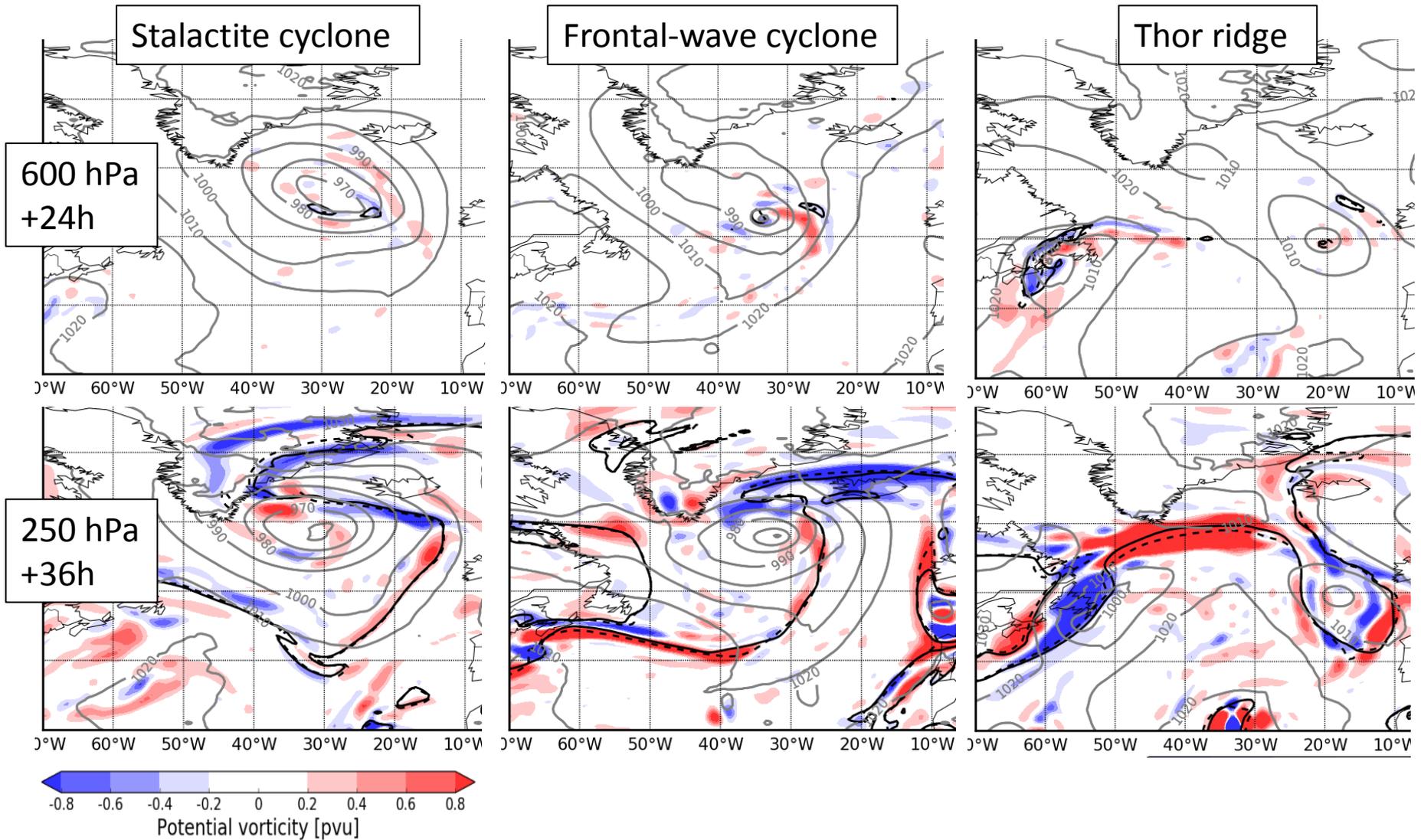
- Resolution: lon x lat:  $0.5^\circ \times 0.5^\circ$
- time step: 15 min

# Recall of Meryl's results on Stalactite Cyclone



More positive PV anomalies at 600 hPa due to more heating during liquid transition and less heating during ice transition

# PV anomalies for 3 cases (B85 – PCMT)

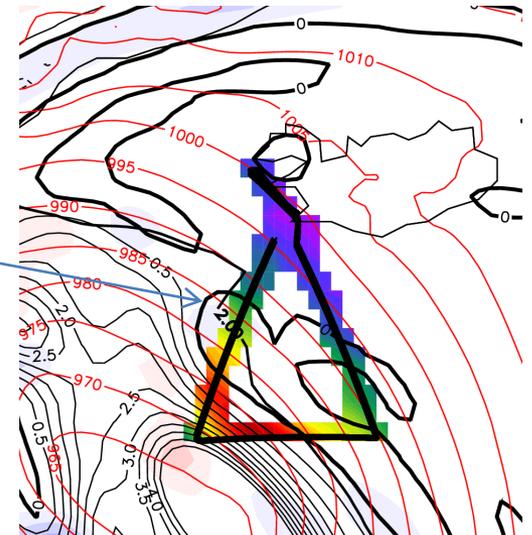


Ridge building stronger for B85 for two deep extratropical cyclones but the reverse occurs for the moderate intensity cyclone.

# Main questions

- What are the **systematic differences between Arpege ensemble forecast outputs (PEARP) and remote sensing airborne measurements of wind (Doppler RASTA) and ice water content (Delanoë and Hogan, 2008; Cazenave, 2018) ?**
- Can we generalize the results found by Meryl on the Stalactite Cyclone about **the difference between the two convection schemes PEARP-B85 et PEARP-PCMT in terms of ice water content, PV and horizontal wind speed ?**

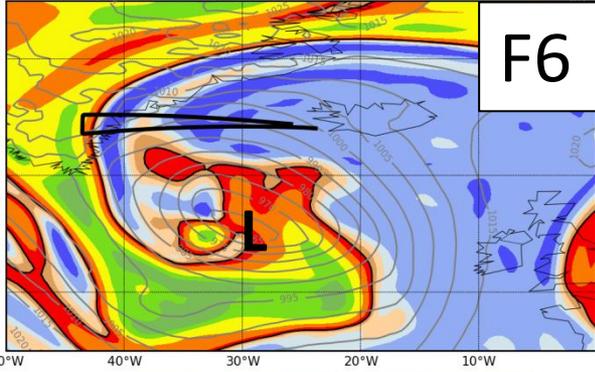
Shadings: wind speed computed along the flight legs and derived from 12 forecasts separated by 15 minutes



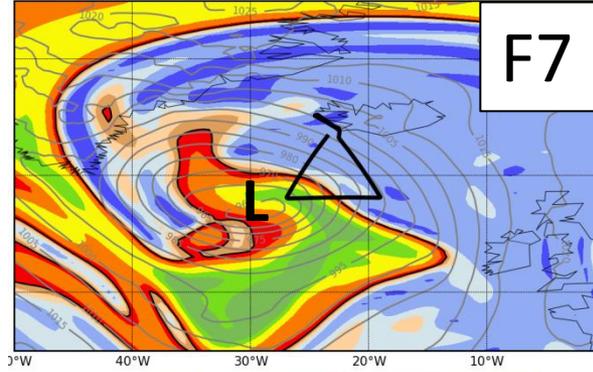
PV@300hPa, SLP

# Flights

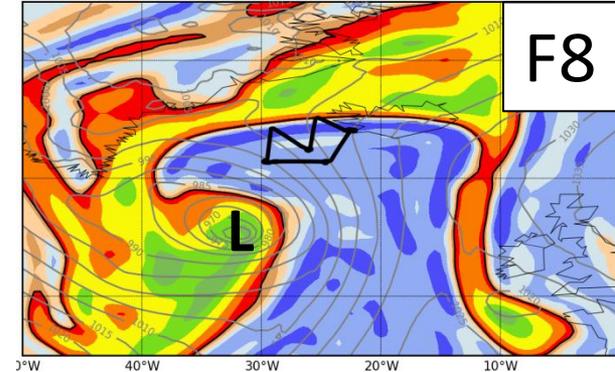
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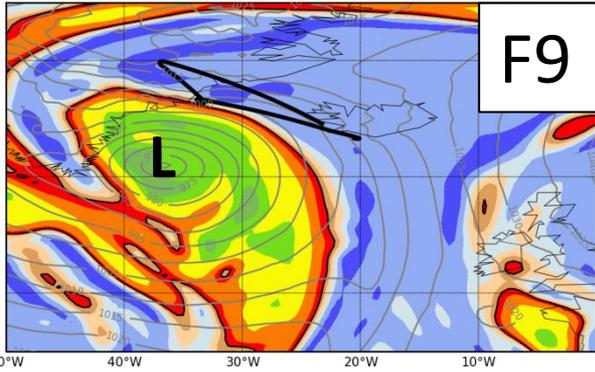
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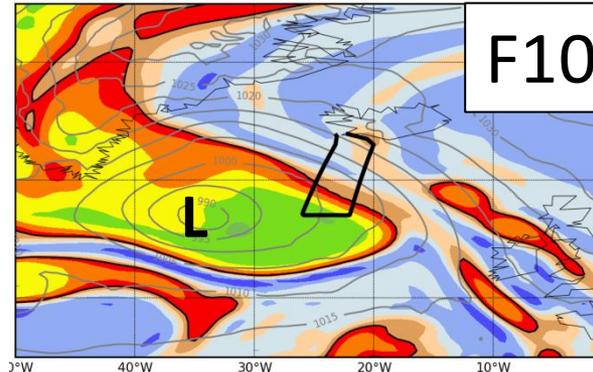
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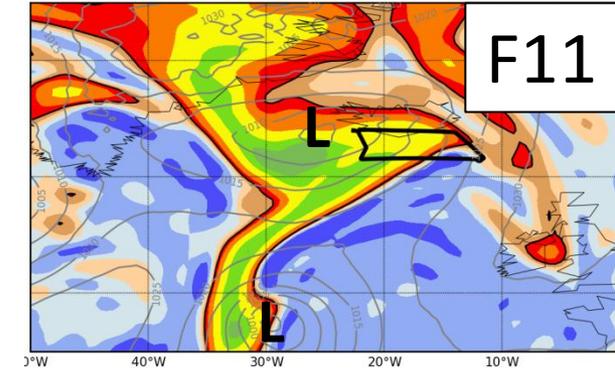
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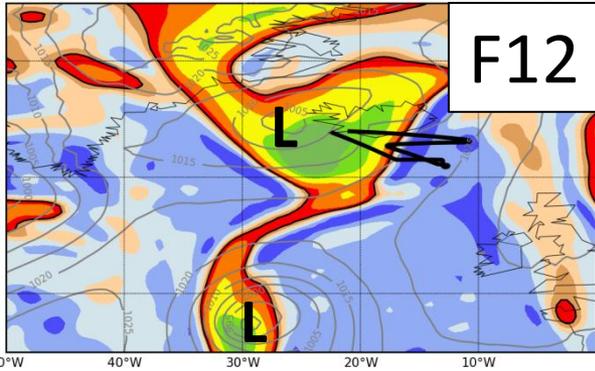
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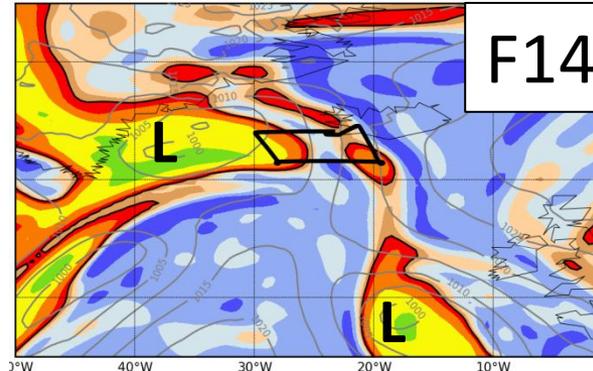
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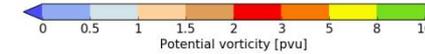
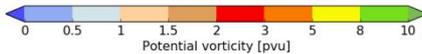
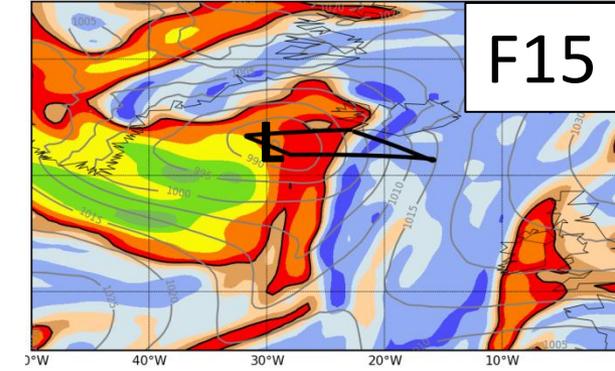
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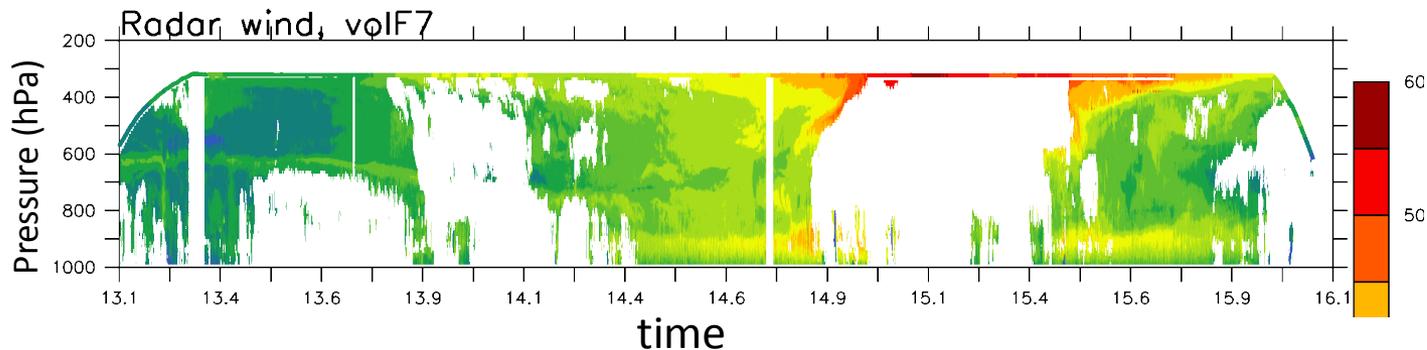
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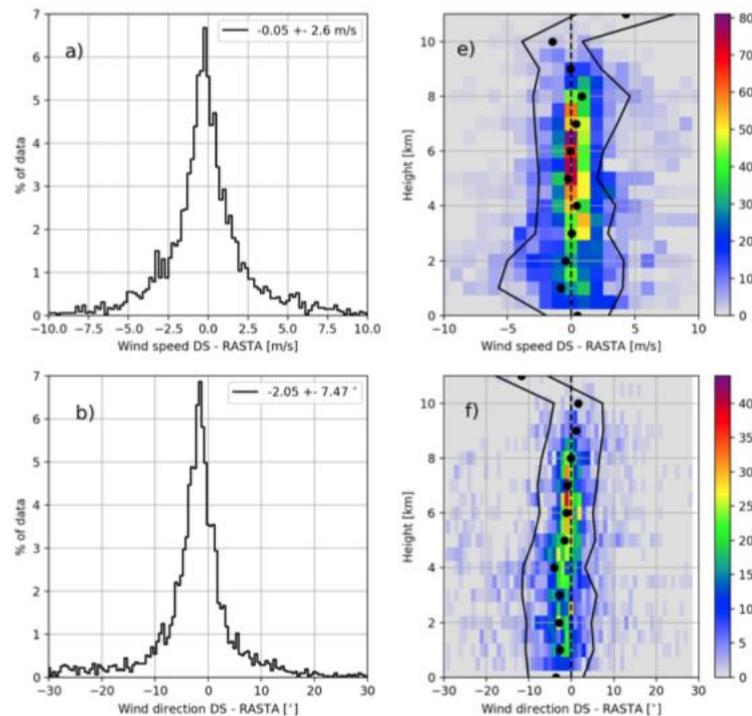
300hPa 000h 20161012H18P vol F15



# Retrieved Doppler radar wind speed



## Dropsondes vs RASTA (all flights, ~ 60 DS)

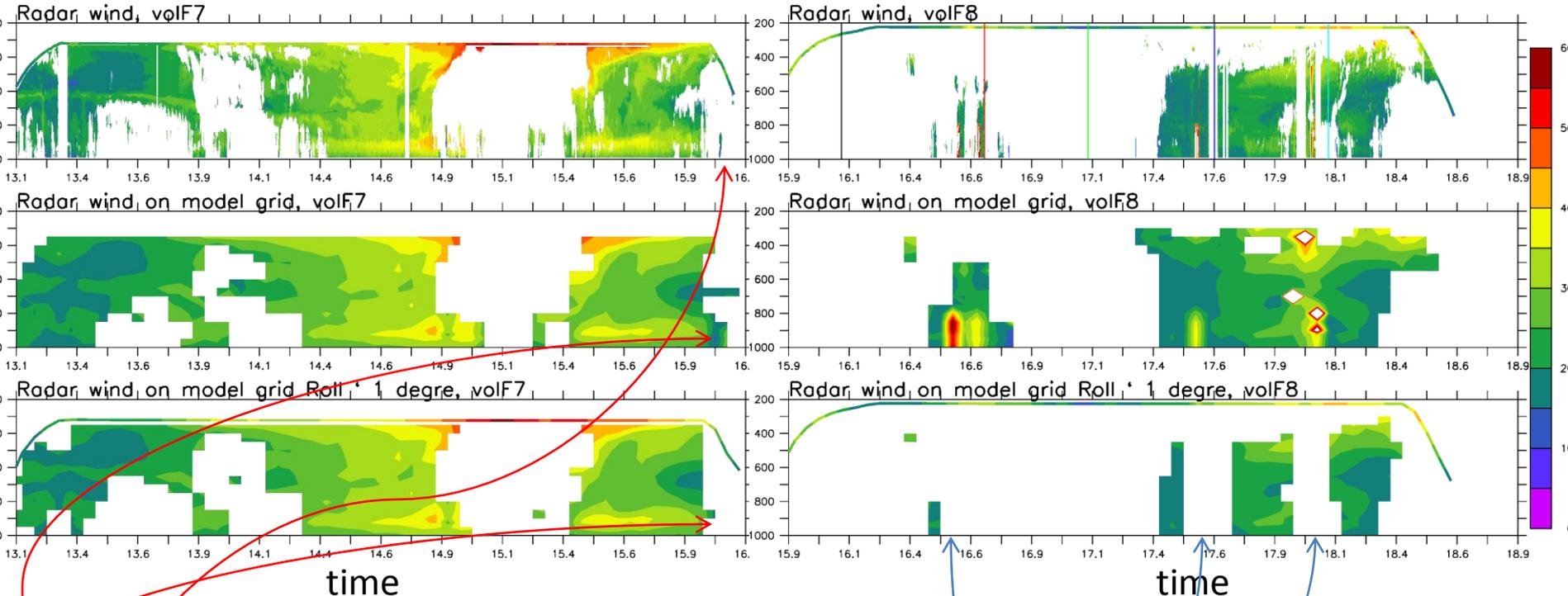


Wind speed:  $0.05 \pm 2.6$  m/s  
Wind direction:  $-2.05 \pm 7.47$  °

From Julien's talk

No bias in wind speed, slight one in wind direction

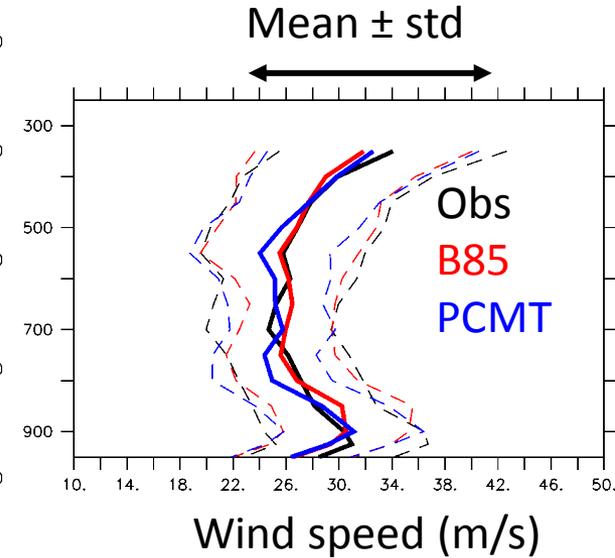
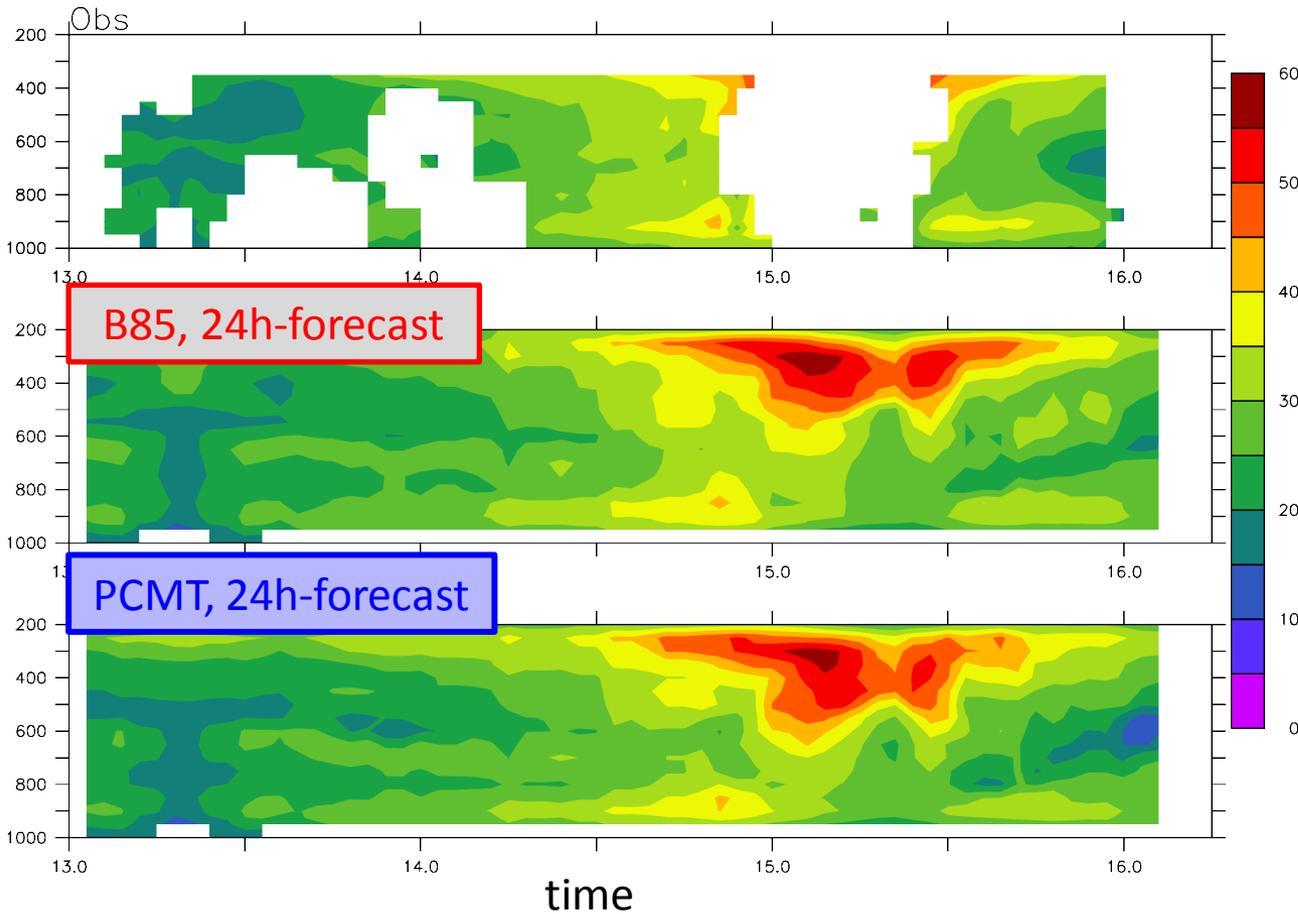
# Different steps before comparing to the model



- Interpolation on model grid: Aircraft wind speed: 200 m/s; grid  $0.5^\circ \times 0.5^\circ \sim 28 \text{ km} \times 55 \text{ km}$  at 60N  $\rightarrow$  observed data averaged every 3 minutes
- Suppression of regions where there are not enough observations
- Suppression of data when the aircraft roll is greater than  $1^\circ$ .

# Comparison between « observed » wind speed and simulated wind speed

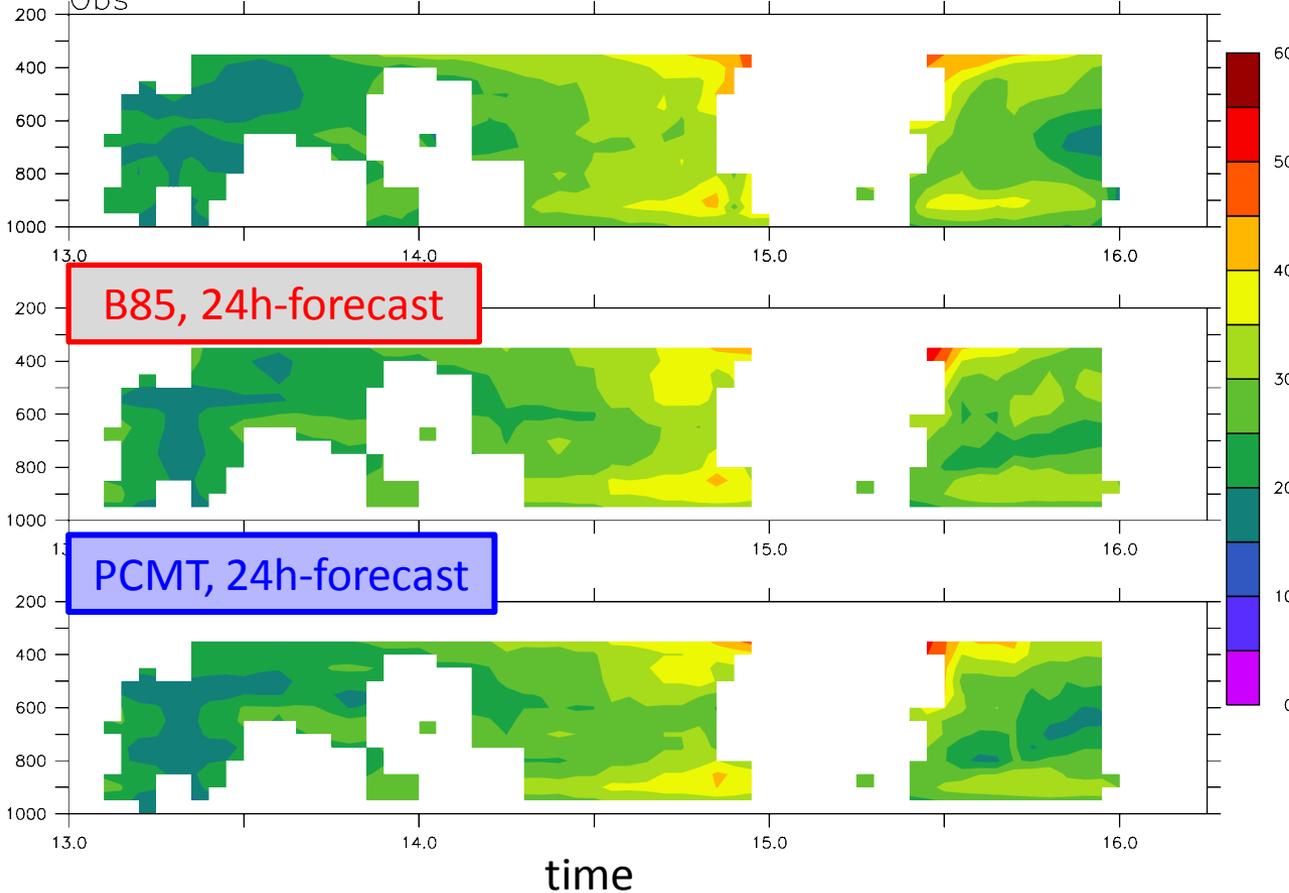
volF7, 20161001H12P



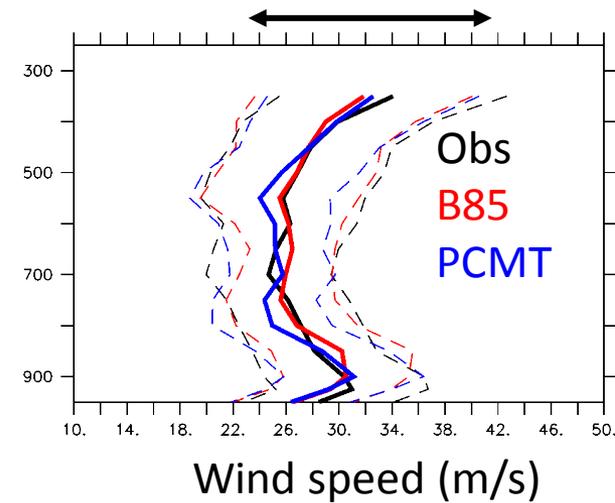
# Comparison « observed » wind speed and simulated wind speed

volF7, 20161001H12P

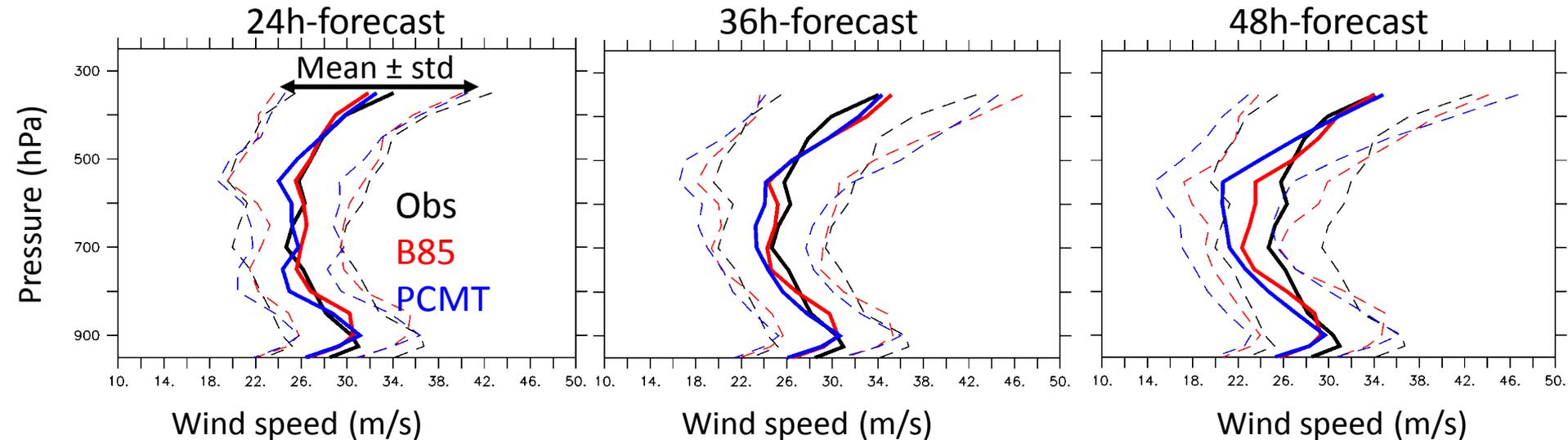
Obs



Mean  $\pm$  std

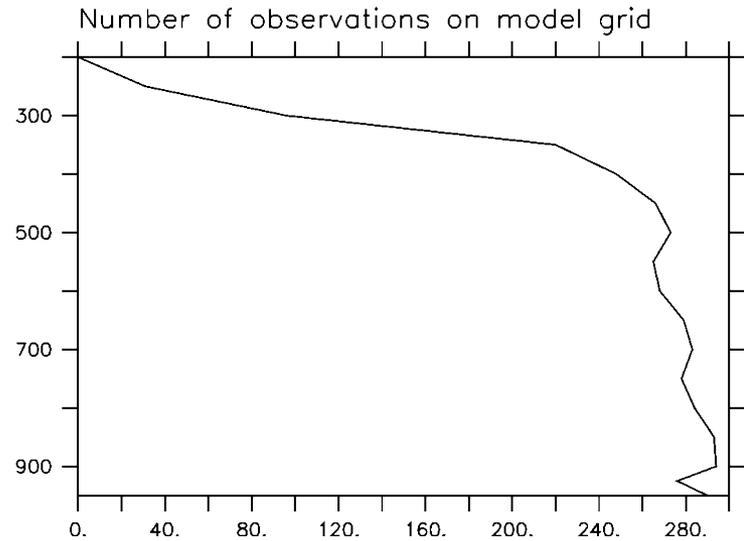
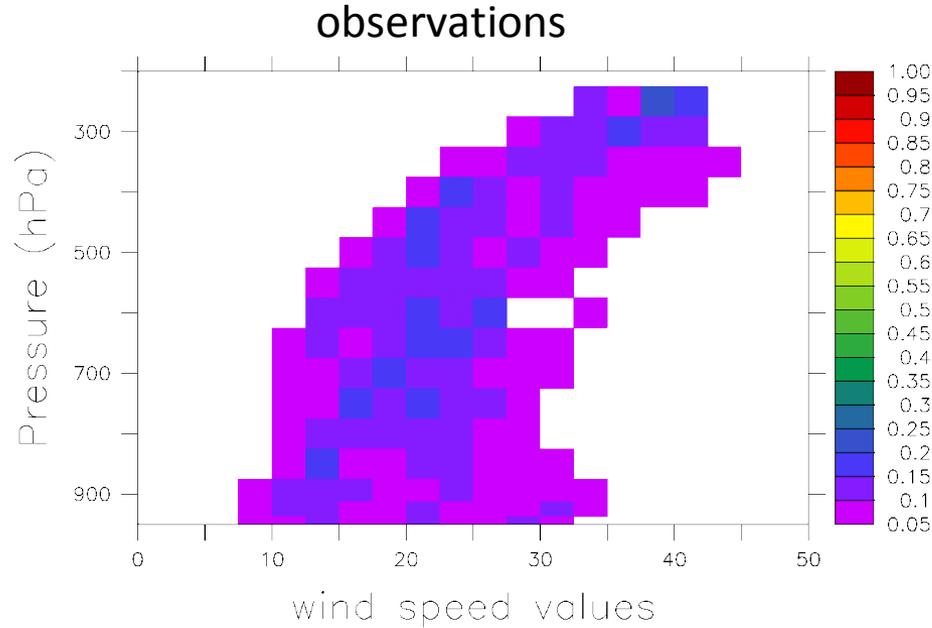


# Wind speed differences for F7 as function of lead time



- Wind speed underestimation between mid- and low levels (500-850hPa), more obvious after 48 hours.
- Stronger underestimation for PCMT scheme.

# Wind speed pdfs over 9 flights



Not many observations at the jet level (pressure less than 350 hPa)

# Pdfs of wind speed differences over 9 flights

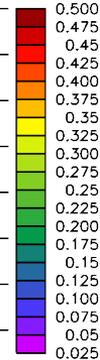
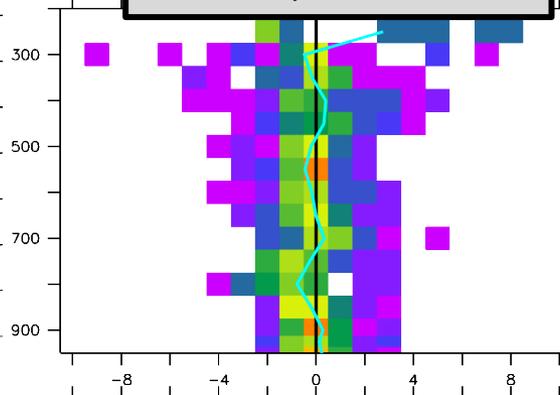
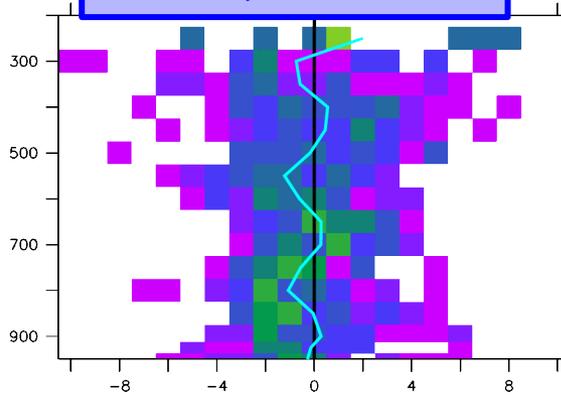
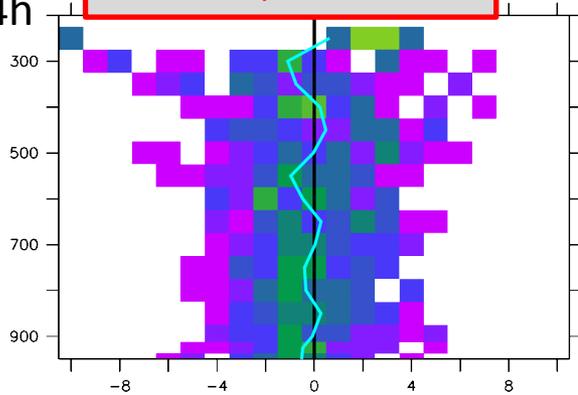
Lead time

24h

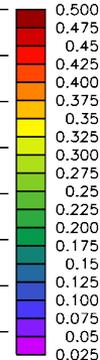
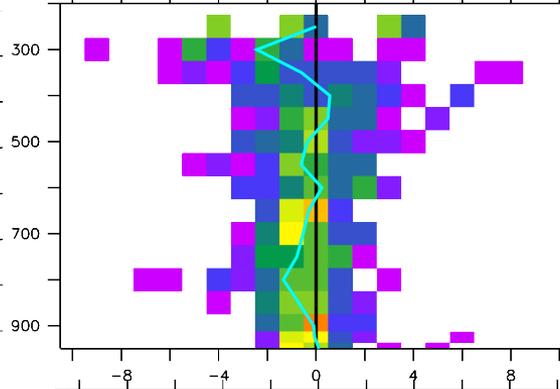
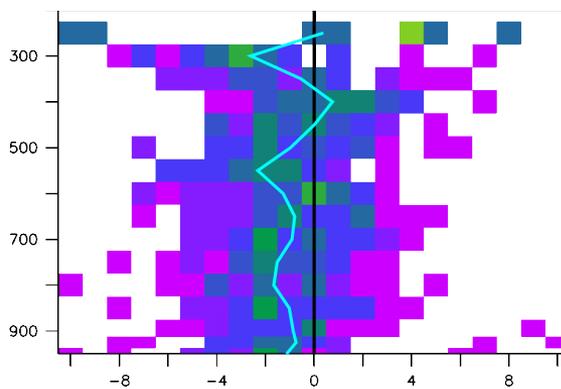
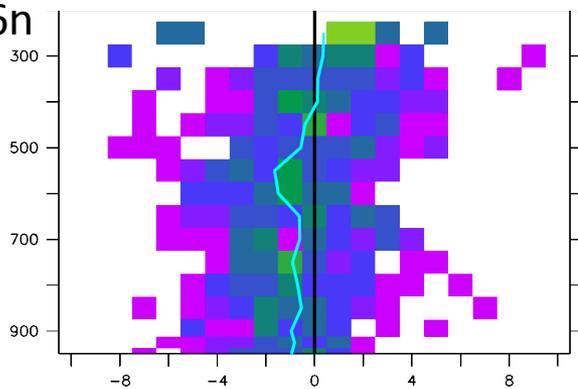
UMOD, B85-OBS

UMOD, PCMT-OBS

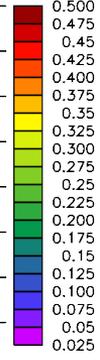
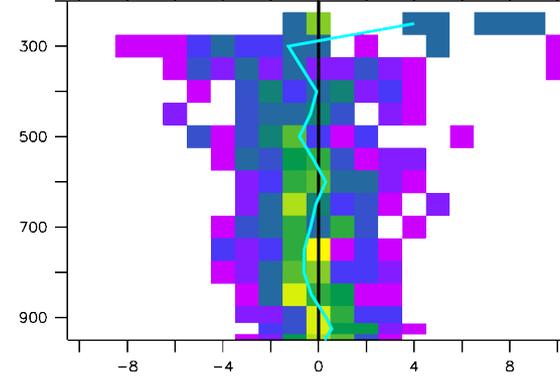
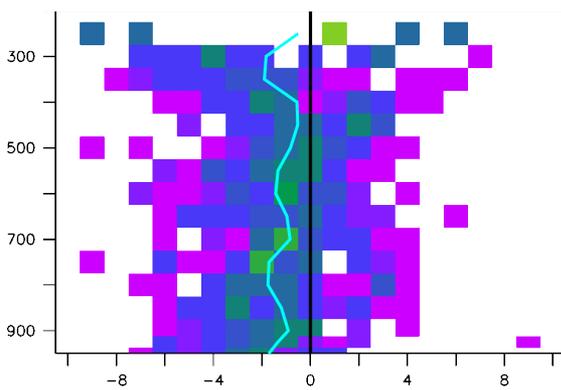
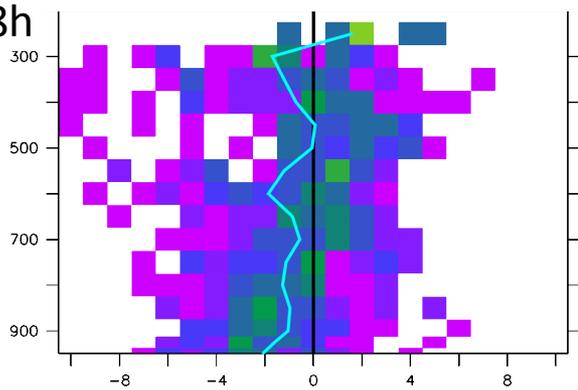
UMOD, PCMT-B85



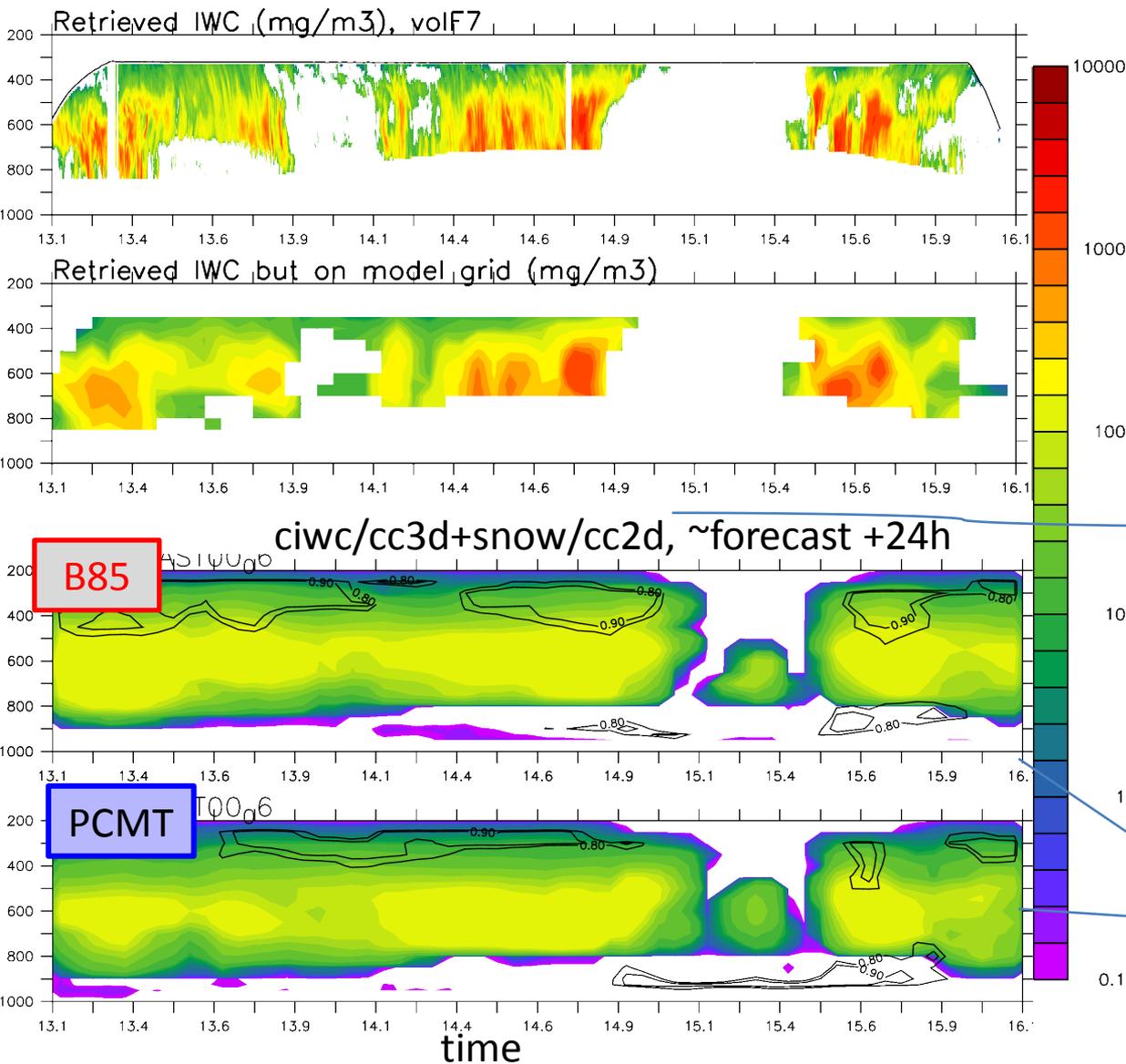
36h



48h

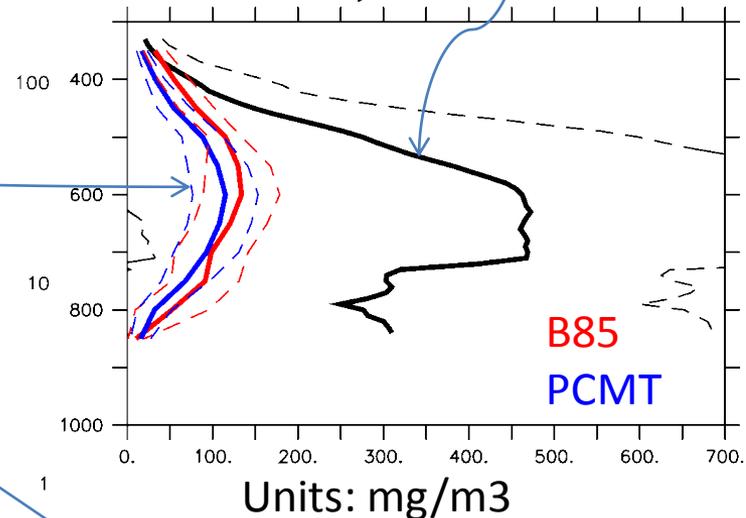


# Ice Water Content, flight F7



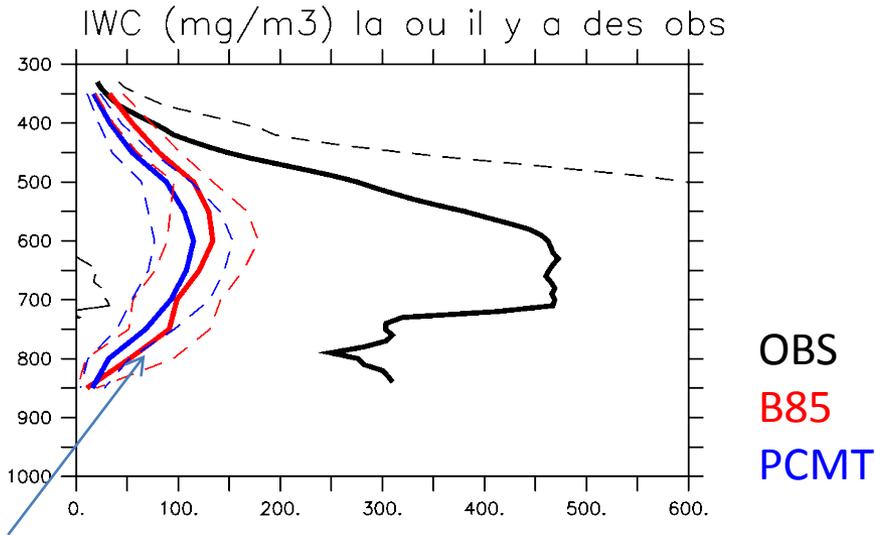
Obs (retrieved IWC from radar/lidar; Delanoë and Hogan, 2008; Cazenave, 2018)

IWC là ou il y a des obs

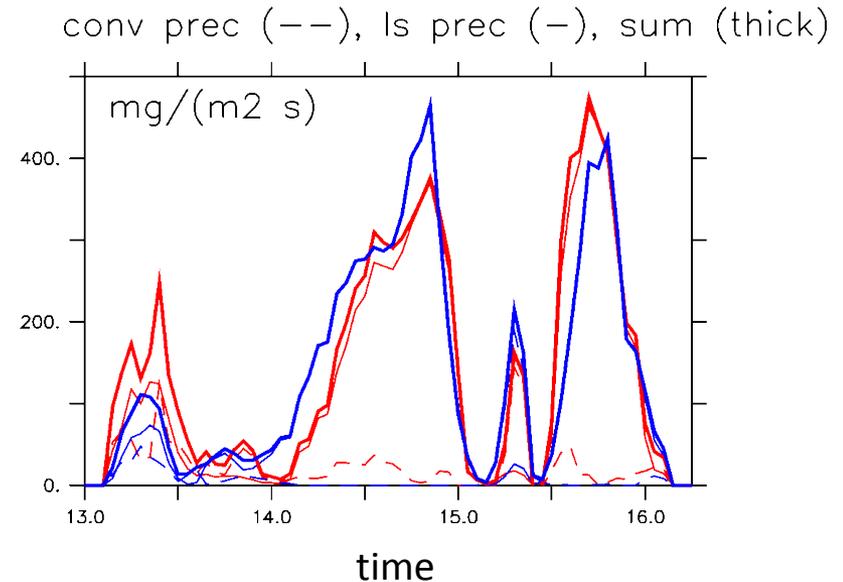


3 flight hours: 12 forecasts separated by 15 min

# Ice Water Content, flight F7



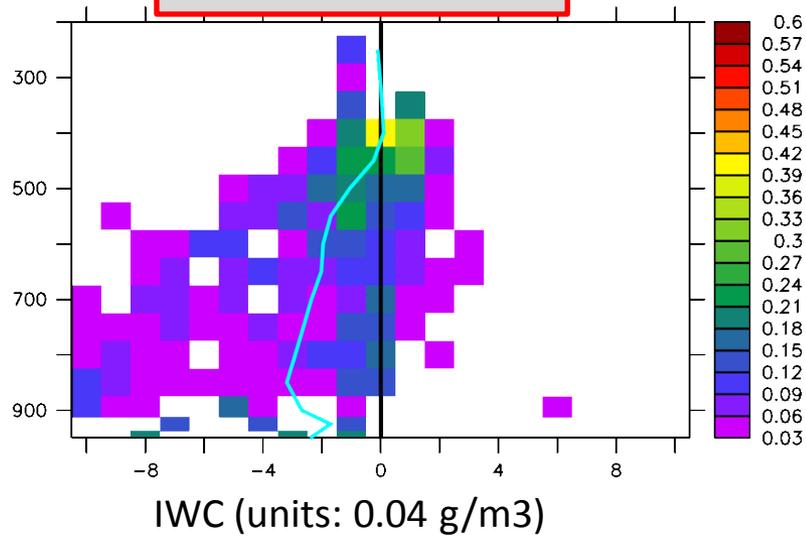
Only the stratiform part



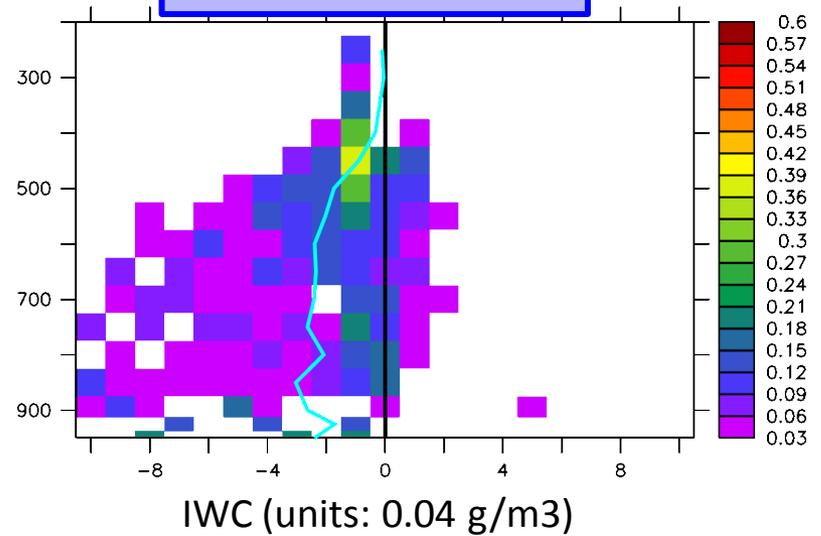
- Strong underestimation of the simulated IWC
- Convective precipitation is small compared to large-scale precipitation (not systematically found)
- Need to change the fall speed of snow (1.5 m/s → 0.6 m/s) to get higher values

# Pdfs IWC, all flights

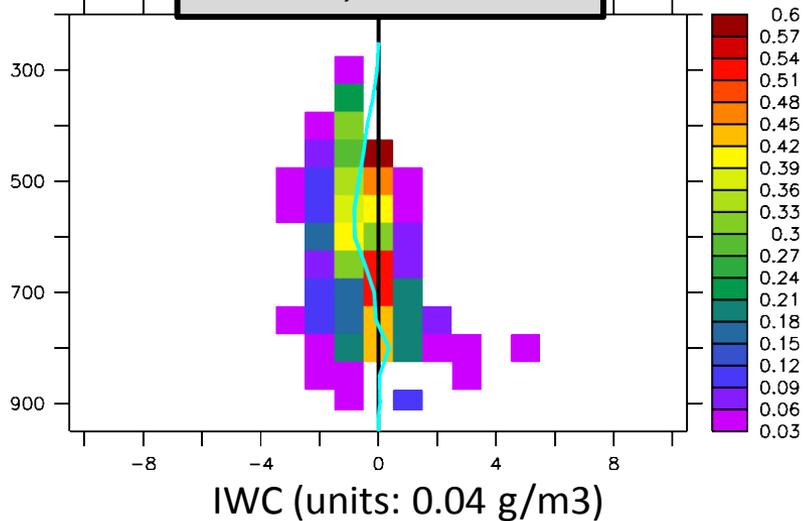
UMOD, B85-OBS



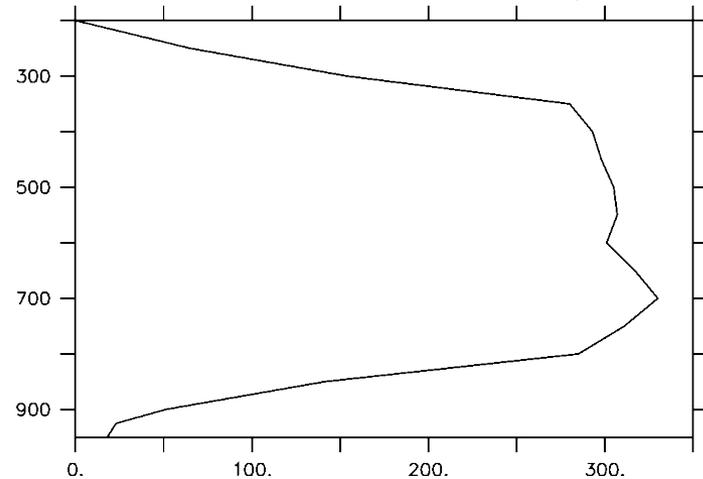
UMOD, PCMT-OBS



UMOD, PCMT-B85



Number of observations on model grid



# Conclusions

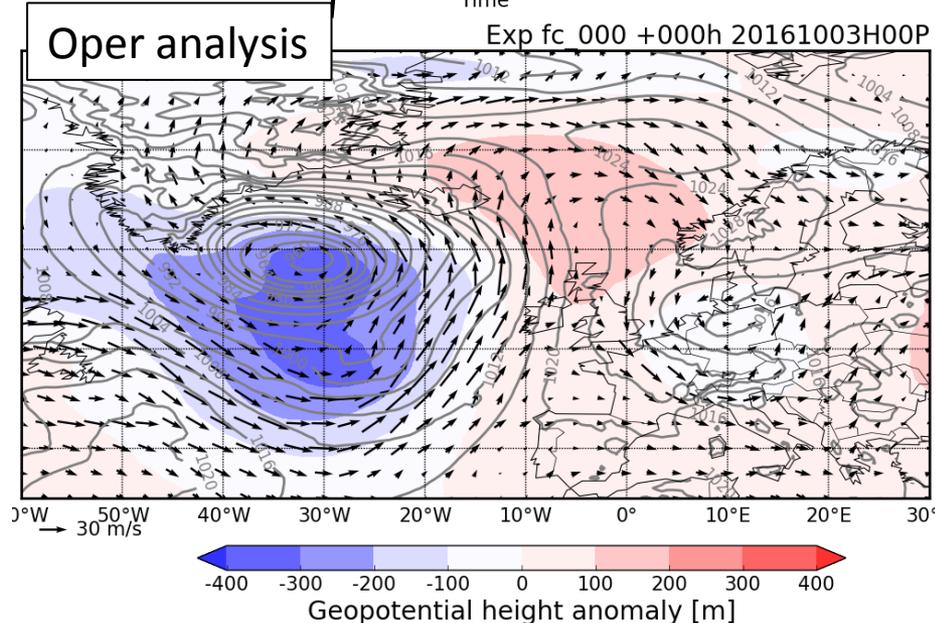
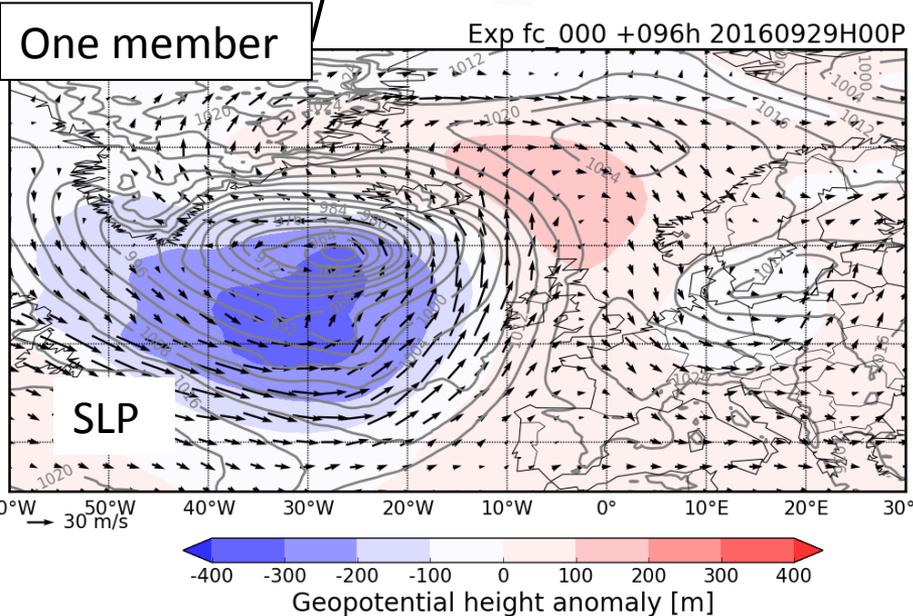
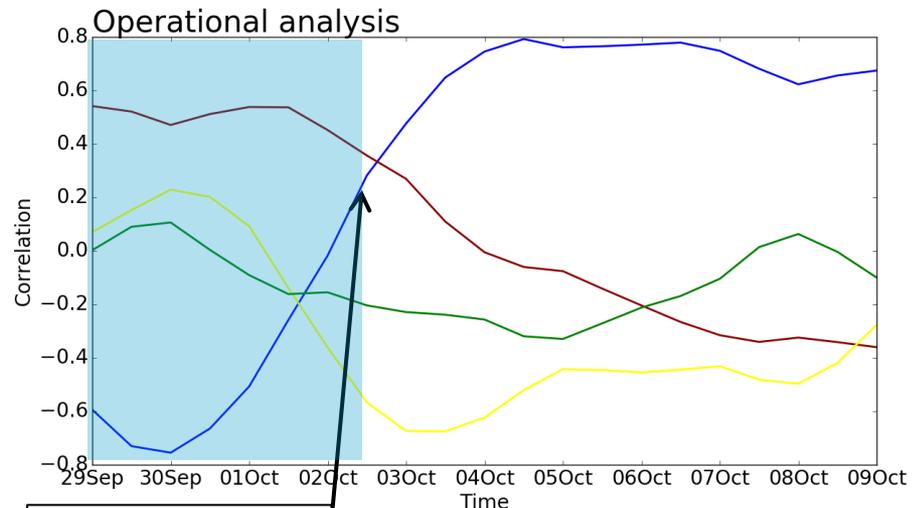
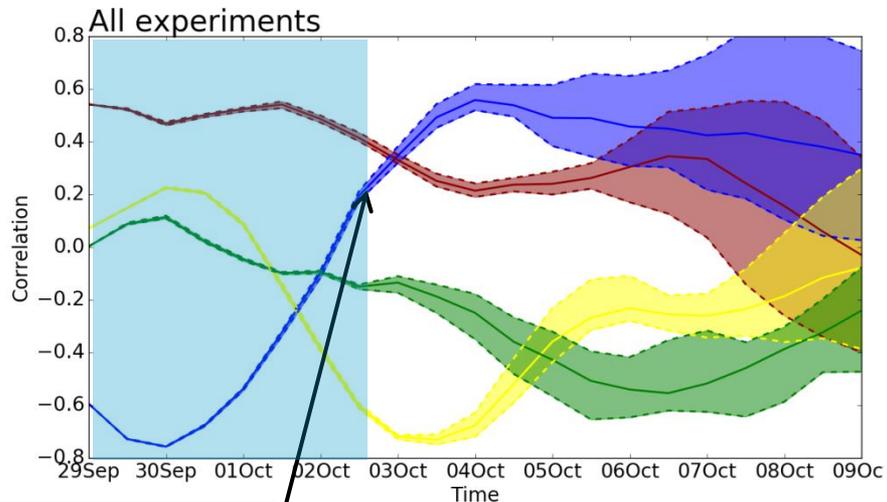
- Wind speed underestimation at mid and low levels (500-850hPa).
- At higher altitude, biases seem to be less strong but lack of observations at the jet level.
- Stronger wind speed underestimation for PCMT scheme.
- Underestimation increases with lead time
- B85: more ice at higher altitude than PCMT: so potentially WCBs reach higher altitude.

## Next steps

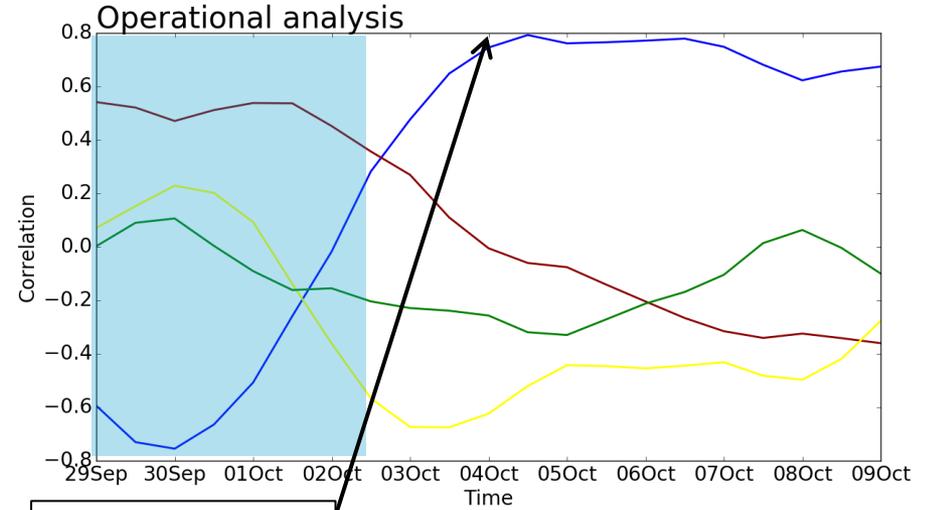
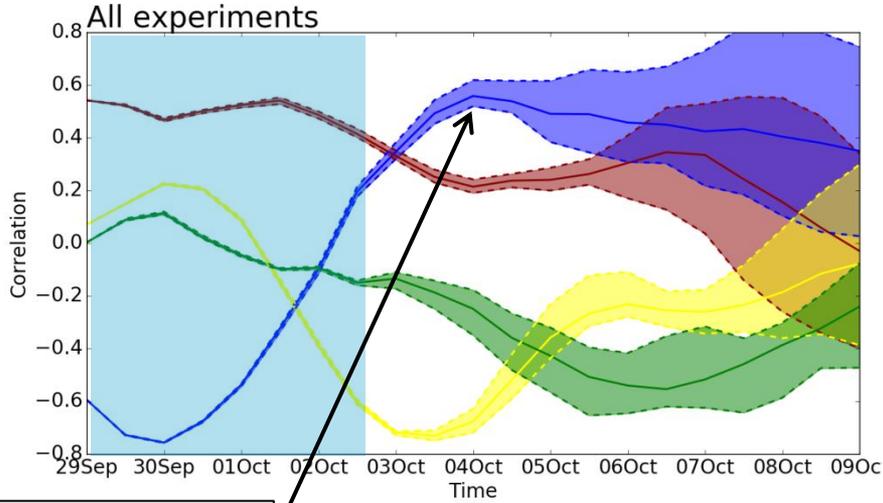
- Intercomparison with dropsondes and wind speed measured by the aircraft.
- New set of simulations with a different snow fall speed (to reach closer IWC to observations), different diffusion coefficient

Additional slides

# Part II: Medium-range predictability of the Scandinavian blocking



# Medium-range predictability of the Scandinavian blocking

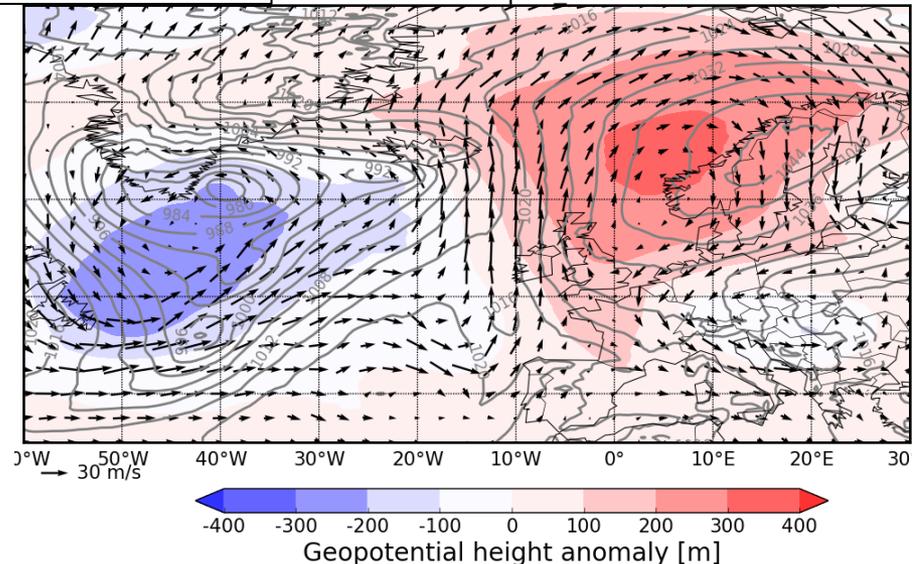
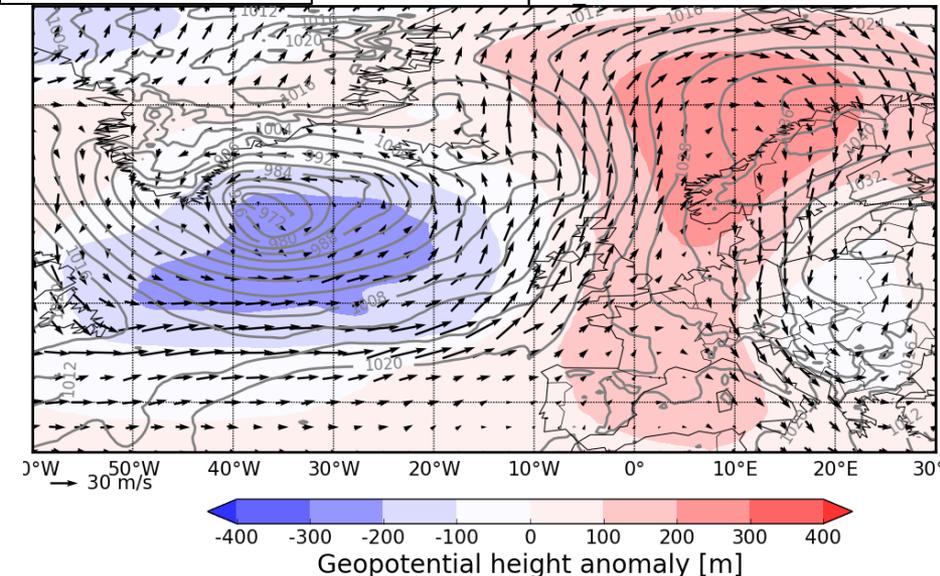


One member

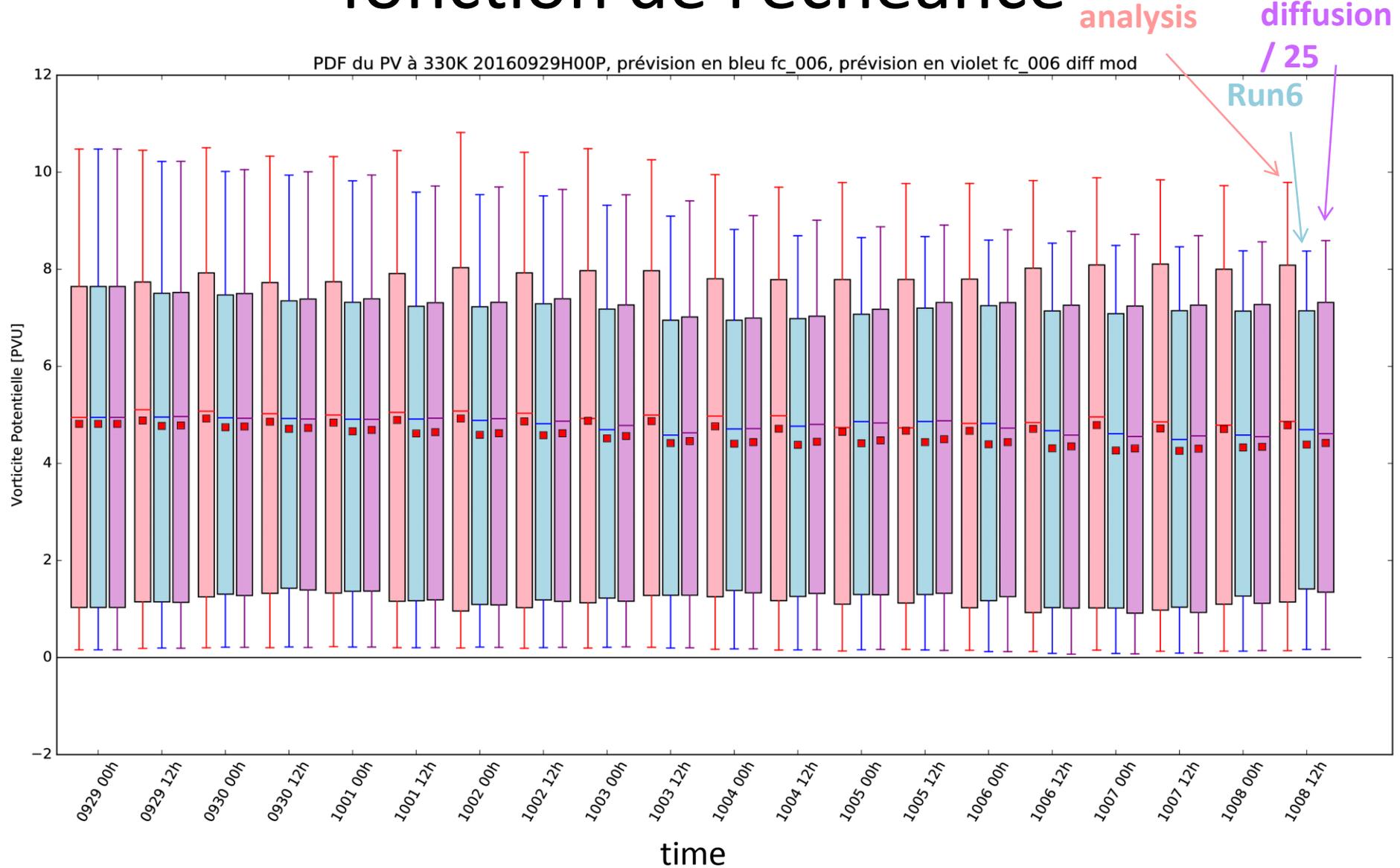
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Oper analysis

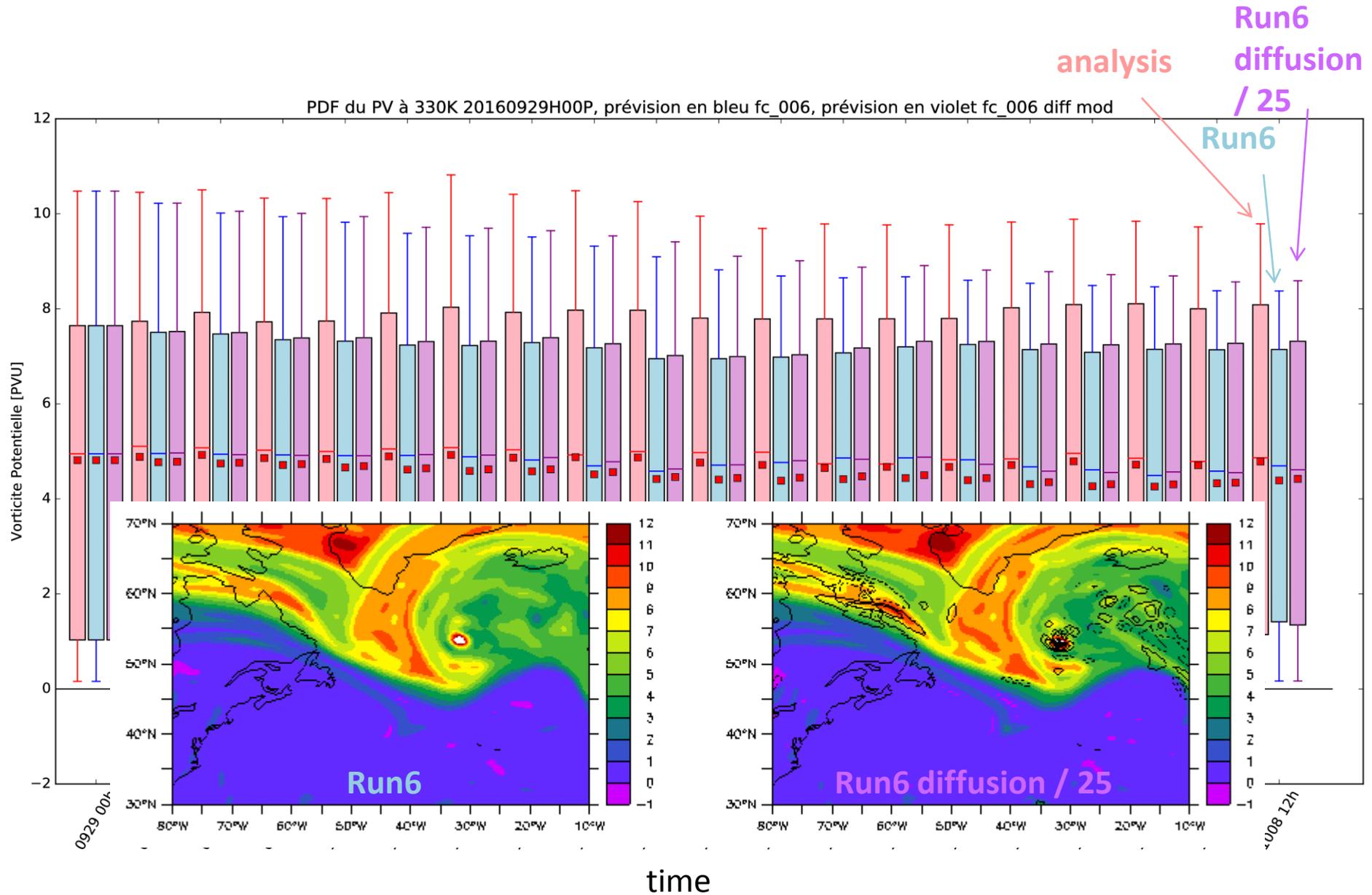
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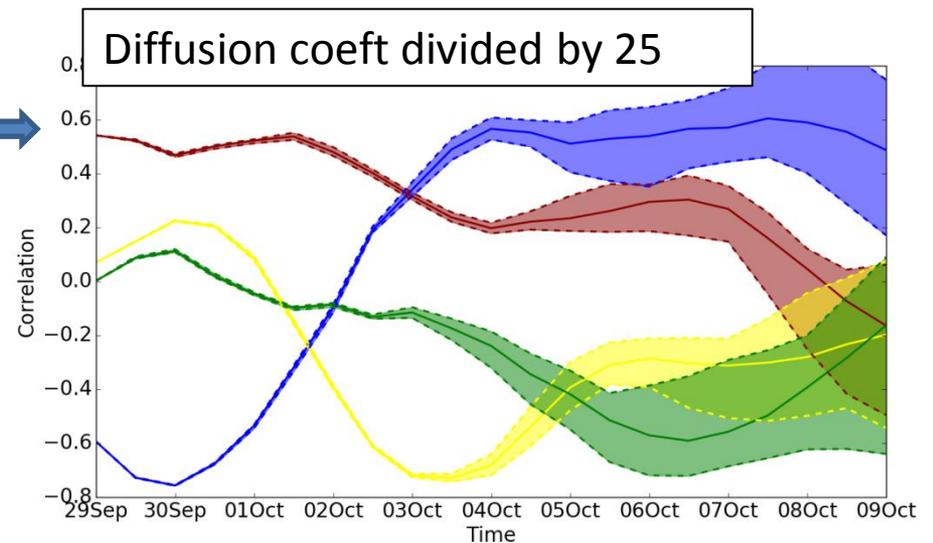
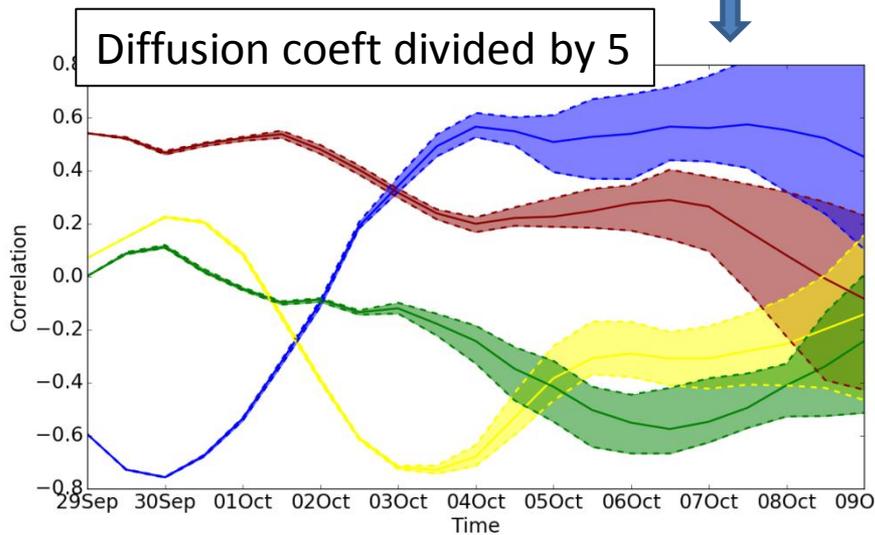
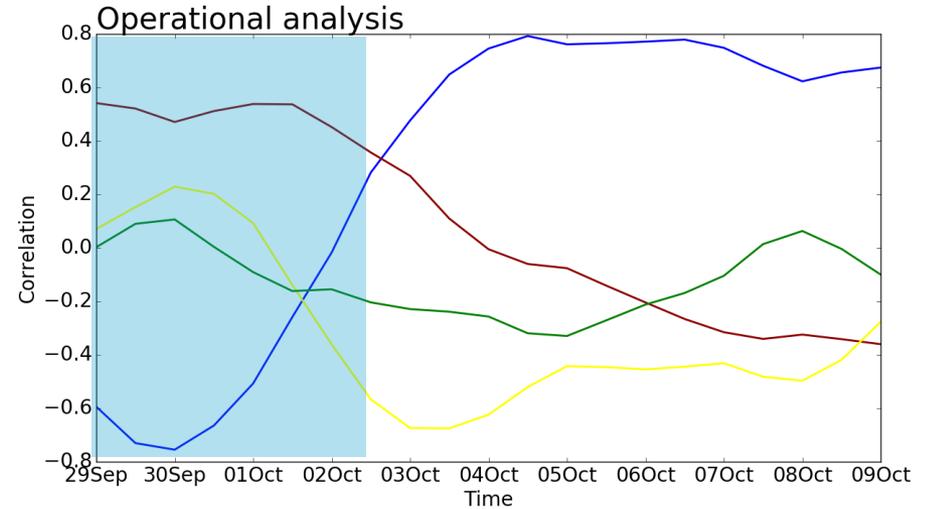
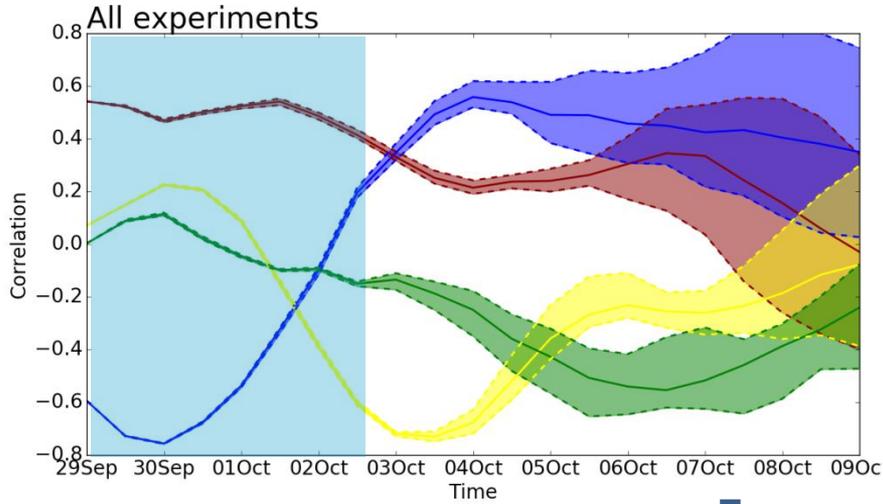
# Statistiques du PV sur isentrope en fonction de l'échéance



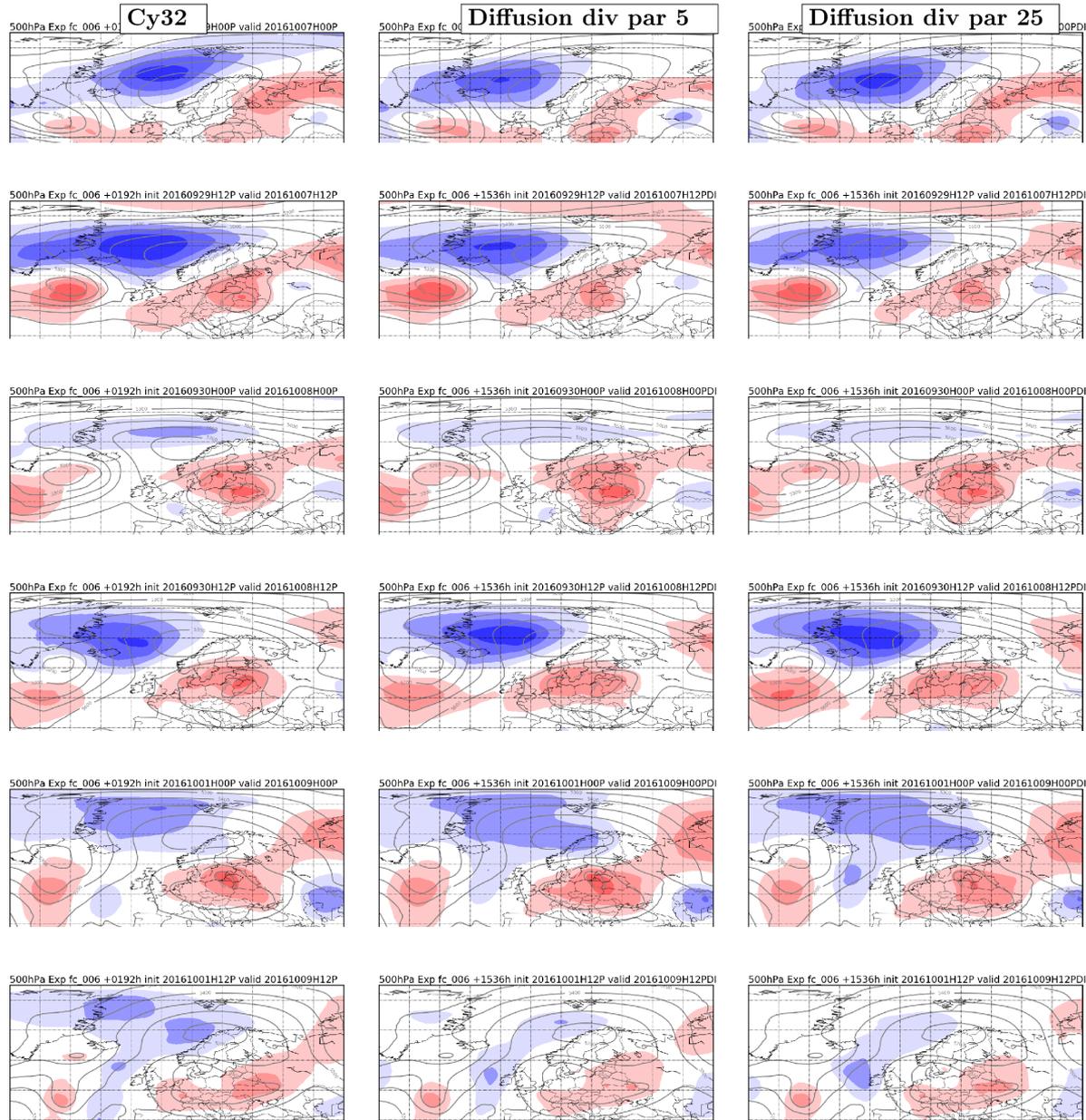
# PV statistics on 330-K surface as function of lead time



# Medium-range predictability of the Scandinavian blocking

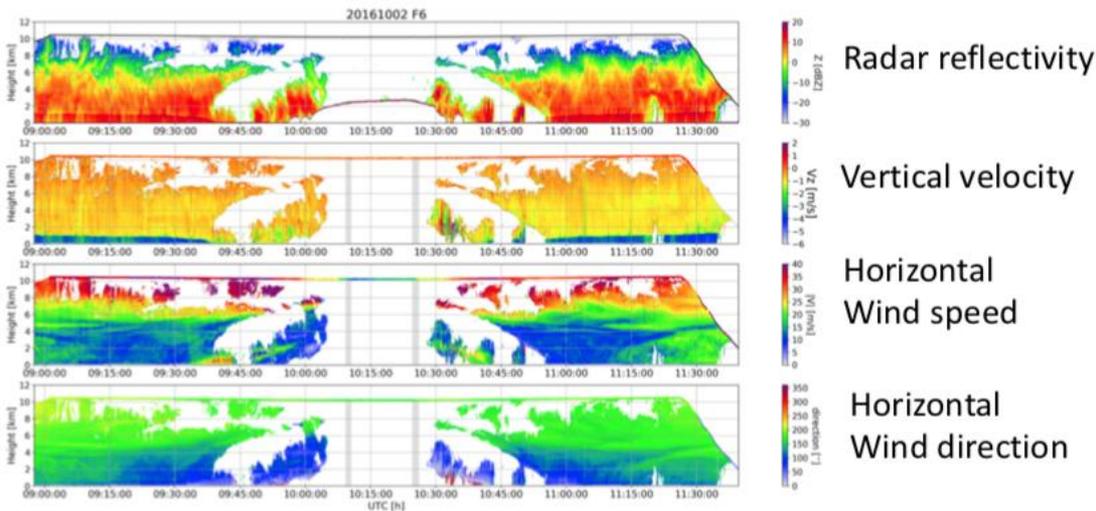


# 500-hPa Z anomalies (8-day forecast- analysis)



# Comparison vent -RASTA

## RASTA WIND retrieval assessment



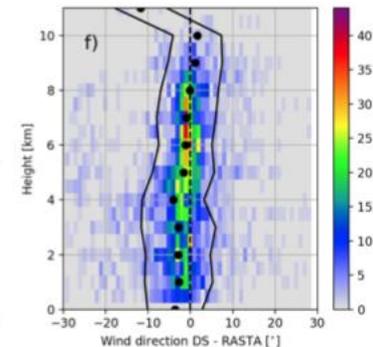
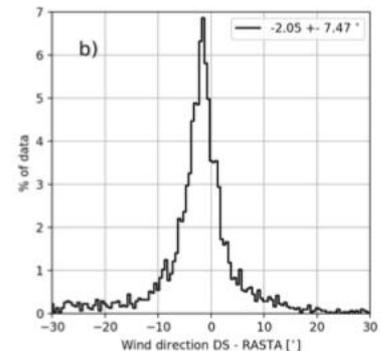
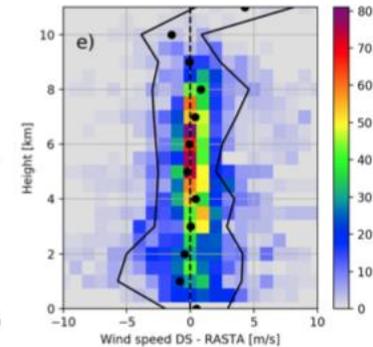
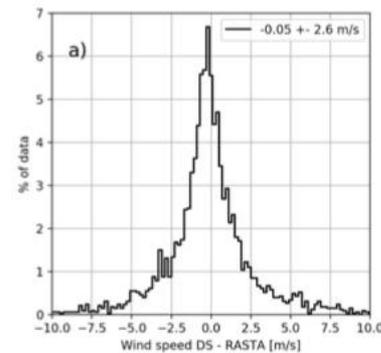
We use the dropsonde launch time with a 10s window for RASTA measurements

Wind speed:  $0.05 \pm 2.6$  m/s  
 Wind direction:  $-2.05 \pm 7.47^\circ$

Iceland: NAWDEX

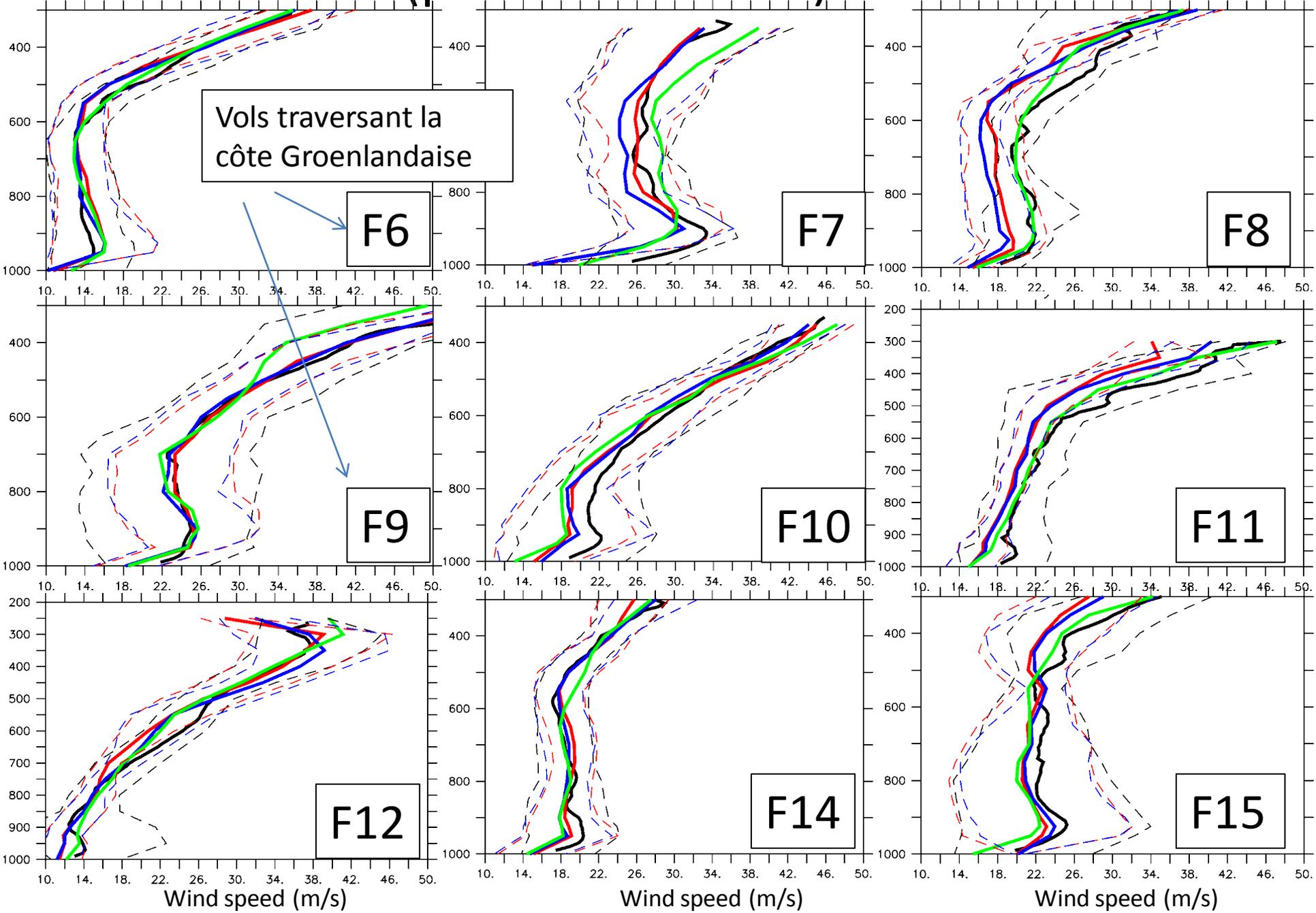
## RASTA against DS (all flights)

As a function of altitude



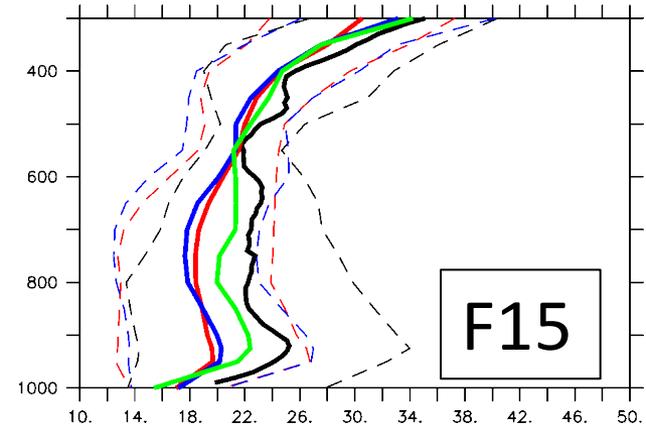
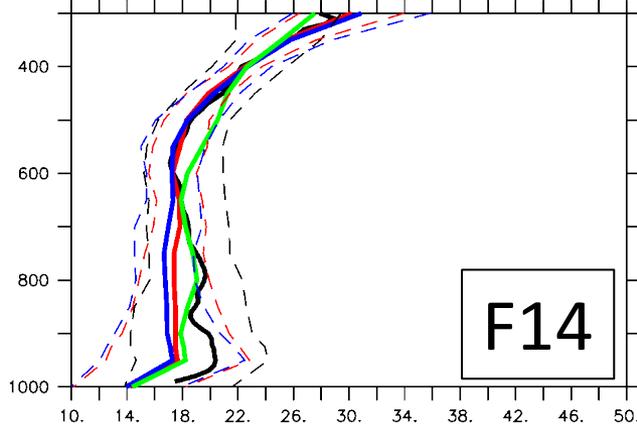
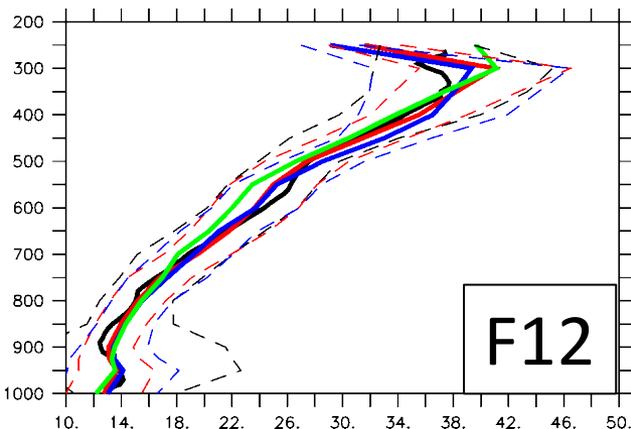
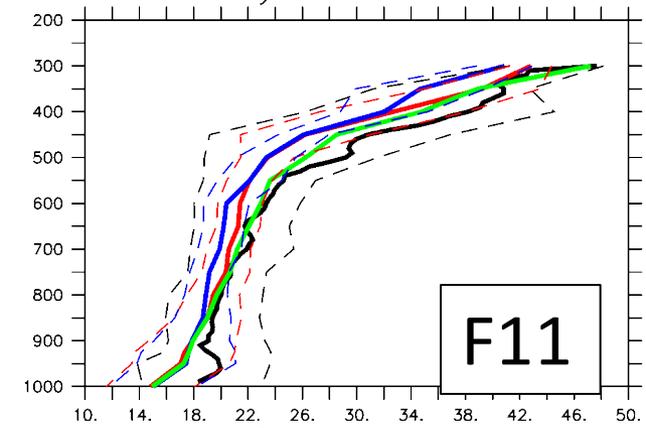
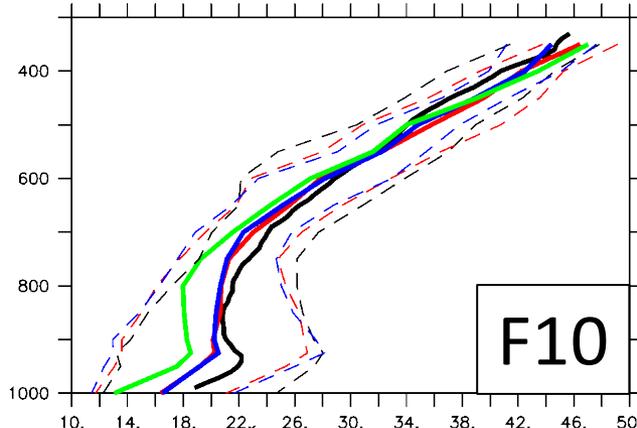
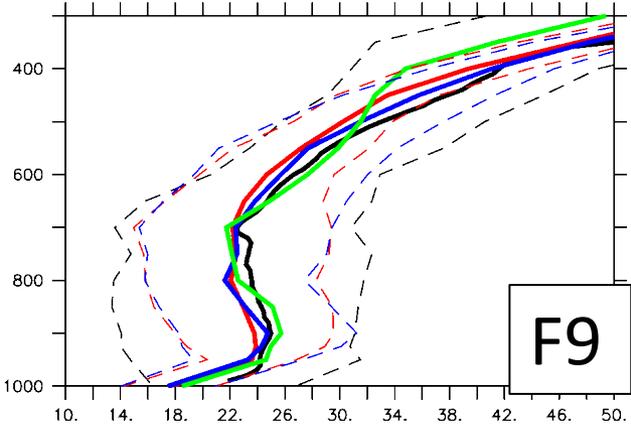
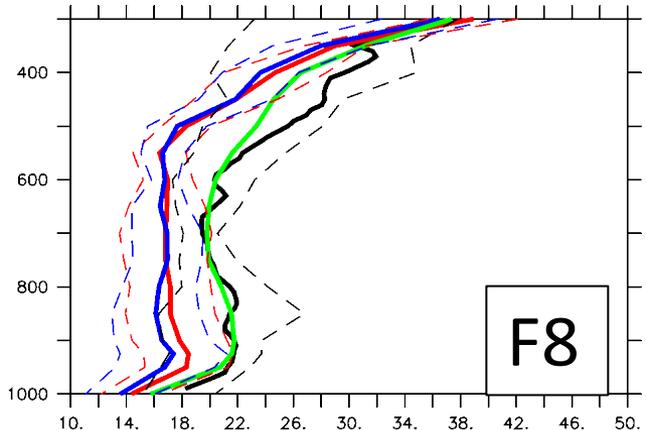
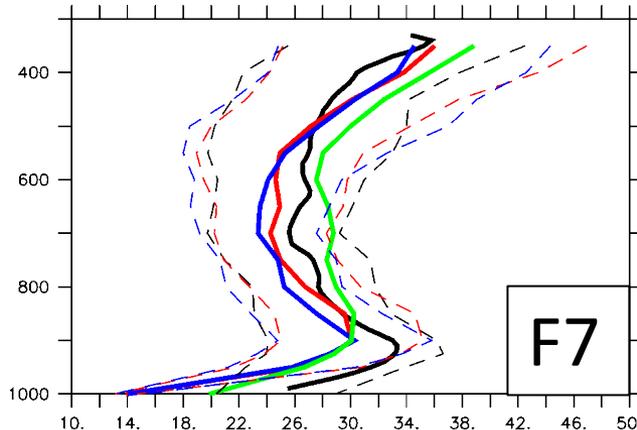
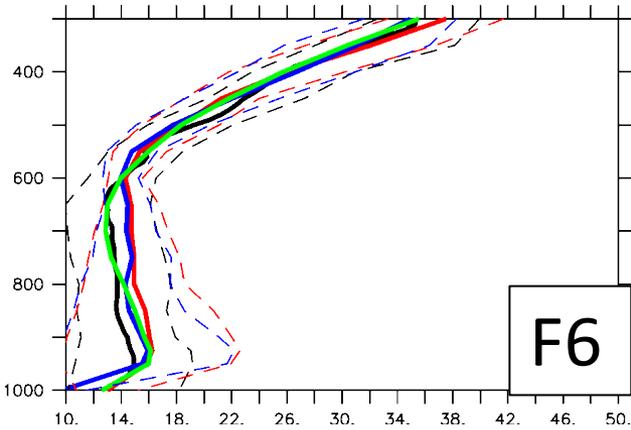
# Vitesse de vent (prévision à ~24h)

Obs Run 0 Run 6 Analysis



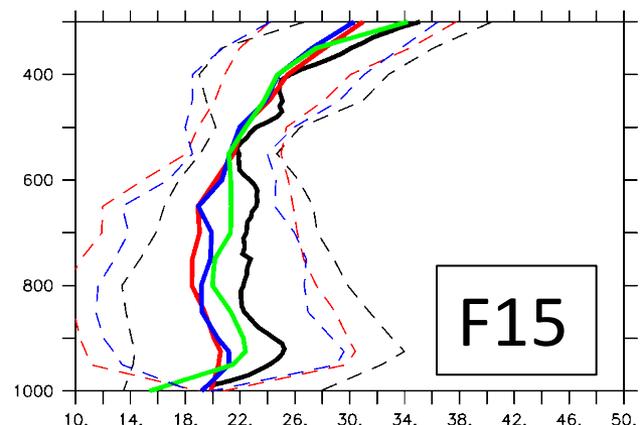
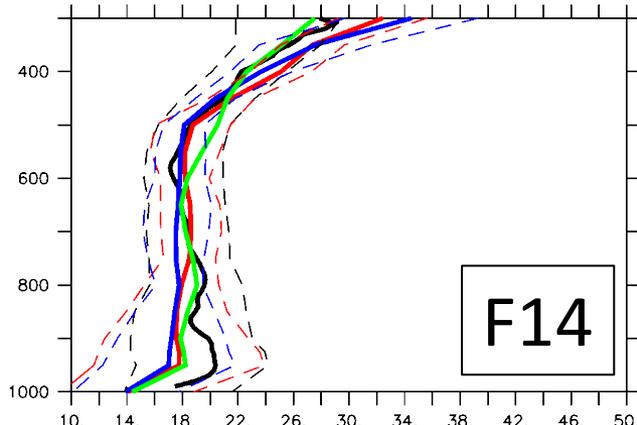
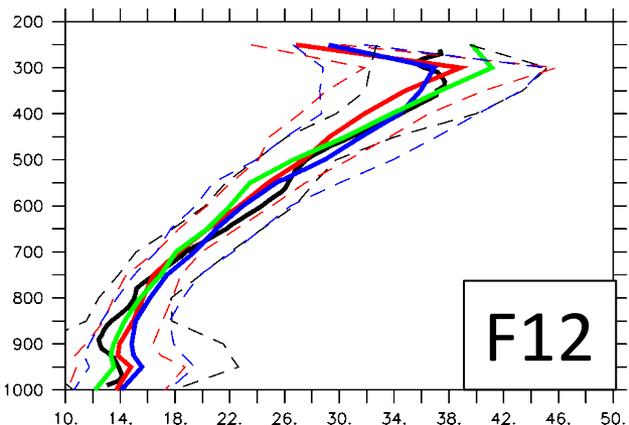
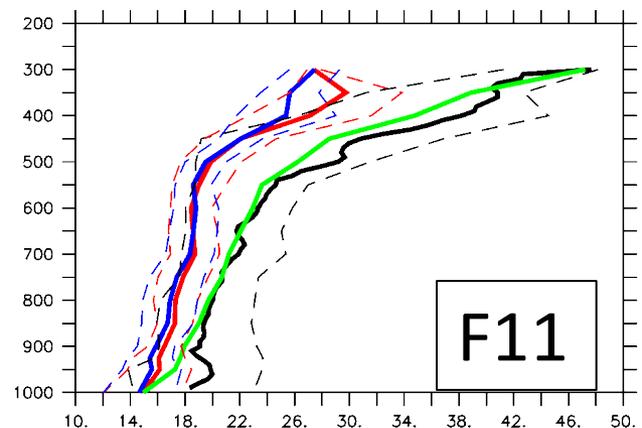
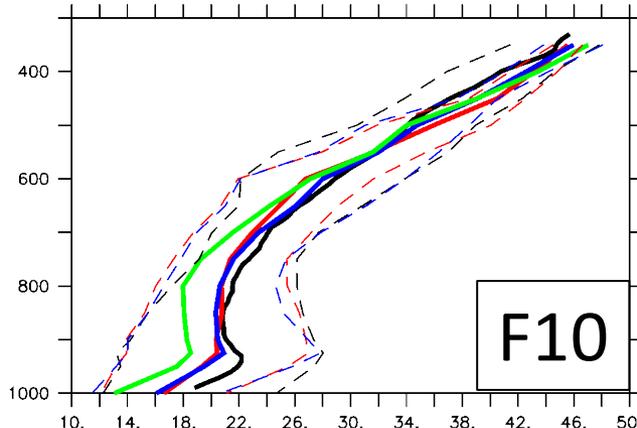
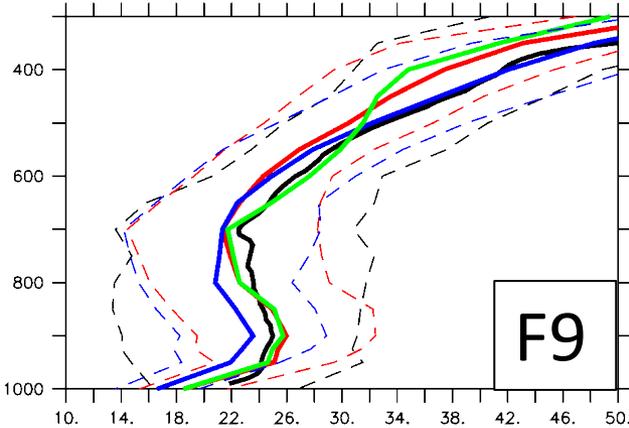
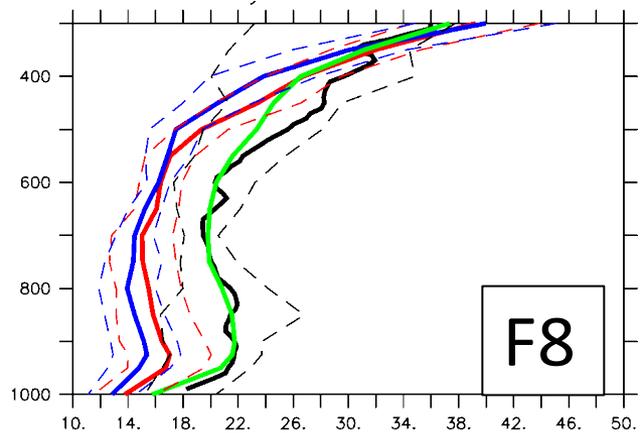
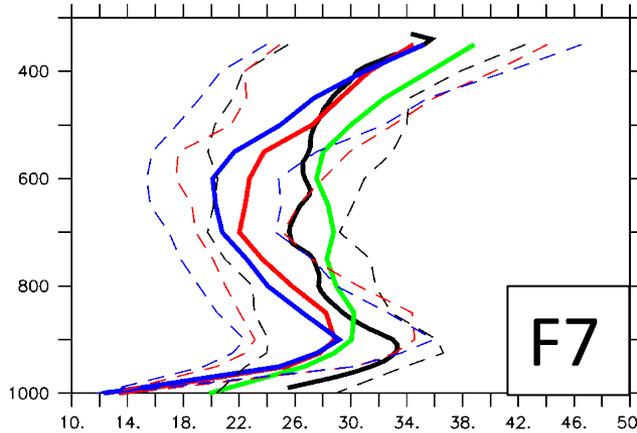
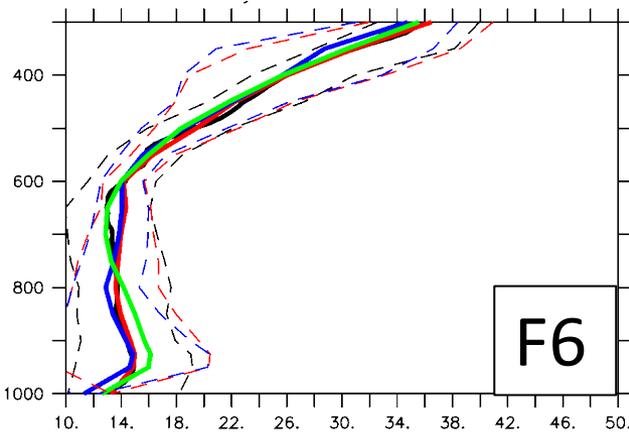
# Vitesse de vent (prévision à ~36h)

Obs Run 0 Run 6  
Analysis 18h

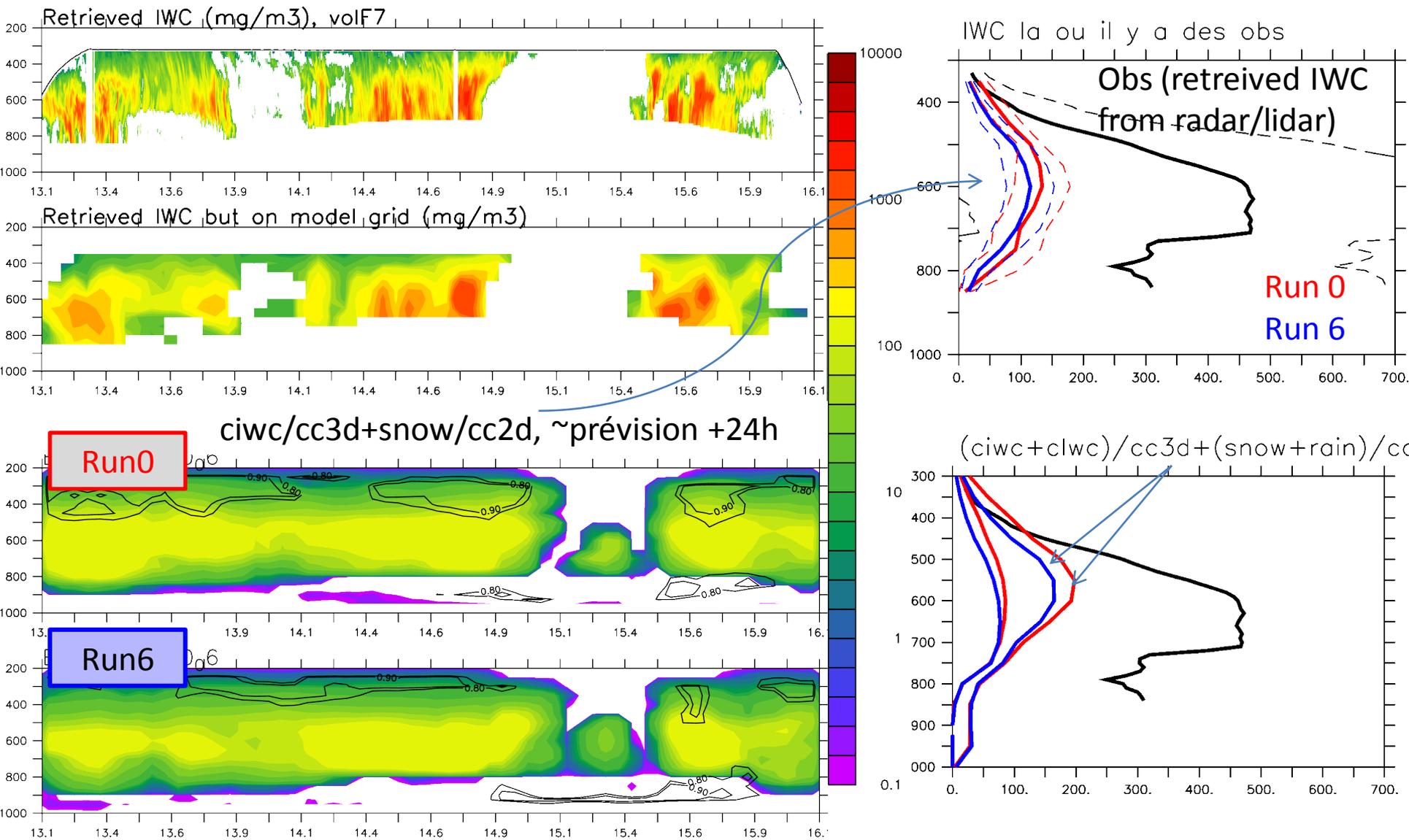


# Vitesse de vent (prévision à ~48h)

Obs Run 0 Run 6  
Analysis 18h



# Coupes verticales le long du vol du contenu en glace (nuage et precip)

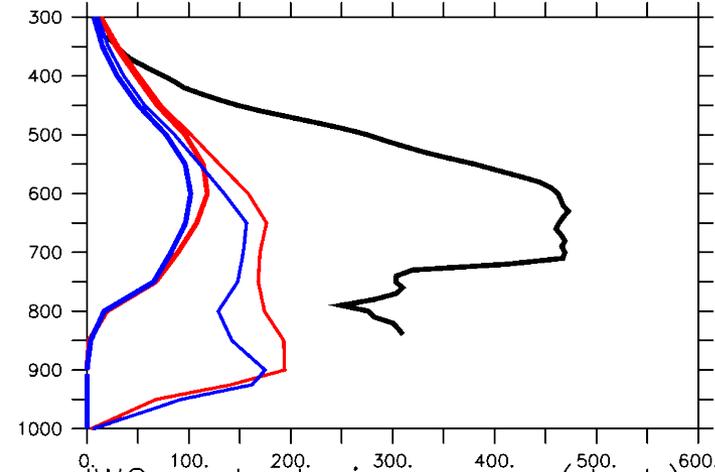
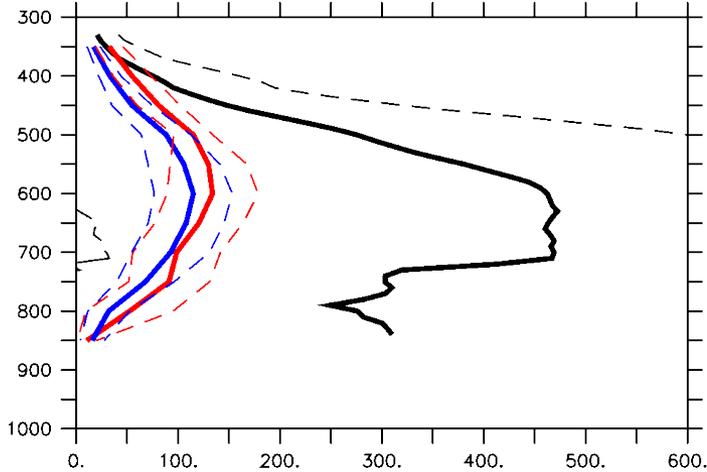


# Contenu en glace (nuage et precip), vol F7

VoIF7, 0 LAST00<sub>0</sub>6, 6 LAST00<sub>0</sub>6, 20161001H12P, +25h to +28.25h

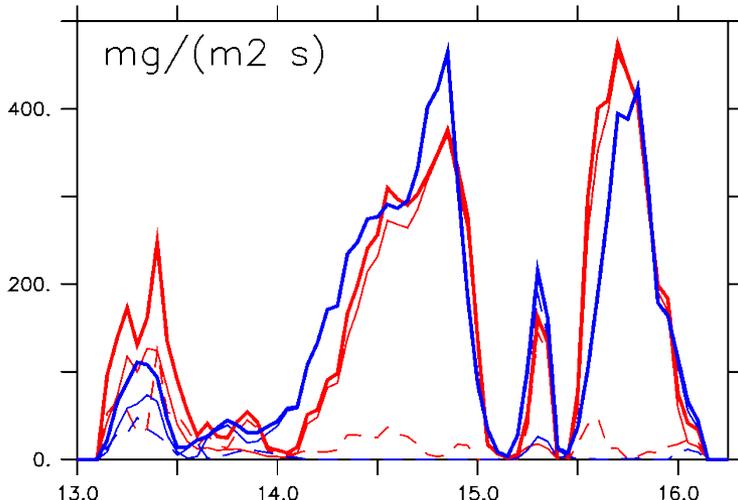
IWC partout  $ciwc/cc3d+snow/cc2d$  (thick)  
 $(ciwc+clwc)/cc3d+(snow+rain)/cc2d$  (thin)

IWC (mg/m<sup>3</sup>) la ou il y a des obs

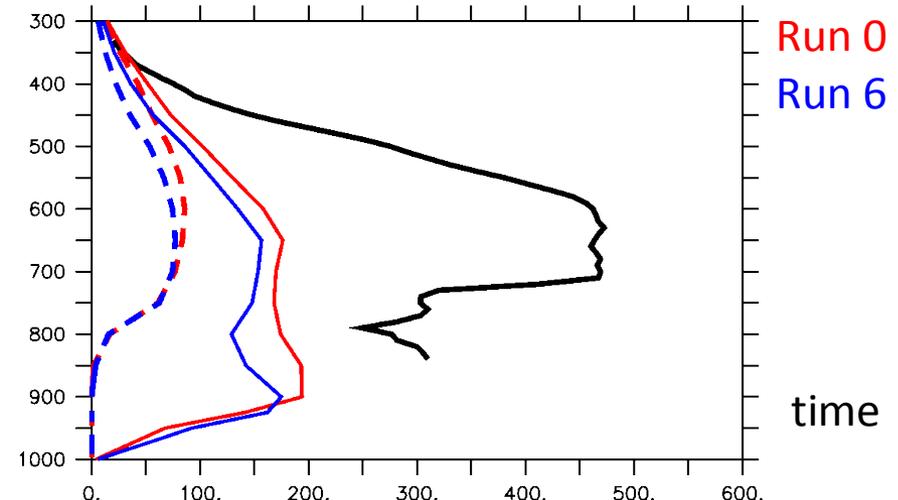


IWC partout  $ciwc+snow$  (dash)

conv prec (---), ls prec (-), sum (thick)



$(ciwc+clwc)/cc3d+(snow+rain)/cc2d$



Run 0  
Run 6

time

# Contenu en glace (nuage et precip)

Run 0

Run 6

