



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

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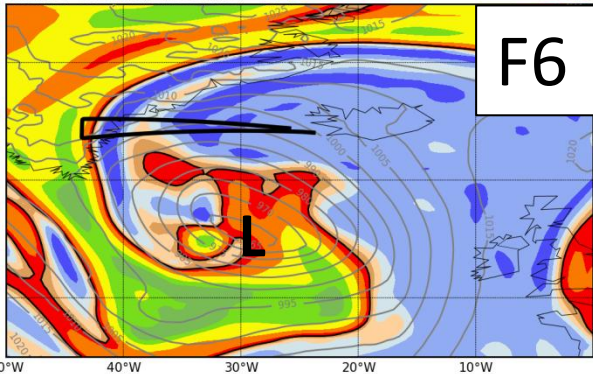
Main questions

- 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) ?**
- Are there systematic **differences between the two convection schemes PEARP-B85 et PEARP-PCMT in terms of ice water content, PV and horizontal wind speed ?**

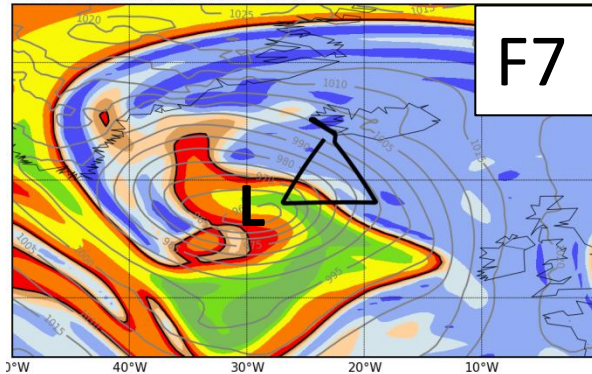
PV@300hPa, SLP

9 Flights

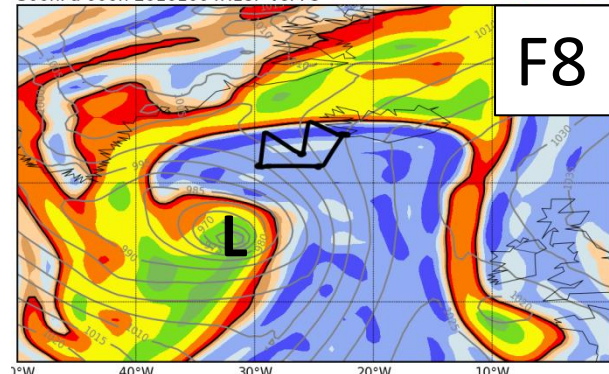
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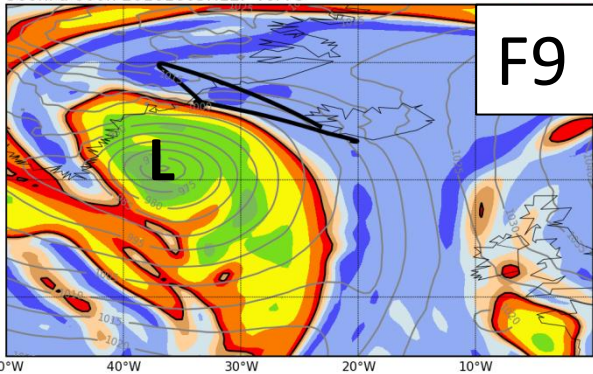
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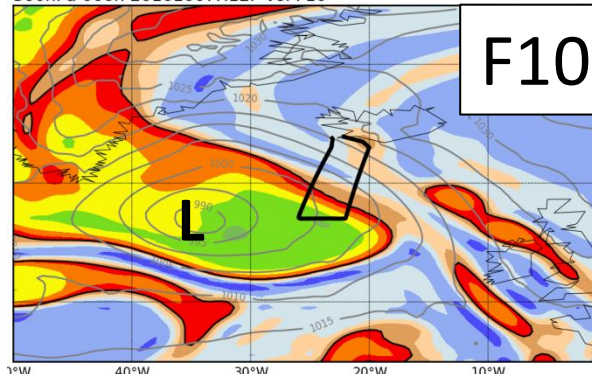
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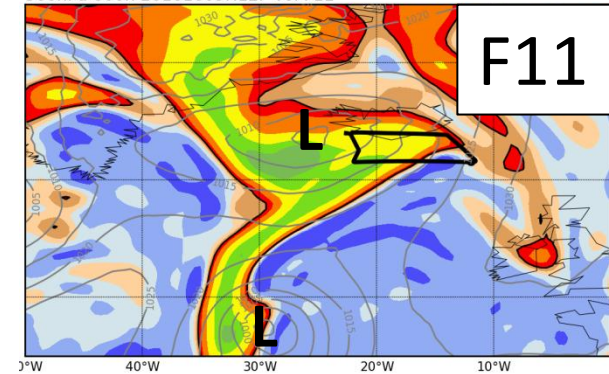
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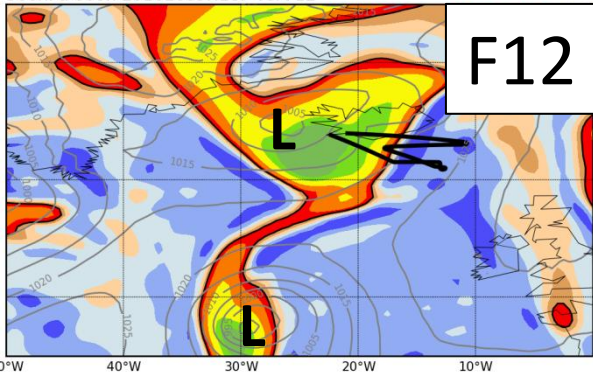
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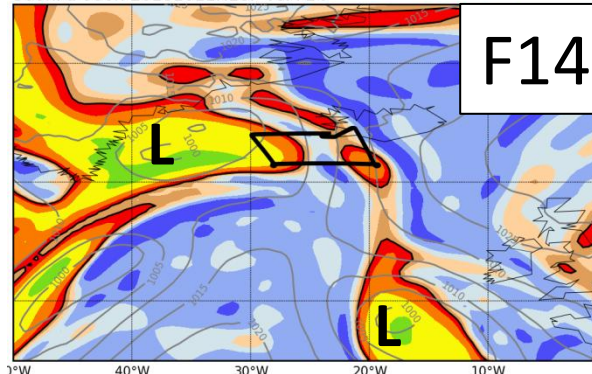
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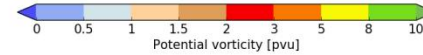
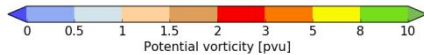
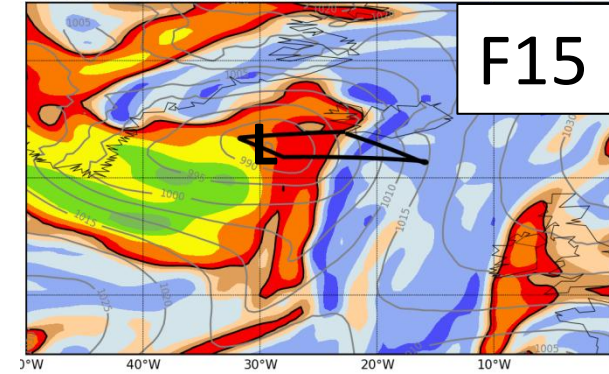
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300hPa 000h 20161011H18P vol F14



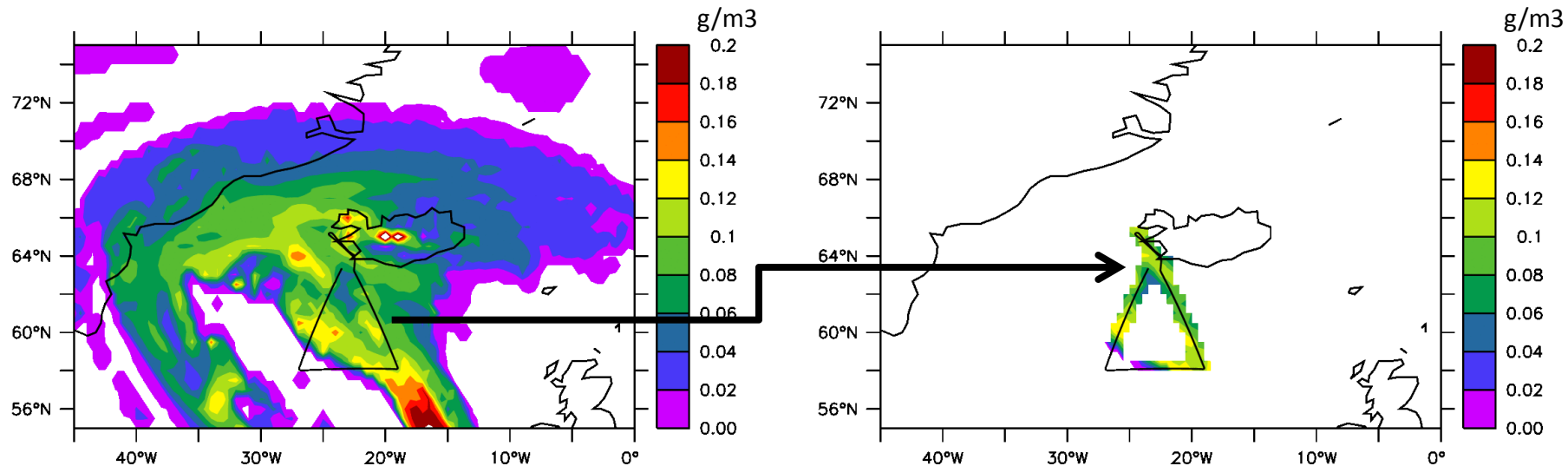
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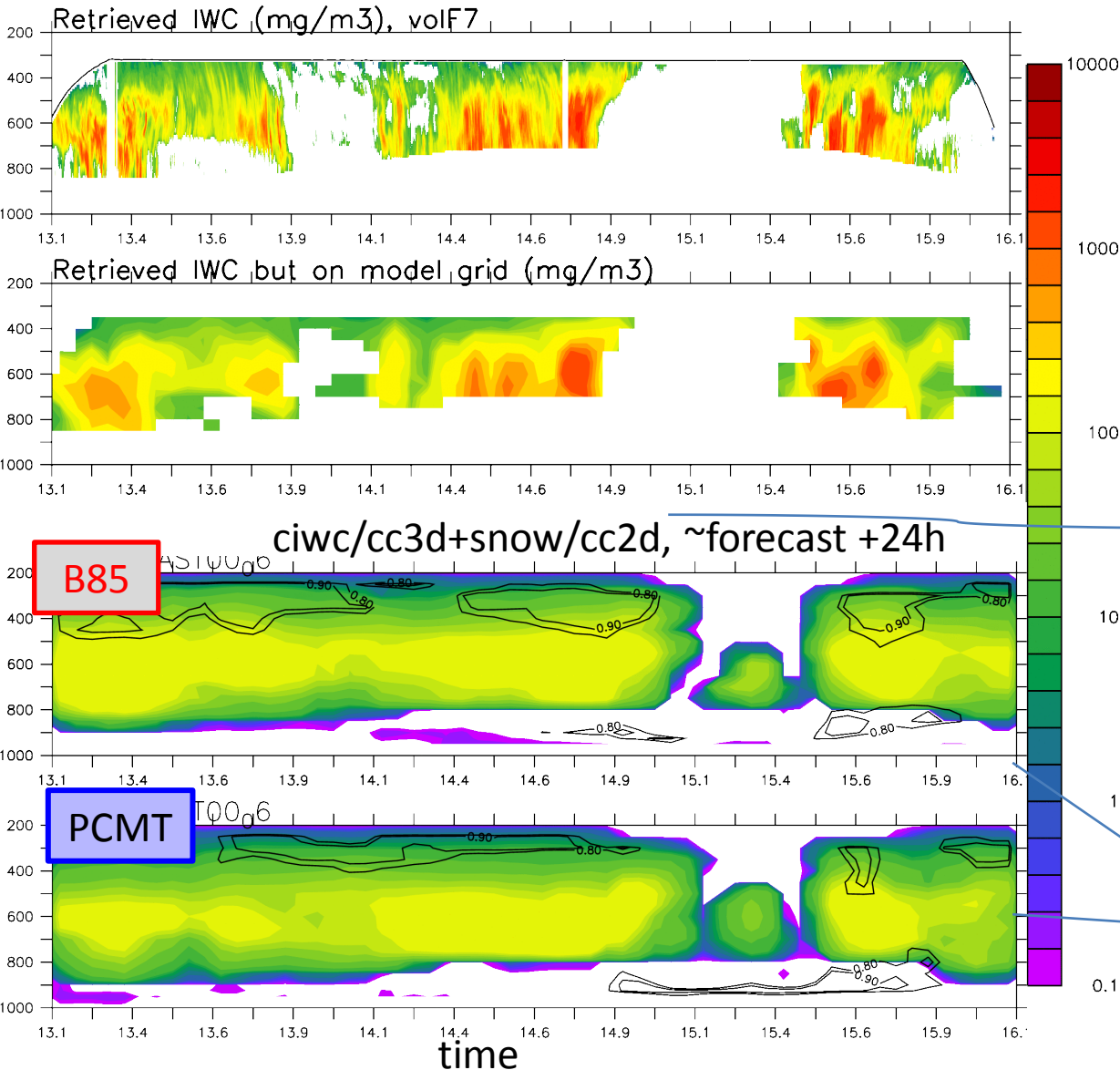
Comparing two convection schemes using Arpege

- **Arpege** / 2-3 days forecast
- Resolution: T798 with stretching → 10km over France, 20km on Iceland
- Initial condition: Arpege operational analysis (10/01/2016, 12UTC)
- Two convection schemes associated to two members:
 - **B85: Bougeault (1985): closure in humidity, used in operational NWP version.**
 - **PCMT: Piriou et al. (2007) « Prognostic Condensates Microphysics and Transport »; closure in CAPE, used in Arpege climate version.**
- Output resolution: lon x lat: $0.5^\circ \times 0.5^\circ$ (or $0.1^\circ \times 0.1^\circ$) + every 15 minutes.

Cloud Ice Water content/3D cloud fraction+Snow/2D cloud fraction, ~forecast +24h

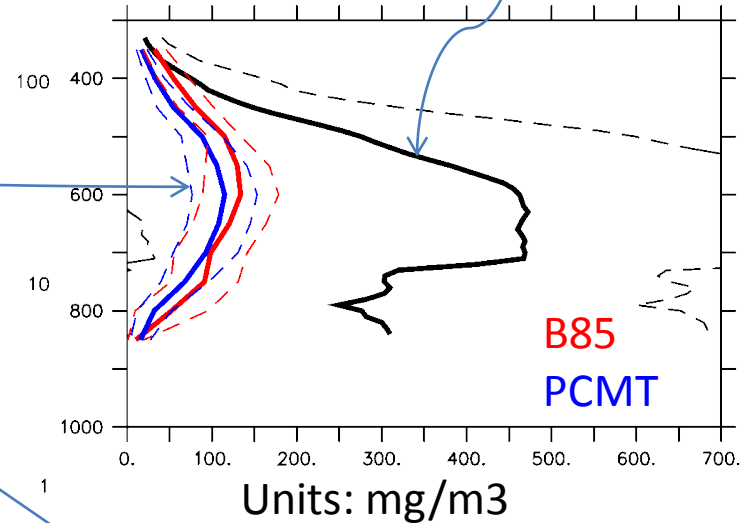


Results of last year: Ice Water Content, flight F7



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

What are the changes / improvements ?

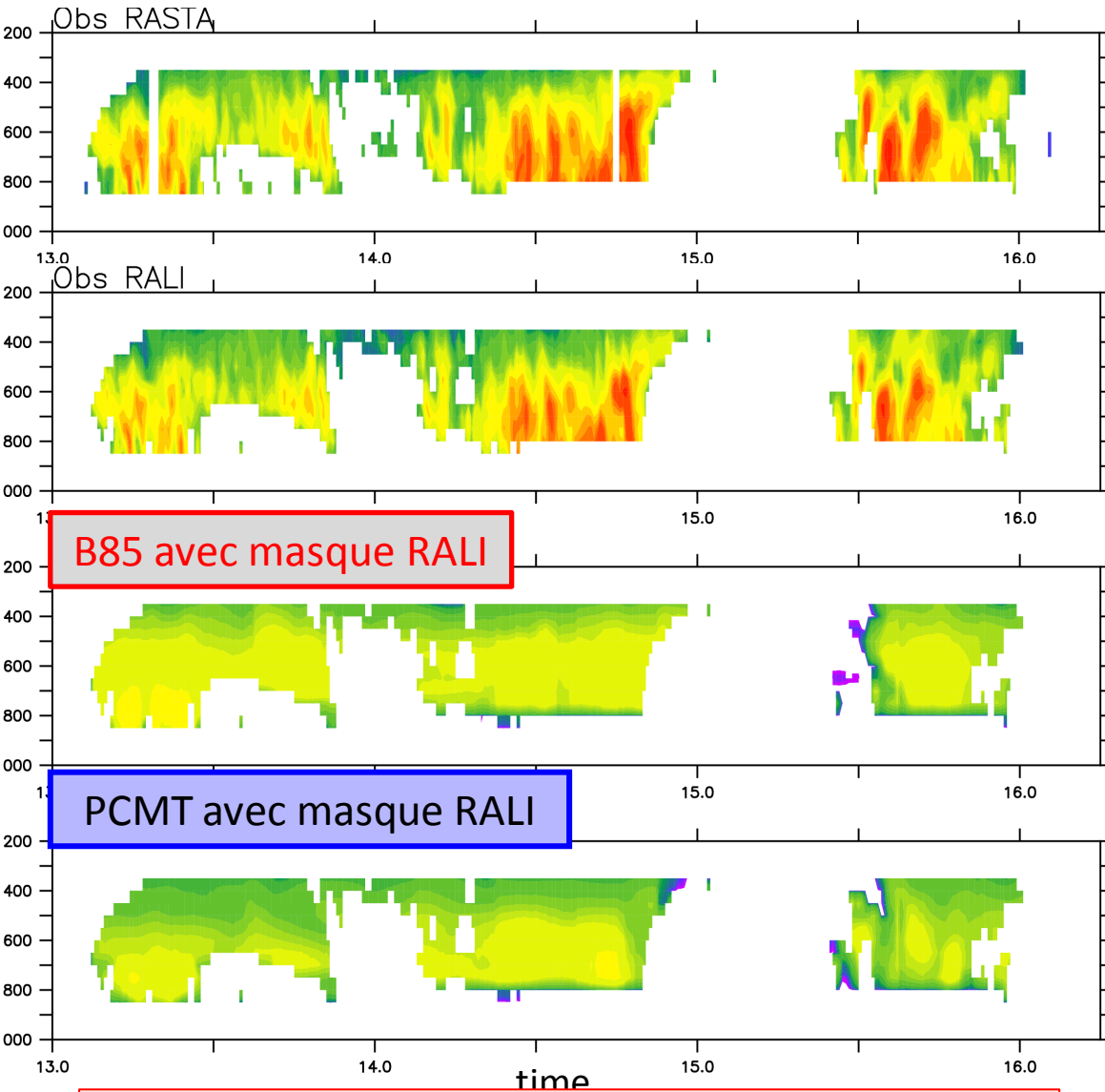
Last year

- Resolution $0.5^{\circ} \times 0.5^{\circ}$
- Variables derived from GRIB files (not clear if it was containing the convective part)
- Snow fall speed: 1.5 m/s
- We were comparing two runs with different deep and shallow convection schemes.
- RASTA old version

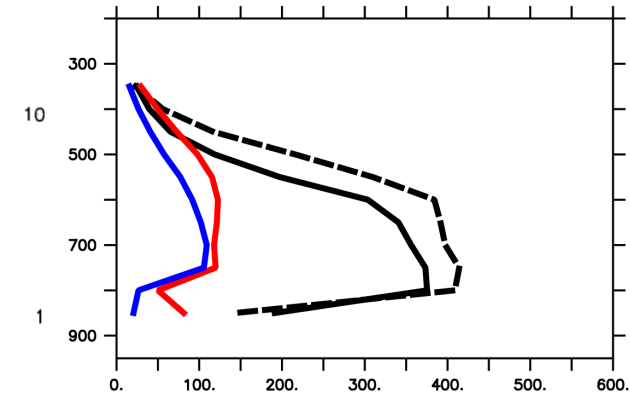
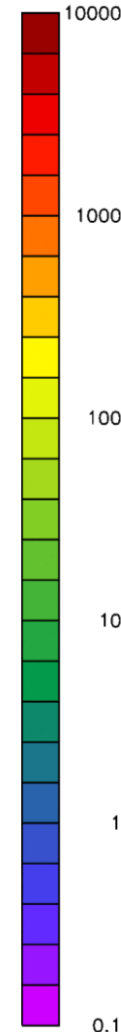
This year

- Resolution $0.1^{\circ} \times 0.1^{\circ}$
- Variables directly coming from the microphysics part with well identified convective and stratiform parts.
- Snow fall speed: 1.5 m/s and 0.6 m/s
- Comparing two runs with same shallow convect° scheme and differing from the deep convect° scheme only.
- RASTA new version + RALI

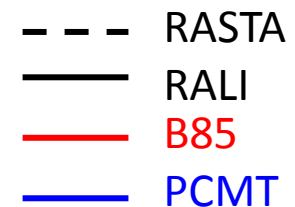
Flight F7



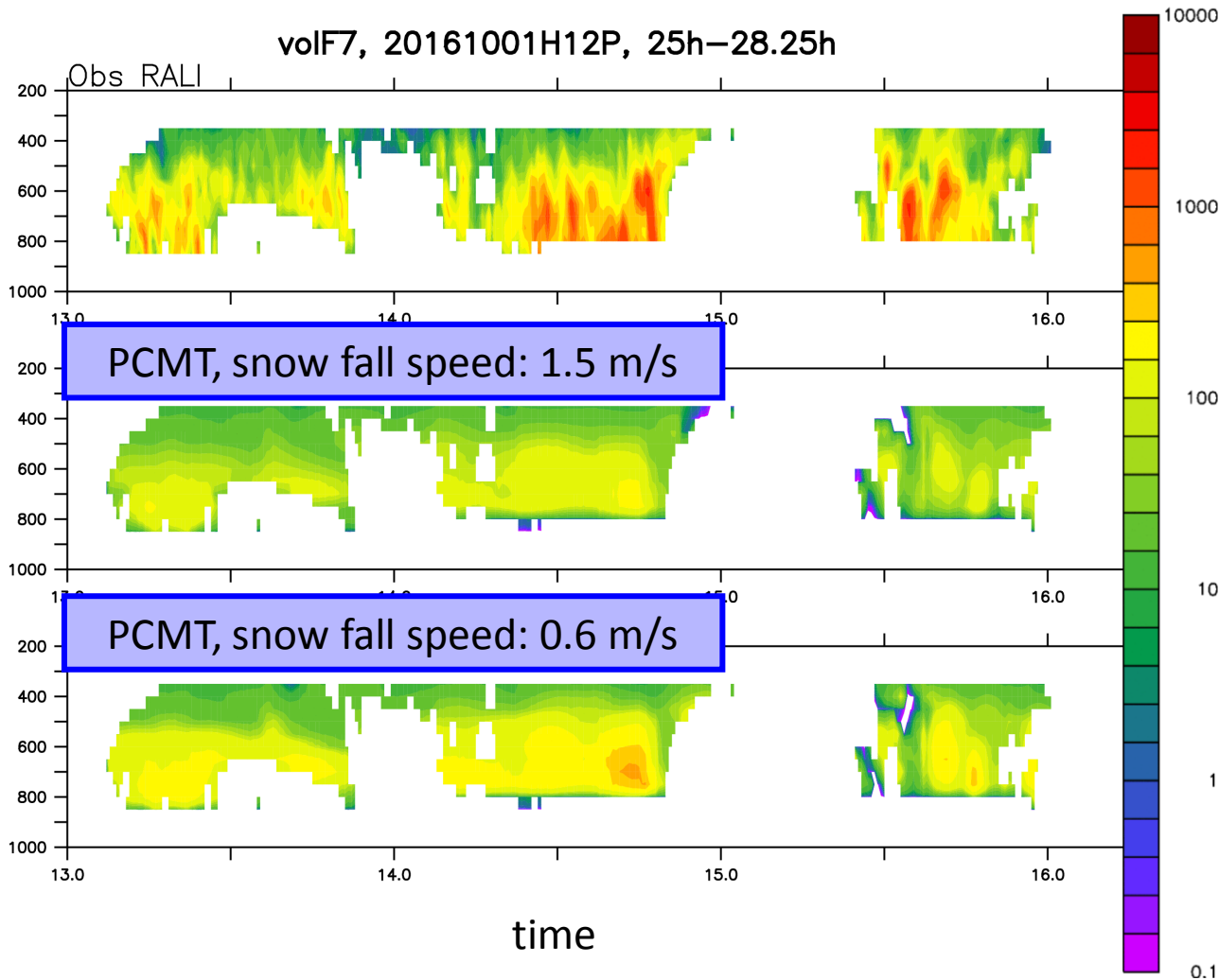
Factor: 4 between the mean simulated IWC and the mean retrieved IWC from RALI



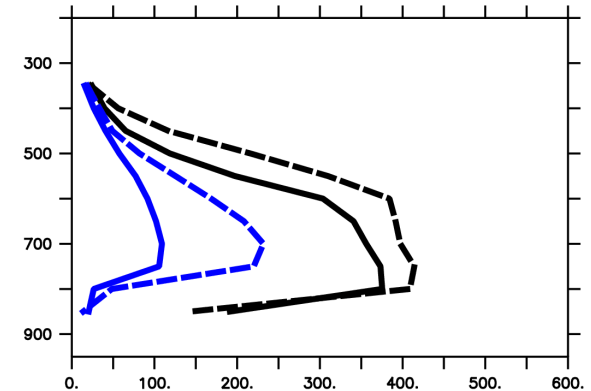
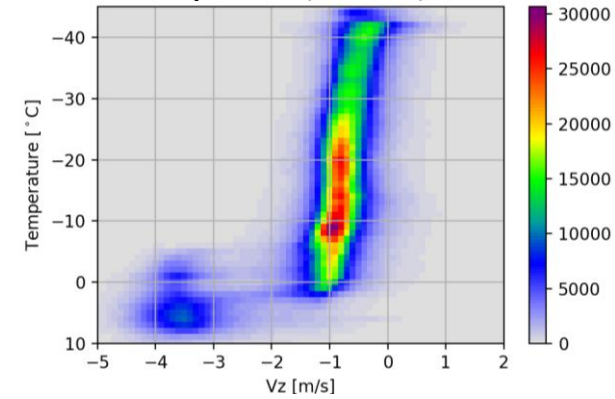
mg/m3



Effect of snow fall speed



RASTA statistics of fall speed (V_t+w)

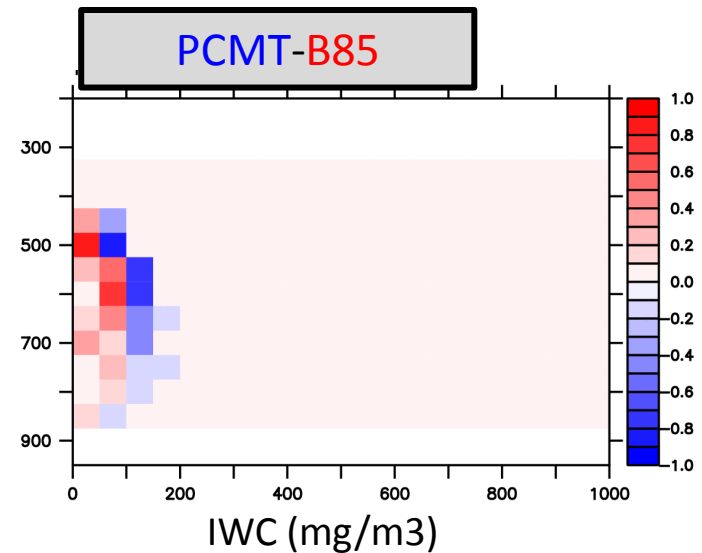
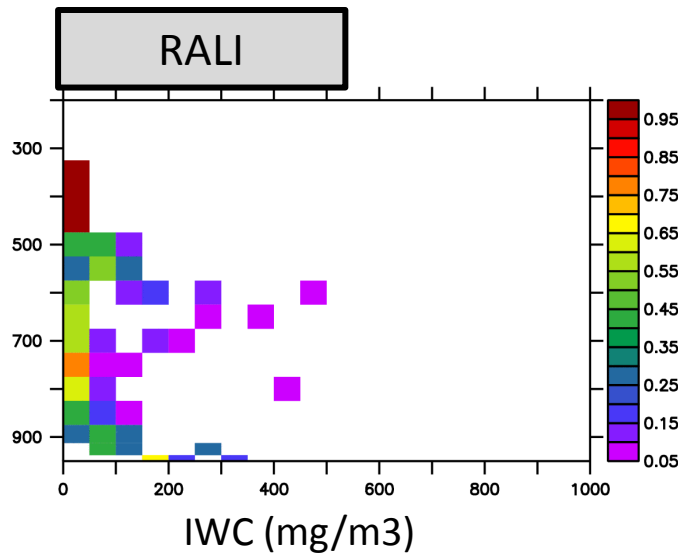
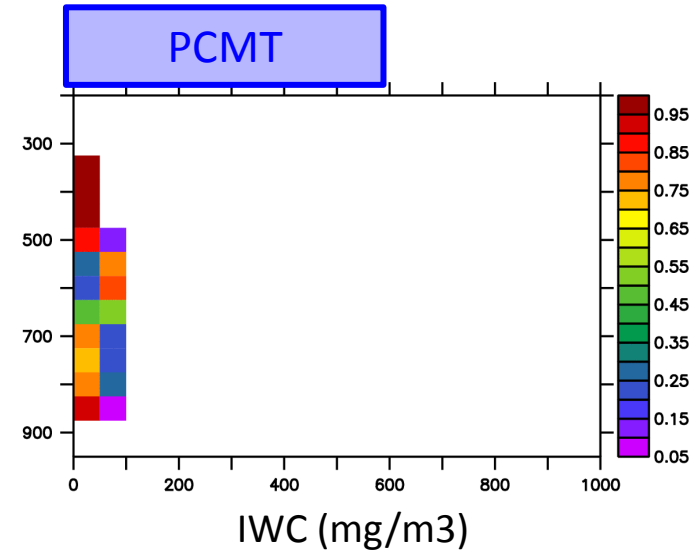
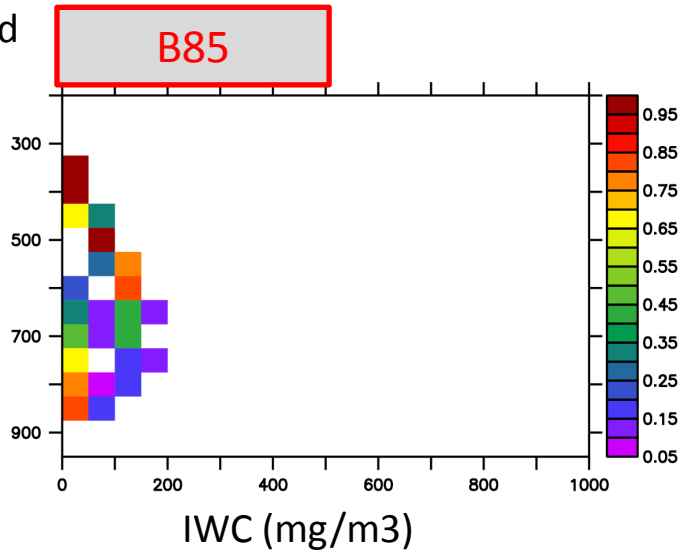


- RASTA mg/m³
- RALI
- 0.6 m/s
- 1.5 m/s

Factor: 1.5 in the mean; 2.0 in the max

Pdfs of IWC, all flights

Snow fall speed
1.5 m/s

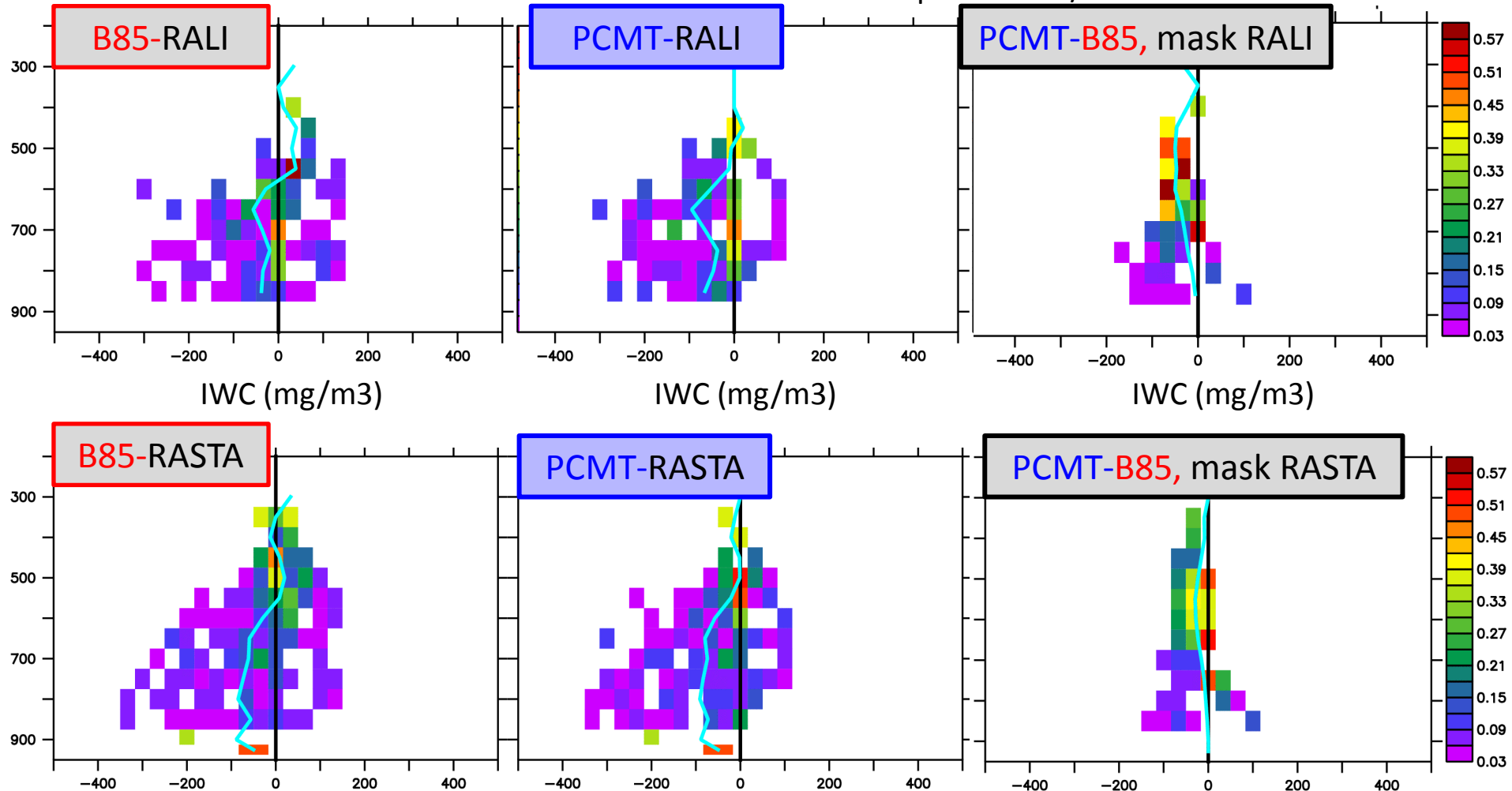


e max

Higher IWC for B85 than PCMT, especially between 500 and 700hPa → confirmation over 9 flights of Meryl's results

Pdfs of the difference in IWC with RALI, all flights

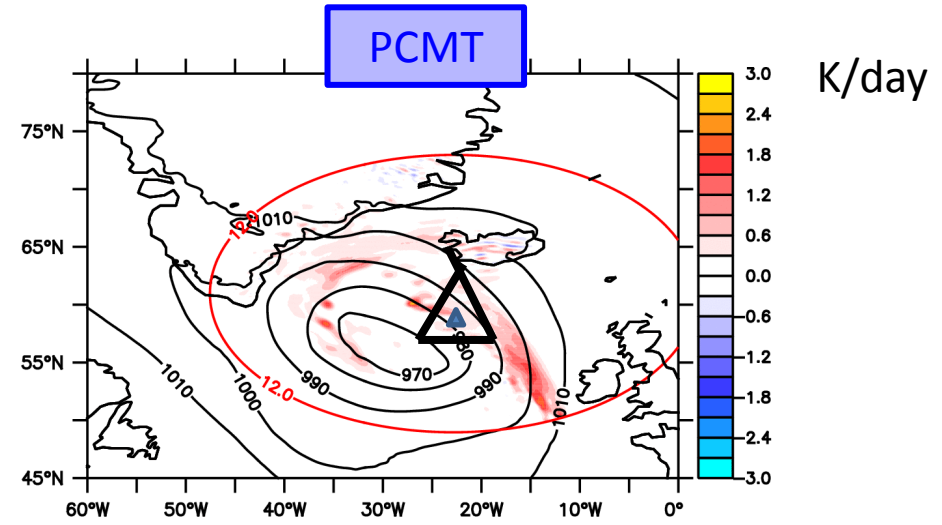
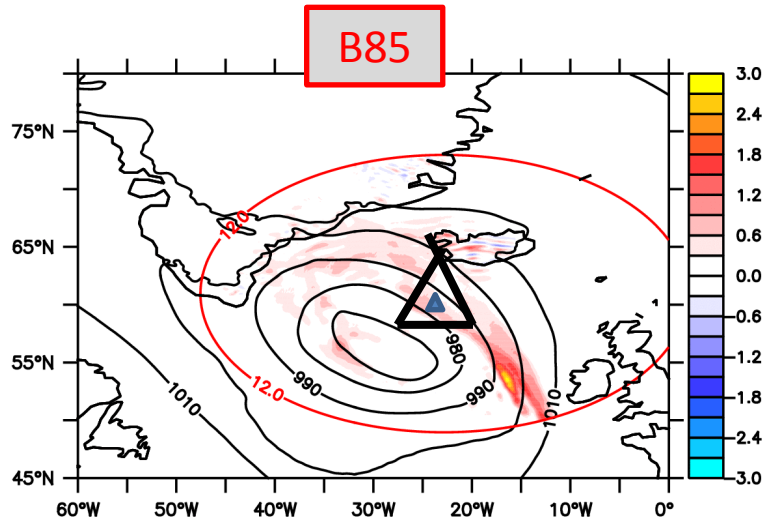
Snow fall speed 1.5 m/s



- Against RASTA retrievals: clear underestimation of IWC at all levels
- Against RALI retrievals: underestimation of IWC below 600 hPa only, especially lack of high values.

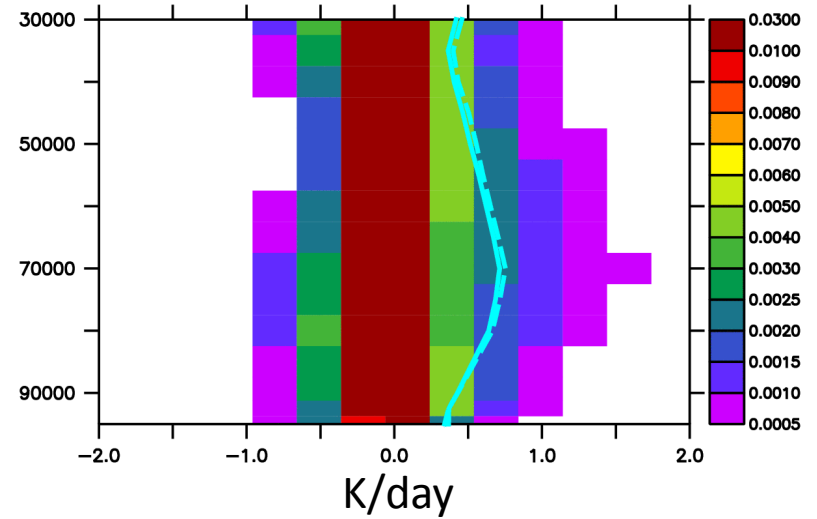
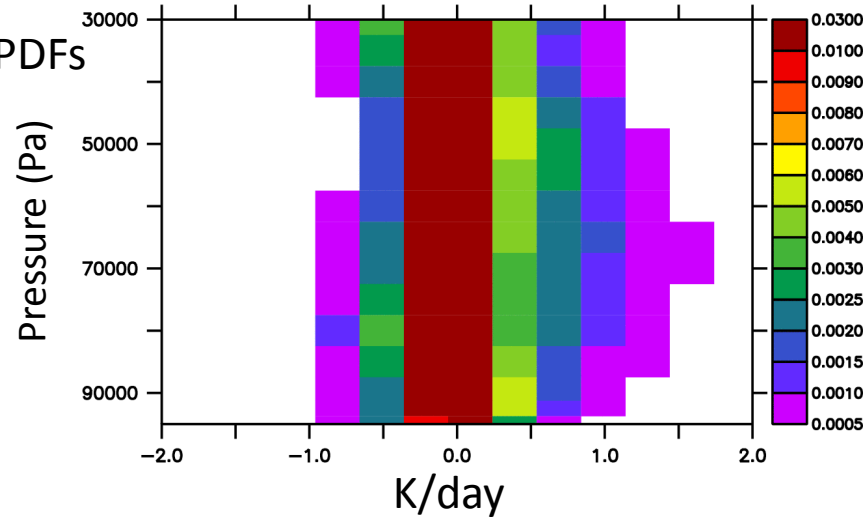
Statistics of heating rate

F7

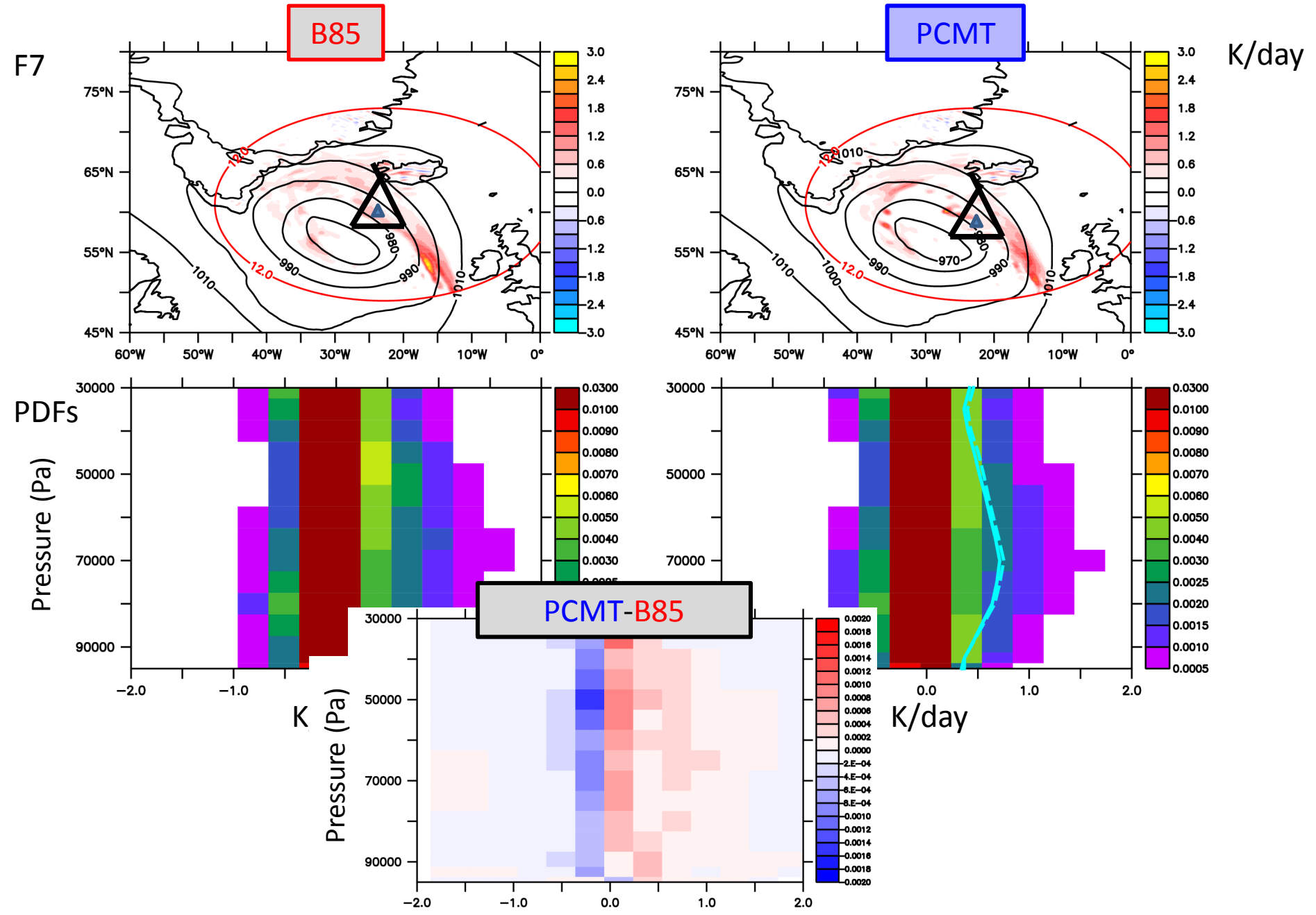


K/day

PDFs



Statistics of heating rate



Conclusions

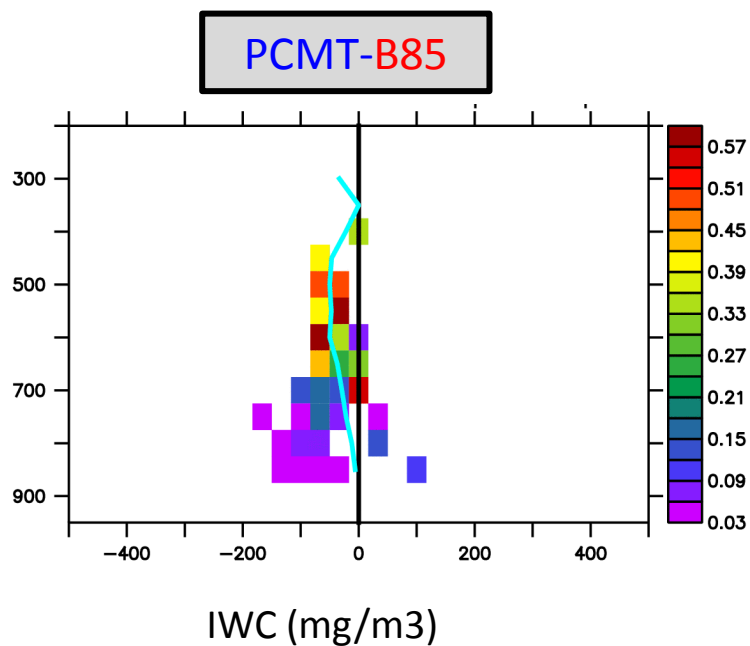
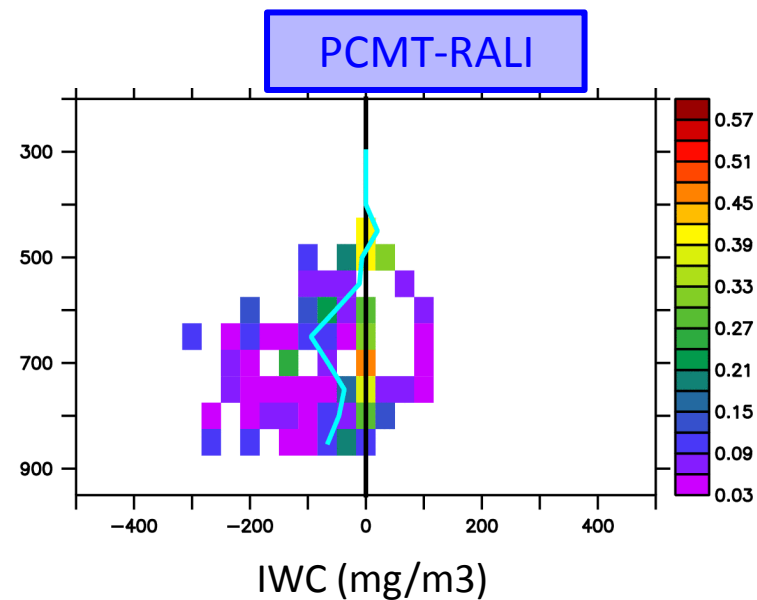
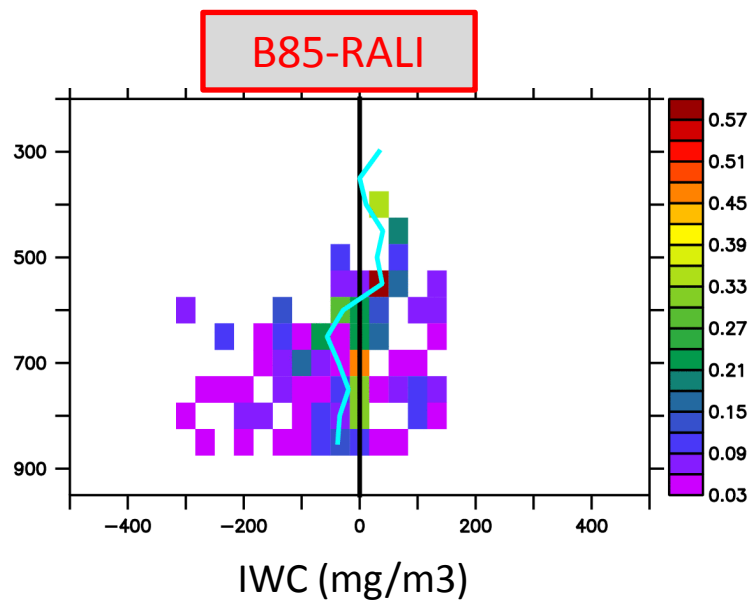
- Factor of 4 between RALI/RASTA IWC retrievals and simulated IWC with 1.5 m/s fall speed
- Factor of 1.5 between RALI/RASTA IWC retrievals and simulated IWC with 0.6 m/s fall speed
- Whatever the fall speed, significant underestimation of the peak values of IWC below 600 hPa (e.g., factor 2 in F7).
- Underestimation more visible in PCMT.
- B85: more ice at higher altitude and more intense heating rate than PCMT: so potentially WCBs reach higher altitude → confirmation of Meryl's case study

To be done:

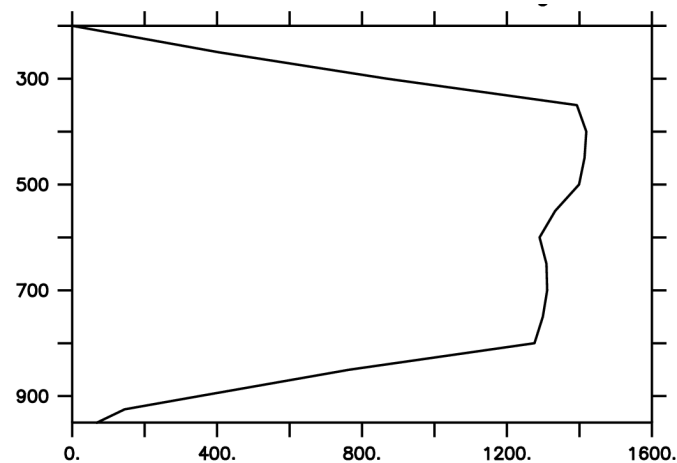
- Computation of WCB trajectories for the 9 flights (LAGRANTO?)
- Systematic analysis of PV/wind differences like in Meryl's study

Additional slides

Pdfs of the difference in IWC with RALI, all flights

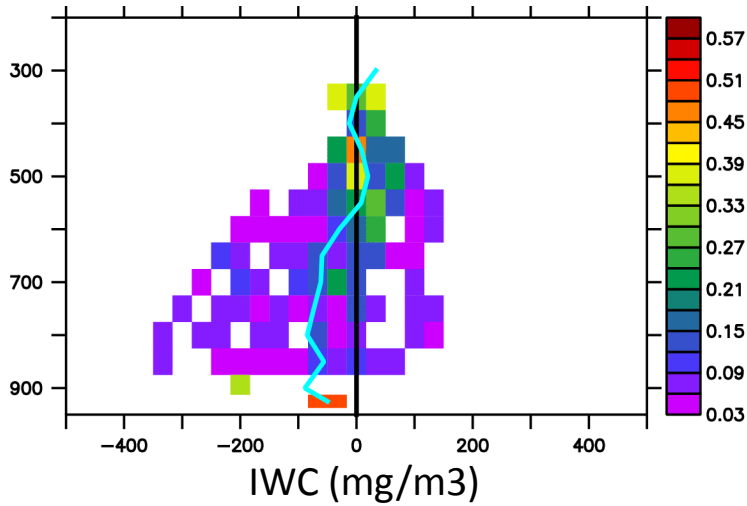


Number of observations (on model grid)

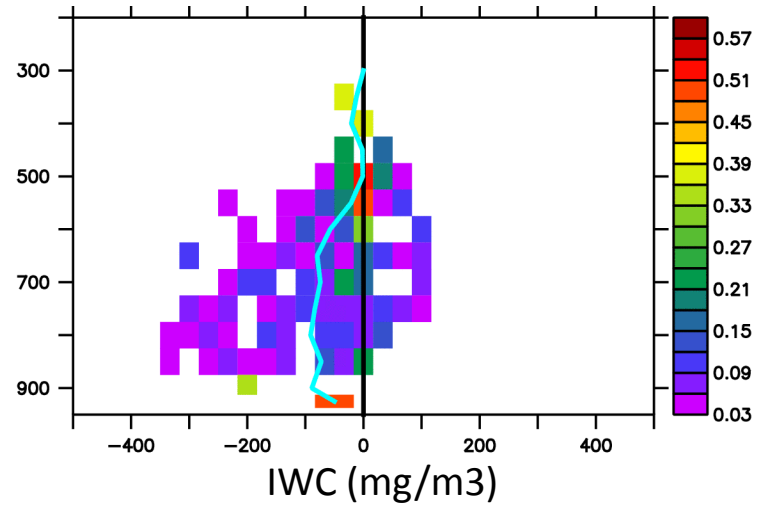


Pdfs of the difference in IWC with RASTA, all flights

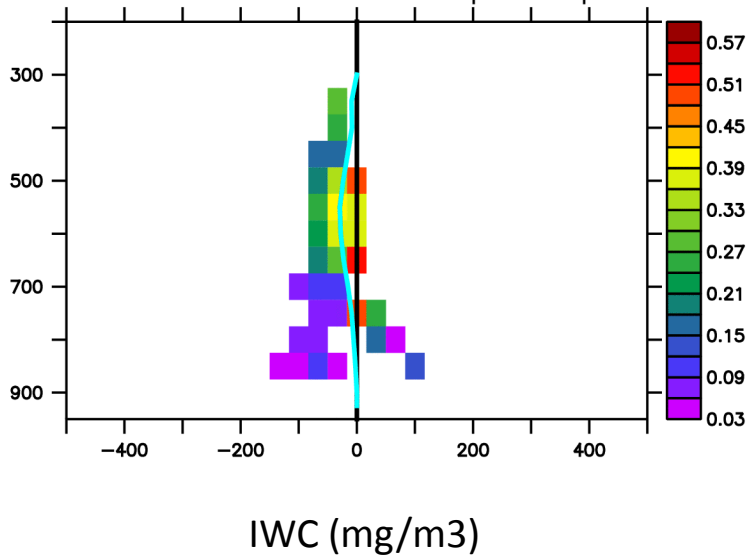
B85-RASTA



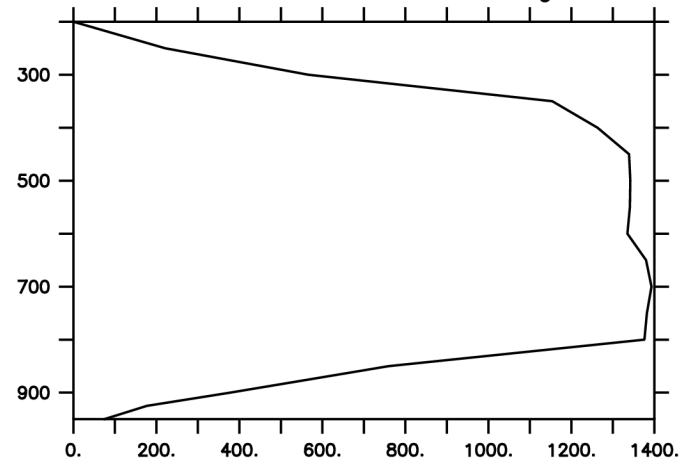
PCMT-RASTA



PCMT-B85

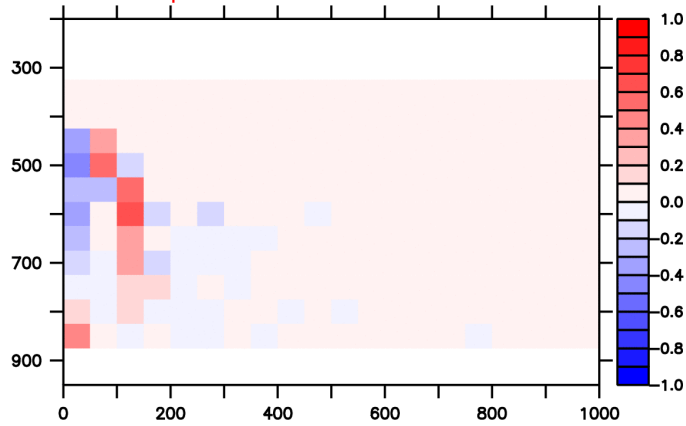


Number of observations (on model grid)



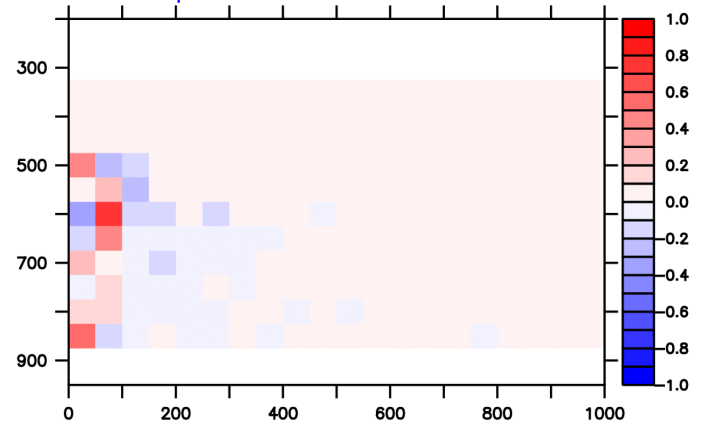
Pdfs of IWC, all flights

B85-RALI



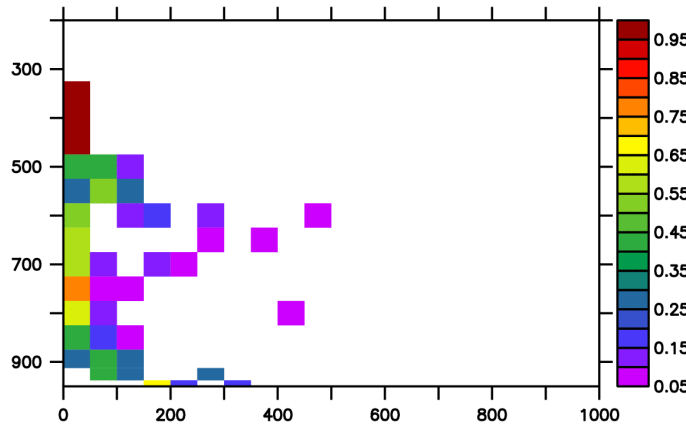
IWC (mg/m3)

PCMT-RALI



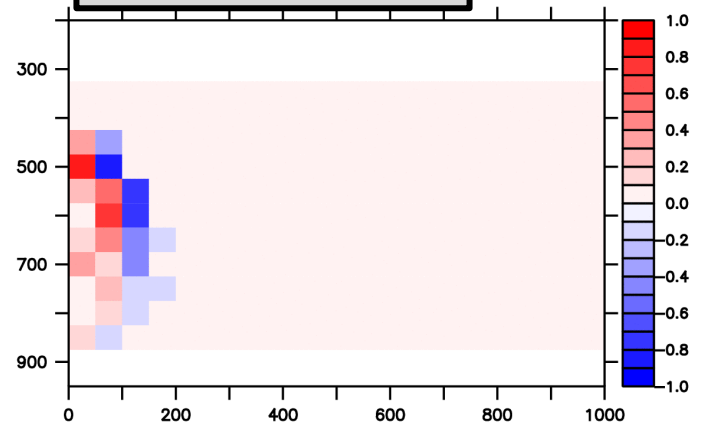
IWC (mg/m3)

RALI



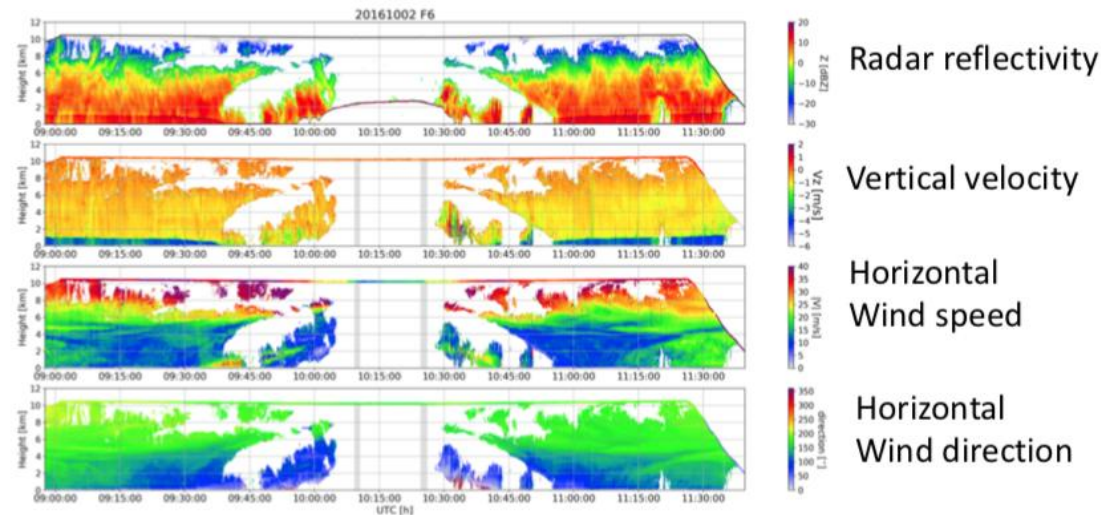
IWC (mg/m3)

PCMT-B85



Comparison vent -RASTA

RASTA WIND retrieval assessment



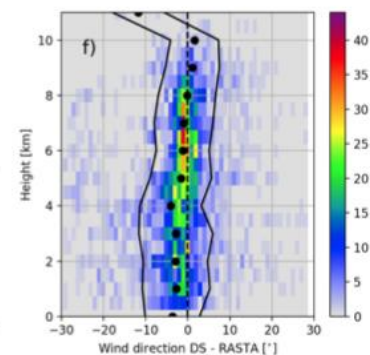
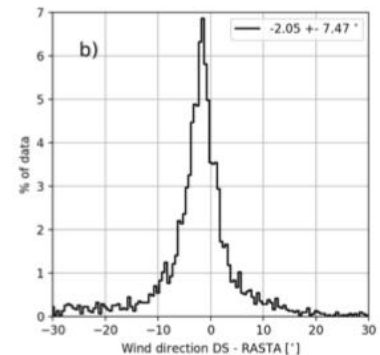
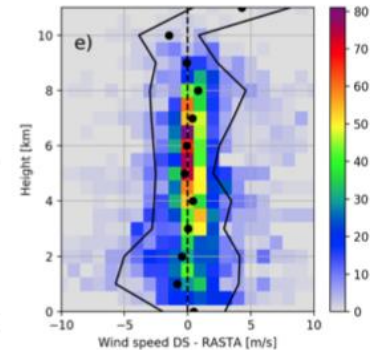
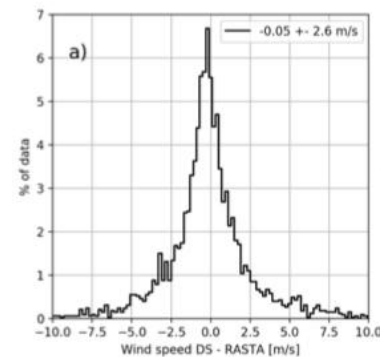
We use the dropsonde launch time with a 10s window for RASTA measurements

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

Iceland: NAWDEX

RASTA against DS (all flights)

As a function of altitude



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

