Réunion ANR DIP-NAWDEX 2020

Diabatic processes in the Warm Conveyor Belt of the Stalactite Cyclone

Sensitivity to the two deep convection schemes in ARPEGE

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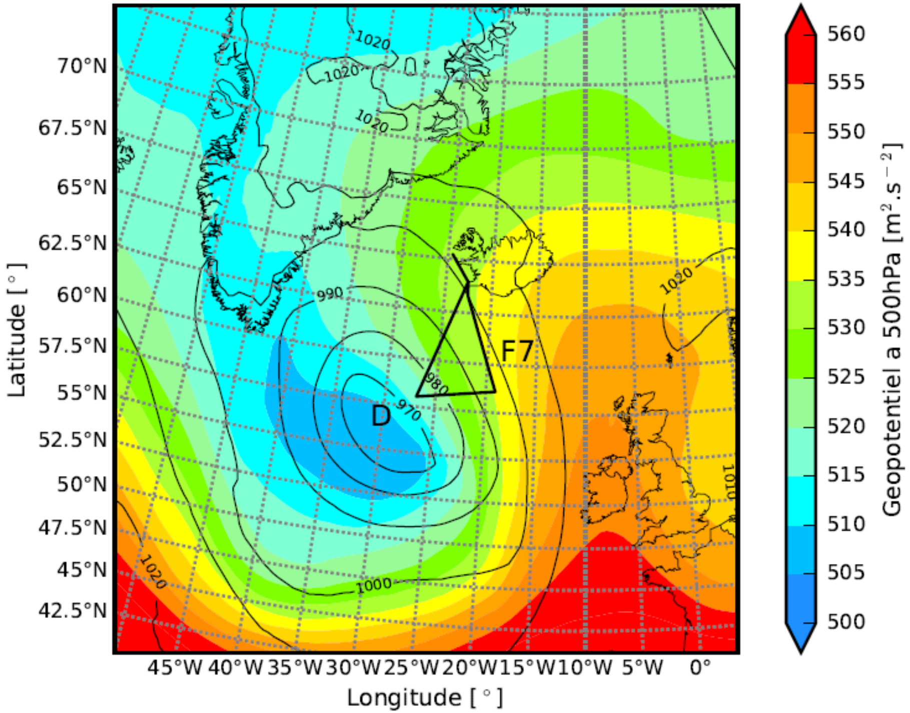
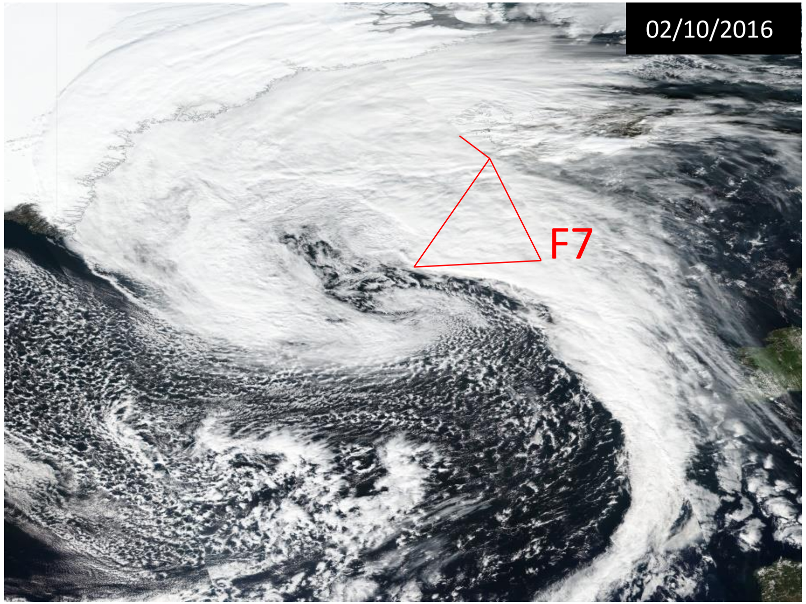
Stalactite Cyclone

Geopotential at 500 hPa and
Mean Sea Level Pressure



ARPEGE Analysis, 02/10/2016 at 12h UTC



MODIS, Nasa Worldview Application

ARPEGE-EPS (cy41.op1)

NWP :

- Resolution : 10km on France, 20km on Islande (TL798 C2.4)
- Level : 90 from 14m to 50km (1hPa)
- Time step : 514,3s
- Initial Condition : ARPEGE analysis of the 01/10/2016 at 12h UTC

Outputs :

- Resolution : 0,5°
- Level : model grid
- Time step : 15min
- Heating and PV tendencies

Deep convection scheme in ARPEGE-EPS

Bougeault, 1985 (B85)

- Mass-Flux scheme
- Closure : moisture

Piriou et al, 2007 (PCMT)

- Mass-Flux scheme
- Closure : CAPE
- Microphysic and transport schemes
- Strong entrainment

Shallow convection : KFB (Bechtold et al. 2001) // PMMC (Pergaud et al. 2009)

Influence of these two deep convection schemes on the Stalactite Cyclone WCB

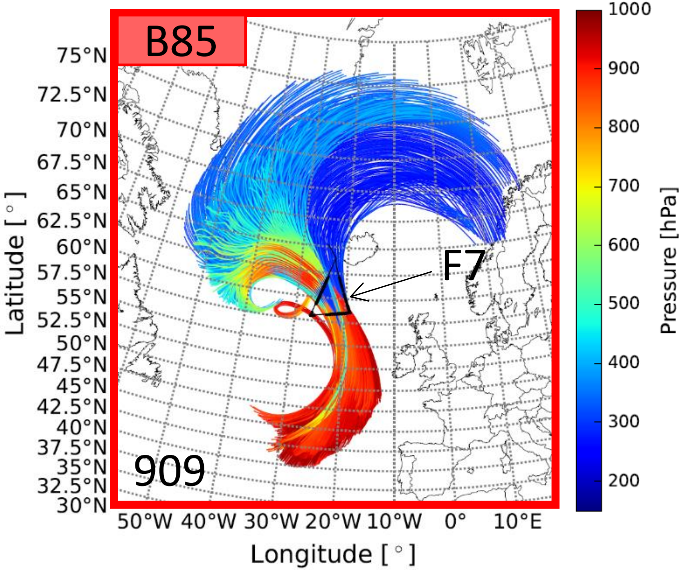
Research questions

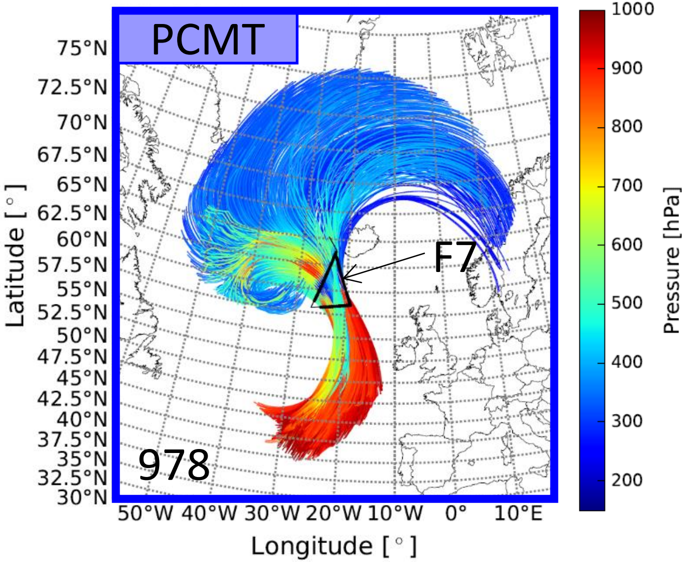
- Along the flight track, in particular in the WCB region, what are the differences in PV and wind between the two convection schemes ?
- Which scheme is closer to the observations ?
- What are the difference between the two convection scheme in the upper level ridge building ?

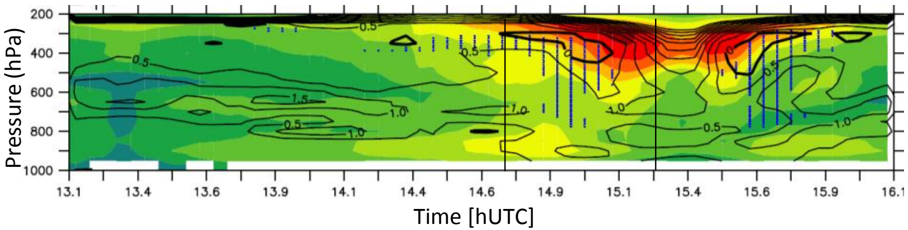
Warm Conveyor Belt – Flight F7

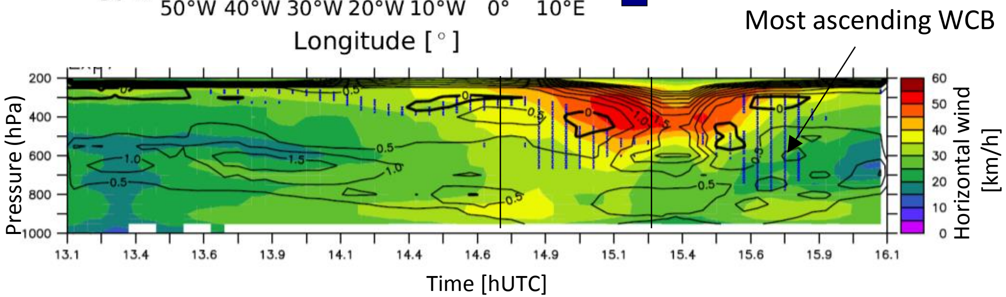
Trajectories : -24h / +24h

WCB : -300hPa in 24h for every 24h in 48h of trajectory + P_0>850hPa





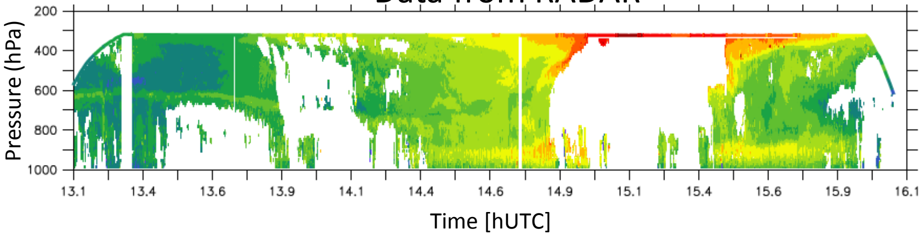




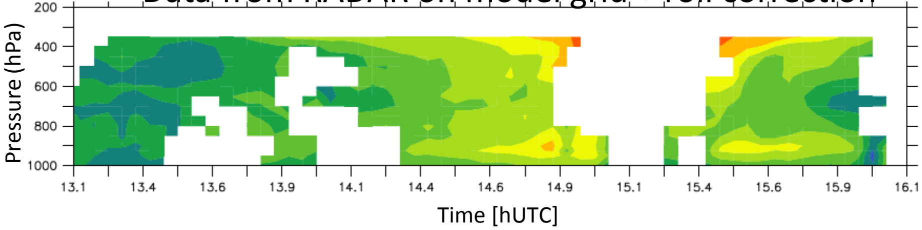
Wind Observations from RADAR / Model

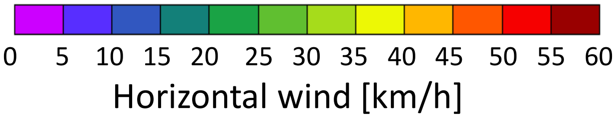
Observations

Data from RADAR

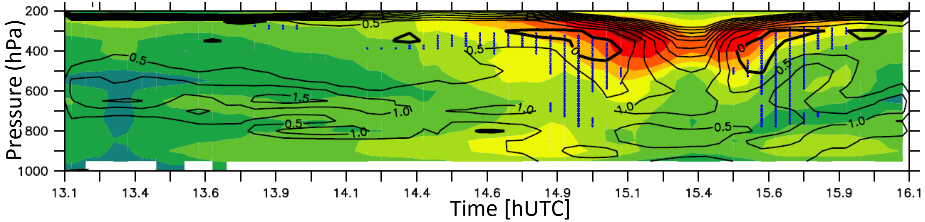


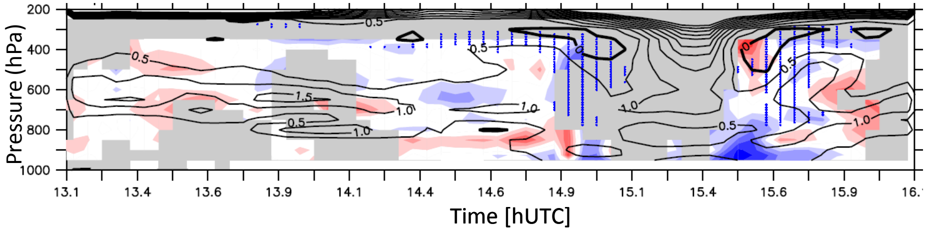
Data from RADAR on model grid + roll correction

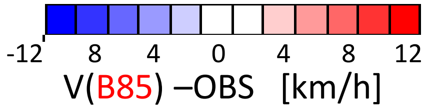




Model : B85







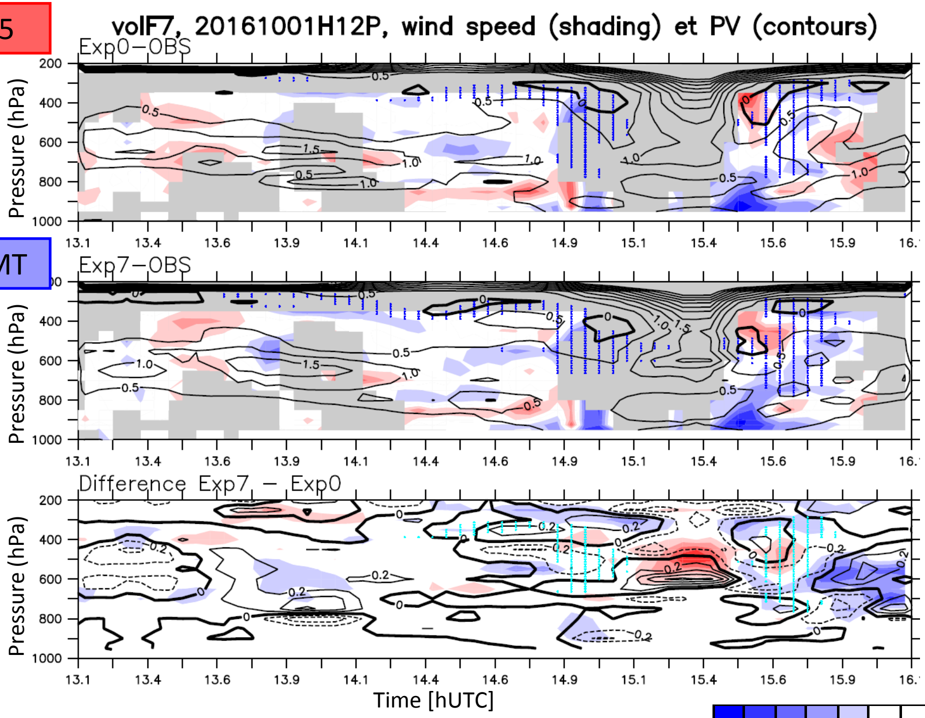
Link between PV and wind

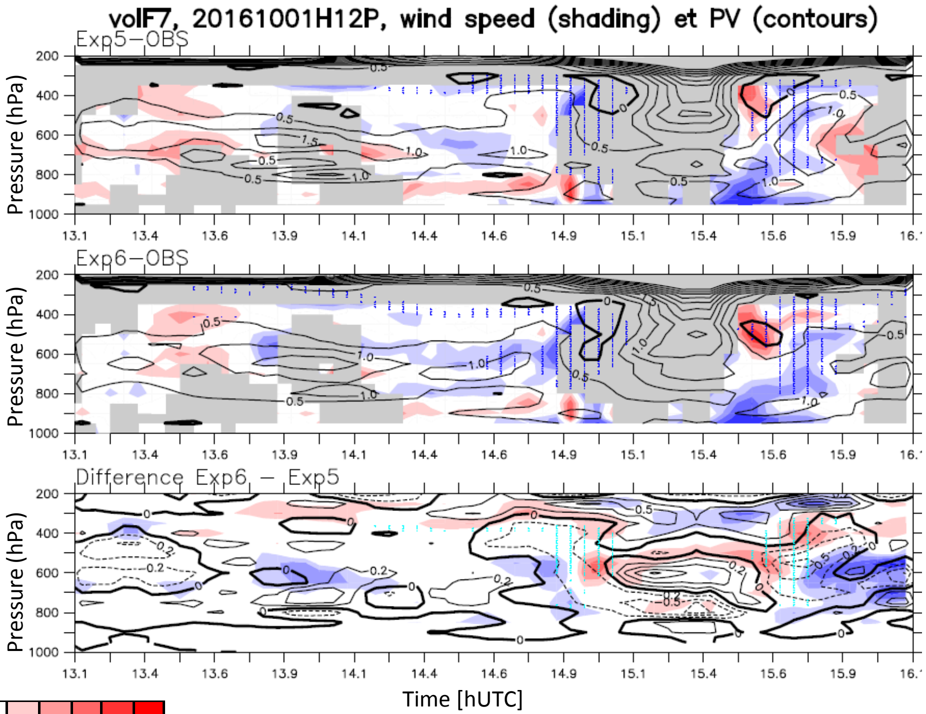
KFB

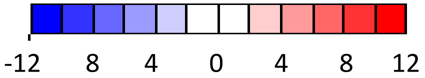
PMMC

B85

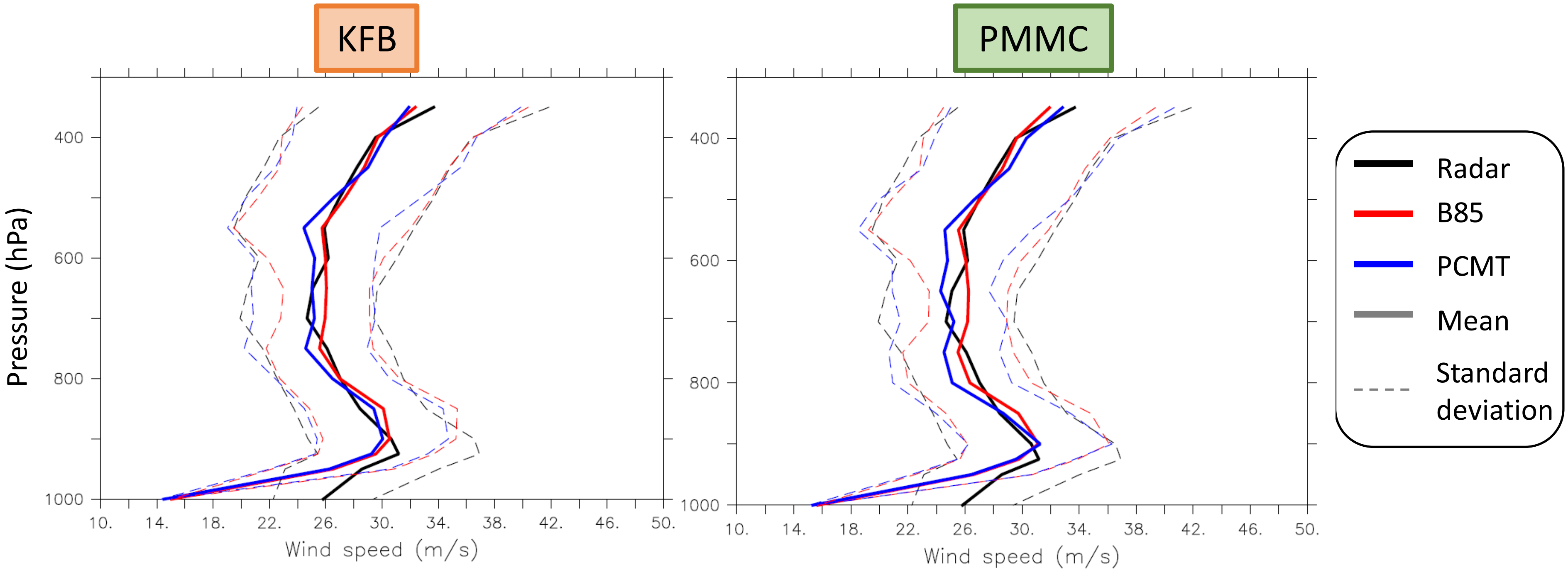
PCMT



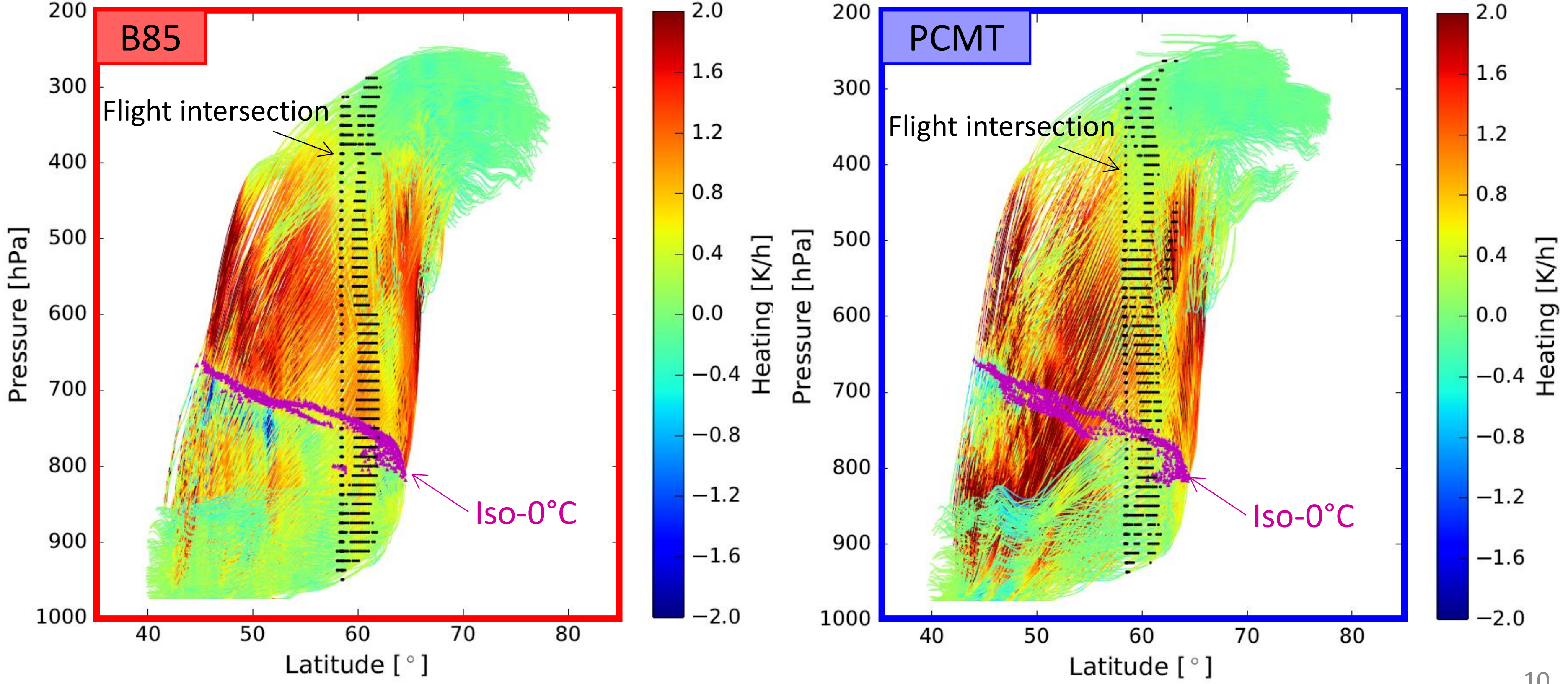




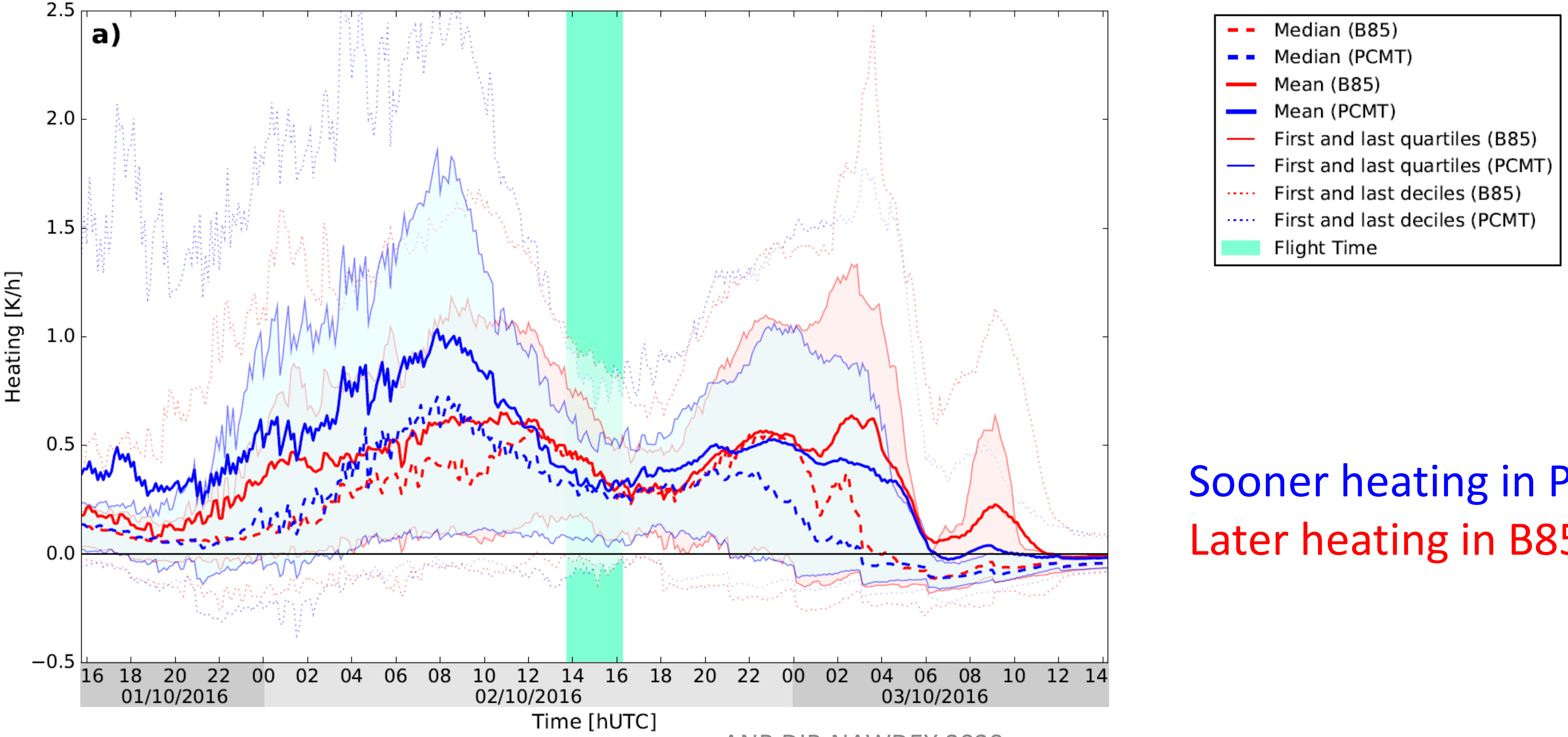
Wind profile where there is observation



Different heating in the liquid phase



Evolution in time of the heating

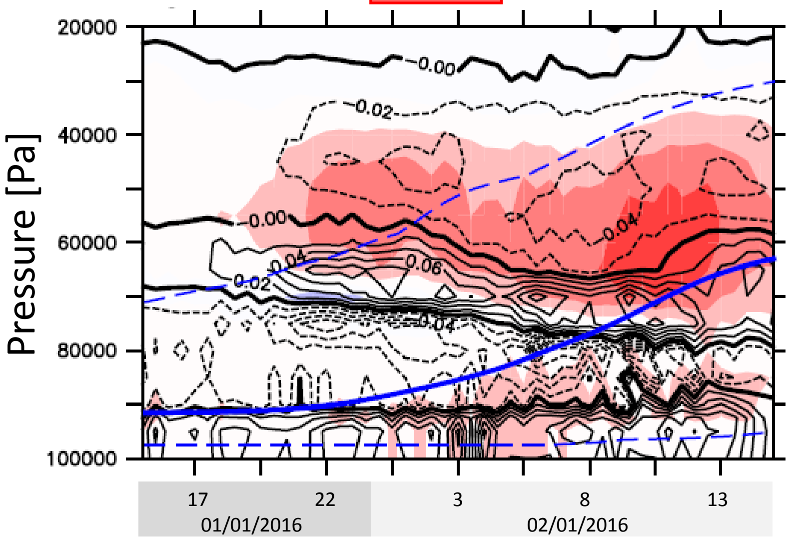


Sooner heating in PCMT

Later heating in B85

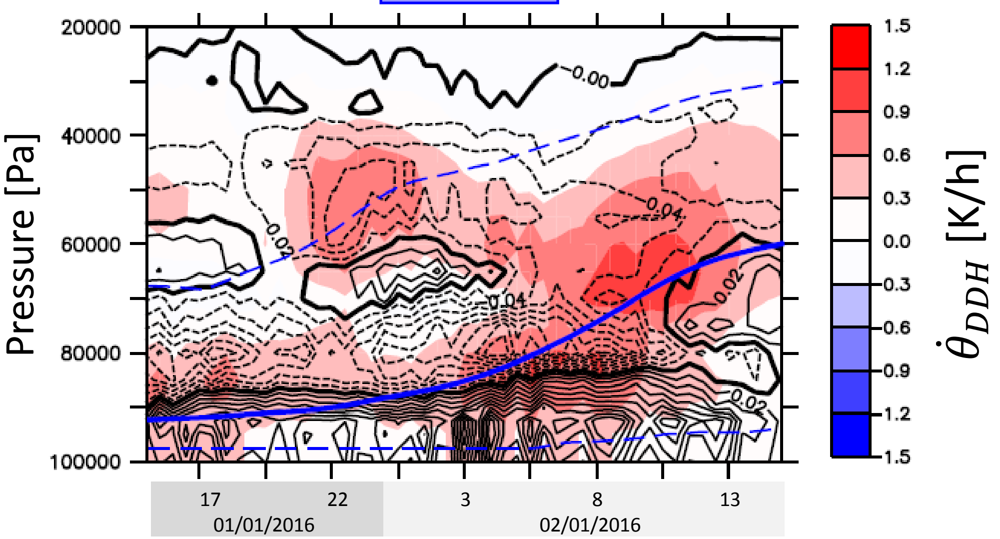
Vertical profile of mean heating and $\dot{PV}$ along WCB trajectories

B85



Trajectories below the heating

PCMT



Lower Heating

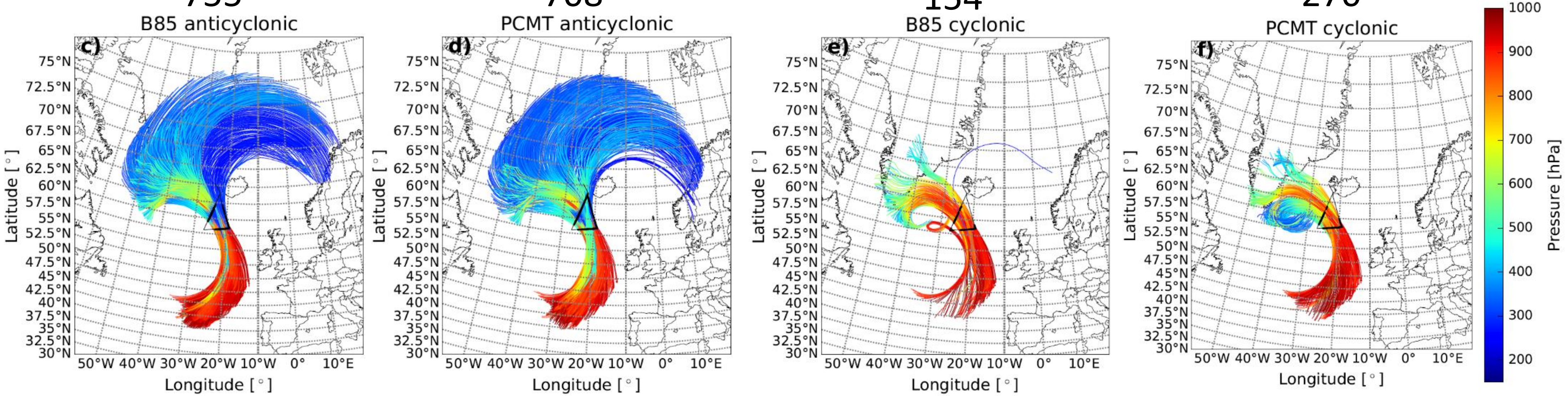
-> many trajectories in the PV < 0 part

Separation anticyclonic/cyclonic trajectories

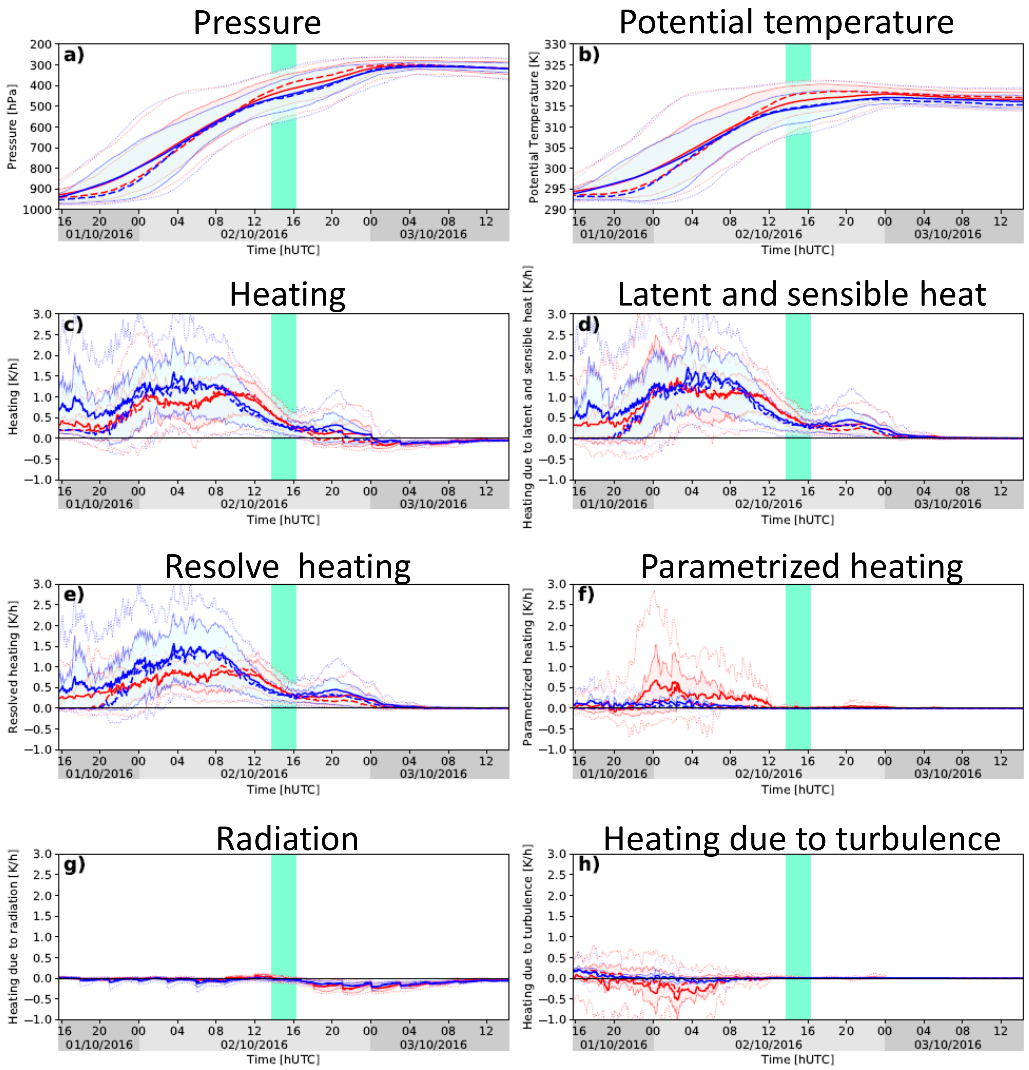
Mean direction during 3h -> to the left : cyclonic

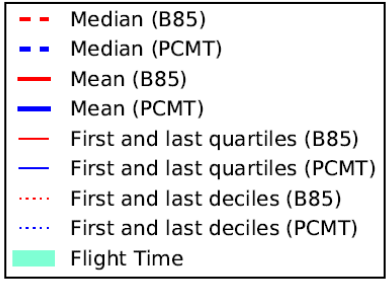
-> to the right : anticyclonic

B85	PCMT	B85	PCMT
755	708	154	270



Heating budget for anticyclonic trajectories above 315K

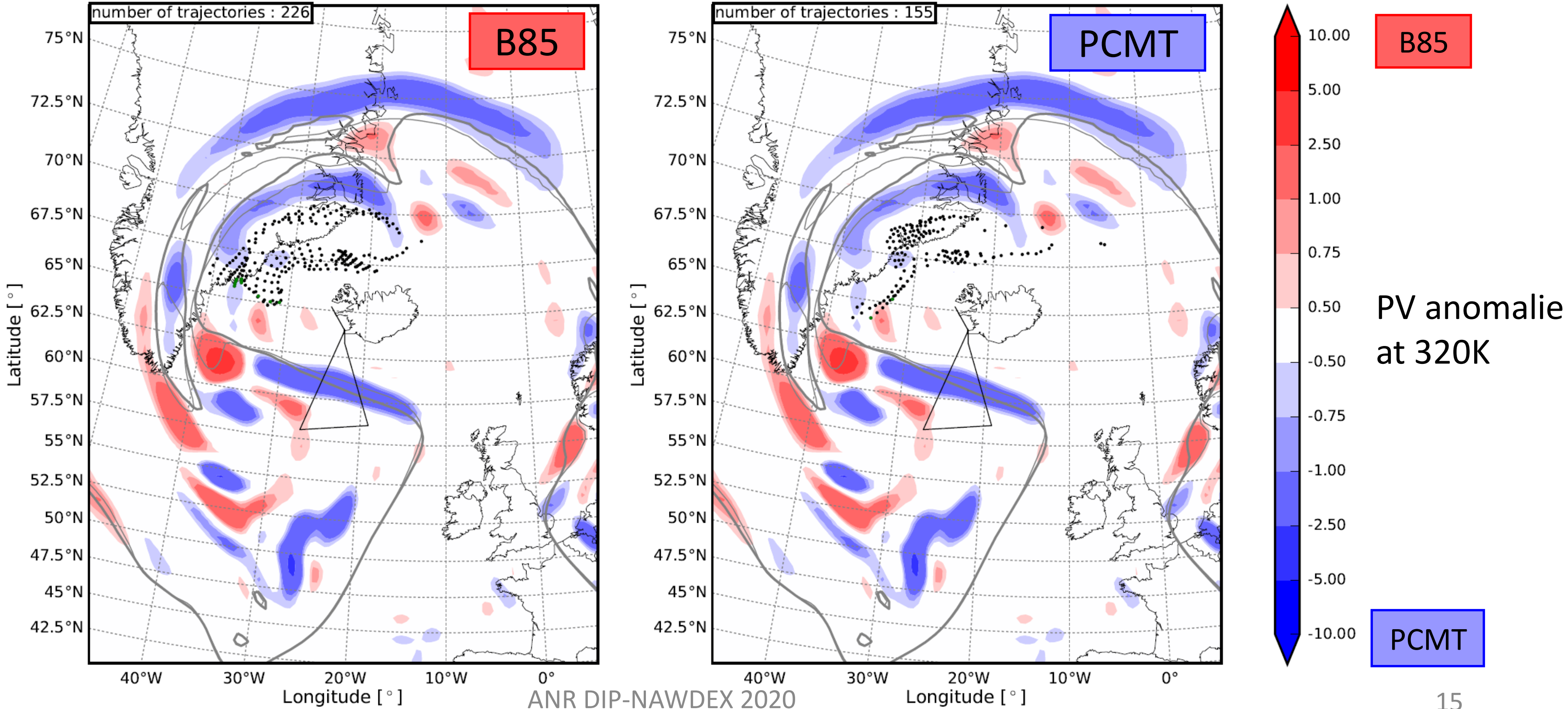




Heating in ice phase from parametrization with B85

Ridge Building

Trajectories between 317-323K (+36h)



Differences between B85/PCMT

B85

- Upper Heating
- Ice phase heating (higher IWC)
- In the flight:
  - Trajectories are still below the heating
  - Still production of PV
- After the flight:
  - Heating due to ice phase
  - Higher and more trajectories which bring PV – in high altitude
  - Higher and stronger anticyclone at later stage

PCMT

- Earlier and lower Heating
- Liquid phase heating
- In the fligth:
  - Trajectories inside the heating
  - More destruction of PV
- After the flight:
  - Less trajectories in upper levels
  - Weaker anticyclone at later stage

Perspectives

Short-term: (article)

- Improve heating and PV budget
- Create generic WCB trajectories (from warm sector)

Long-term:

- Study other flights (-> Gwendal Rivière)
- Use other convection schemes (new PCMT, Tiedke)

Vertical profile of mean heating and $\dot{PV}$ along WCB trajectories

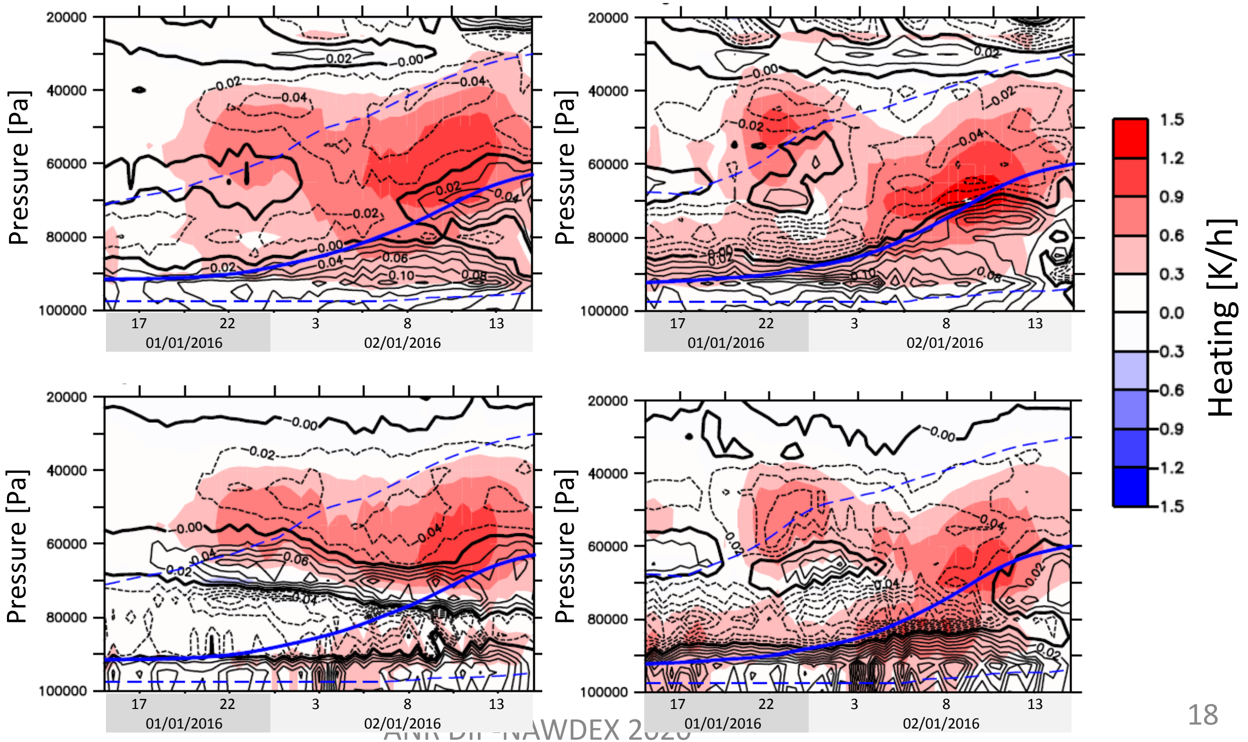
B85 PCMT

Finite differences

$$\frac{\theta(t+15mn)-\theta(t-15mn)}{\Delta t}$$

$$+u\frac{\Delta\theta}{\Delta x}+v\frac{\Delta\theta}{\Delta y}+\omega\frac{\Delta\theta}{\Delta P}$$

$\dot{\theta}$ from DDH

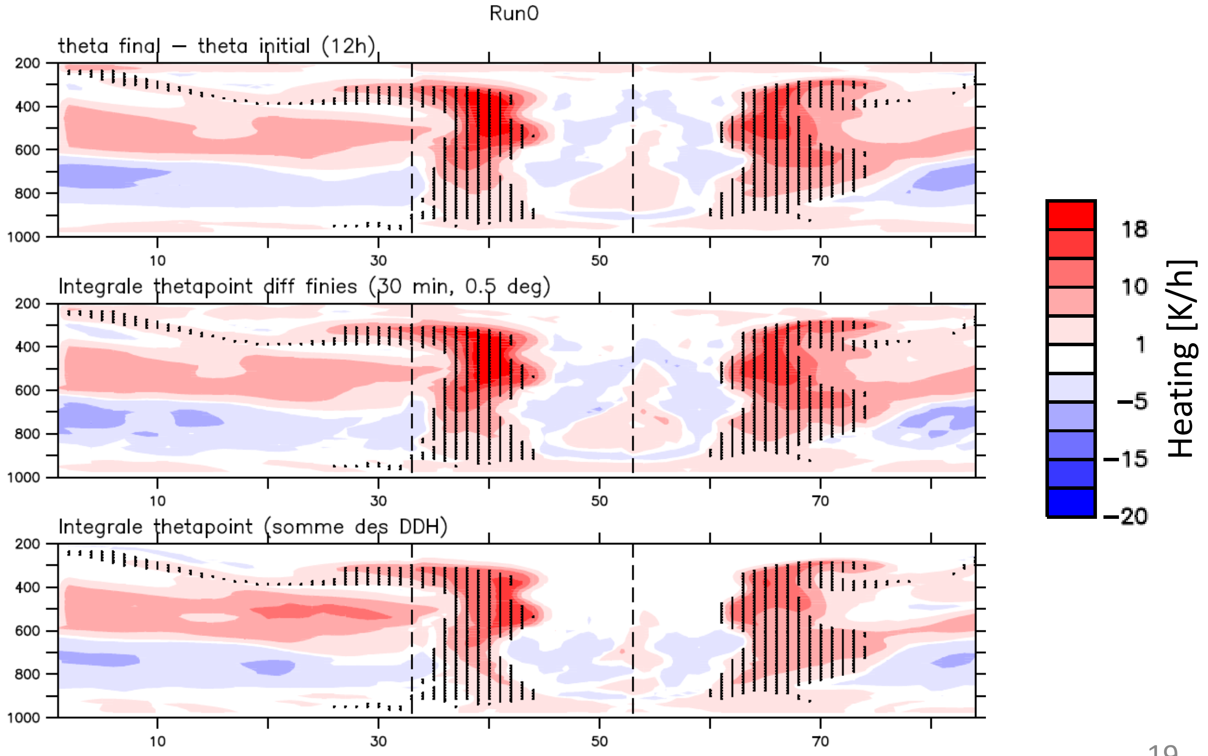


Integrated heating during 12h before the flight

Finite differences

$$\int\left(\frac{\theta(t+15mn)-\theta(t-15mn)}{\Delta t}+u\frac{\Delta\theta}{\Delta x}+v\frac{\Delta\theta}{\Delta y}+\omega\frac{\Delta\theta}{\Delta P}\right)dt$$

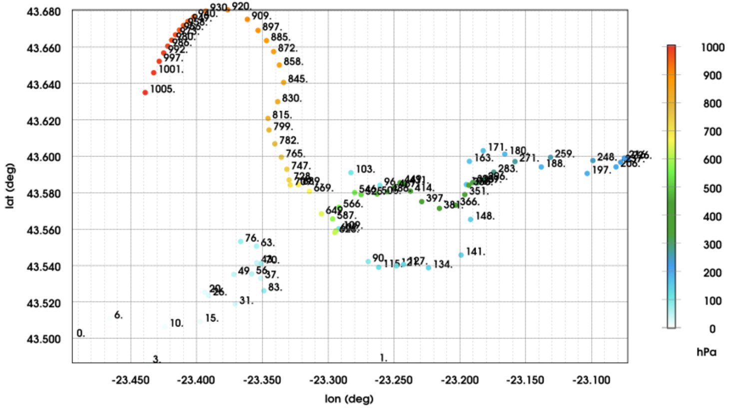
$\int \dot{\theta}\, dt$ from DDH



Thank you for your attention

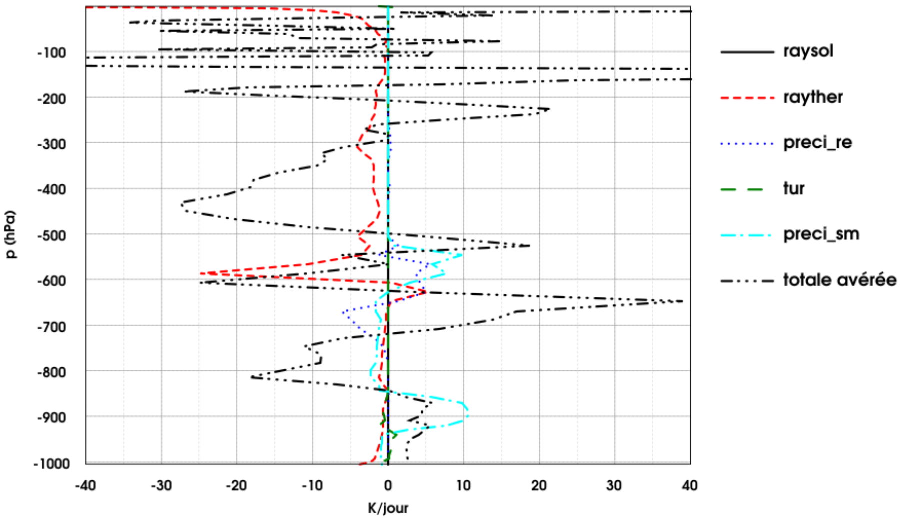
Point B en fonction de p (couleur des points)

Min=0. Max=1010. Moy=437. Ect=342. Rcm=555.



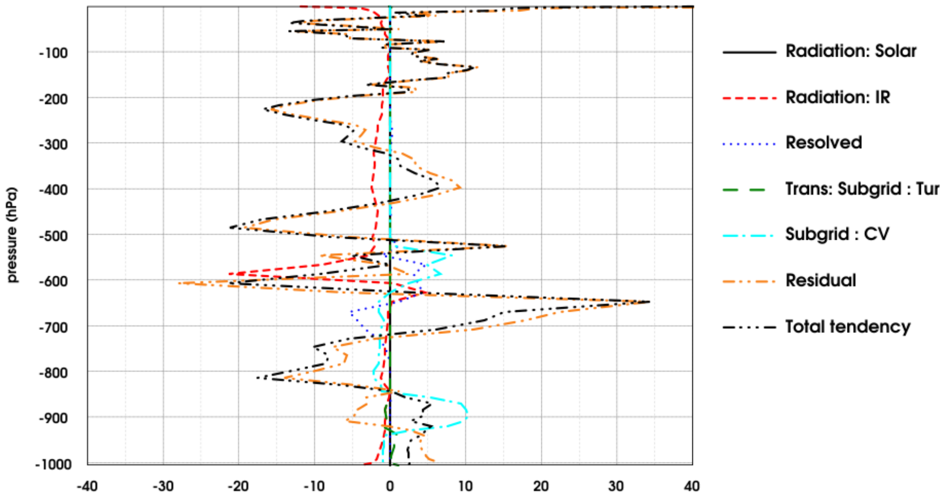
Tendance de theta en 15 mn, (lon,lat)=(-23.26692712,43.27491477)

DHFDLARPE+0076.ren.manq >>> DHFDLARPE+0078.ren.manq



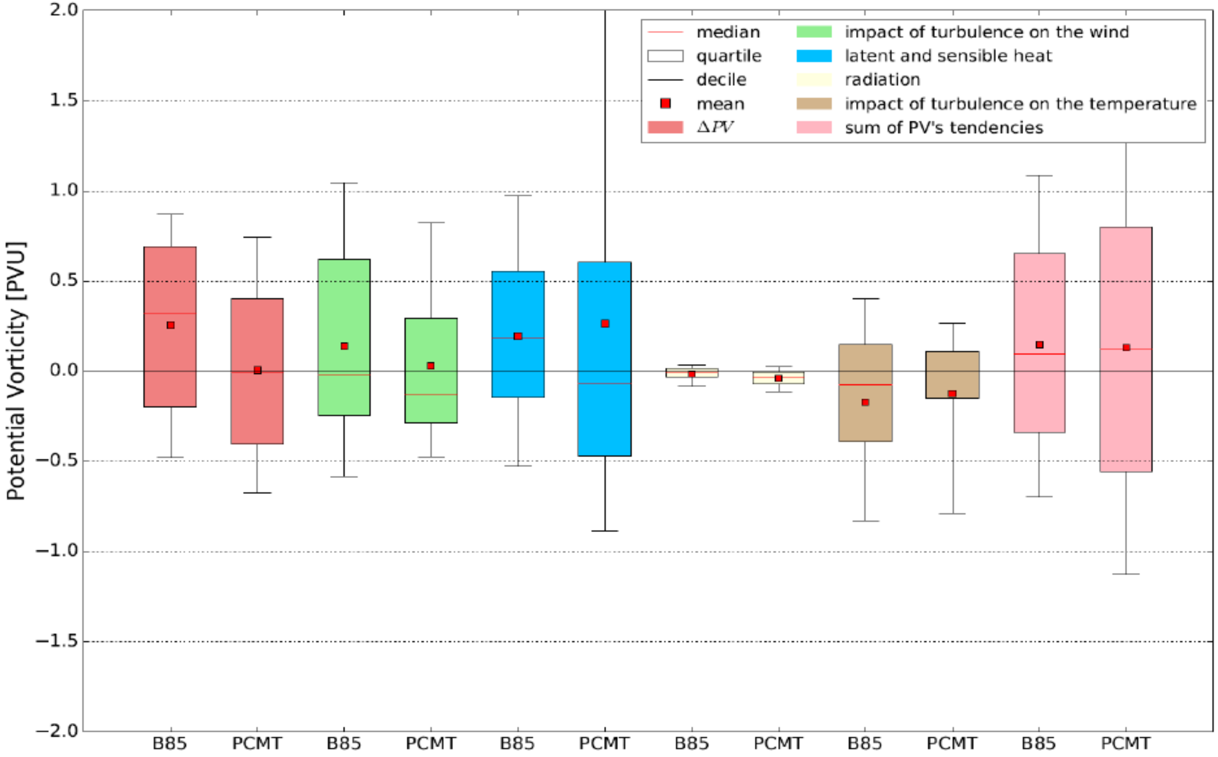
TEMPERATURE BUDGET (K/day) , FCST (fdiff2.lfa)

BASE 2016-10-01 21:30 ECH 0.25 H, 1 dom., 90 niv.



PV budget

12h before the flight, common WCB trajectories



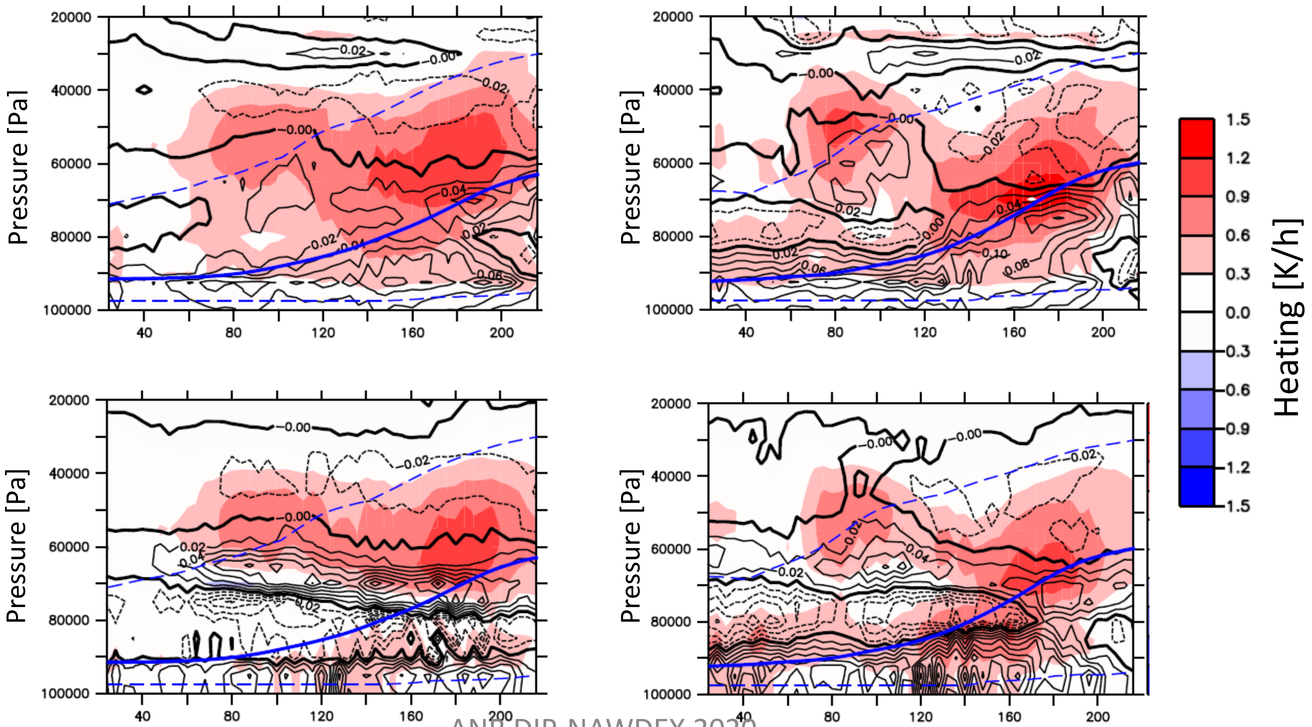
Vertical profile of mean heating and $\dot{PV}$ along S2 WCB trajectories

$$\dot{PV} = -g\left(-\frac{\partial\dot{\theta}}{\partial P}\bigg|_P (f+\xi)\right)$$

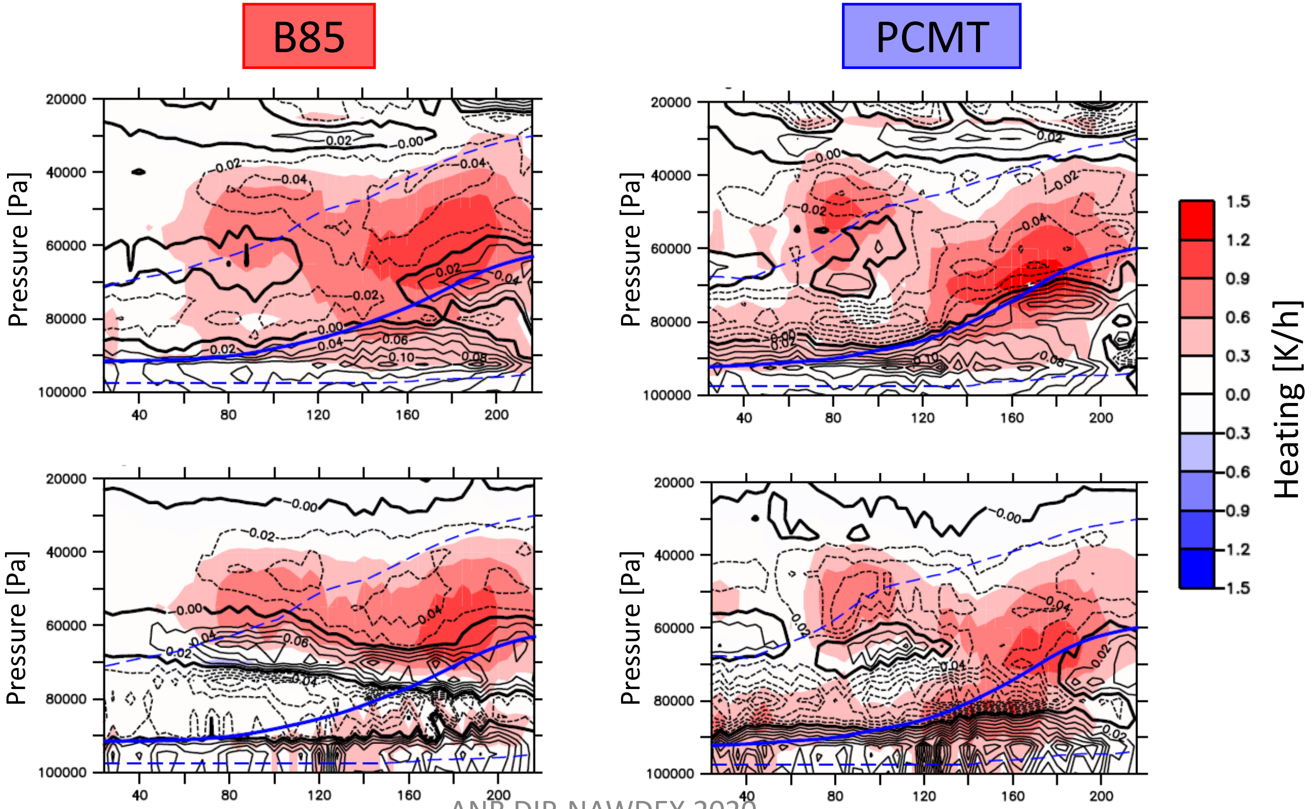
B85 | PCMT

$\frac{\partial\theta_{GRIB}}{\partial t}$

$\frac{\partial\theta_{DDH}}{\partial t}$



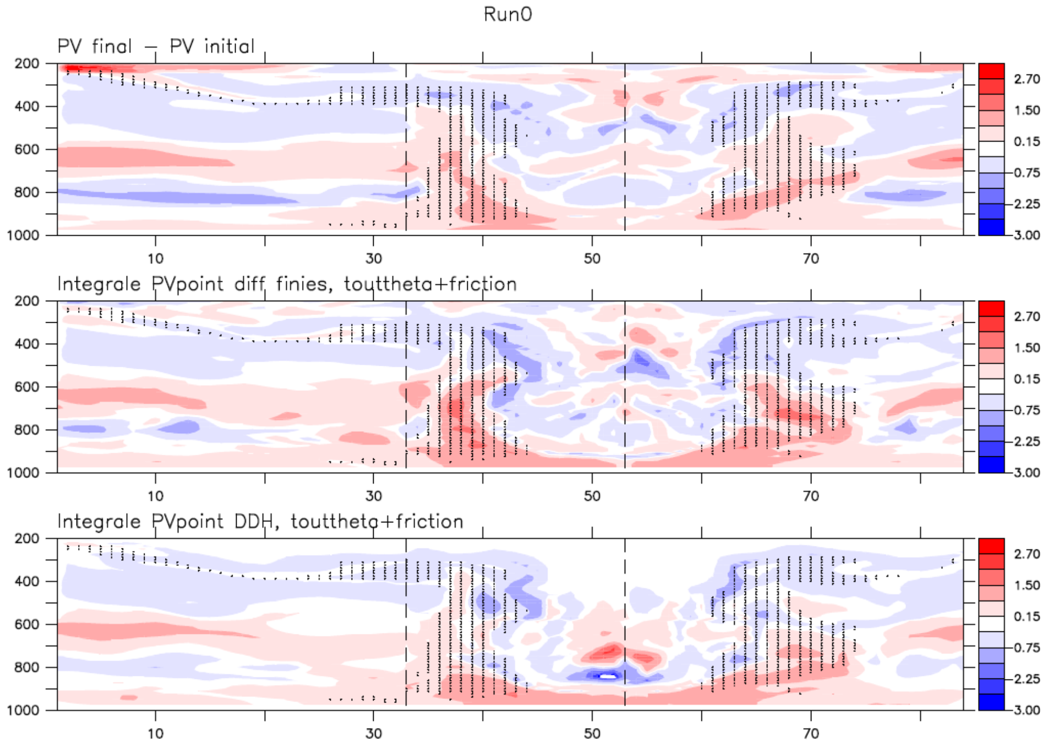
Vertical profile of mean heating and $\dot{PV}$ along S2 WCB trajectories



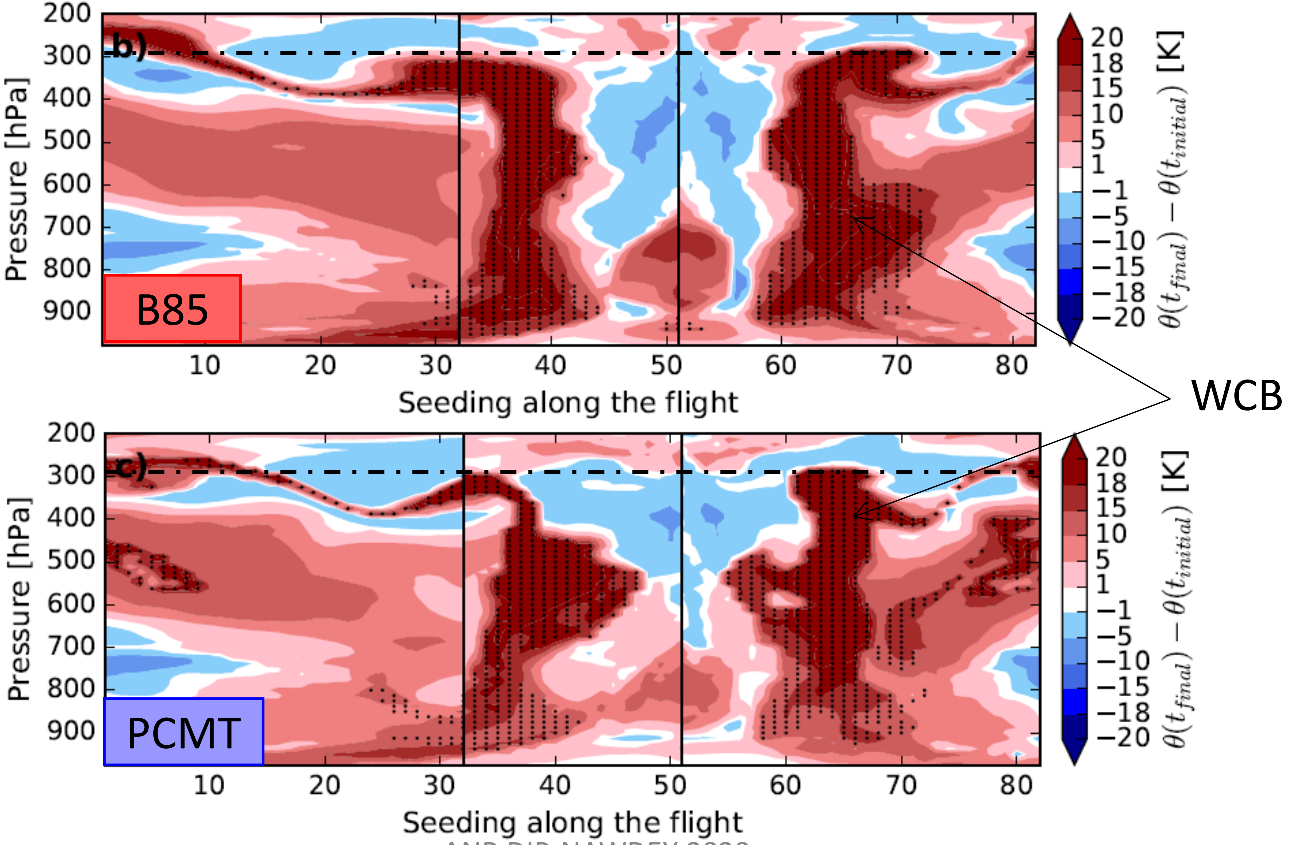
$$\frac{\partial \theta_{GRIB}}{\partial t}$$

$$\frac{\partial \theta_{DDH}}{\partial t}$$

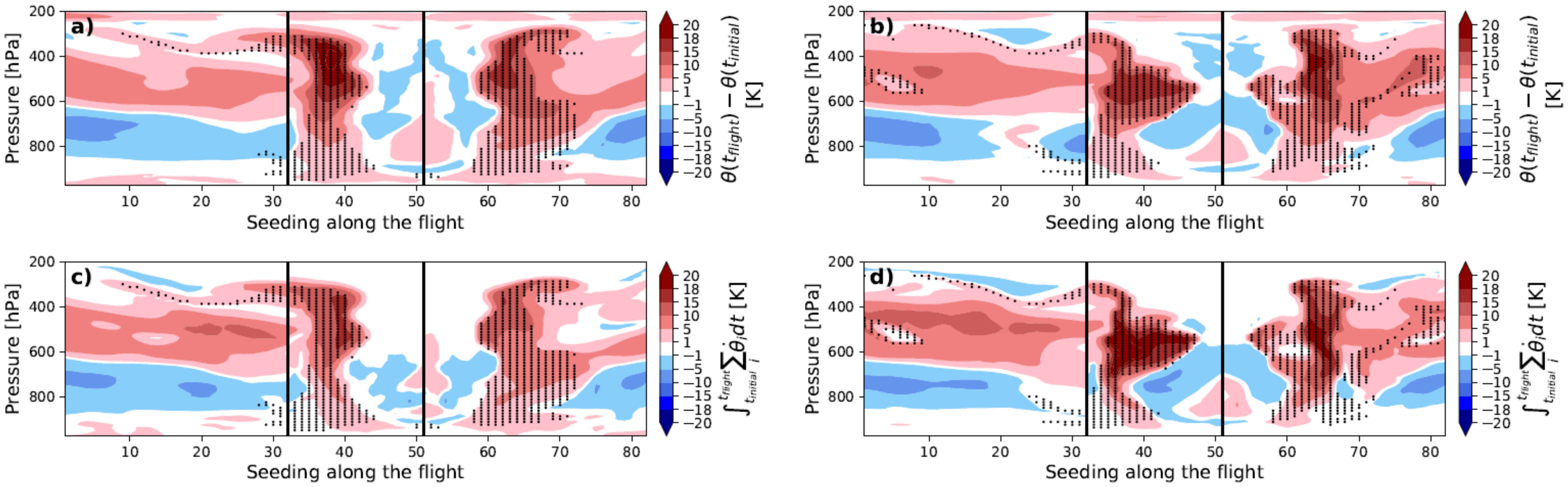
Integrated PV during the entire trajectories



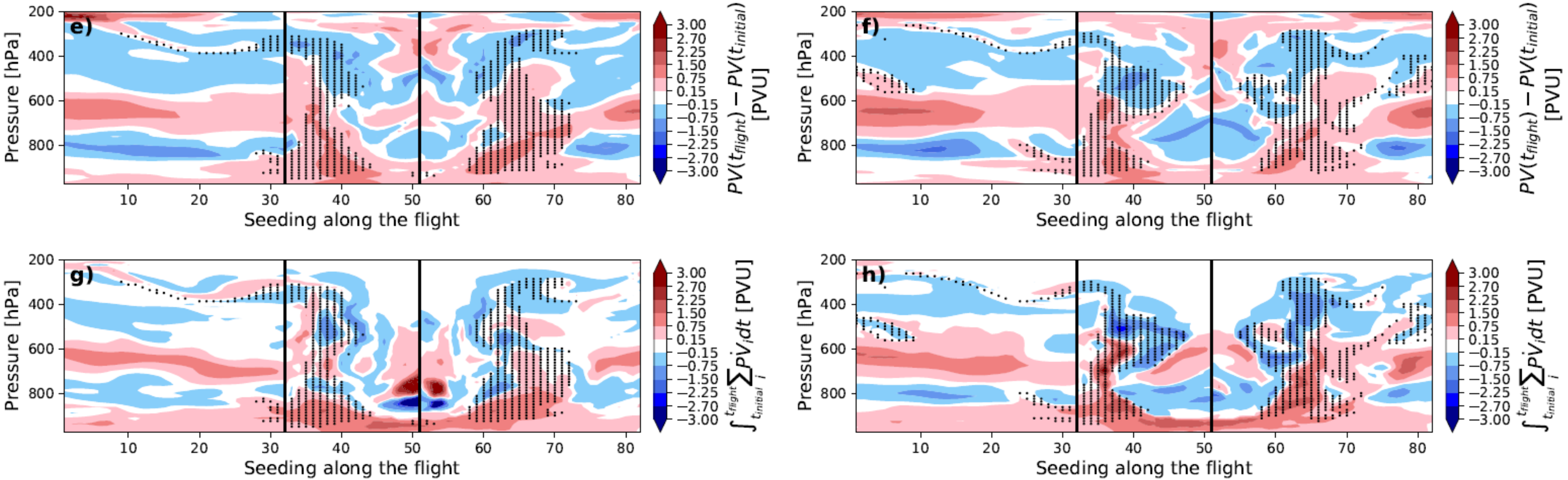
Integrated heating along the total length of trajectories

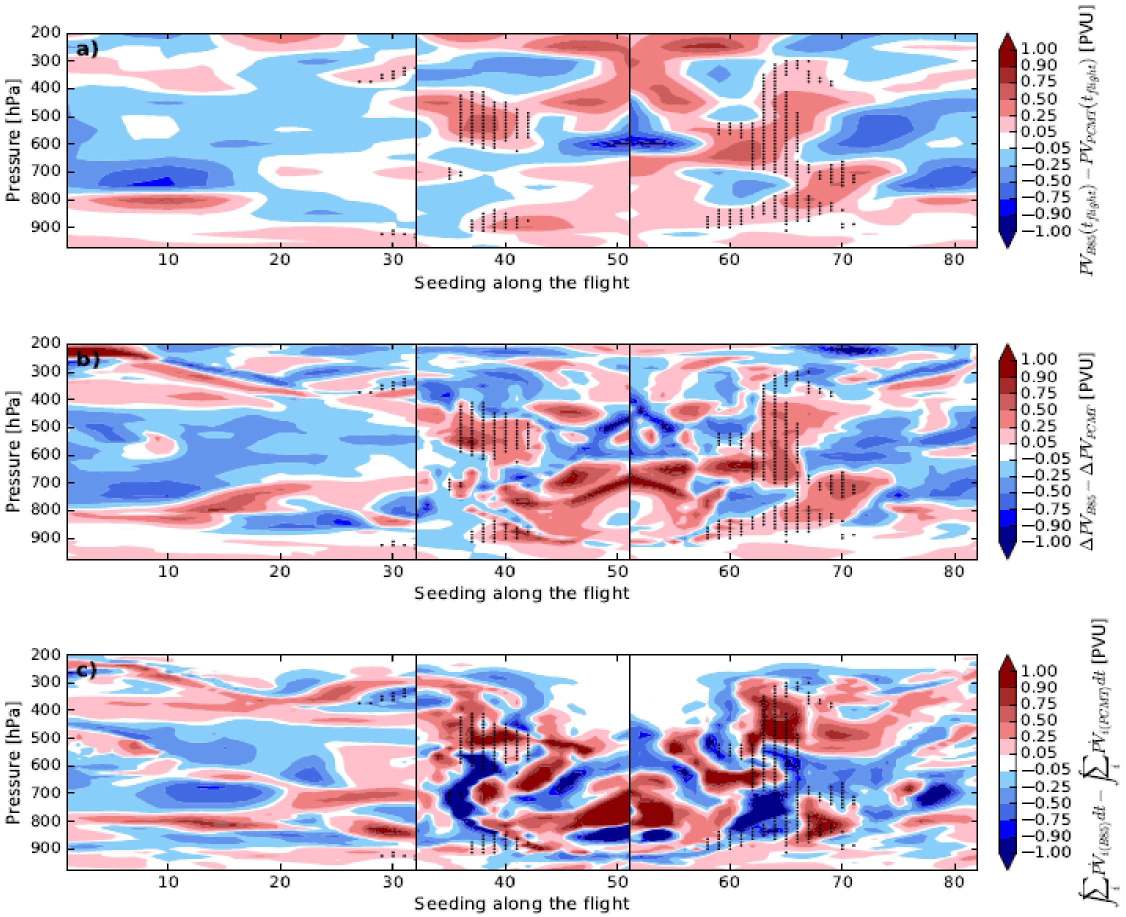


Heating budget
12h before the flight



PV budget
12h before the flight




a)
b)
c)
Pressure [hPa]
Seeding along the flight
200
300
400
500
600
700
800
900
10
20
30
40
50
60
70
80
1.00
0.90
0.75
0.50
0.25
0.05
−0.05
−0.25
−0.50
−0.75
−0.90
−1.00
$PV_{BSS}(t_{flight}) - PV_{PCMT}(t_{flight})$ [PVU]
$\Delta PV_{BSS} - \Delta PV_{PCMT}$ [PVU]
$\int \sum_i \dot{PV}_{i(BSS)} dt - \int \sum_i \dot{PV}_{i(PCMT)} dt$ [PVU]

Number of trajectories > 315K