Workshop NAWDEX 2019

Diabatic processes in the Warm Conveyor Belt of the Stalactite Cyclone

Sensitivity to the two convective parametrization schemes in ARPEGE

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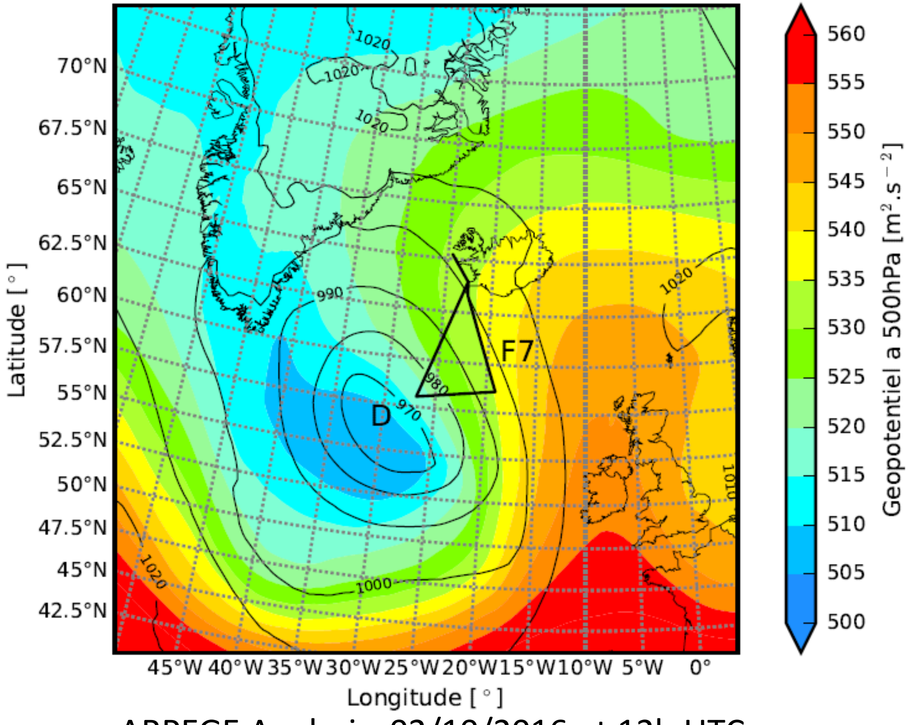
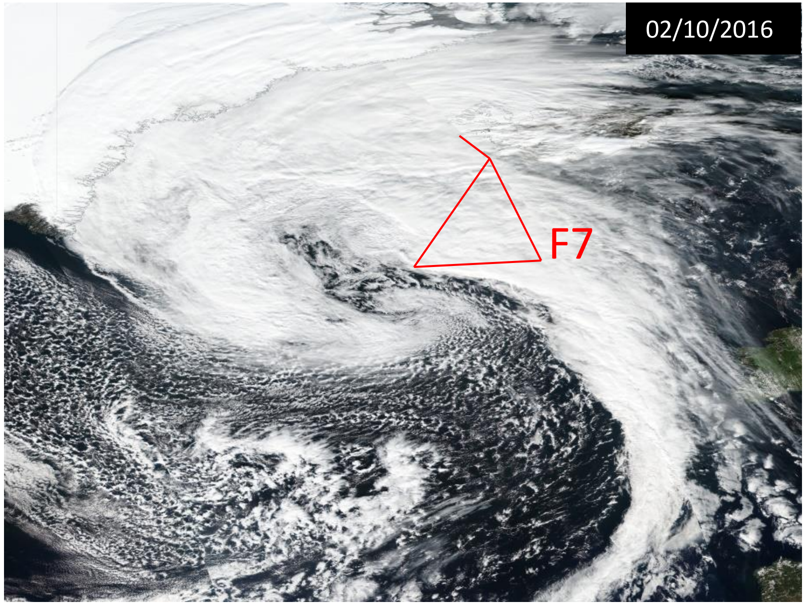
Stalactite Cyclone

Geopotential at 500 hPa and Mean Sea Level Pressure



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

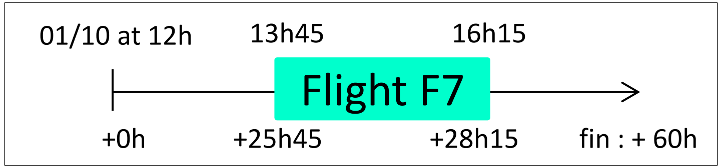


MODIS, Nasa Worldview Application

ARPEGE (cy41.op1)

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

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



Convection scheme in ARPEGE

Bougeault, 1985 (B85)

- Mass-Flux scheme
- Closure : moisture
- Shallow convection : KFB (Bechtold et al. 2001)

Piriou et al, 2007 (PCMT)

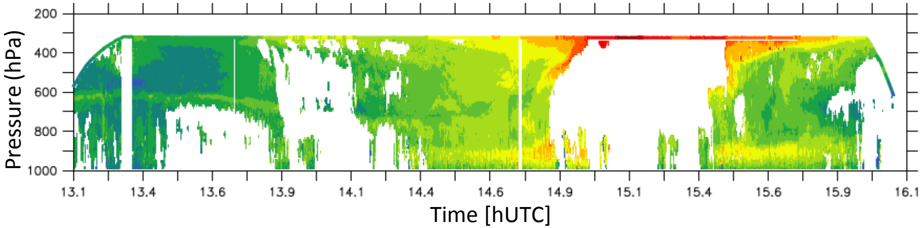
- Mass-Flux scheme
- Closure : CAPE
- Shallow convection : PMMC09 (Pergaud et al. 2009)
- Microphysic and transport schemes
- Strong entrainment

Influence of these two convection schemes on the Stalactite Cyclone WCB

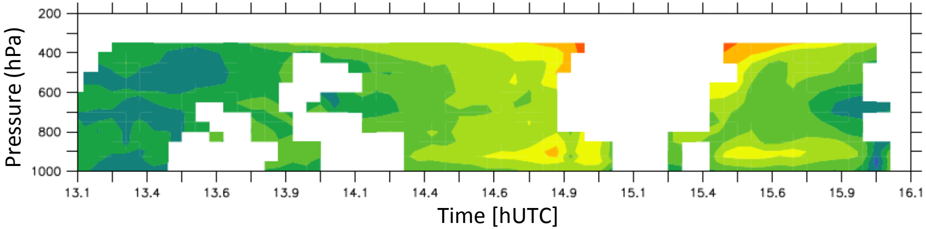
Wind Observations from RADAR / Model

Observations

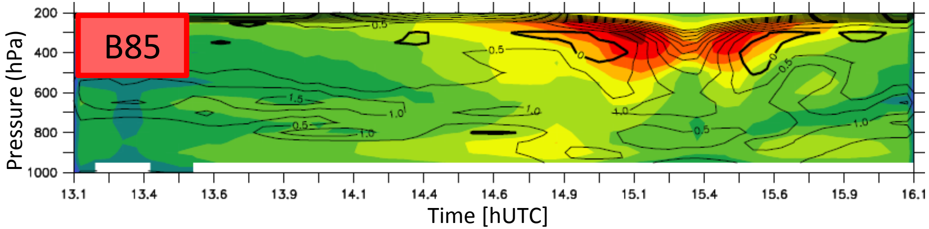
Data from RADAR

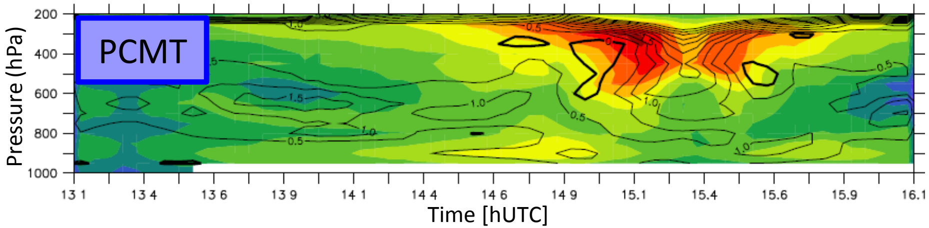


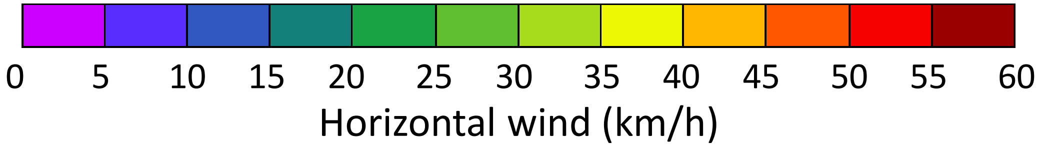
Data from RADAR on model grid + roll correction



Model



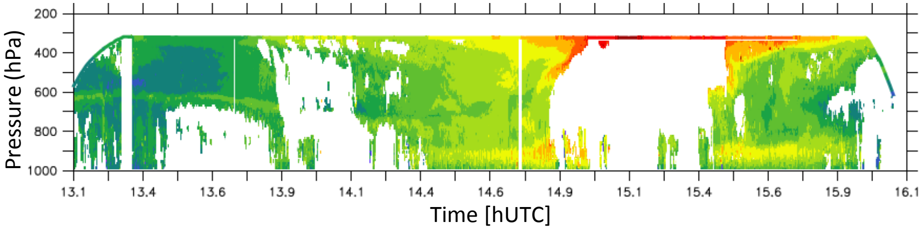




Wind Observations from RADAR / Model

Observations

Data from RADAR



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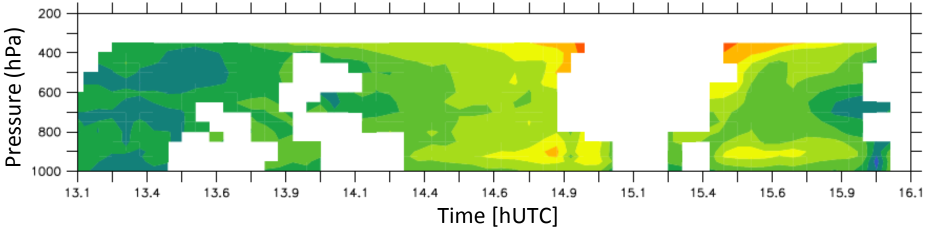

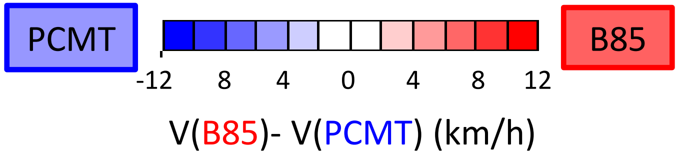

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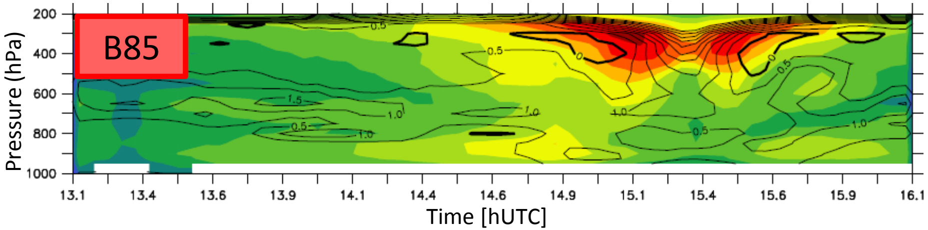
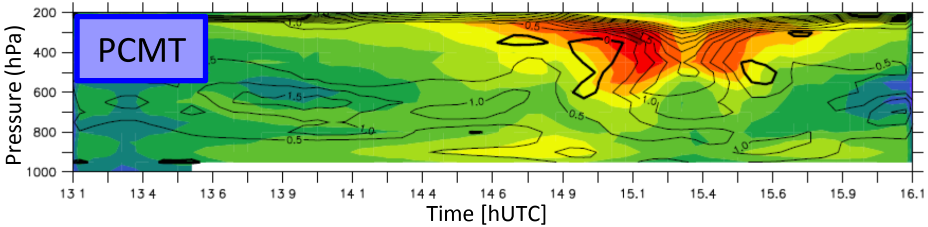
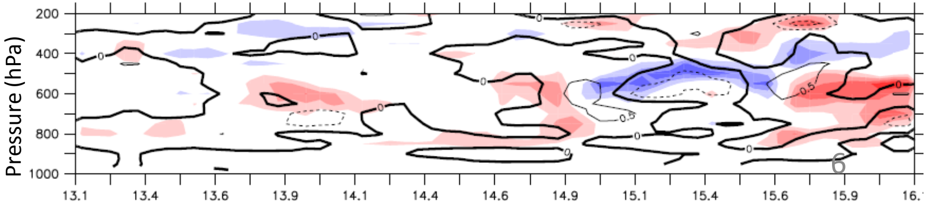


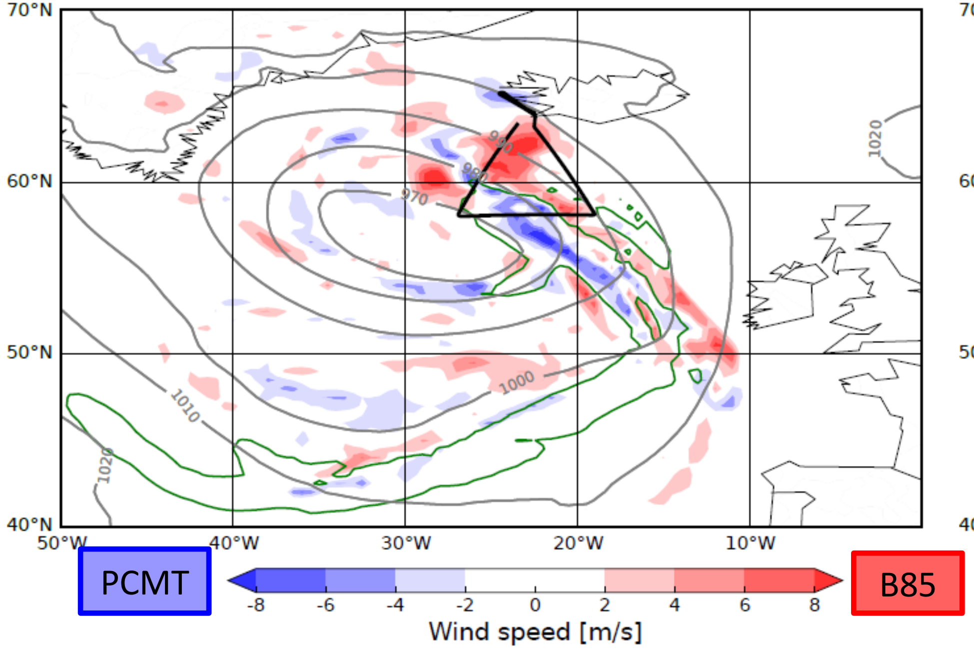




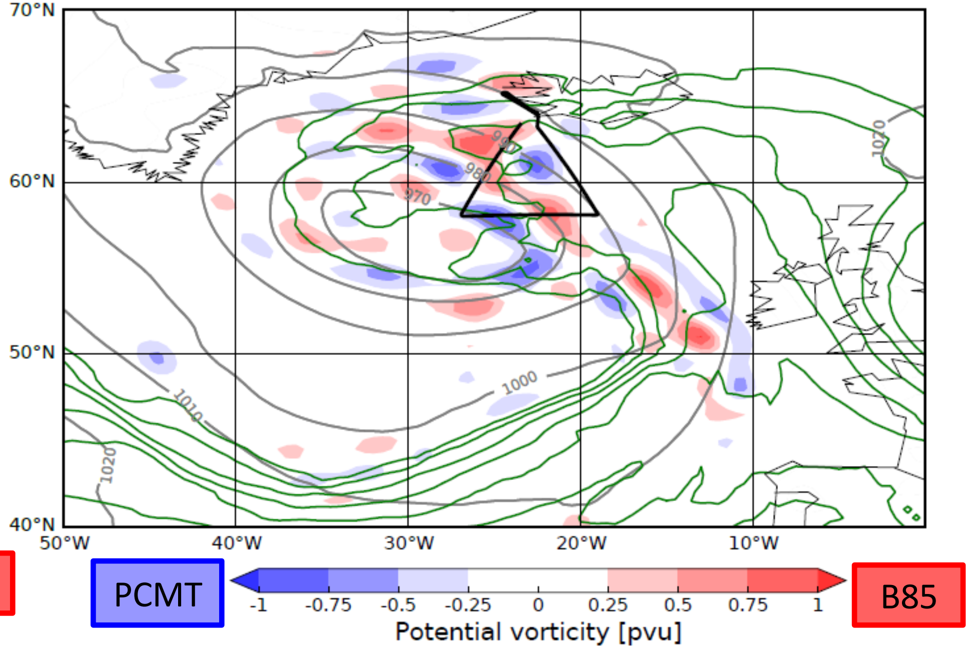
PV and wind anomalies in the WCB

02/10/2016 at 15h UTC (+27h)

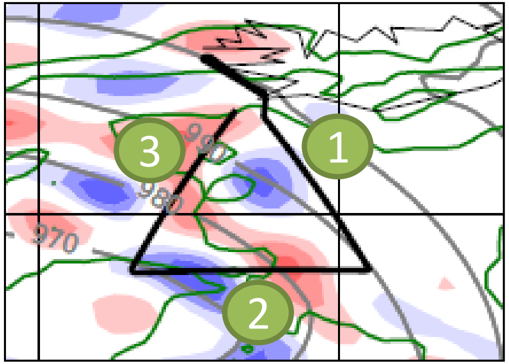
V(B85)- V(PCMT) at 600hPa



PV(B85)- PV(PCMT) at 600hPa

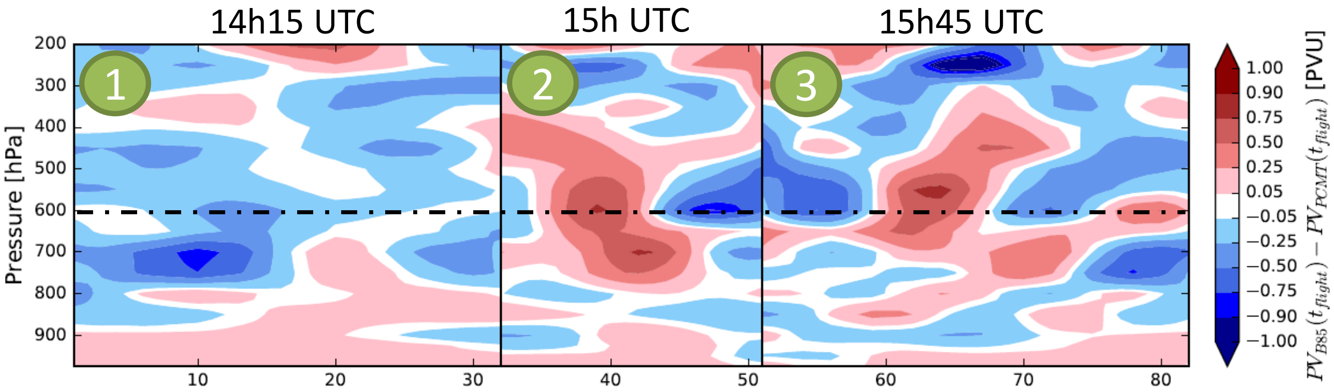


Difference of PV along the flight



PV(B85)- PV(PCMT) at 600hPa

PV(B85)- PV(PCMT)

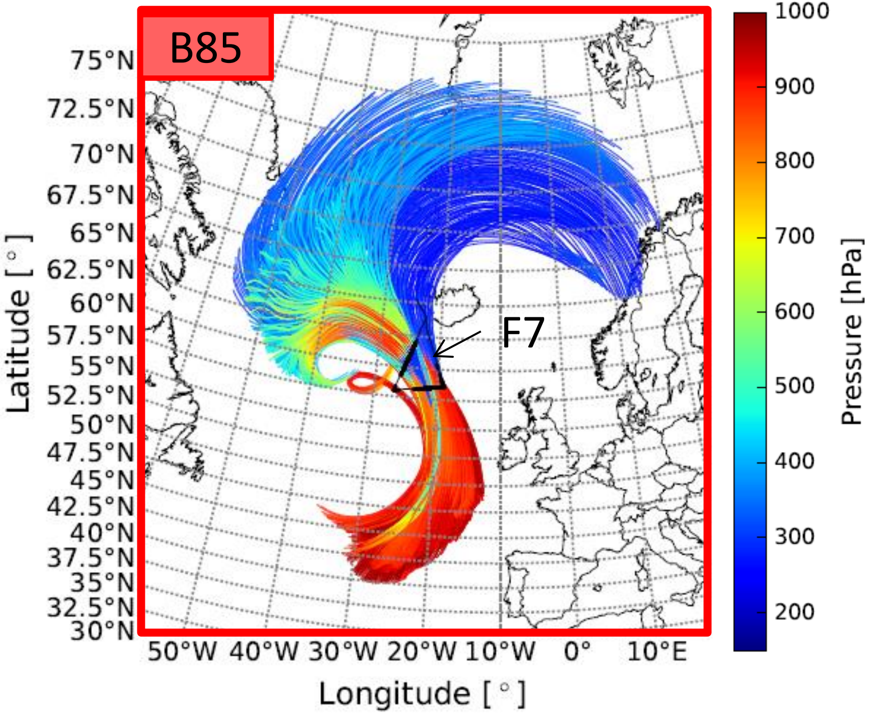


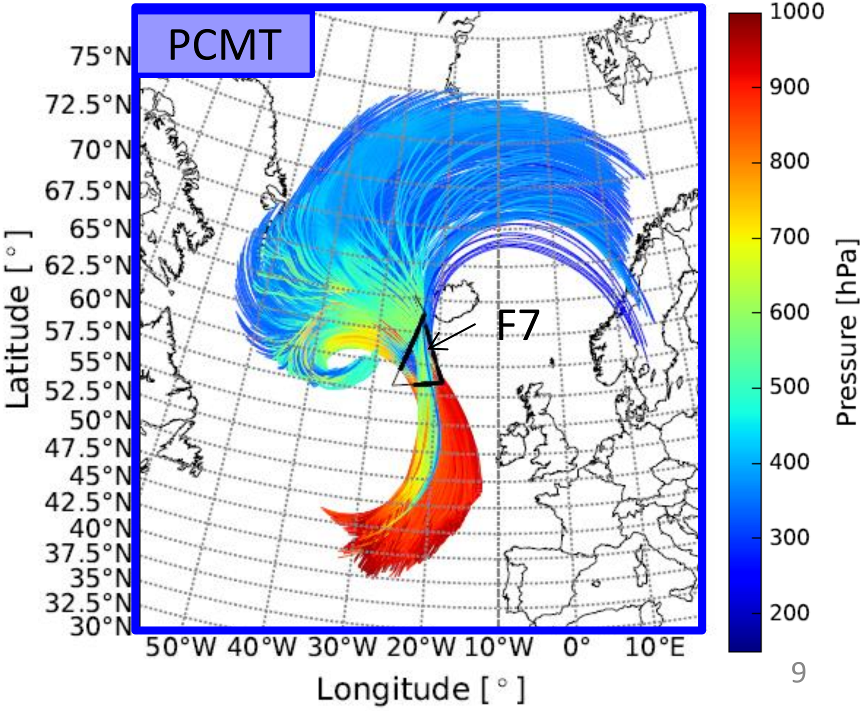
Explain PV anomalies ⟶ WCB trajectories

Warm Conveyor Belt – Flight F7

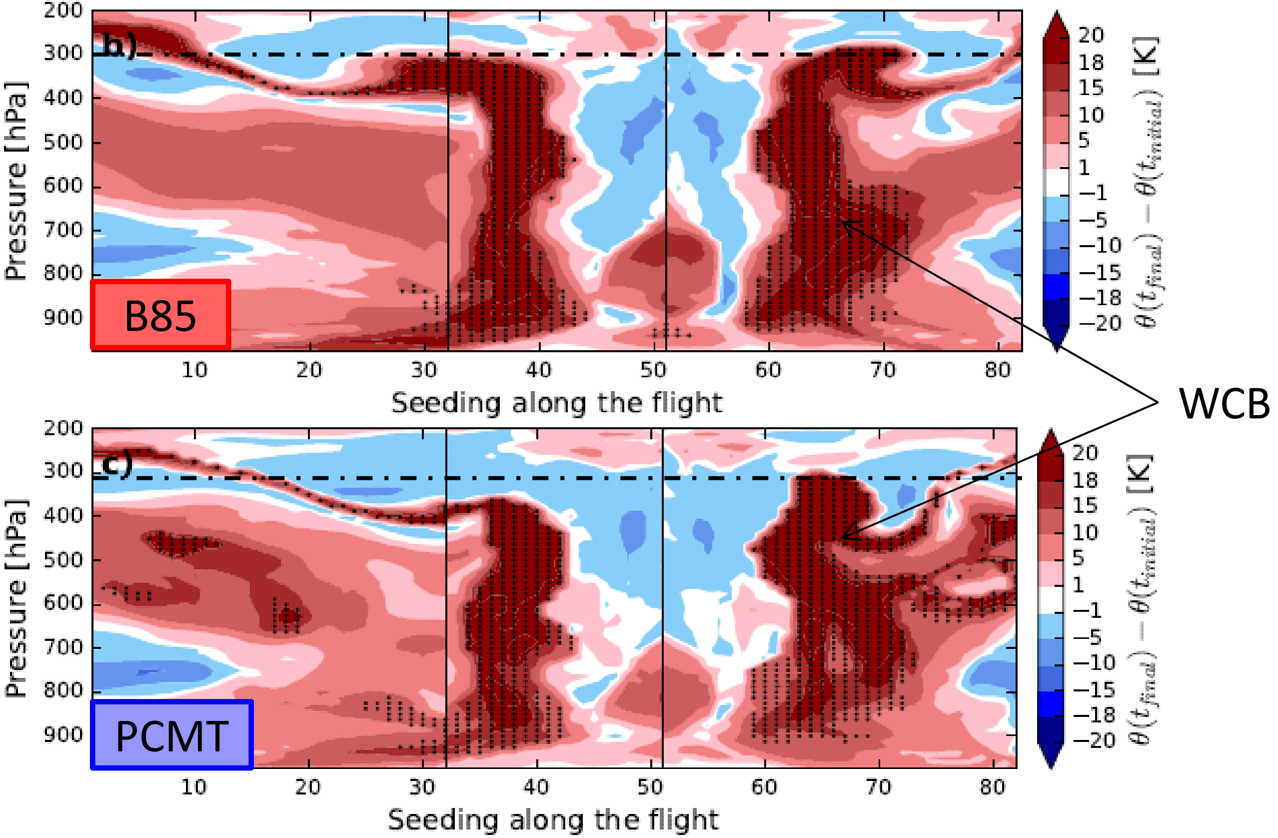
Trajectories : -24h / +24h

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

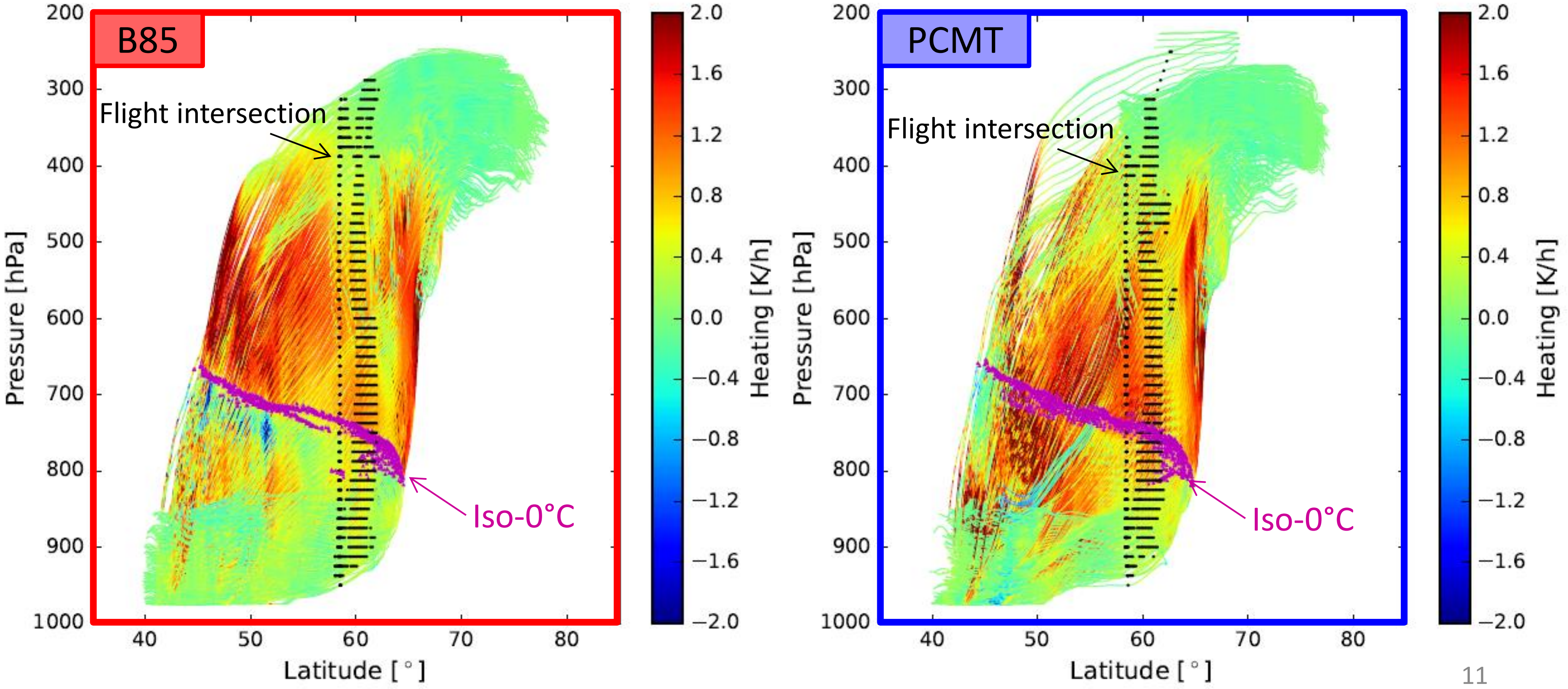




Heating budget on the total length of trajectories



Different heating in the liquid phase



Heating budget: 12h before the flight

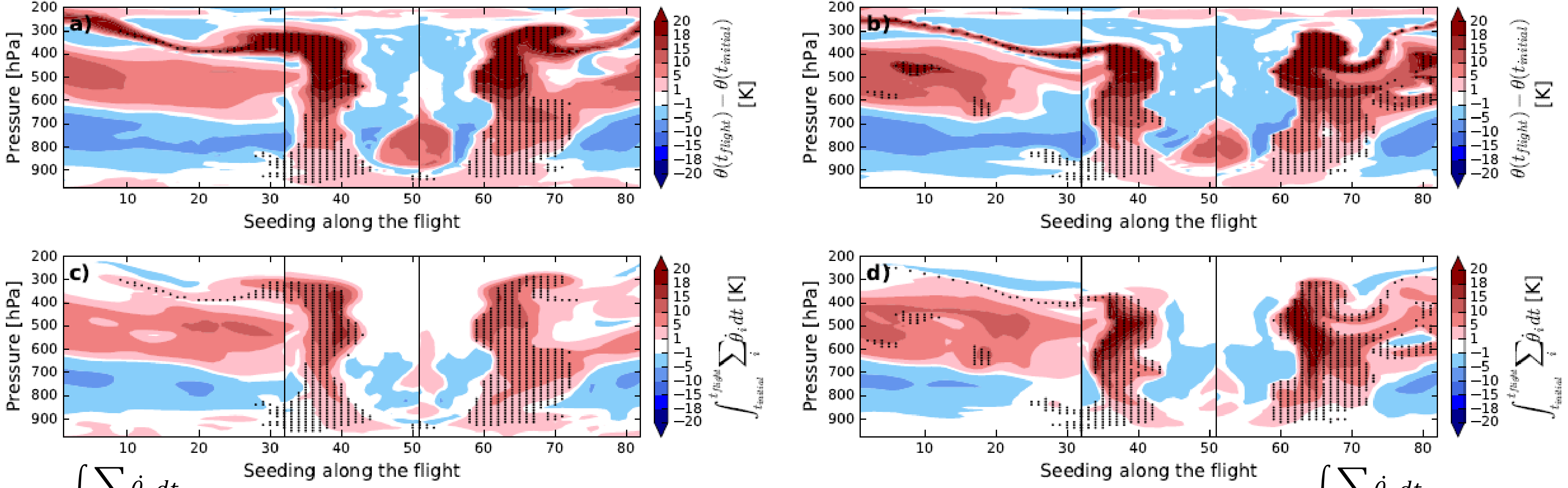
$$\Delta\theta = \int \sum_i \dot{\theta}_i \, dt$$

B85

PCMT

$\Delta\theta$

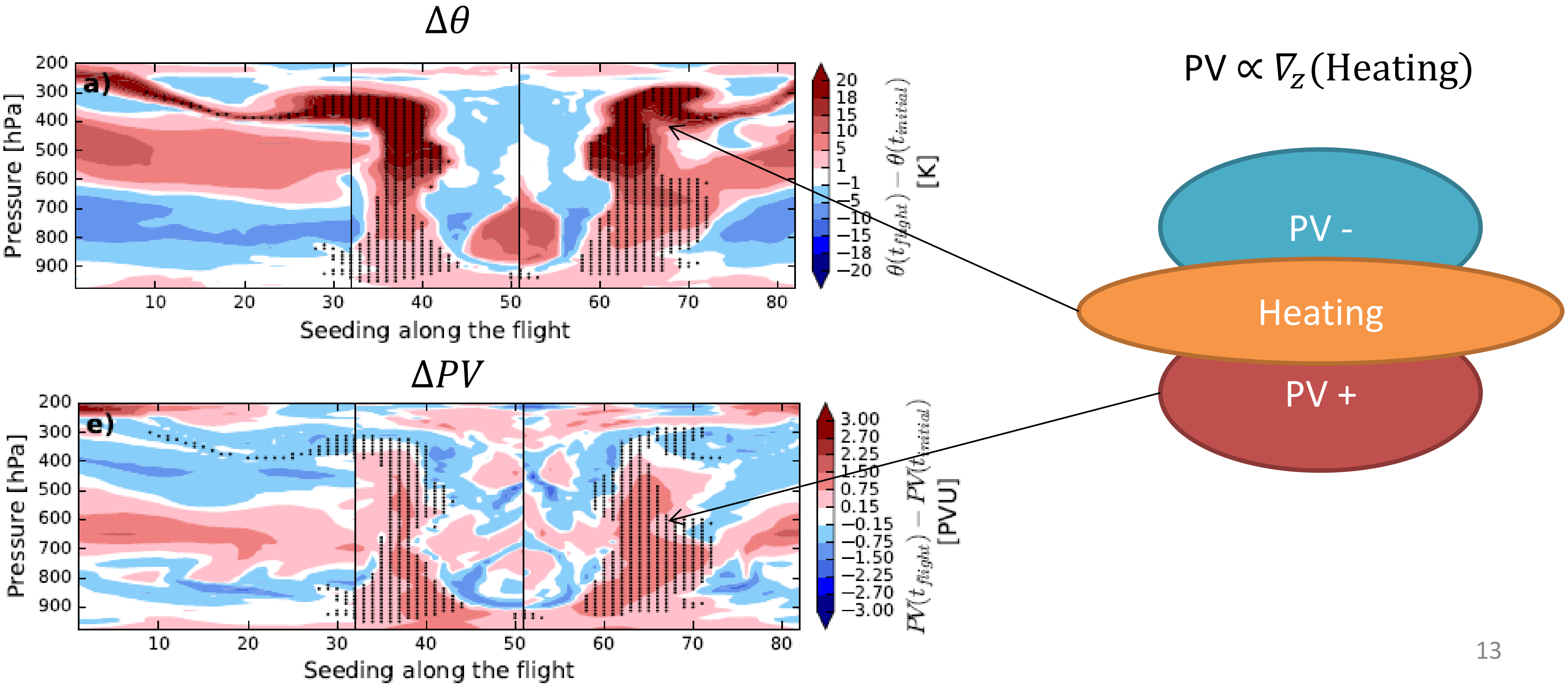
$\Delta\theta$



$\int \sum_i \dot{\theta}_i \, dt$

$\int \sum_i \dot{\theta}_i \, dt$

Link between heating and PV

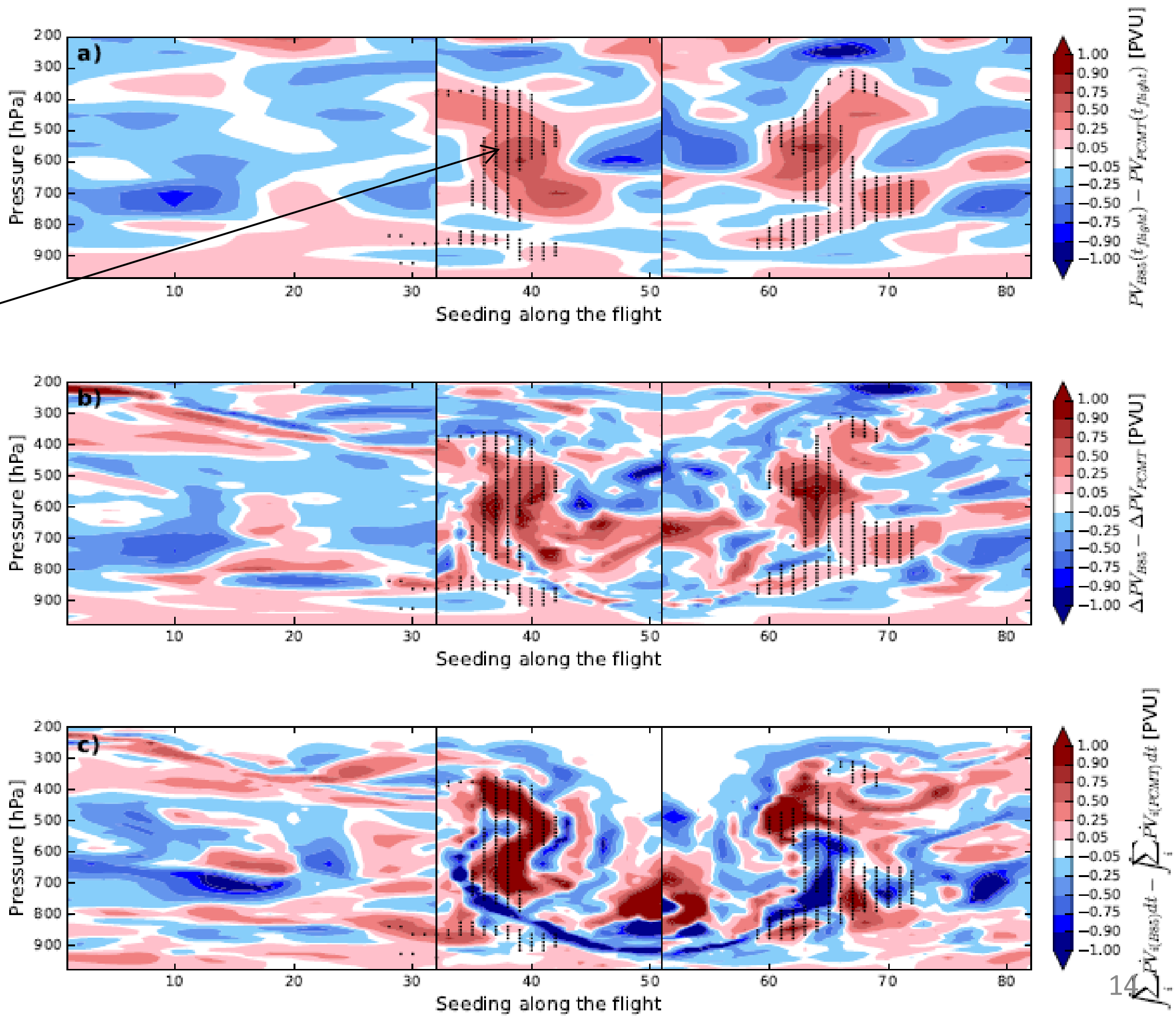


PV(B85)- PV(PCMT)

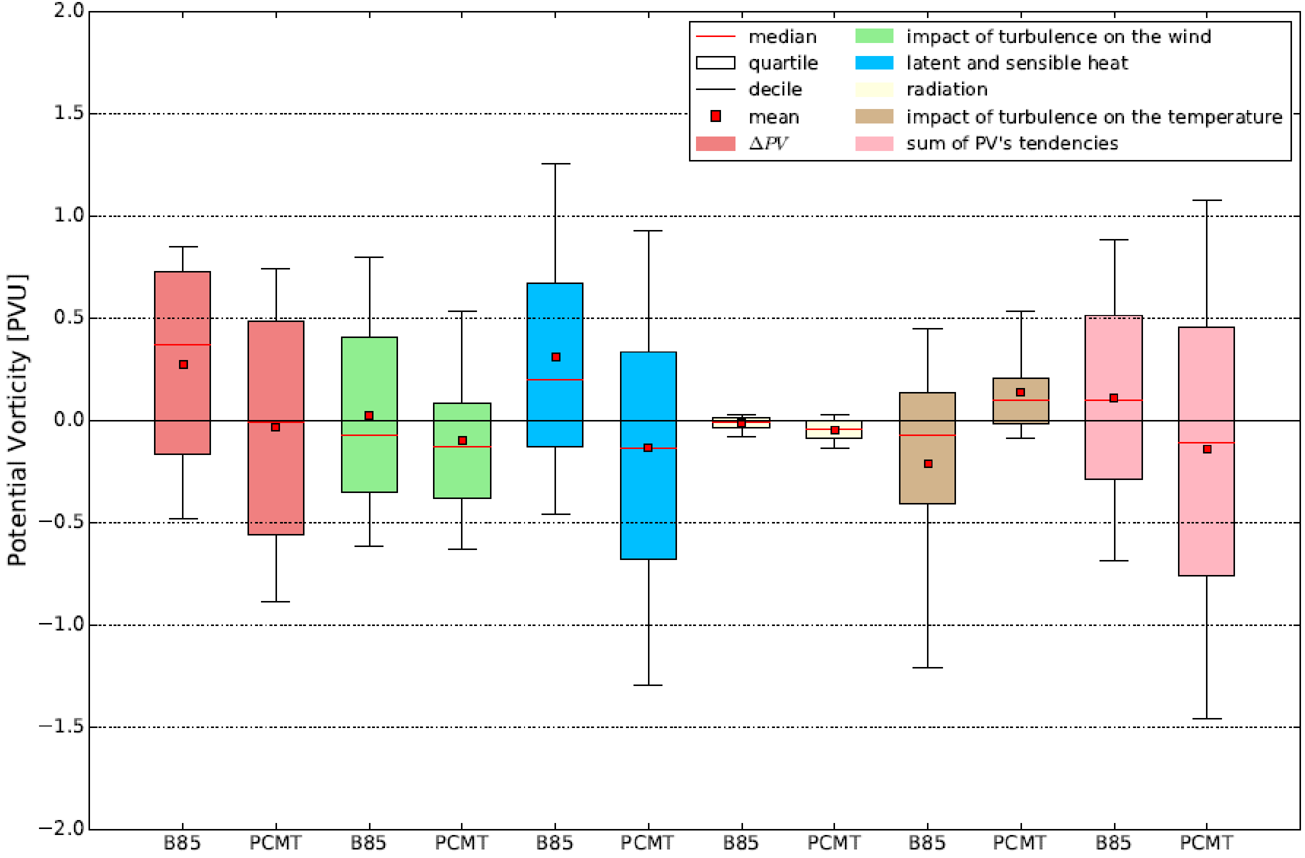
Common points

ΔPV(B85)- ΔPV(PCMT)

$\int \sum \dot{PV}$(B85)- $\int \sum \dot{PV}$(PCMT)



Which diabatic processes explain PV differences ?



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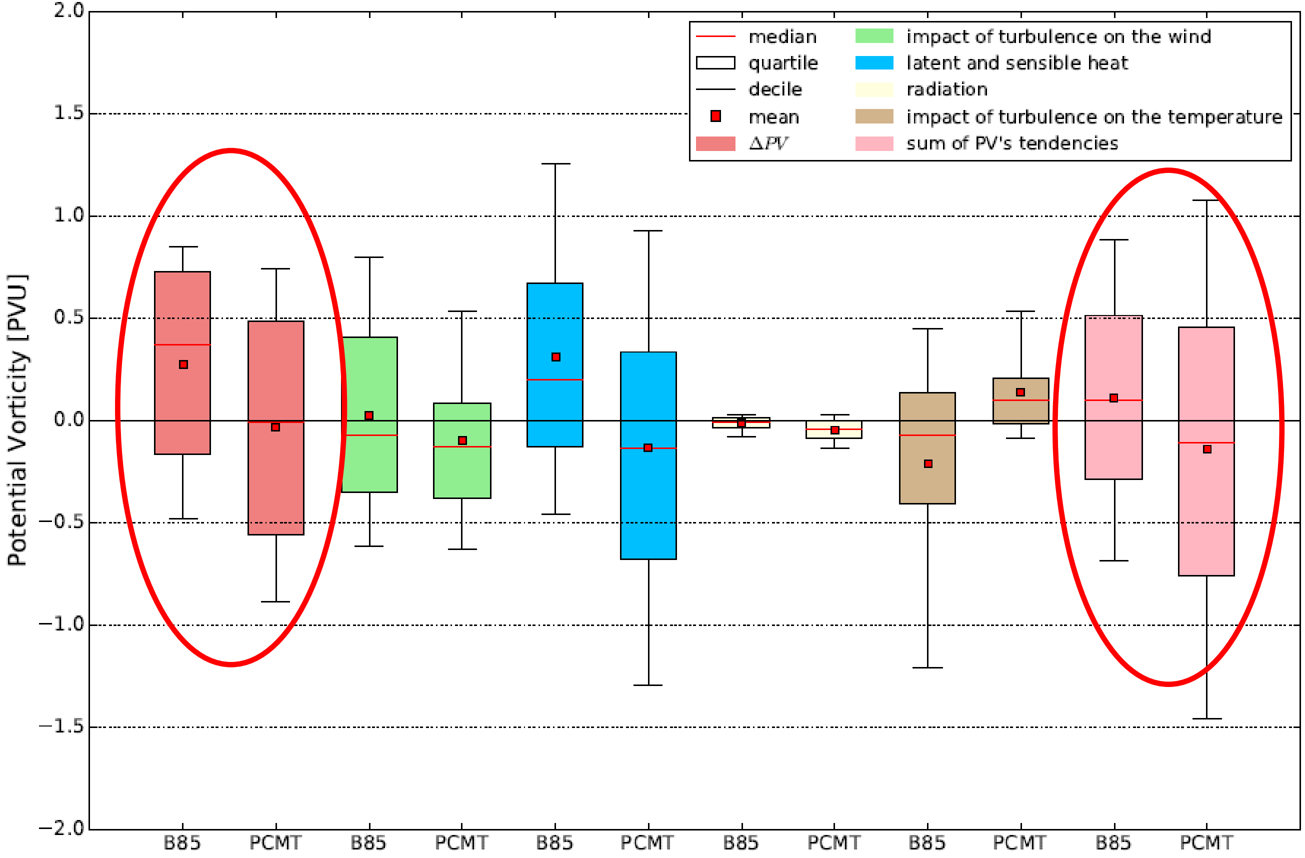

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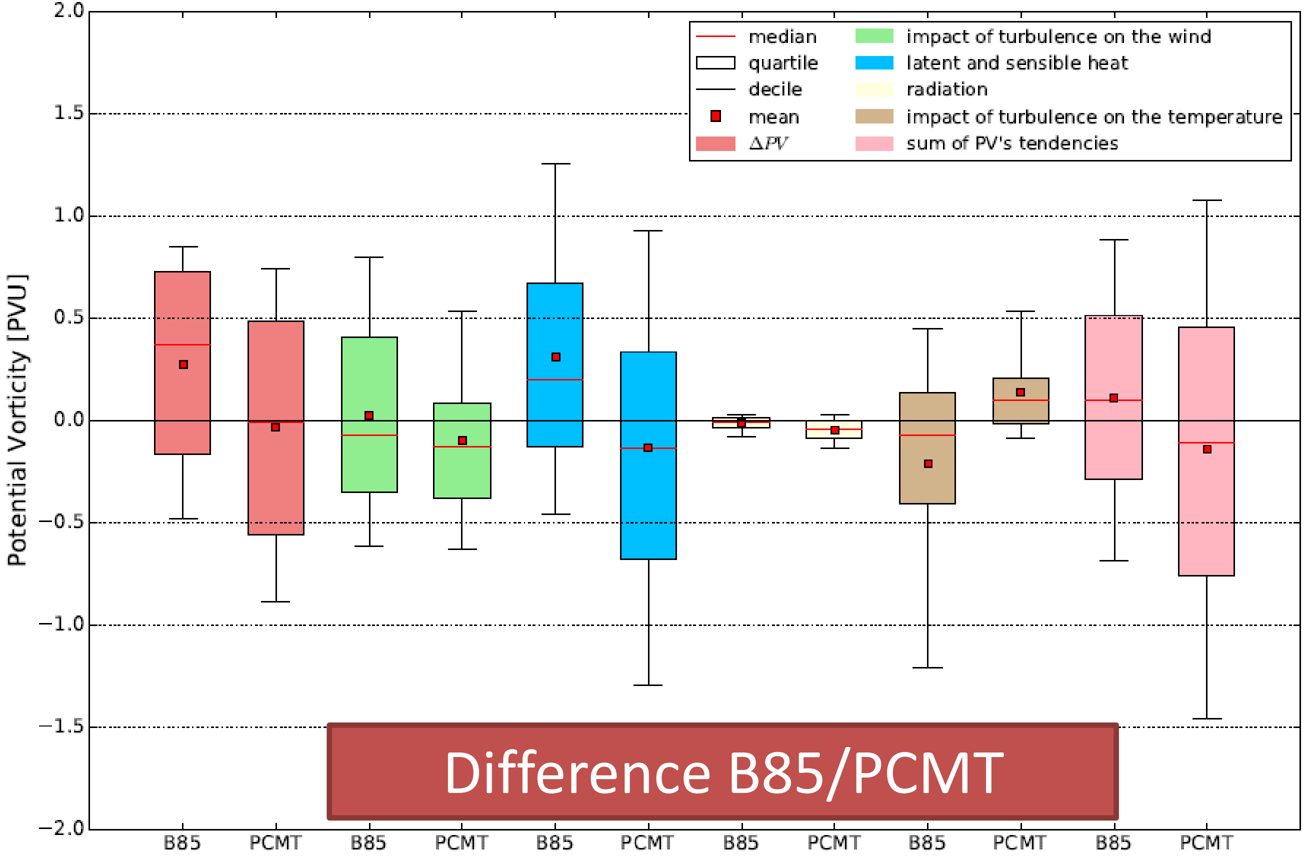

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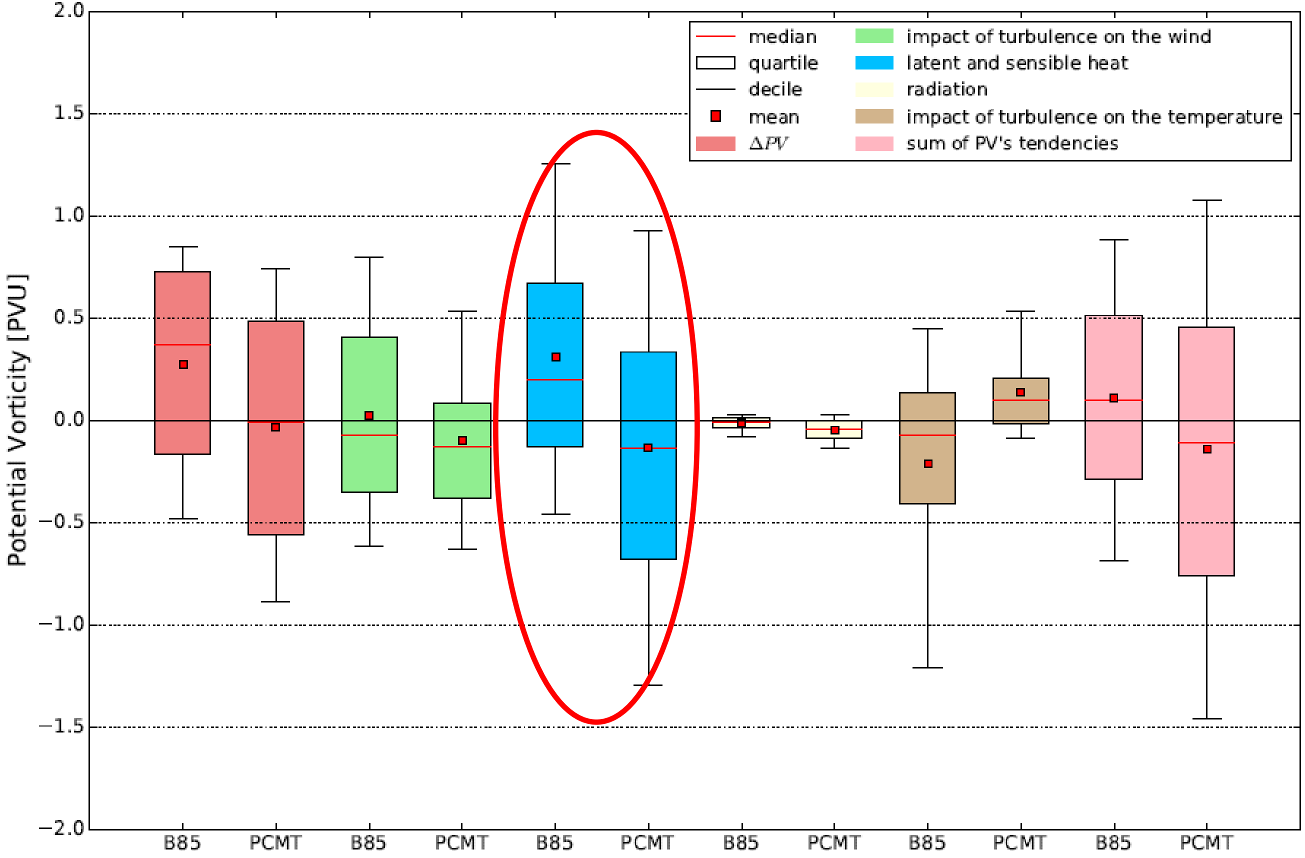

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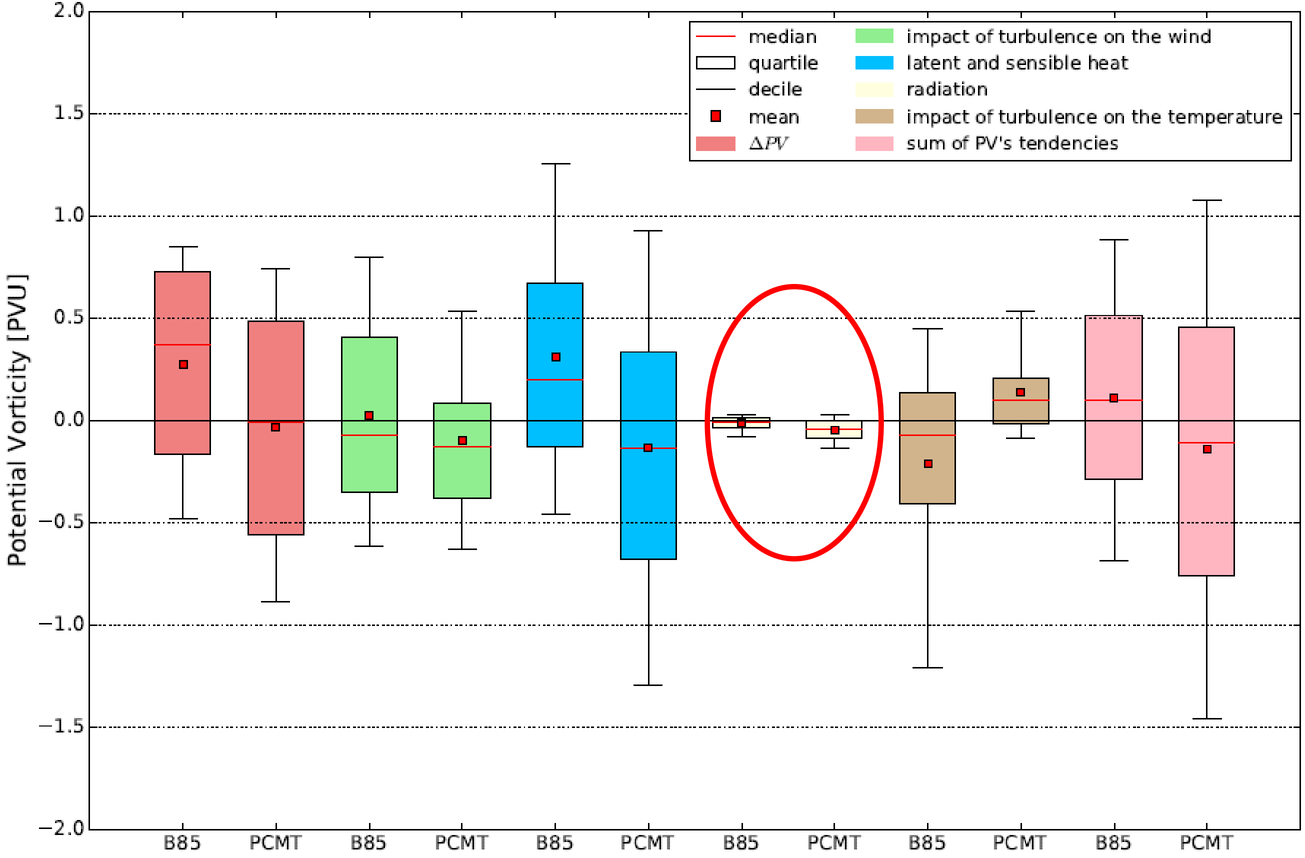

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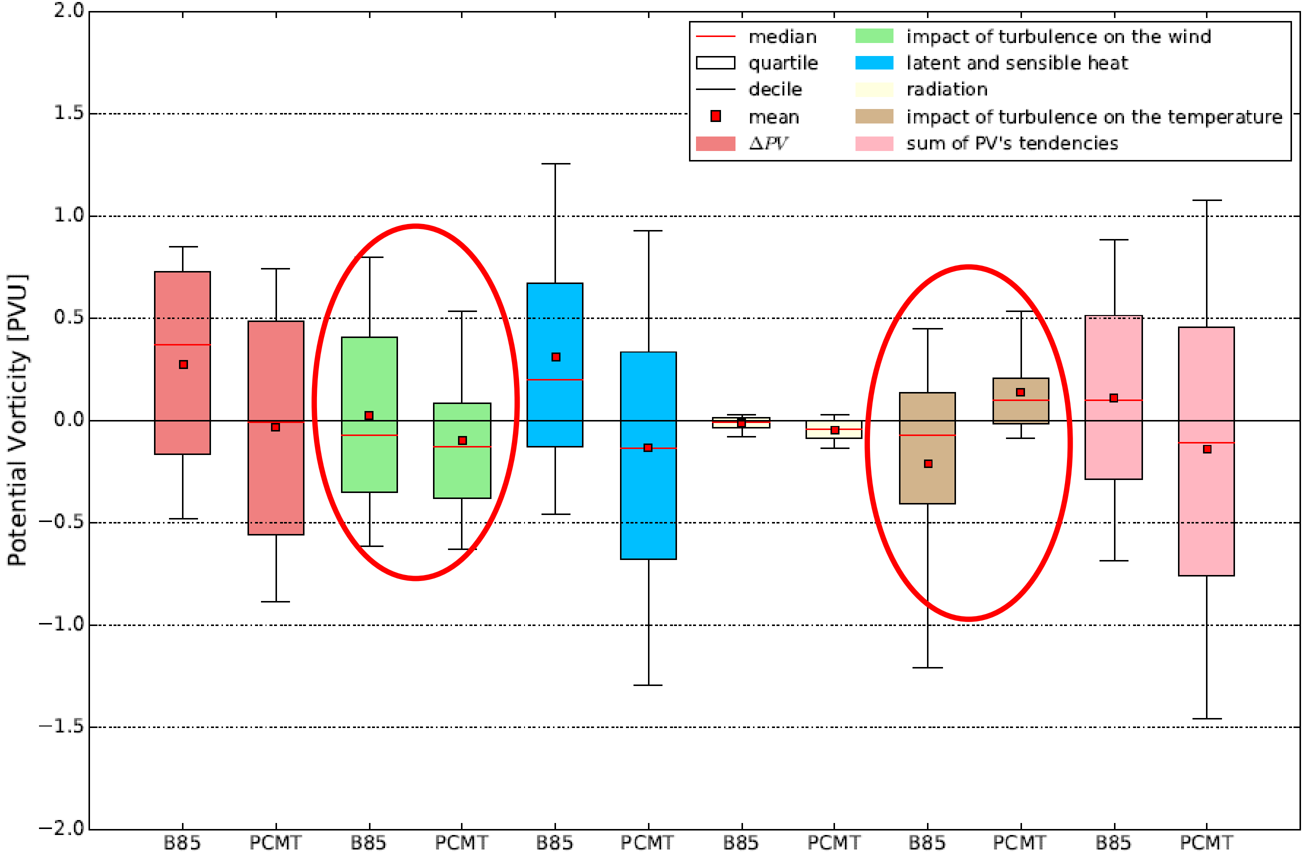


Differences between B85/PCMT

B85

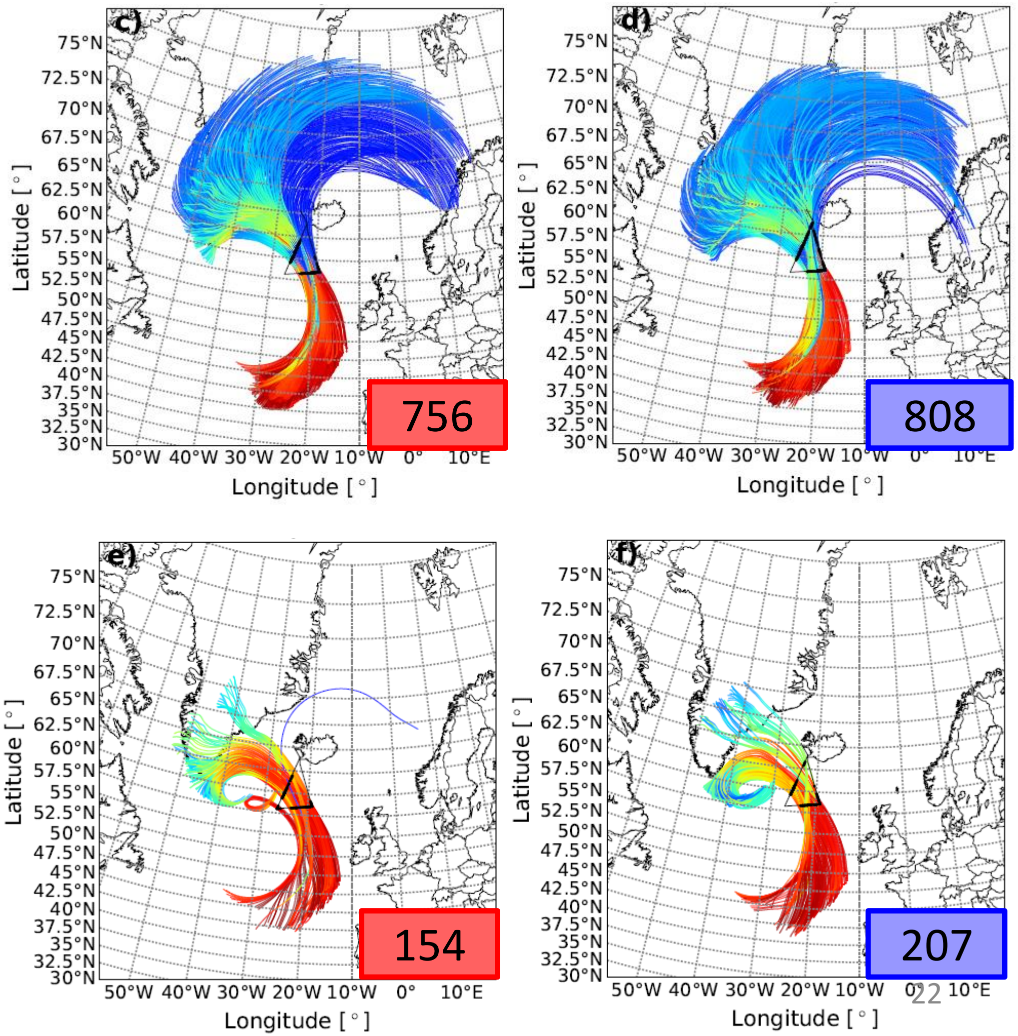
- Upper Heating
- Ice phase heating
- $PV ++$
- $\Delta PV > 0$ in the flight

PCMT

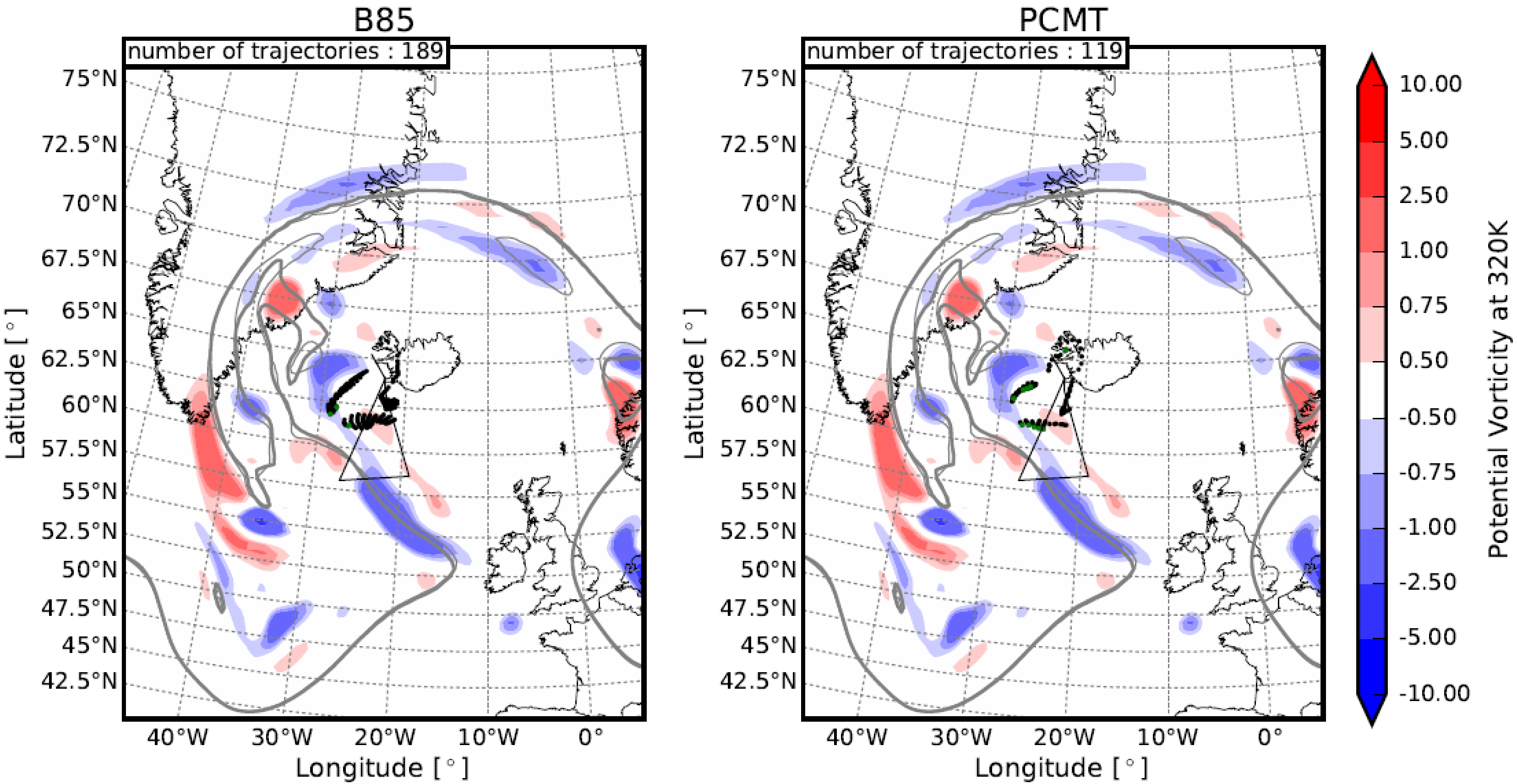
- Earlier Heating
- Liquid phase heating
- $PV +$
- $\Delta PV < 0$ in the flight

Impact on the uper-level anticyclone

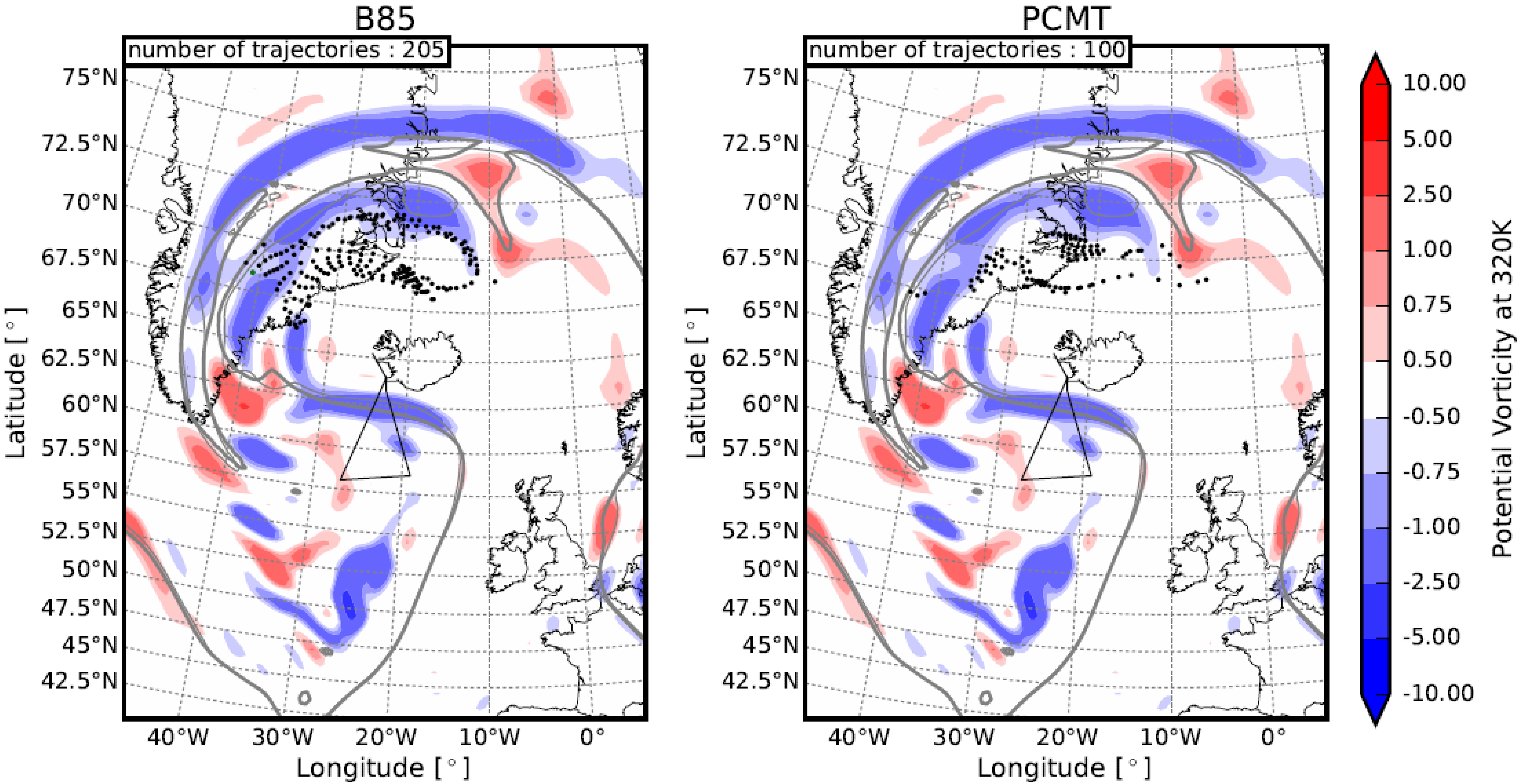
anticyclonic/cyclonic trajectories



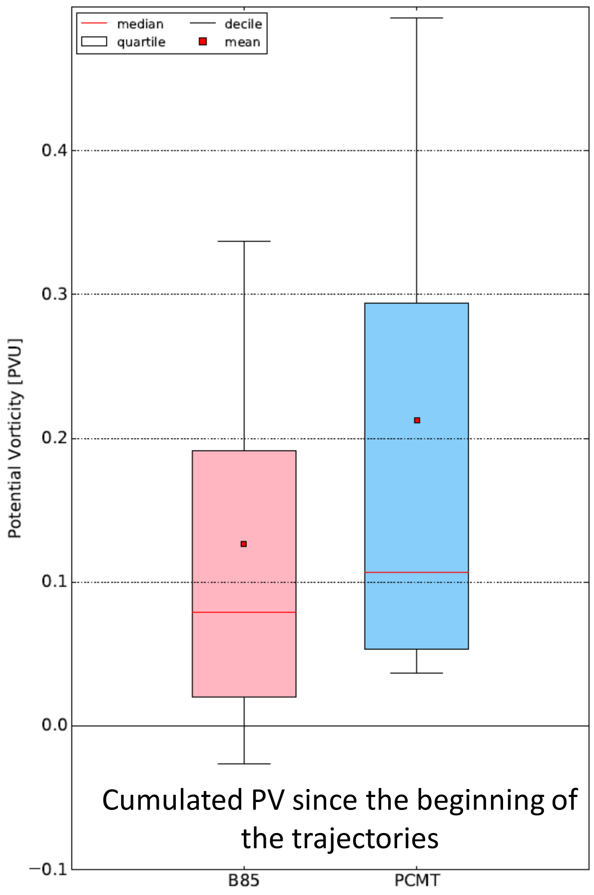
02/10/2016 at 18hUTC

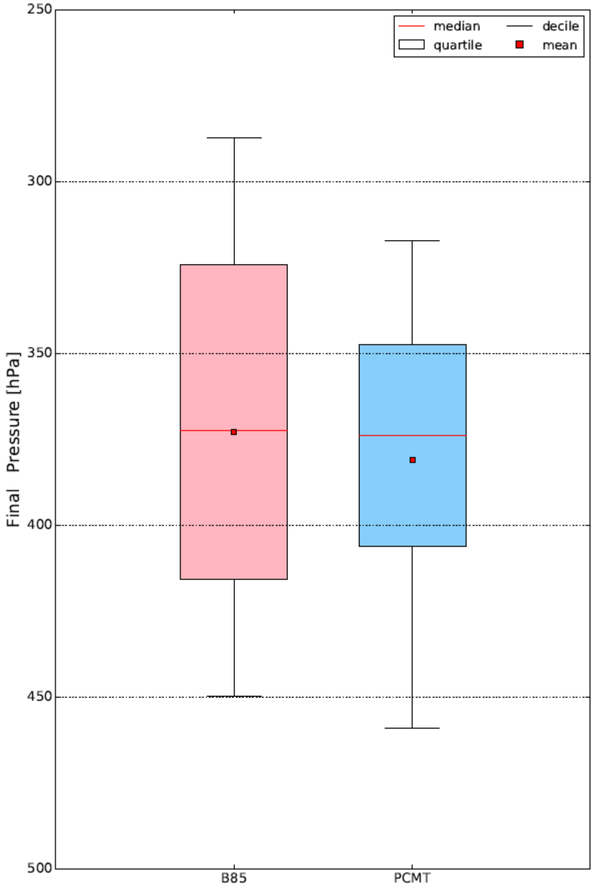


03/10/2016 at 2hUTC



PV and final pressure distribution





Differences between B85/PCMT

B85

- Upper Heating
- Ice phase heating
- $PV++$
- $\Delta PV > 0$ in the flight
- $\Delta PV > 0$ in the anticyclone : +
- Final Pressure : -
- $PV > 320\ K$: +

PCMT

- Earlier Heating
- Liquid phase heating
- $PV+$
- $\Delta PV < 0$ in the flight
- $\Delta PV > 0$ in the anticyclone : ++
- Final Pressure : +
- $PV > 320\ K$: -

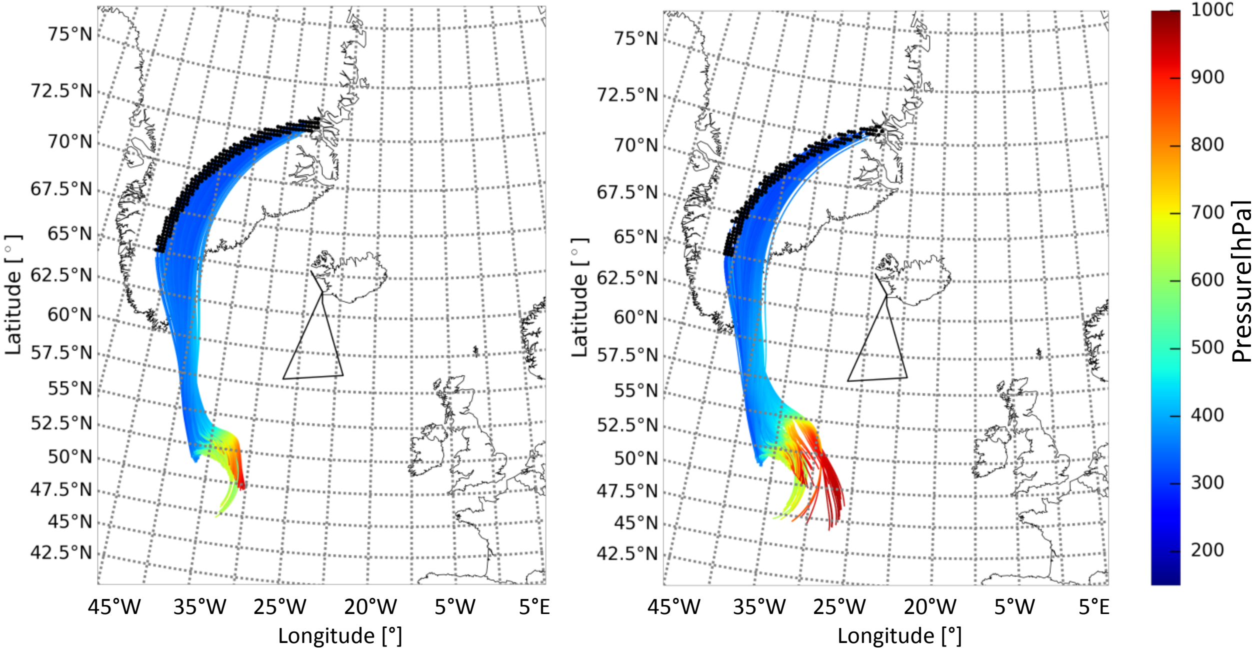
Conclusion and perspectives

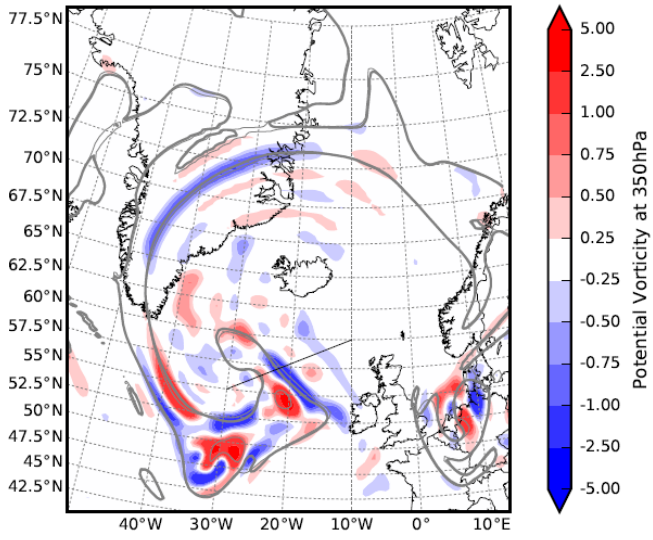
- Conclusion
  - Cumulated PV in the WCB explains PV difference along the flight
  - Difference due to microphysic
  - $\Delta PV > 0$: + in B85
  - PV anomalie in high altitude due to WCB

- Perspectives
  - Improve heating and PV budget
  - Study other flights (-> Gwendal Rivière)
  - Use other convection schemes (new PCMT, Tiedke)

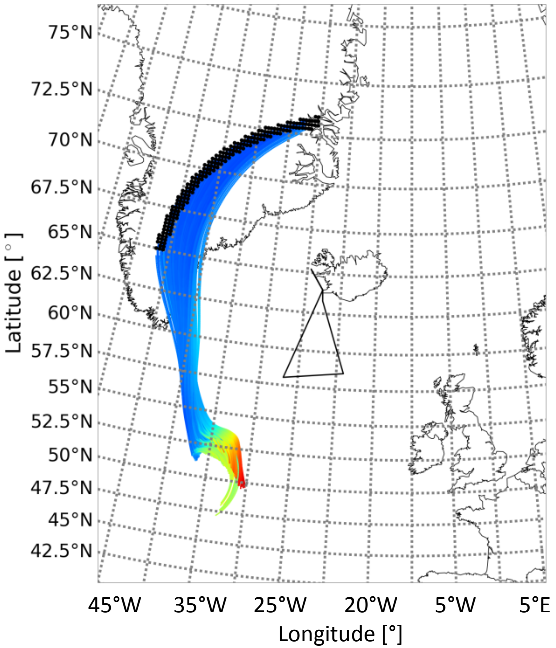
Thank you for your attention

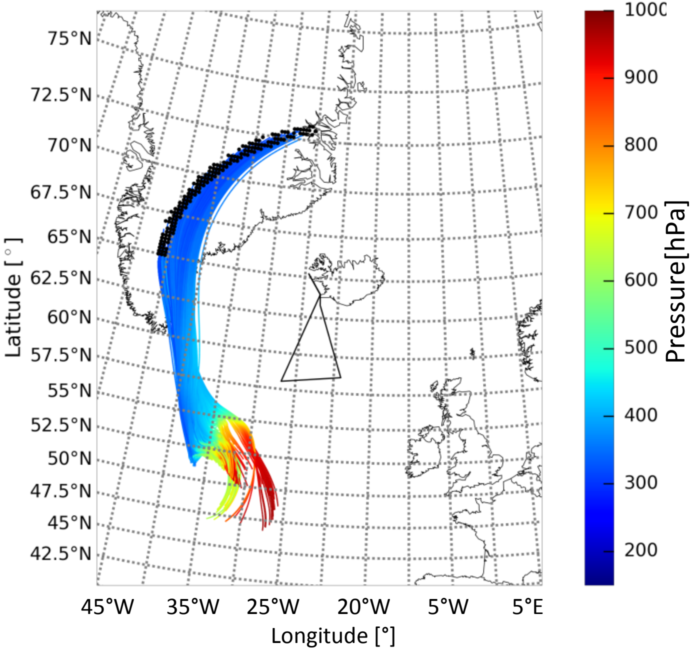
Backward trajectories

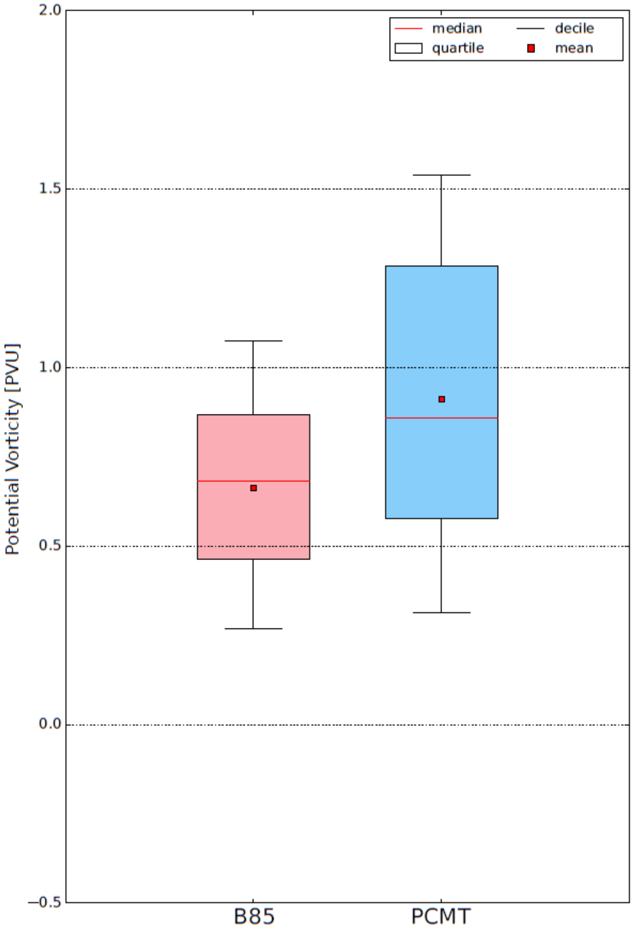




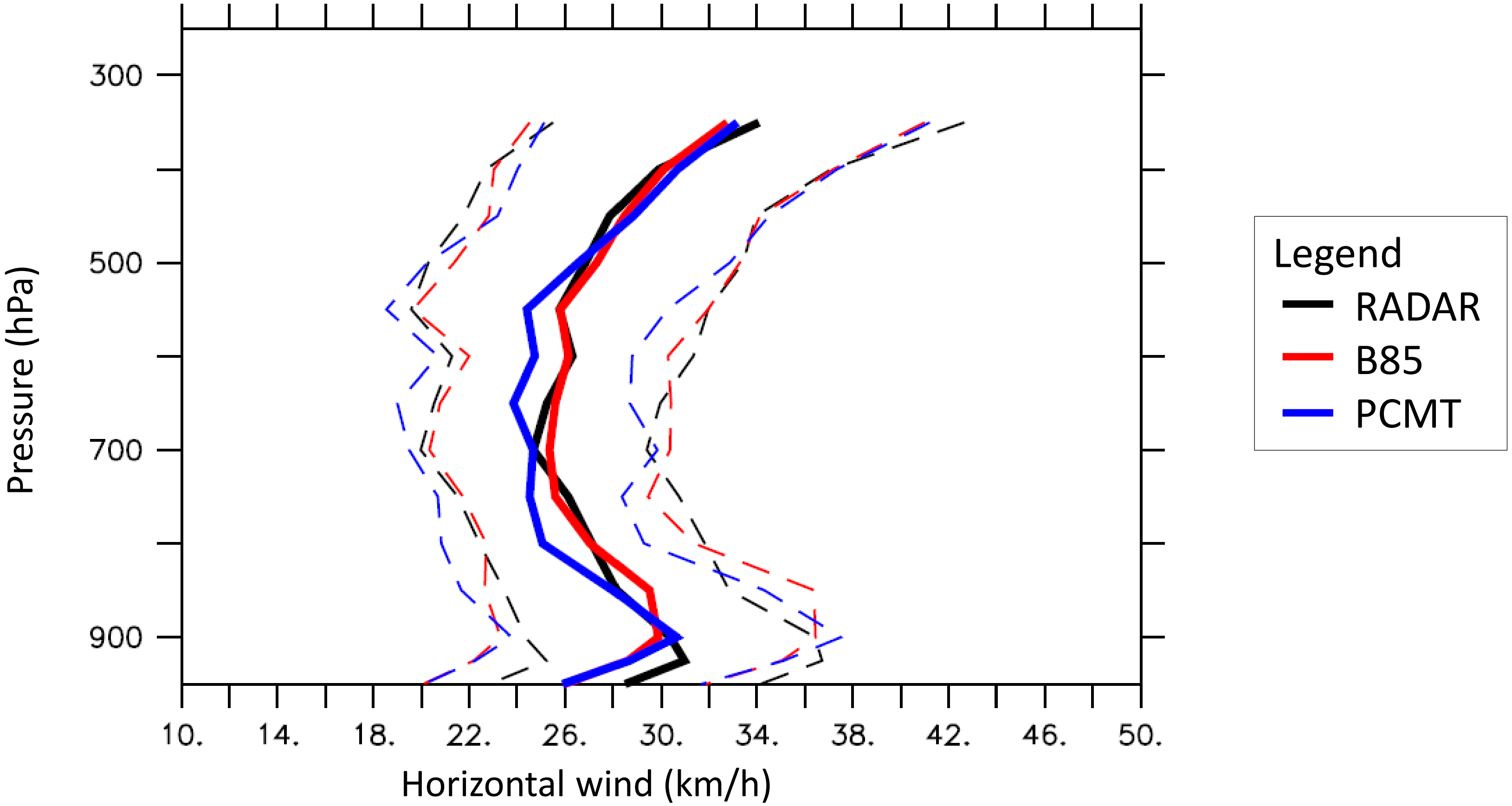
Backward trajectories



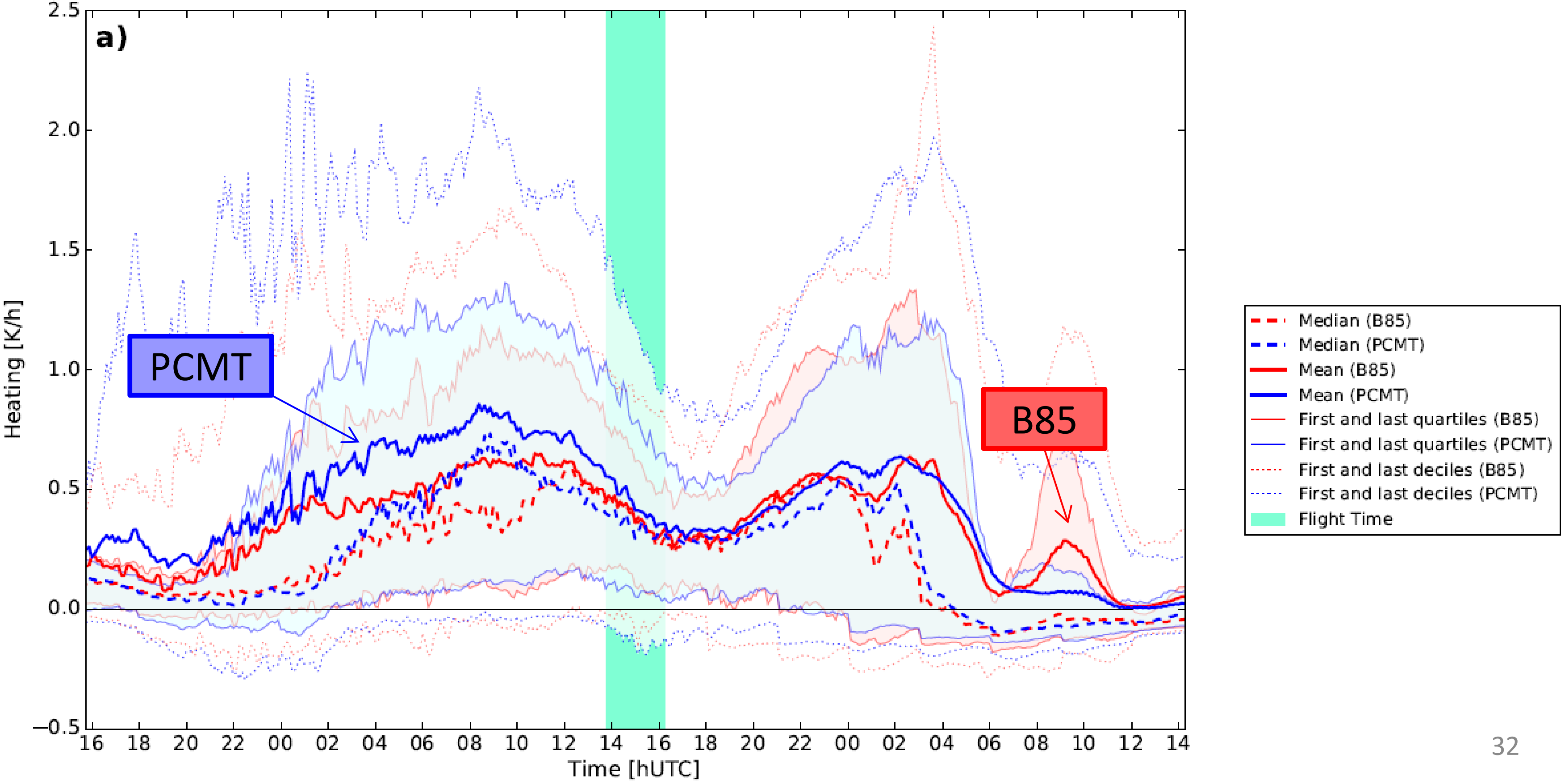




Vertical wind profile



Time evolution of the heating



PV budget: 12h before the flight

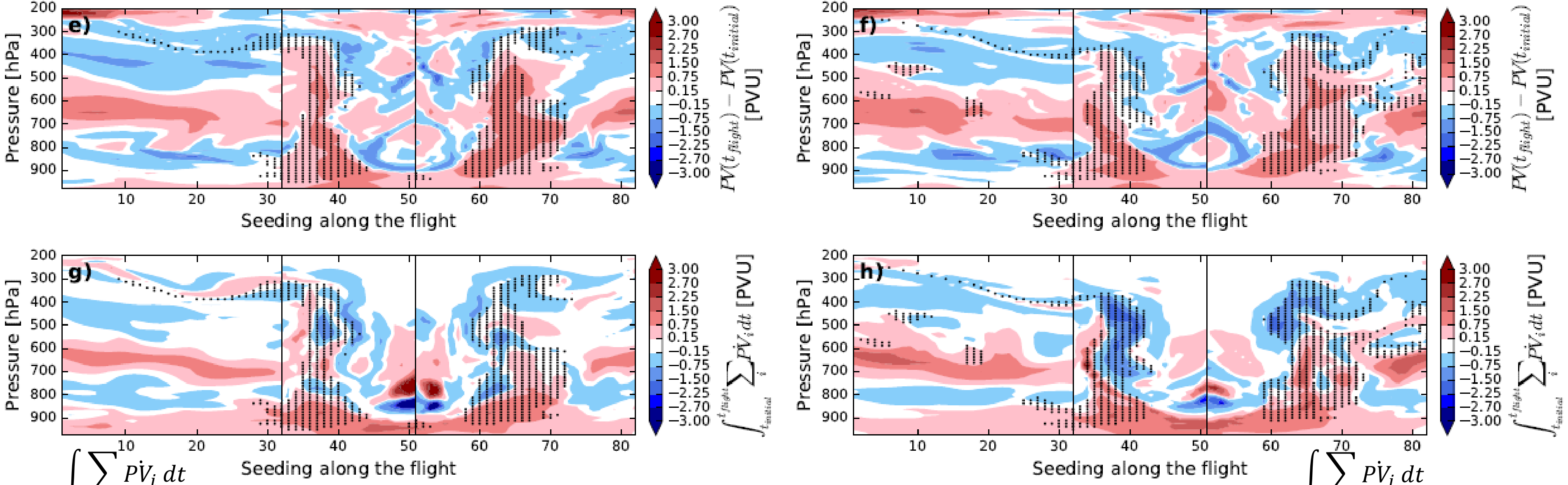
$$\Delta PV = \int \sum_i \dot{PV}_i \, dt$$

B85

PCMT

ΔPV

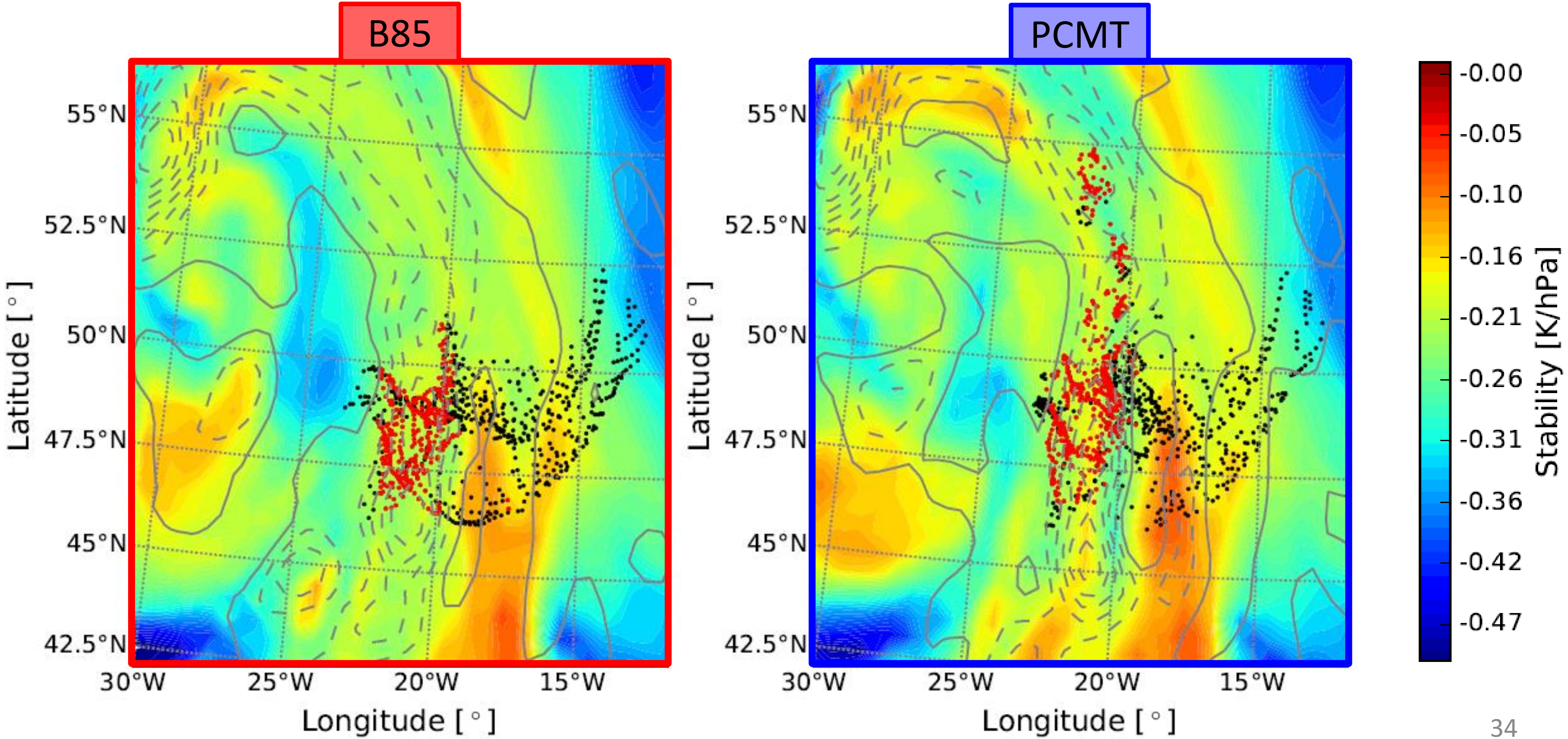
ΔPV



$\int \sum_i \dot{PV}_i \, dt$

$\int \sum_i \dot{PV}_i \, dt$

… due to instable front in PCMT



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