Effet de la paramétrisation de la convection sur la bande transporteuse d'air chaud de la dépression Stalactite et sur le courant jet d'altitude

G. Rivière, M. Wimmer, P. Arbogast, J. M. Piriou , J. Delanoë, C. Labadie

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Main questions

- How different are Warm Conveyor Belts between runs with parametrized convection and without ?

- What is the impact of parametrized convection on jet stream in the WCB outflow region ?

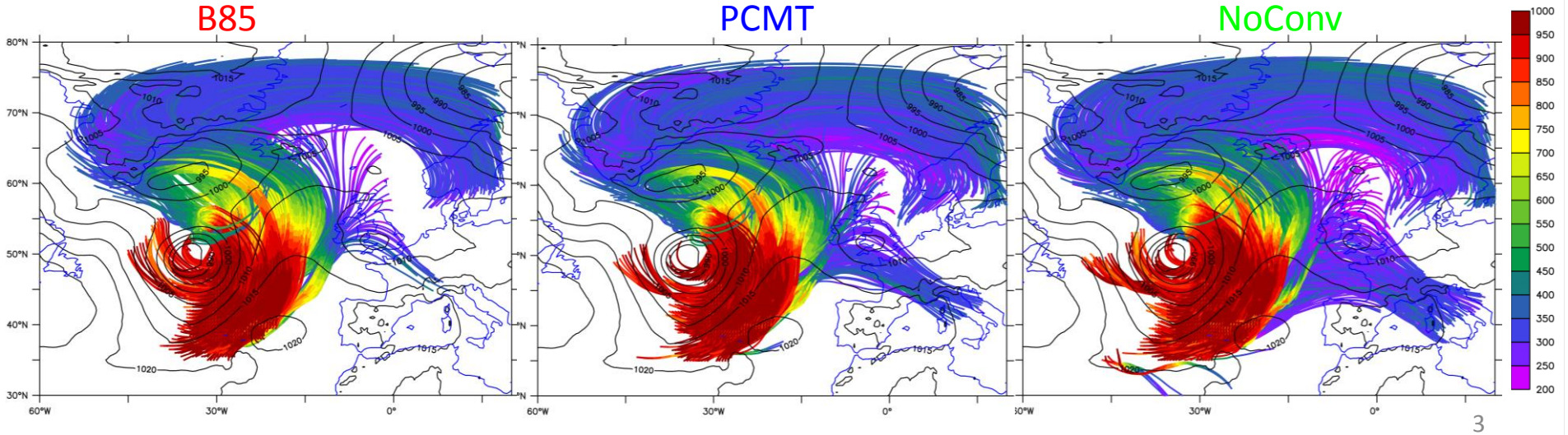
- How do the two convection schemes PEARP-B85 and PEARP-PCMT differ in the representation of WCBs ?

- What are the forecast errors in the representation of the jet stream for the different runs with and without parametrized convection ?

Comparing two convection schemes using Arpege

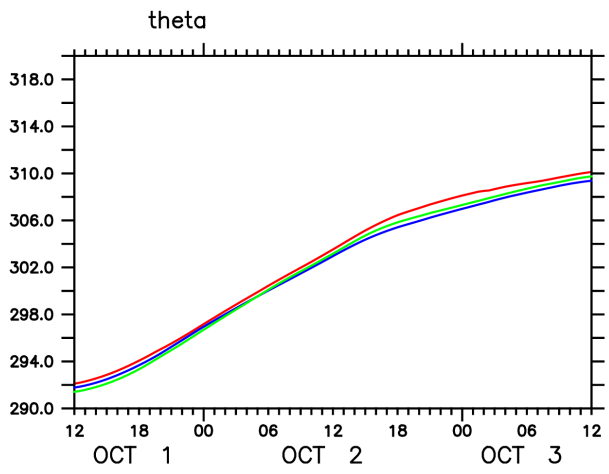
- **Arpege** / 2-3 days forecast
- Resolution: T798 with stretching → 10km over France, 20km on Iceland
- Initial condition: Arpege operational analysis (10/01/2016, 12UTC)
- Two convection schemes associated to two members:
  - → B85: Bougeault (1985): closure in humidity, used in operational NWP version.
  - → PCMT: Piriou et al. (2007) « Prognostic Condensates Microphysics and Transport »; closure in CAPE, used in Arpege climate version.
  - → No parametrized convection
- Output resolution: lon x lat: 0.5° x 0.5° (or 0.1°x0.1°) .

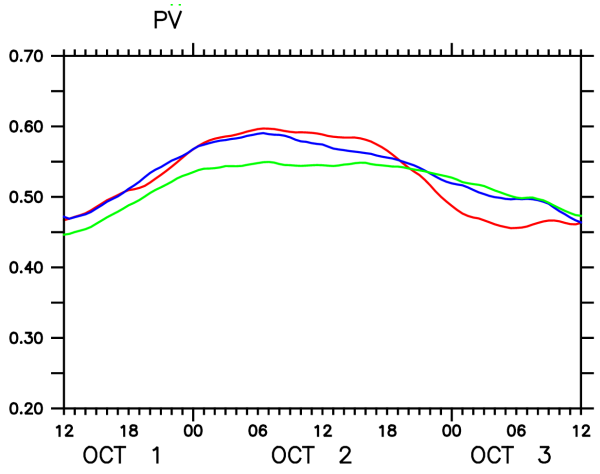
Lagrangian trajectories initiated in the warm sector on Oct 1, 12UTC criterion: 300 hPa in 24 h

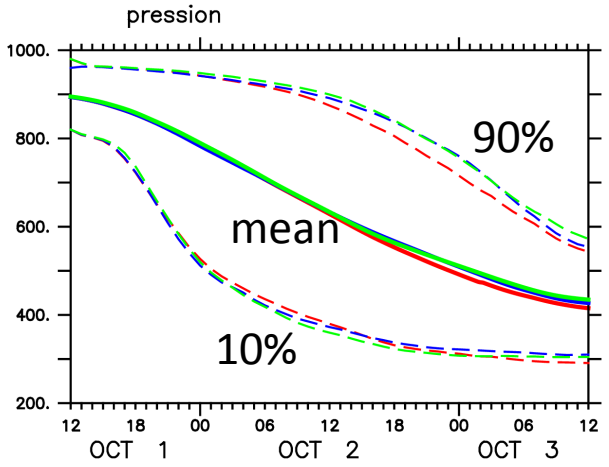


Number of WCBs and averaged quantities along them

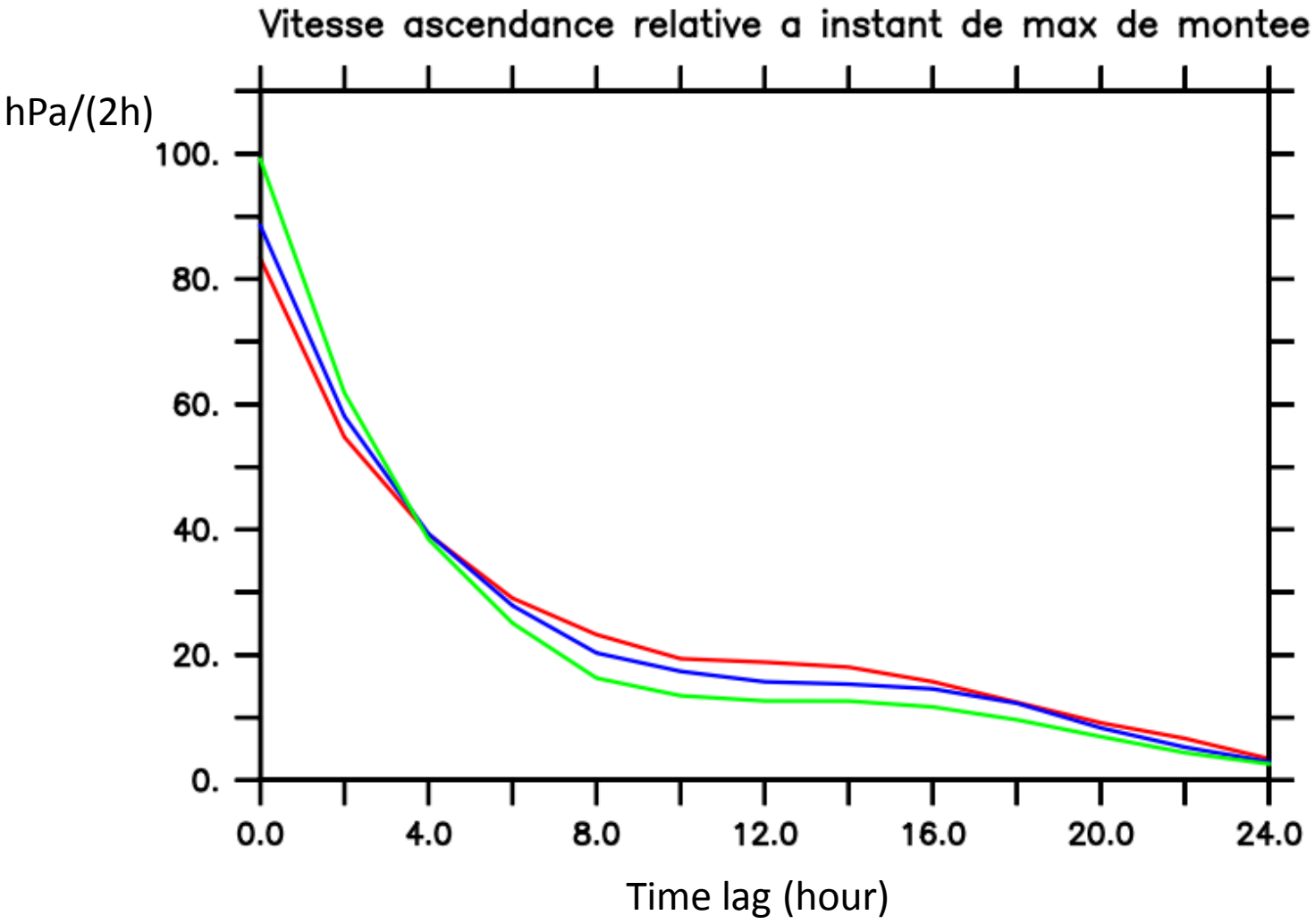
Criterion	B85	PCMT	NoConv
Total number of WCBs	9876	10086	11421
Only upper tropo (final pressure< 400hPa)	4528	4110	4494







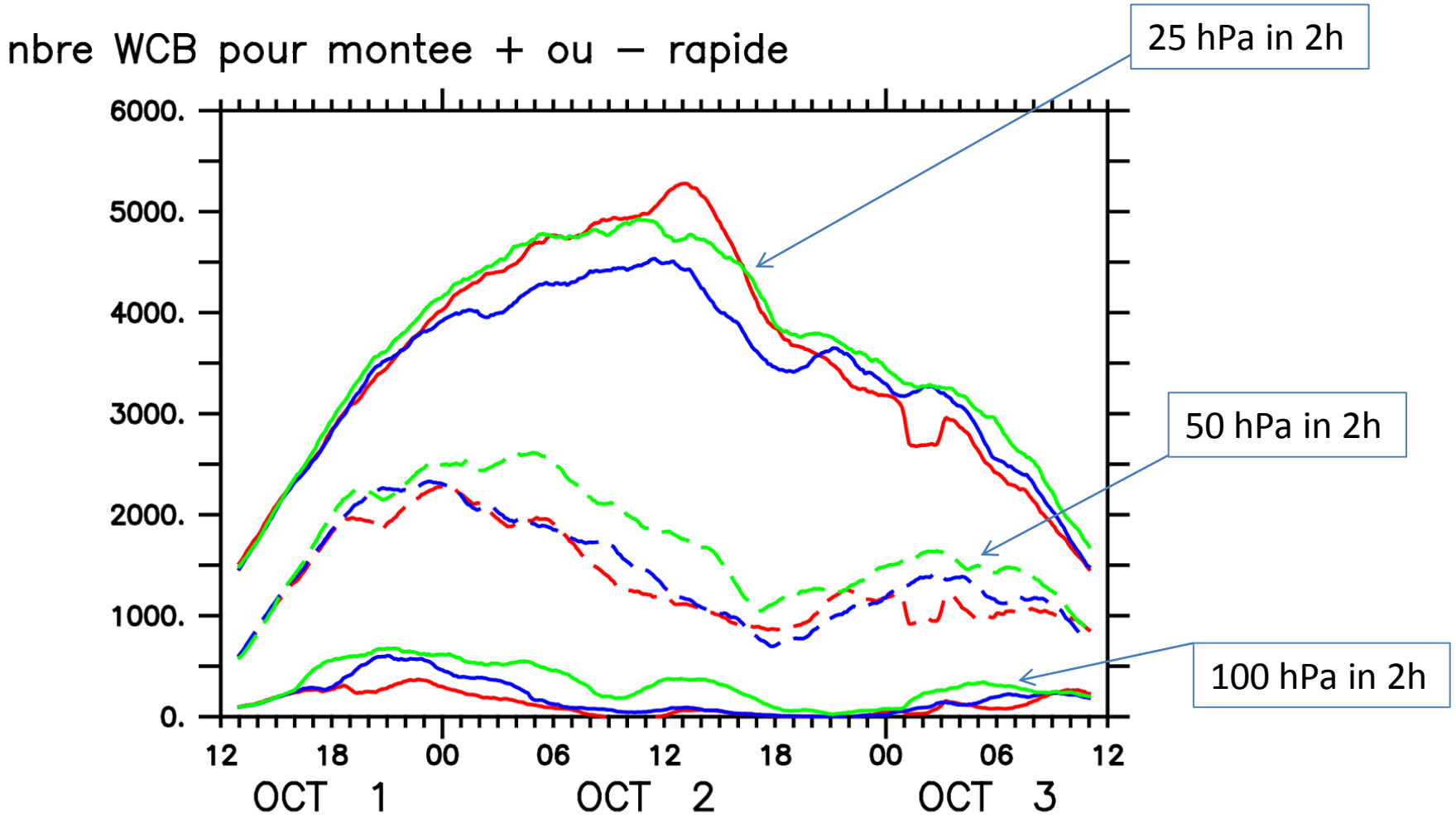
Ascending velocities



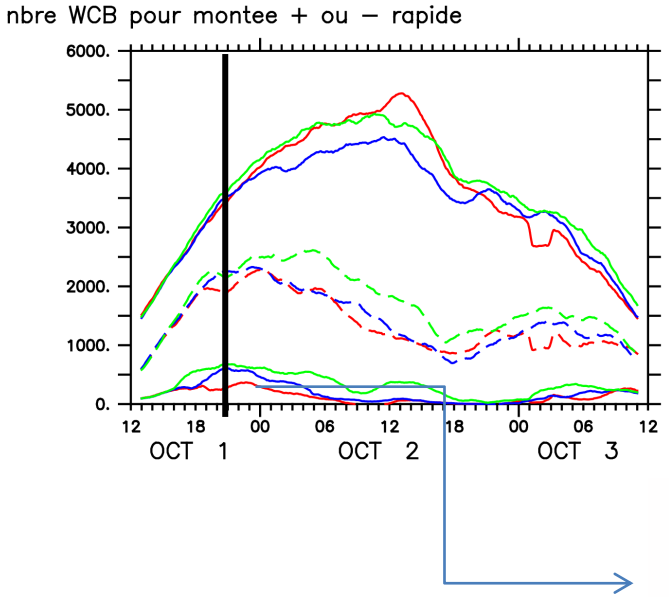
More rapid ascents in **NoConv** than **B85** at the time of maximum ascents but more sustained ascents in B85. **PCMT** is in between.

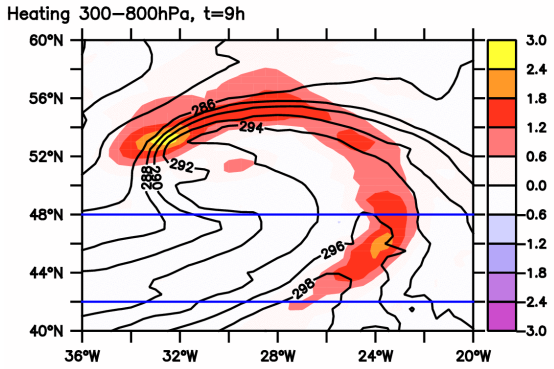
Nber of trajectories satisfying a criterion on ascends

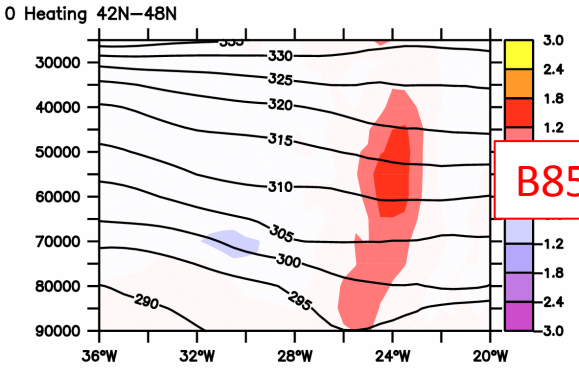
B85 PCMT NoConv



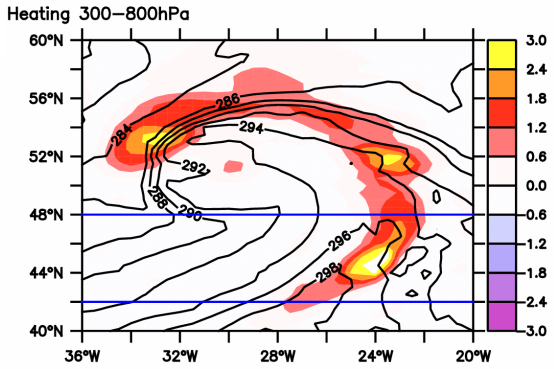
Early times (t0+9h)

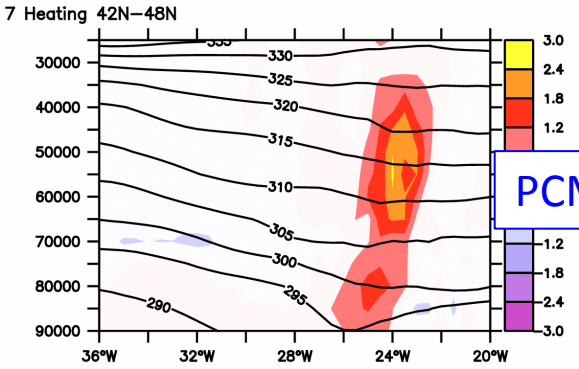




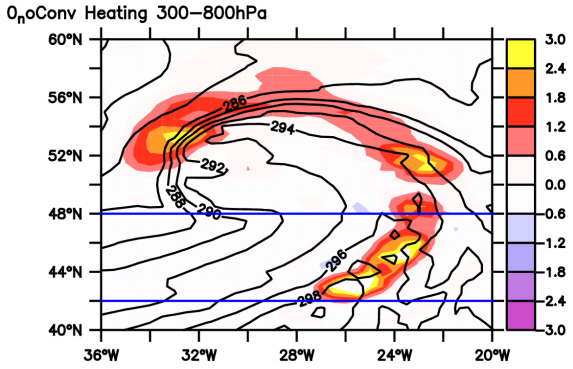


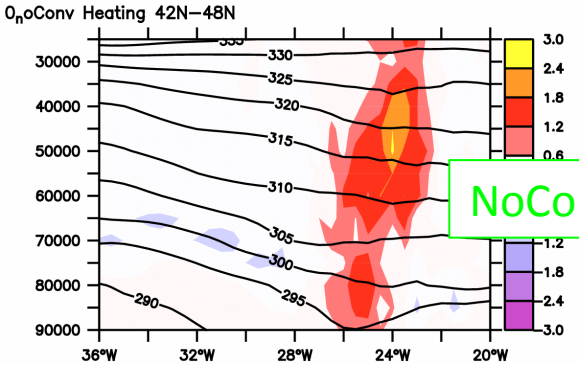
B85





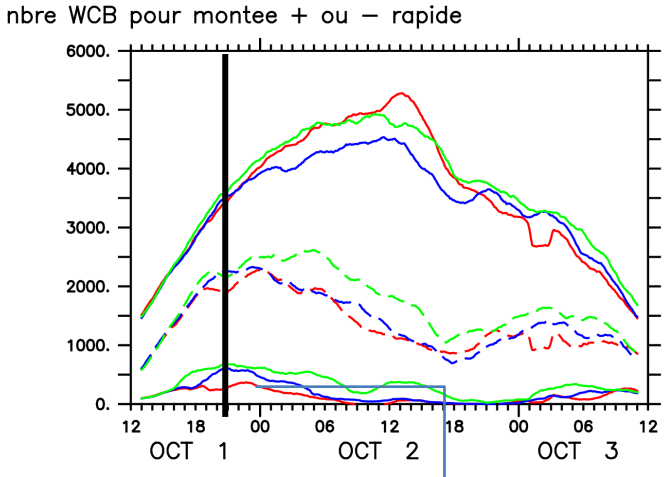
PCMT

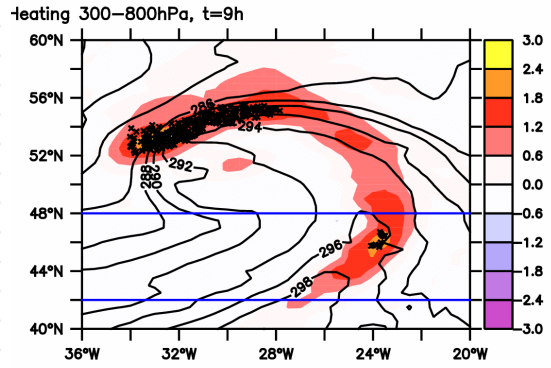


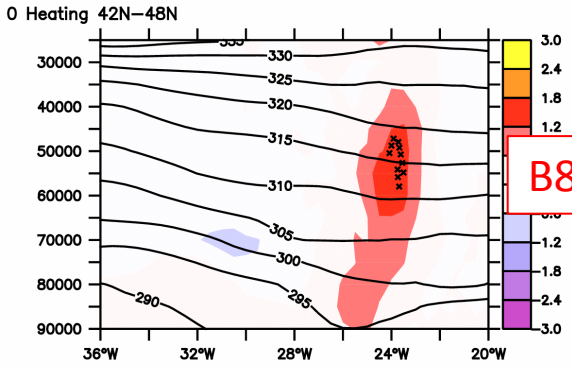


NoConv

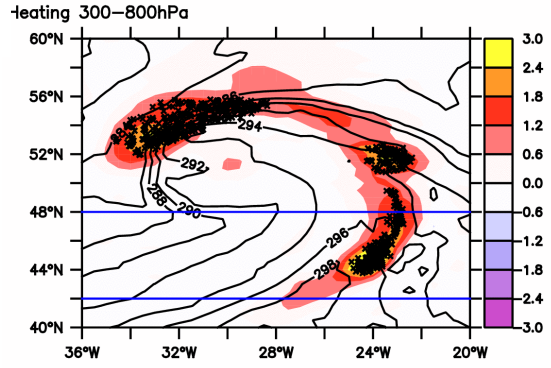
Early times (t0+9h)

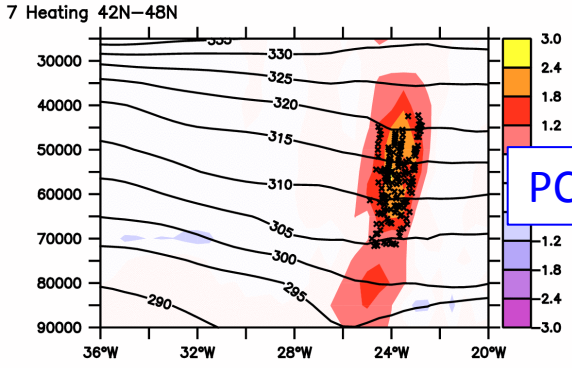




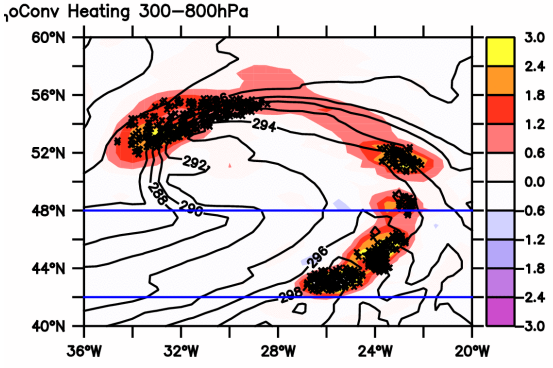


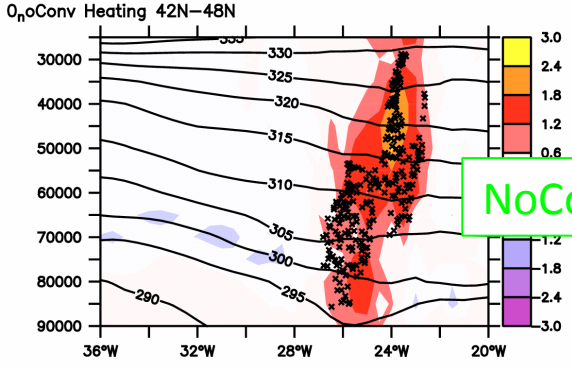
B85





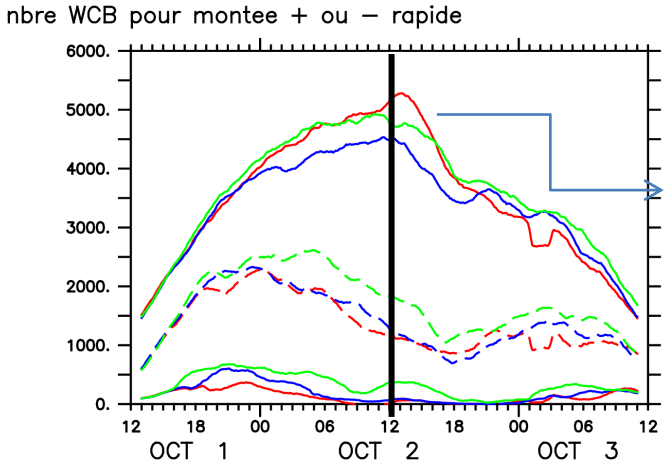
PCMT

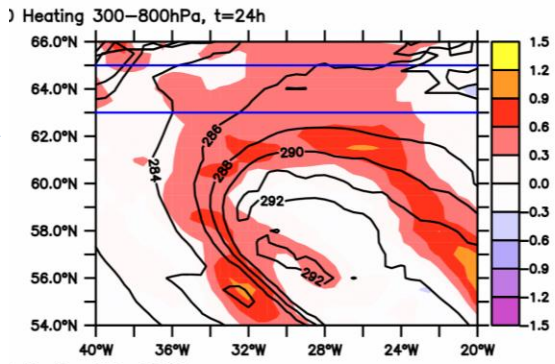


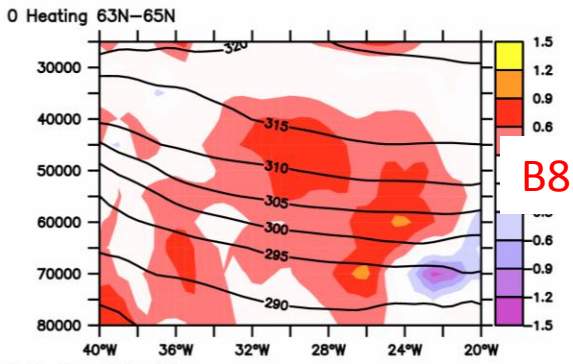


NoConv

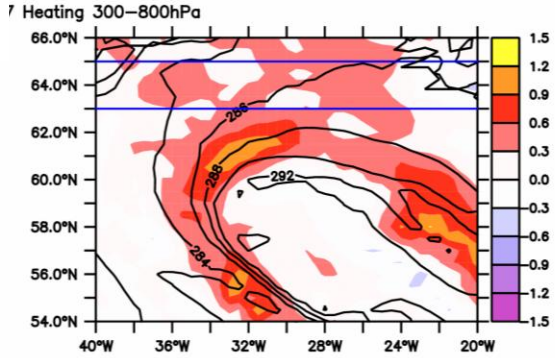
Later times (t0+24h)

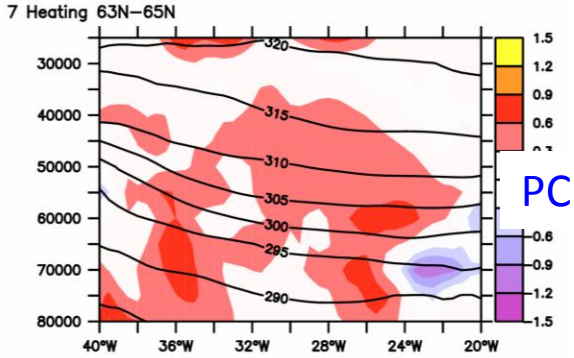




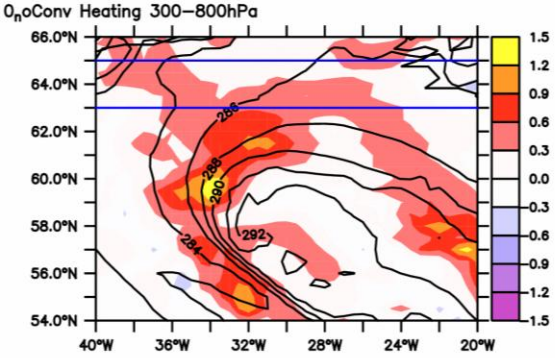


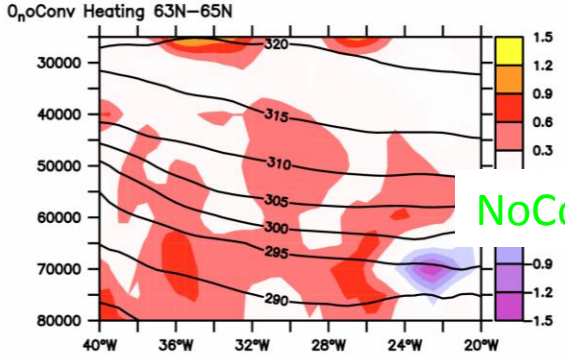
B85





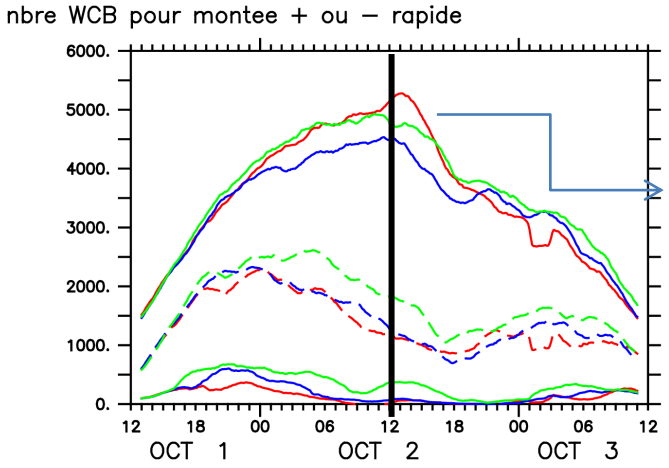
PCMT

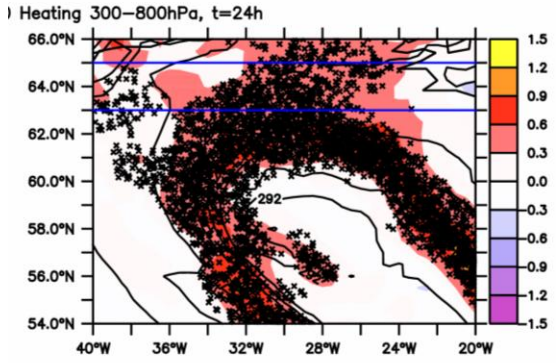


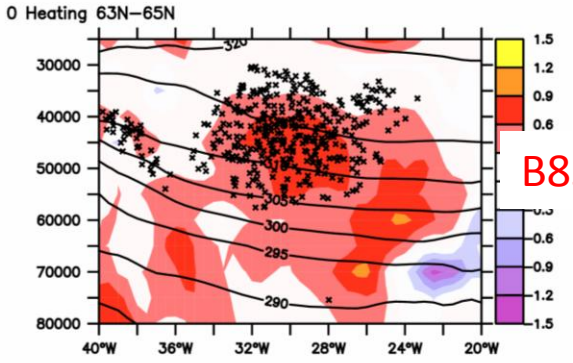


NoConv

Later times (t0+24h)







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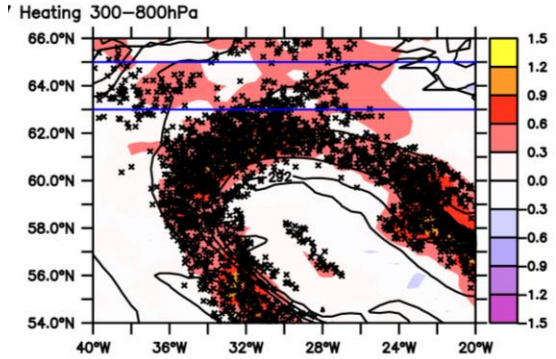
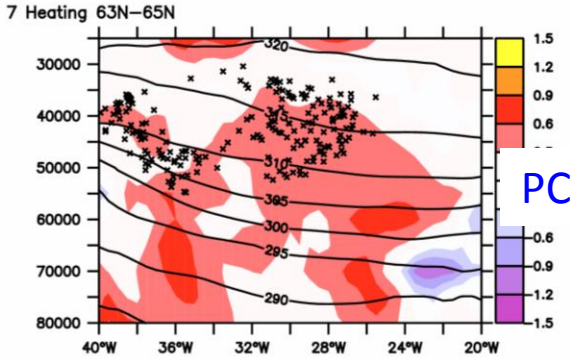
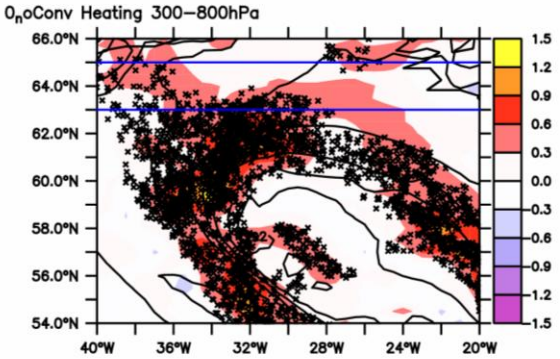
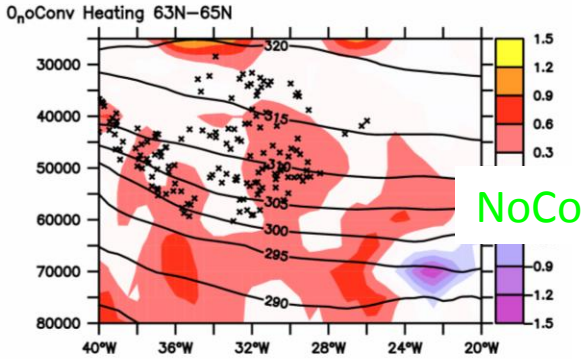




PCMT

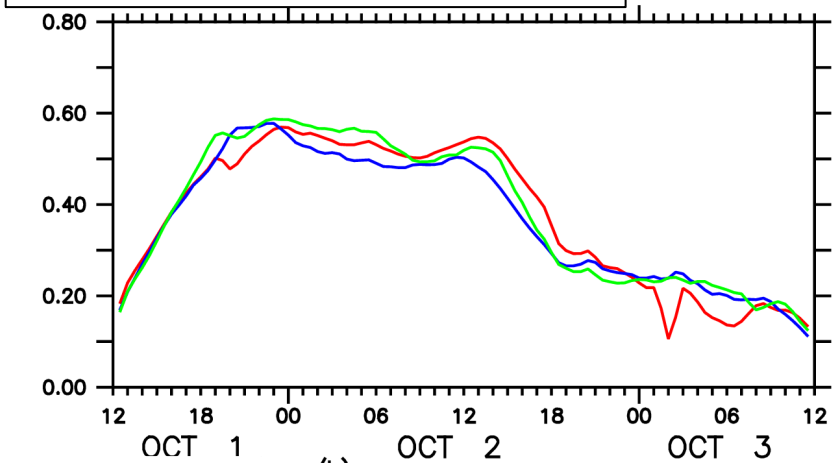




NoConv

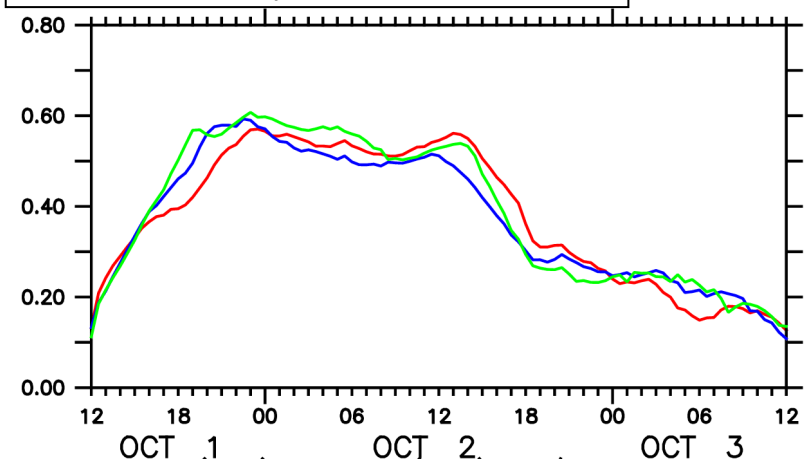
Heating and PV tendencies along trajectories

Rate of change of θ along traj K/h



$$\dot{\theta} = \frac{\theta(t + 30\ \text{min}) - \theta(t - 30\ \text{min})}{\Delta t} + \mathbf{u} \cdot \nabla\, \theta(t)$$

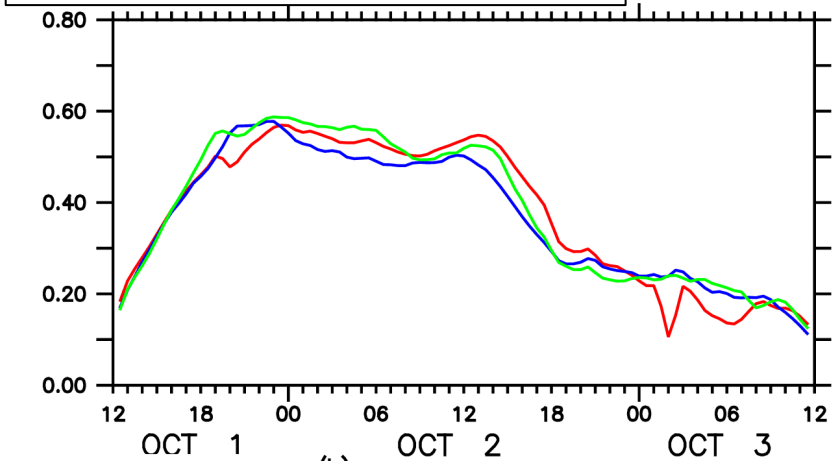
K/h



Consistency between heating rate fields computed with finite differences and variations in potential temperature along trajectories

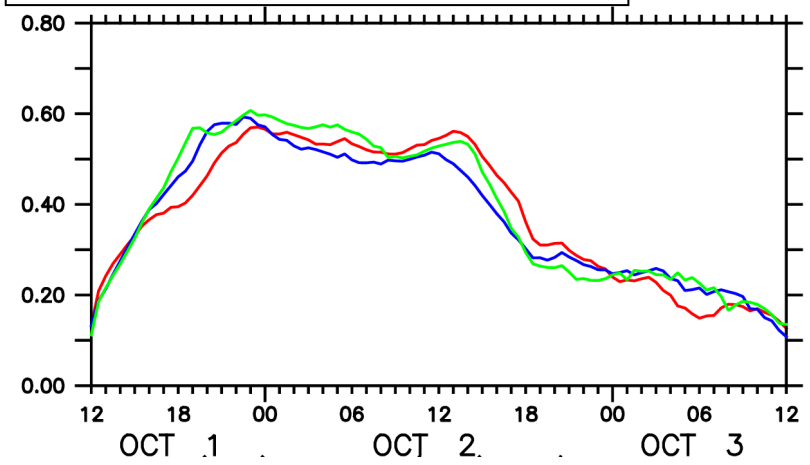
Heating and PV tendencies along trajectories

Rate of change of θ along traj K/h

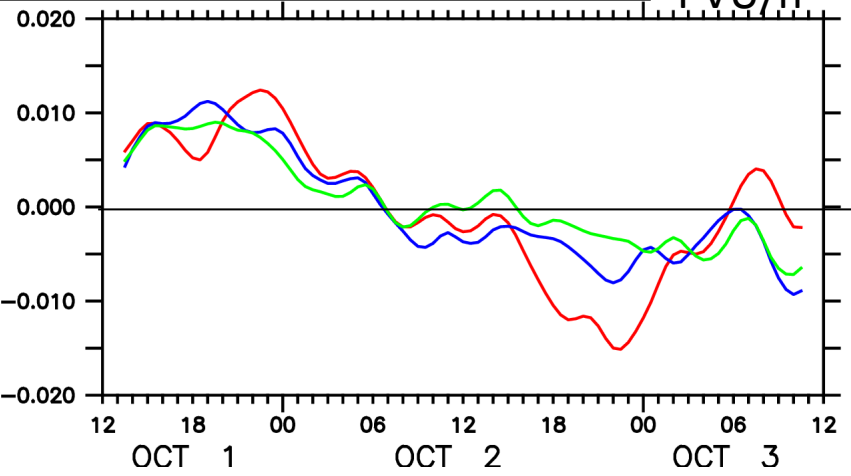


$$\dot{\theta} = \frac{\theta(t + 30\ \text{min}) - \theta(t - 30\ \text{min})}{\Delta t} + \mathbf{u} \cdot \nabla\, \theta(t)$$

K/h

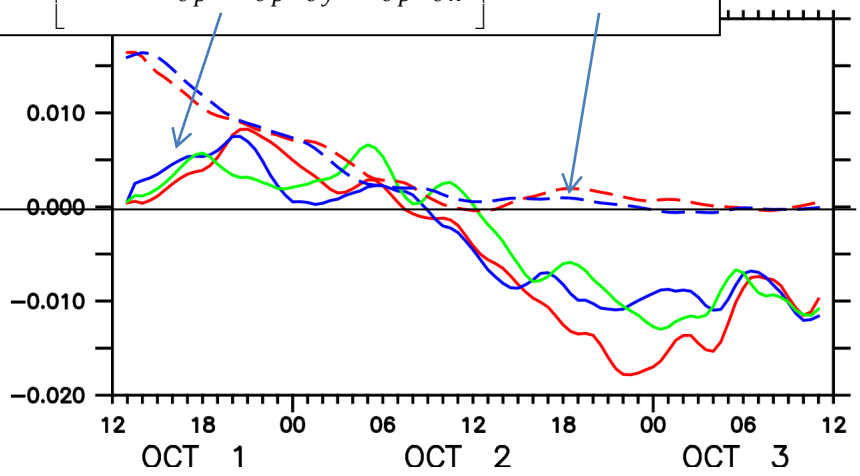


Rate of change of PV along traj PVU/h

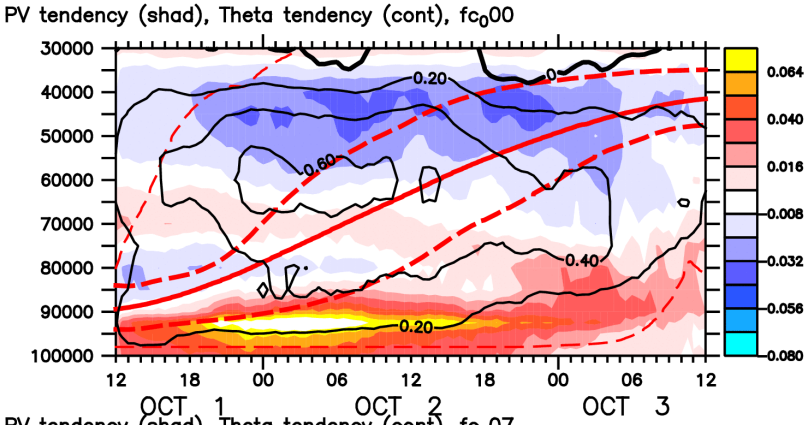


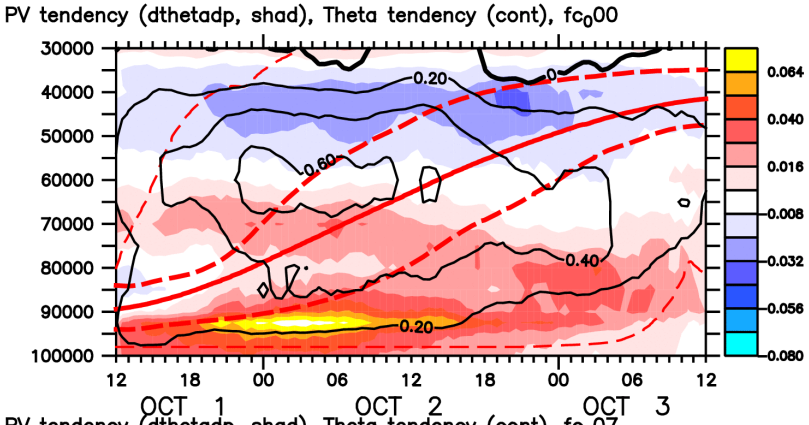
$$\frac{DPV}{Dt} = -g\left[(\varsigma + f)\frac{\partial \dot{\theta}}{\partial p} + \frac{\partial u}{\partial p}\frac{\partial \dot{\theta}}{\partial y} - \frac{\partial v}{\partial p}\frac{\partial \dot{\theta}}{\partial x}\right] - g(\nabla \wedge \mathbf{F}) \cdot \nabla\, \theta$$

PVU/h

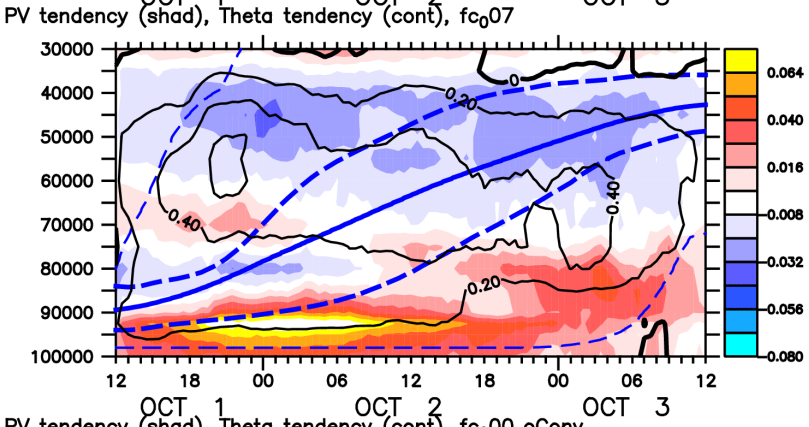


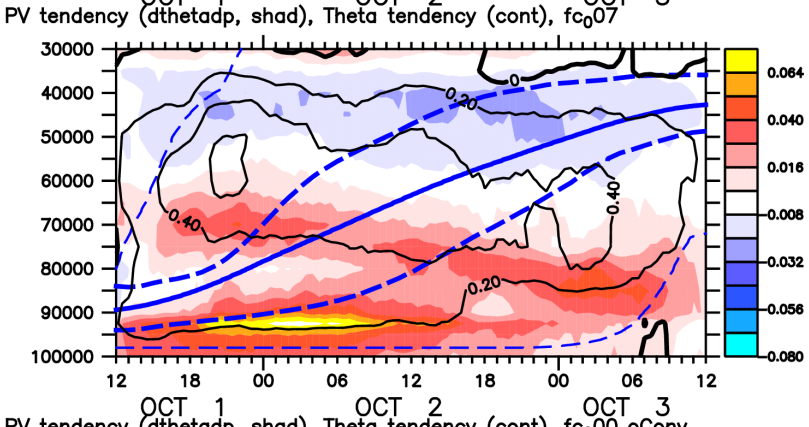
Vertical profiles of heating and PV tendencies along trajectories



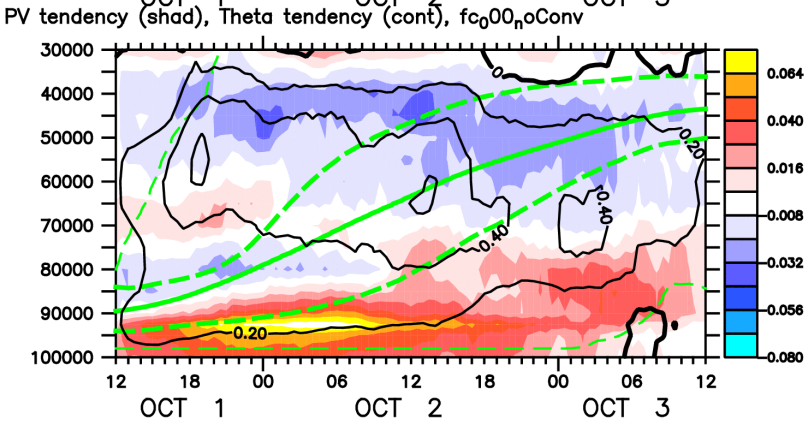


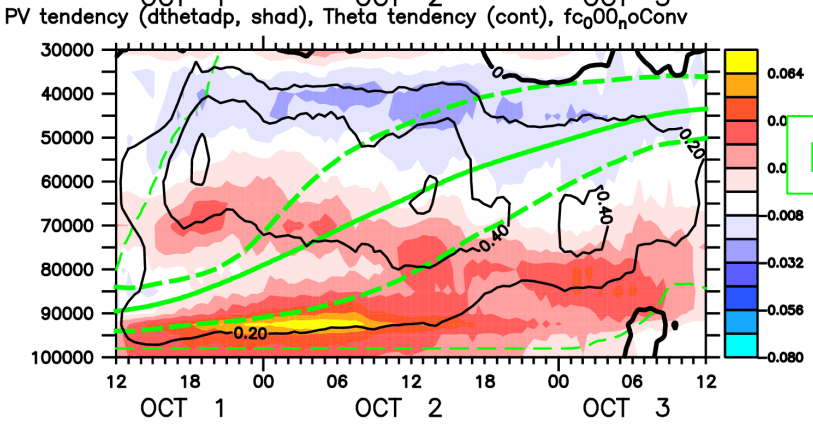
B85





PCMT

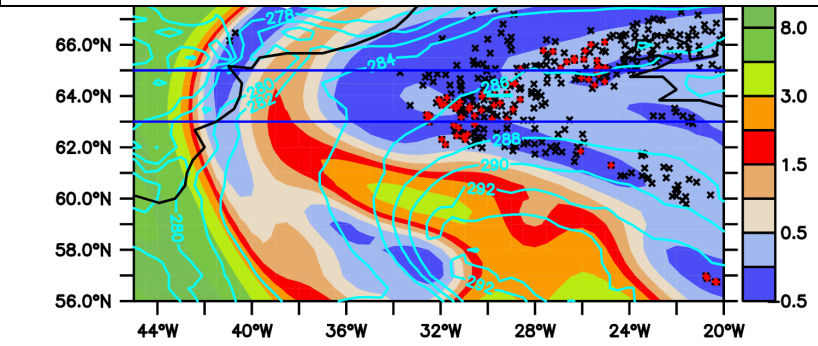




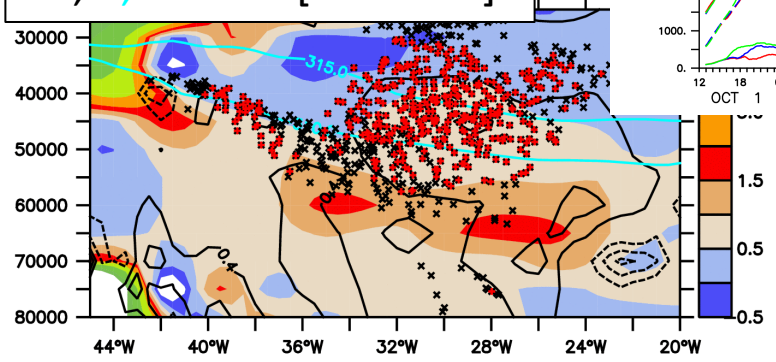
NoConv

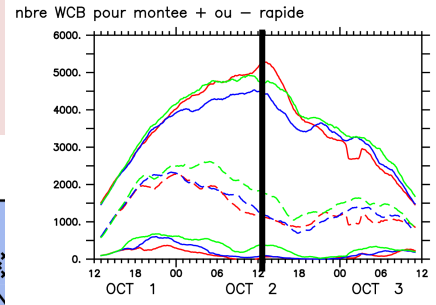
Heating and PV tendencies budgets

PV@300mb, θ@850 mb, WCB250-350mb



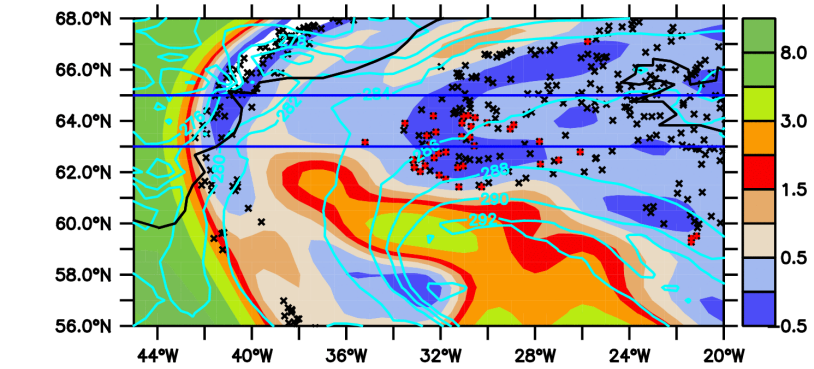
PV, θ, WCB in [63N-65N]



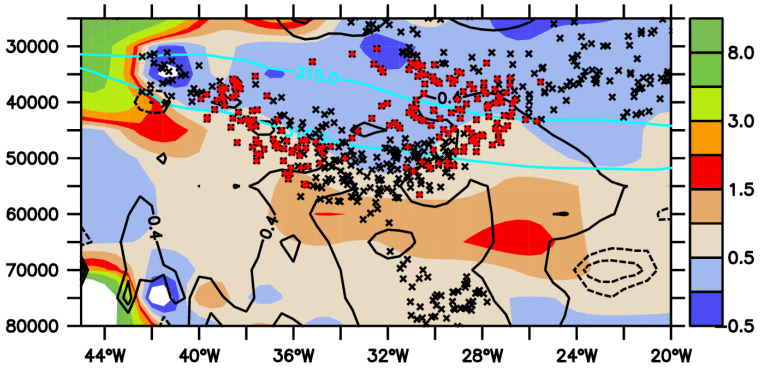


B85

7 PV 300 hPa, WCB 25000:35000hPa, t=24h

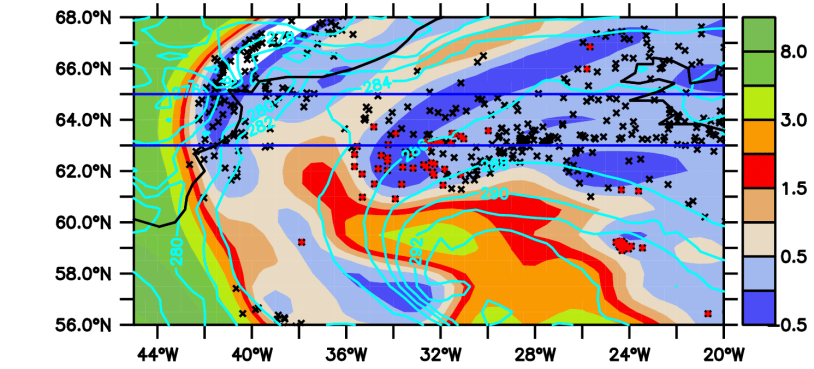


7 Heating, PV, theta 63N–65N

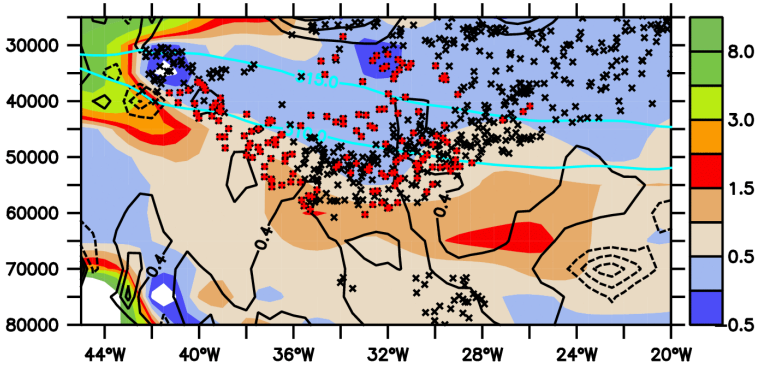


PCMT

0_noConv PV 300 hPa, WCB 25000:35000hPa, t=24h

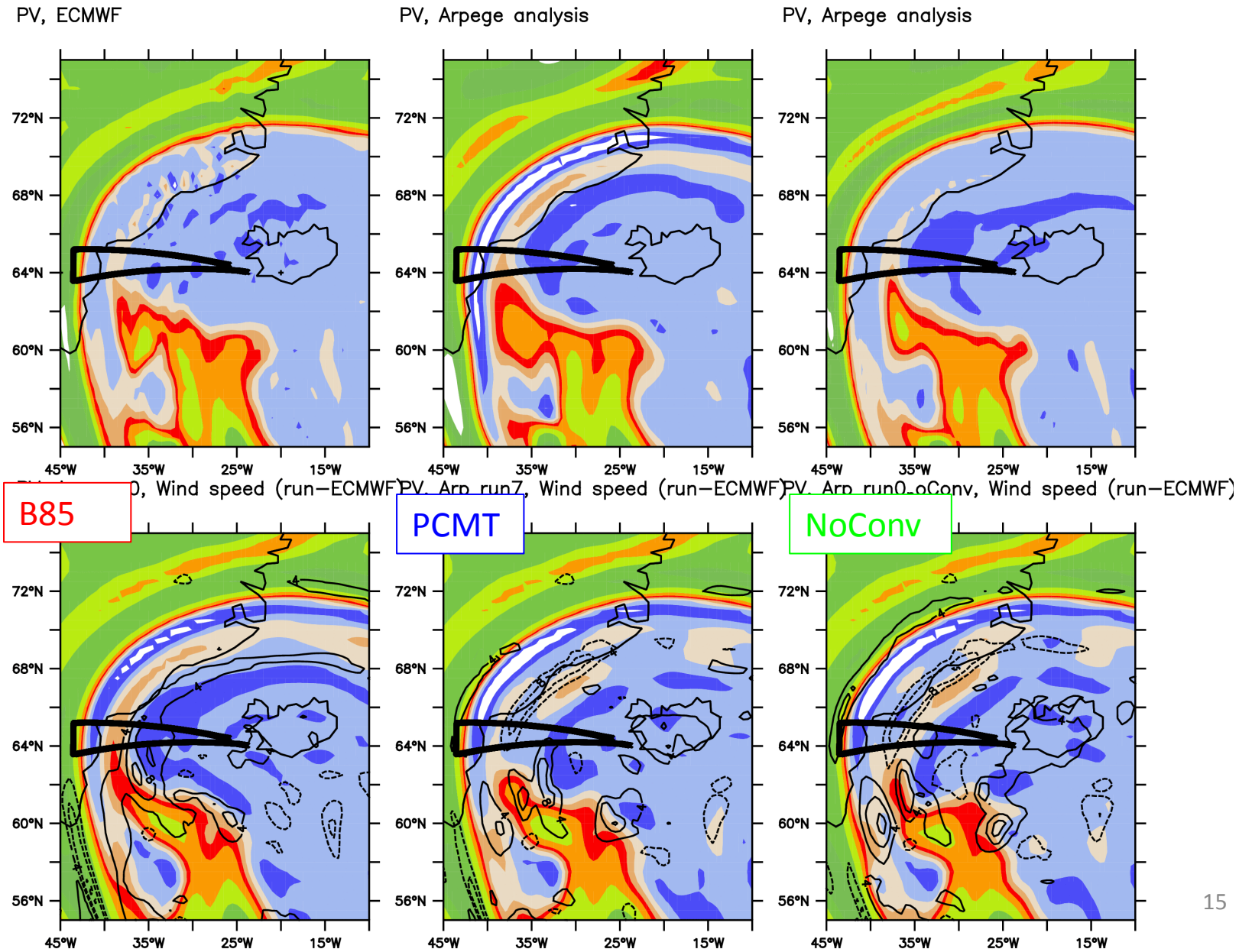


0_noConv Heating, PV, theta 63N–65N

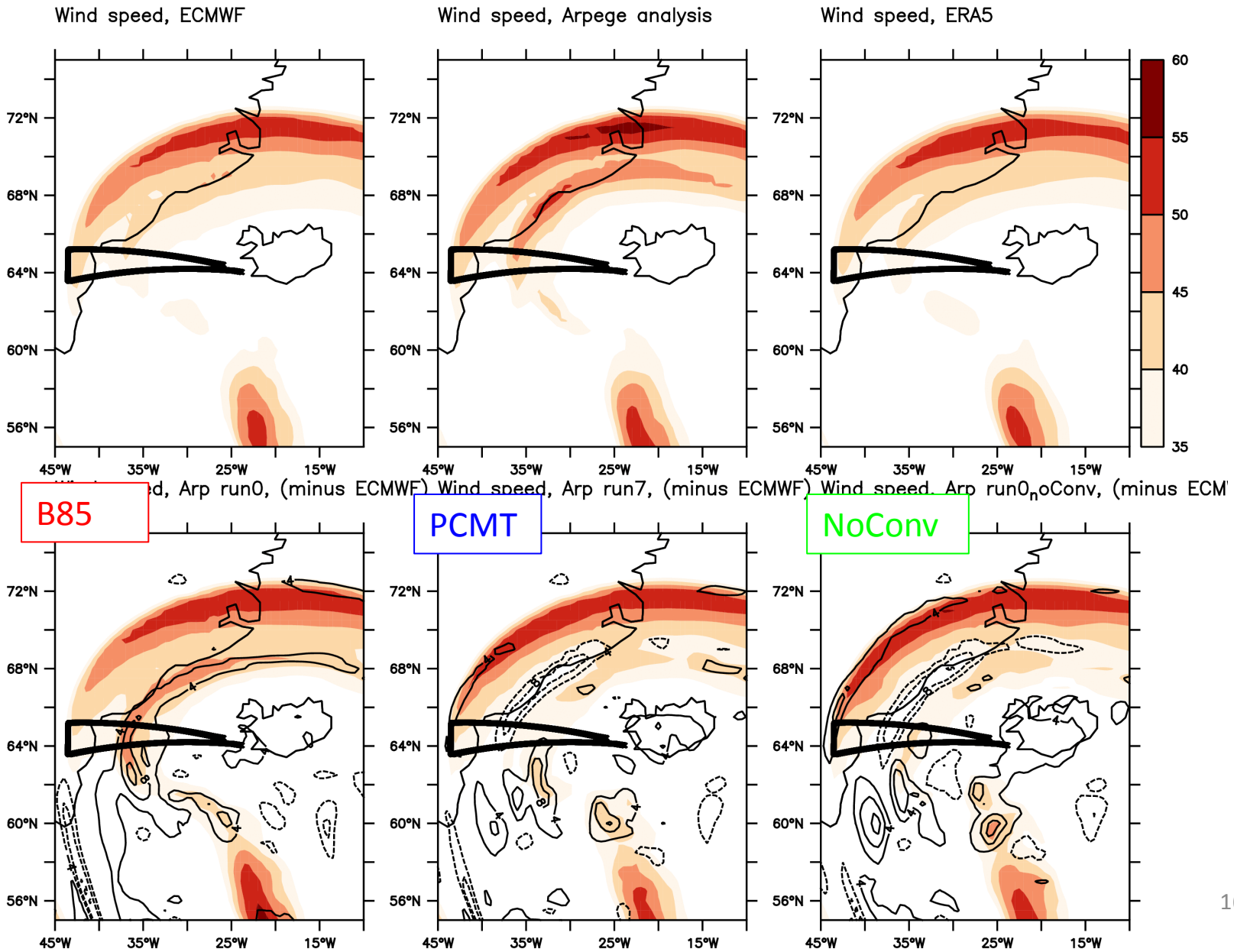


NoConv

PV anomalies at 300 hPa

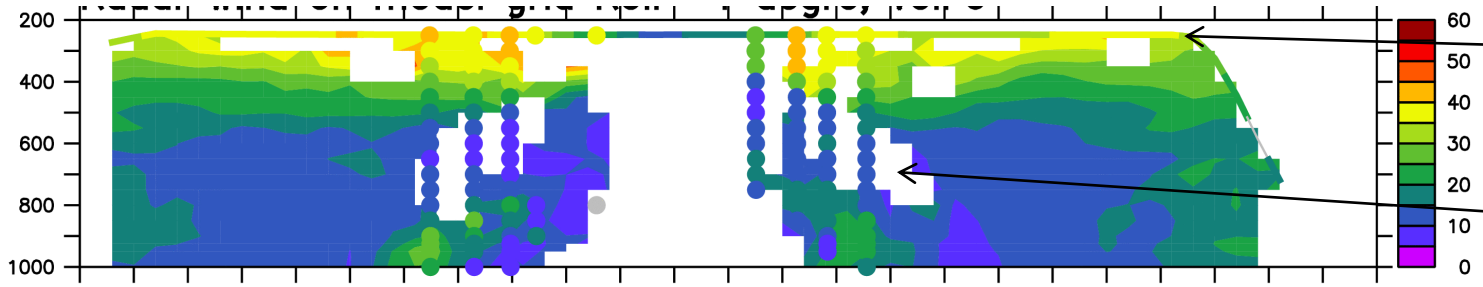


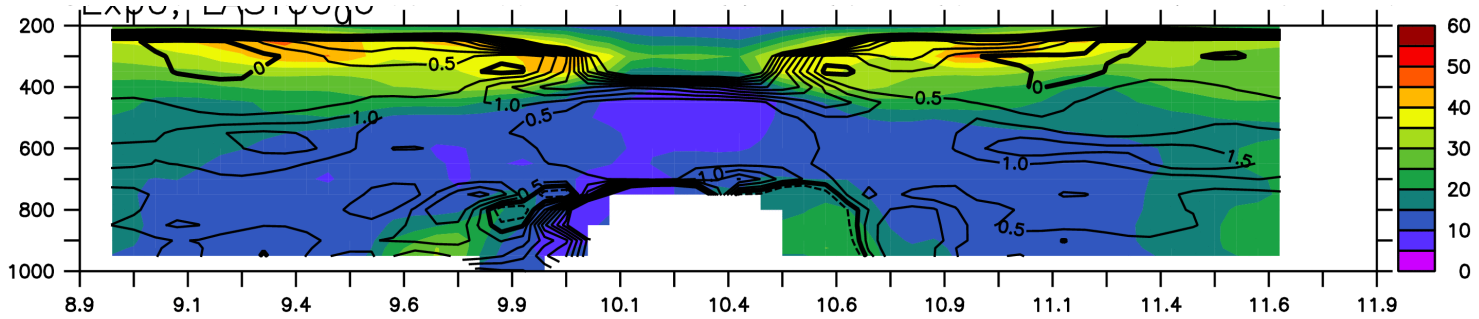
Double jet structure at 300 hPa

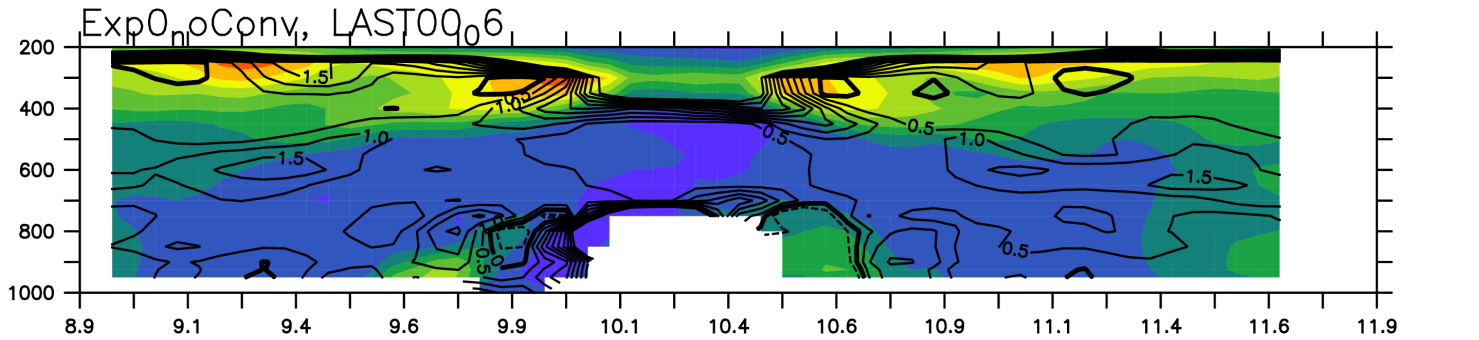


Vertical profiles of wind speed along Flight 6

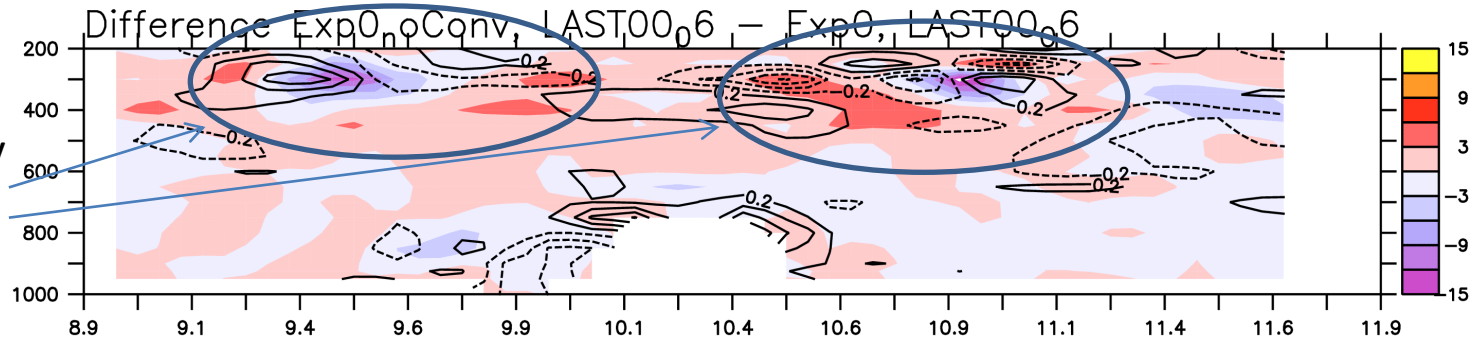
RASTA OBS



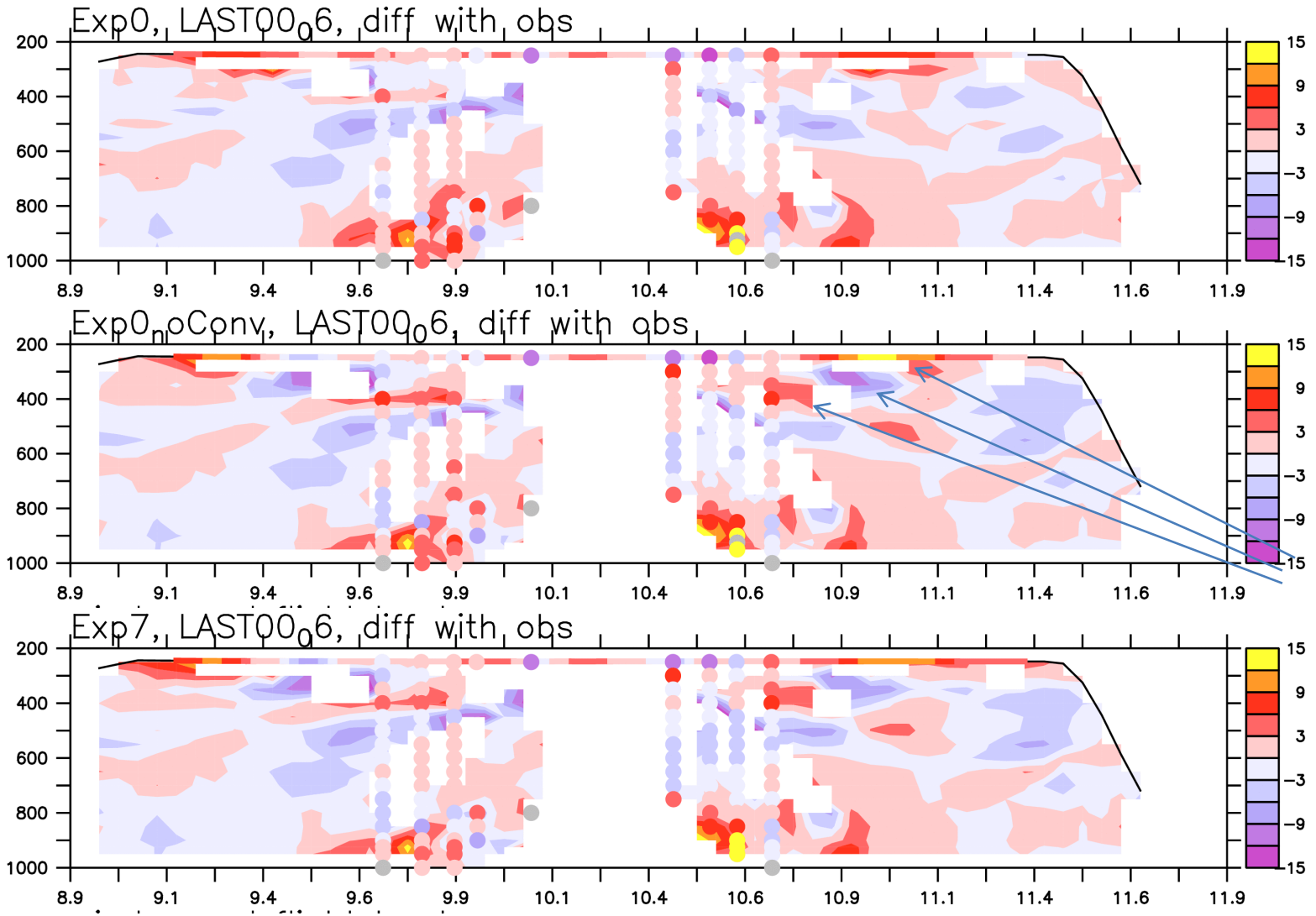




Tripole anomaly in Wind speed



Forecast anomalies with respect to observations



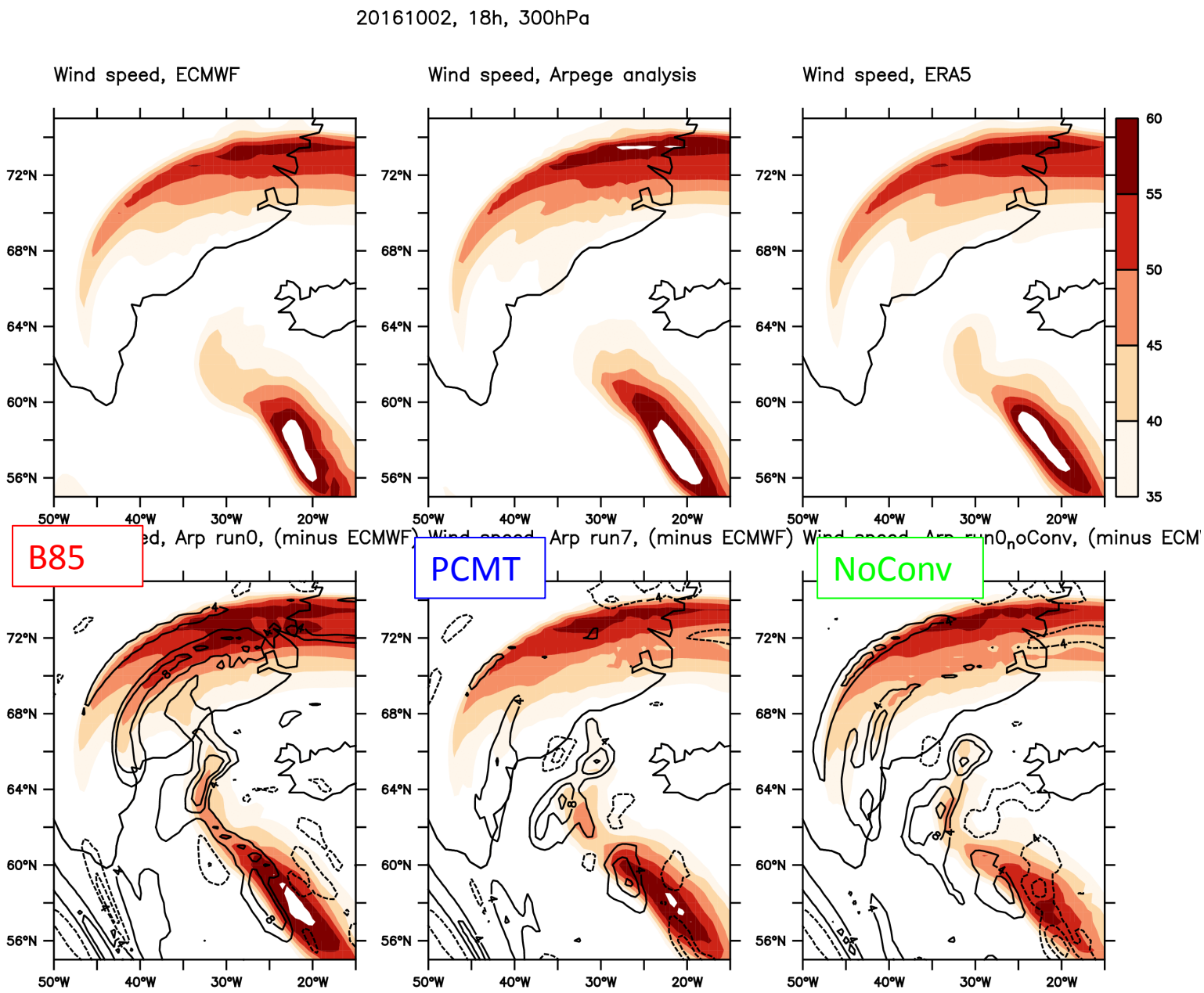
B85-OBS

NoConv-OBS

Tripole anomaly

PCMT-OBS

Wind speed forecast error after 30h

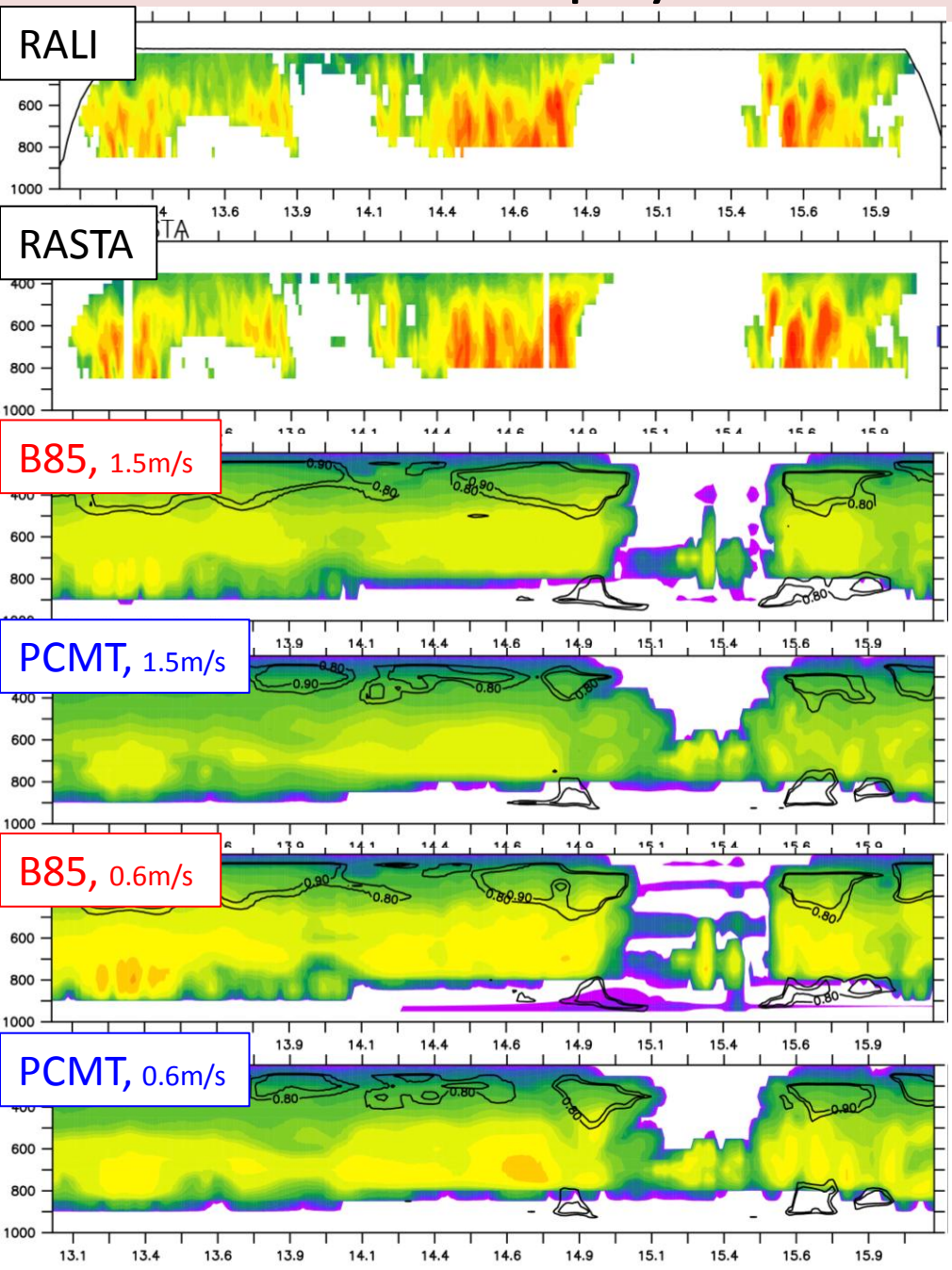


Conclusion

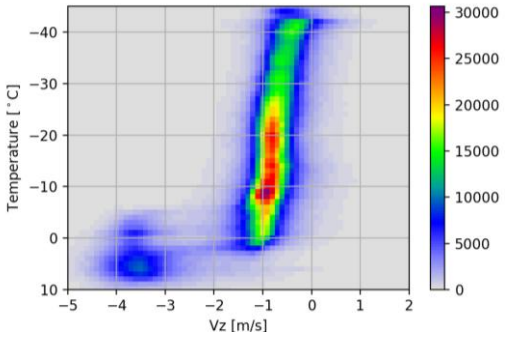
- NoConv: sooner stronger heating, more isolated regions, more rapid ascents than B85 and PCMT ahead of the cold front
- More sustained ascents in B85 than PCMT and NoConv
- PCMT has an intermediate behavior between B85 and NoConv.
- More PV desctruction in WCB outflow region in B85 than PCMT and NoConv.
- The more active dynamics in the upper troposphere in B85 is consistent with observations and (re)-analysis but too strong (consistent with IWC observations, not shown).

Additional slides

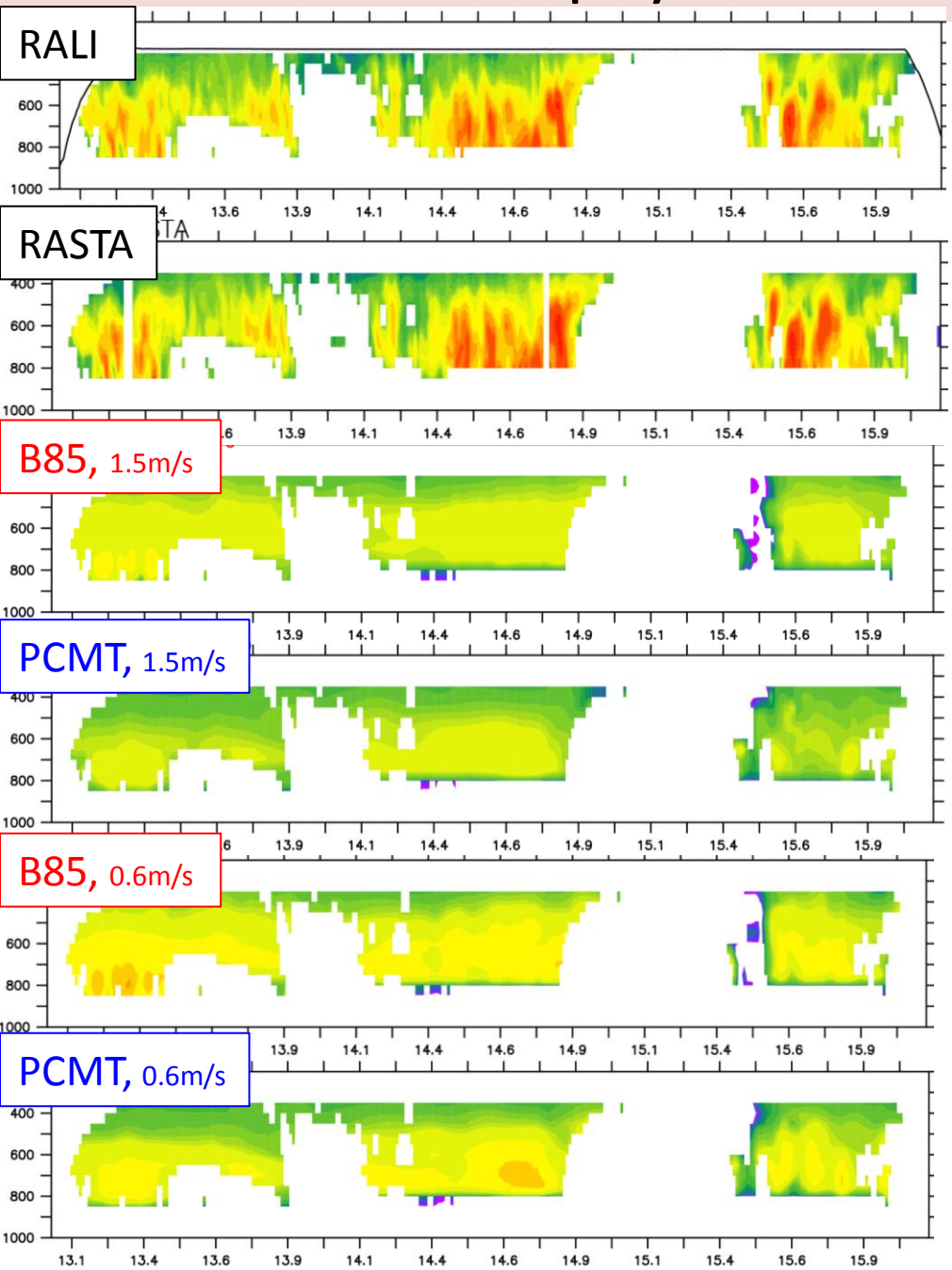
Microphysics: Ice water content F7



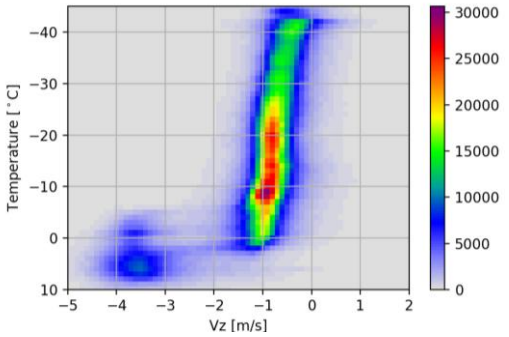
RASTA statistics of fall speed (Vt+w)



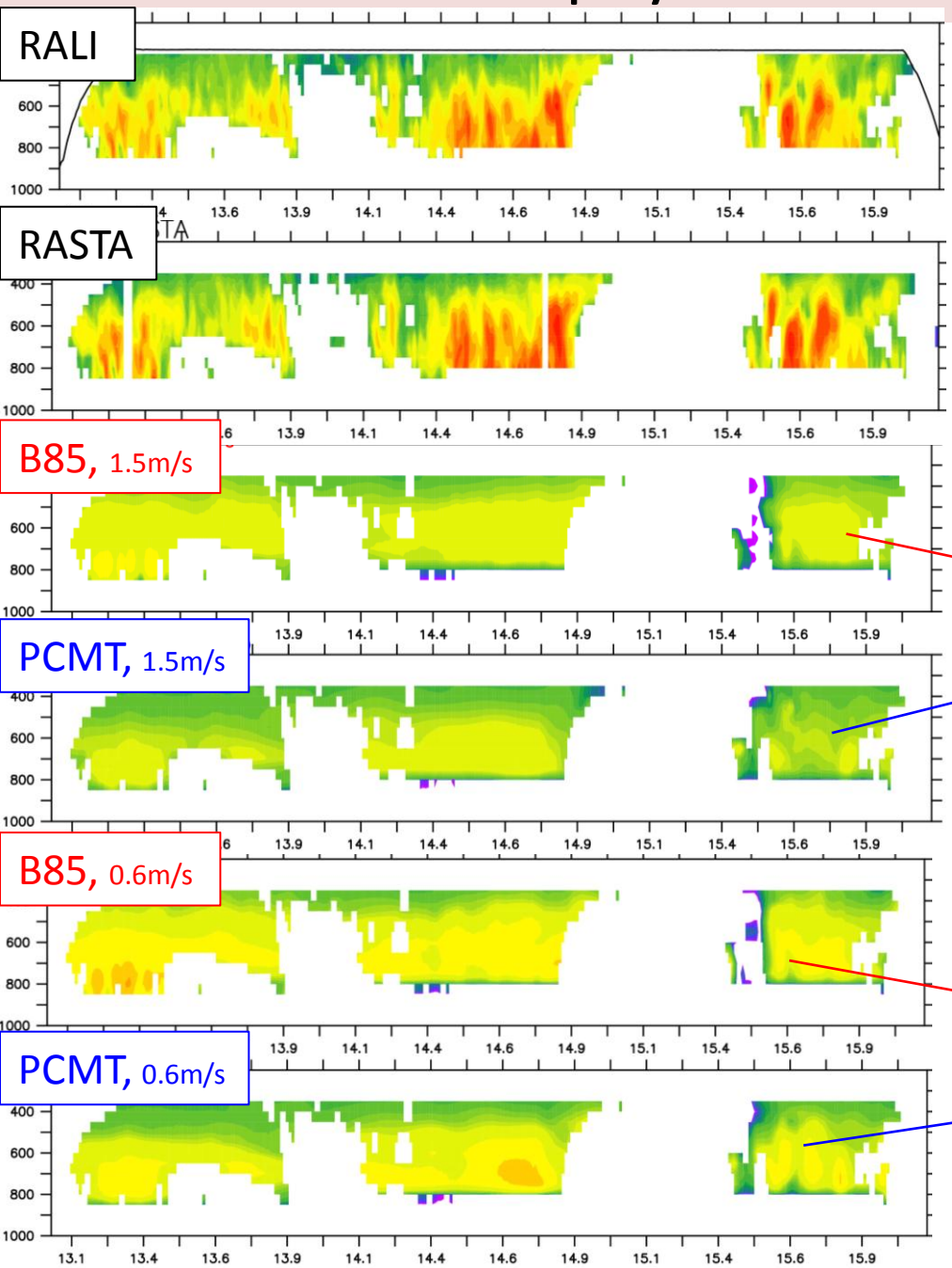
Microphysics: Ice water content F7

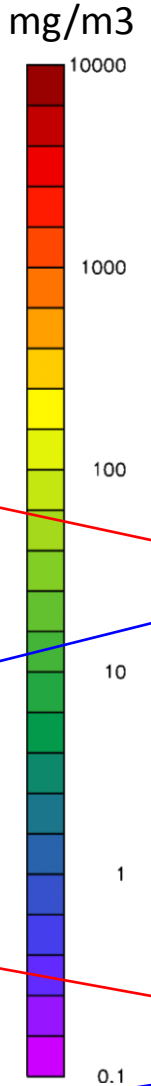


RASTA statistics of fall speed (Vt+w)

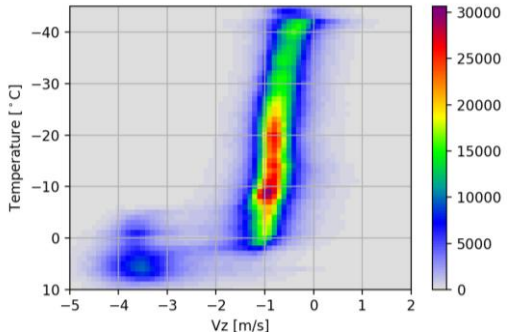


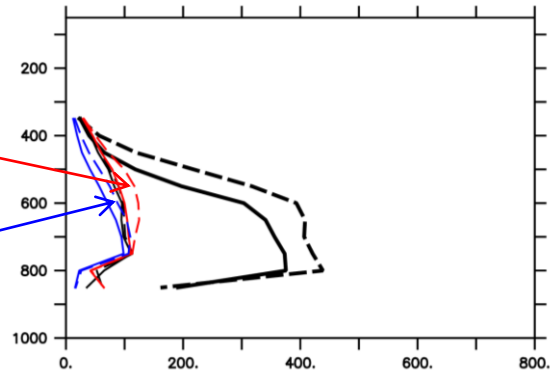
Microphysics: Ice water content F7

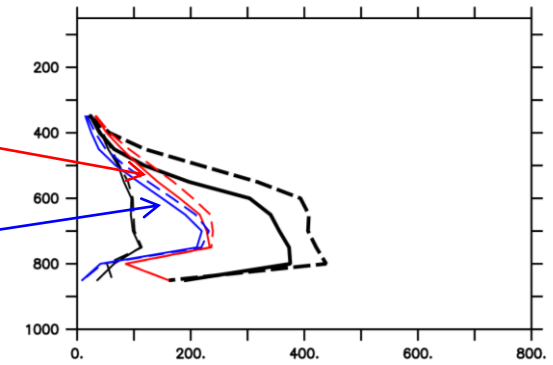




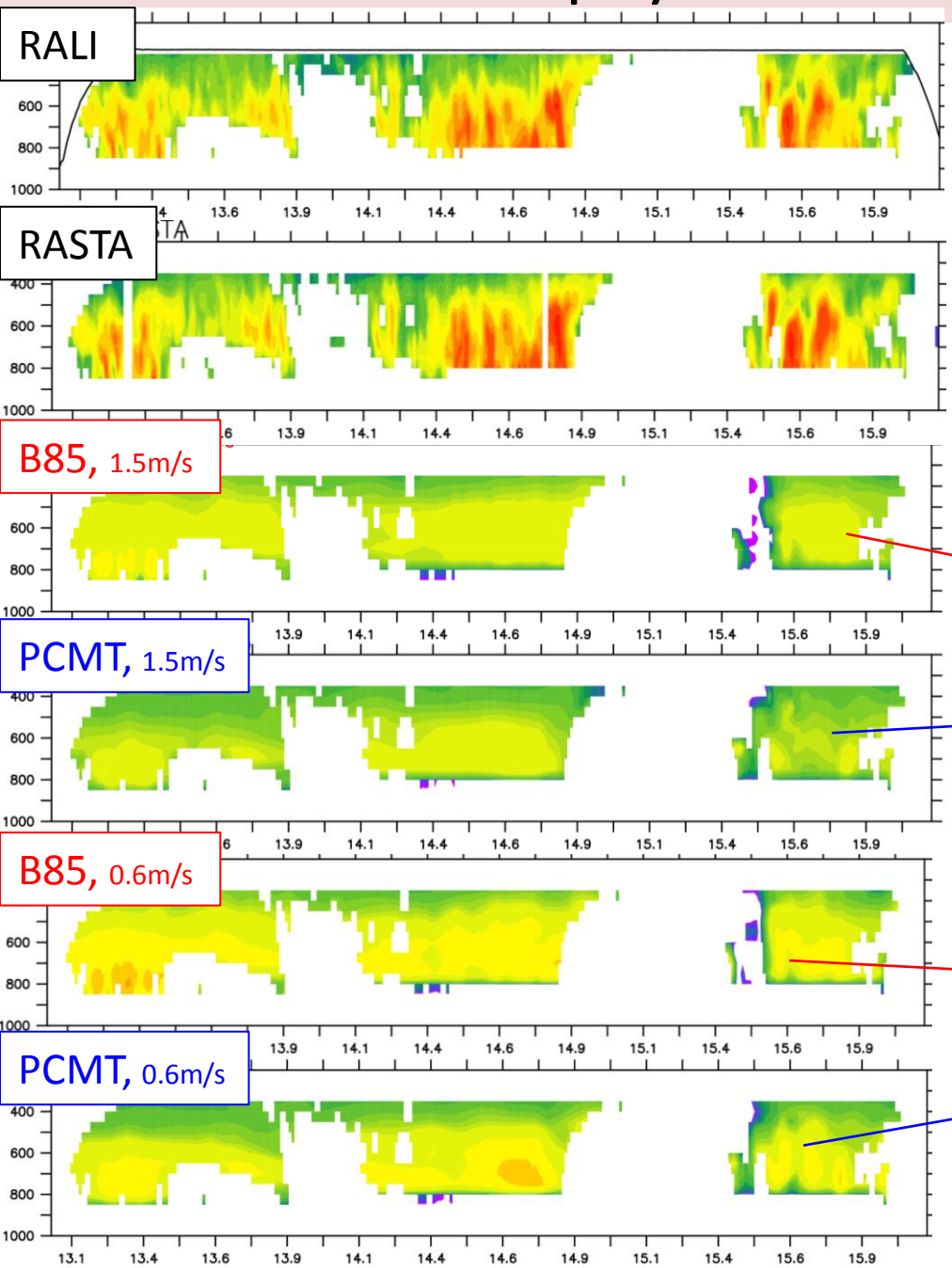
RASTA statistics of fall speed (Vt+w)



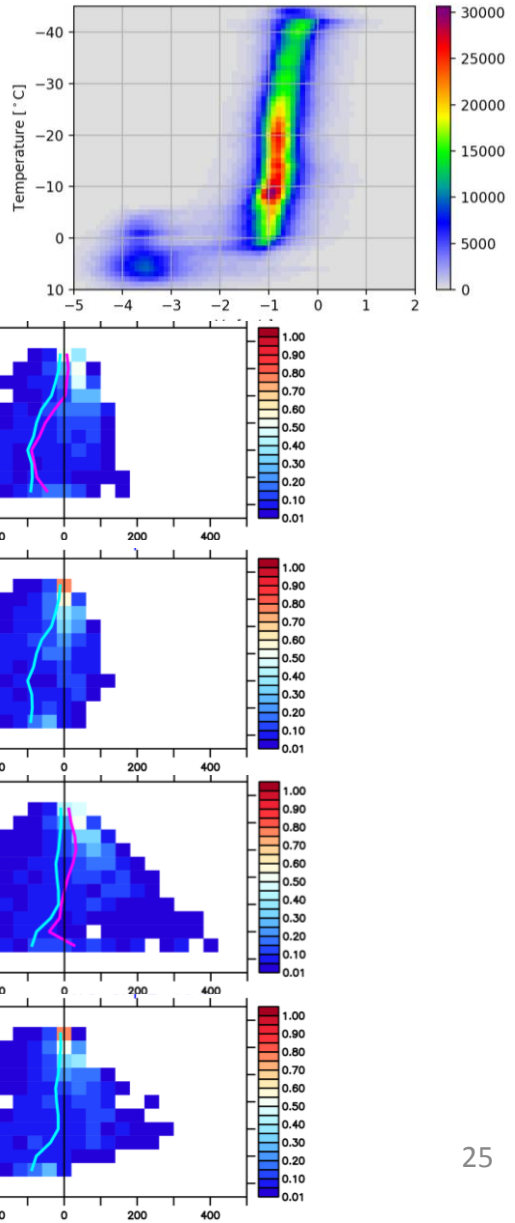




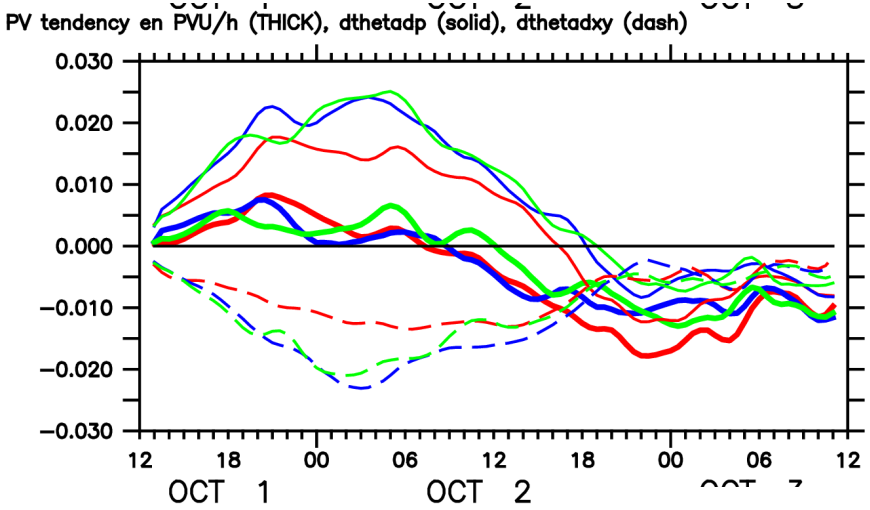
Microphysics: Ice water content F7

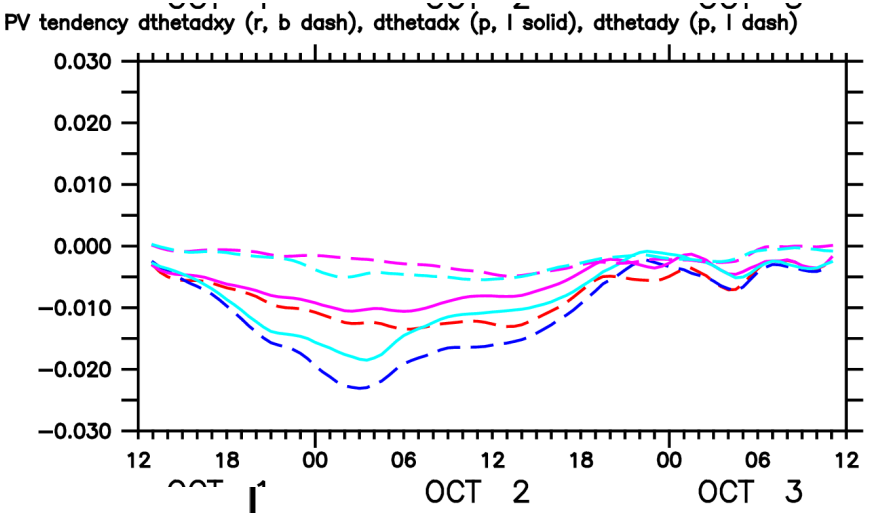


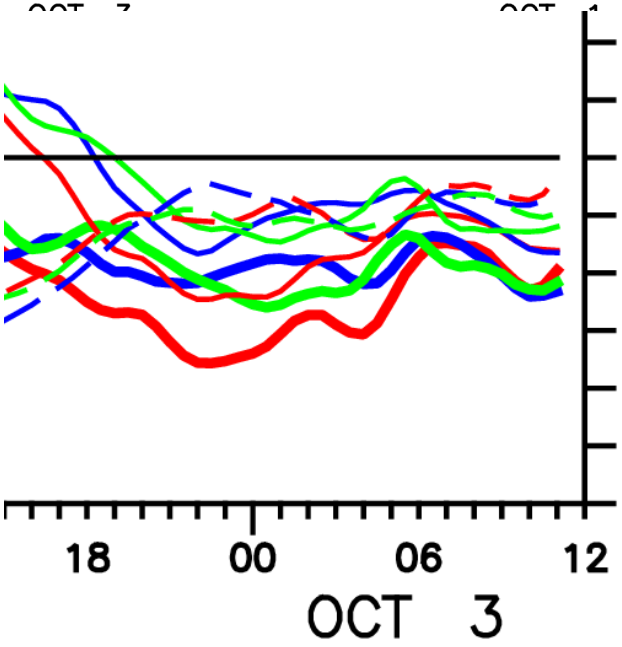
RASTA statistics of fall speed (Vt+w)



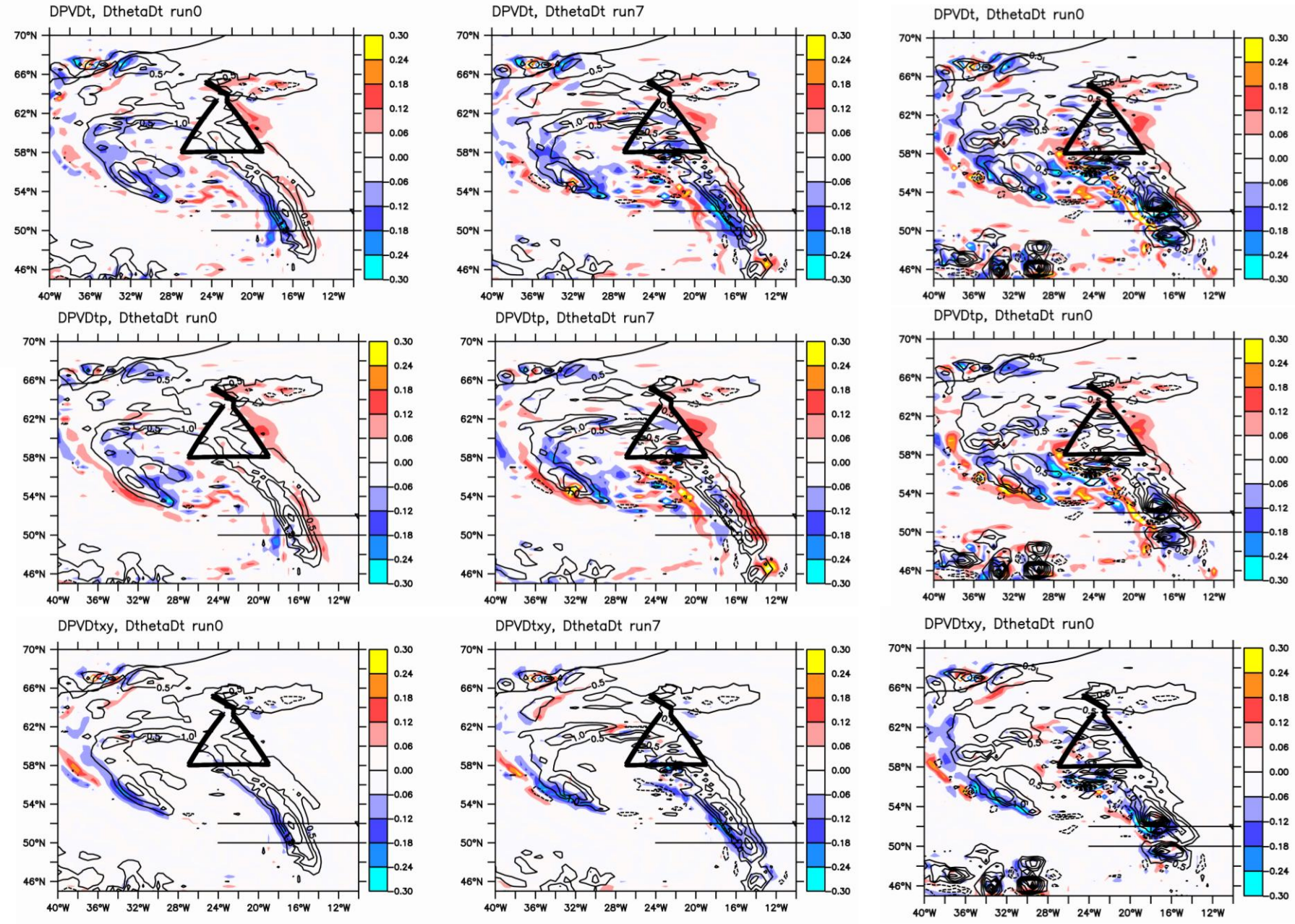
Heating and PV tendencies budgets





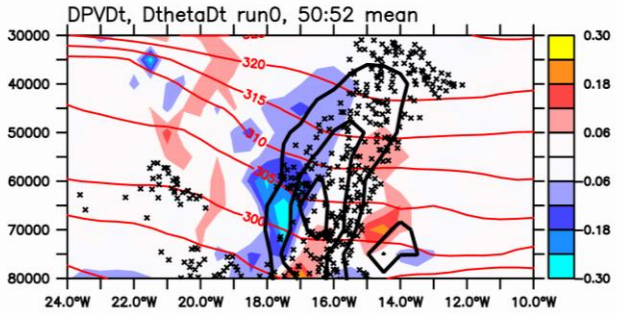


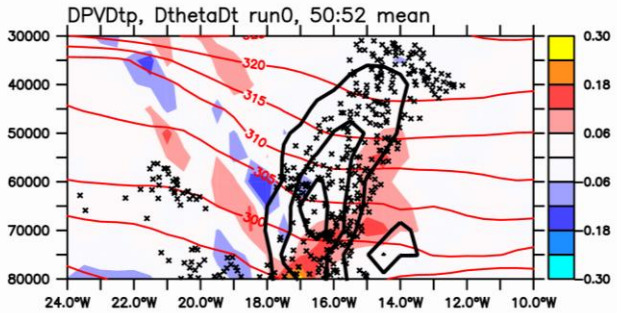
Heating and PV tendencies budgets (t0+24h)

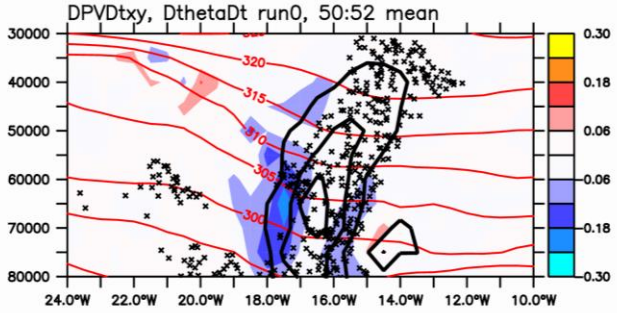


Heating and PV tendencies budgets (t0+24h), 50N-52N

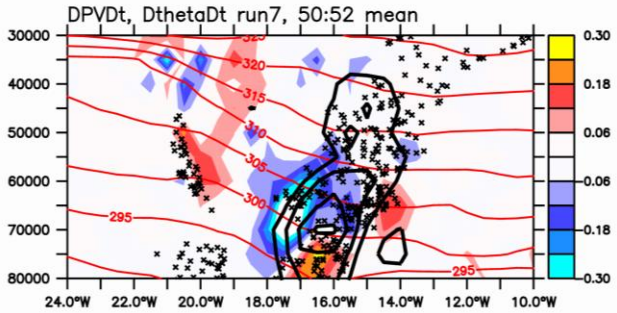
B85

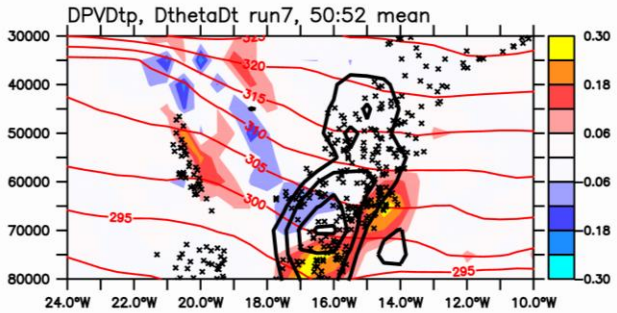


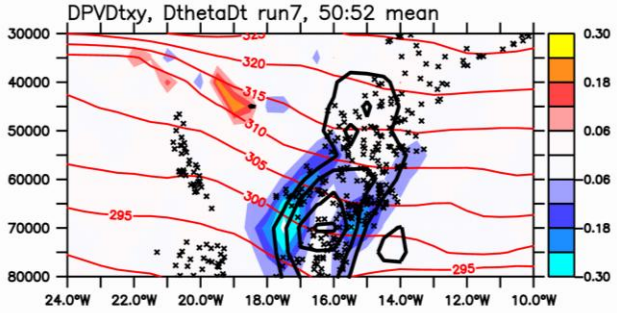




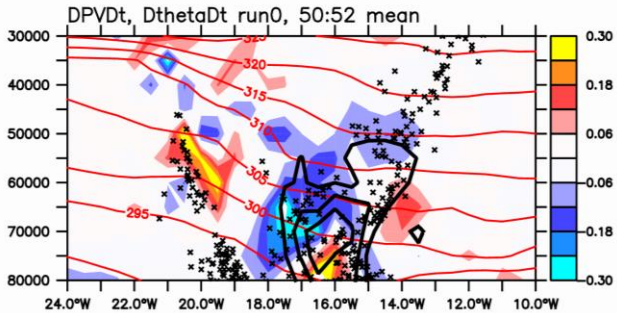
PCMT

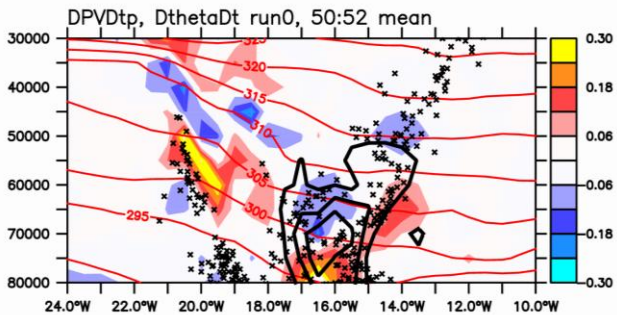


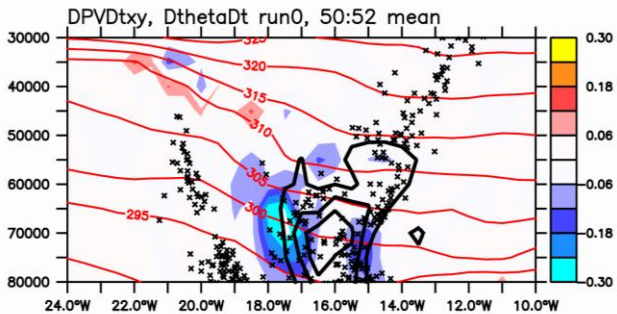




NoConv



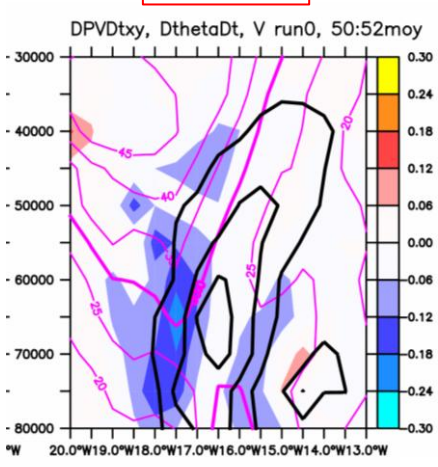


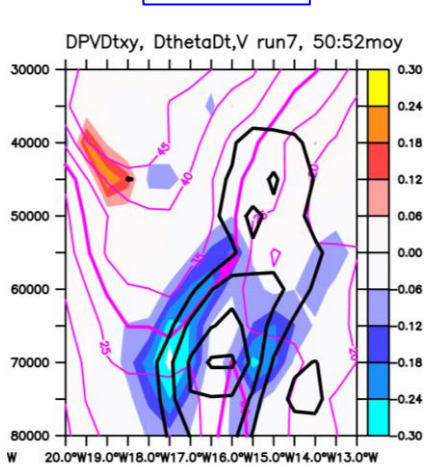


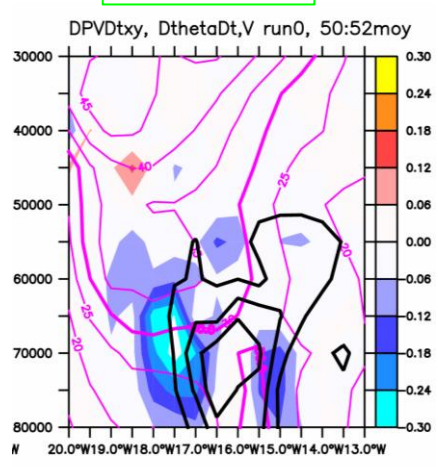
Understanding the negative PV tendency due to horizontal gradient of heating rate along the cold front

B85 PCMT NoConv

$$\frac{DPV}{Dt} = \ldots + g\,\frac{\partial v}{\partial p}\,\frac{\partial \dot{\theta}}{\partial x}$$

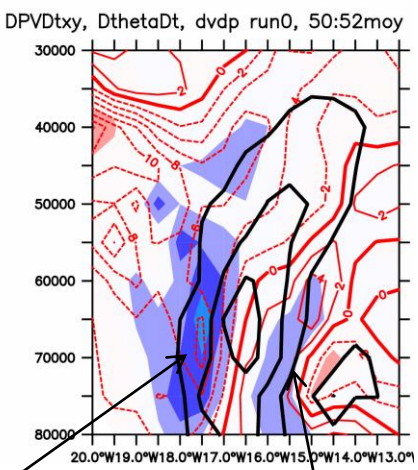


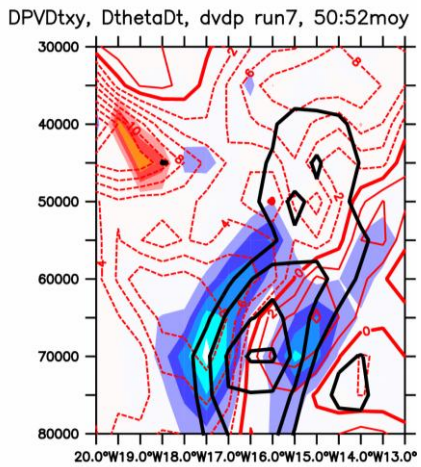


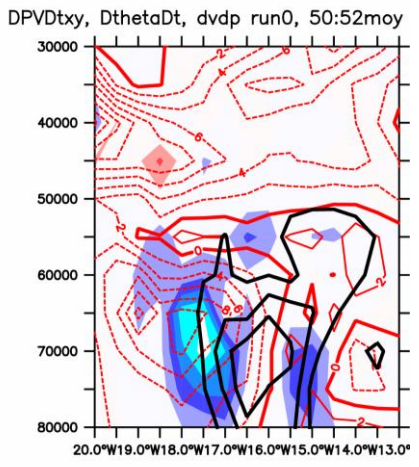


$$\frac{\partial v}{\partial p}$$

$$\frac{DPV}{Dt} = \ldots + g\,\frac{\partial v}{\partial p}\,\frac{\partial \dot{\theta}}{\partial x}$$







$$\frac{\partial v}{\partial p} < 0;\ \frac{\partial \dot{\theta}}{\partial x} > 0$$

$$\frac{\partial v}{\partial p} > 0;\ \frac{\partial \dot{\theta}}{\partial x} < 0$$

Eulerian Heating rate budget after 24h