



Impacts des schémas de convection profonde du modèle ARPEGE sur une bande transporteuse d'air chaud lors de la POI6 de NAWDEX

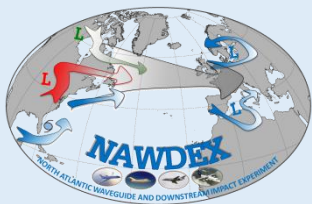
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^{*}*Laboratoire de Météorologie Dynamique, Paris*

P. Arbogast, J.-M. Piriou, J. Delanoë, Q. Cazenave, J. Pelon, C. Labadie

AMA, 8-12/03/2021 Toulouse



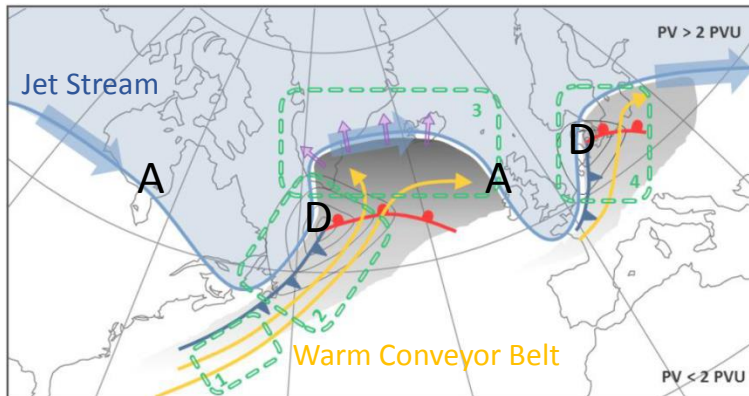
NAWDEX

North Atlantic Waveguide Downstream Impact Experiment

- Etude des processus diabatiques dans la Warm Conveyor Belt et l'effet sur le Jet Stream
- Projet international
- Campagne de mesure en automne 2016 avec 4 avions
- Plateforme RALI : lidar, radar et radiomètre

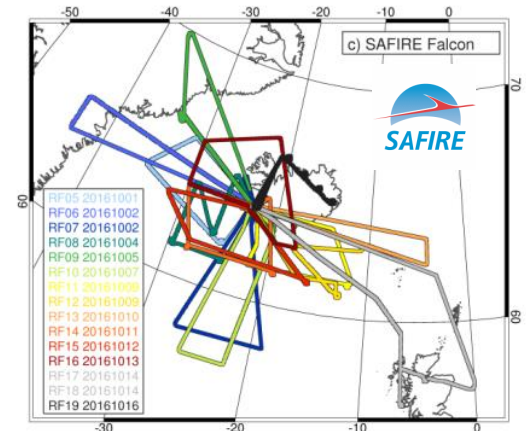


Falcon 20



Schäfler et al, 2018

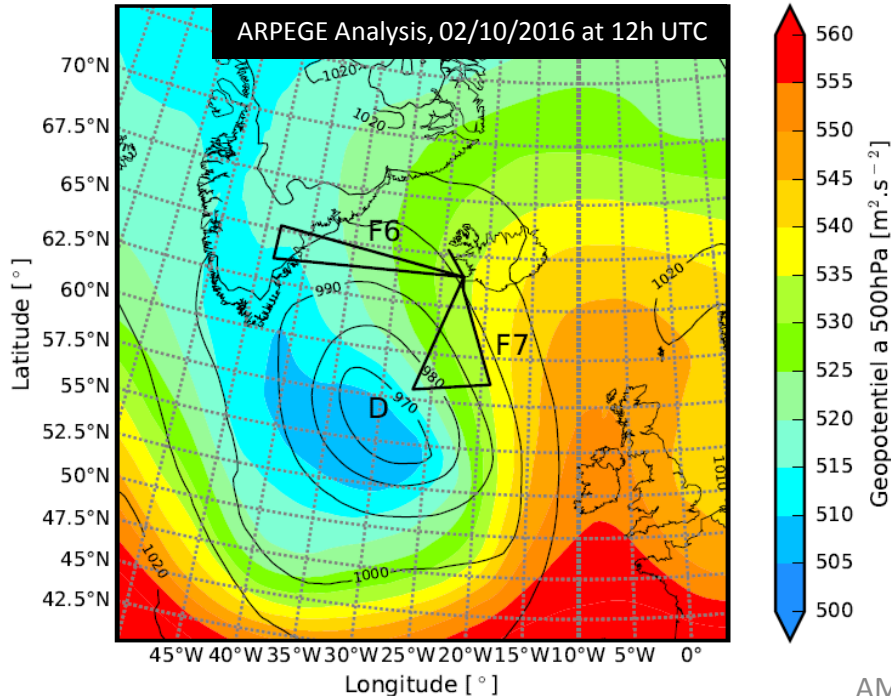
AMA 2021



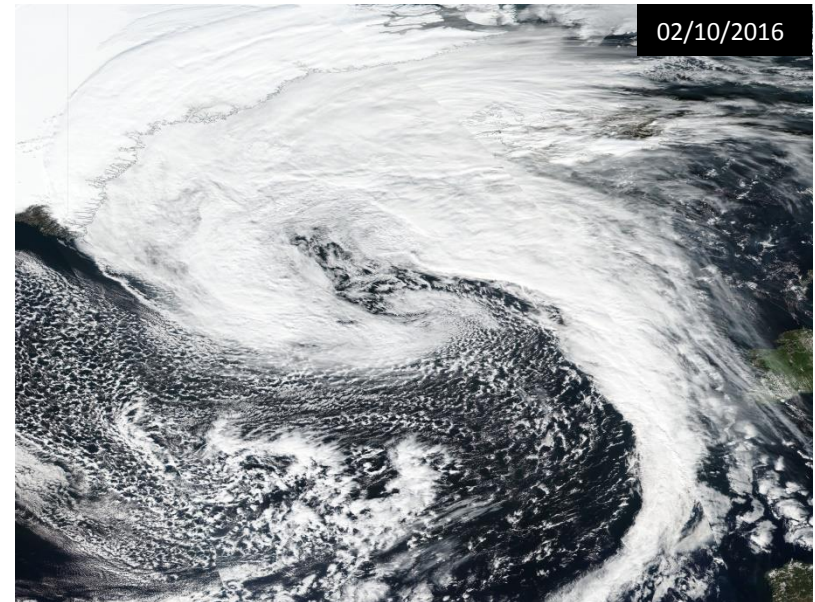
Stalactite Cyclone / NAWDEX IOP 6

Dépression formée au large de Terre Neuve -> Bombe météorologique (-26hPa en 24h)

Geopotentiel à 500 hPa (couleur)
et Pression au niveau de la mer (contour)



MODIS, Nasa Worldview Application



Problématiques

Quelles modifications de la bande transporteuse d'air chaud observe-t-on avec/sans schéma de convection profonde ?

Comment les schémas de convection profonde modifient la représentation de la bande transporteuse d'air chaud dans un modèle global ?

Quel est l'impact de la paramétrisation de la convection profonde sur le jet stream en sortie de la bande transporteuse d'air chaud ?

Quelles sont les erreurs de prévision sur la représentation du jet stream pour différentes simulations, avec et sans paramétrisation de la convection profonde ?

Modèle et configuration des simulations


Modèle global : ARPEGE-EPS

Résolution horizontale : 10km sur la France, 20km sur l'Islande (TL798 C2.4)


Pas de temps : 450s

Résolution des sorties : 0.5° x 0.5°

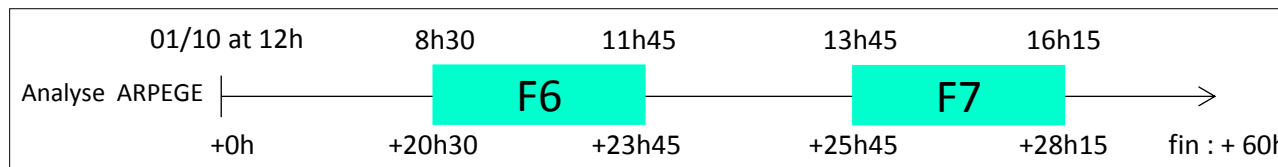
Bougeault, 1985 **B85**

- Schéma en flux de masse
 - Fermeture en humidité
-  utilisé dans le code opérationnel

Piriou et al, 2007 **PCMT**

- Schéma en flux de masse
 - Fermeture en CAPE
 - Couplé aux schémas de microphysiques et de transports
 - Fort entrainement
-  utilisé dans ARPEGE-CLIMAT

Pas de paramétrisation de la convection profonde
NoConv

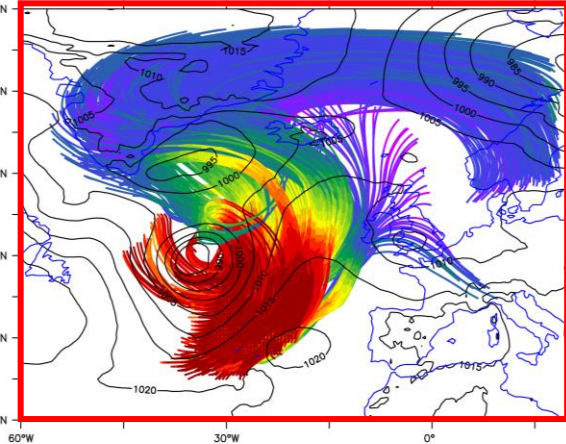


Warm Conveyor Belt issue du secteur chaud

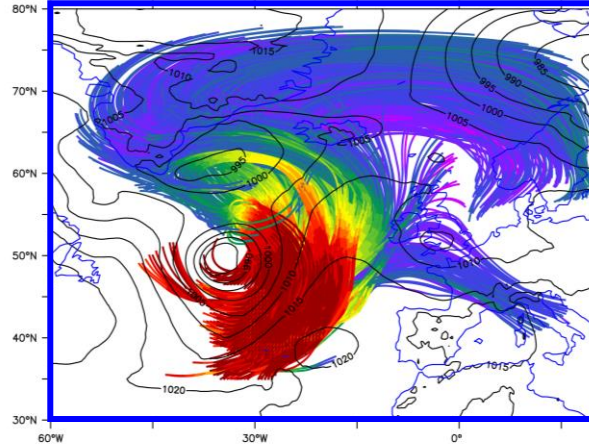
Trajectoires lagrangiennes de 48h : initialisées dans le secteur chaud le 1^{er} Octobre à 12h UTC

Critères : -300hPa en 24h et $P_0 > 850\text{hPa}$

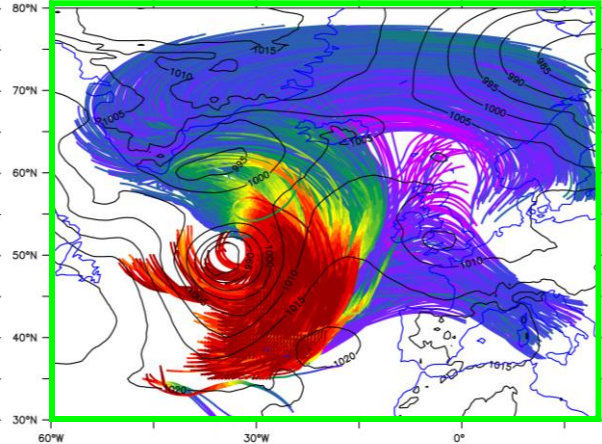
B85 : 9876 traj



PCMT : 10 086 traj

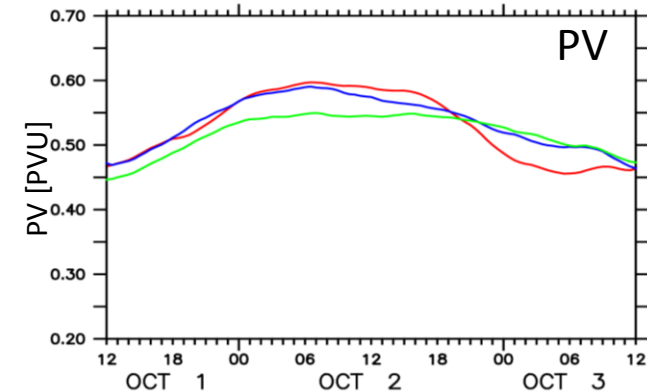
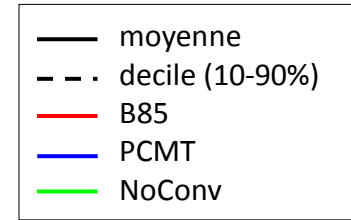
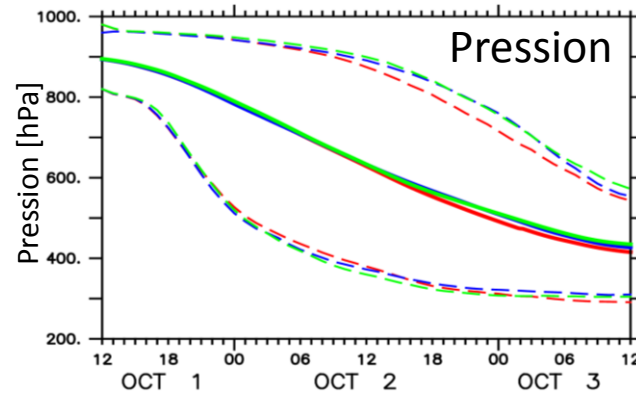
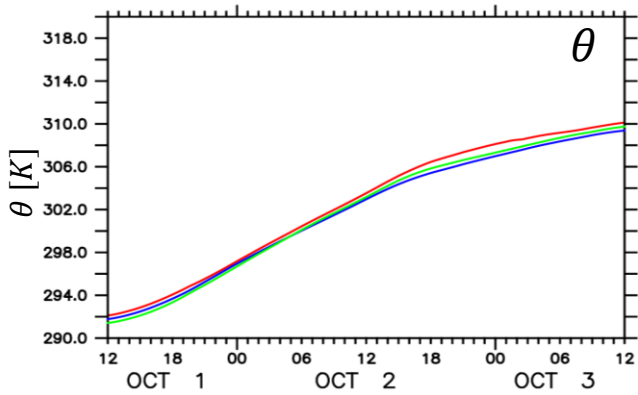


NoConv : 11 421 traj

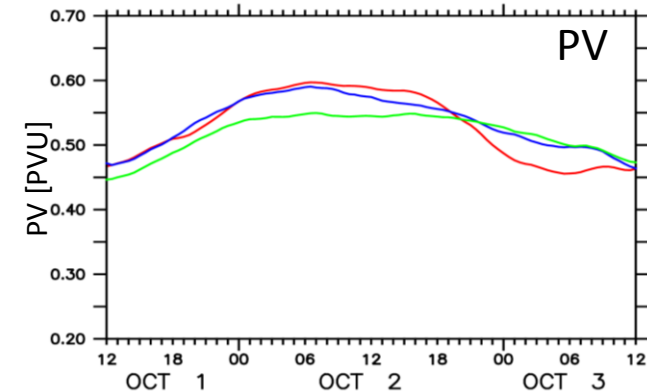
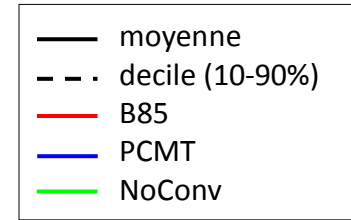
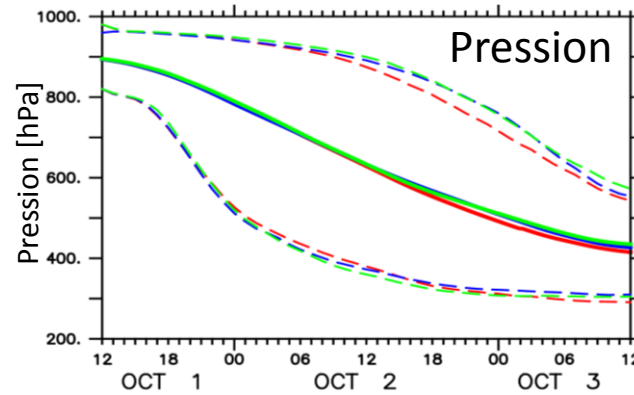
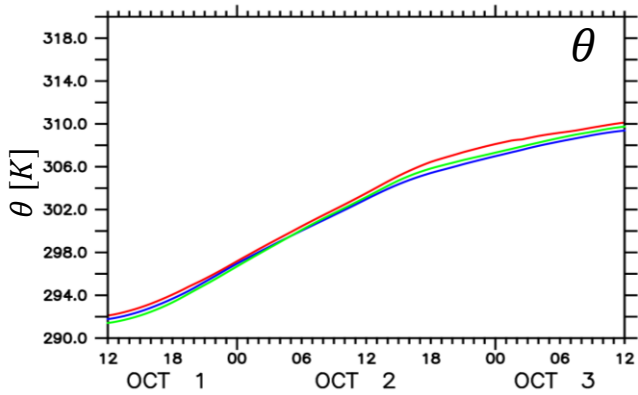


Pression [hPa]

Quantités moyennées le long des trajectoires

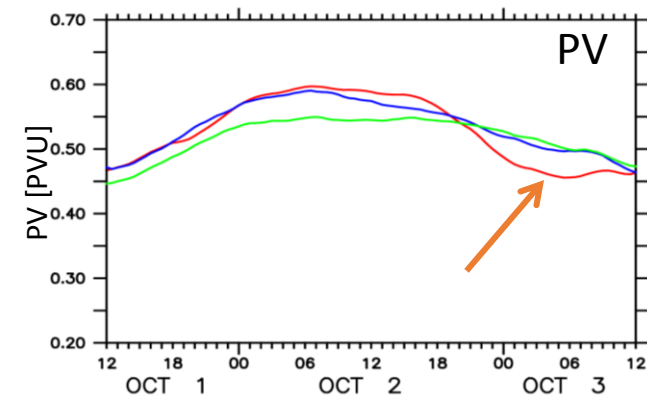
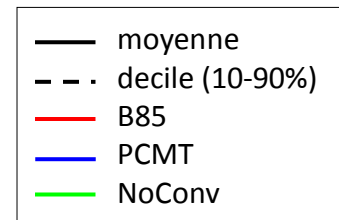
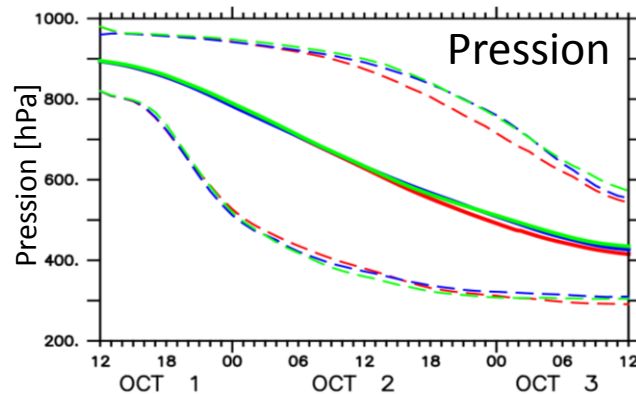
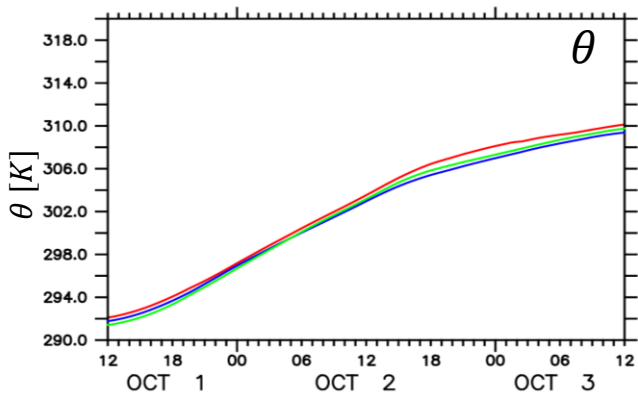


Quantités moyennées le long des trajectoires



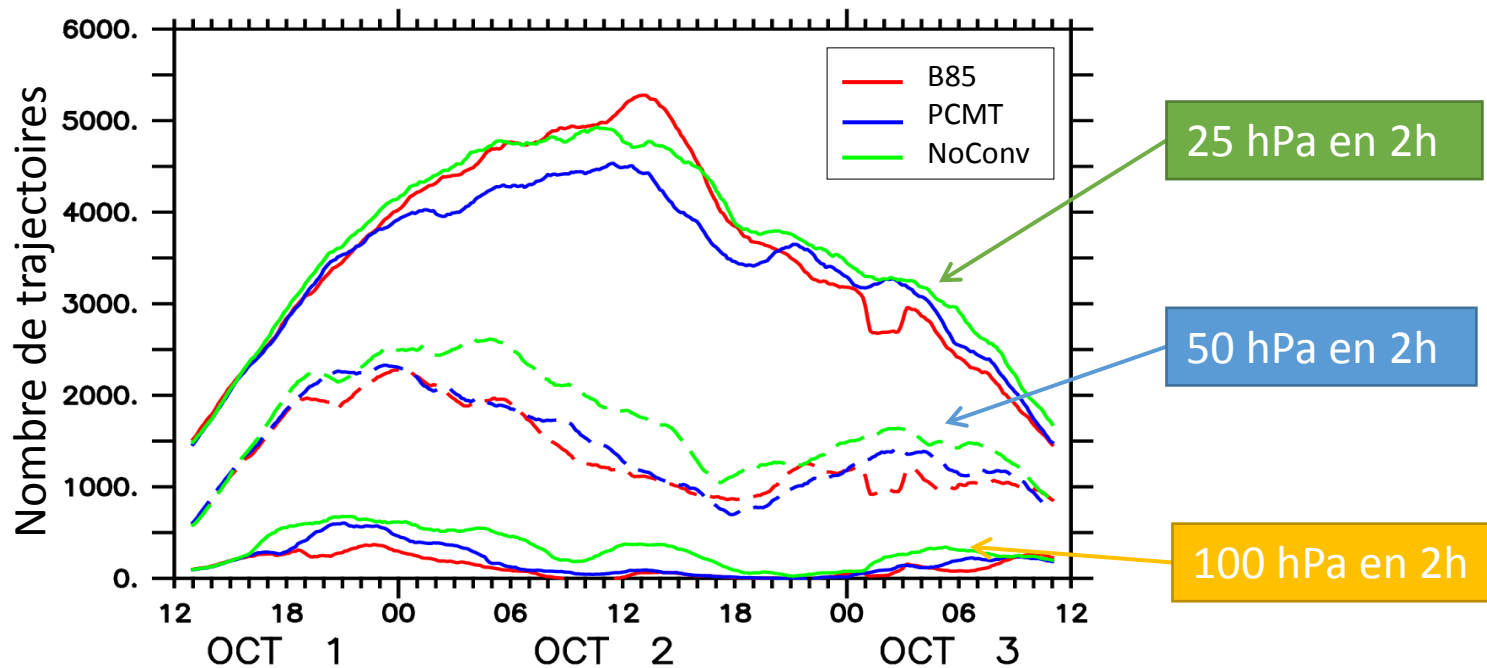
- Pas de différence significative pour la pression et la température potentielle

Quantités moyennées le long des trajectoires

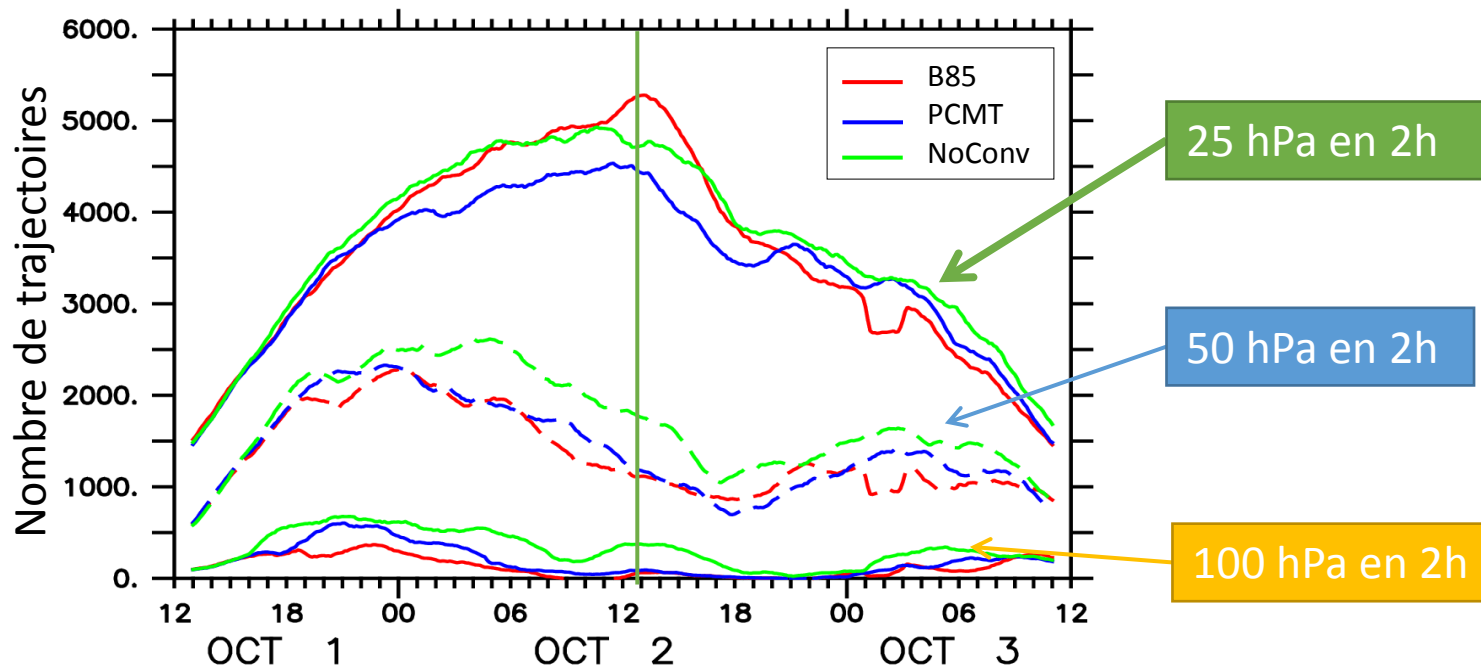


- Pas de différence significative pour la pression et la température potentielle
- Différence en PV: la fin des trajectoires de B85 connaît une chute de PV

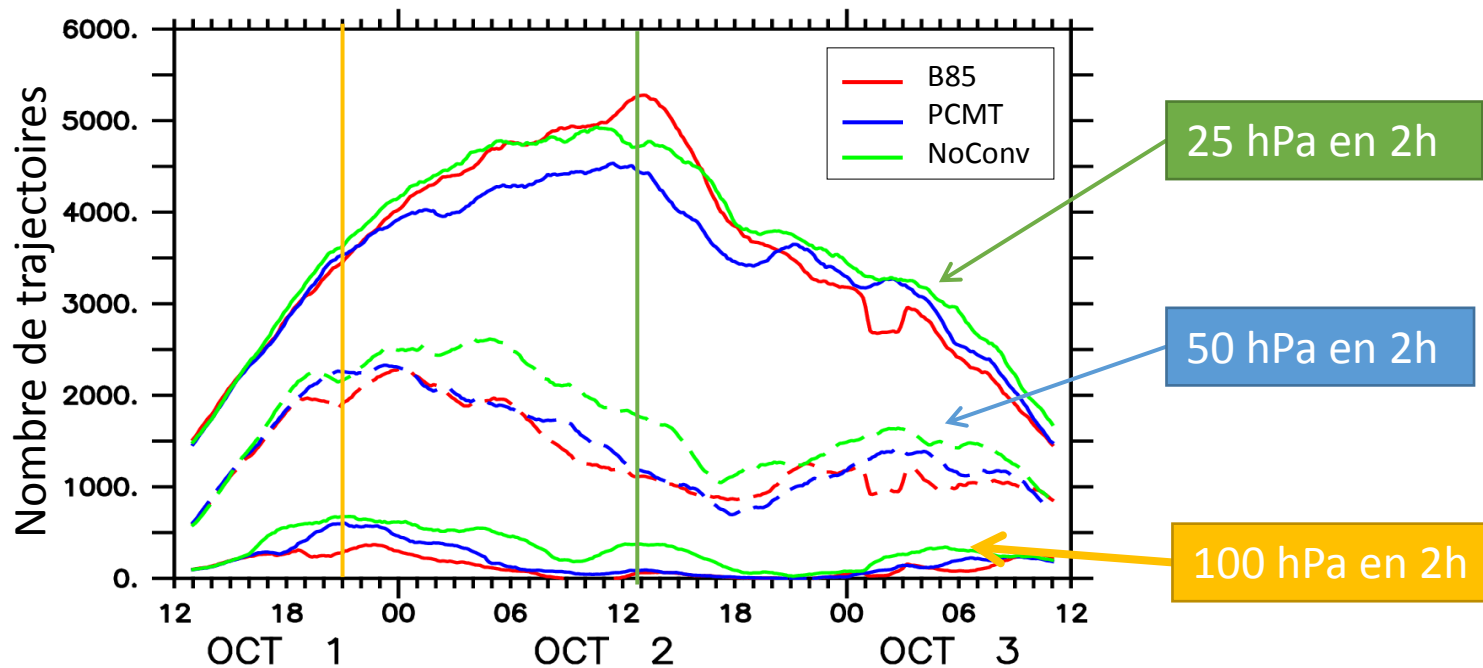
Nombre de trajectoires selon un seuil d'ascendance



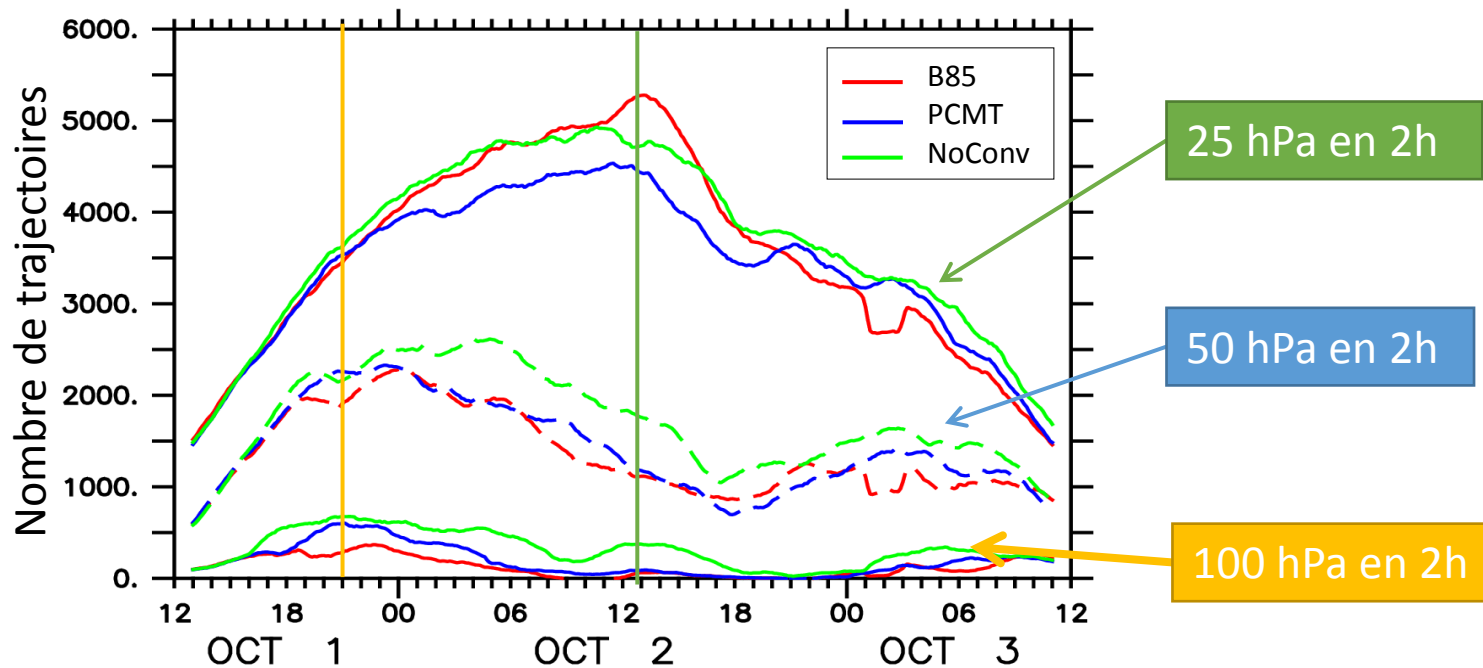
Nombre de trajectoires selon un seuil d'ascendance



Nombre de trajectoires selon un seuil d'ascendance



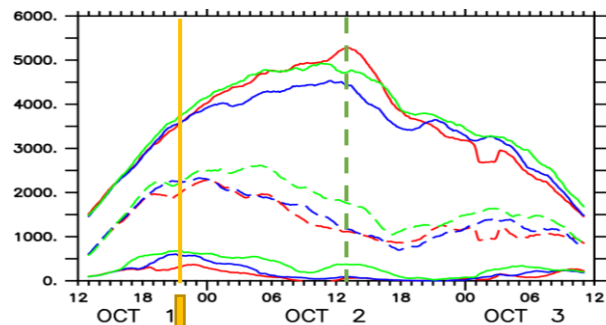
Nombre de trajectoires selon un seuil d'ascendance



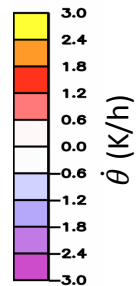
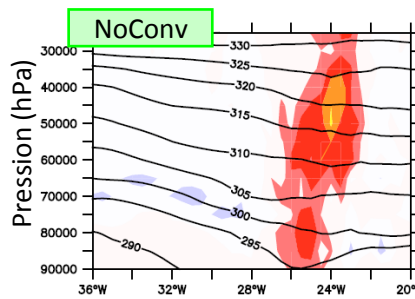
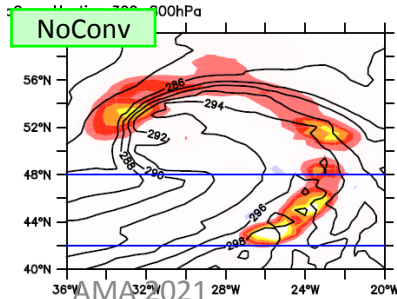
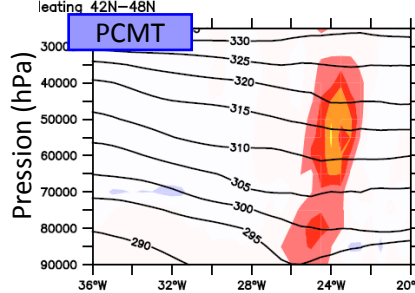
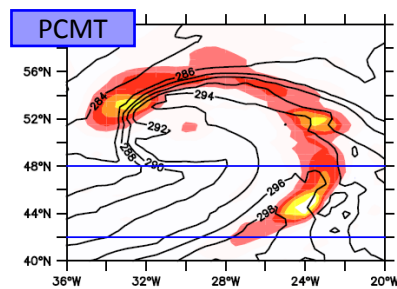
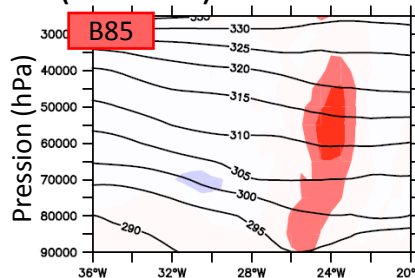
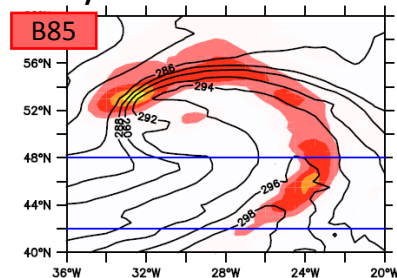
Ascendances plus rapides sans schéma de convection profonde
Ascendances plus lentes avec B85

Trajectoires avec la plus forte ascendance à +9h

Nombre de trajectoires

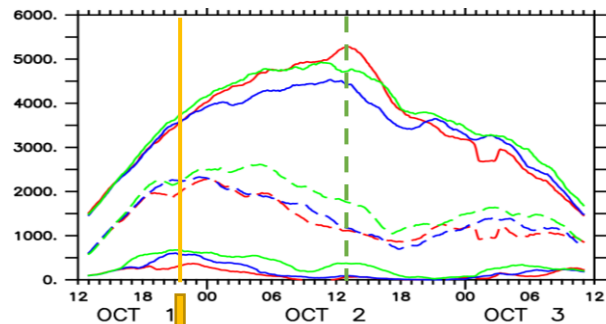


Chauffage moyen entre 300-800hPa (couleur) et θ à 850hPa (contour)

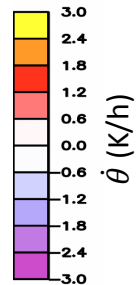
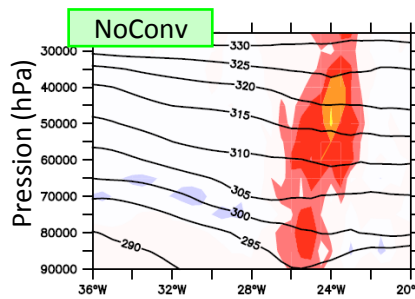
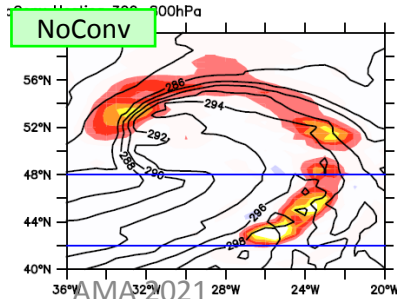
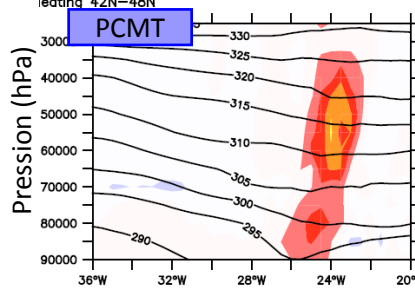
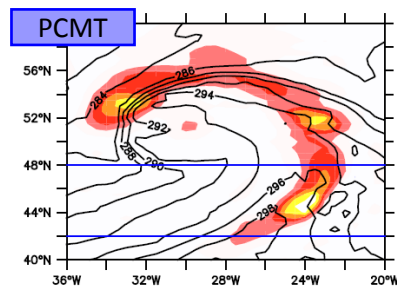
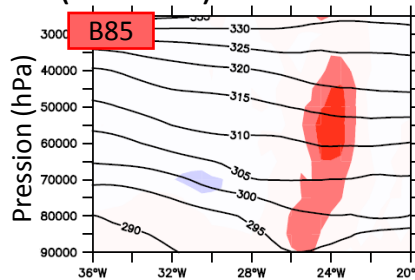
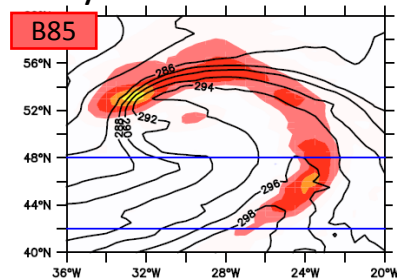


Trajectoires avec la plus forte ascendance à +9h

Nombre de trajectoires



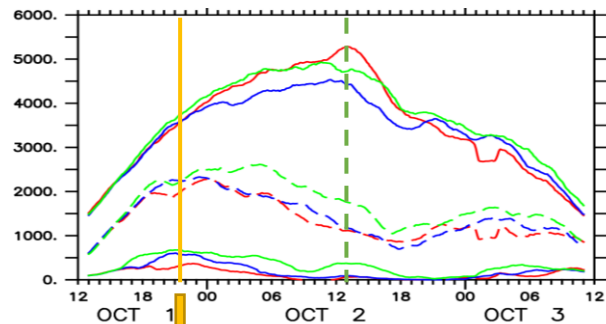
Chauffage moyen entre 300-800hPa (couleur) et θ à 850hPa (contour)



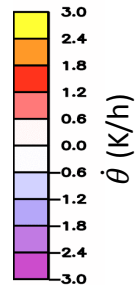
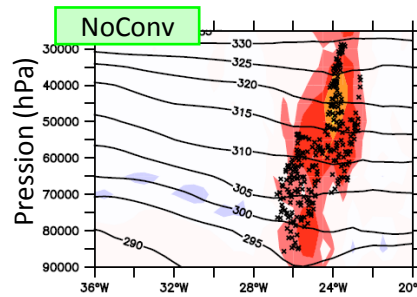
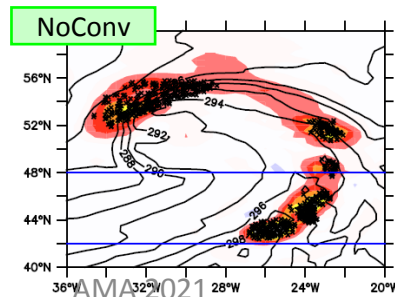
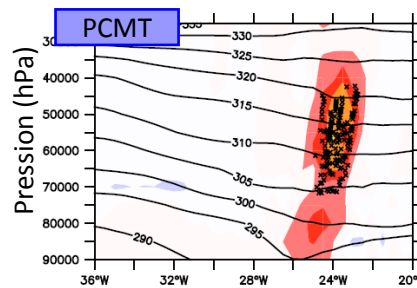
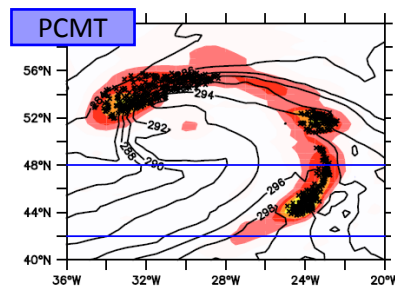
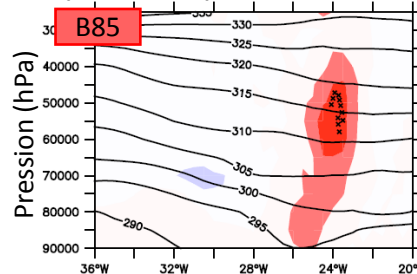
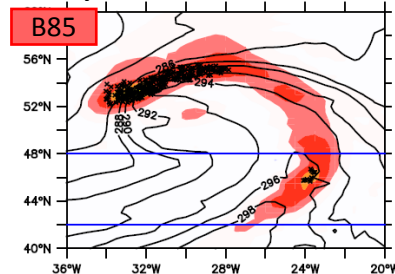
Chauffage plus fort et moins homogène dans NoConv

Trajectoires avec la plus forte ascendance à +9h

Nombre de trajectoires



Chauffage moyen entre 300-800hPa (couleur) et θ à 850hPa (contour)

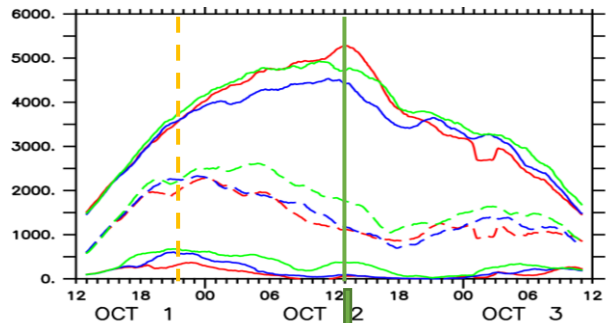


Trajectoires (100hPa en 2h)
entre 300 et 800hPa

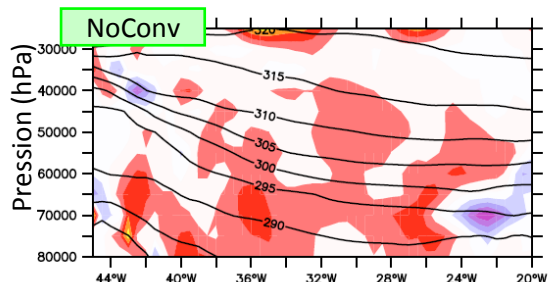
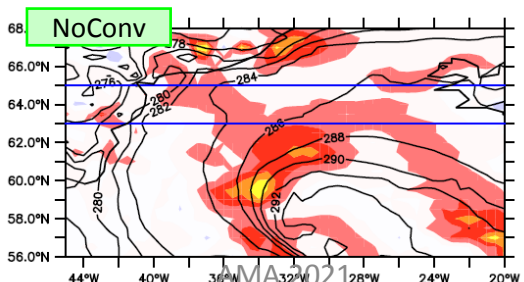
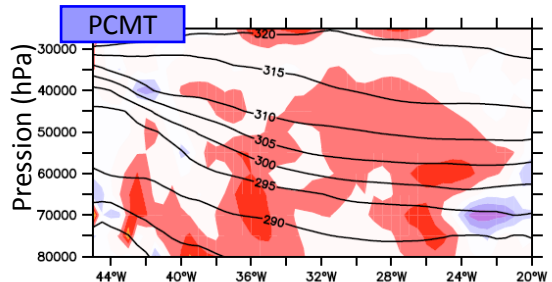
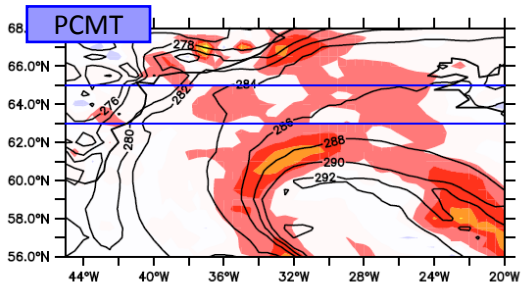
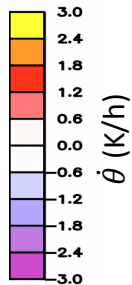
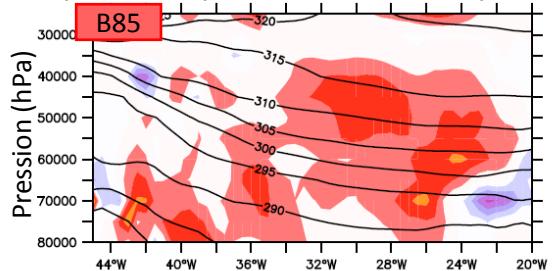
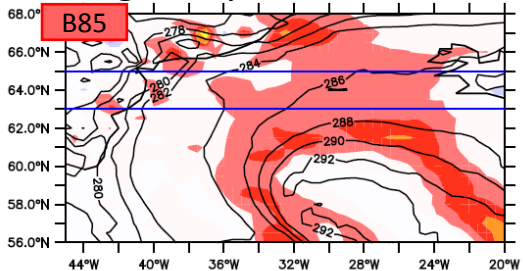
Chauffage plus fort et moins
homogène dans NoConv

Trajectoires avec ascendance plus lente à +24h

Nombre de trajectoires

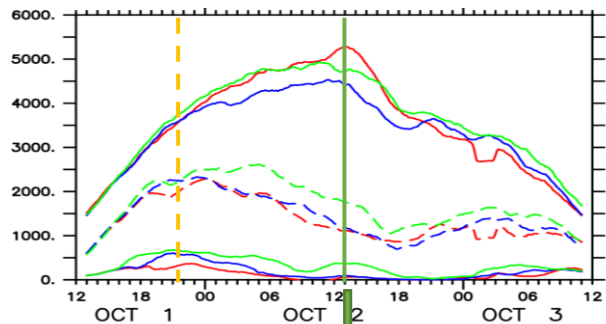


Chauffage moyen entre 300-800hPa (couleur) et θ à 850hPa (contour)

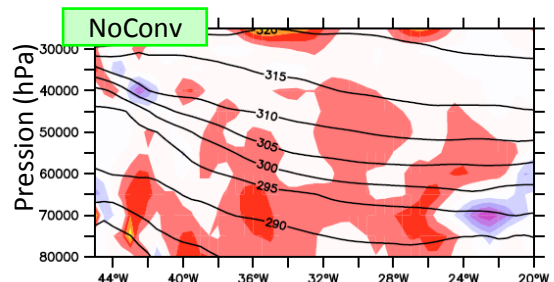
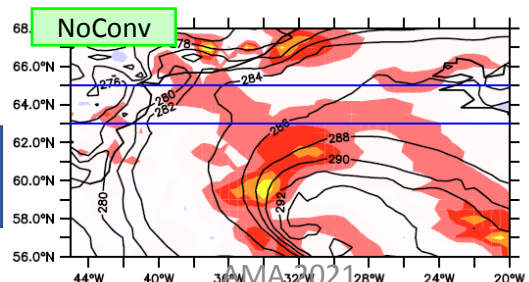
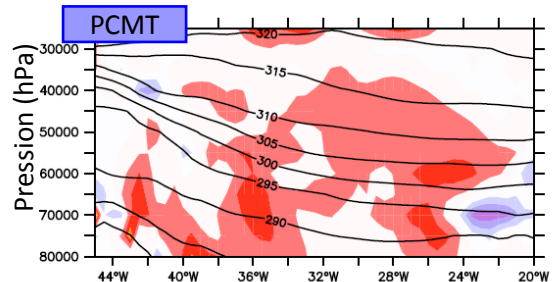
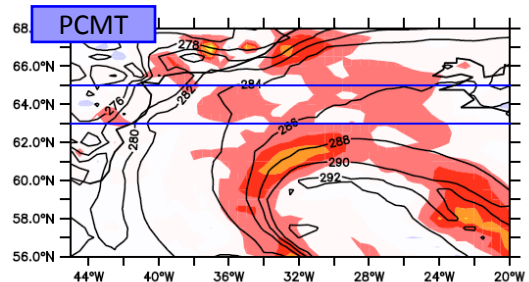
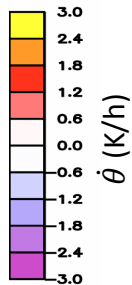
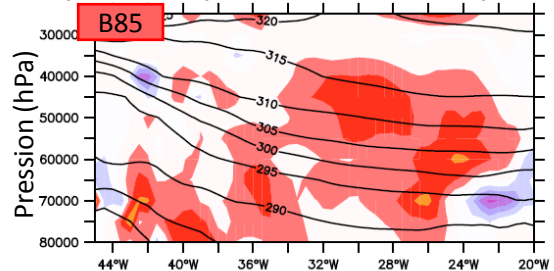
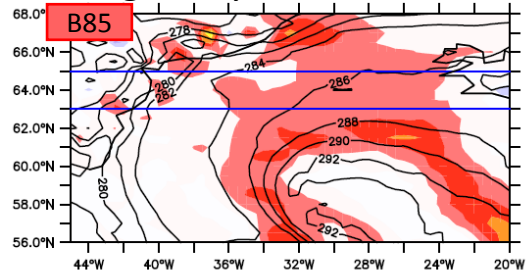


Trajectoires avec ascendance plus lente à +24h

Nombre de trajectoires



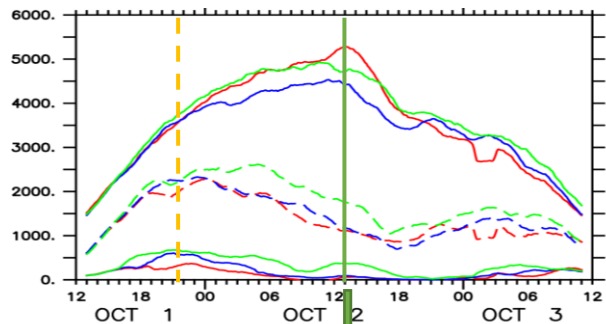
Chauffage moyen entre 300-800hPa (couleur) et θ à 850hPa (contour)



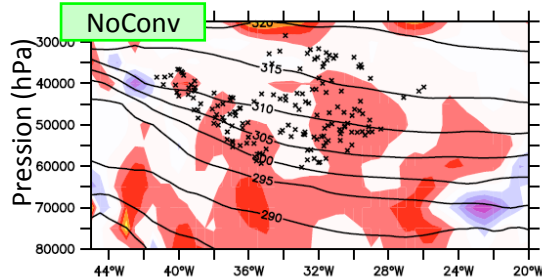
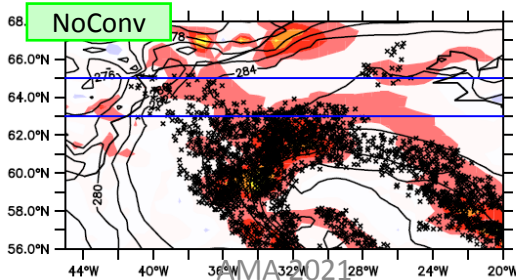
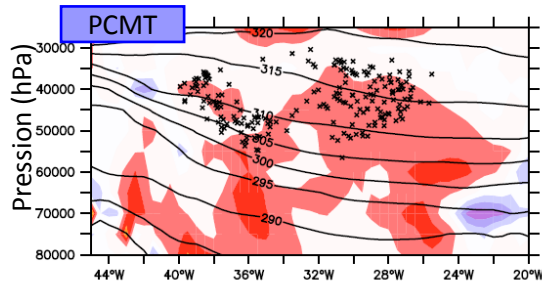
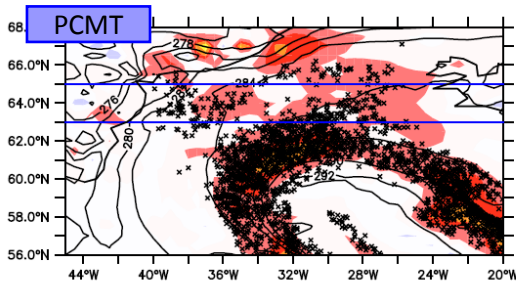
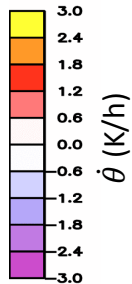
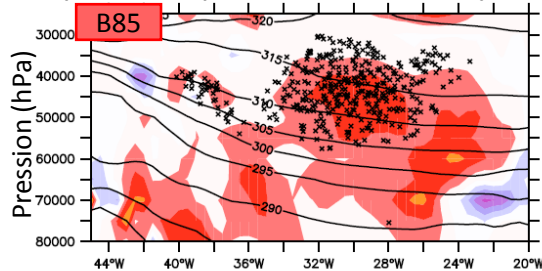
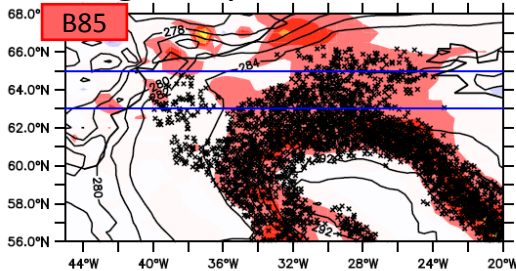
Chauffage plus fort dans B85

Trajectoires avec ascendance plus lente à +24h

Nombre de trajectoires



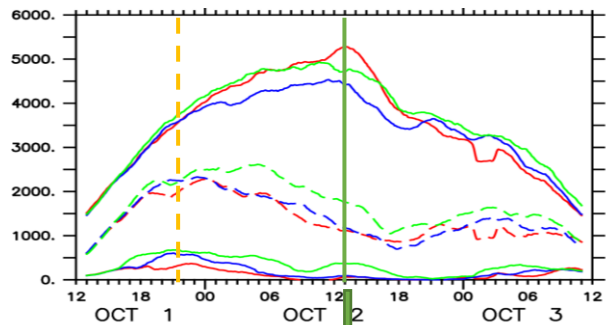
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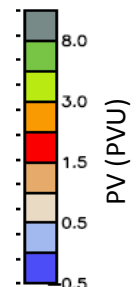
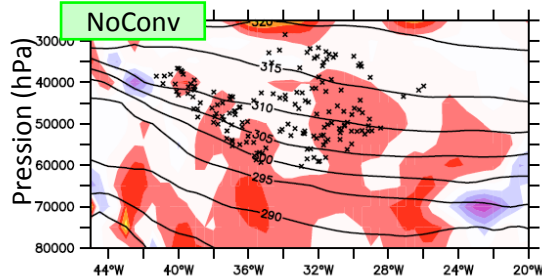
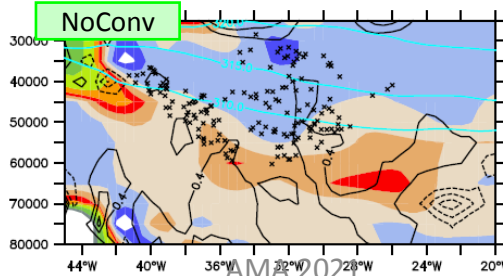
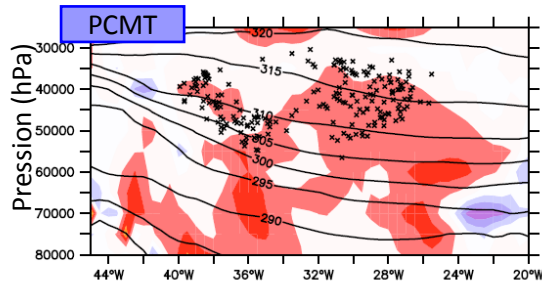
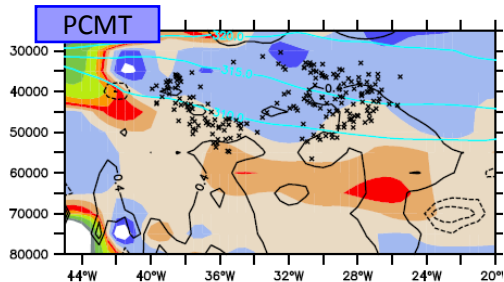
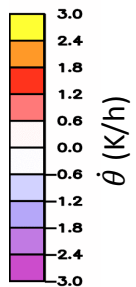
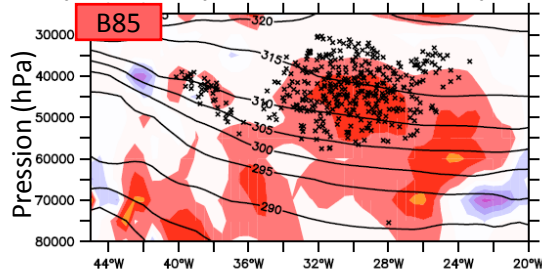
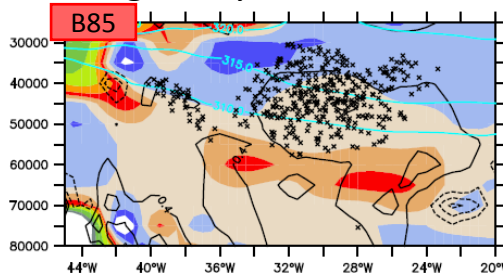
Chauffage plus fort dans B85

Trajectoires avec ascendance plus lente à +24h

Nombre de trajectoires

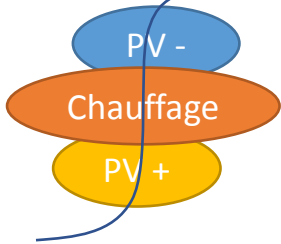


Chauffage moyen entre 300-800hPa (couleur) et θ à 850hPa (contour)

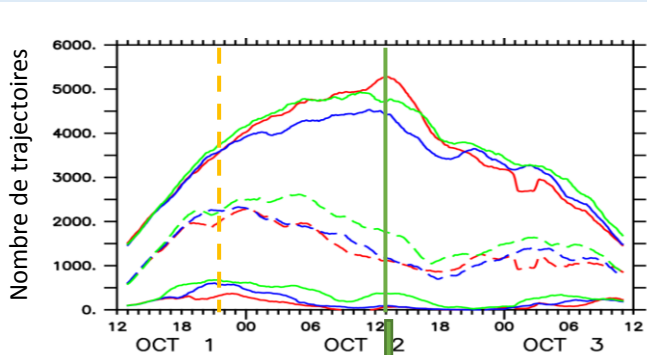


$$\frac{dPV}{dt} = \frac{1}{\rho} (\eta_a \cdot \nabla \theta + \nabla \wedge F \cdot \nabla \theta)$$

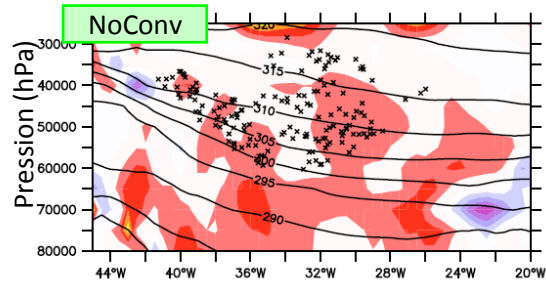
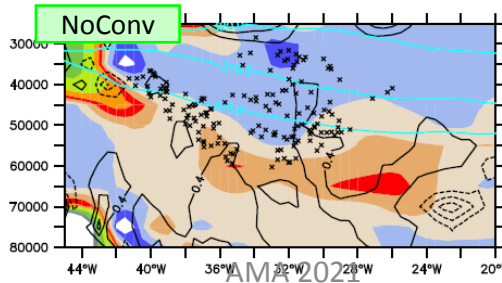
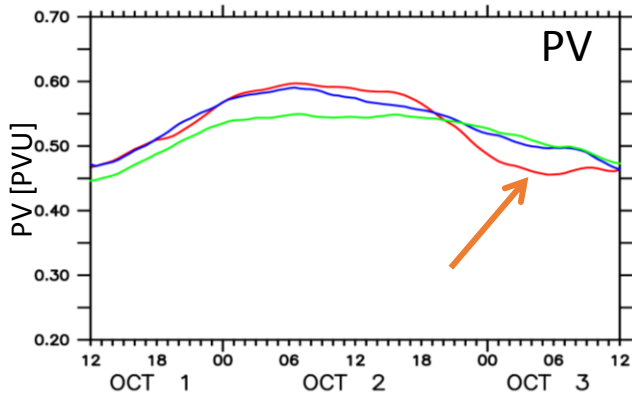
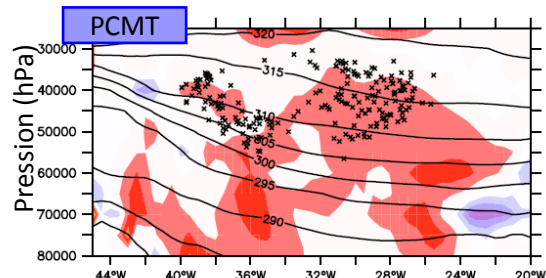
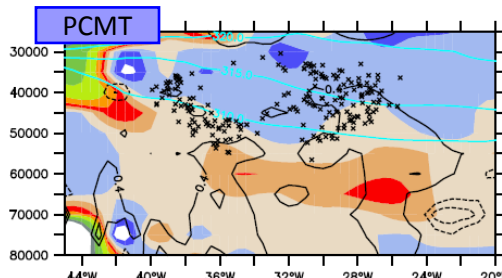
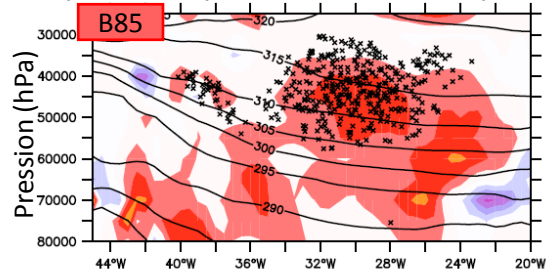
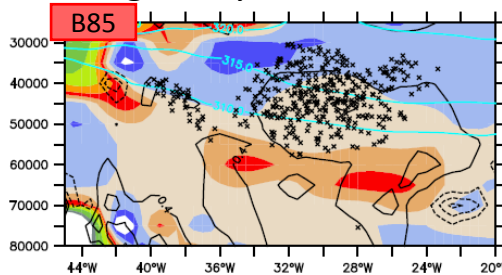
trajectoire



Trajectoires avec ascendance plus lente à +24h

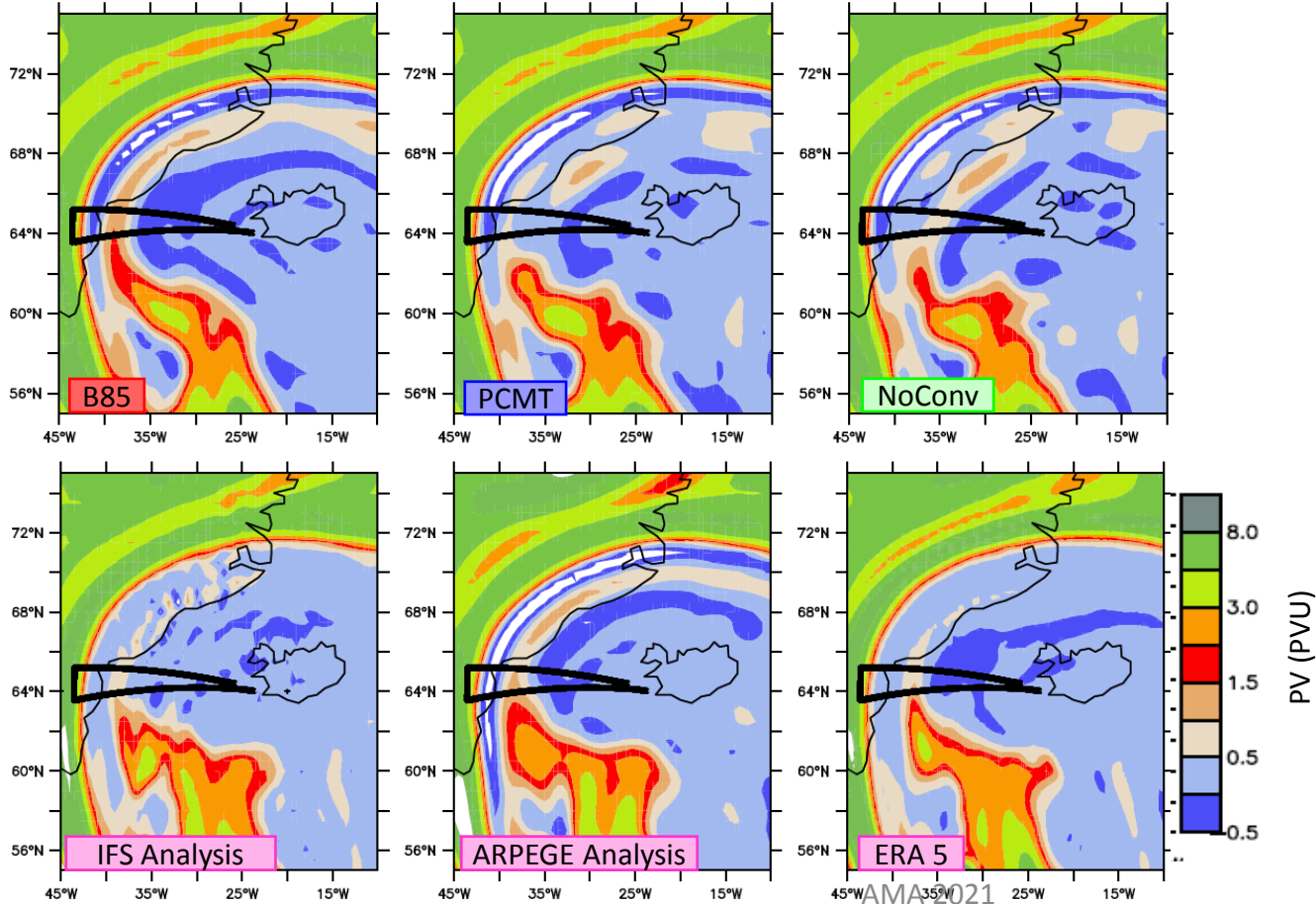


Chauffage moyen entre 300-800hPa (couleur) et θ à 850hPa (contour)



Anomalie de PV à 300 hPa

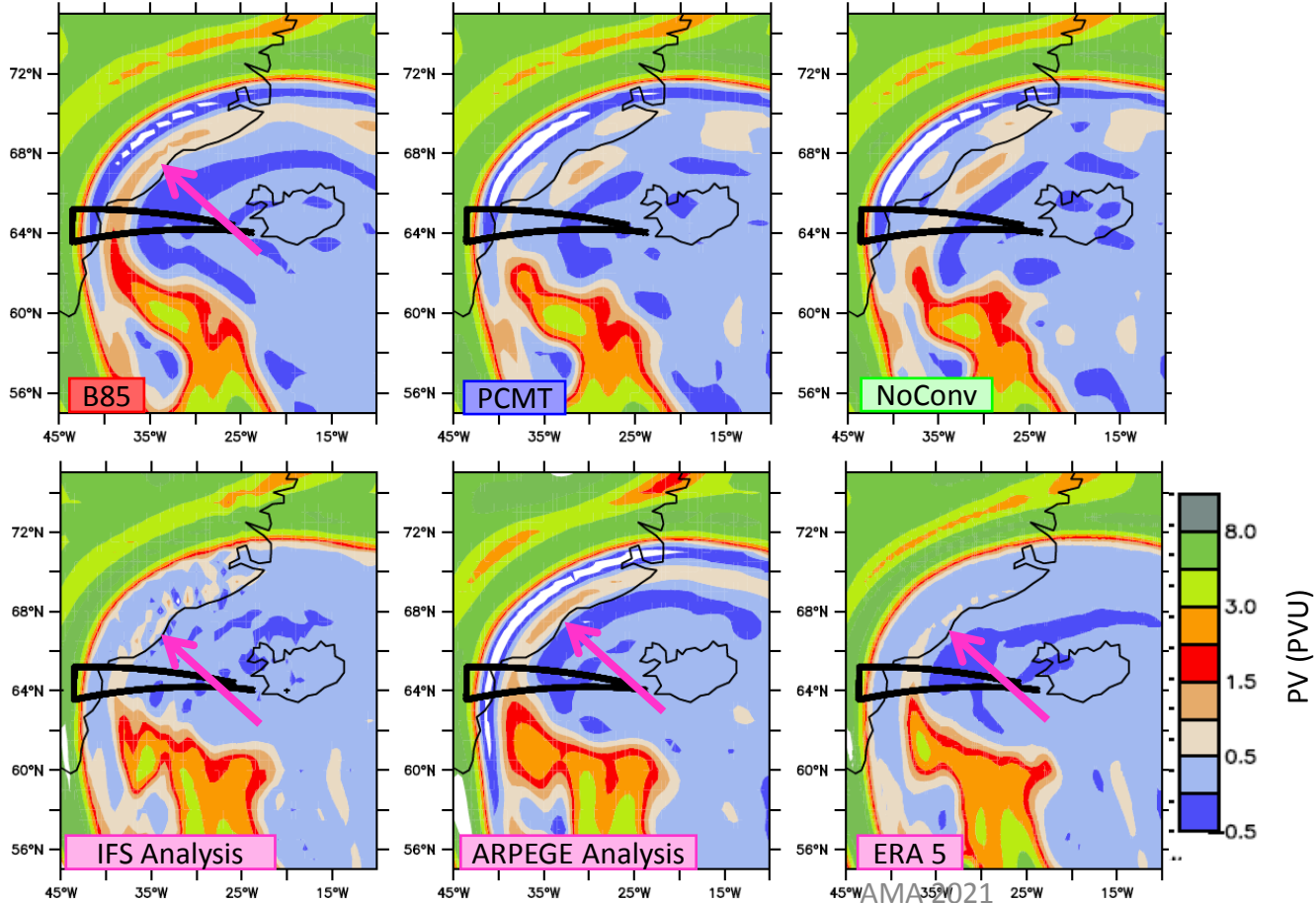
20181002 at 12hUTC



Anomalie de PV à 300 hPa

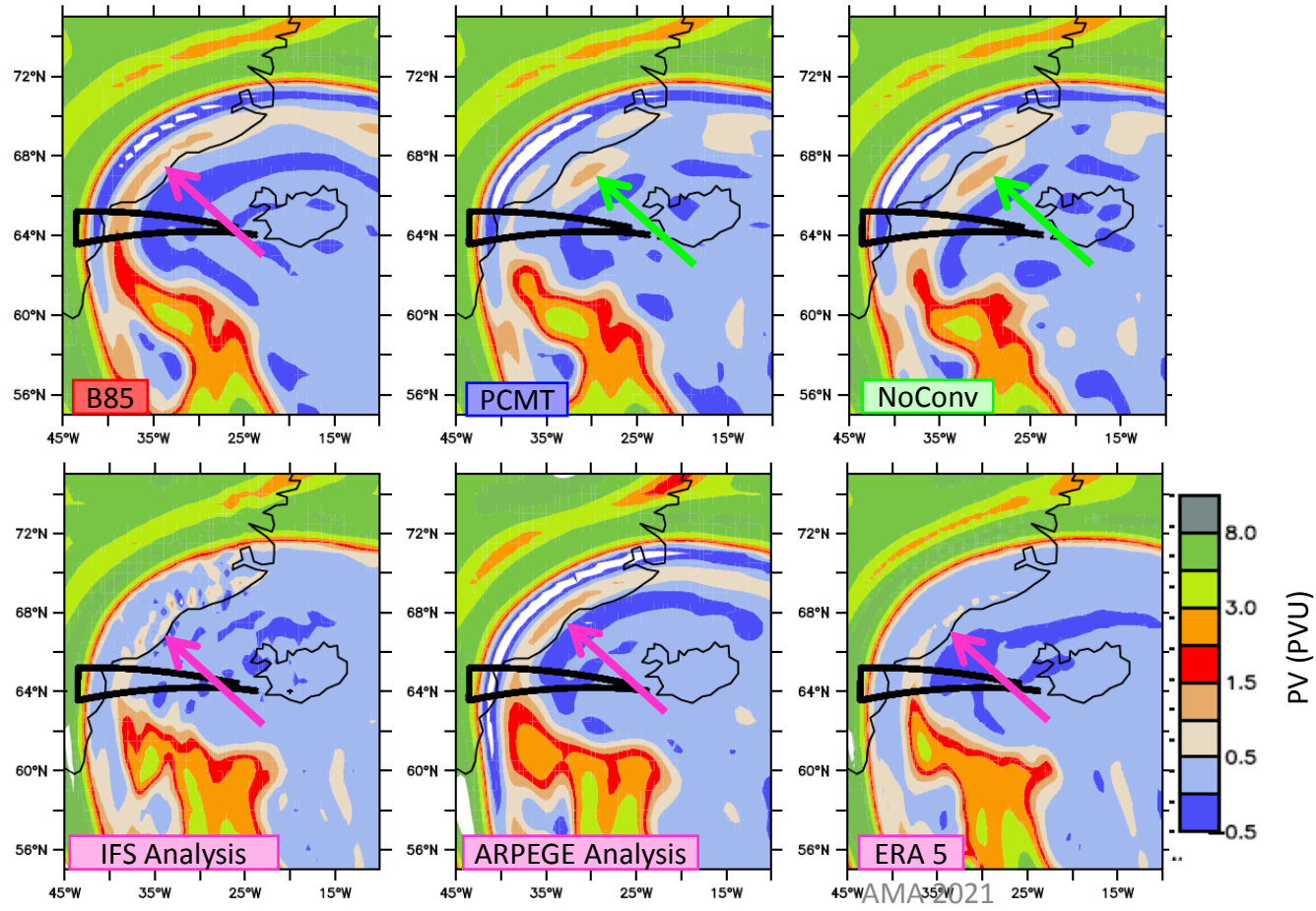
20181002 at 12hUTC

Fort PV le long de la côte du Groenland



Anomalie de PV à 300 hPa

20181002 at 12hUTC



Fort PV le long de la côte du Groenland

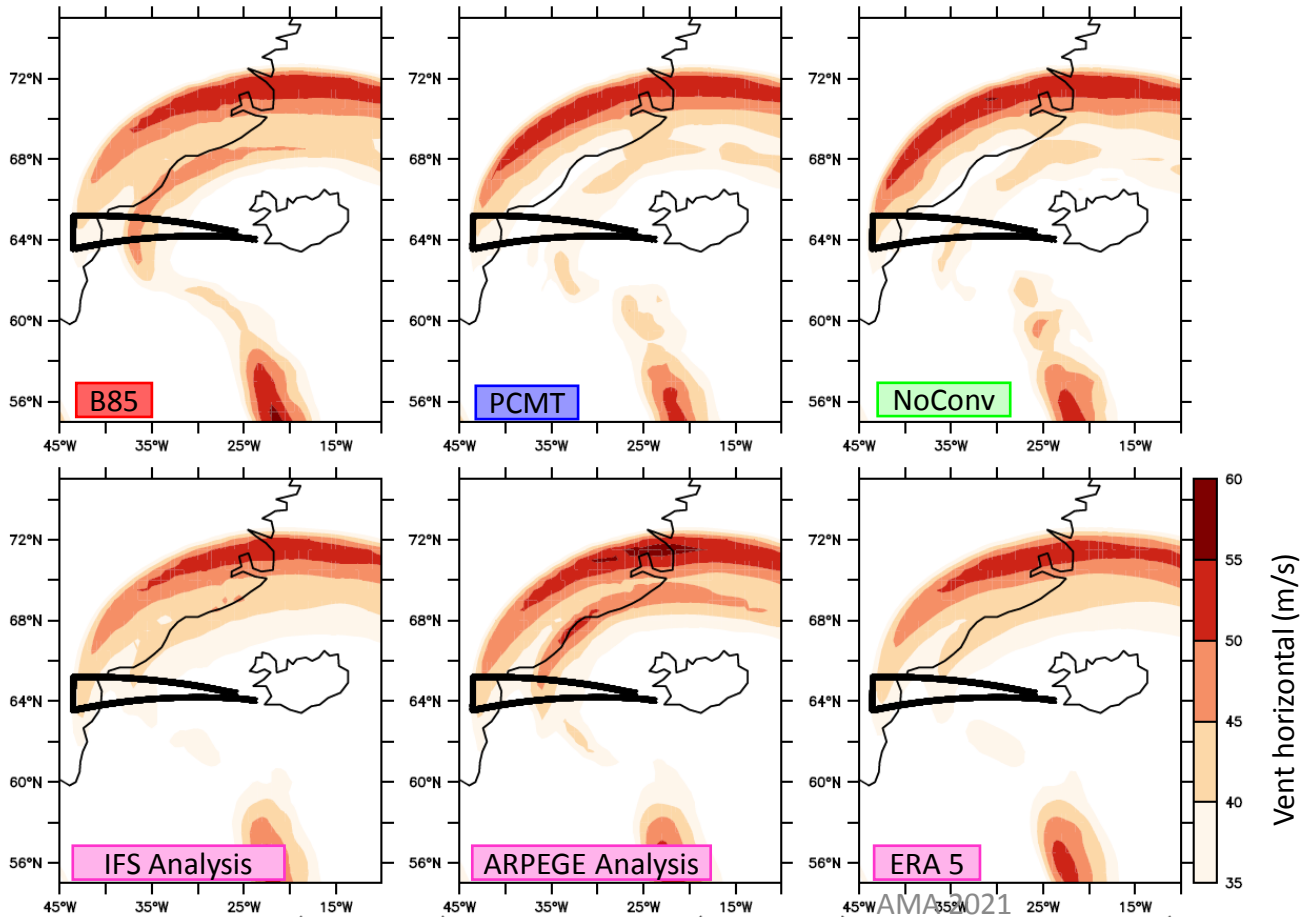
Zone de fort PV décalée à l'Est

Double jet à 300 hPa

20181002 at 12hUTC

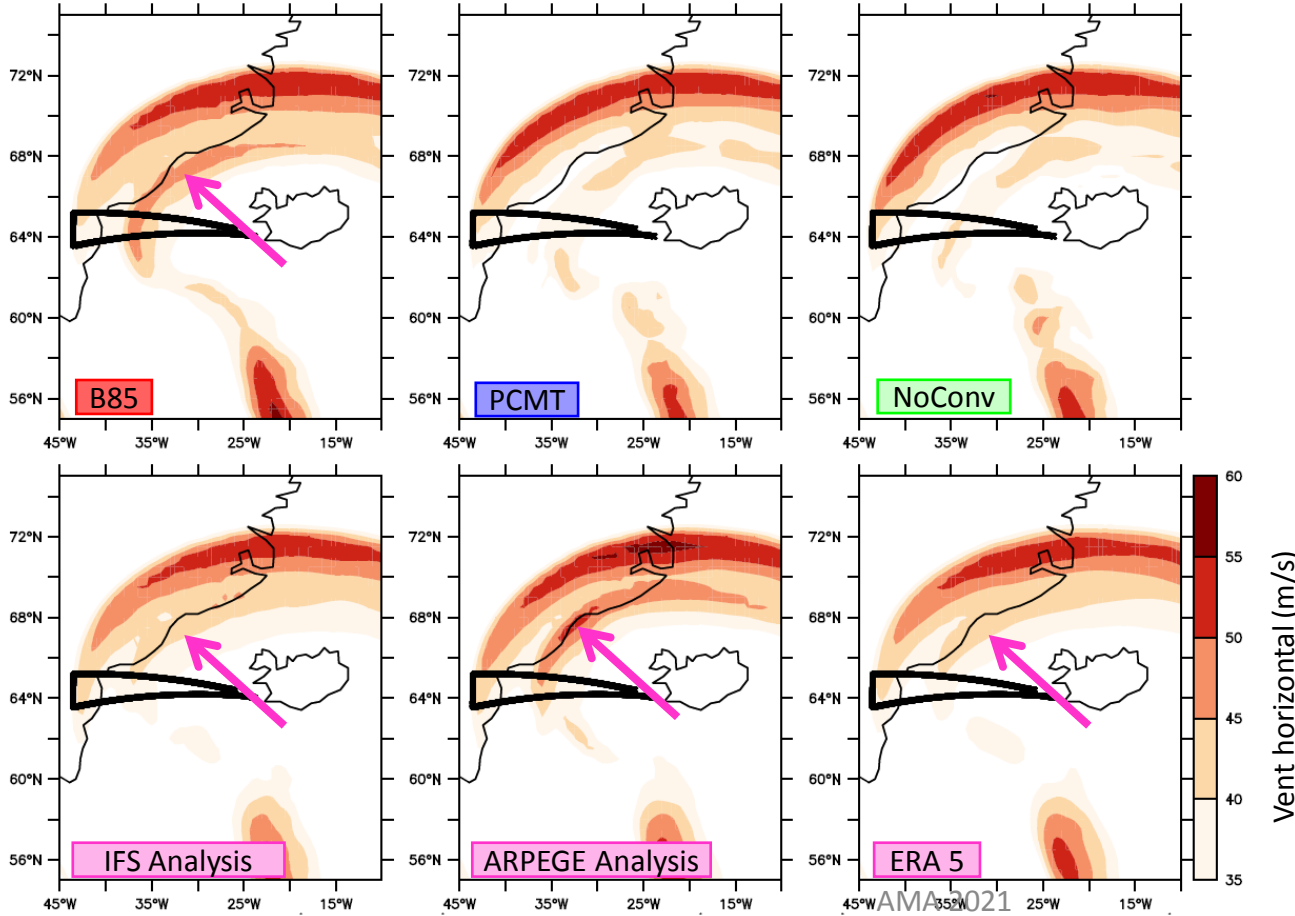
Fort PV le long de la
côte du Groenland

Zone de fort PV
décalée à l'Est



Double jet à 300 hPa

20181002 at 12hUTC



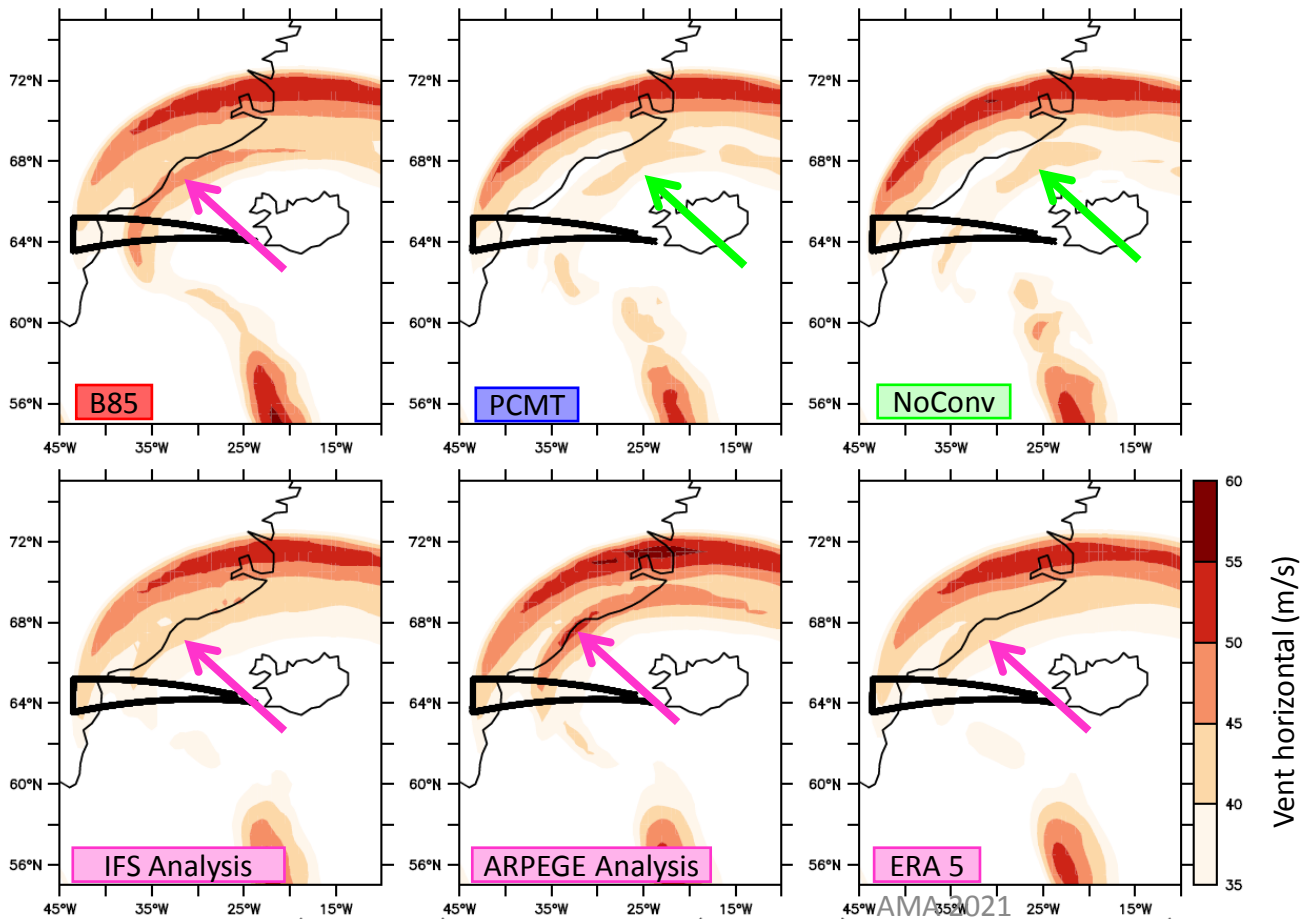
Fort PV le long de la
côte du Groenland

Double jet

Zone de fort PV
décalée à l'Est

Double jet à 300 hPa

20181002 at 12hUTC



Fort PV le long de la côte du Groenland

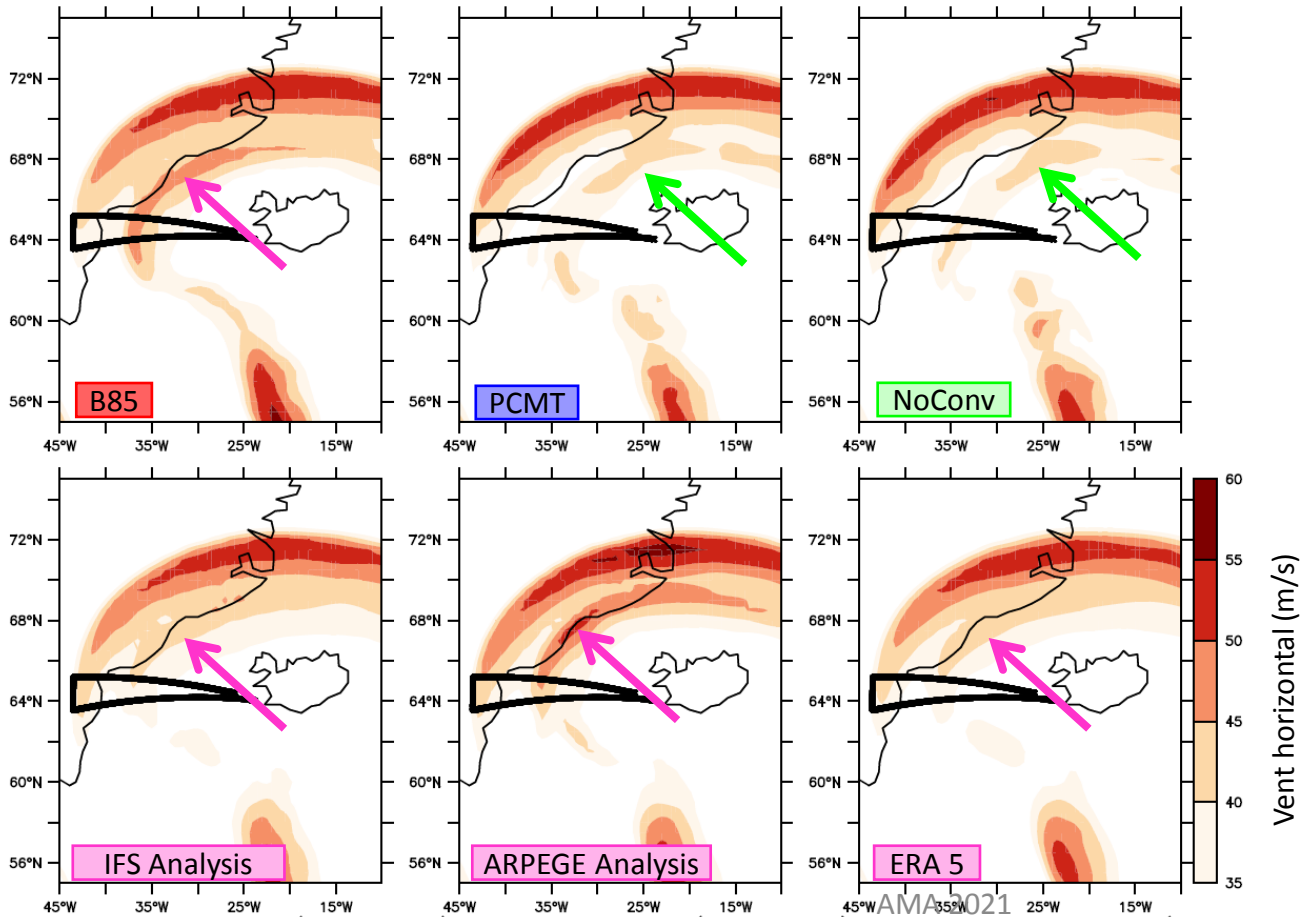
Double jet

Zone de fort PV décalée à l'Est

Double jet trop à l'Est

Double jet à 300 hPa

20181002 at 12hUTC



Fort PV le long de la
côte du Groenland

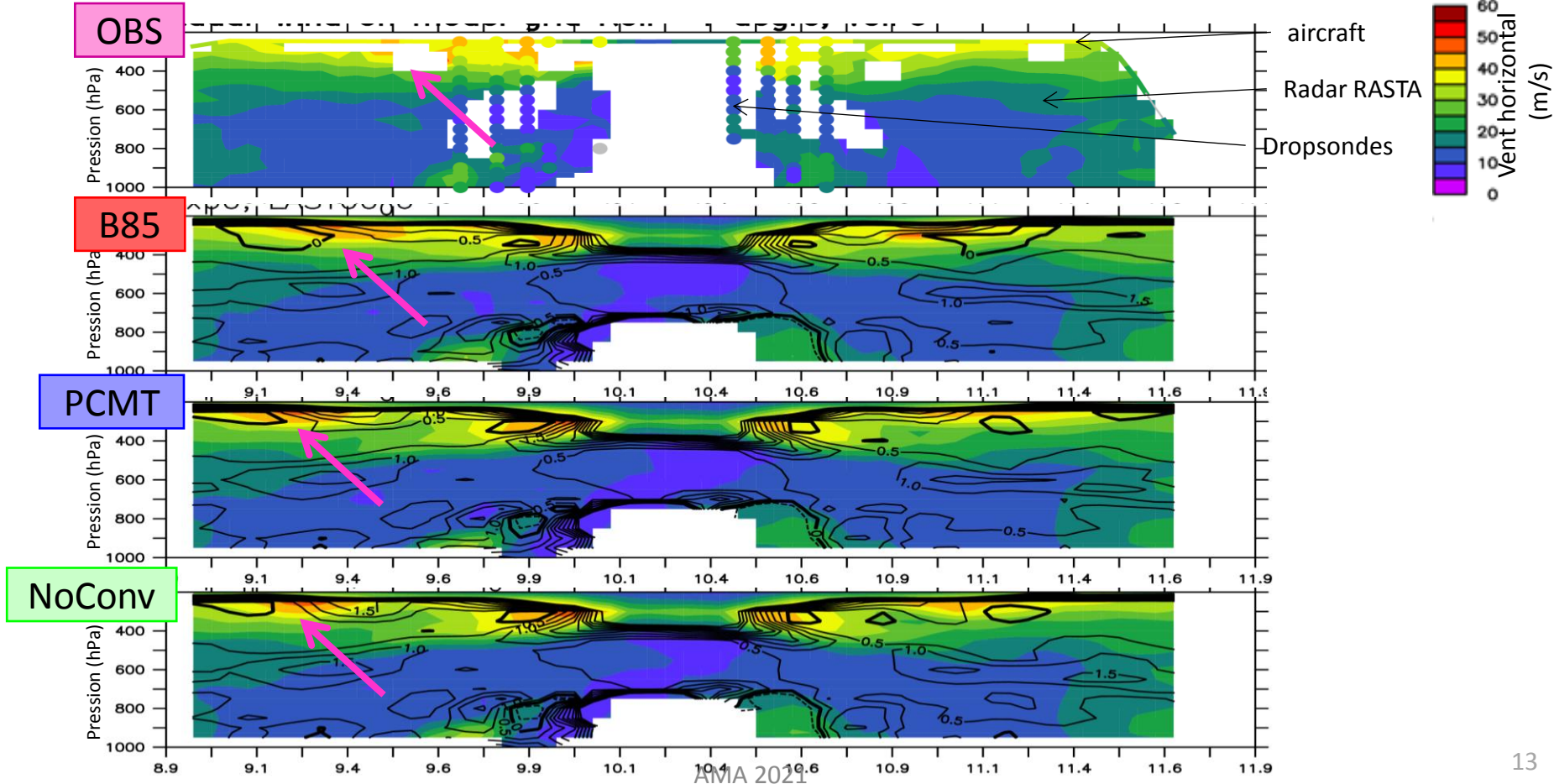
Double jet

Zone de fort PV
décalée à l'Est

Double jet
trop à l'Est

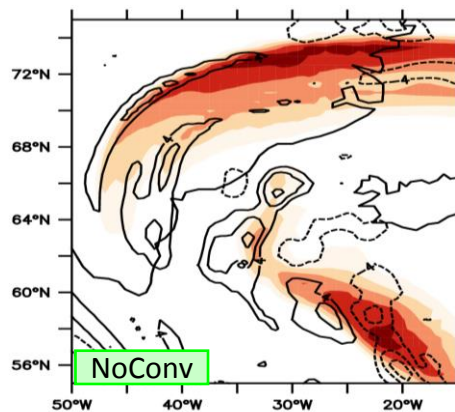
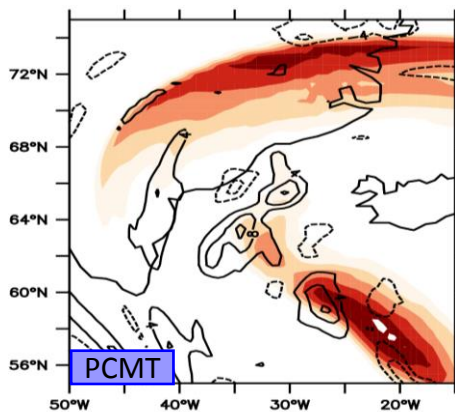
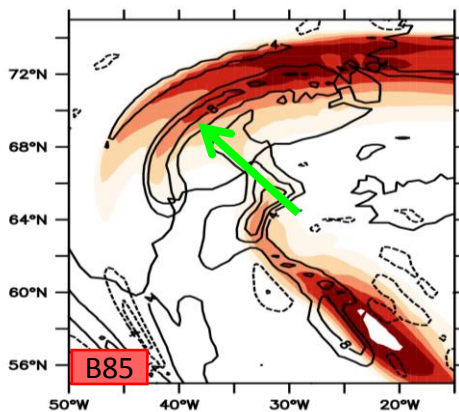
B85 plus proche des analyses

Profil vertical de vent horizontal le long du vol F6

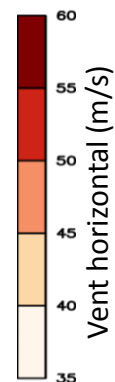
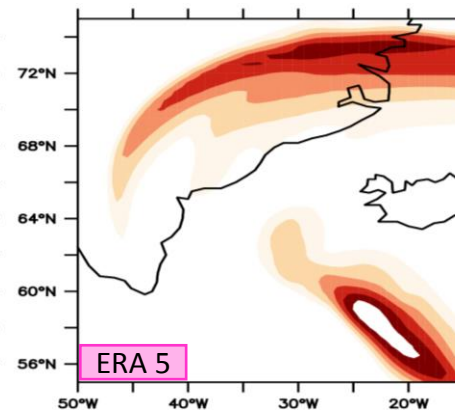
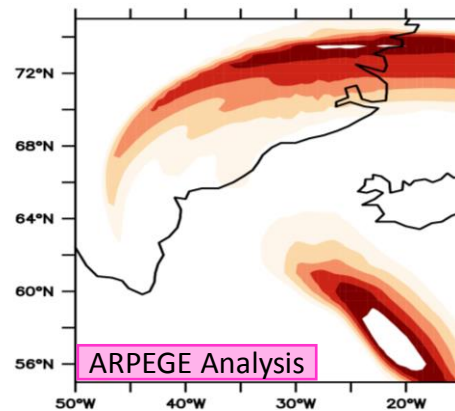
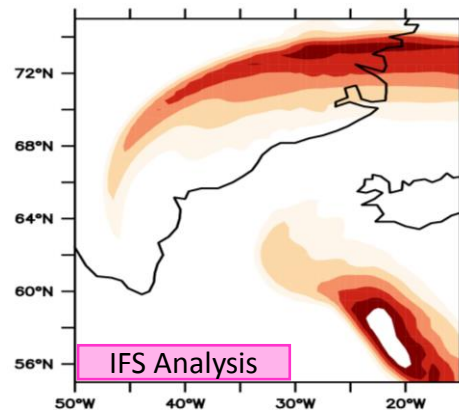


Disparition du double jet à 300hPa après 30h d'échéance

20181002 à 18hUTC



Toujours un fort double jet dans B85



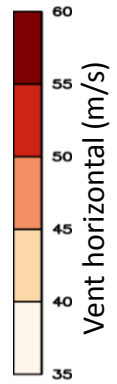
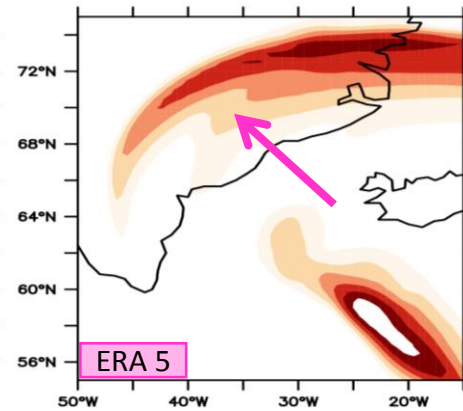
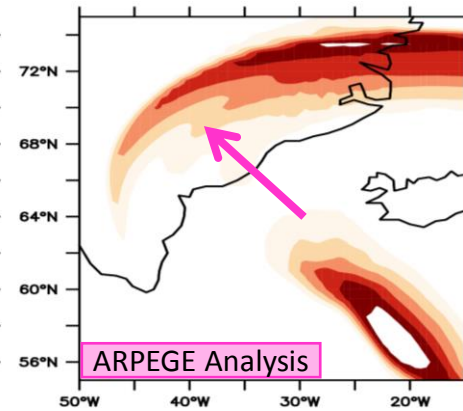
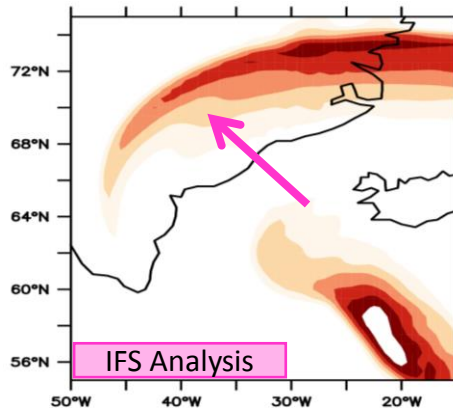
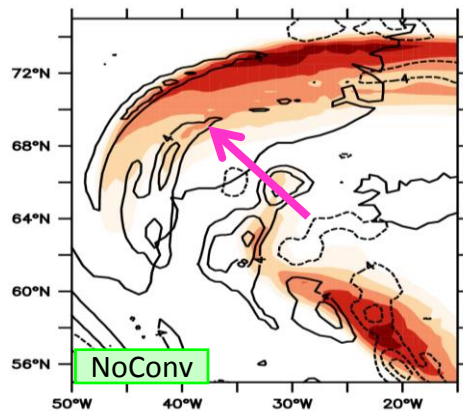
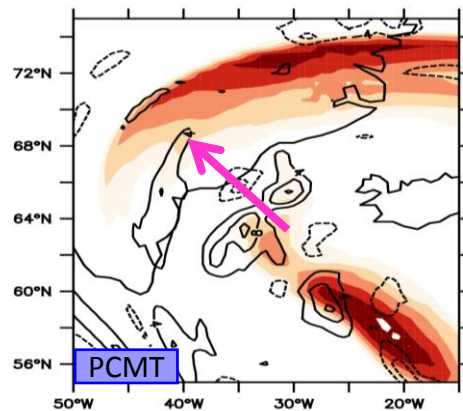
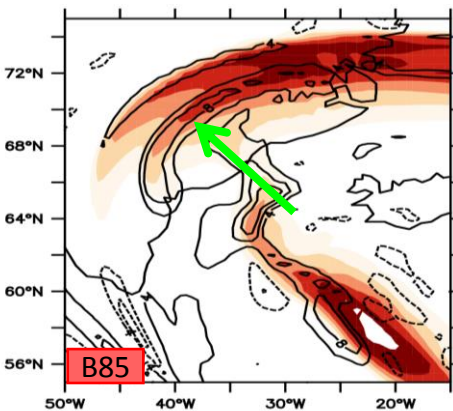
Contour :
différences de vent
avec l'analyse IFS

Disparition du double jet à 300hPa après 30h d'échéance

20181002 à 18hUTC

Pas de double jet

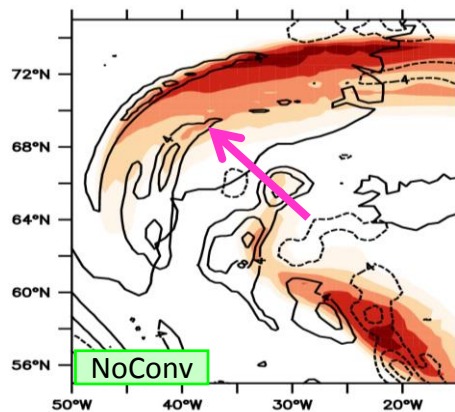
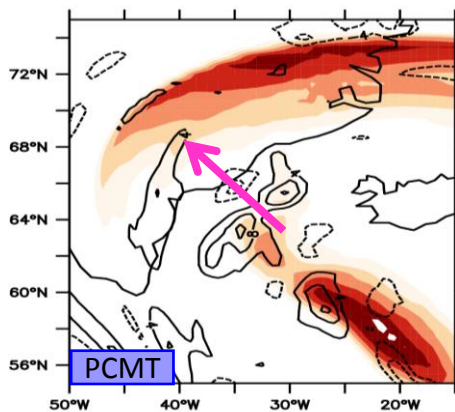
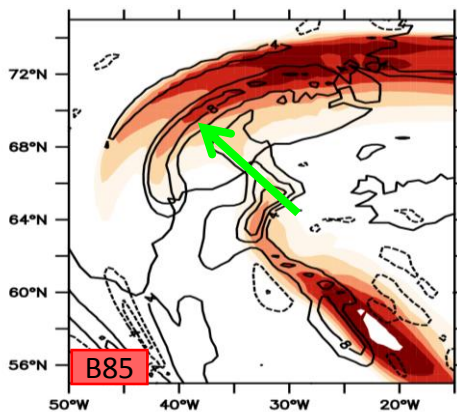
Toujours un fort double jet dans B85



Contour :
différences de vent
avec l'analyse IFS

Disparition du double jet à 300hPa après 30h d'échéance

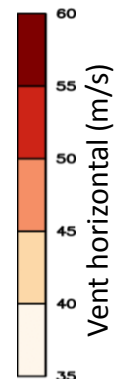
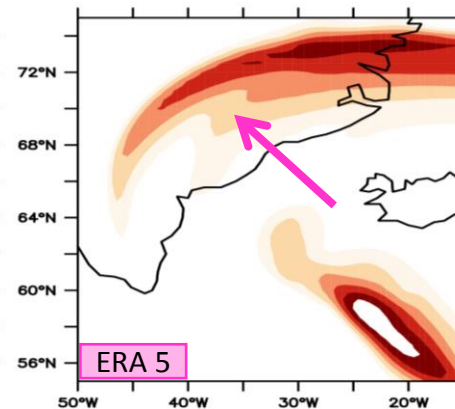
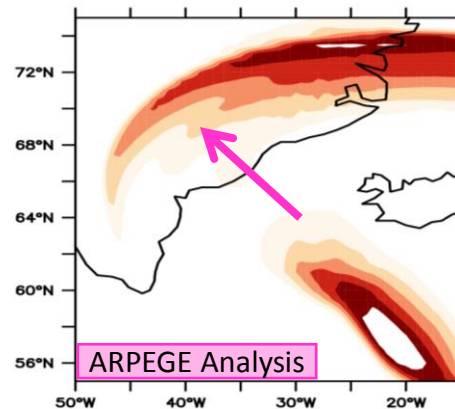
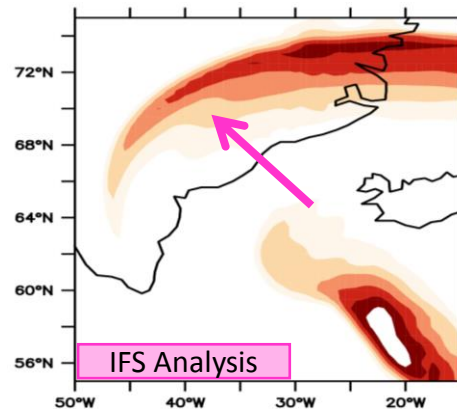
20181002 à 18hUTC



Pas de double jet

Toujours un fort double jet dans B85

B85 plus éloigné des analyses



Contour :
différences de vent
avec l'analyse IFS

Conclusion

- **NoConv**: chauffage plus fort et plus tôt, dans des régions isolées, ascendance plus forte le long du front froid qu'avec **B85** et **PCMT**
- **PCMT** a un comportement intermédiaire entre **B85** et **NoConv**.
- Ascendance plus faible en flux de sortie avec **B85** que **PCMT** et **NoConv**
- Destruction de PV dans le flux de sortie de la WCB dans **B85** que **PCMT** et **NoConv**.
- La dynamique plus active en haute troposphère dans **B85** est retrouvée dans les mesures et (ré)-analyses mais semble trop forte (résultats consistents avec les mesures d'IWC, non montrées).

Perspectives : Comparaison avec le schéma de Tiedke (1993)



Merci pour votre
attention