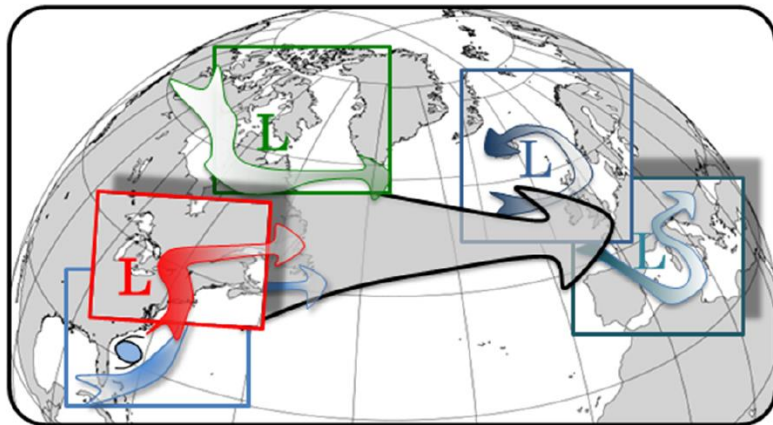


Processus diabatiques au sein de la WCB de la dépression Stalactite

Sensibilité à 2 schémas de paramétrisation de la convection dans ARPEGE



Meryl WIMMER
M2 SOAC - DC

Encadrants de stage :

- Philippe ARBOGAST, CNRM
- Gwendal RIVIERE, LMD

Problématique

But du stage : Etudier l'effet des différents schémas de convection du modèle ARPEGE sur les processus diabatiques d'une WCB

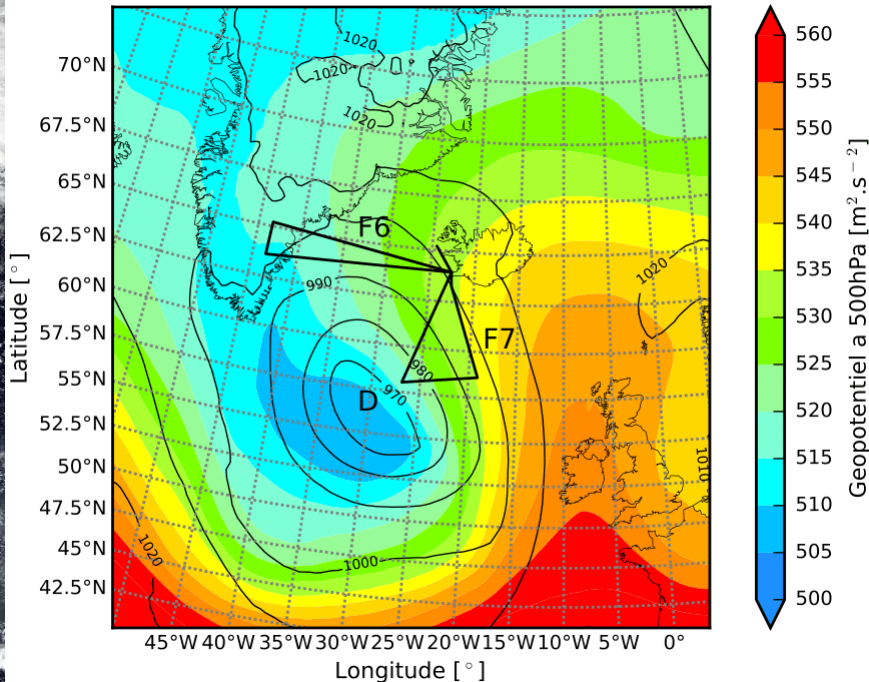
Dépression étudiée : Stalactite (02/10/2016)

2 versions d'ARPEGE

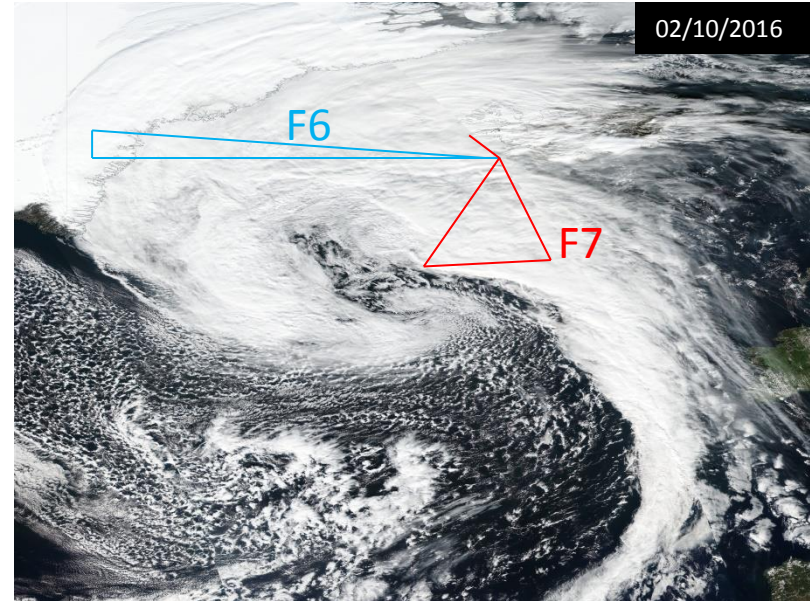
- Version opérationnelle de 2016 : Run0
- Version avec schéma de convection PCMT : Run6

Etude des vols F6 et F7

Carte de géopotentiel à 500 hPa et pression au niveau de la mer

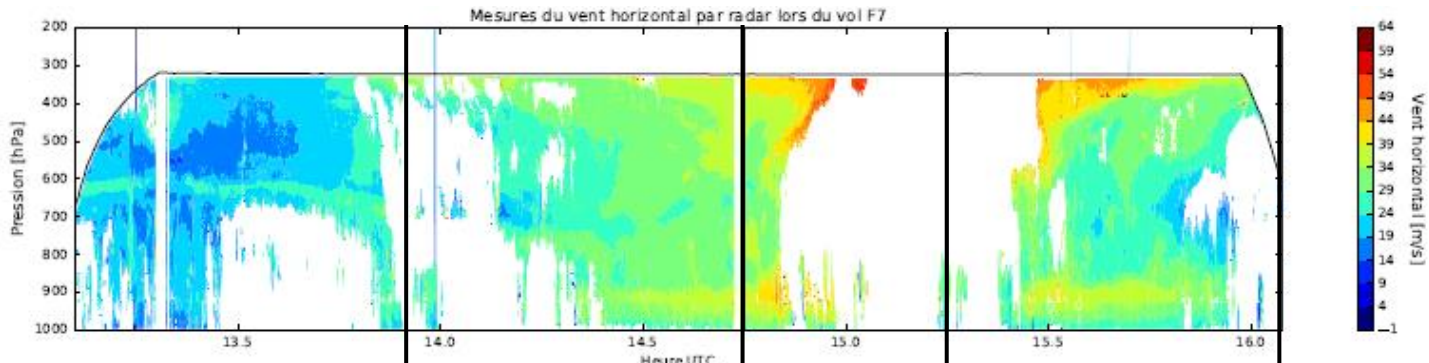
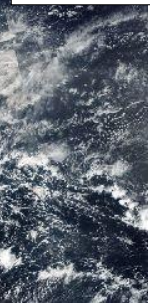
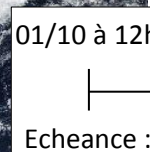


Analyse ARPEGE, du 02/10/2016 à 12h

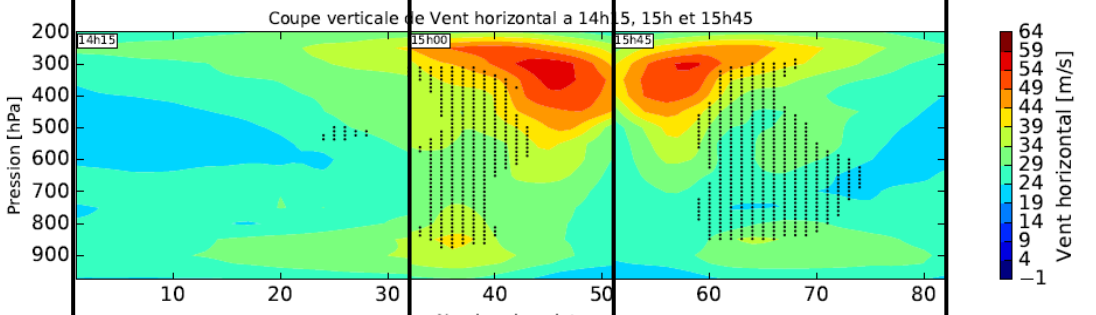


MODIS, Nasa Worldview Application

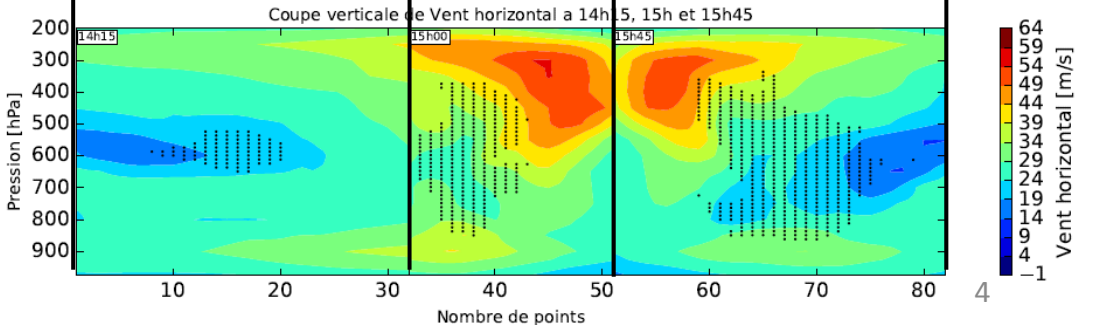
Validation des prévisions Radar – vol F7



Run0

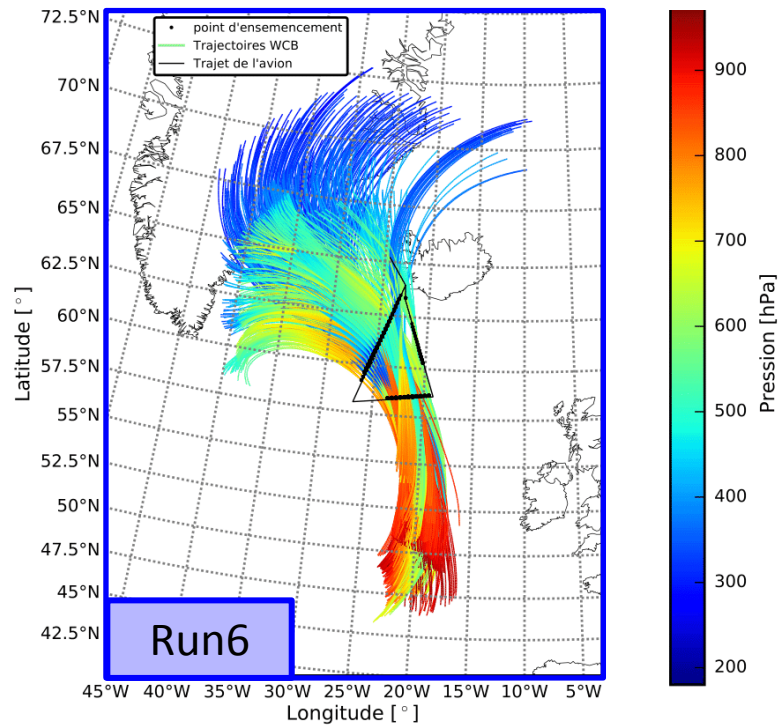
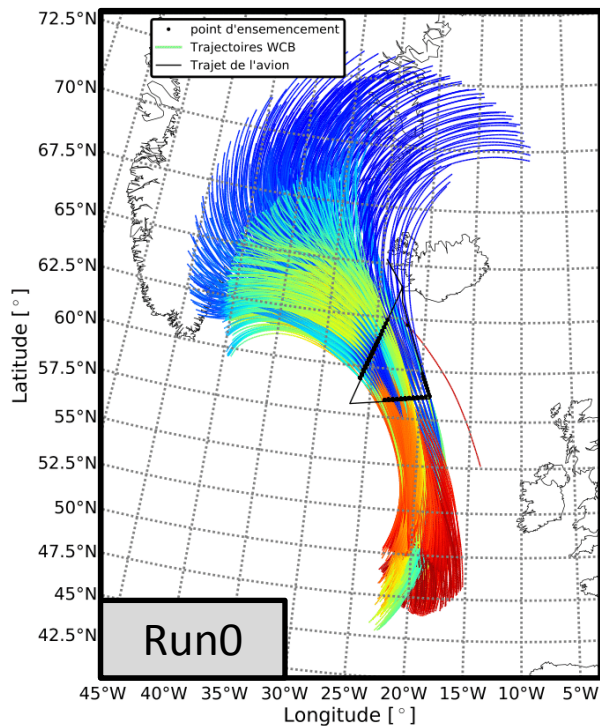


Run6



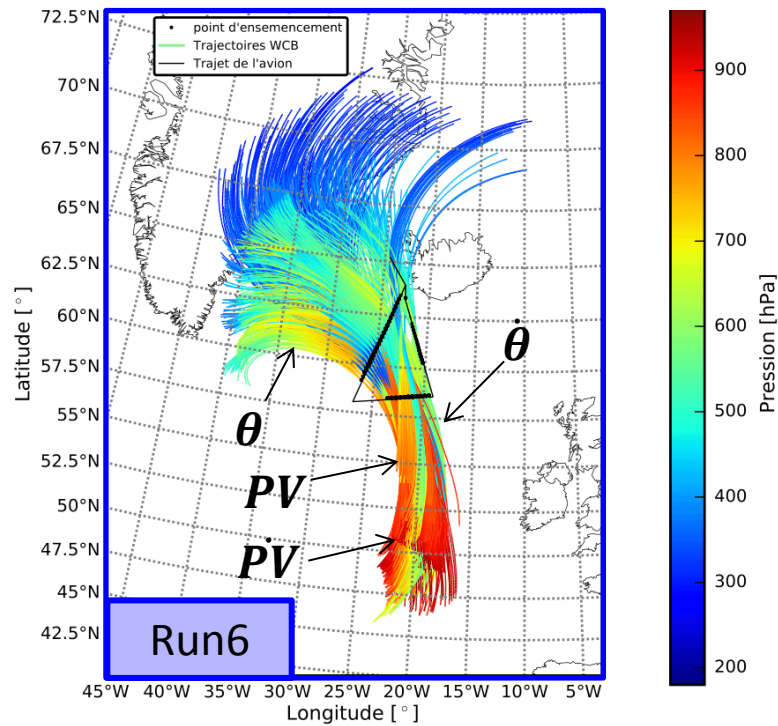
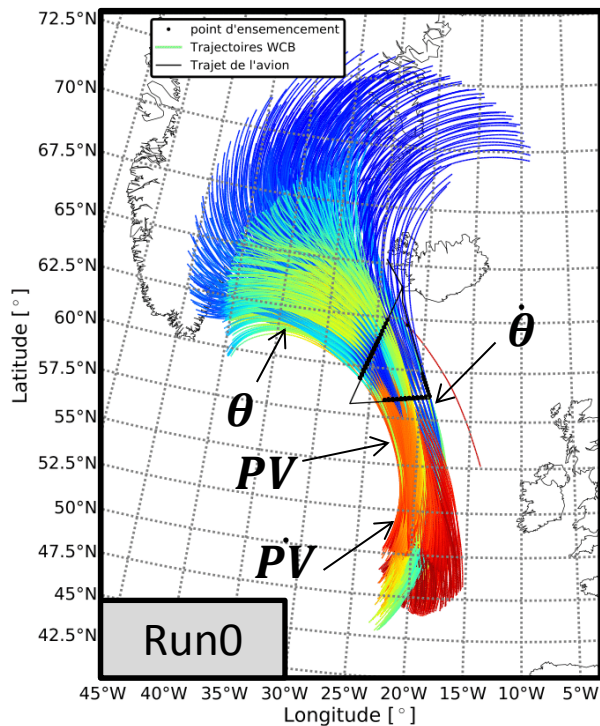
Warm Conveyor Belt – vol F7

Critère : -300 hPa en 24h



Warm Conveyor Belt – vol F7

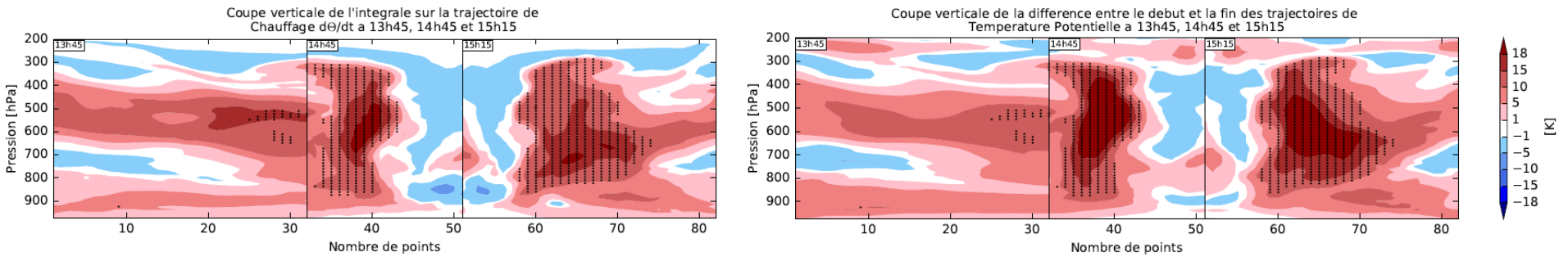
Critère : -300 hPa en 24h



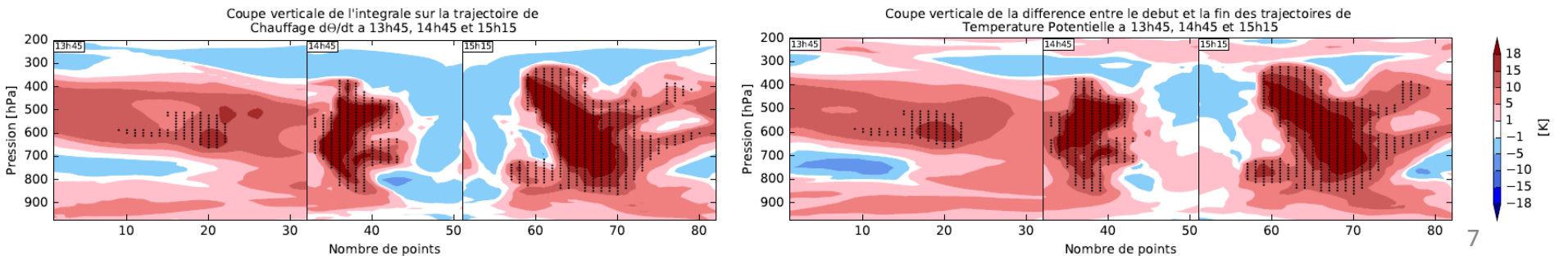
Bilan en chauffage

$$\int \sum_i \dot{\theta}_i dt \approx \Delta\theta$$

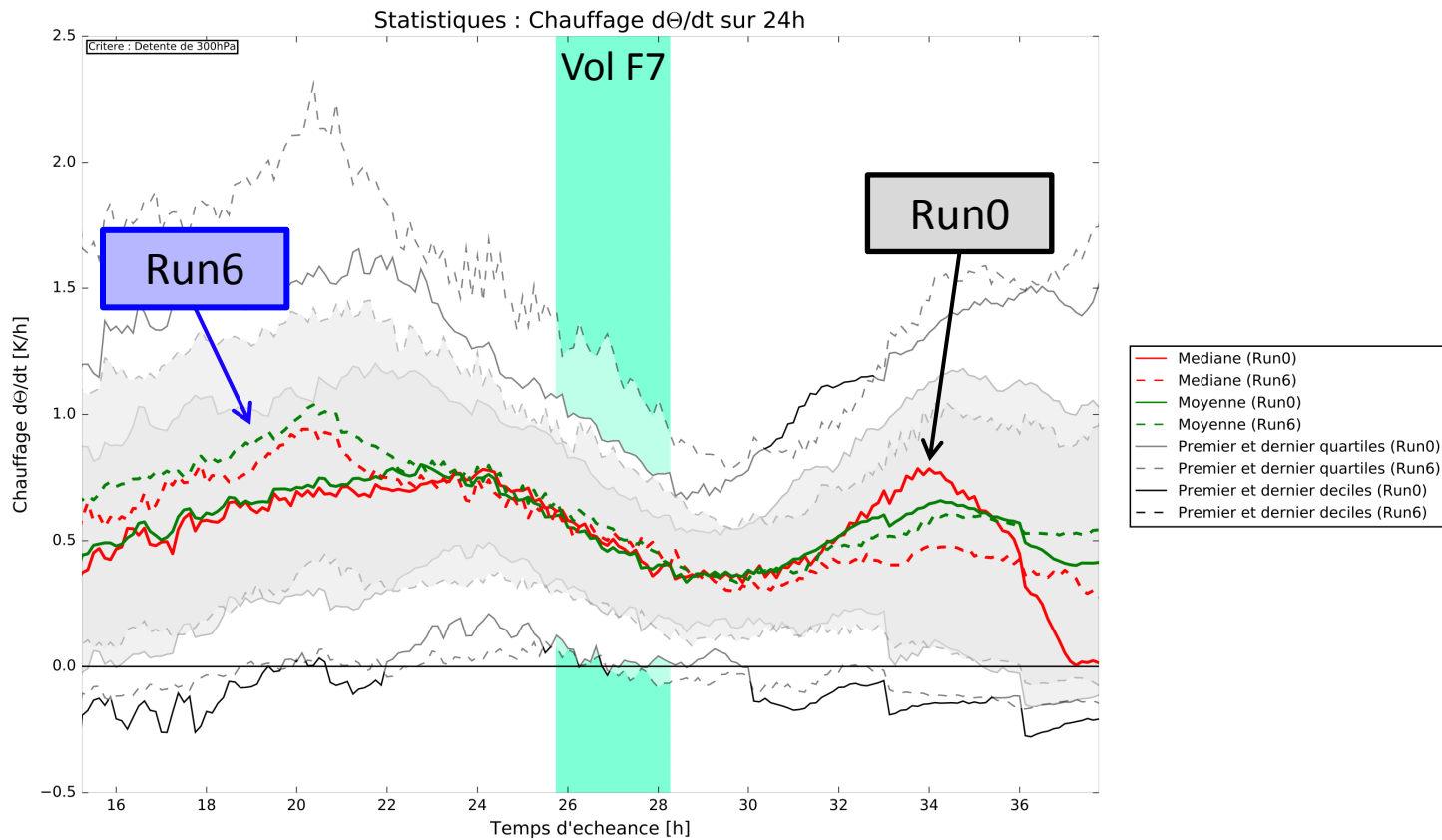
Run0



Run6

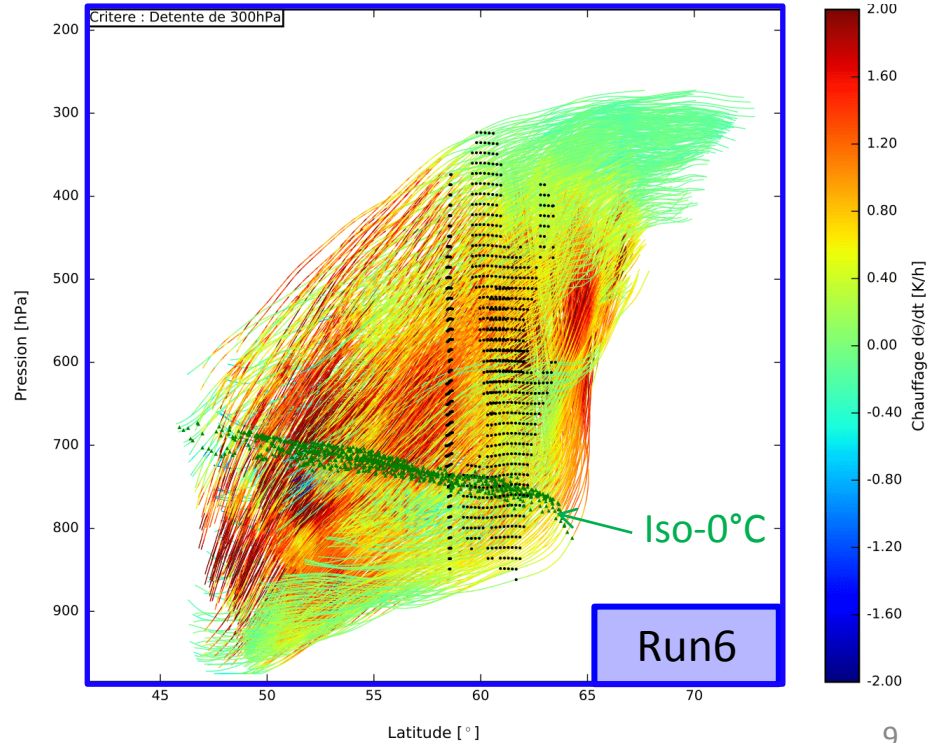
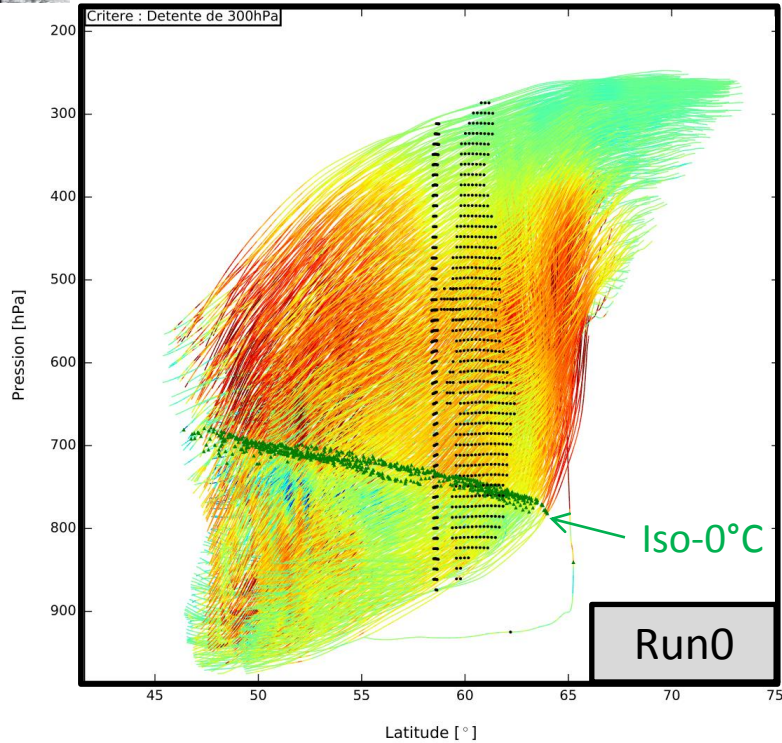


Evolution temporelle du chauffage



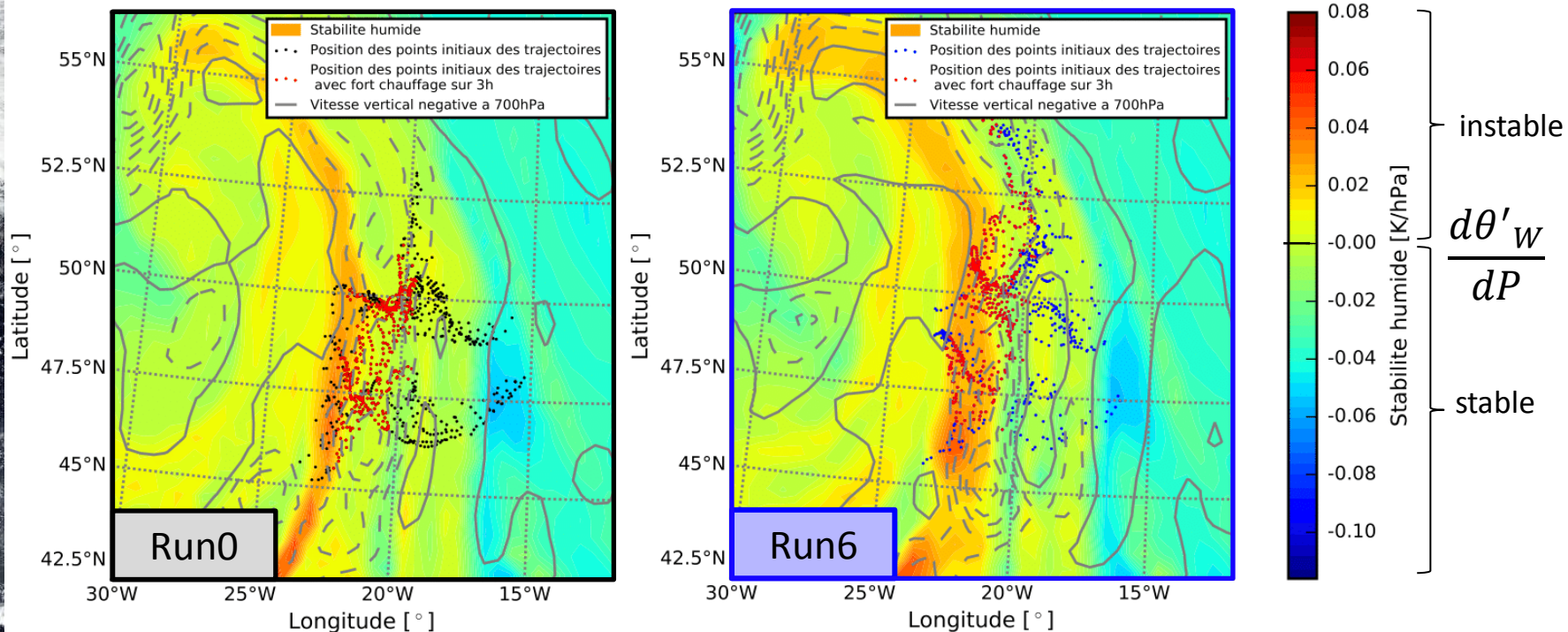


Différence de chauffage dans la phase liquide ...



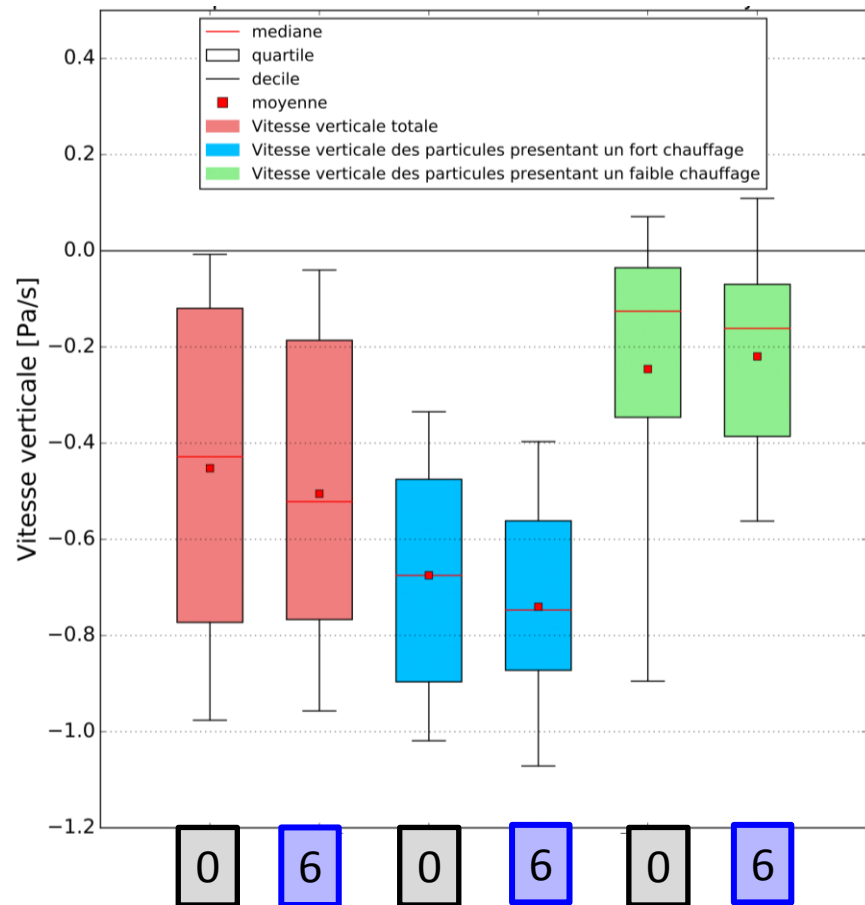
... due à un front plus instable dans le Run6

Stabilité humide et vitesse verticale à 700 hPa, le 02/10/2016 à 2h45

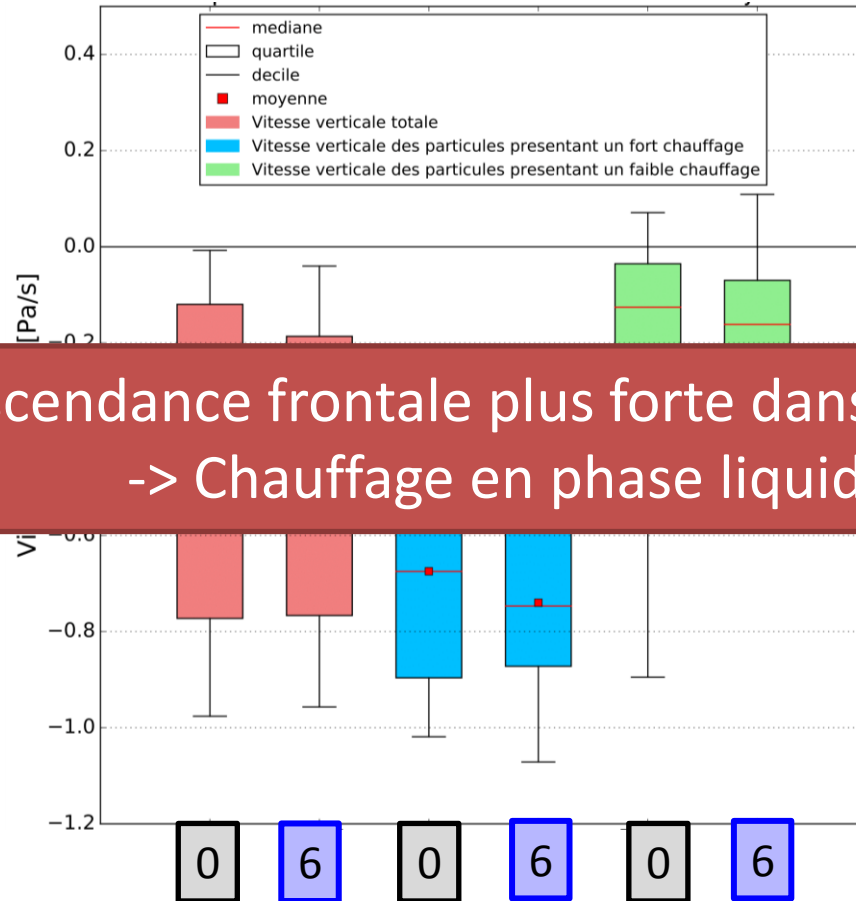




Vitesse verticale en début de trajectoire



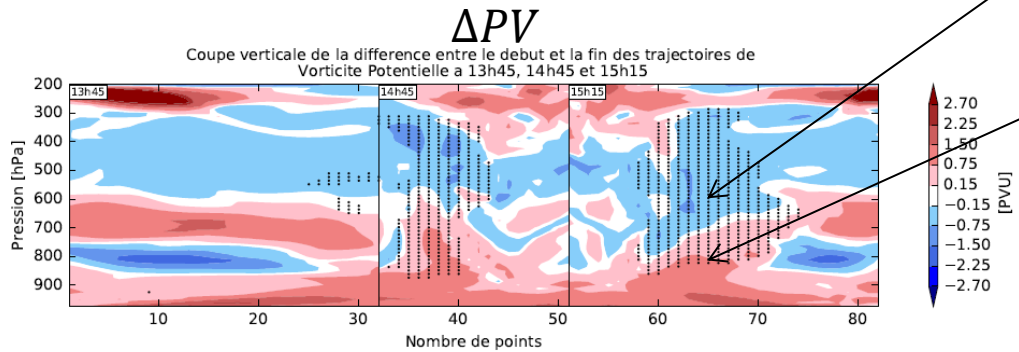
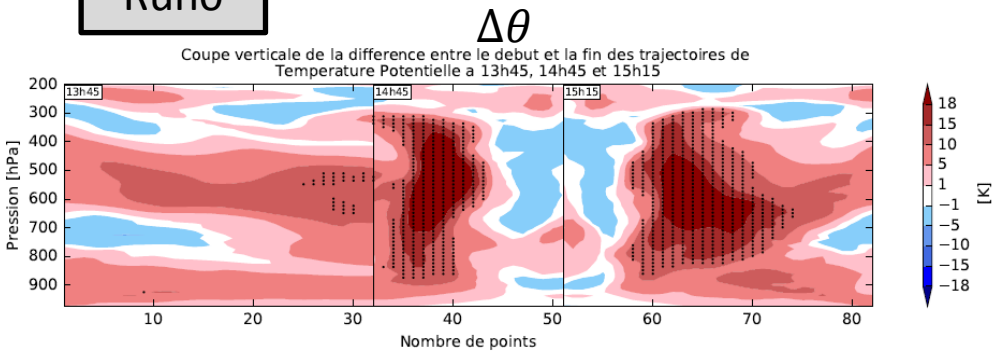
Vitesse verticale en début de trajectoire



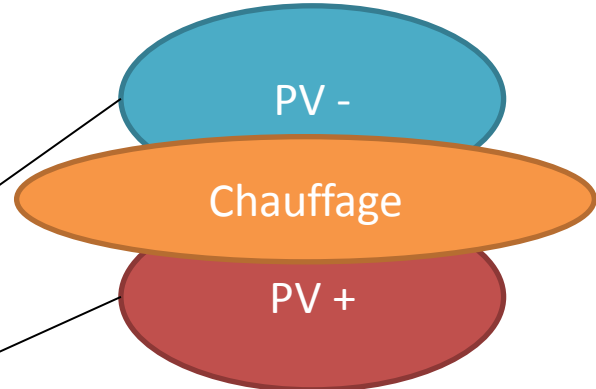
Ascendance frontale plus forte dans le Run6
 -> Chauffage en phase liquide

Lien chauffage-PV

Run0



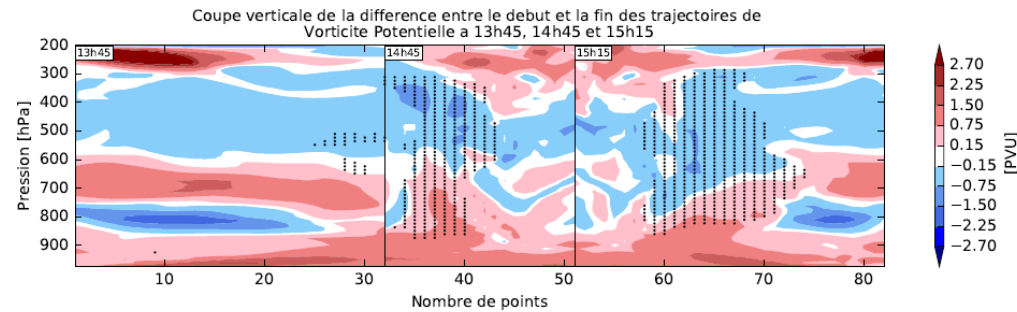
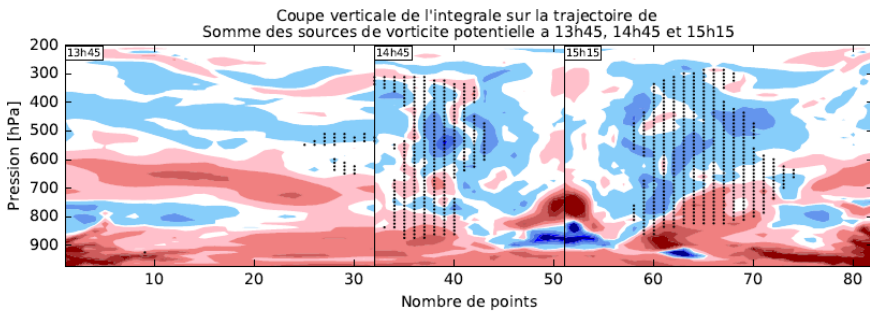
$PV \propto \nabla_z(\text{Chauffage})$



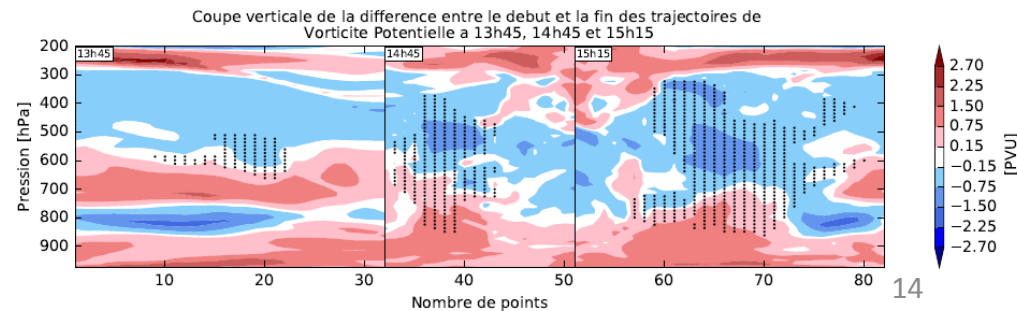
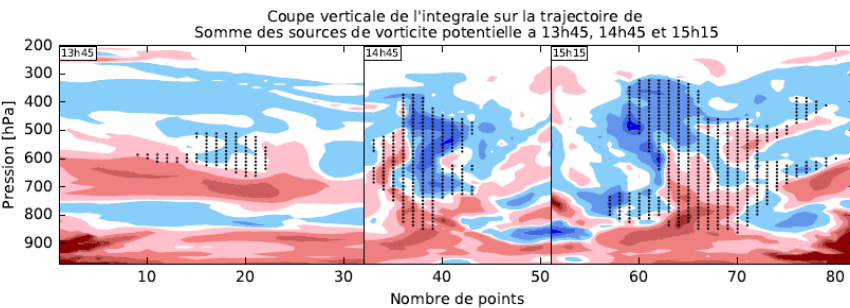
Bilan en PV

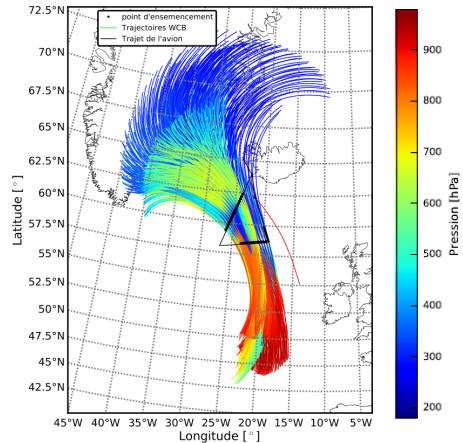
$$\int \sum_i P \dot{V}_i dt \approx \Delta PV$$

Run0



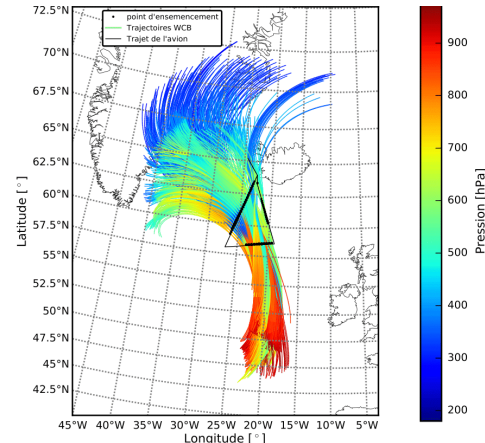
Run6



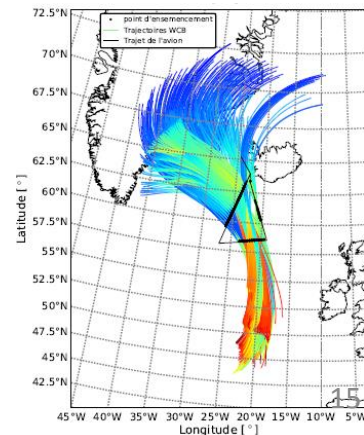
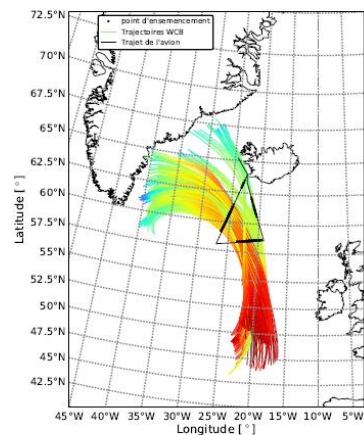
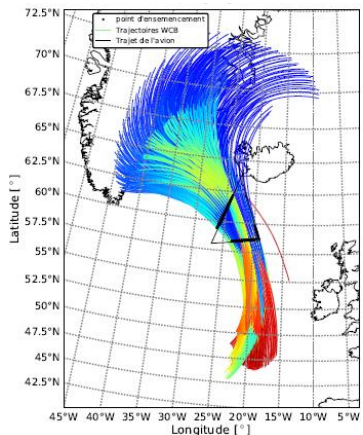
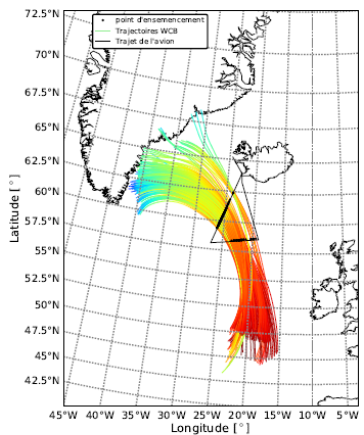


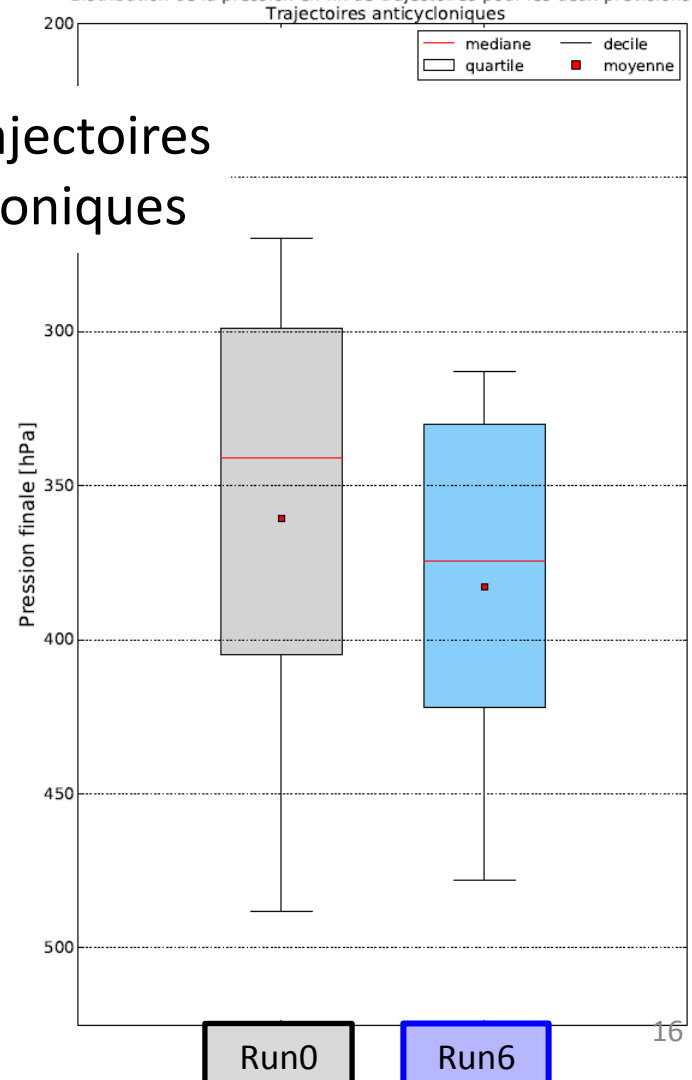
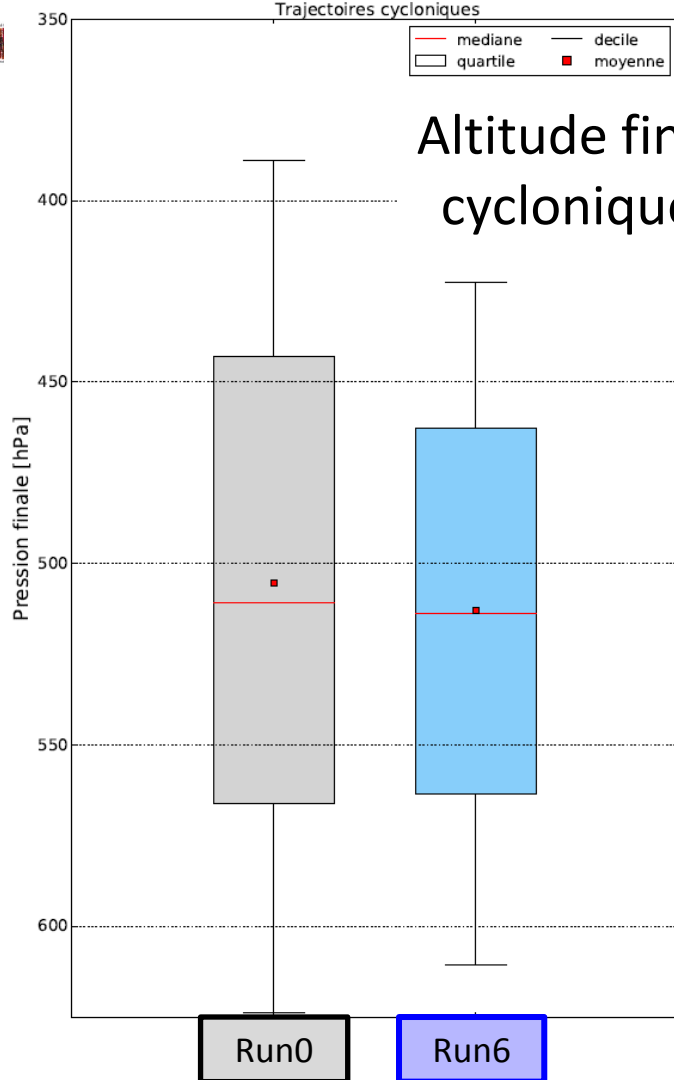
Séparation cycloniques/anticycloniques

Run0



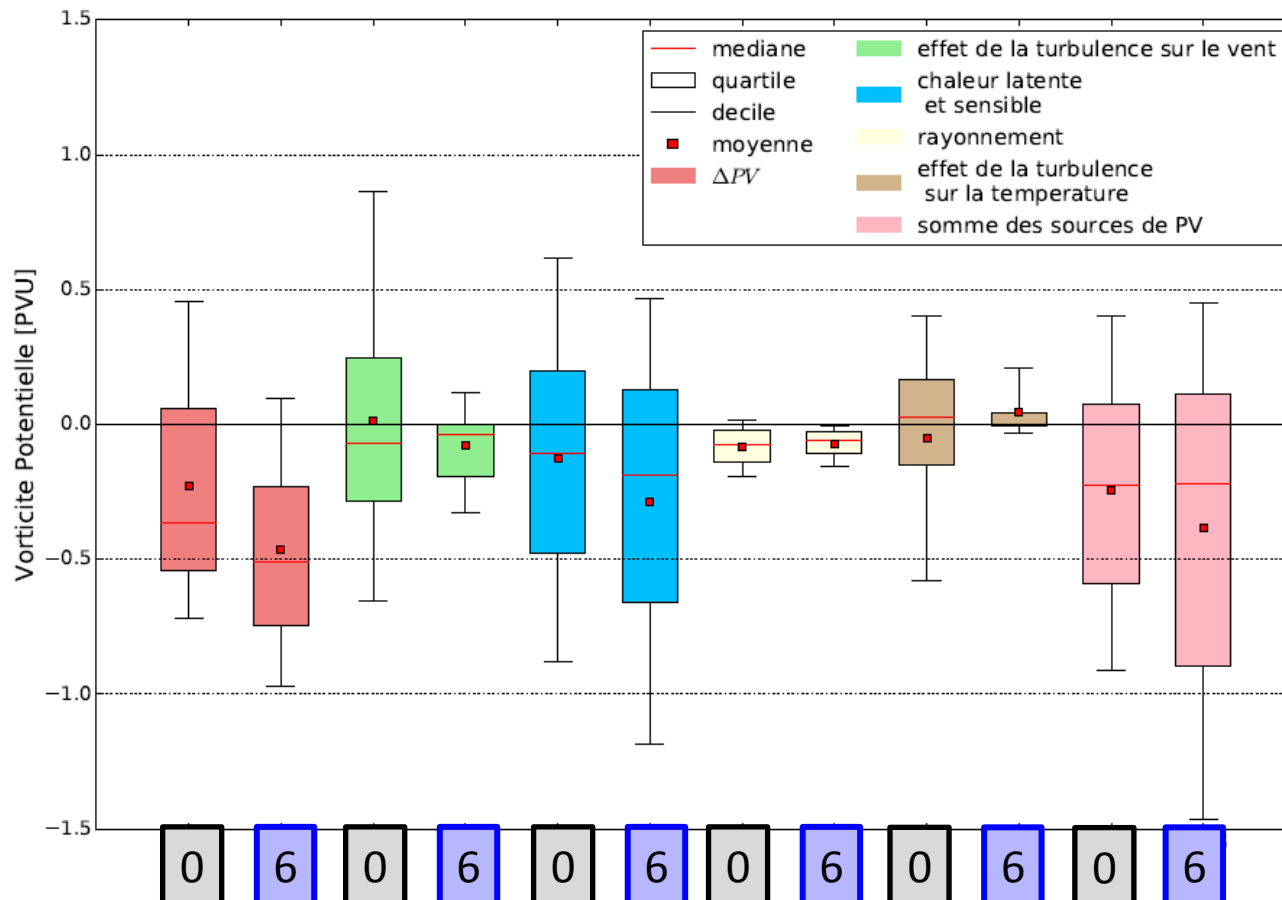
Run6





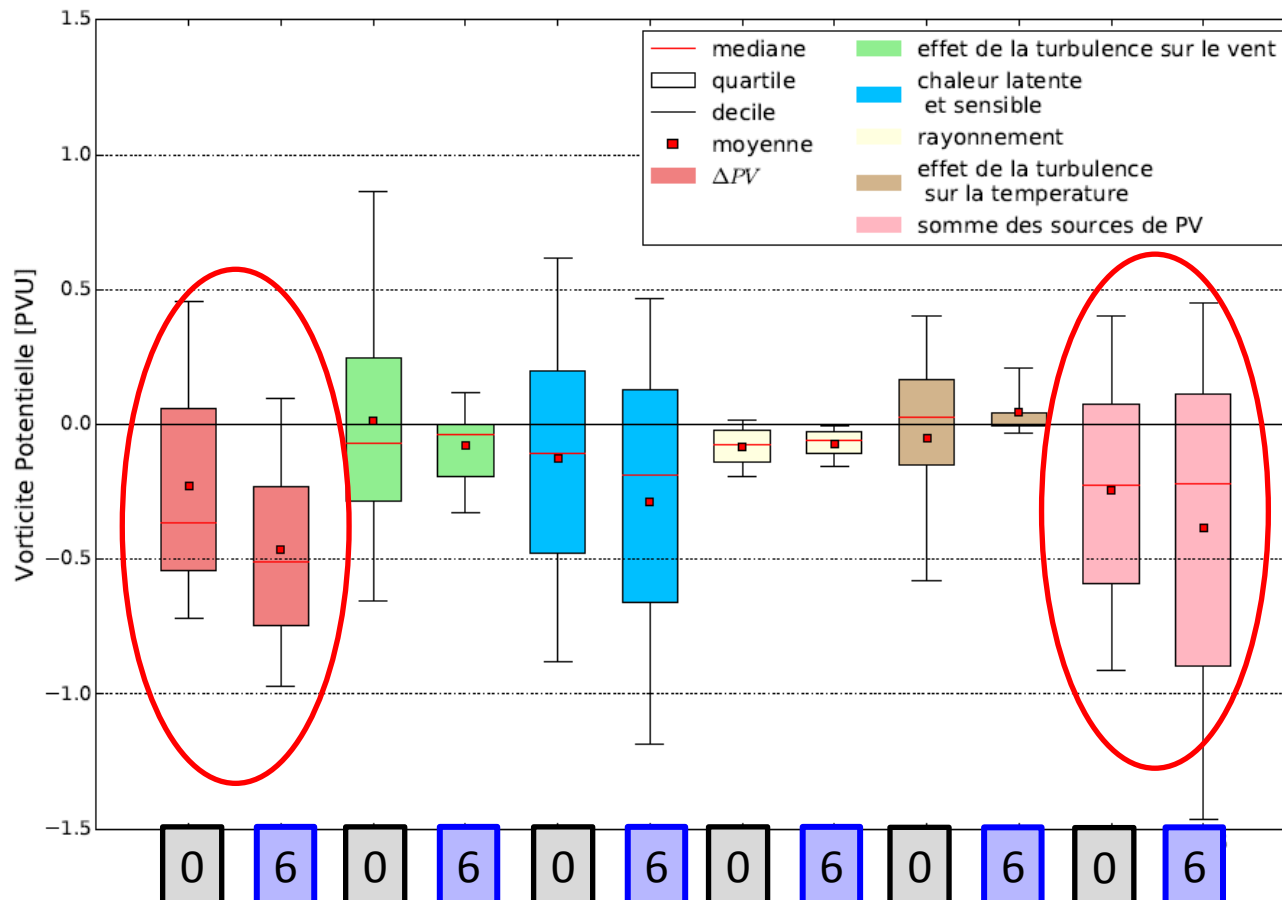


Distribution de PV pour les trajectoires anticycloniques



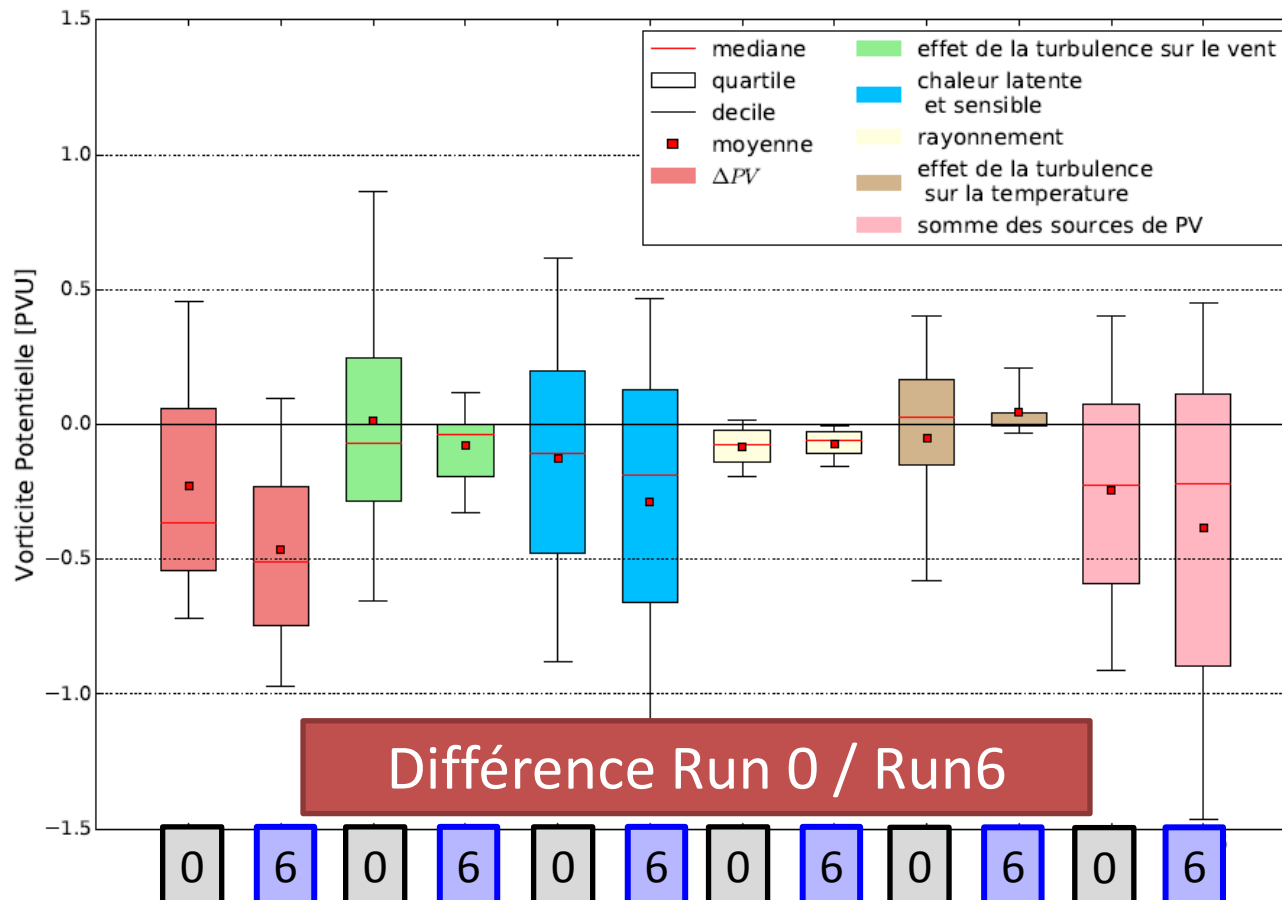


Distribution de PV pour les trajectoires anticycloniques



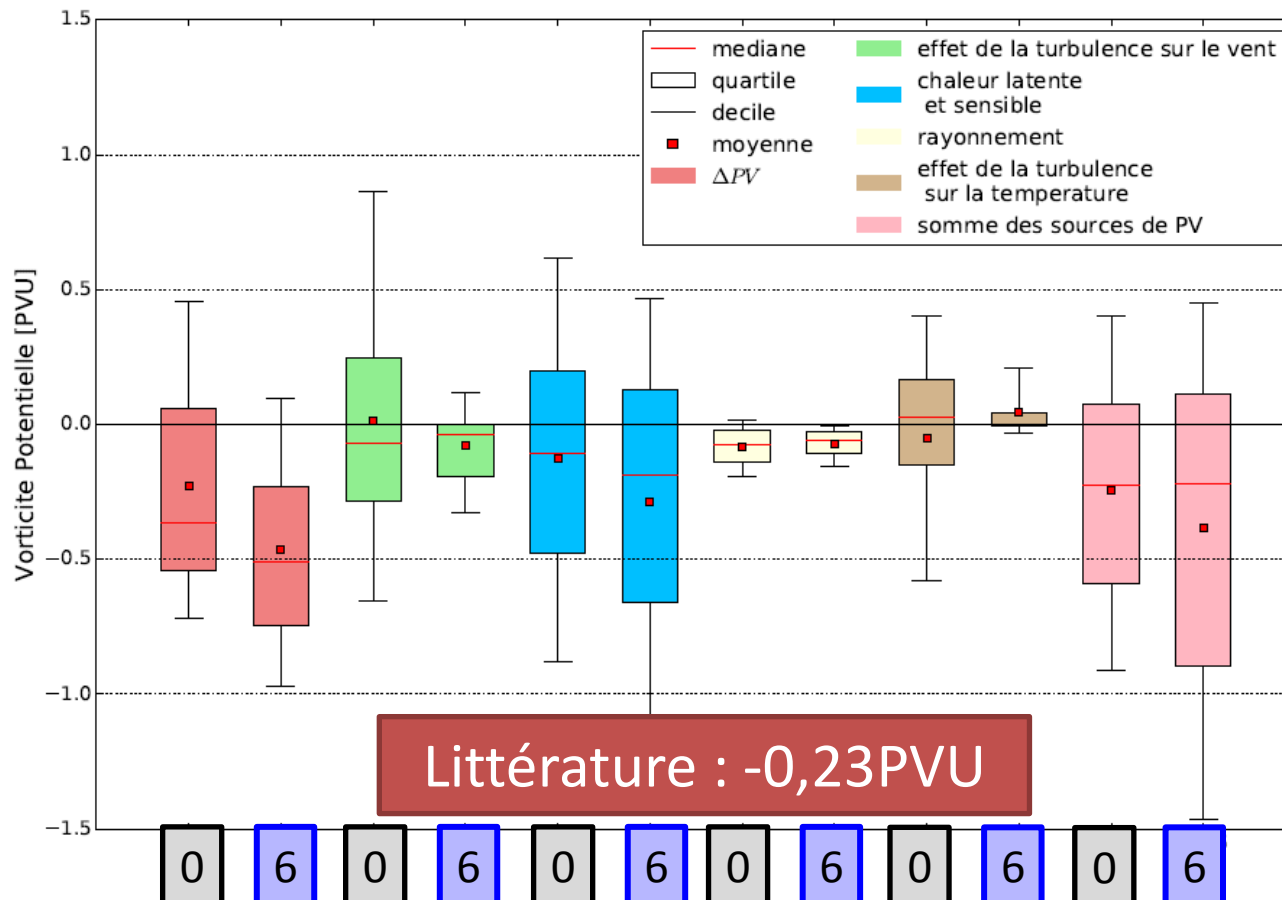


Distribution de PV pour les trajectoires anticycloniques



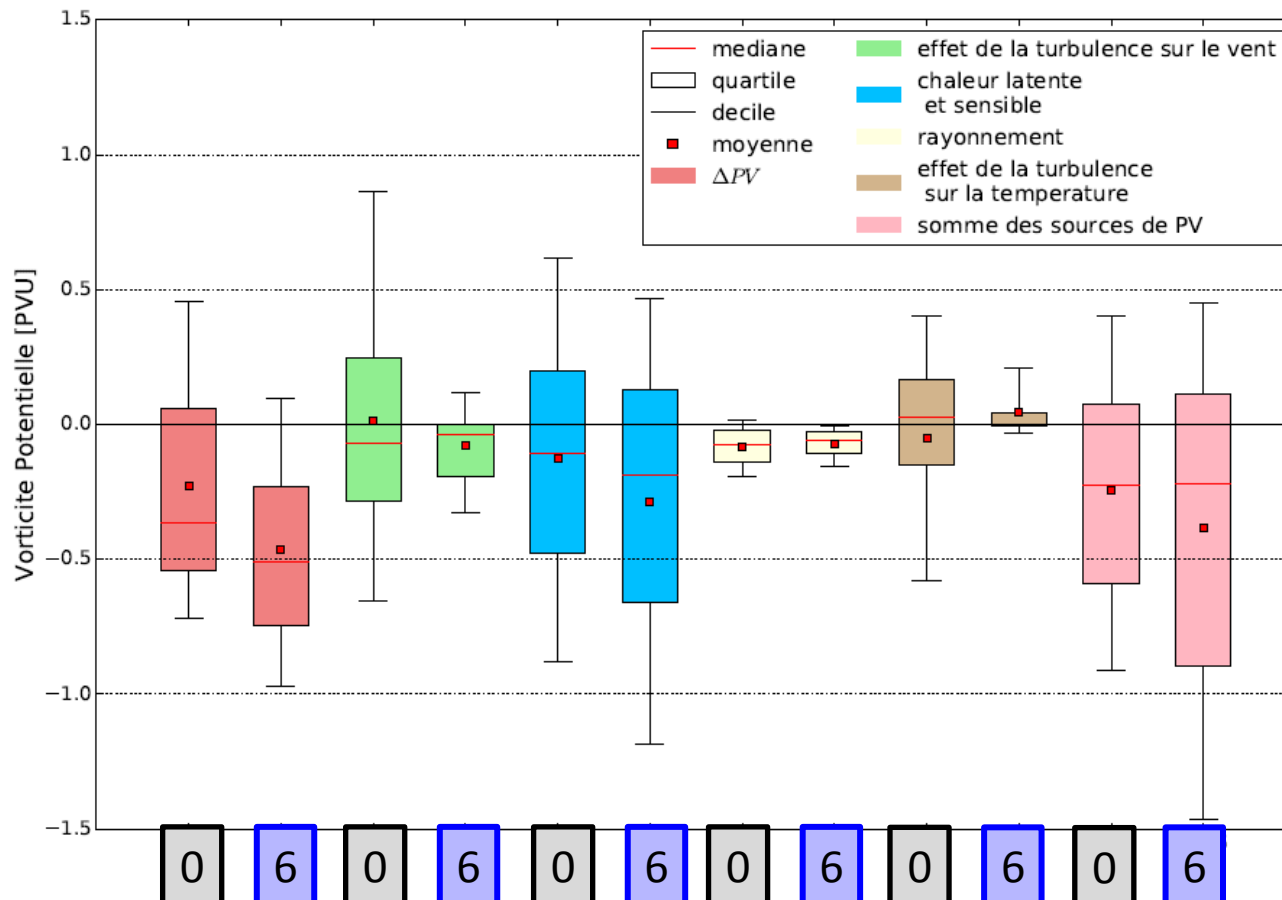


Distribution de PV pour les trajectoires anticycloniques



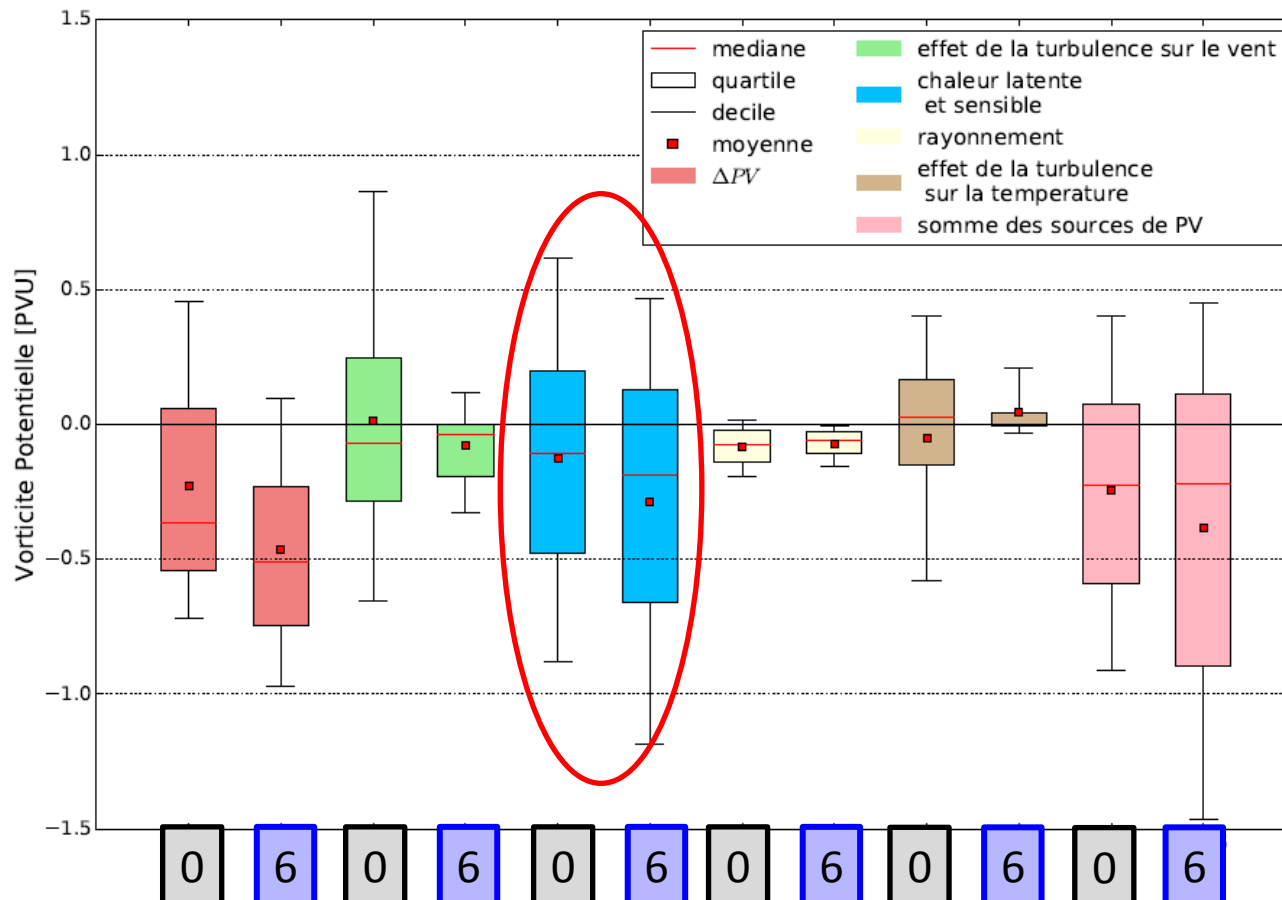


Distribution de PV pour les trajectoires anticycloniques



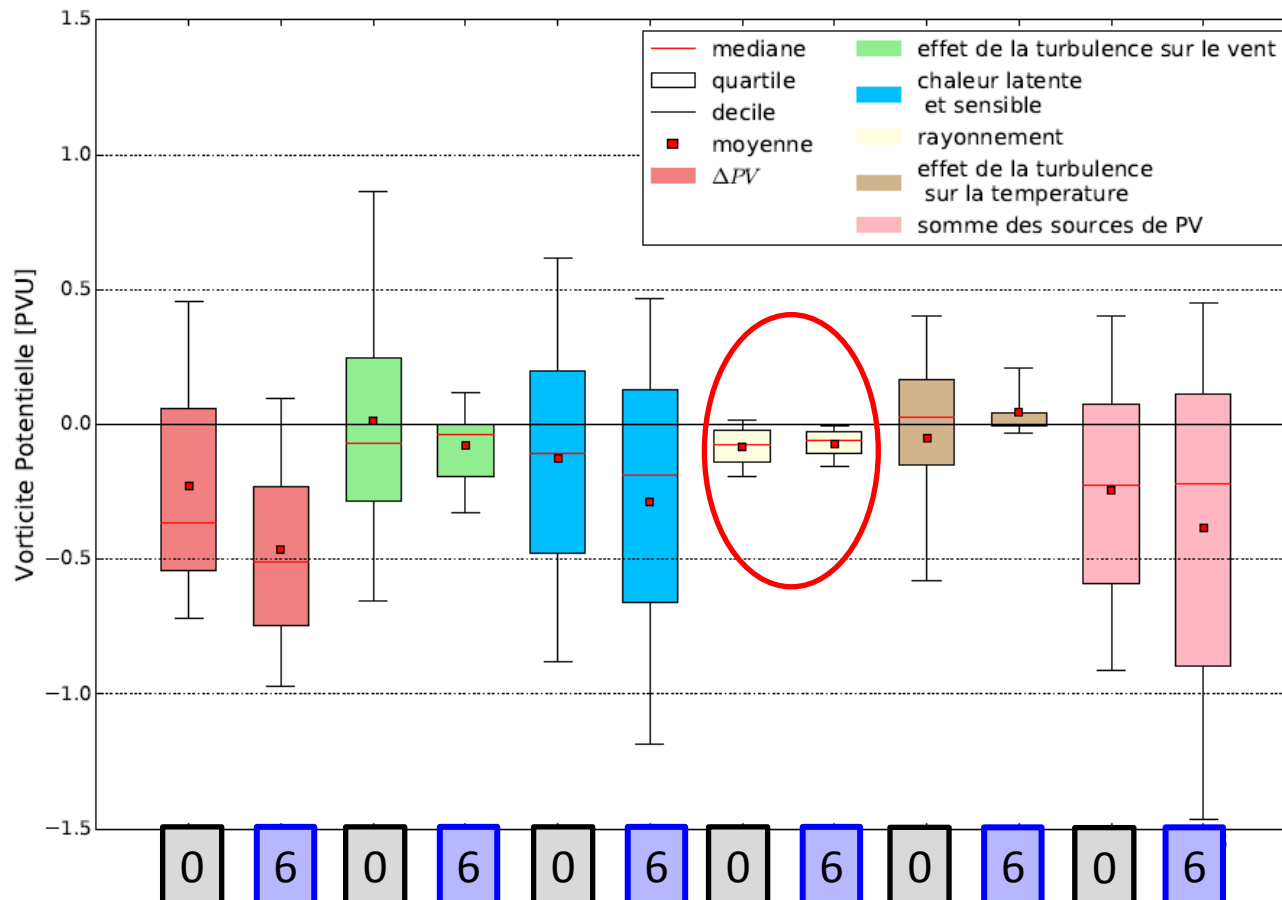


Distribution de PV pour les trajectoires anticycloniques



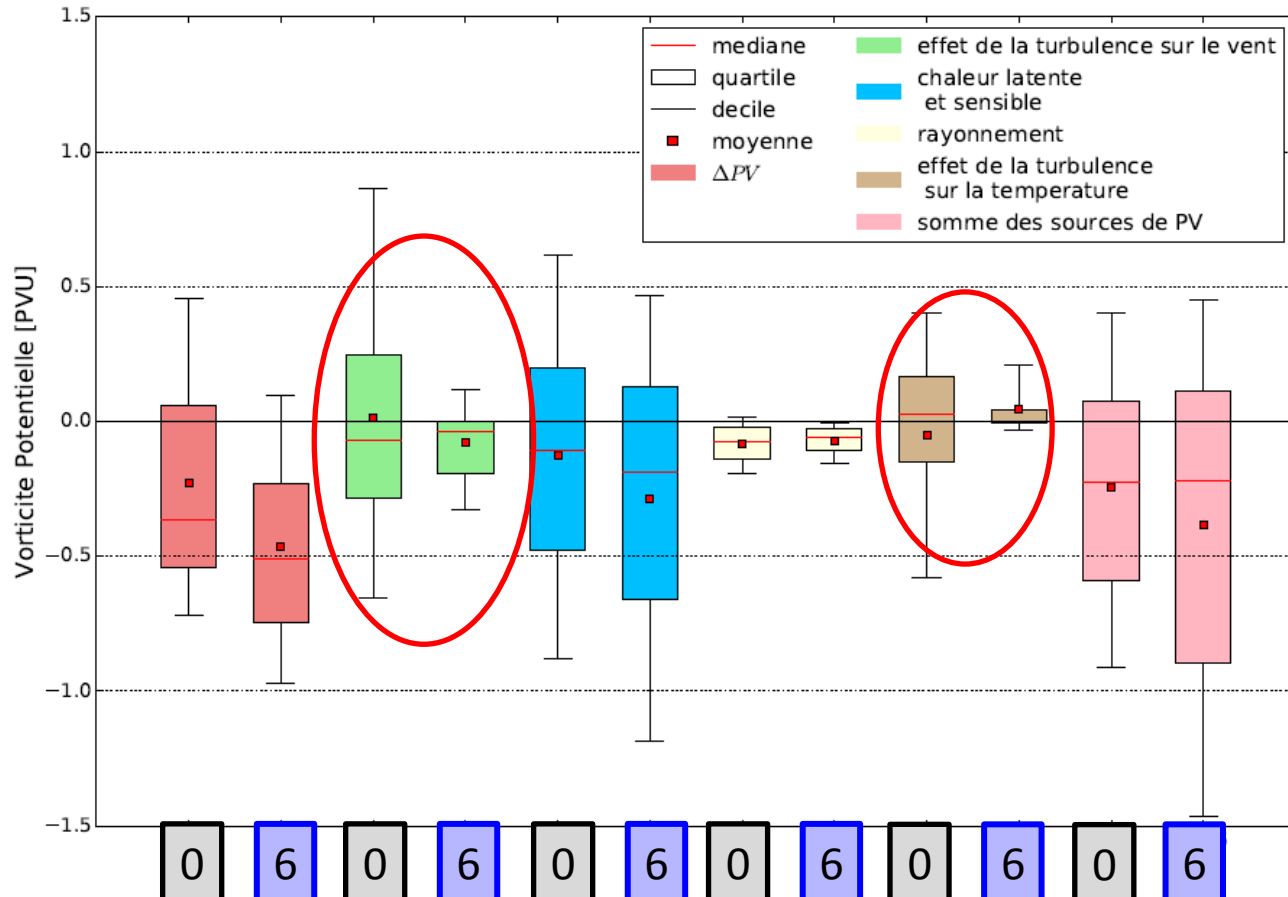


Distribution de PV pour les trajectoires anticycloniques





Distribution de PV pour les trajectoires anticycloniques



Différence entre Run0/Run6

Run0

- Nombre d'anticyclonique : +
- Chauffage en phase glace
- PV < 0 en haute altitude
- Fin plus haute
- $\Delta PV < 0 : +$

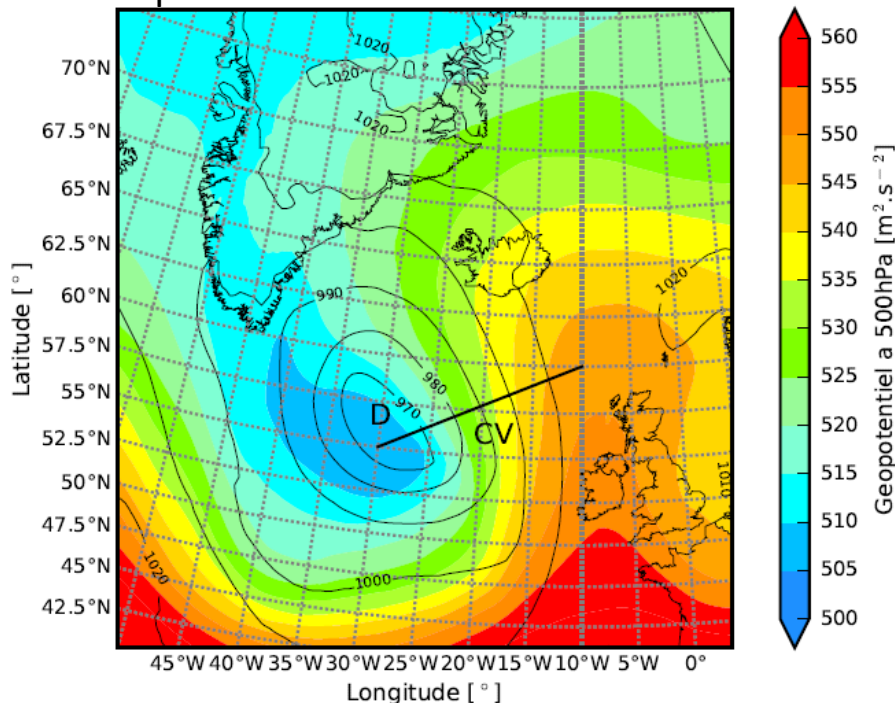
Run6

- Nombre d'anticyclonique : -
- Front froid plus instable
- Chauffage en phase liquide
- PV < 0 en milieu de troposphère
- $\Delta PV < 0 : ++$

Les WCB du vol F7 sont-elles représentatives de la WCB du Stalactite Cyclone ?

WCB indépendantes des vols

Carte de géopotentiel à 500 hPa et pression au niveau de la mer



Analyse ARPEGE, du 02/10/2016 à 12h

-12h / +12h

Critère : -300hPa en 24h

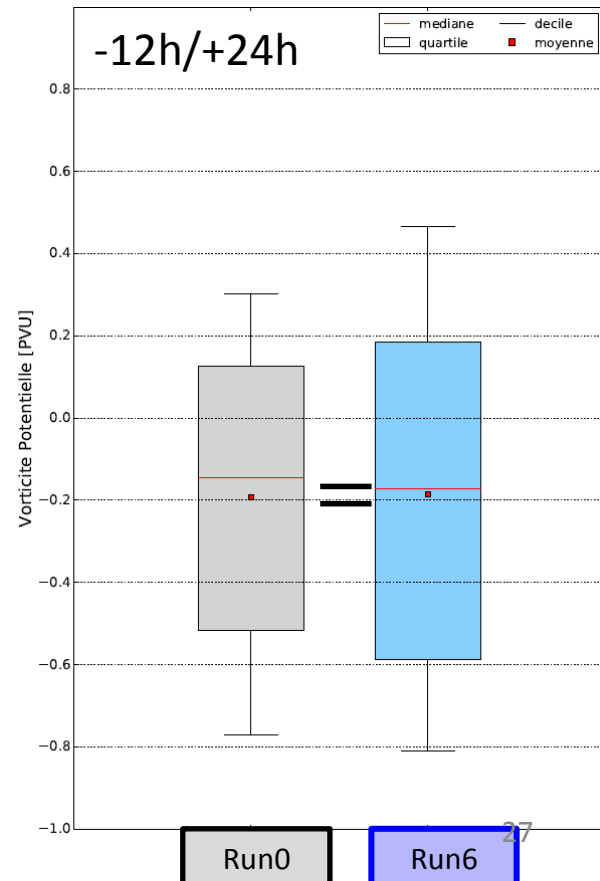
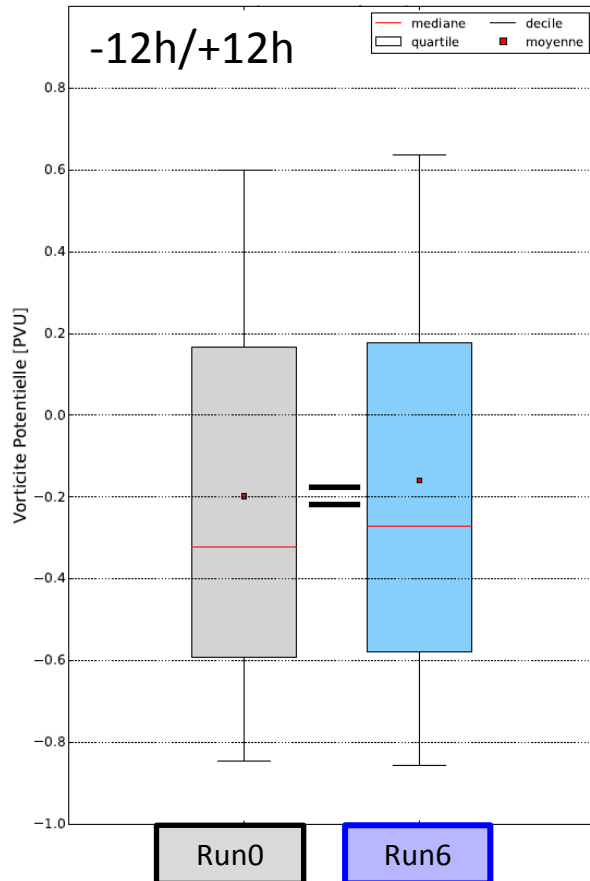
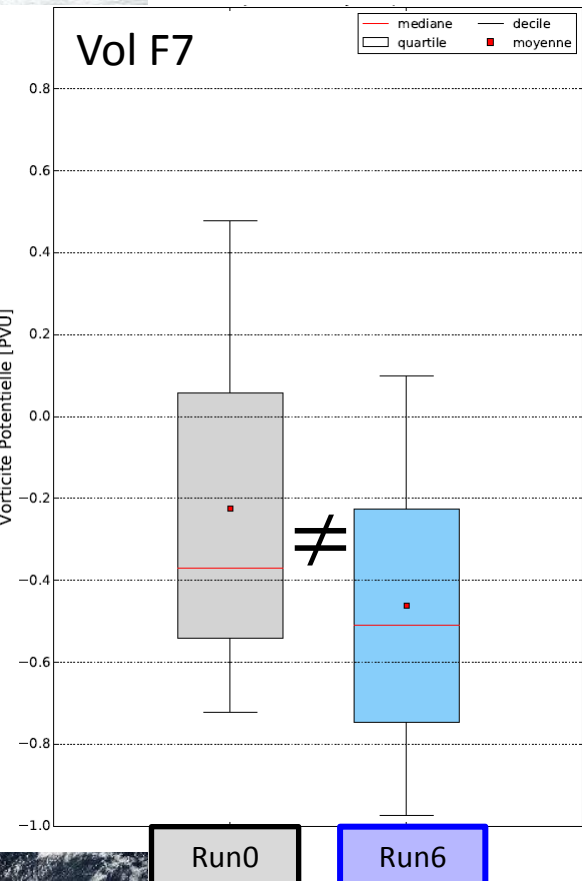
Du 02/01 à 1h au 03/01 à 0h

-12h / +24h

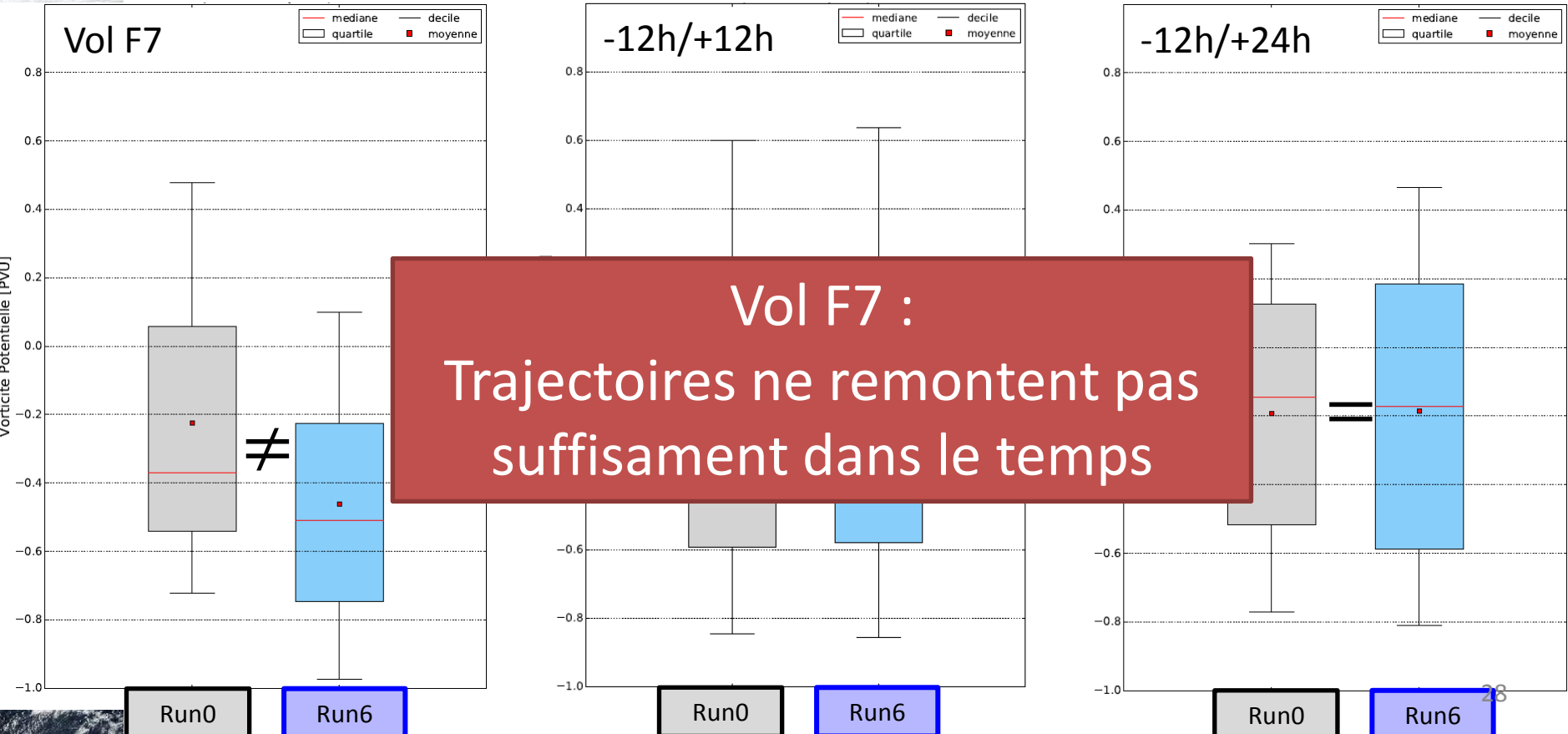
Critère : -450hPa en 36h

Du 02/01 à 0h au 02/01 à 12h

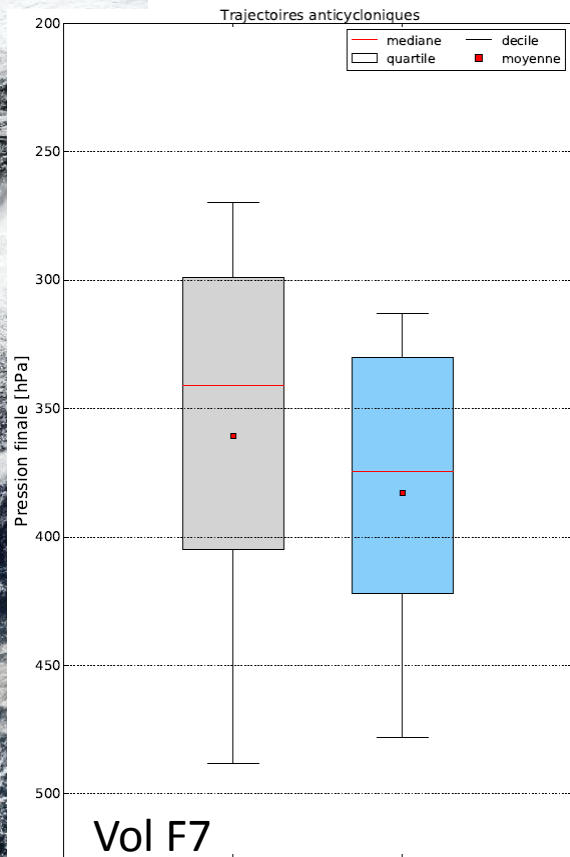
$$\Delta PV_{Run0} \sim \Delta PV_{Run6}$$



$$\Delta PV_{Run0} \sim \Delta PV_{Run6}$$

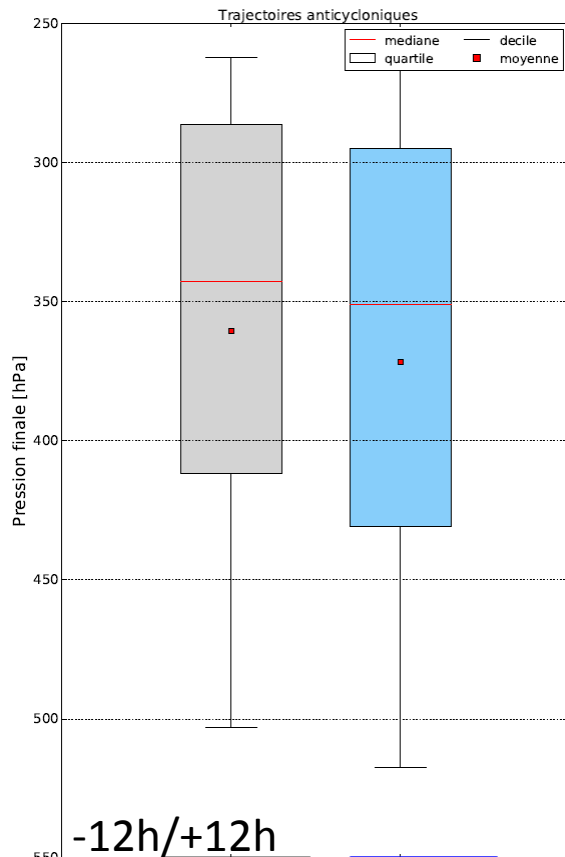


Pression finale : $P_{Run0} < P_{Run6}$



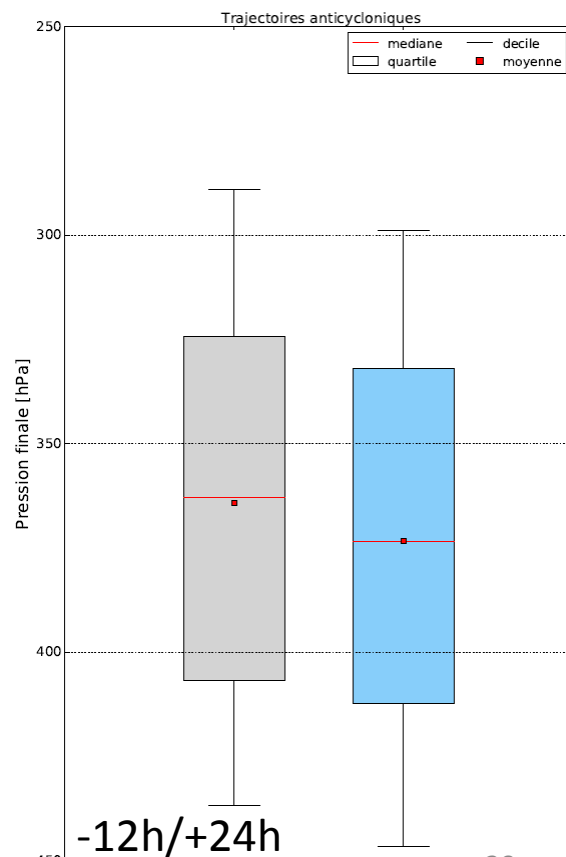
Run0

Run6



Run0

Run6



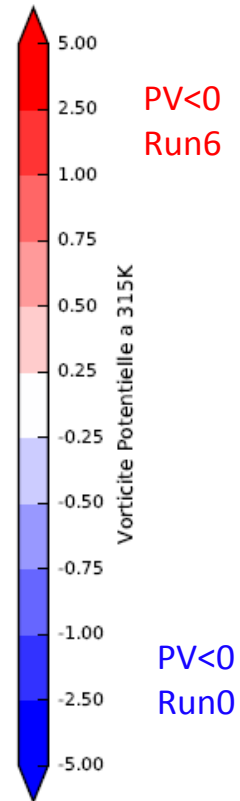
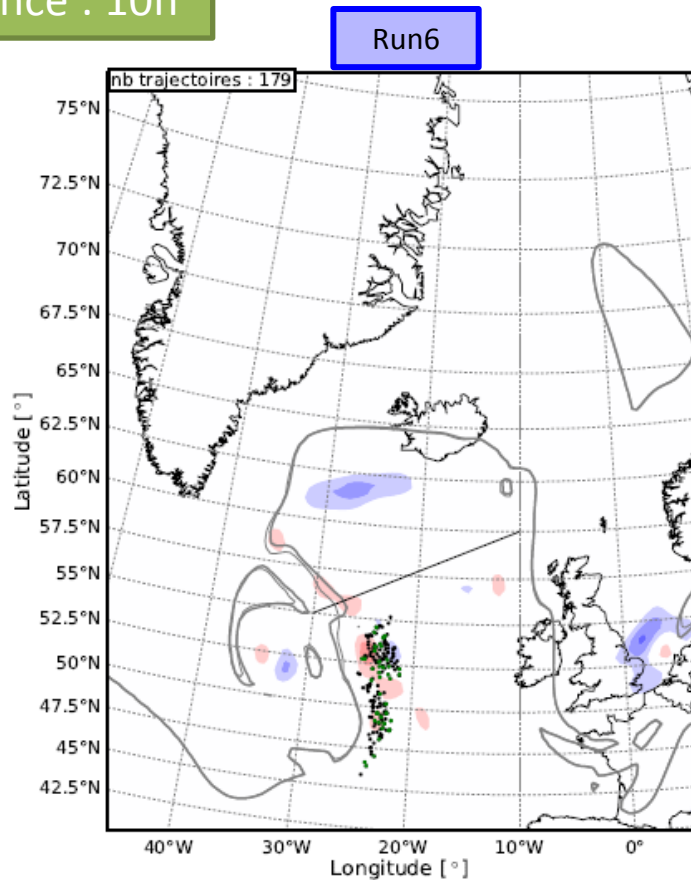
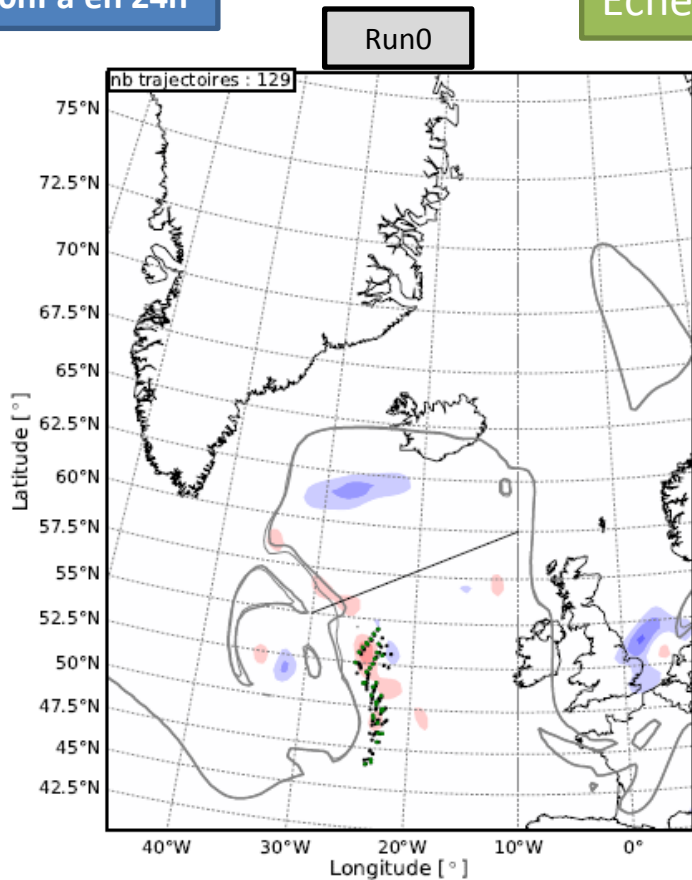
Run0

Run6

Trajectoires anticycloniques dépassant 315K

-12h/+12h
Critère : -300hPa en 24h

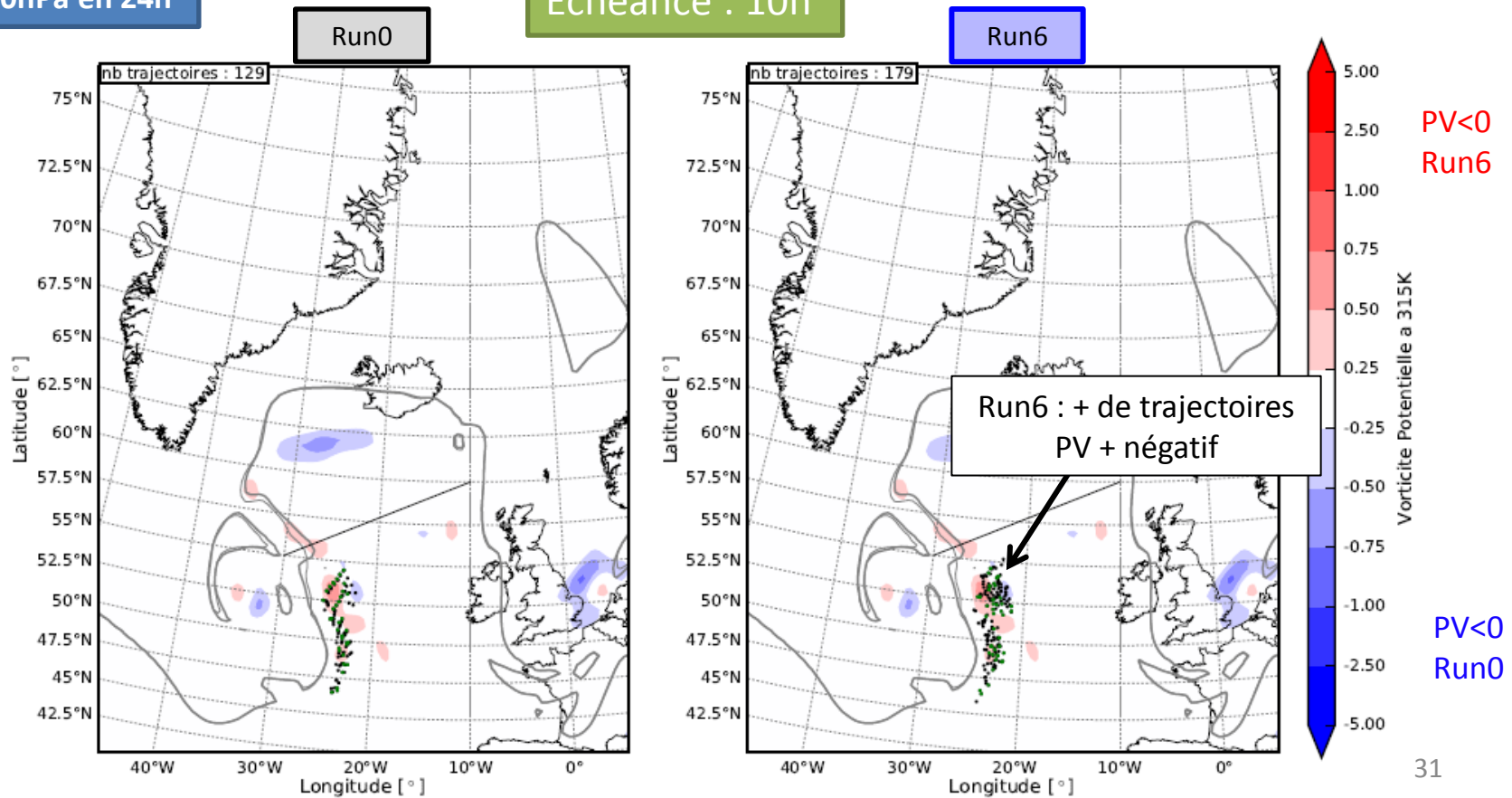
Echeance : 10h



Trajectoires anticycloniques dépassant 315K

-12h/+12h
Critère : -300hPa en 24h

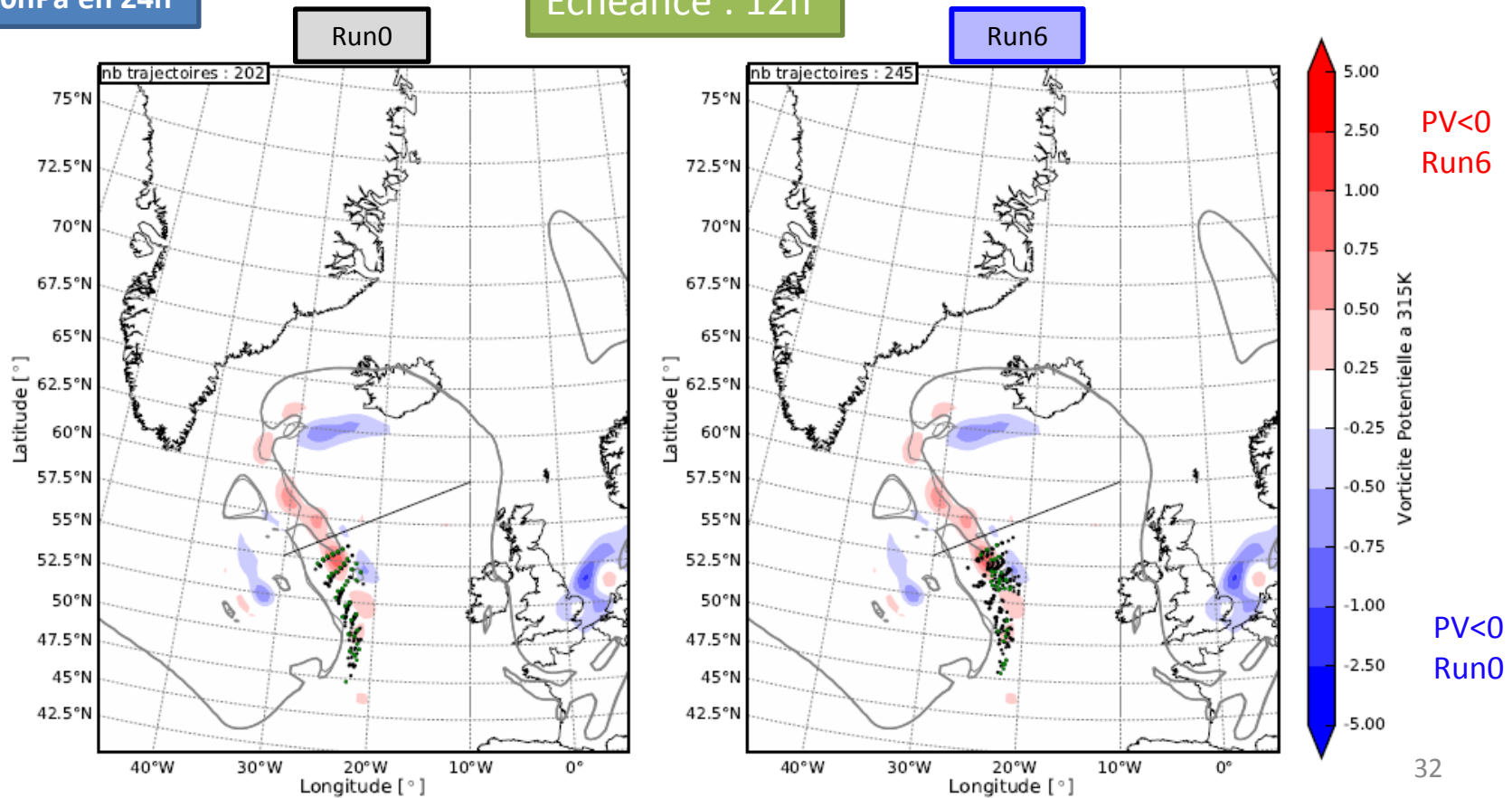
Echeance : 10h



Trajectoires anticycloniques dépassant 315K

-12h/+12h
Critère : -300hPa en 24h

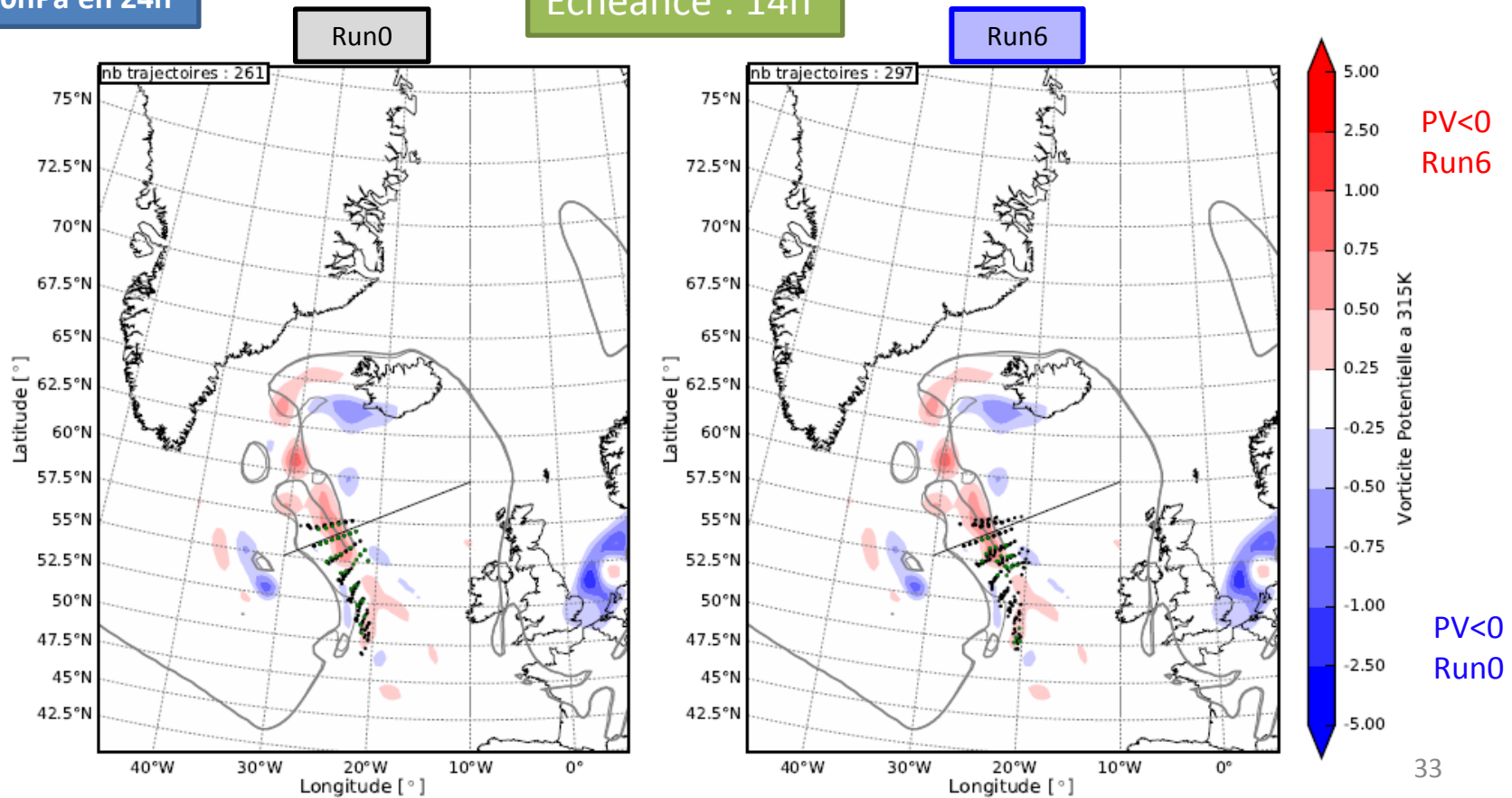
Echeance : 12h



Trajectoires anticycloniques dépassant 315K

-12h/+12h
Critère : -300hPa en 24h

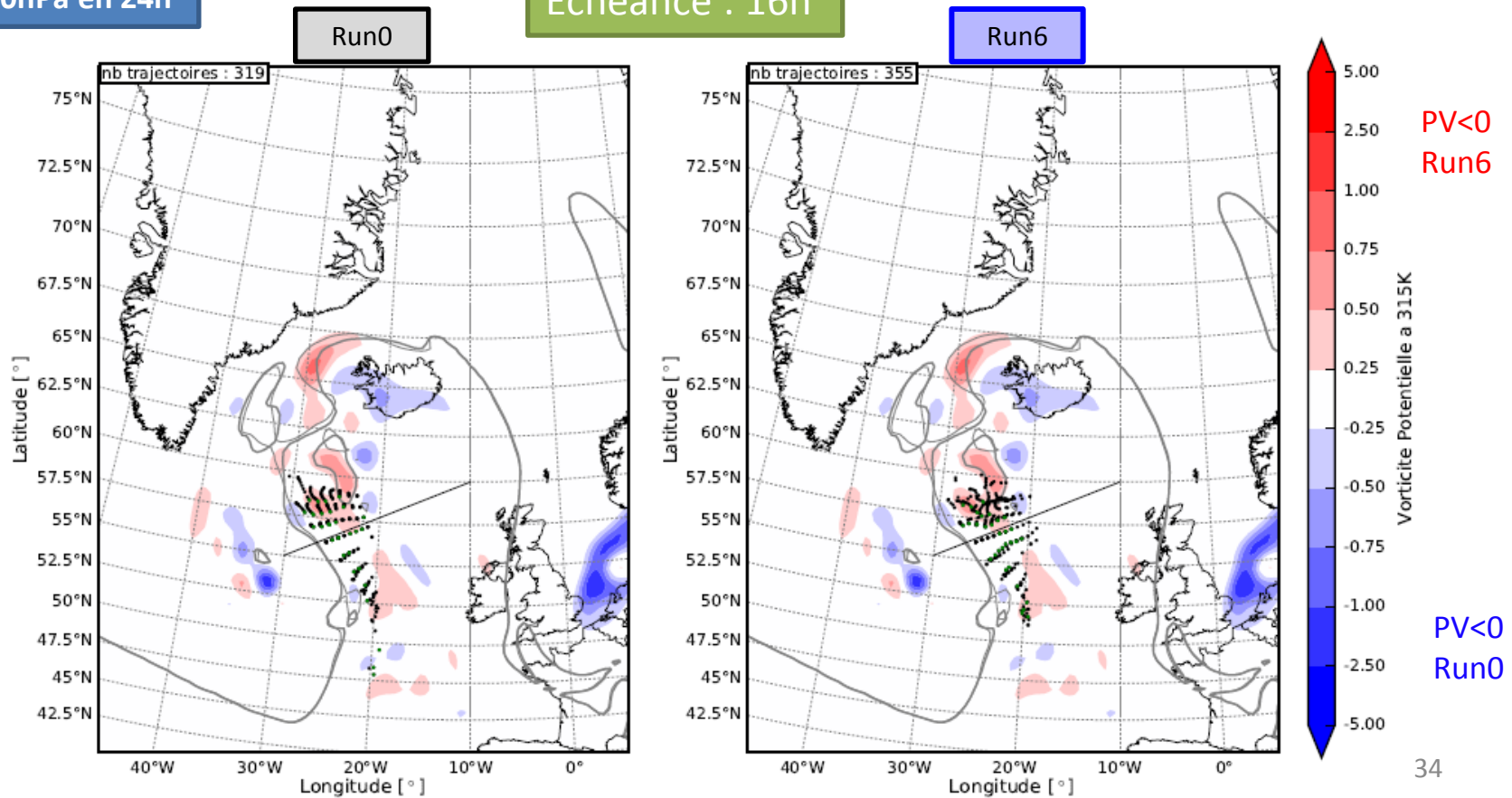
Echeance : 14h



Trajectoires anticycloniques dépassant 315K

-12h/+12h
Critère : -300hPa en 24h

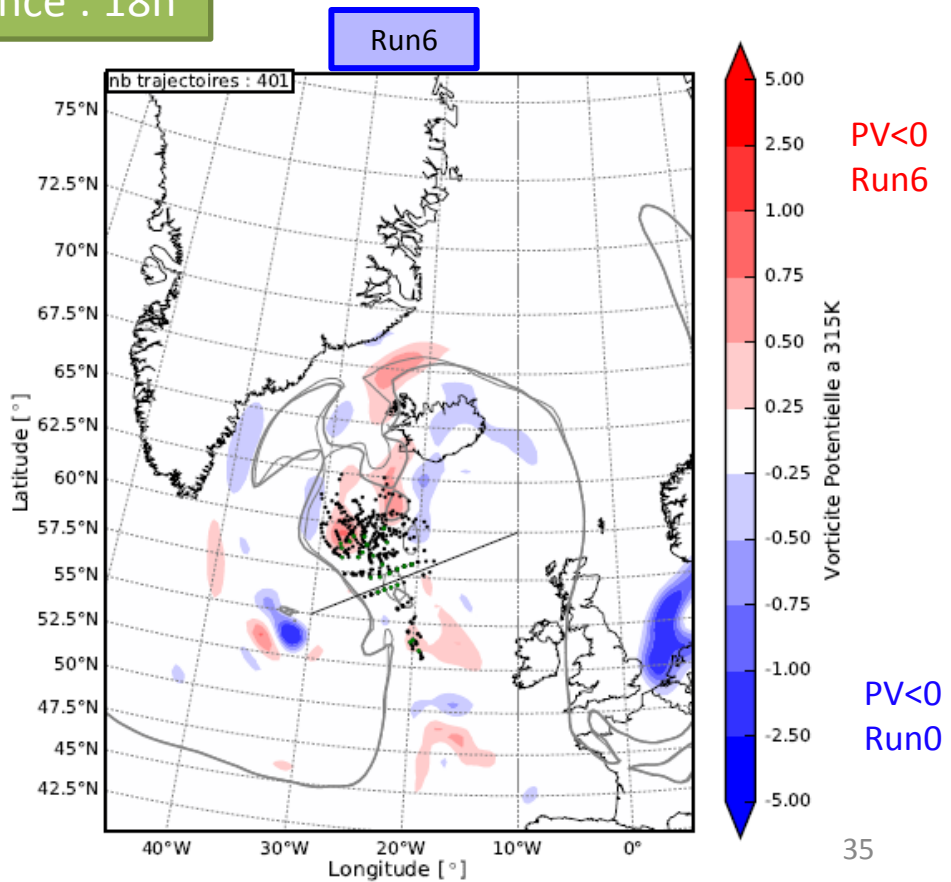
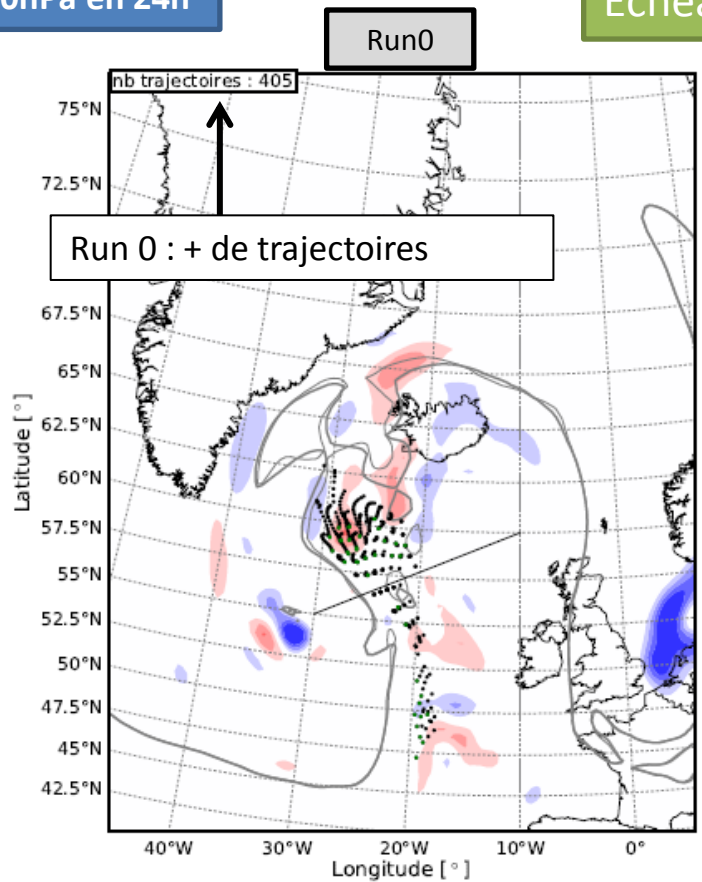
Echeance : 16h



Trajectoires anticycloniques dépassant 315K

-12h/+12h
Critère : -300hPa en 24h

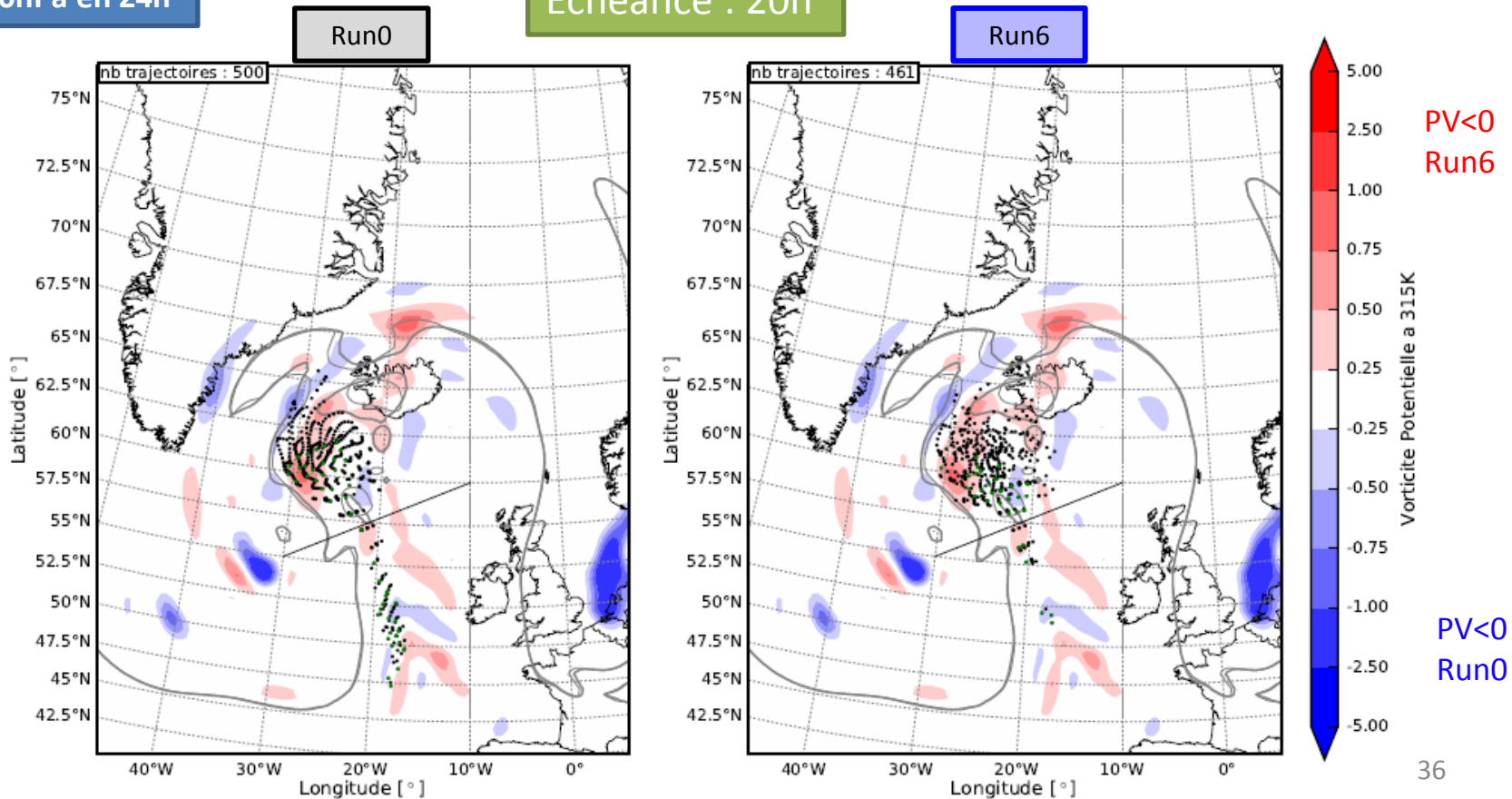
Echeance : 18h



Trajectoires anticycloniques dépassant 315K

-12h/+12h
Critère : -300hPa en 24h

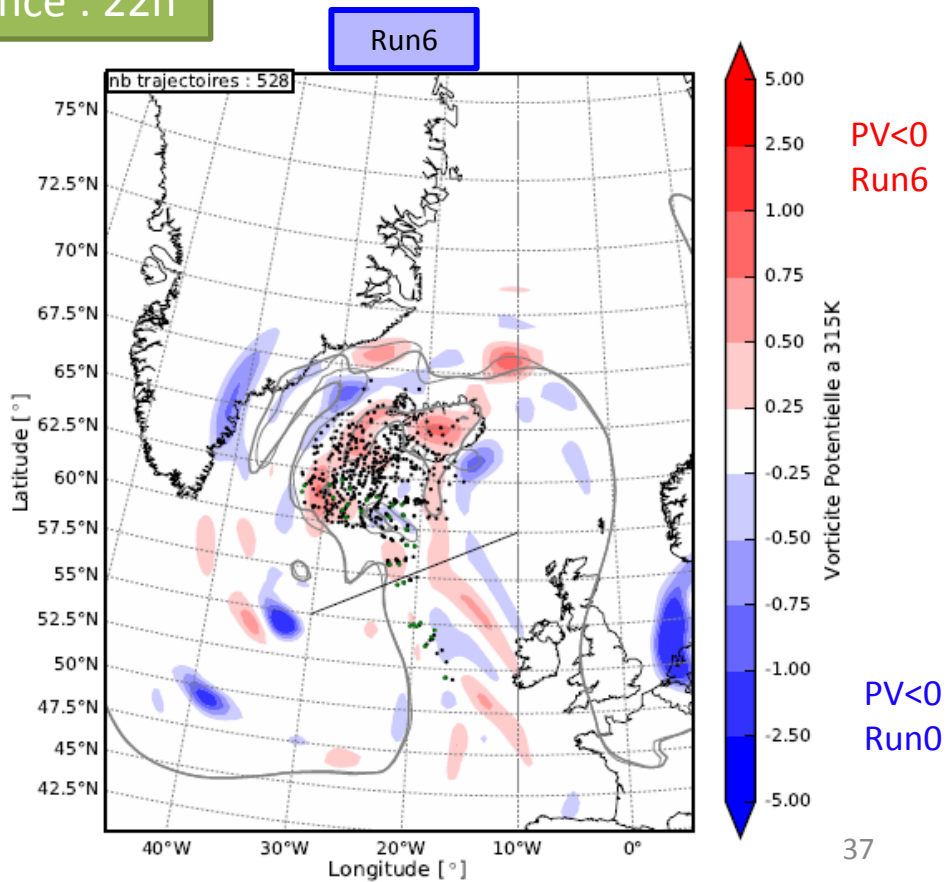
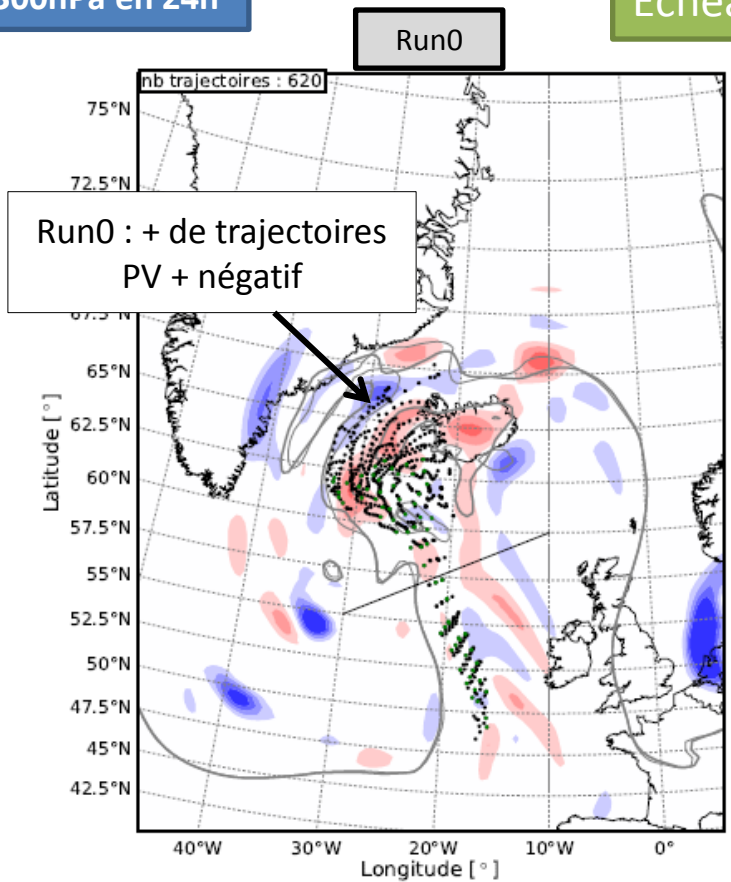
Echeance : 20h



Trajectoires anticycloniques dépassant 315K

-12h/+12h
Critère : -300hPa en 24h

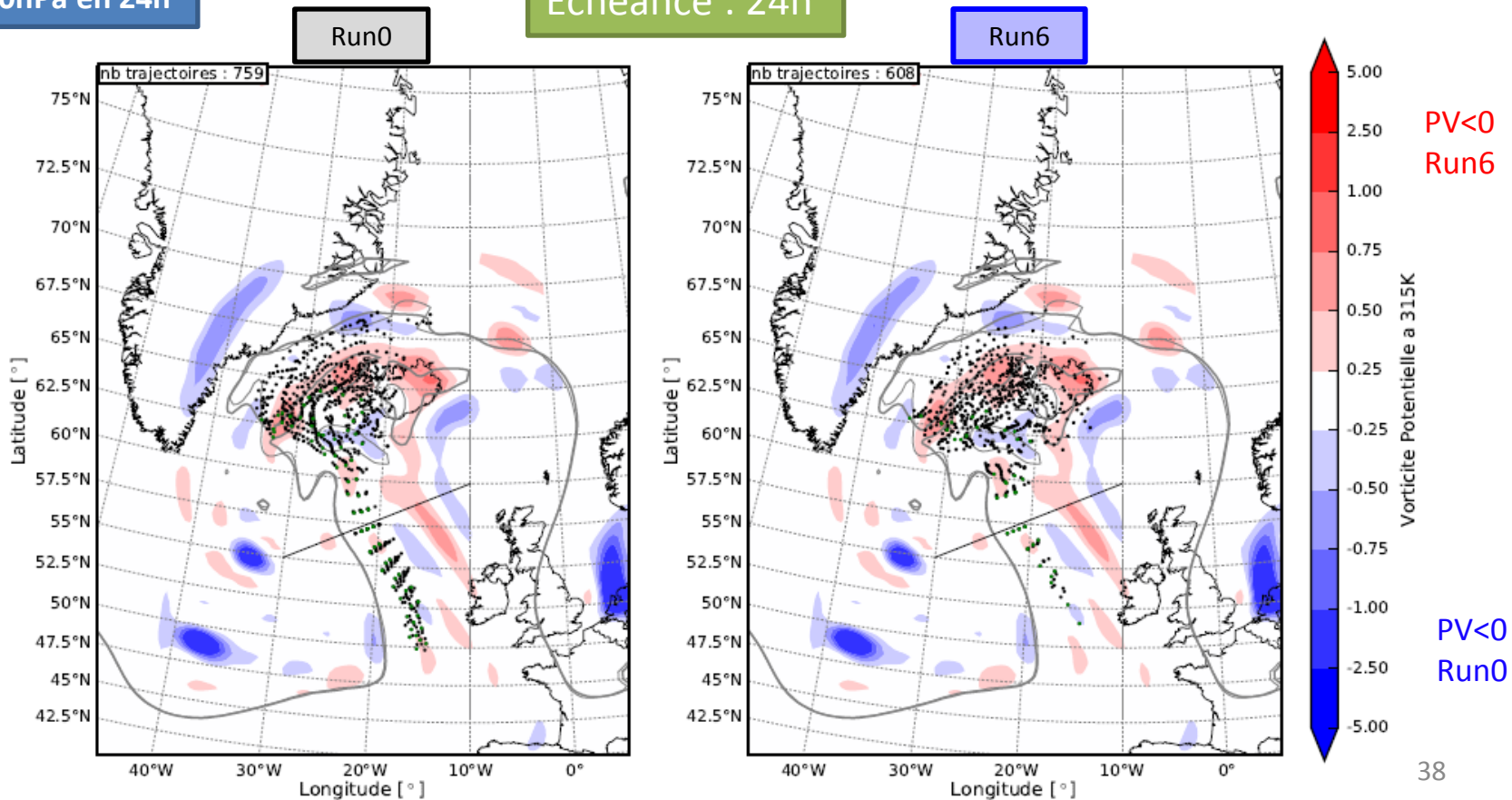
Echeance : 22h



Trajectoires anticycloniques dépassant 315K

-12h/+12h
Critère : -300hPa en 24h

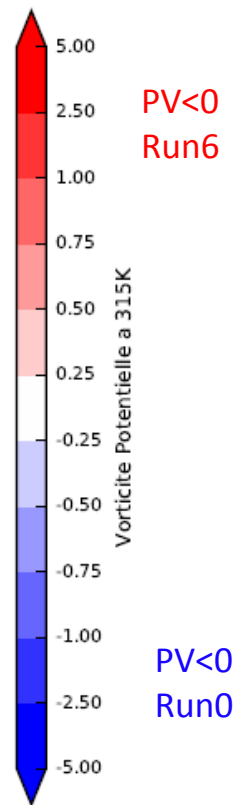
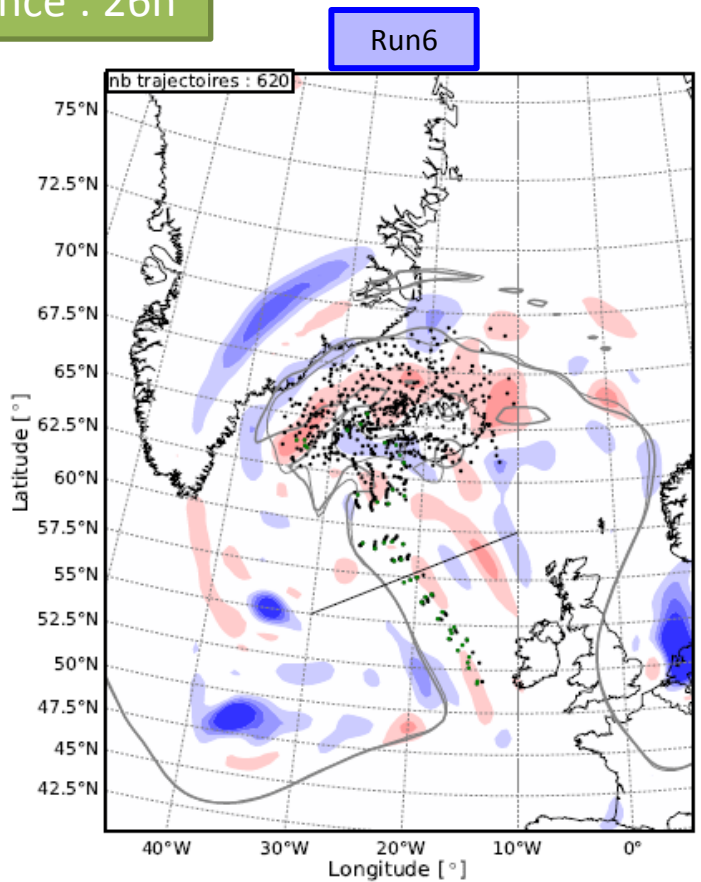
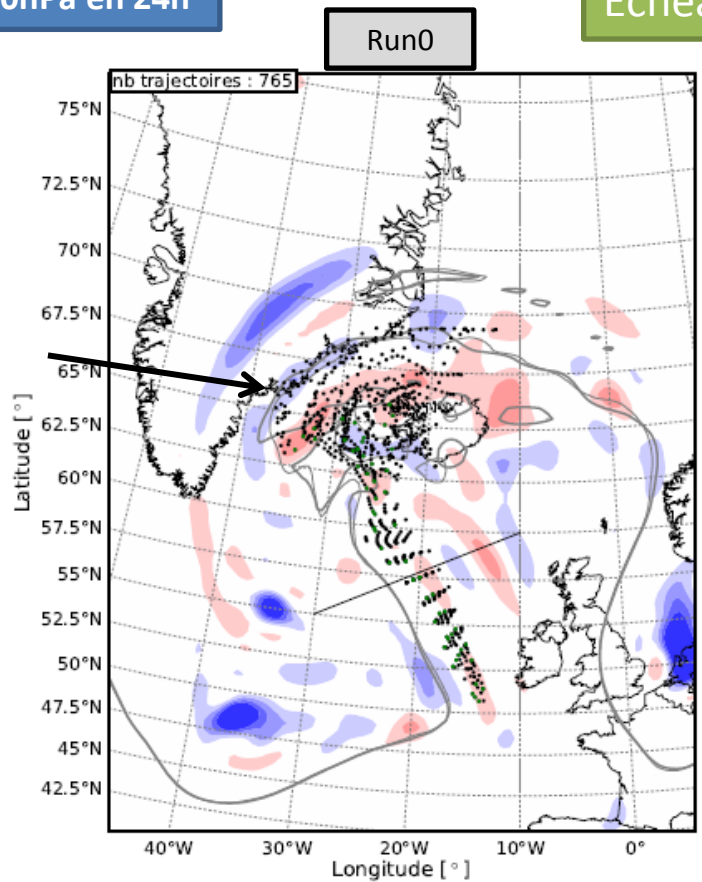
Echeance : 24h



Trajectoires anticycloniques dépassant 315K

-12h/+12h
Critère : -300hPa en 24h

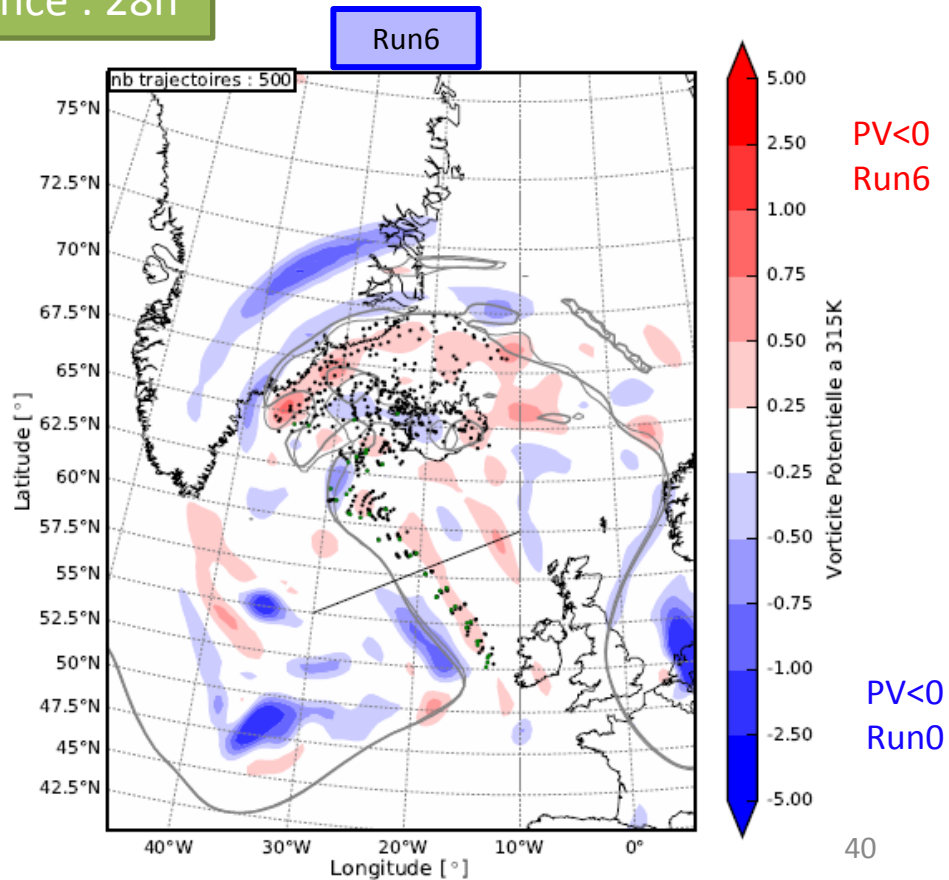
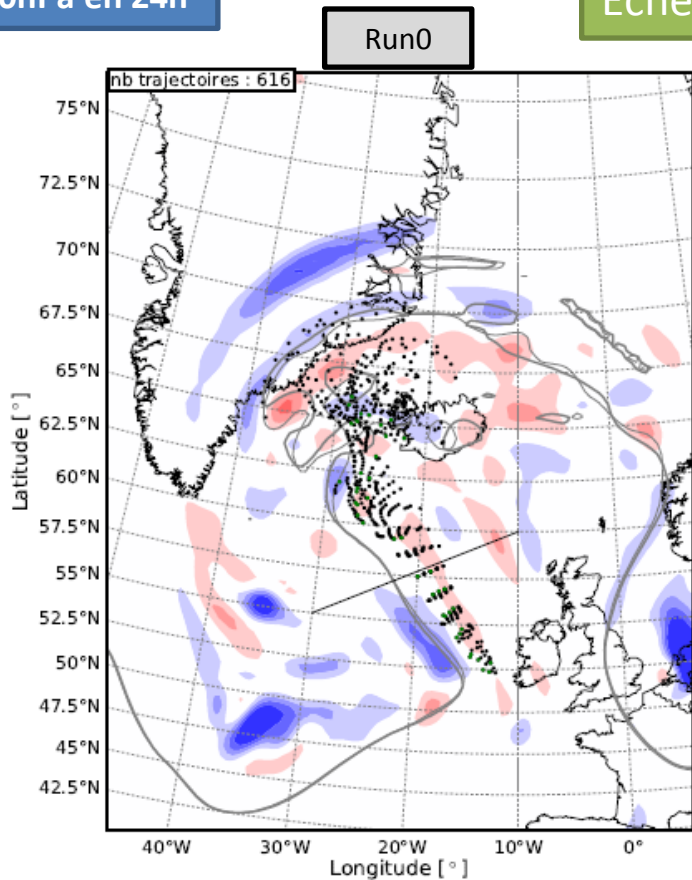
Echeance : 26h



Trajectoires anticycloniques dépassant 315K

-12h/+12h
Critère : -300hPa en 24h

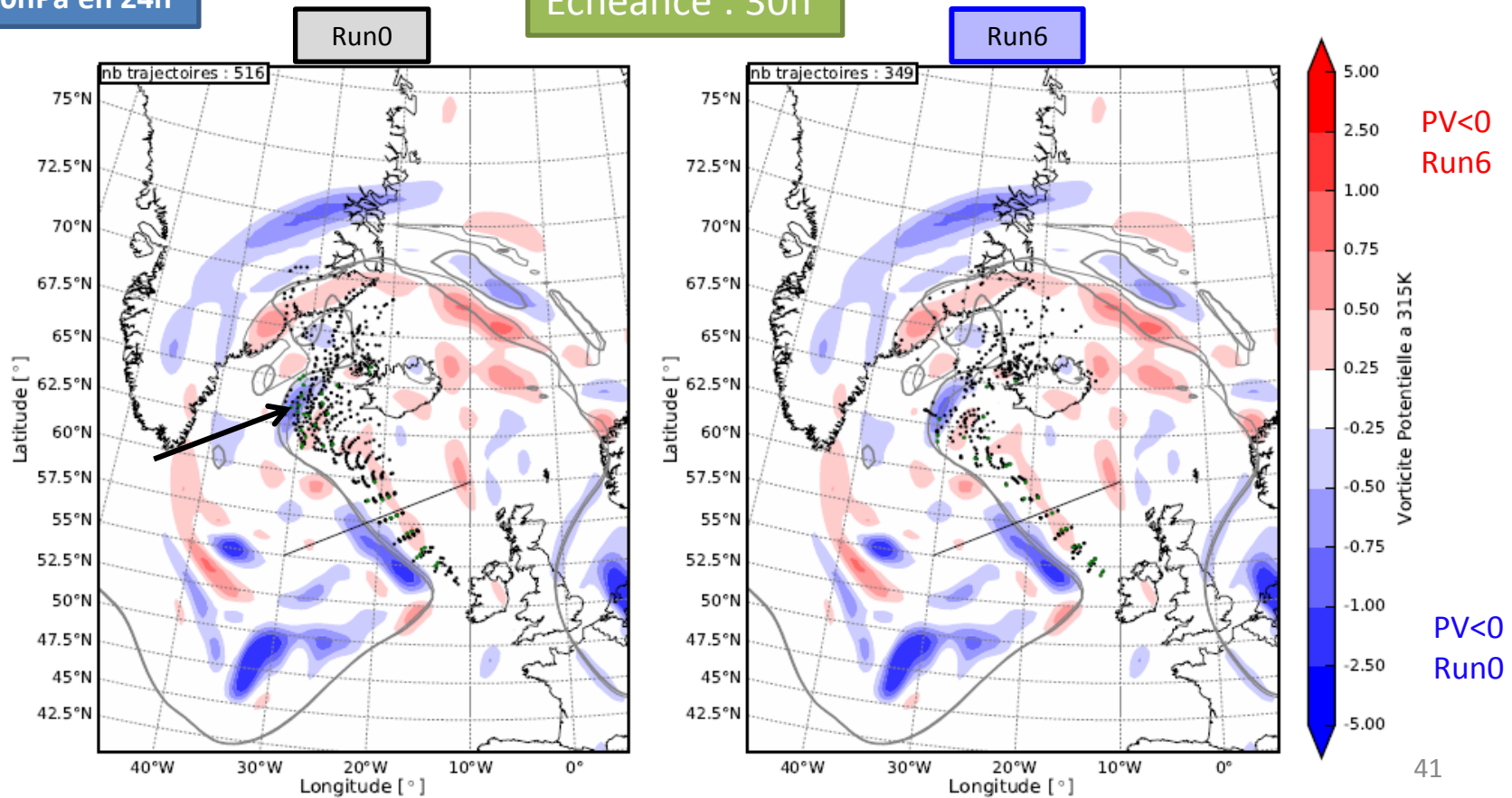
Echeance : 28h



Trajectoires anticycloniques dépassant 315K

-12h/+12h
Critère : -300hPa en 24h

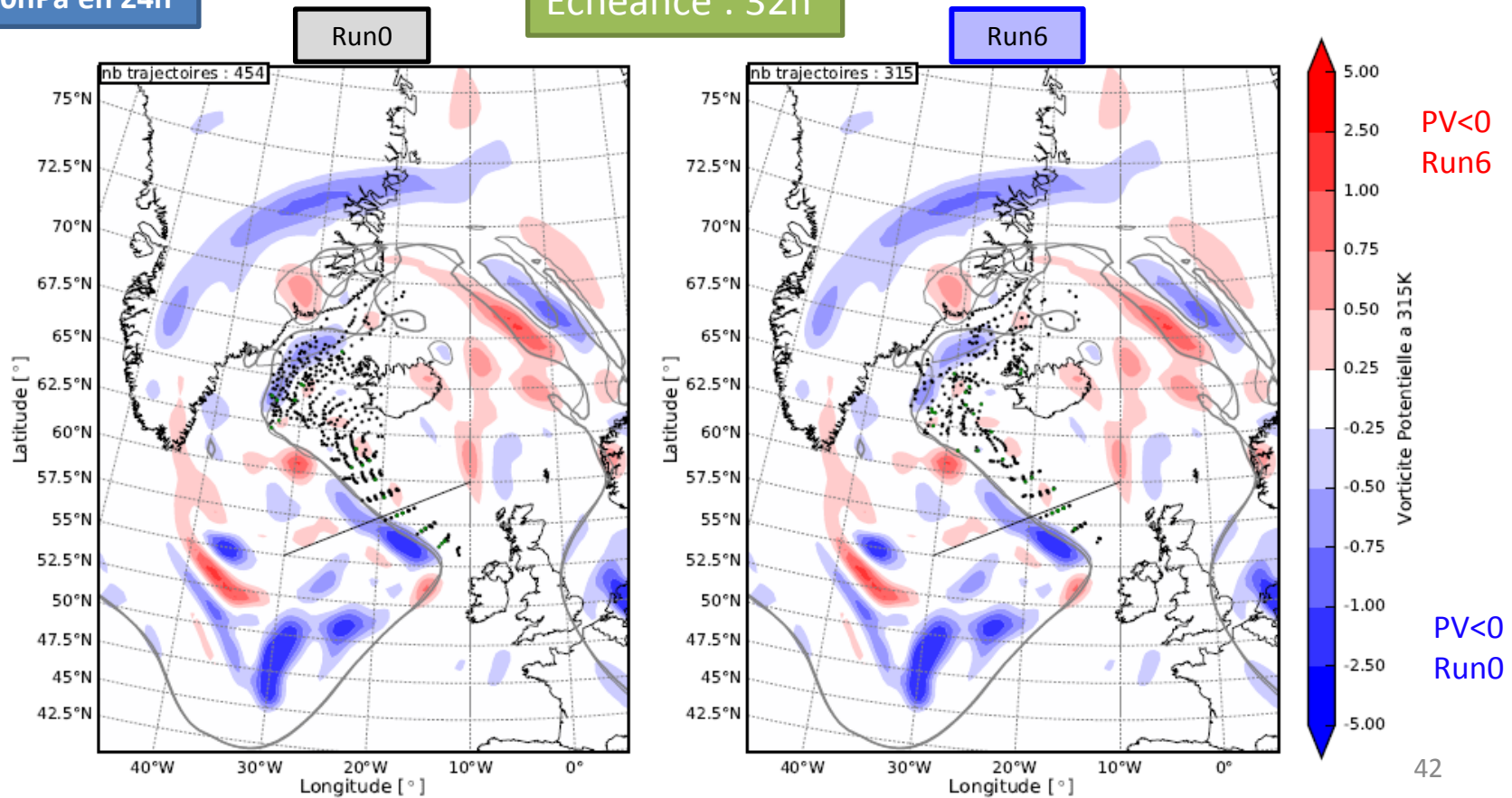
Echeance : 30h



Trajectoires anticycloniques dépassant 315K

-12h/+12h
Critère : -300hPa en 24h

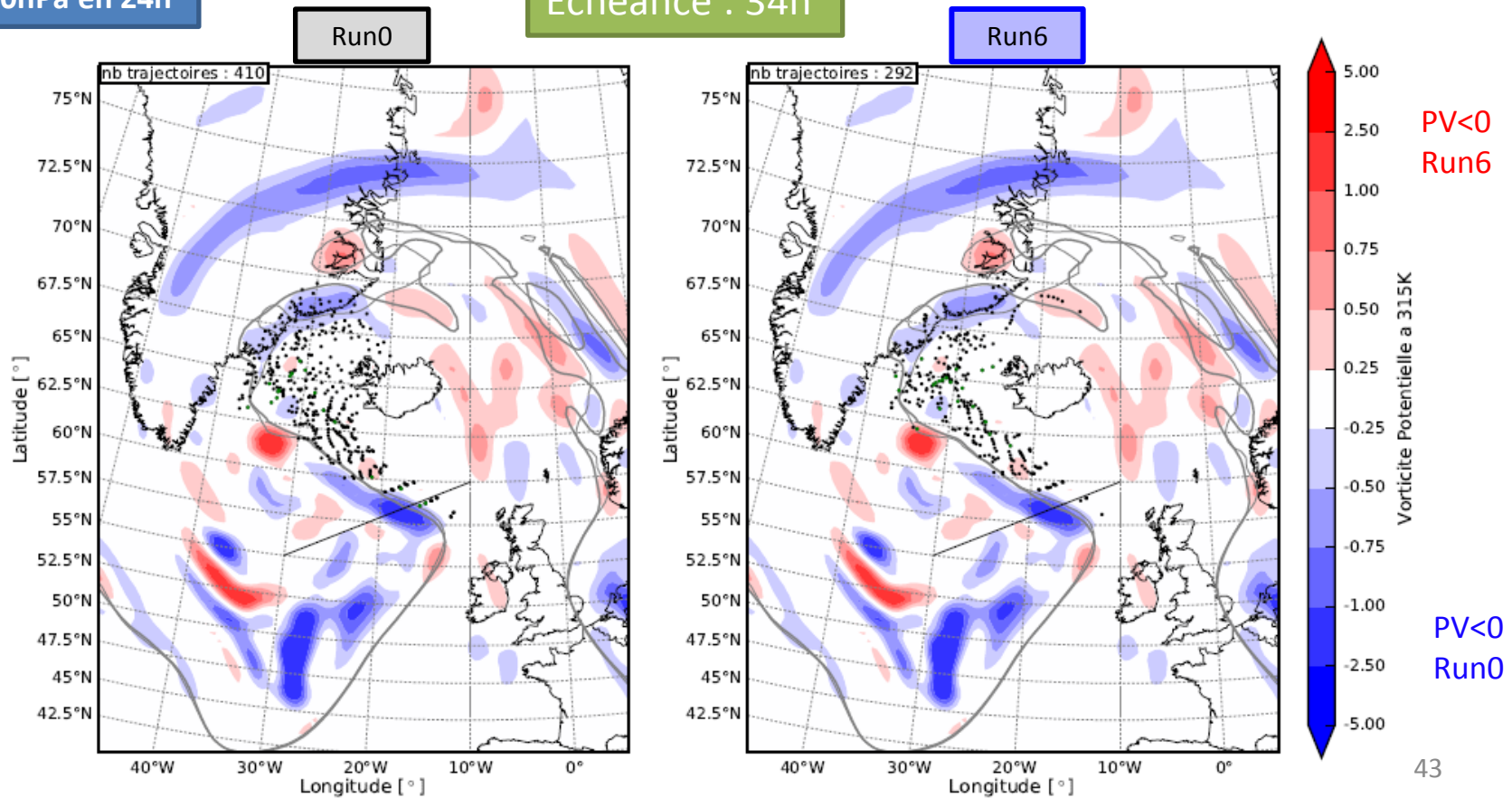
Echeance : 32h



Trajectoires anticycloniques dépassant 315K

-12h/+12h
Critère : -300hPa en 24h

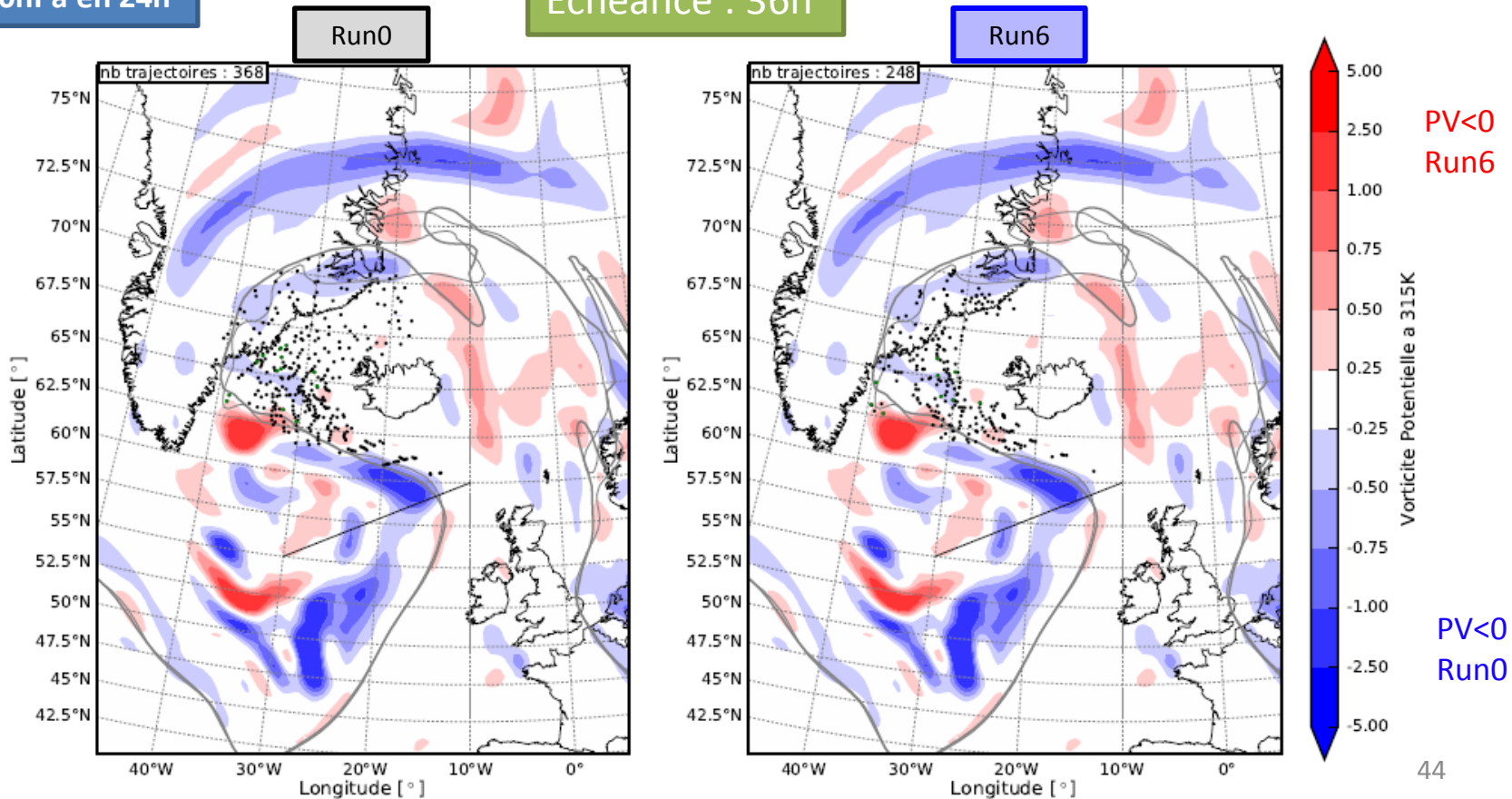
Echeance : 34h



Trajectoires anticycloniques dépassant 315K

-12h/+12h
Critère : -300hPa en 24h

Echeance : 36h





Différence entre Run0/Run6

Run0

- Chauffage en phase glace
- $PV < 0$ en haute altitude
- Fin plus haute
- ~~$\Delta PV < 0 : +$~~

$$\Delta PV_{Run0} \sim \Delta PV_{Run6}$$

- $PV < 0$ en fin de prévision

Run6

- Front froid plus instable
- Chauffage en phase liquide
- $PV < 0$ en milieu de troposphère
- ~~$\Delta PV < 0 : ++$~~

- $PV < 0$ en début de prévision

Conclusion

- Cohérence entre les deux prévisions
- **Impact sur l'anticyclone d'altitude**
 - Chaleur latente et sensible : Impact principal
 - Rayonnement : Impact plus faible
- **Différence dans la distribution verticale de PV négatif**
 - Run0 : haute altitude
 - Run6 : milieu de troposphère

Perspectives

- **Comment expliquer que le PV est plus négatif en haute altitude dans le Run0 que dans le Run6?**

Les trajectoires montent plus haut ?

➔ Trajectoires backward dans les anomalies de $PV < 0$

- **Le critère de sélection des WCB est-il suffisamment générique ?**

➔ Modification du critère des trajectoires WCB

- **Validation sur plusieurs cas : étude sur le vent**

➔ présentation de Gwendal

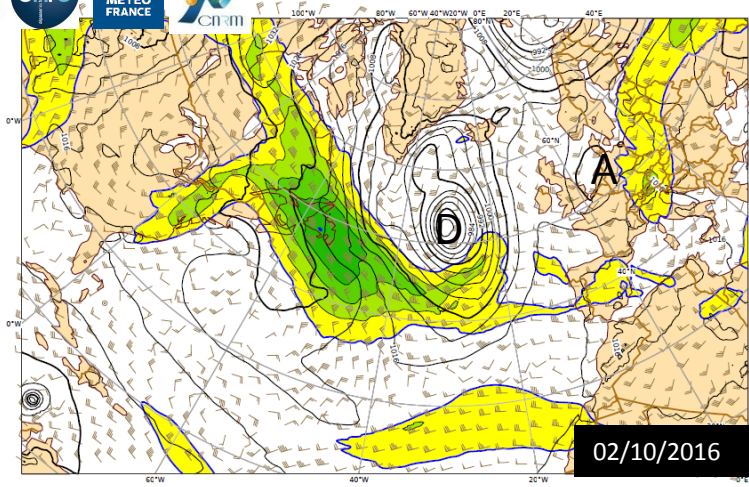
- **Autres schémas de convection**

➔ PCMT amélioré, Tiedtke,...

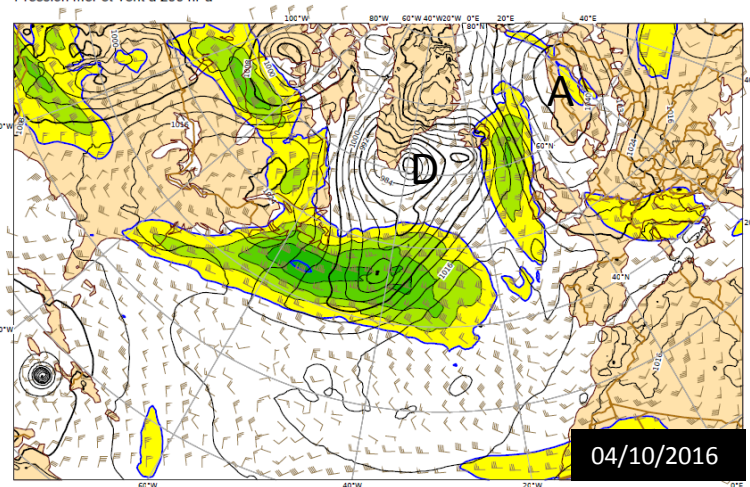
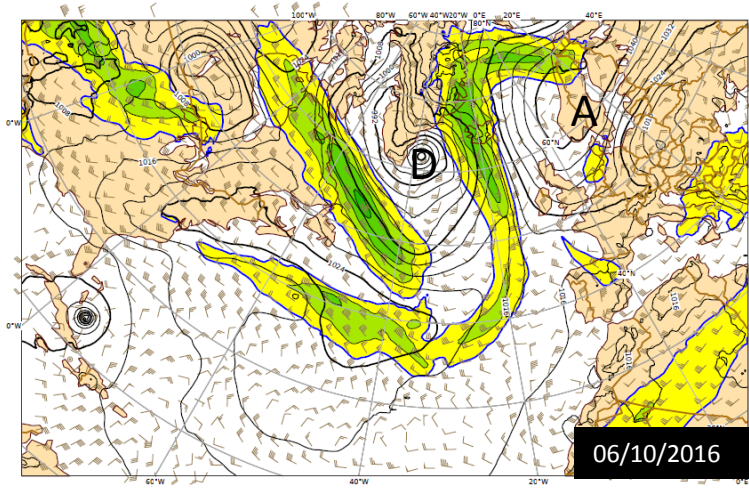


Merci pour votre attention

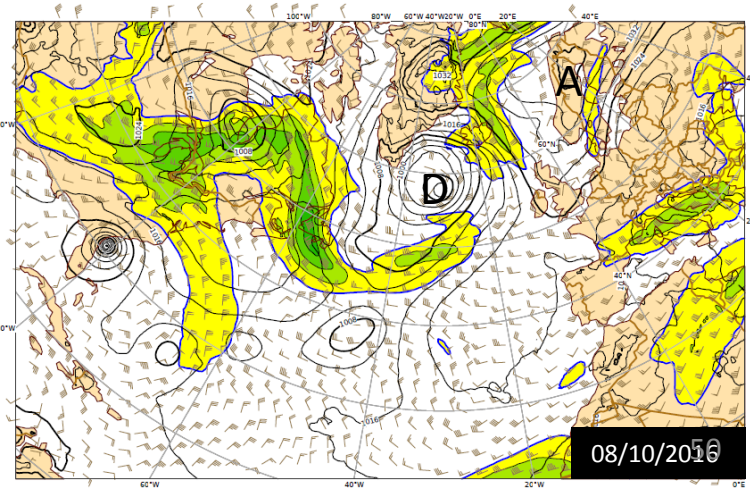




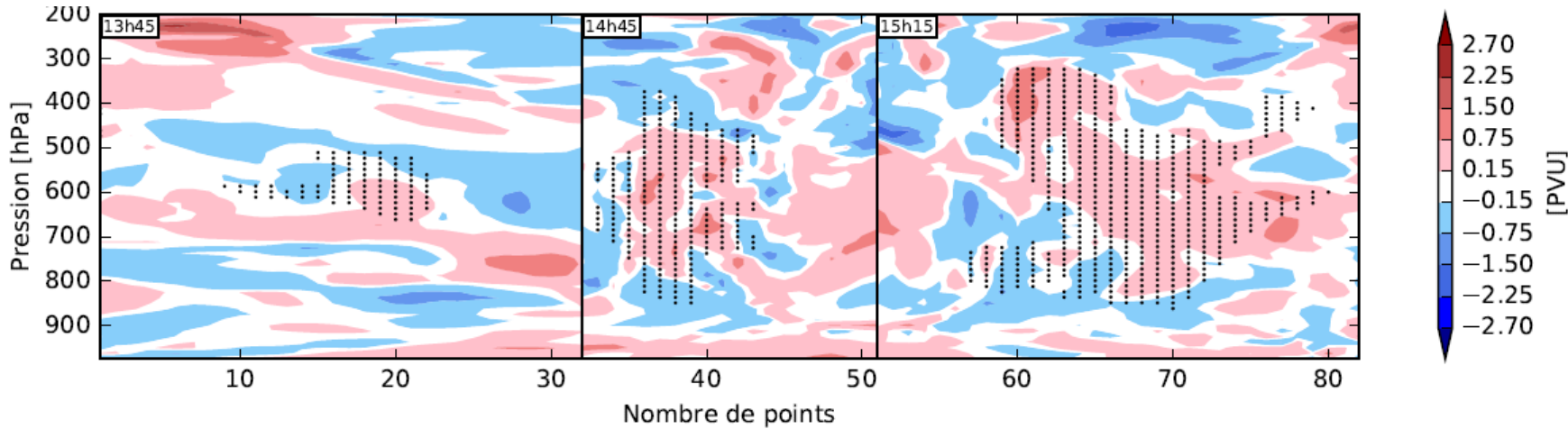
Jeudi 6 Octobre 2016 00UTC - Prevision Arpege t+0h: Jeudi 6 Octobre 2016 00UTC
Pression mer et Vent à 200 hPa



Samedi 8 Octobre 2016 00UTC - Prevision Arpege t+0h: Samedi 8 Octobre 2016 00UTC
Pression mer et Vent à 200 hPa



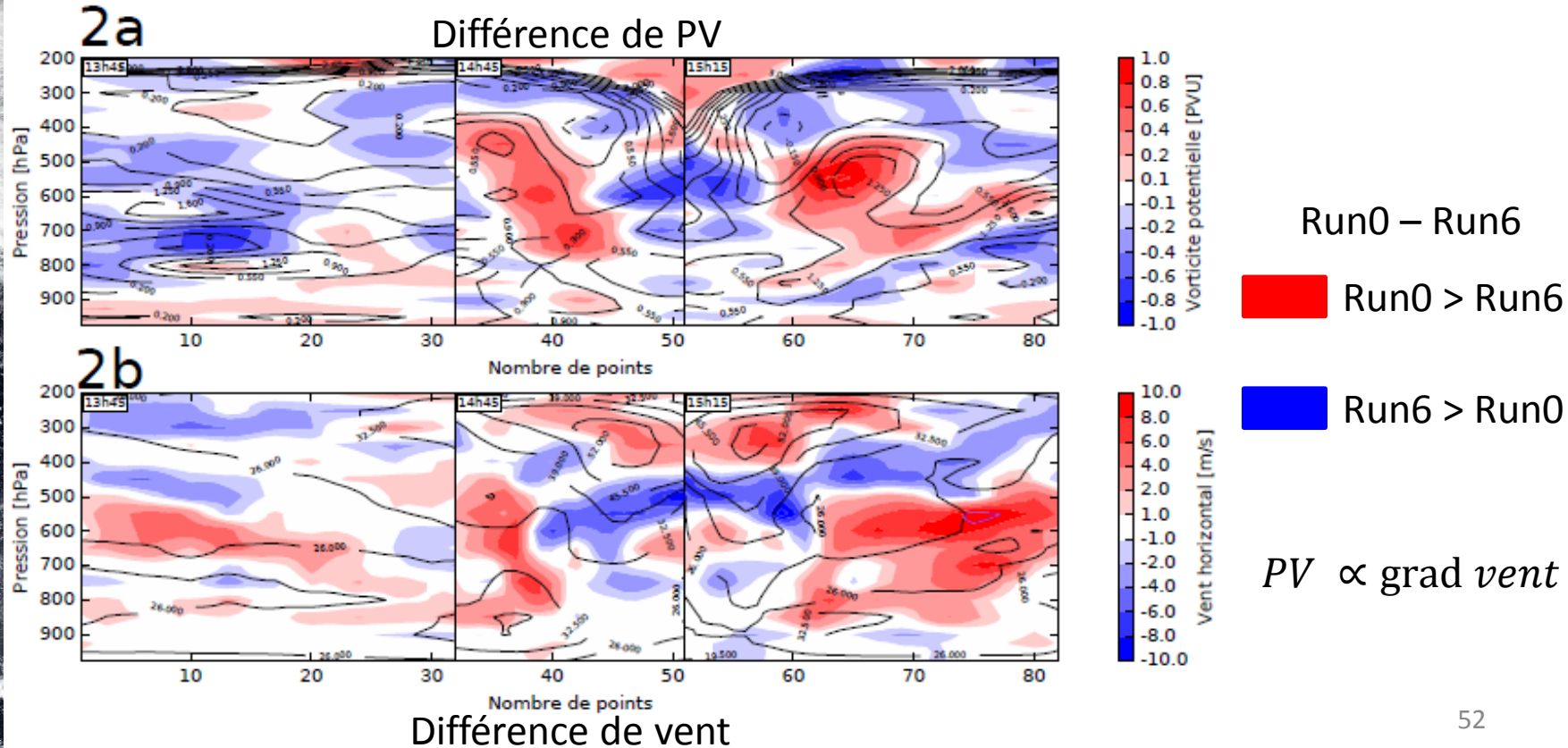
Différence de PV négatif



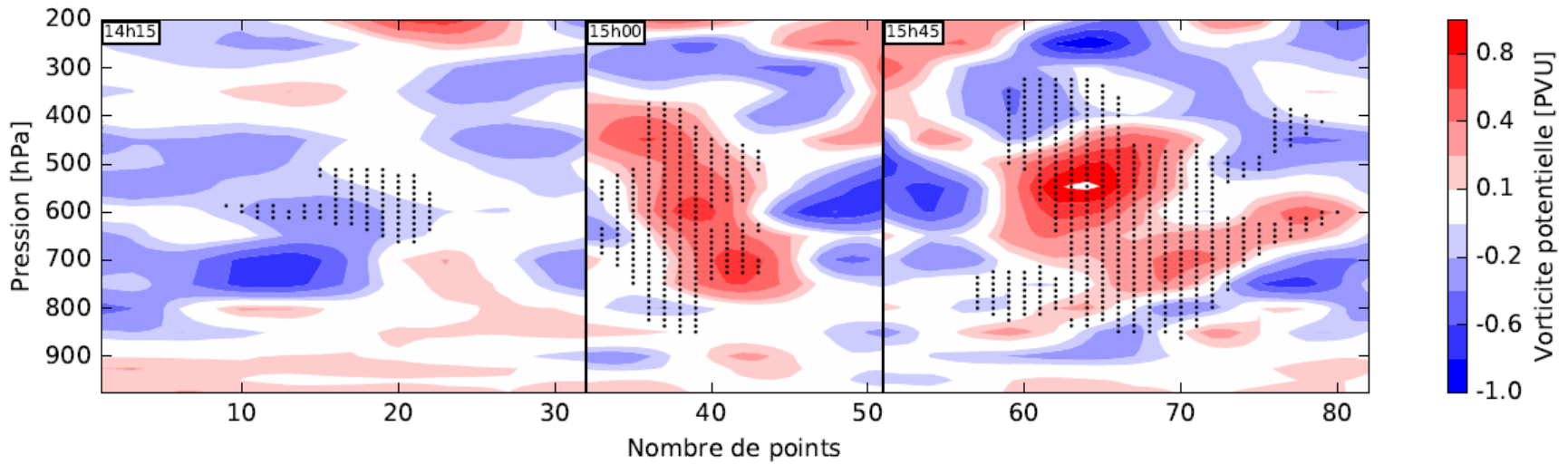
Différence : Run0 – Run6

- Run0 > Run6 -> PV < 0 pour le Run 6
- Run6 > Run0 -> PV < 0 pour le Run 0

Différence de PV négatif



Différence de PV négatif

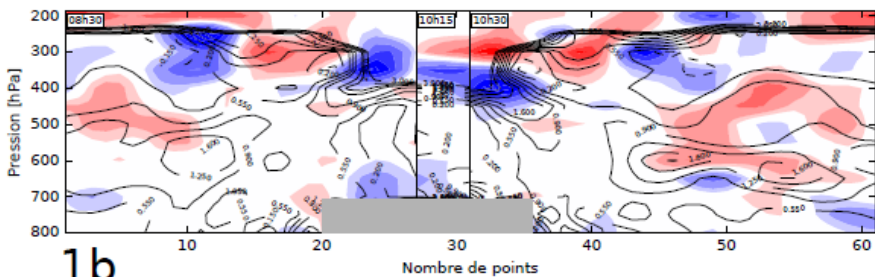


Différence : Run0 – Run6

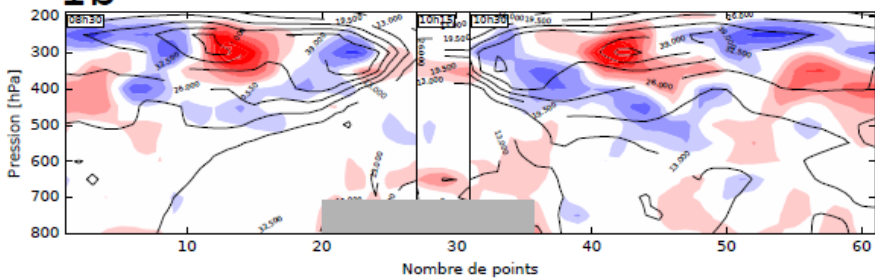
- Run0 > Run6 -> PV < 0 pour le Run 6
- Run6 > Run0 -> PV < 0 pour le Run 0



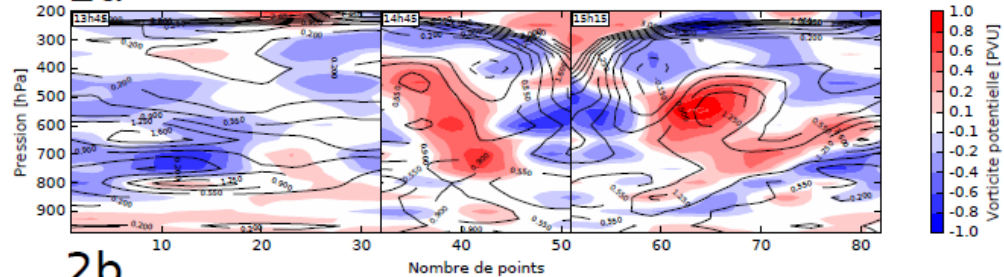
1a



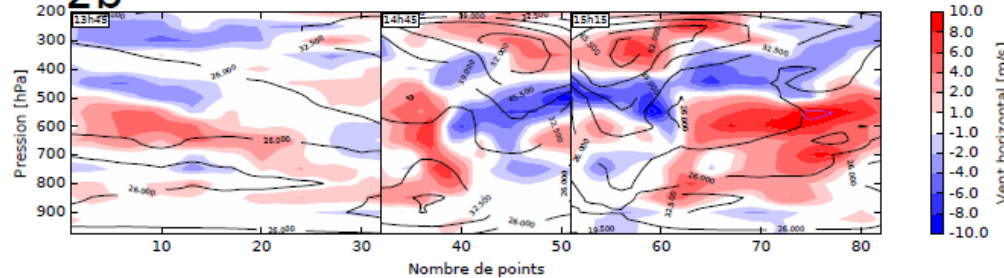
1b



2a

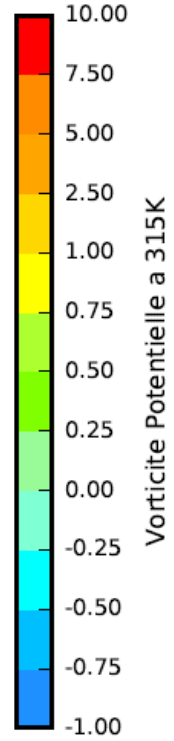
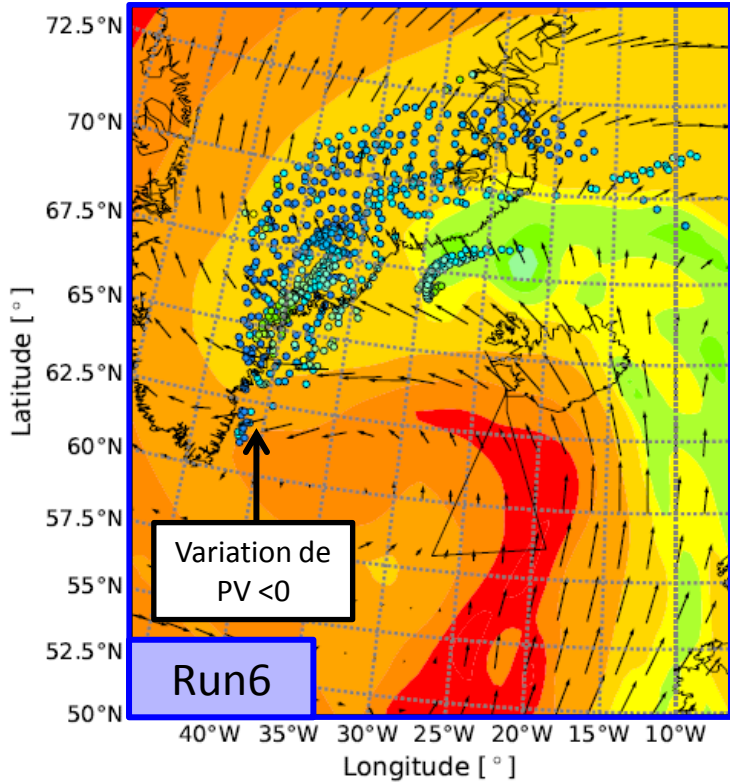
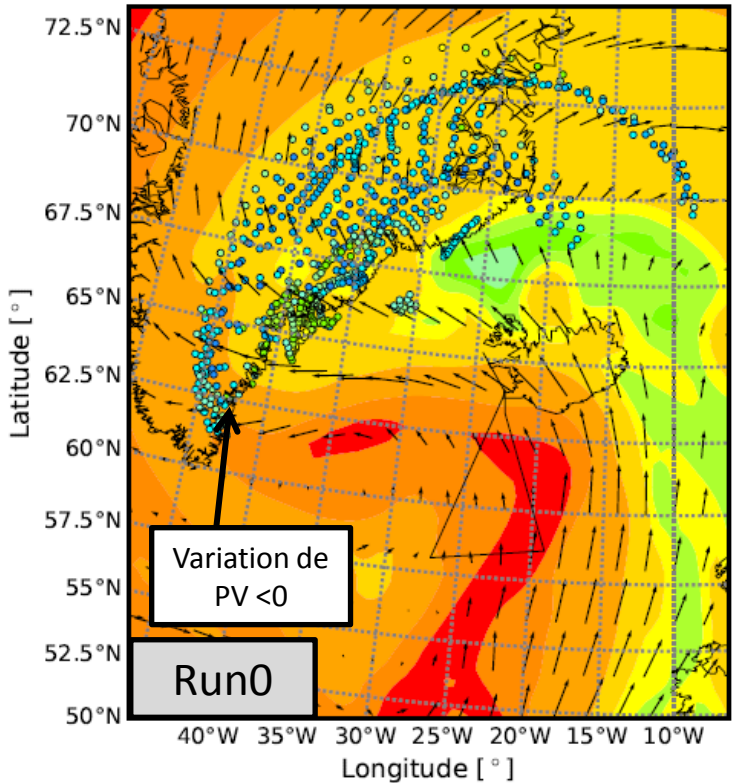


2b



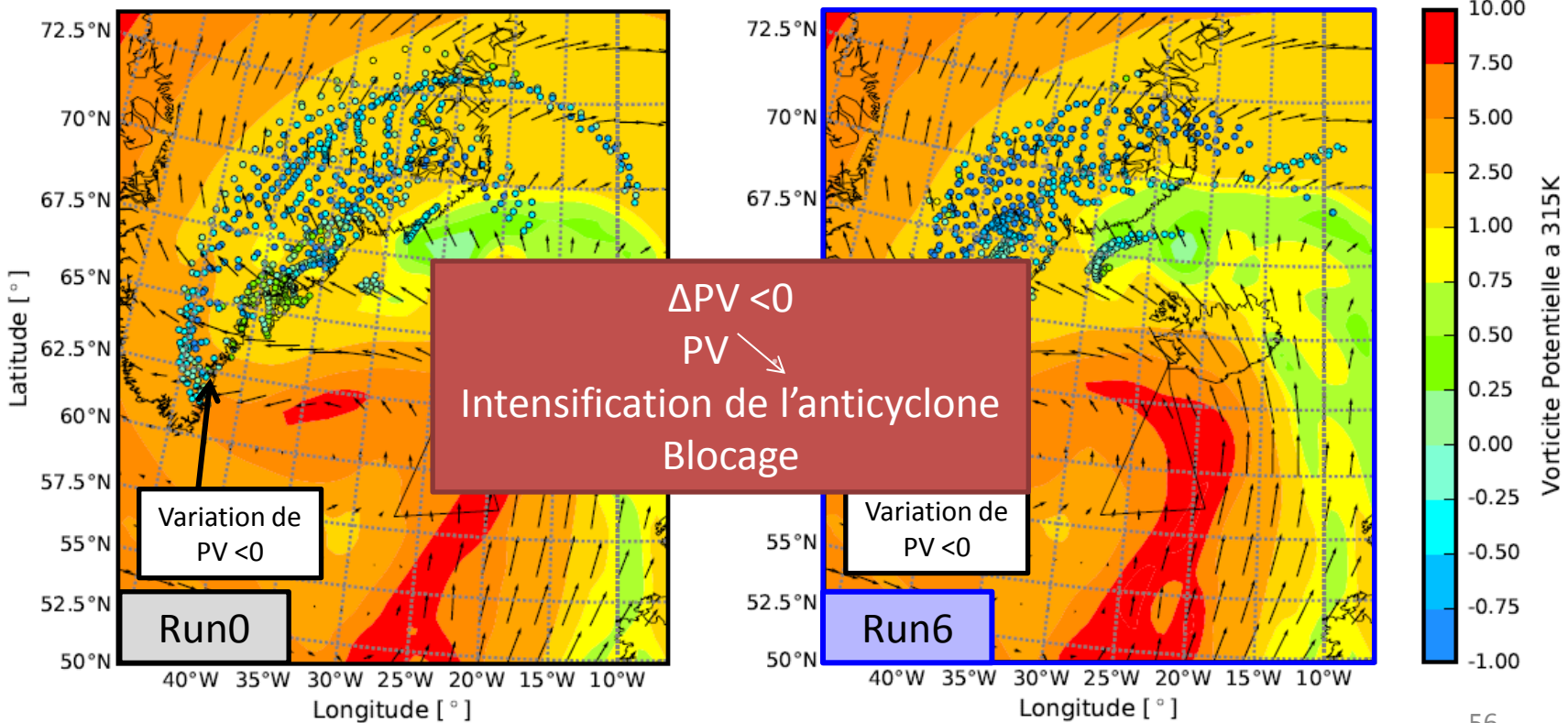
Destruction de PV dans l'anticyclone

Carte de Vorticité Potentielle à 315K, le 03/10/2016 à 6hUTC

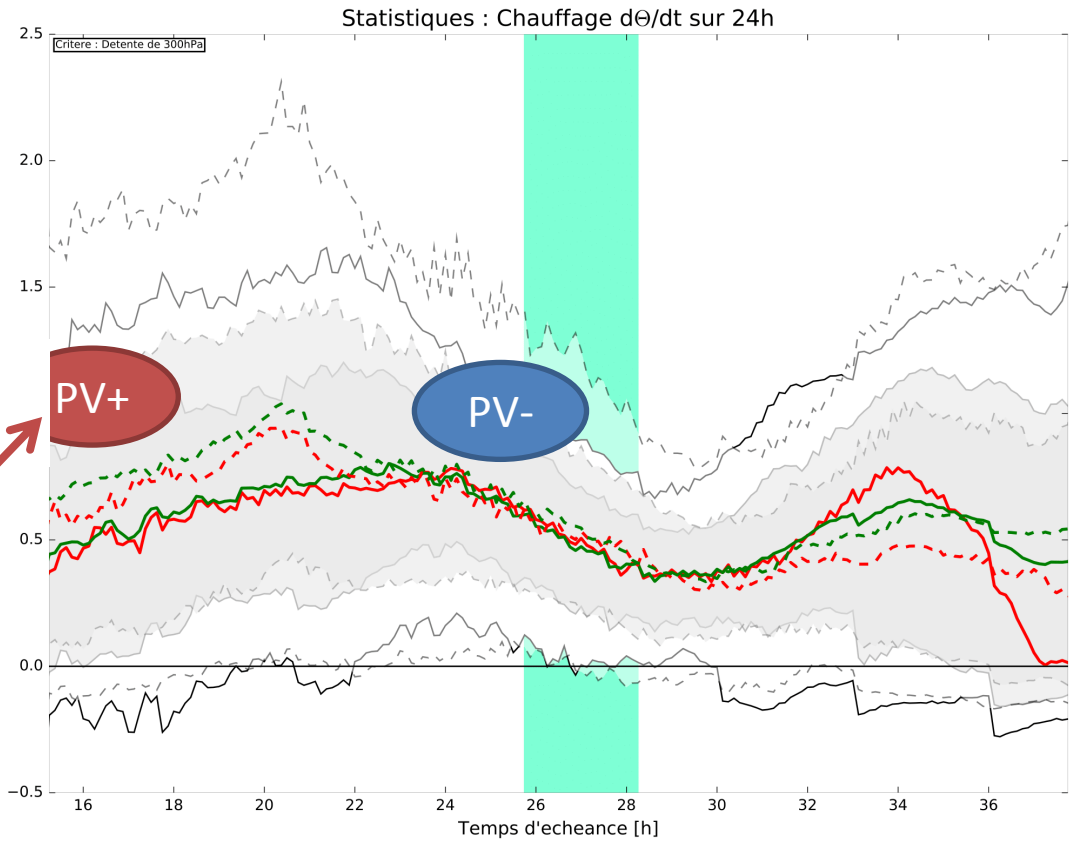


Destruction de PV dans l'anticyclone

Carte de Vorticité Potentielle à 315K, le 03/10/2016 à 6hUTC



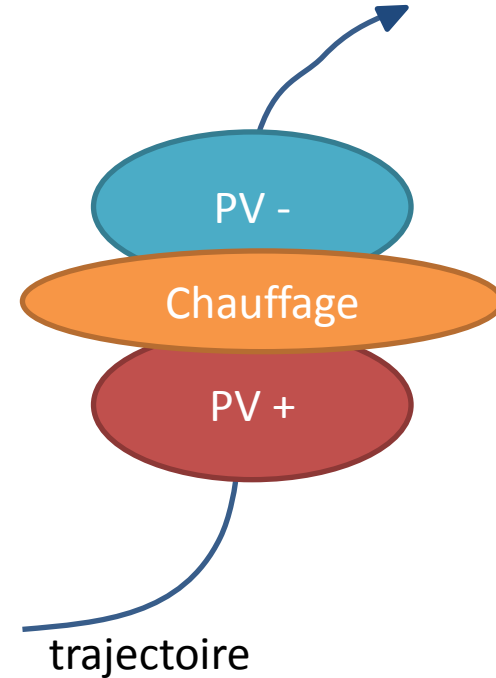
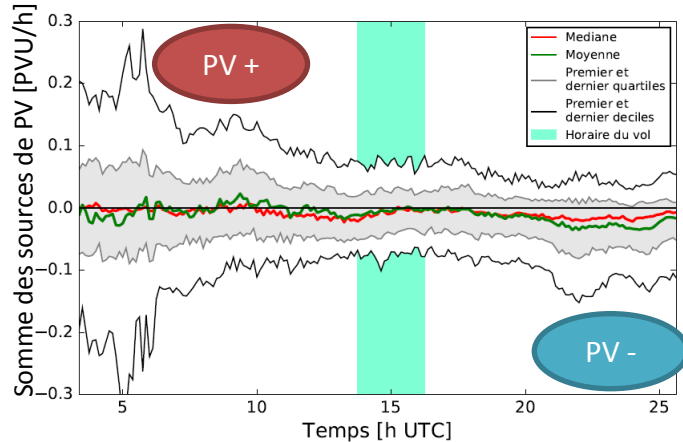
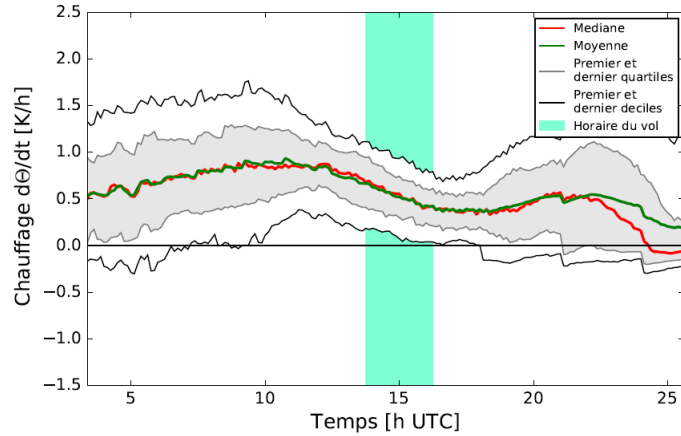
Evolution temporelle du chauffage



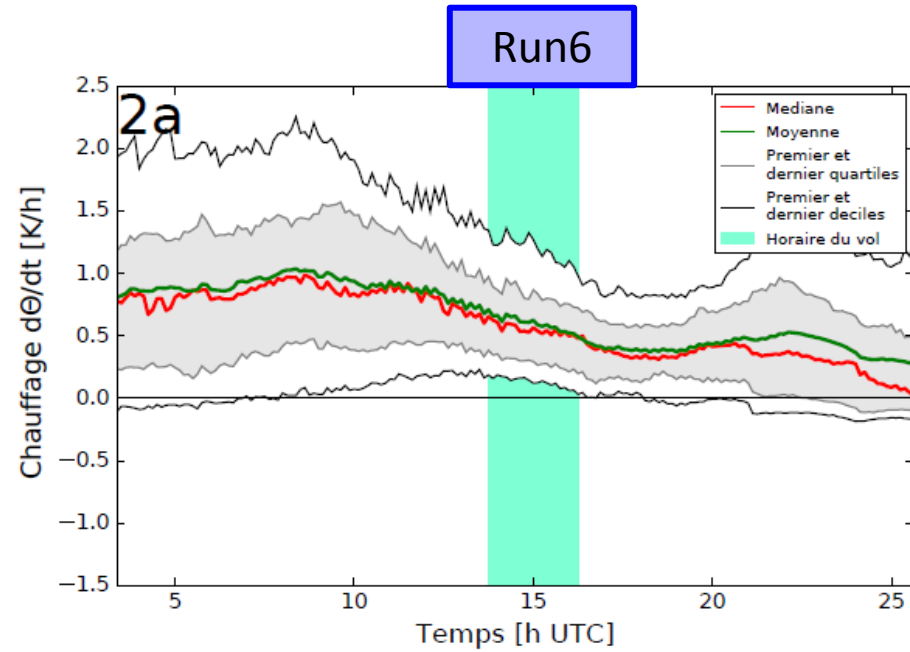
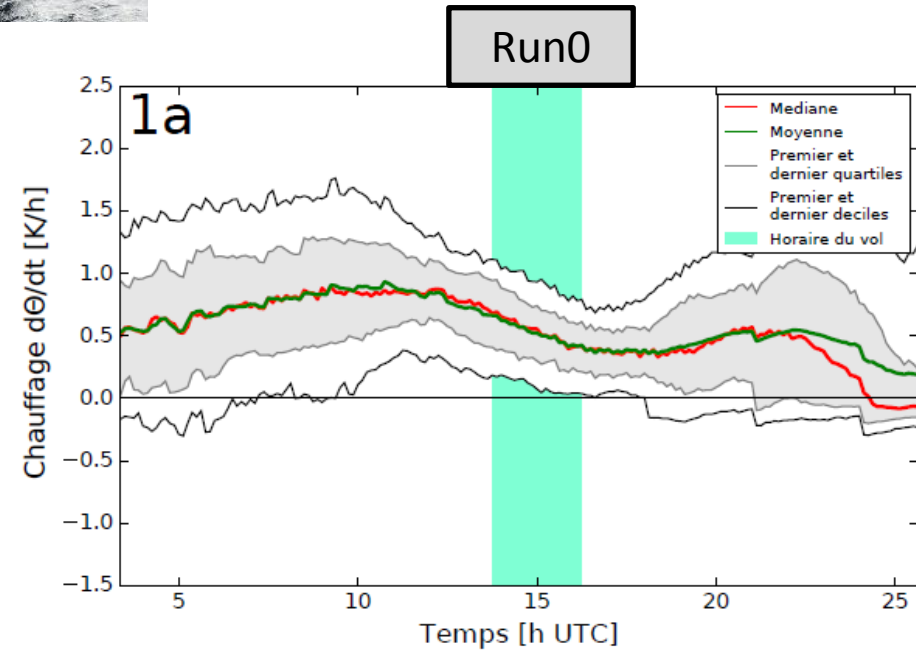
- Mediane (Run0)
- - Mediane (Run6)
- Moyenne (Run0)
- - Moyenne (Run6)
- Premier et dernier quartiles (Run0)
- - Premier et dernier quartiles (Run6)
- Premier et dernier deciles (Run0)
- - Premier et dernier deciles (Run6)

Manque une partie du PV+

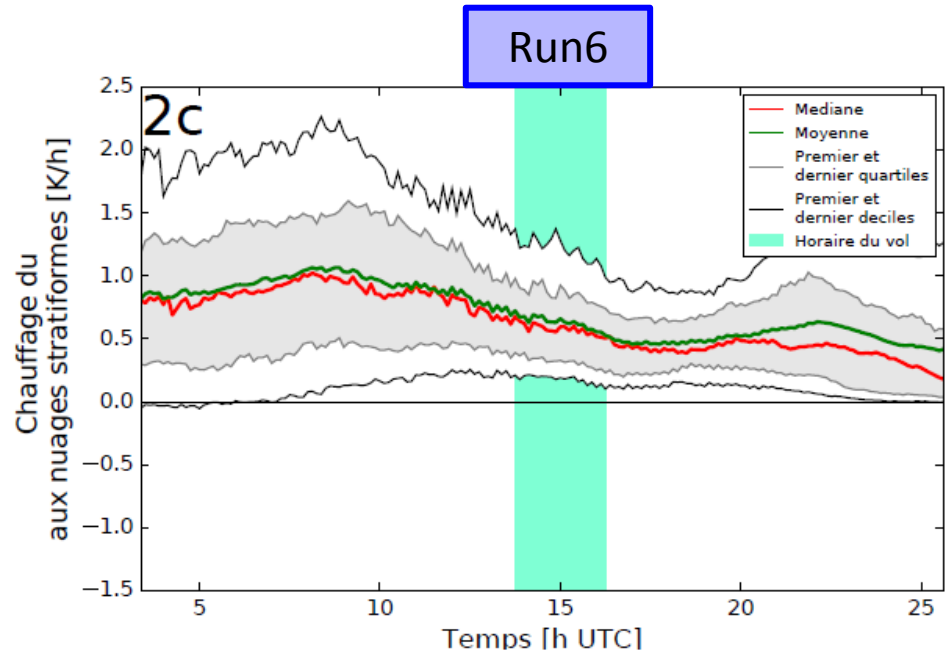
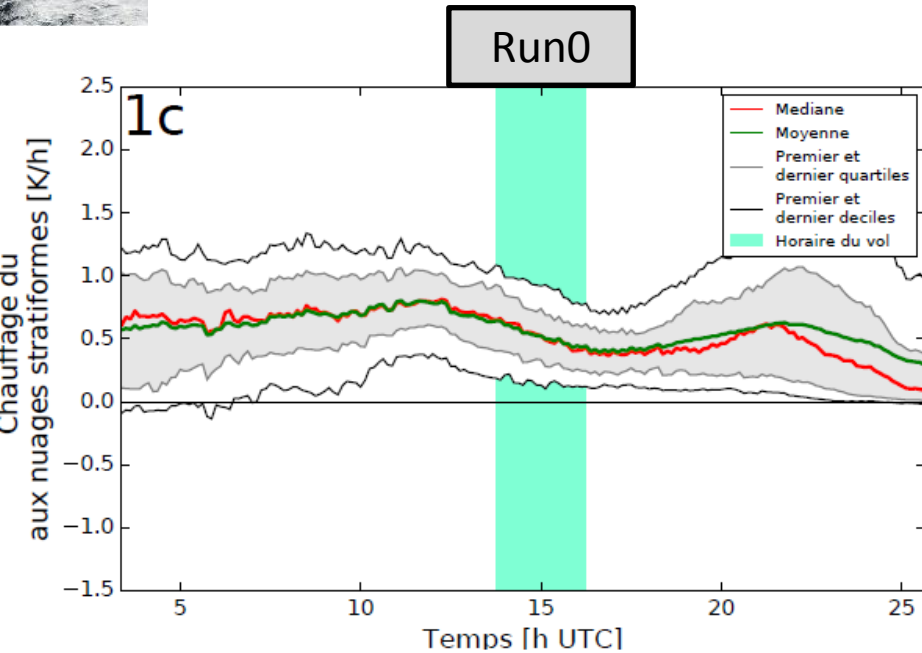
Effet du chauffage sur le PV



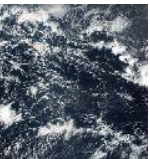
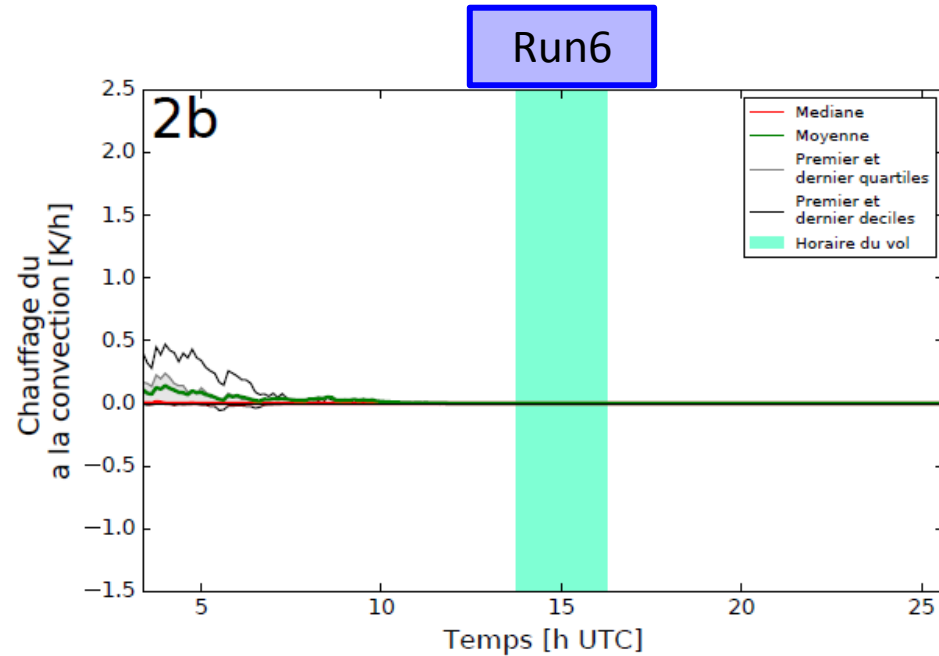
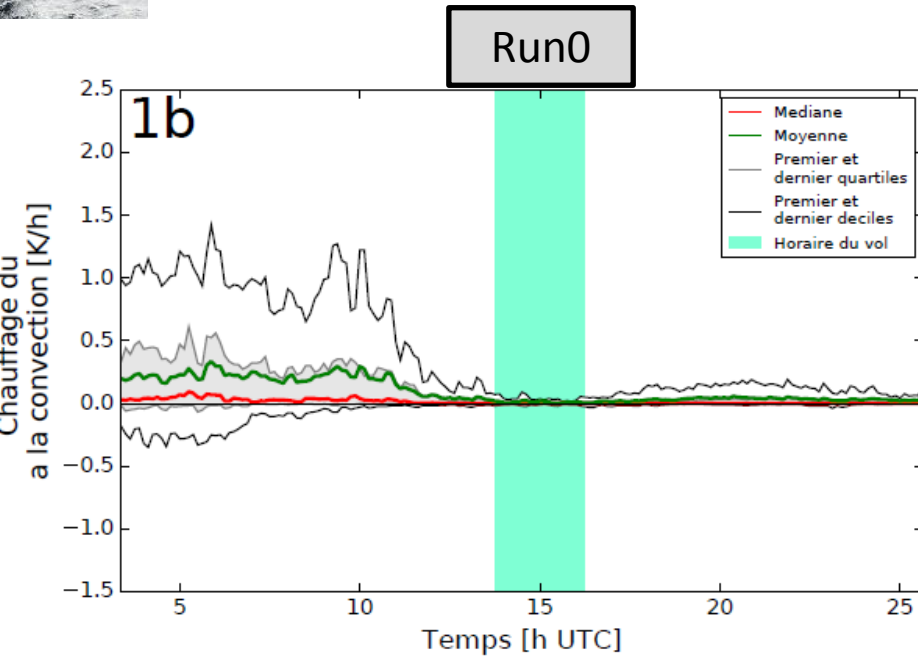
Chauffage



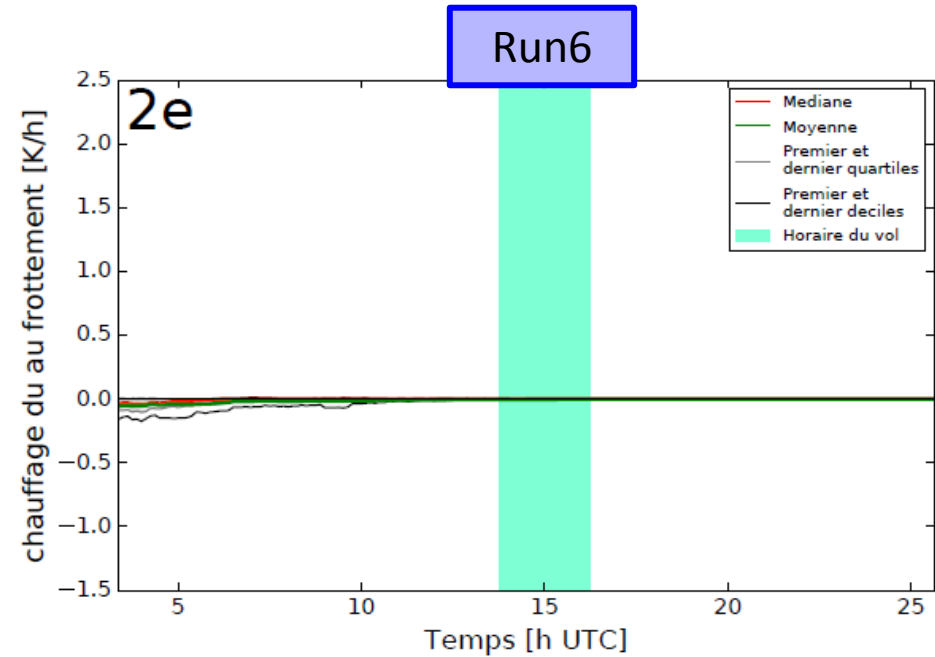
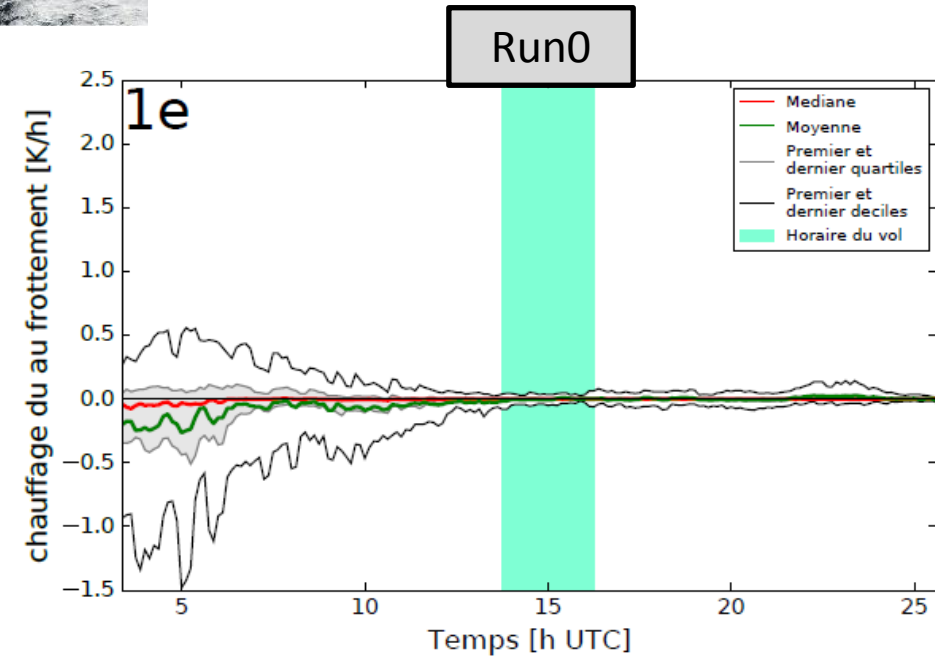
Chauffage stratiforme



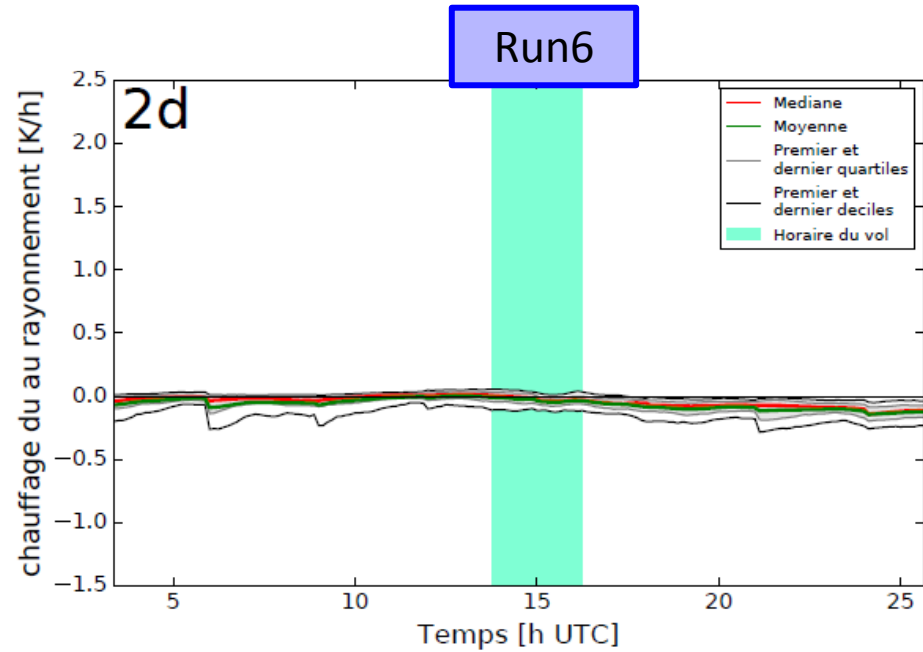
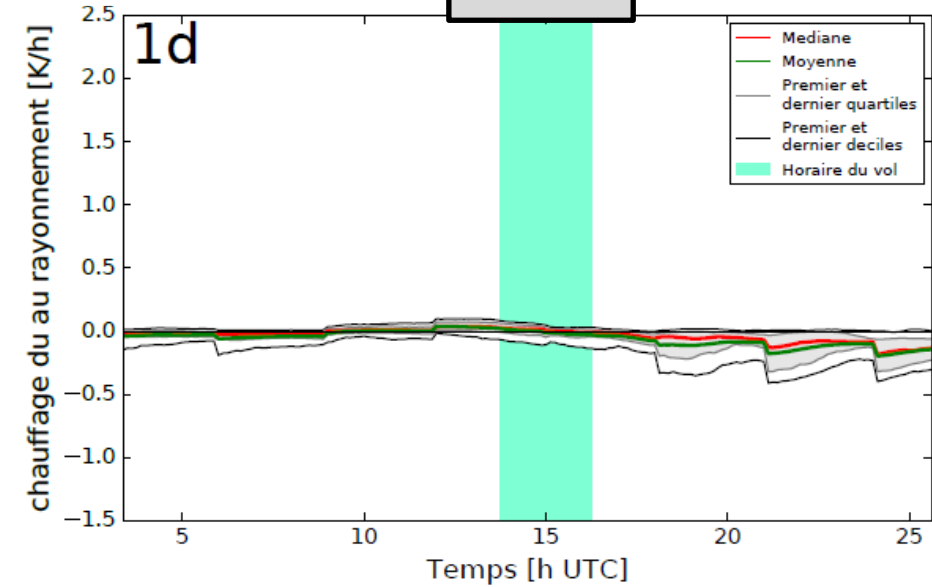
Chauffage convectif



Turbulence

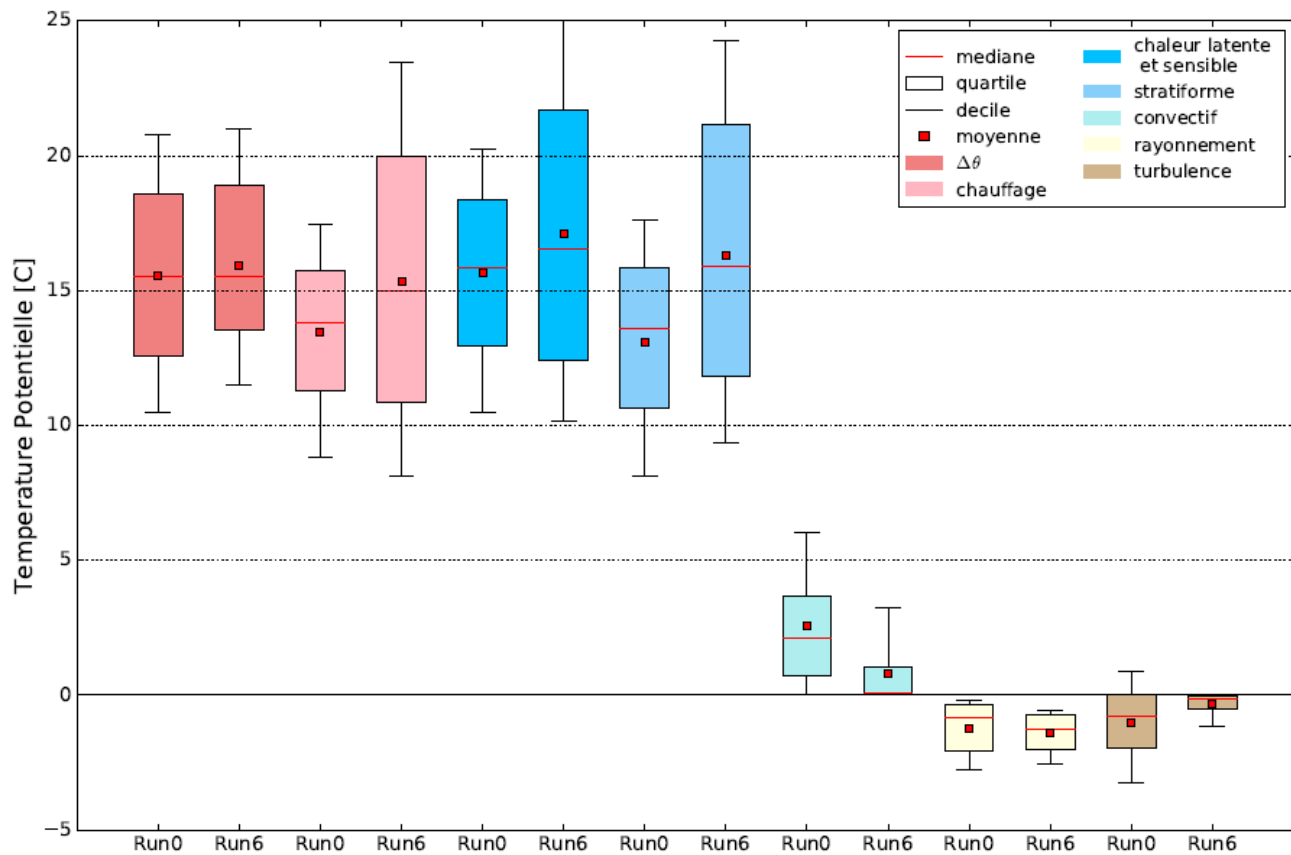


Rayonnement

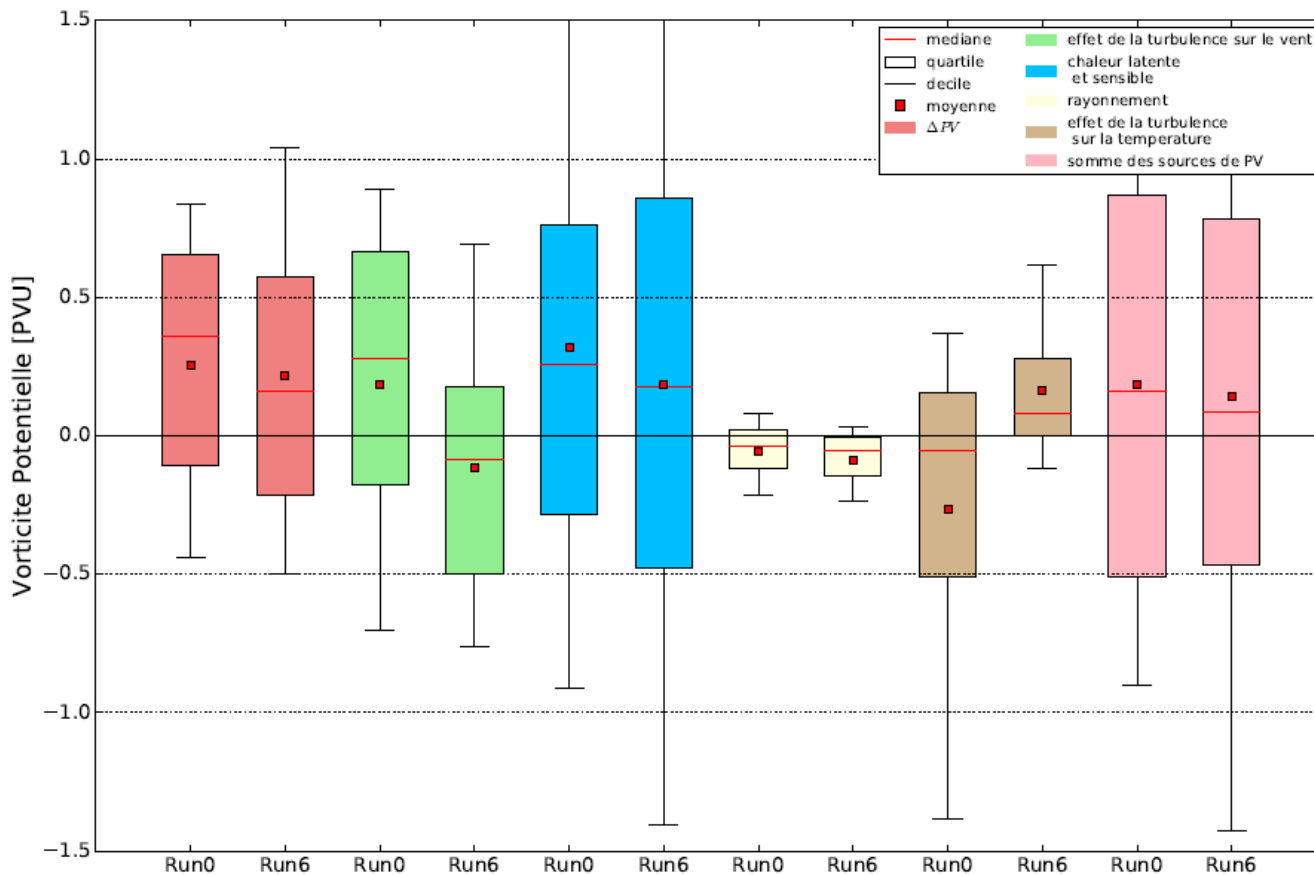




Distribution du chauffage

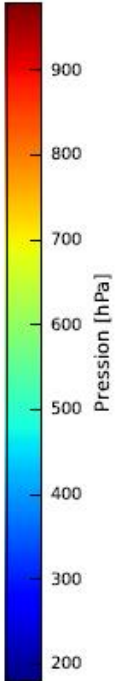
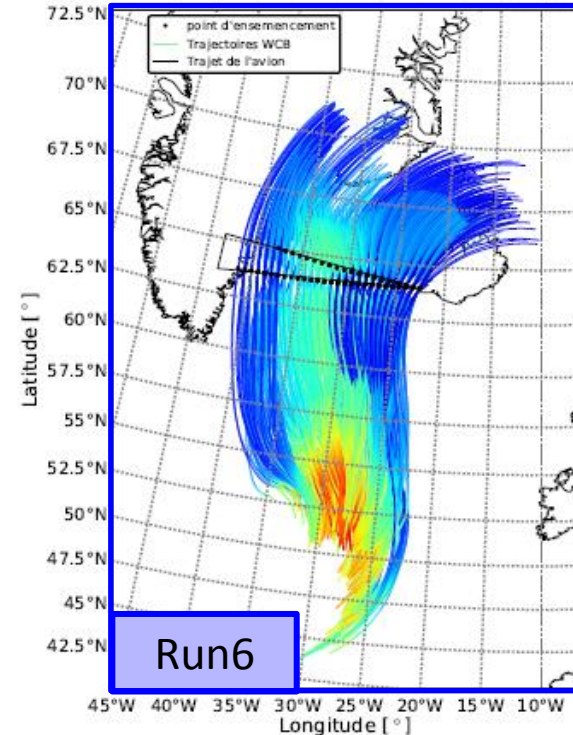
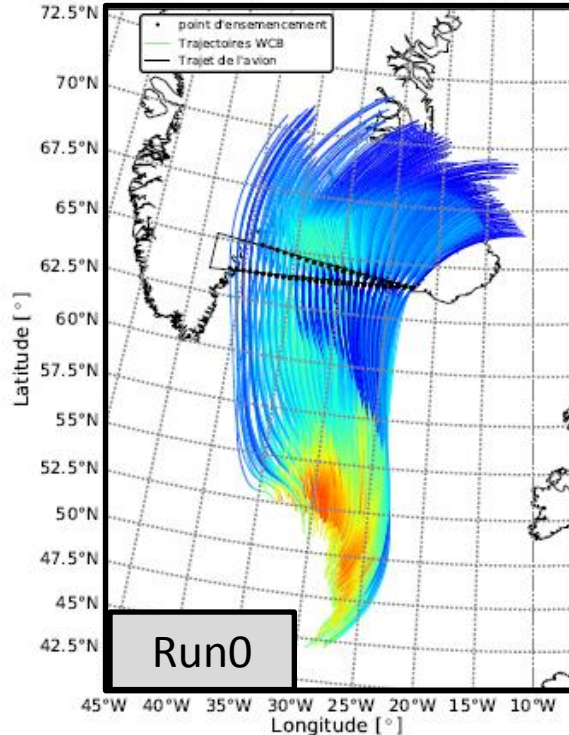


Distribution de PV pour les trajectoires cycloniques



Warm Conveyor Belt – vol F6

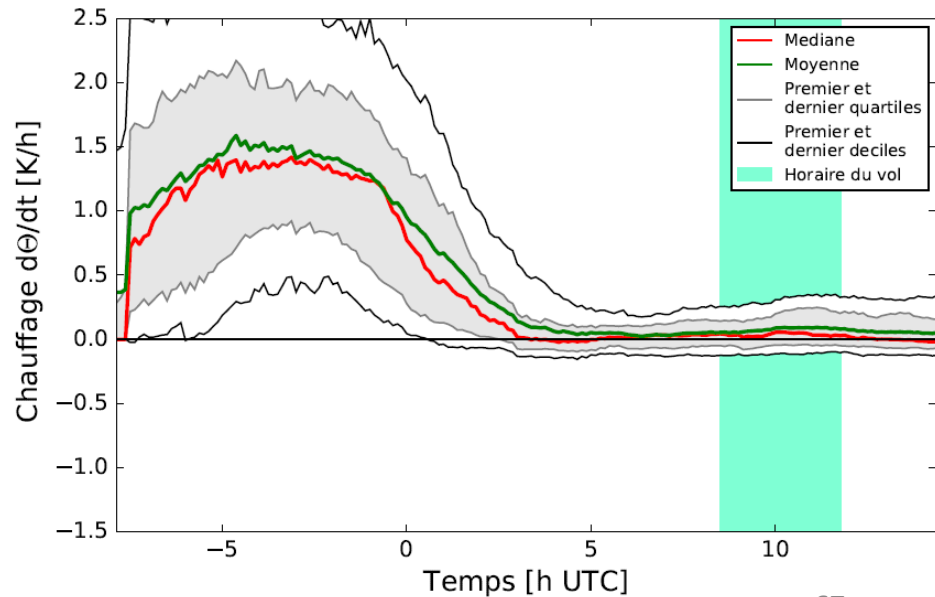
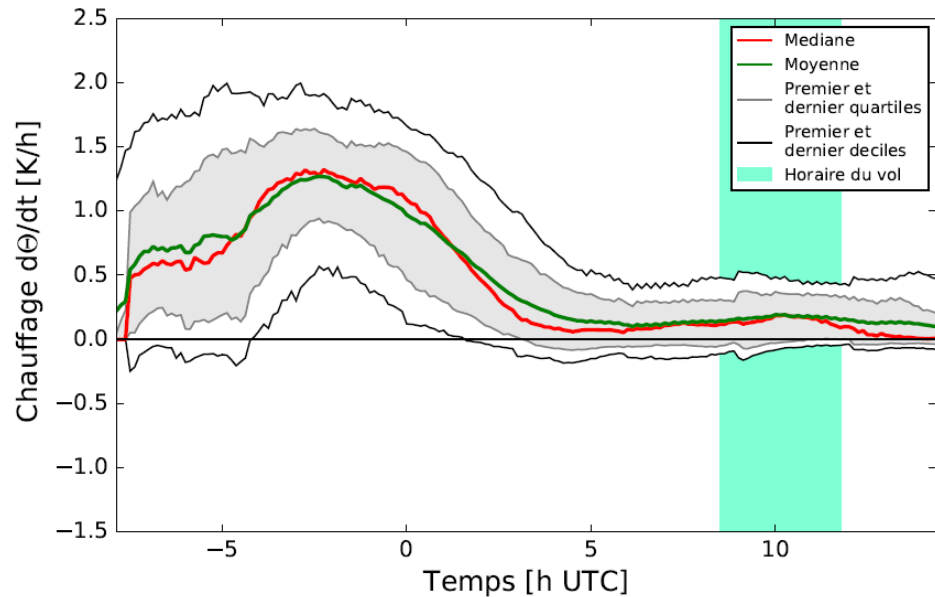
Critère : -300 hPa en 24h



Chauffage

Run0

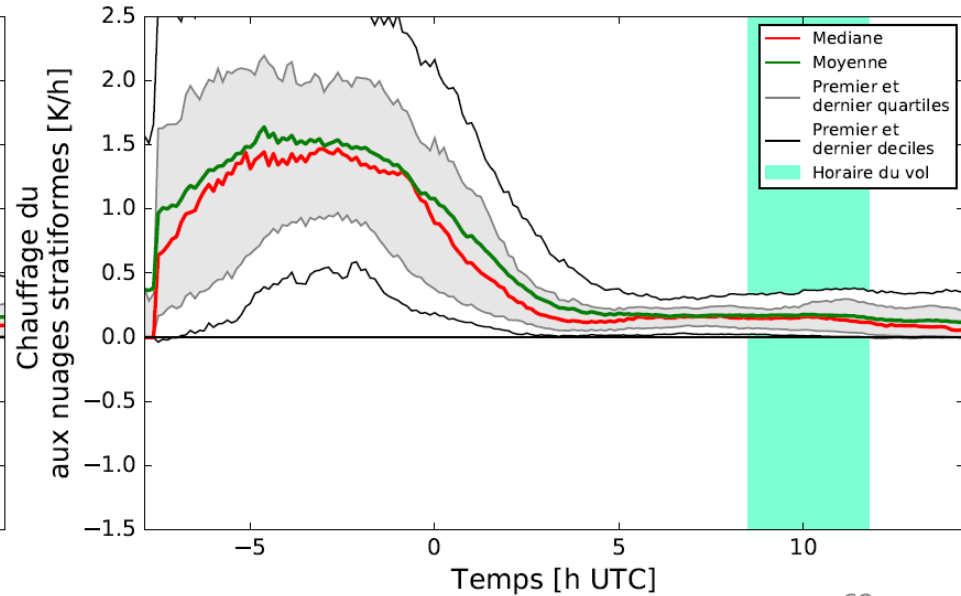
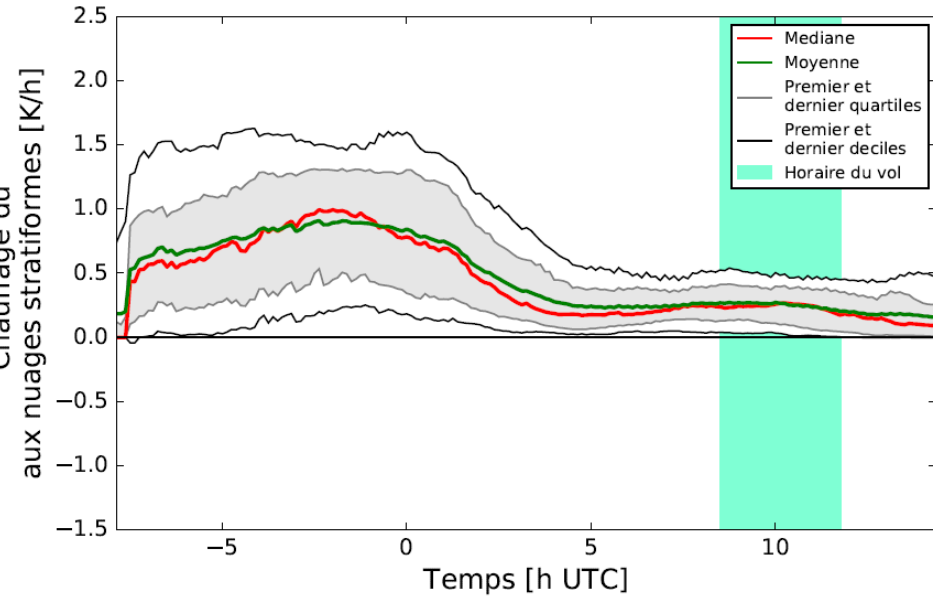
Run6



Chauffage stratiforme

Run0

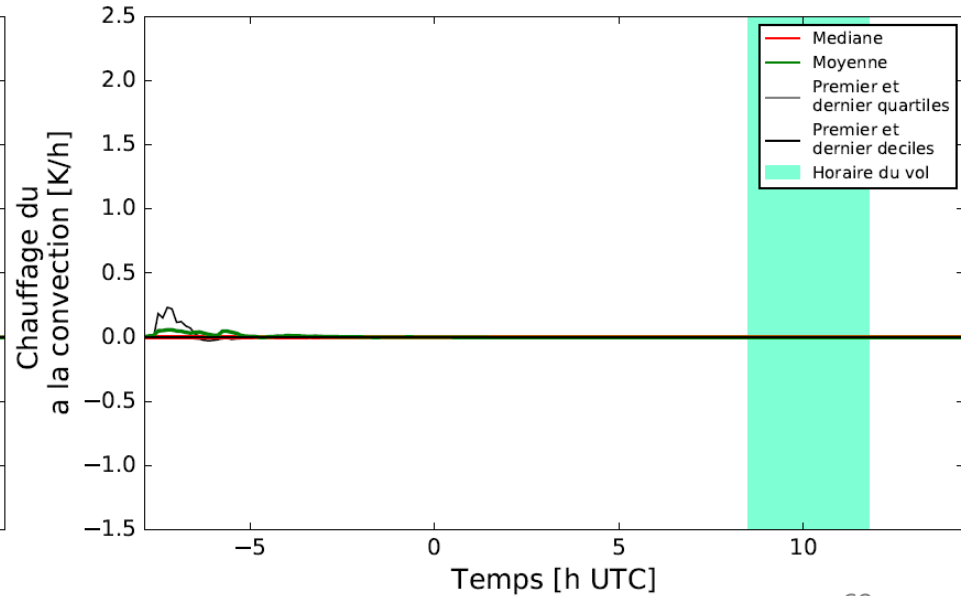
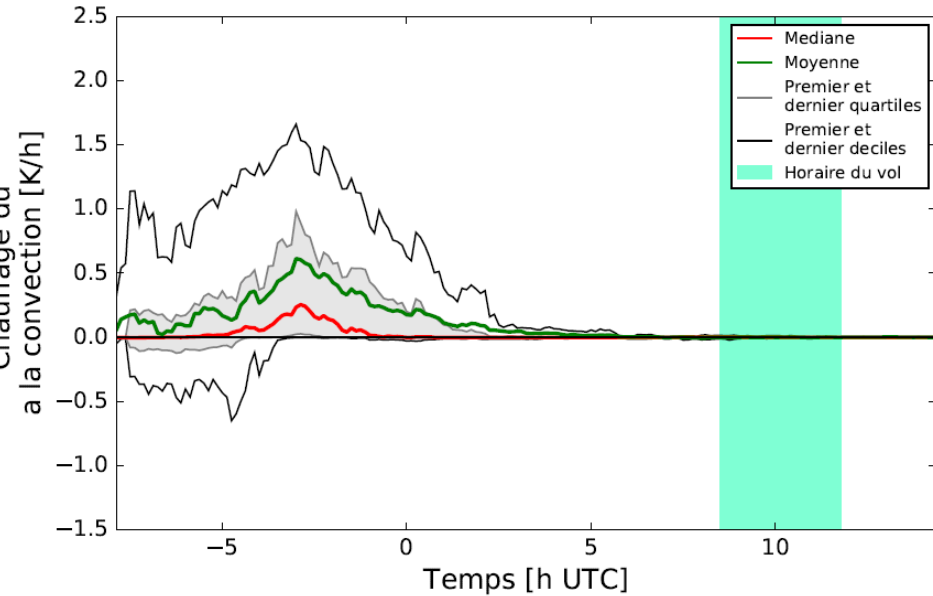
Run6



Chauffage convectif

Run0

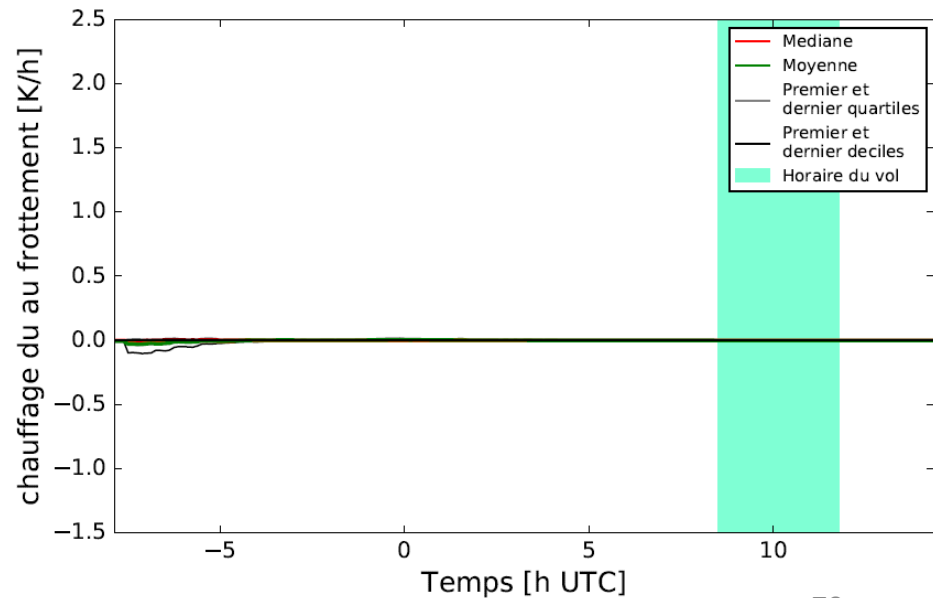
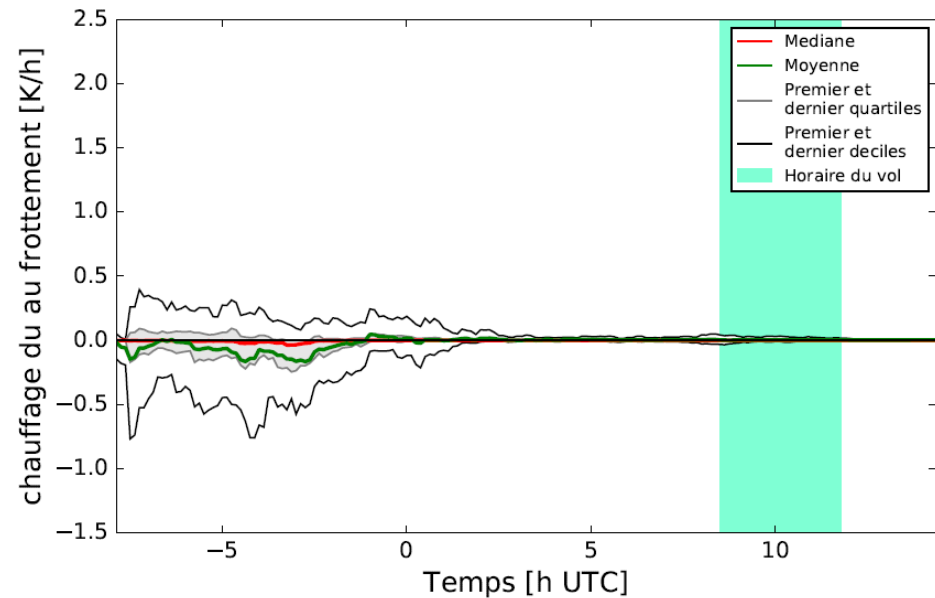
Run6



Turbulence

Run0

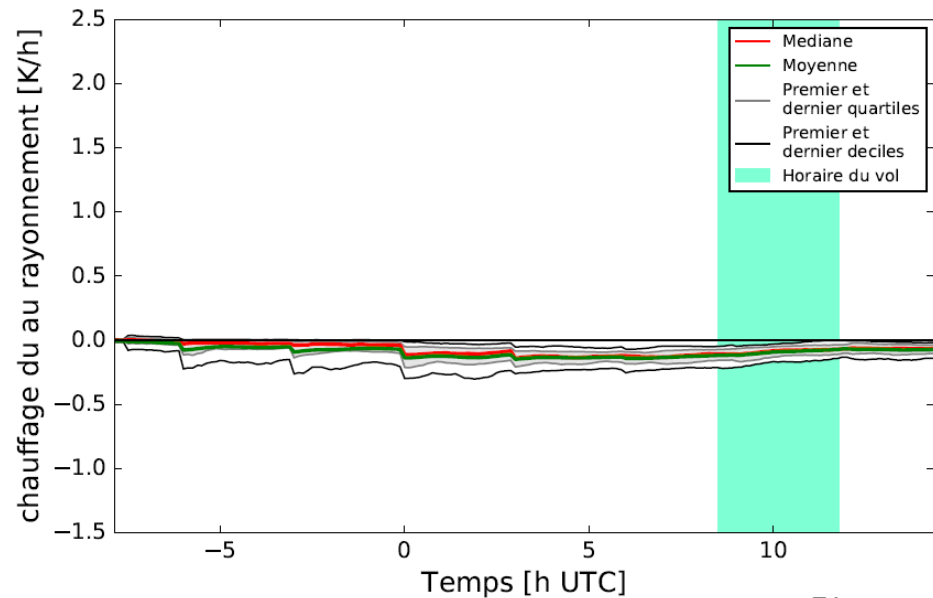
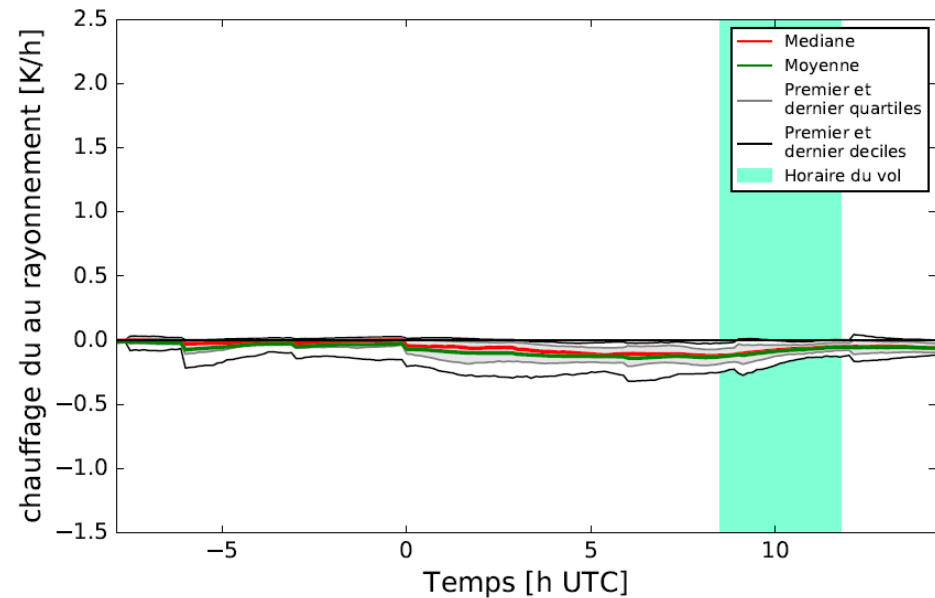
Run6



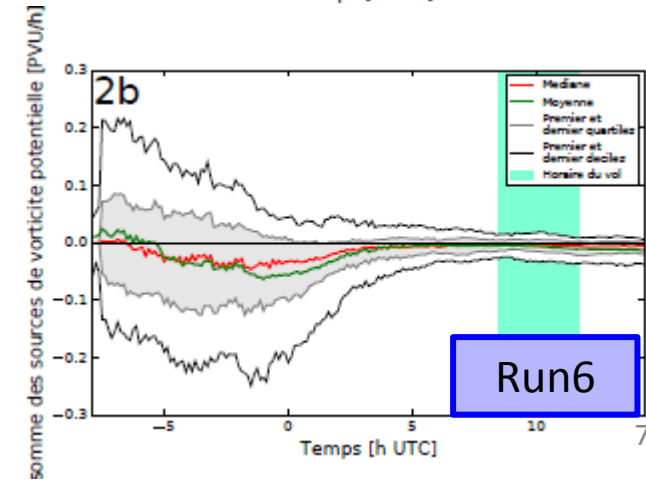
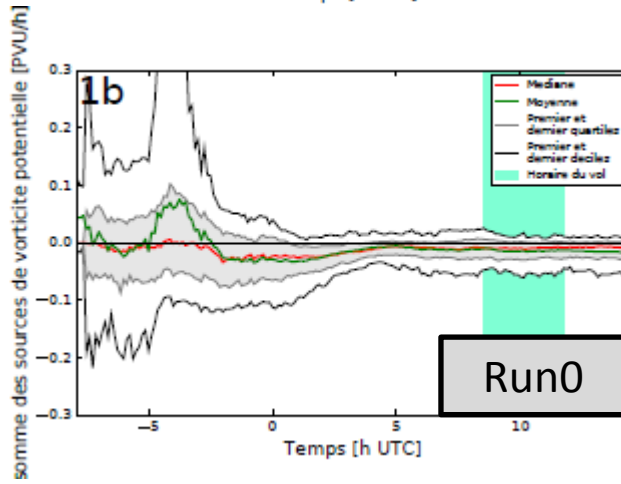
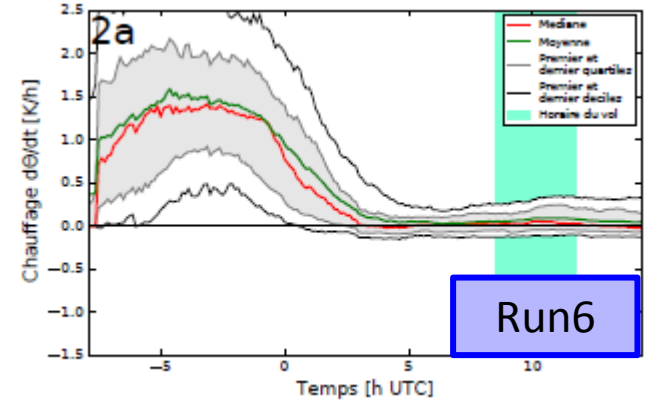
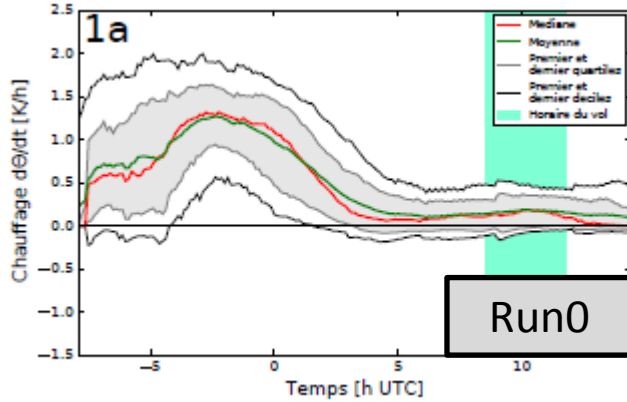
Rayonnement

Run0

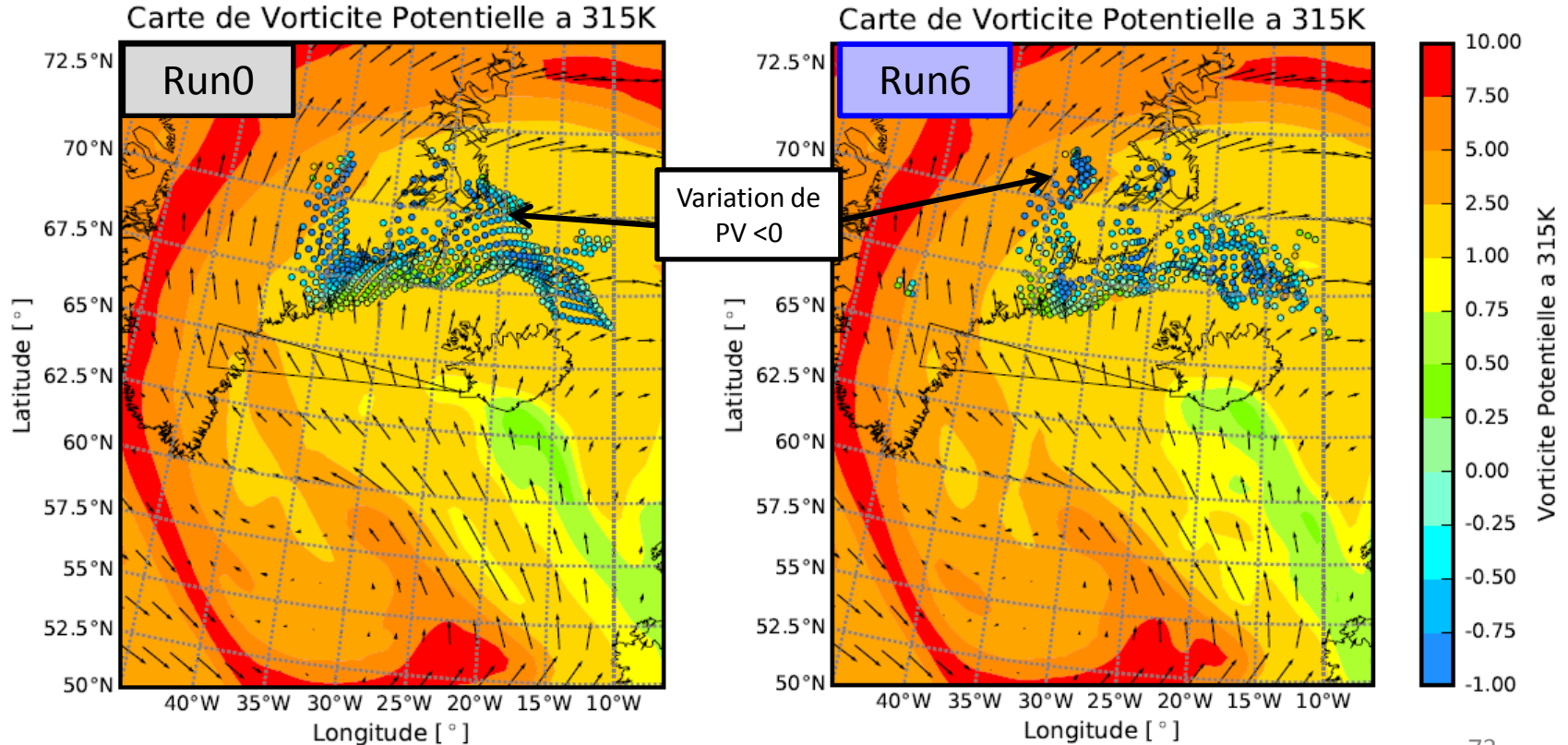
Run6



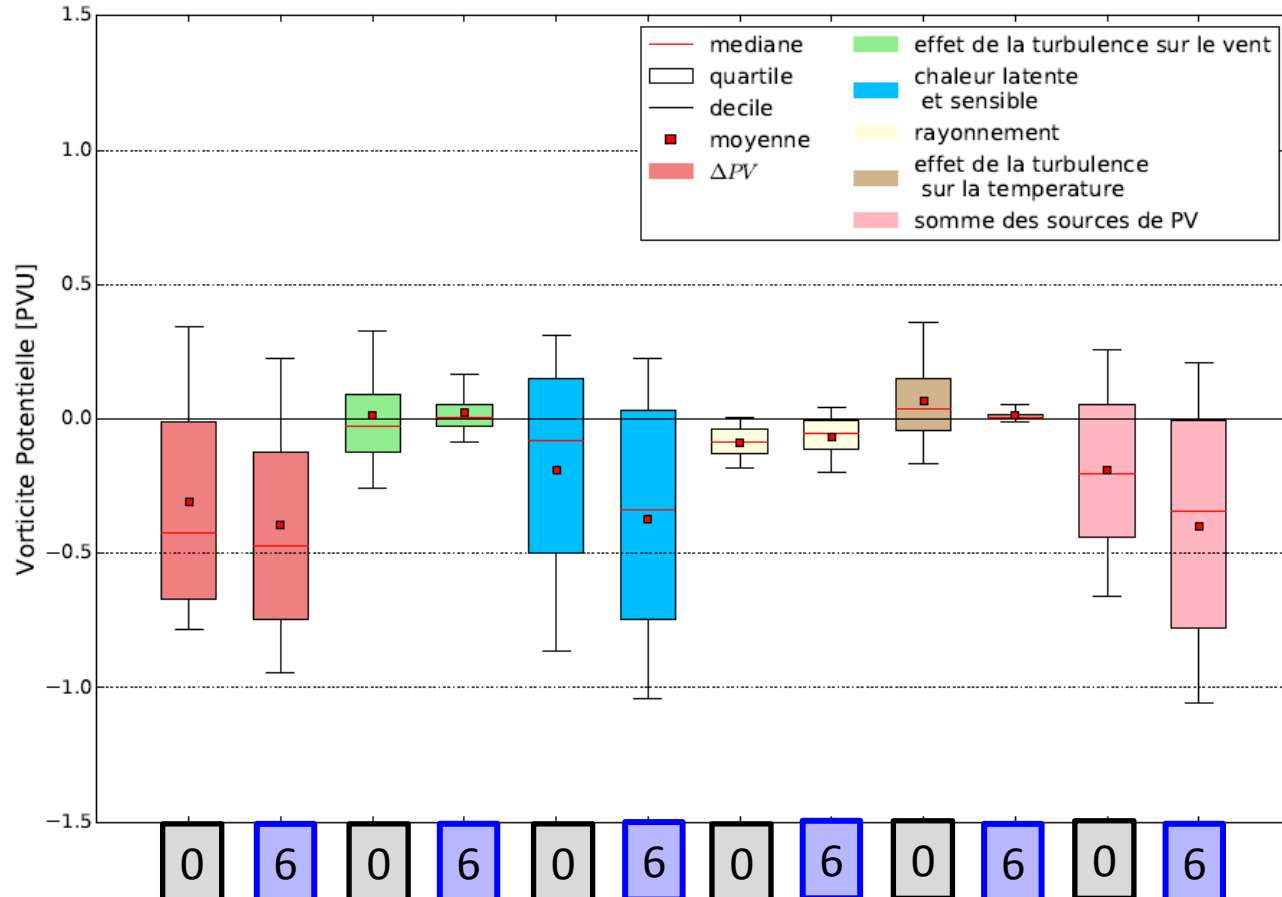
Effet du chauffage sur le PV



Variation de PV au bout de 24h



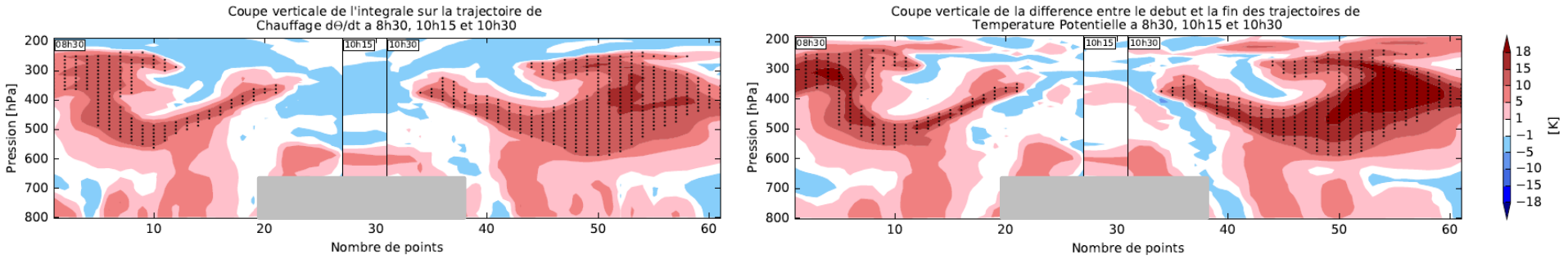
Distribution de PV pour les trajectoires anticycloniques



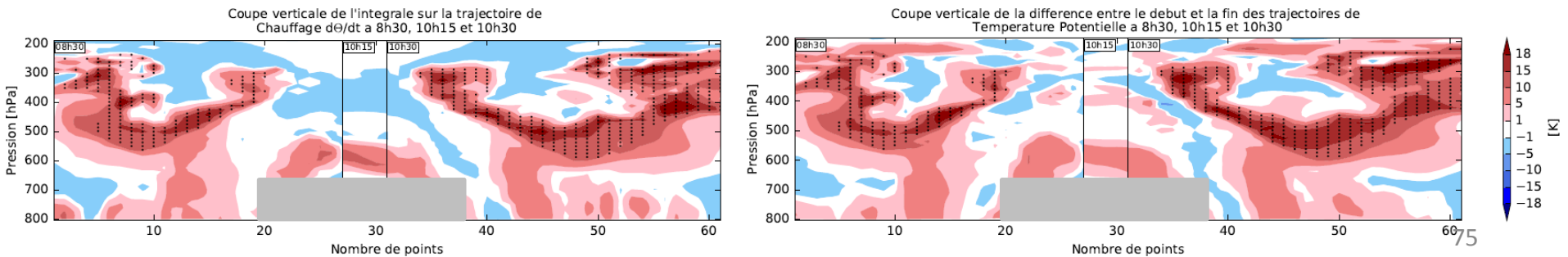
Validation du modèle de trajectoires : $\int \dot{\theta} dt \approx \Delta\theta$

Run0

$$\int \dot{\theta} dt$$

 $\Delta\theta$ 

Run6

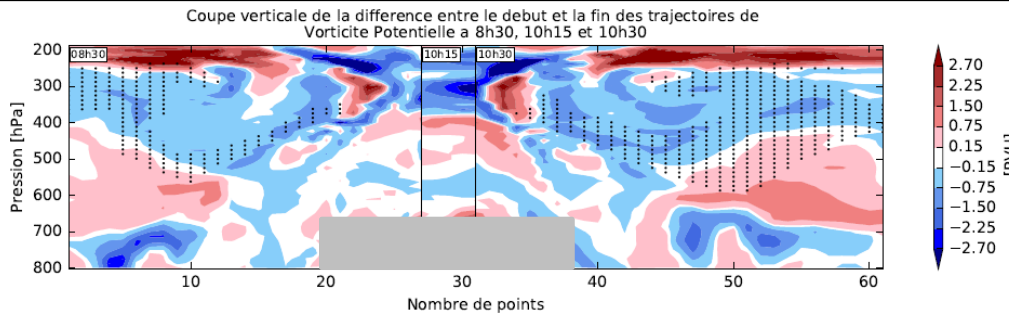
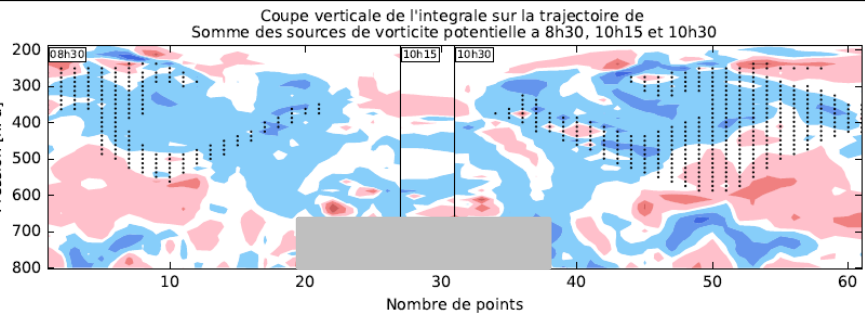


Validation du modèle de trajectoires : $\int \dot{P}V dt \approx \Delta PV$

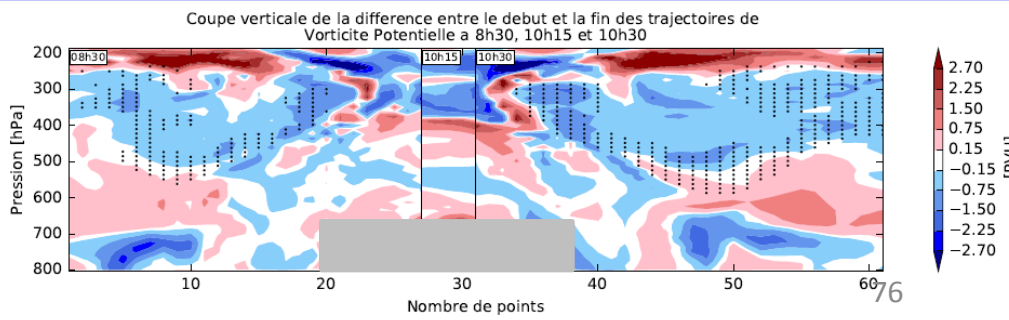
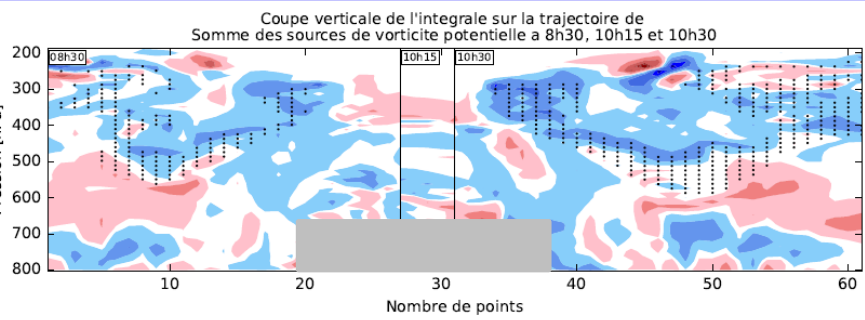
Run0

$$\int \dot{P}V dt$$

$$\Delta PV$$

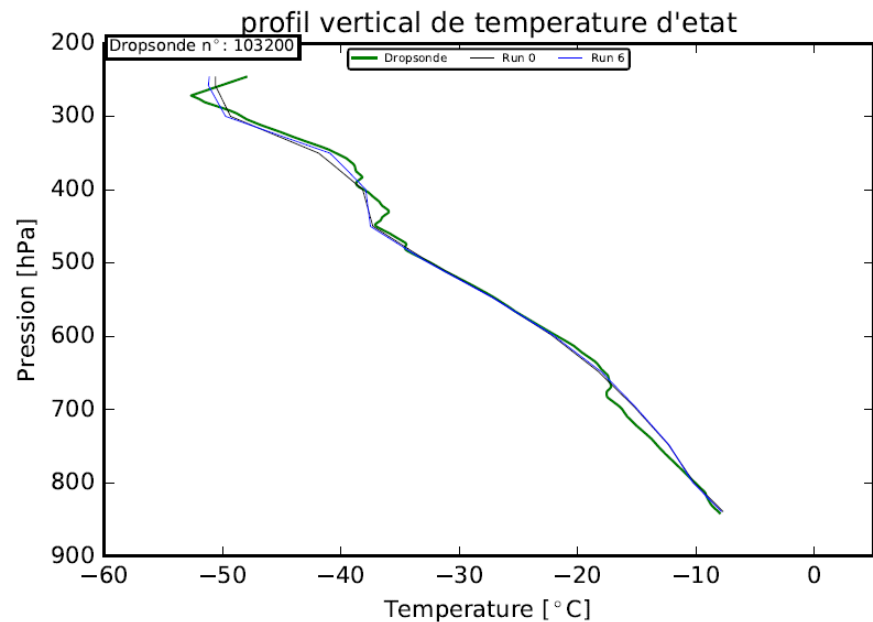
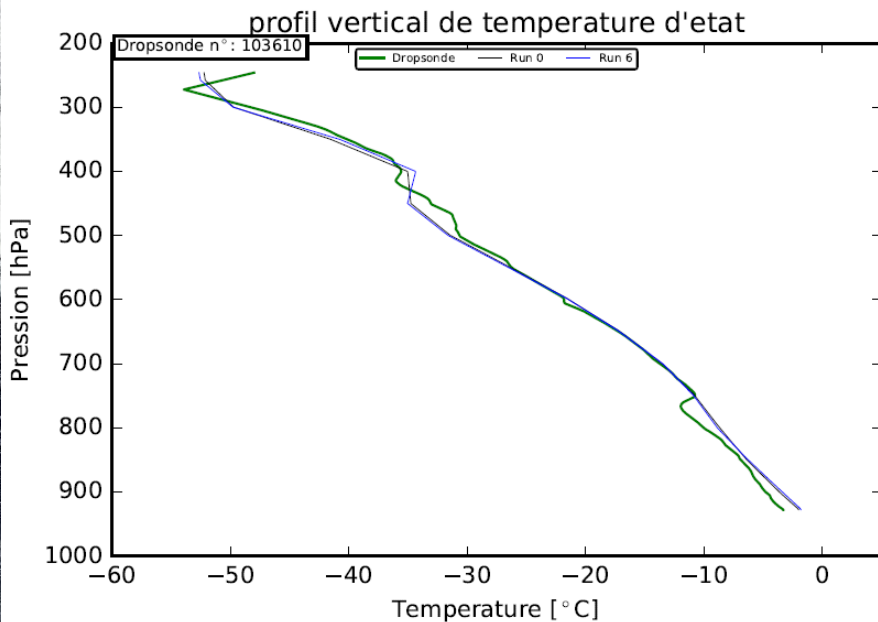


Run6



Validation des prévisions ARPEGE

Dropsondes – vol F6



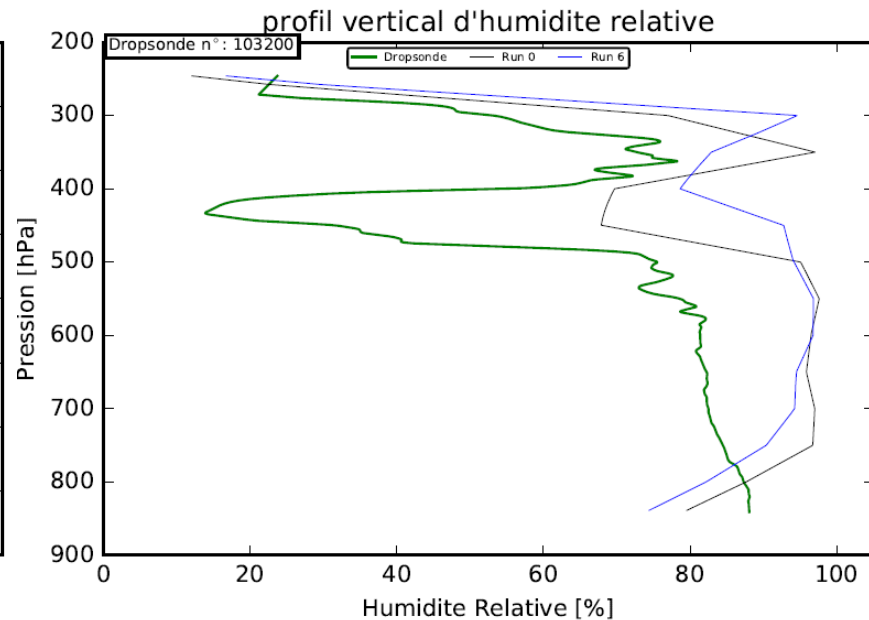
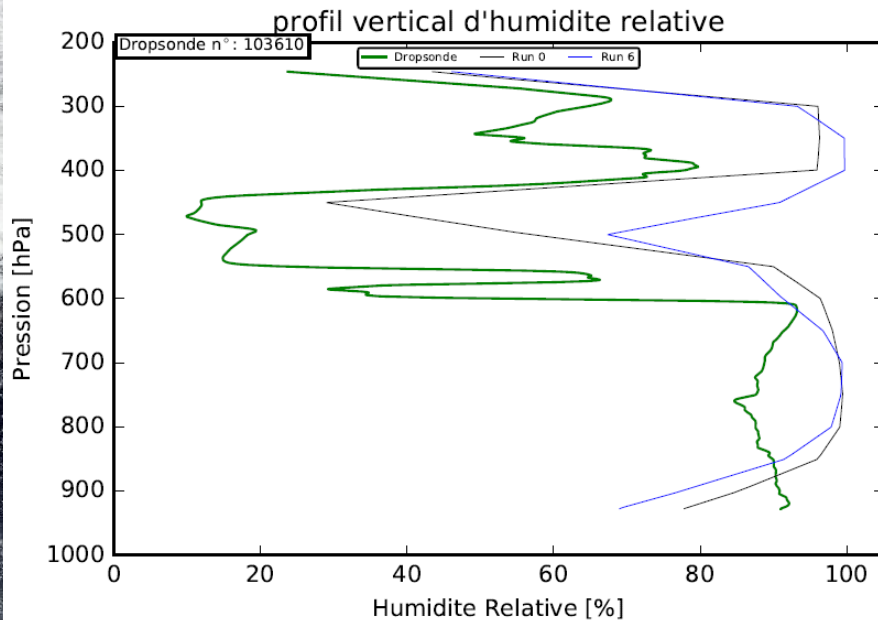
Mesures in situ

Run0

Run6

Validation des prévisions ARPEGE

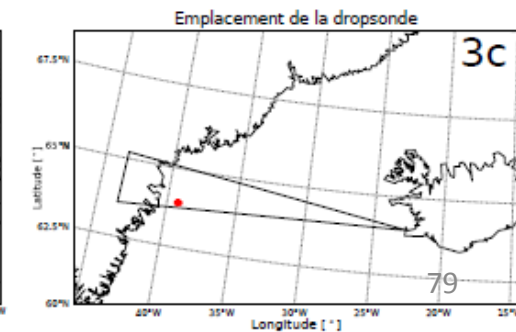
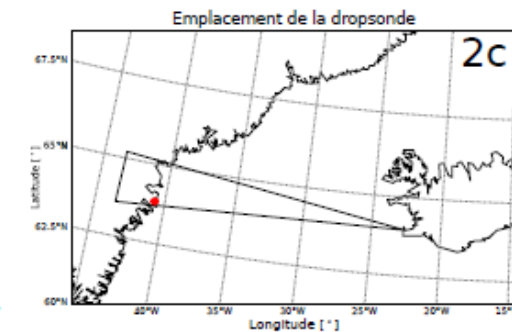
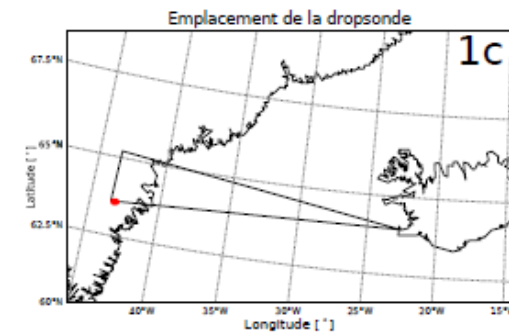
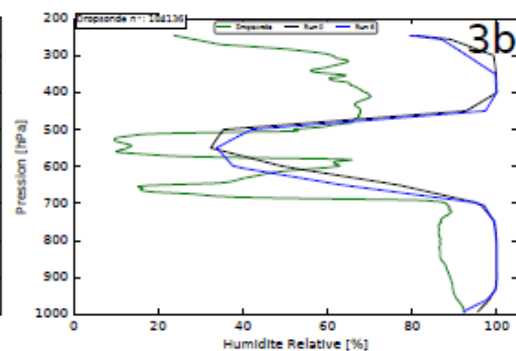
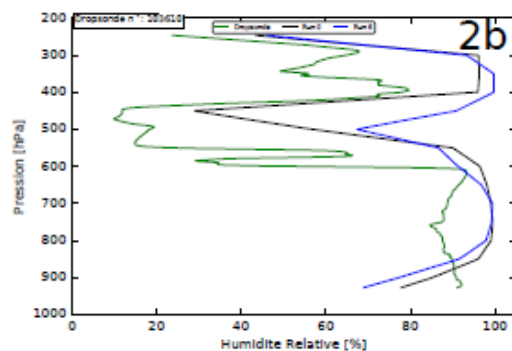
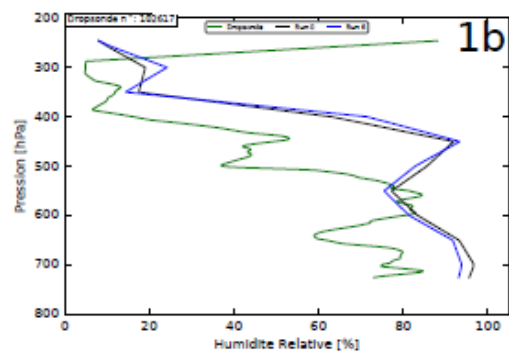
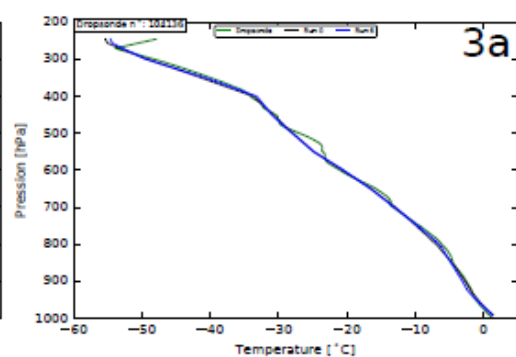
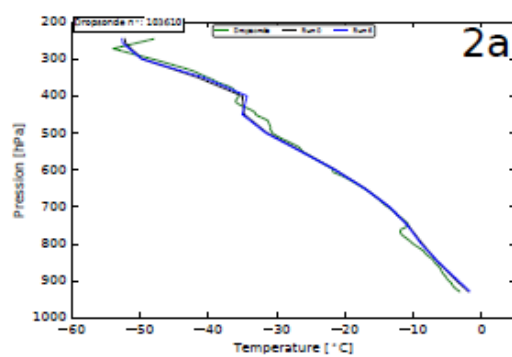
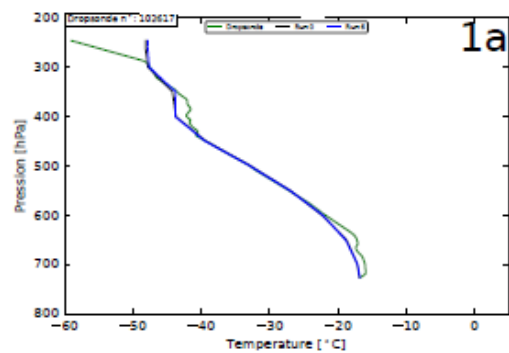
Dropsondes – vol F6



Mesures in situ

Run0

Run6

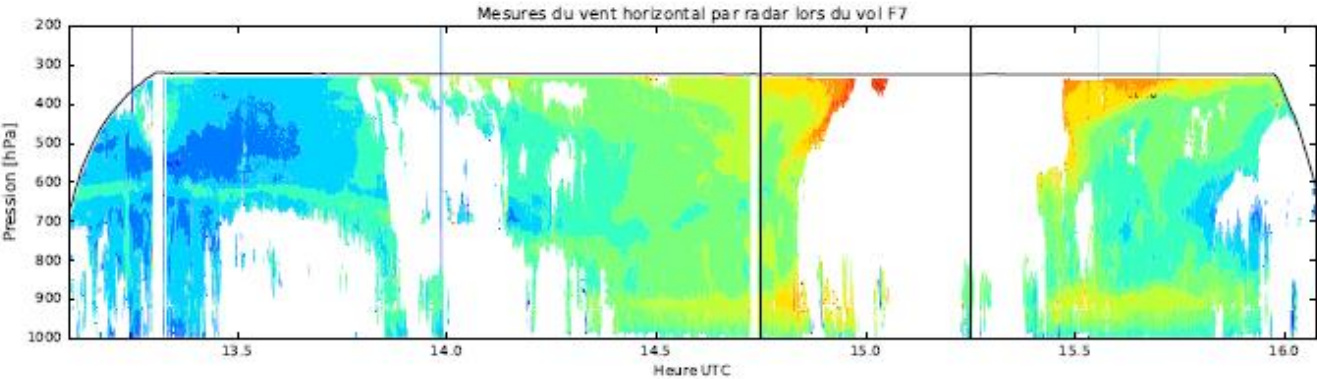
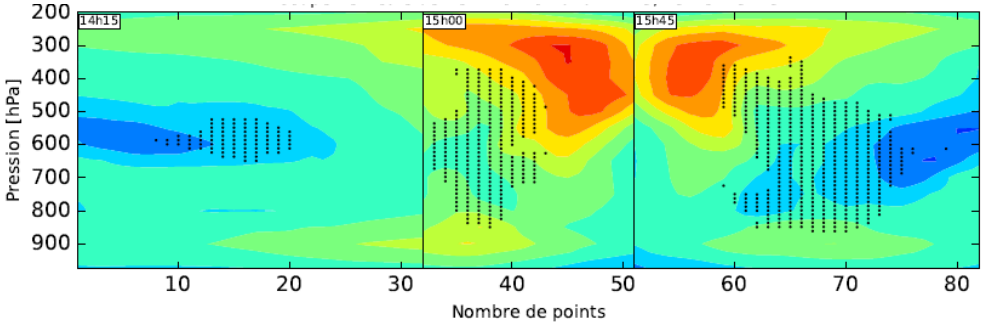
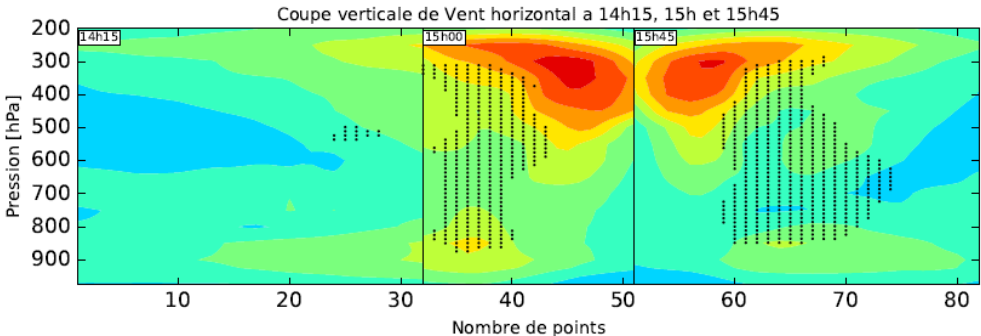




Run0

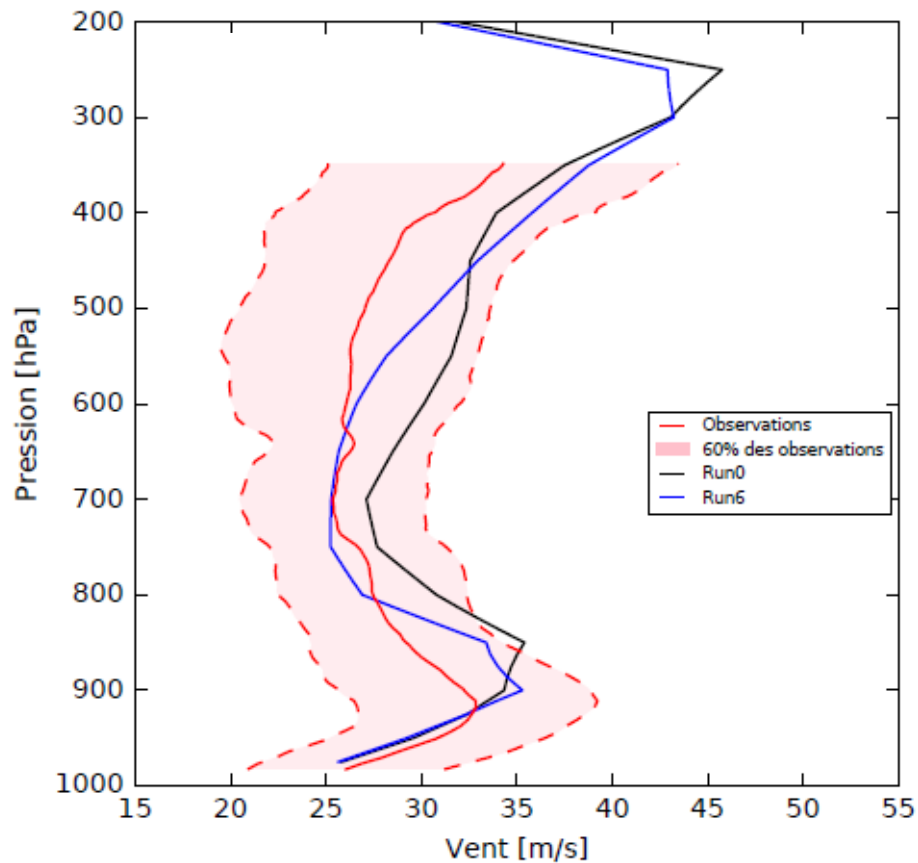
Validation des prévisions ARPEGE Radar – vol F7

Run6





Validation des prévisions ARPEGE Radar – vol F7



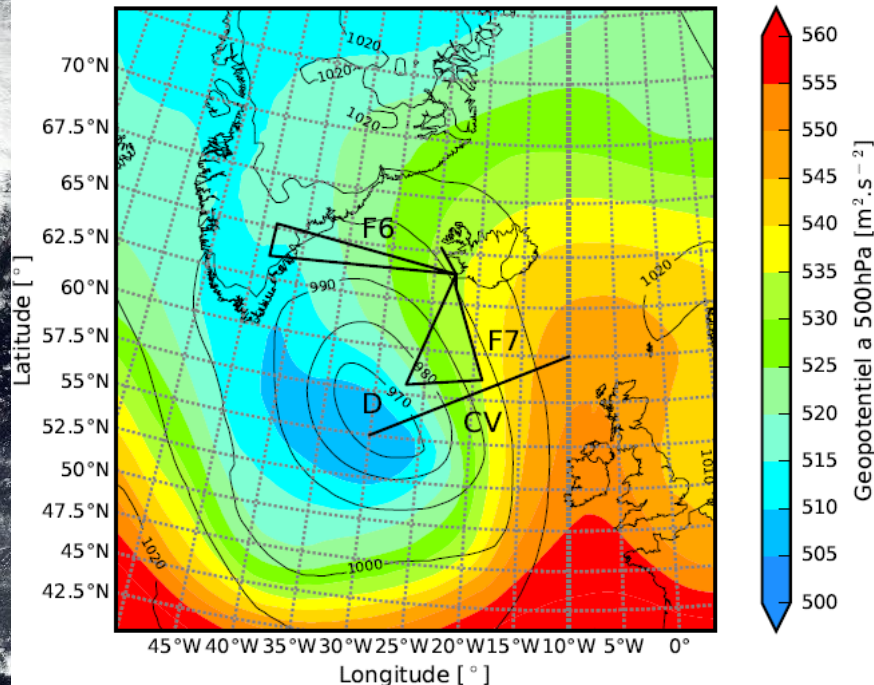
Mesures in situ

Run0

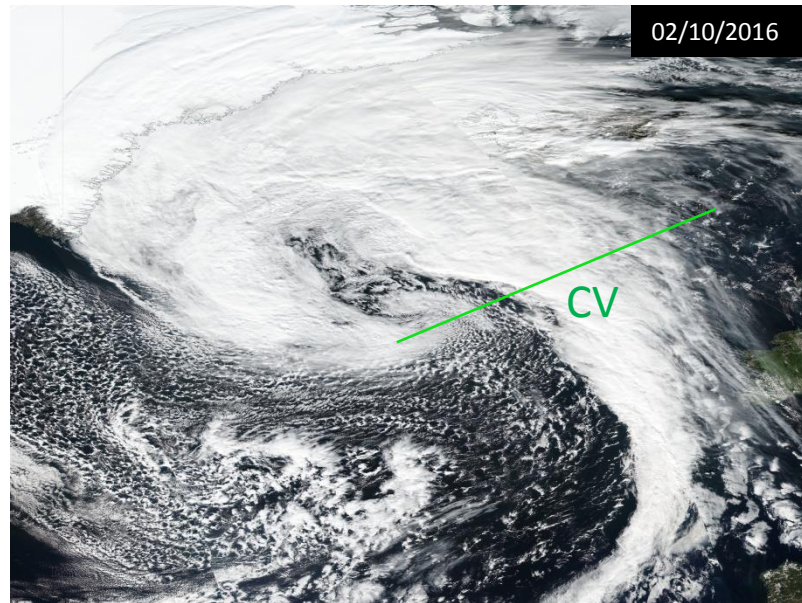
Run6

WCB indépendantes des vols

Carte de géopotentiel à 500 hPa et pression au niveau de la mer



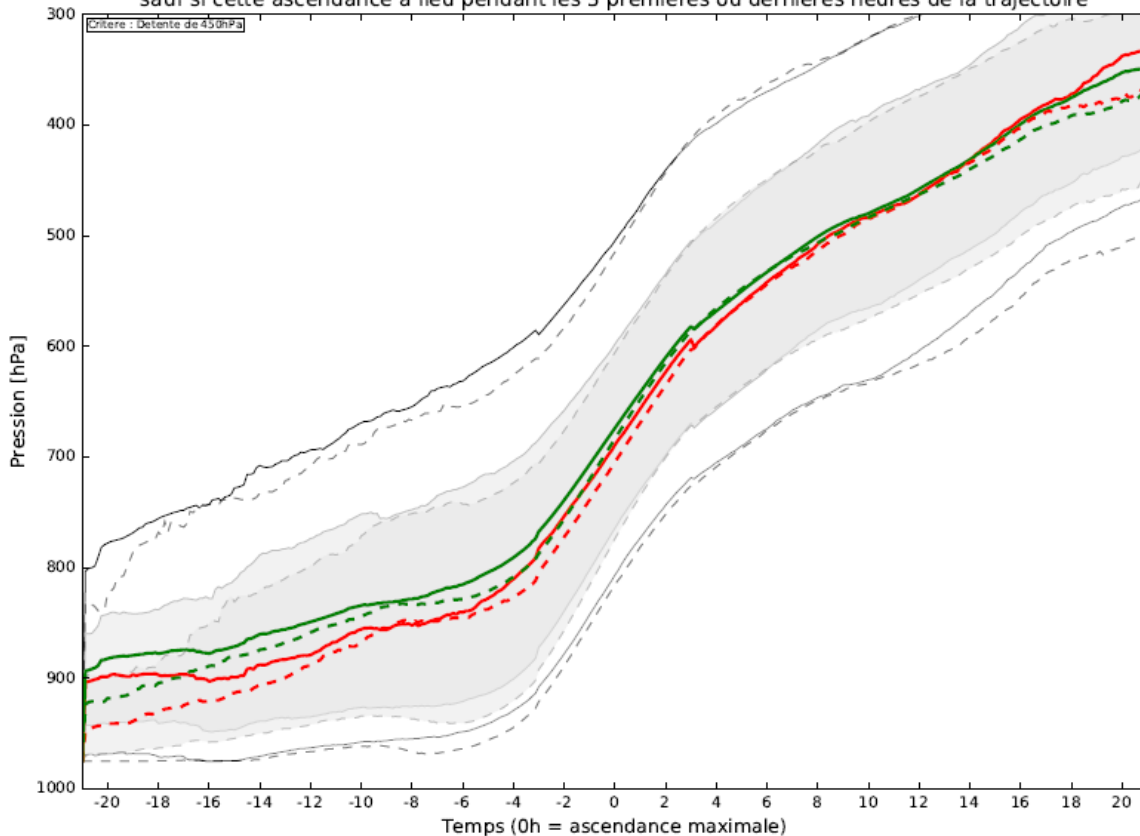
Analyse ARPEGE, du 02/10/2016 à 12h



MODIS, Nasa Worldview Application

Synchronisation selon le maximum d'ascendance

Statistiques : Pression des trajectoires présentant une ascendance maximale sur 6h
sauf si cette ascendance a lieu pendant les 3 premières ou dernières heures de la trajectoire

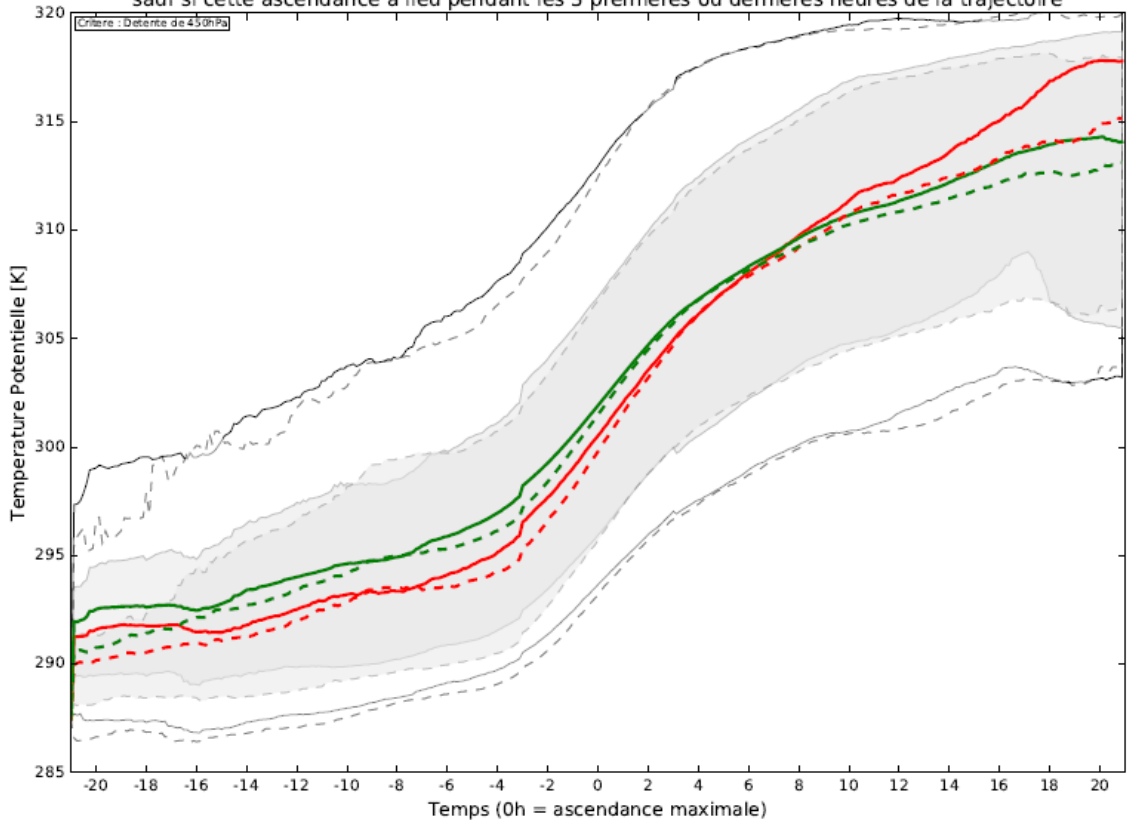


Critère : -300hPa en 24h

- Mediane (Run0)
- - - Mediane (Run6)
- Moyenne (Run0)
- - - Moyenne (Run6)
- Premier et dernier quartiles (Run0)
- - - Premier et dernier quartiles (Run6)
- Premier et dernier deciles (Run0)
- - - Premier et dernier deciles (Run6)

Synchronisation selon le maximum d'ascendance

Statistiques : Temperature Potentielle des trajectoires presentant une ascendance maximale sur 6h sauf si cette ascendance a lieu pendant les 3 premieres ou dernieres heures de la trajectoire

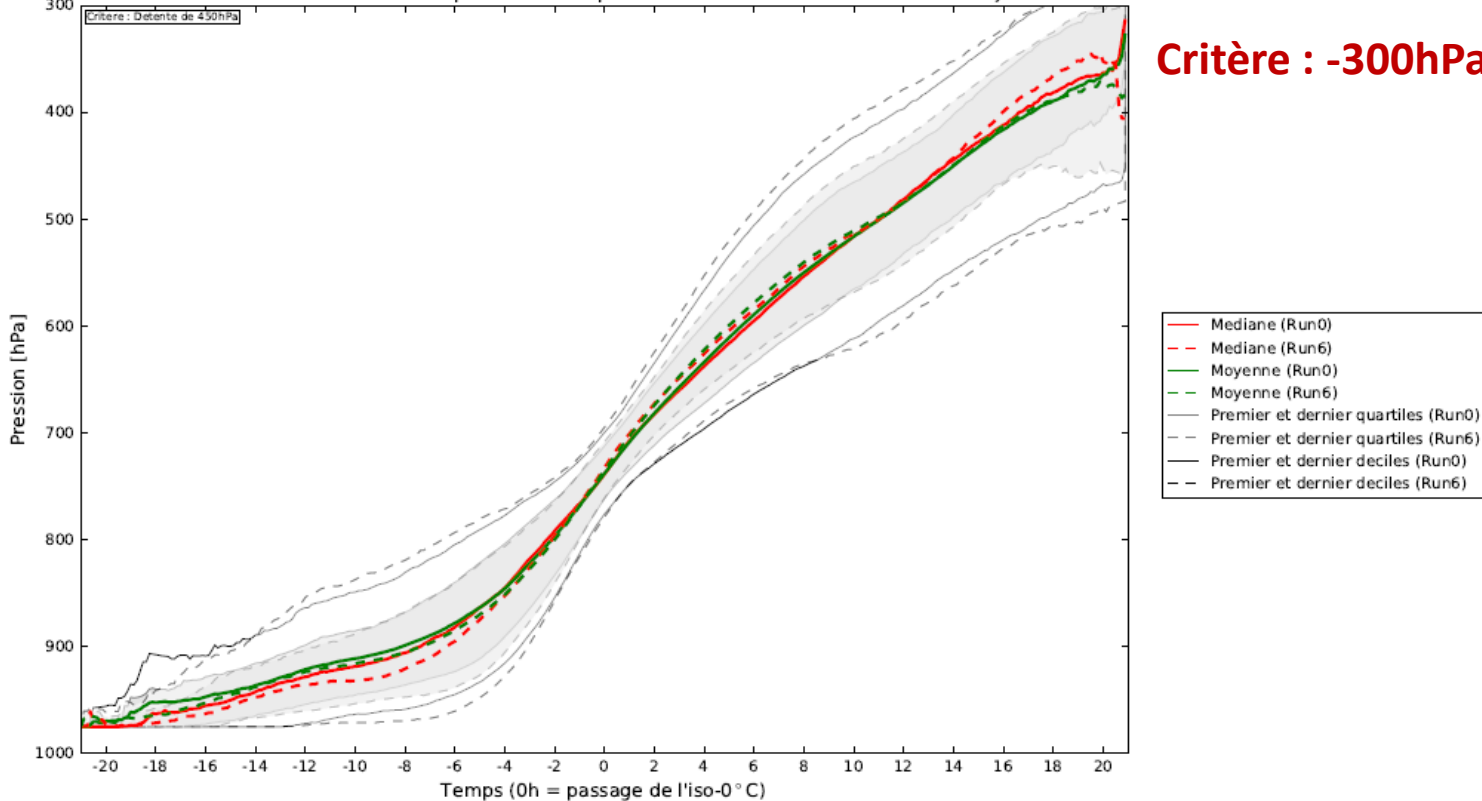


Critère : -300hPa en 24h

- Mediane (Run0)
- - Mediane (Run6)
- Moyenne (Run0)
- - Moyenne (Run6)
- Premier et dernier quartiles (Run0)
- - Premier et dernier quartiles (Run6)
- Premier et dernier deciles (Run0)
- - Premier et dernier deciles (Run6)

Synchronisation selon la traversée de l'iso-0°C

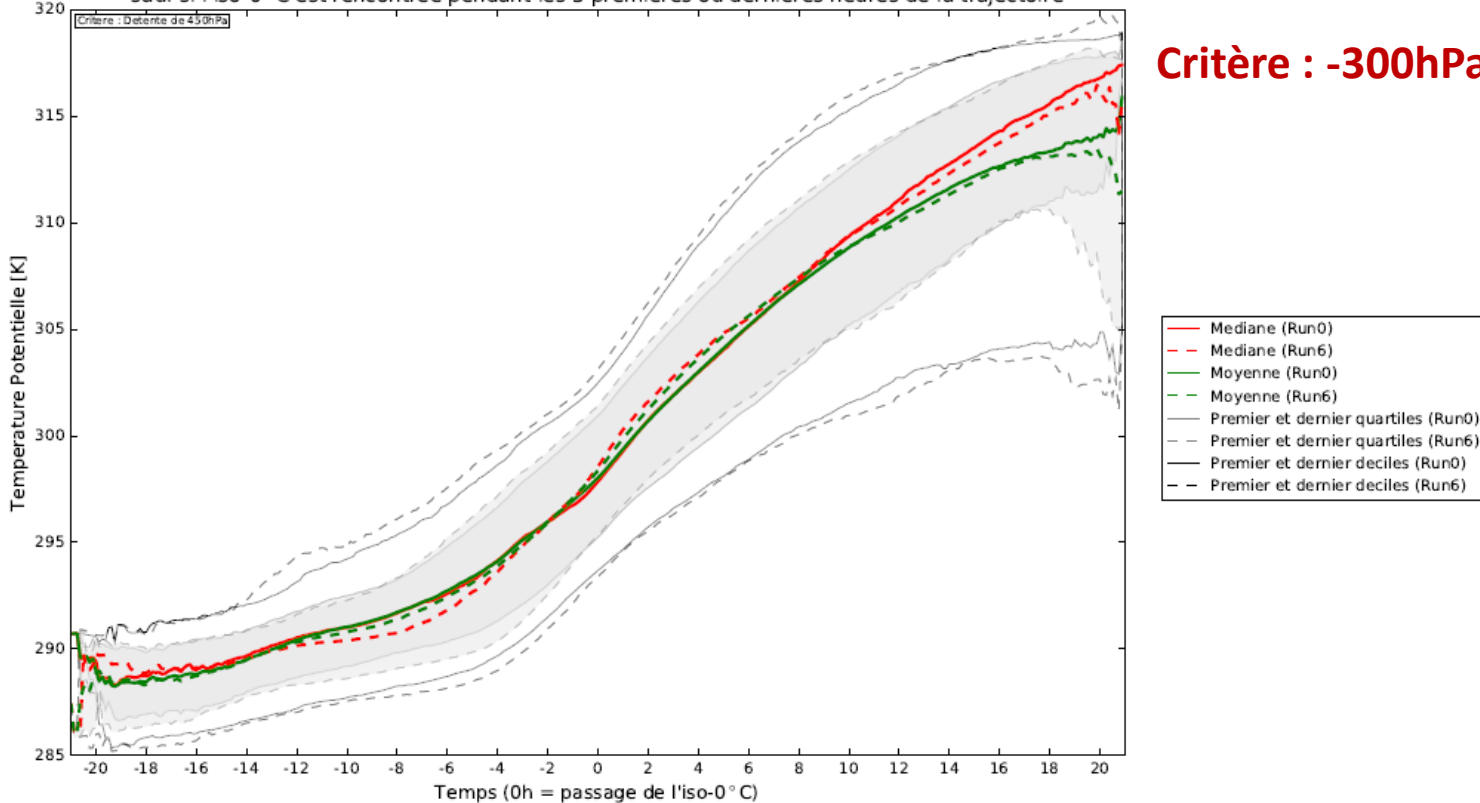
Statistiques : Pression pour les particules traversant l'iso-0°C sur leur trajectoire
sauf si l'iso-0°C est rencontrée pendant les 3 premières ou dernières heures de la trajectoire



Critère : -300hPa en 24h

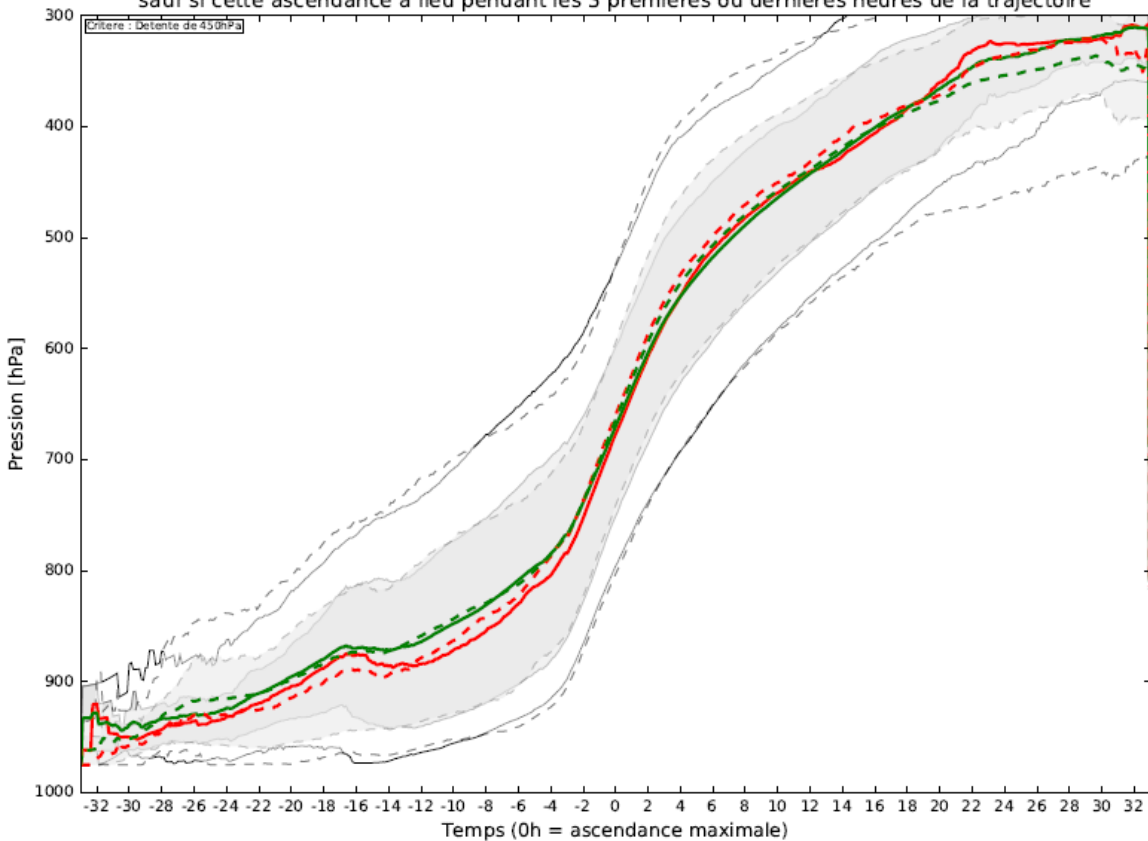
Synchronisation selon la traversée de l'iso-0°C

Statistiques : Temperature Potentielle pour les particules traversant l'iso-0°C sur leur trajectoire
sauf si l'iso-0°C est rencontrée pendant les 3 premières ou dernières heures de la trajectoire



Synchronisation selon le maximum d'ascendance

Statistiques : Pression des trajectoires présentant une ascendance maximale sur 6h
 sauf si cette ascendance a lieu pendant les 3 premières ou dernières heures de la trajectoire

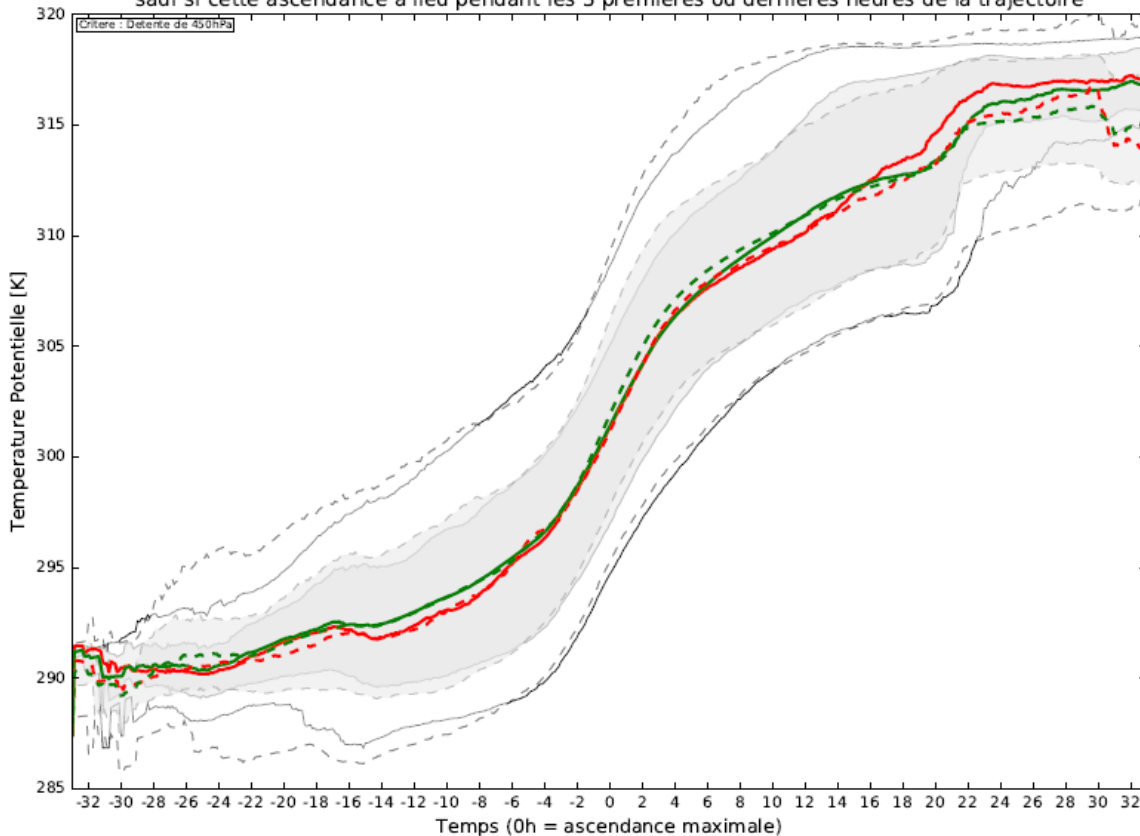


Critère : -450hPa en 36h

- Mediane (Run0)
- - Mediane (Run6)
- Moyenne (Run0)
- - Moyenne (Run6)
- Premier et dernier quartiles (Run0)
- - Premier et dernier quartiles (Run6)
- Premier et dernier deciles (Run0)
- - Premier et dernier deciles (Run6)

Synchronisation selon le maximum d'ascendance

Statistiques : Temperature Potentielle des trajectoires presentant une ascendance maximale sur 6h
sauf si cette ascendance a lieu pendant les 3 premieres ou dernieres heures de la trajectoire

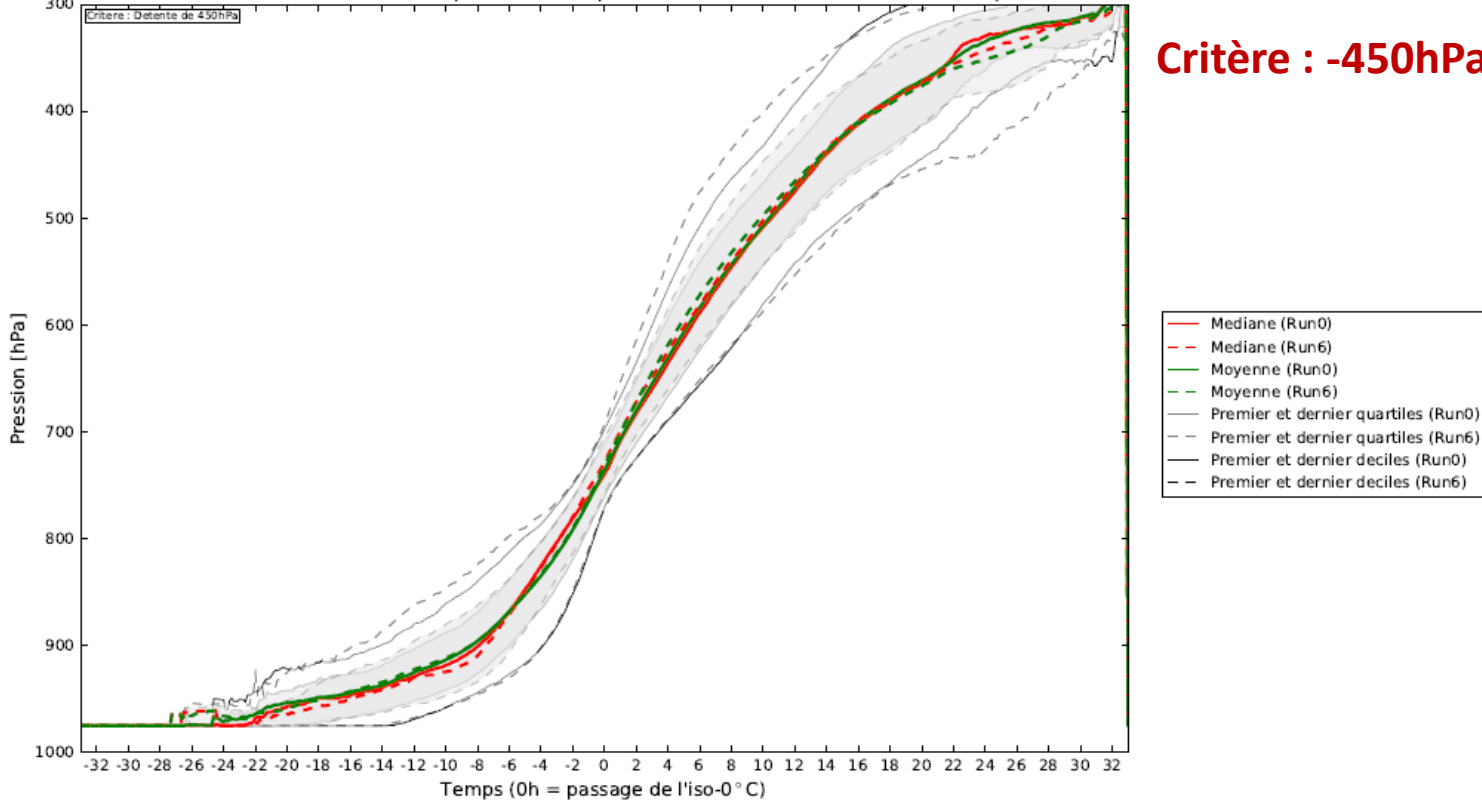


Critère : -450hPa en 36h

- Mediane (Run0)
- - Mediane (Run6)
- Moyenne (Run0)
- - Moyenne (Run6)
- Premier et dernier quartiles (Run0)
- - Premier et dernier quartiles (Run6)
- Premier et dernier deciles (Run0)
- - Premier et dernier deciles (Run6)

Synchronisation selon la traversée de l'iso-0°C

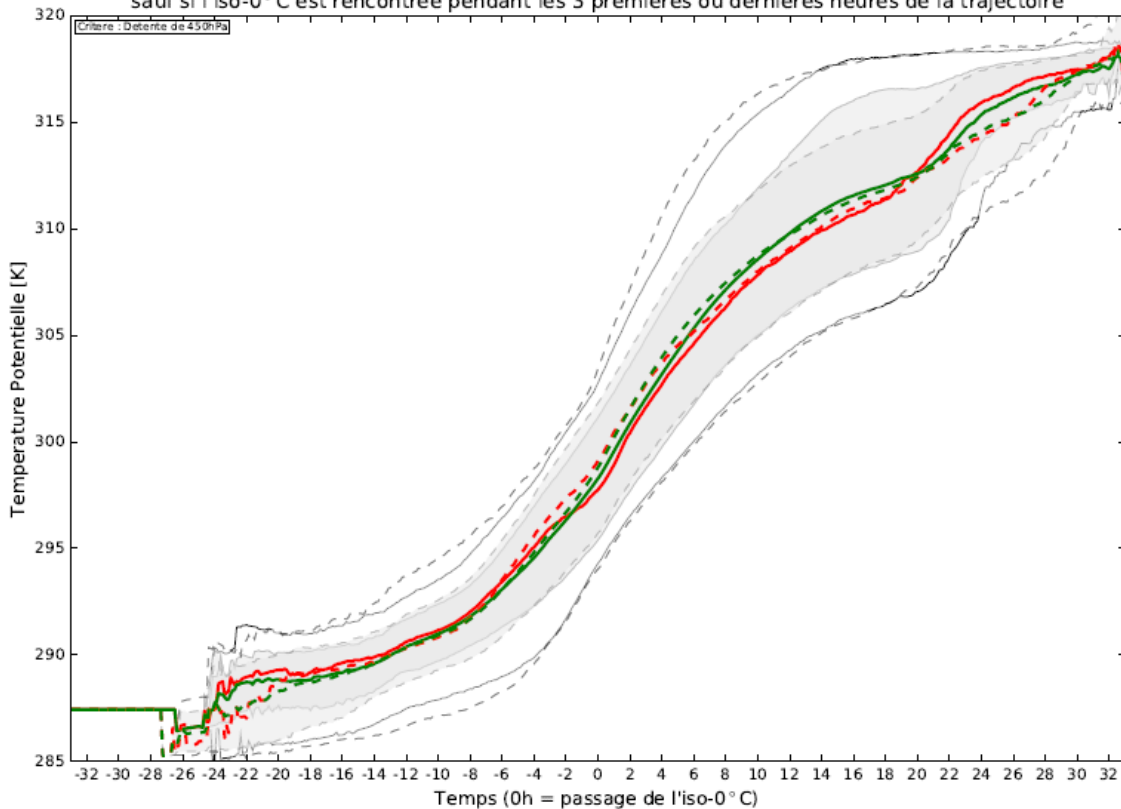
Statistiques : Pression pour les particules traversant l'iso-0°C sur leur trajectoire
sauf si l'iso-0°C est rencontrée pendant les 3 premières ou dernières heures de la trajectoire



Critère : -450hPa en 36h

Synchronisation selon la traversée de l'iso-0°C

Statistiques : Temperature Potentielle pour les particules traversant l'iso-0°C sur leur trajectoire
sauf si l'iso-0°C est rencontrée pendant les 3 premières ou dernières heures de la trajectoire

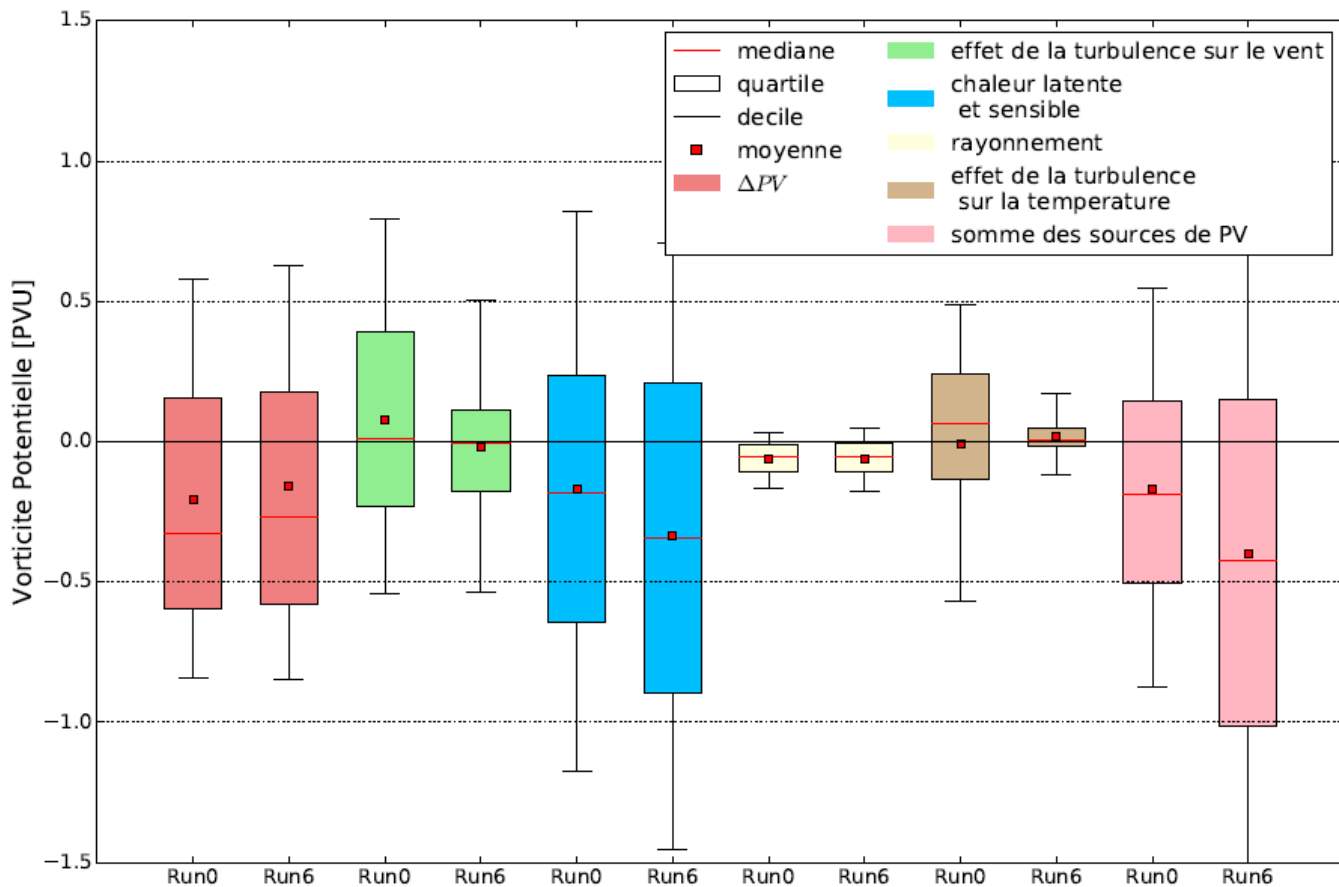


Critère : -450hPa en 36h

- Mediane (Run0)
- - Mediane (Run6)
- Moyenne (Run0)
- - Moyenne (Run6)
- Premier et dernier quartiles (Run0)
- - Premier et dernier quartiles (Run6)
- Premier et dernier deciles (Run0)
- - Premier et dernier deciles (Run6)



Distribution de PV pour les trajectoires anticycloniques



Distribution de PV pour les trajectoires cycloniques

