

Vers une variable pronostique de l'organisation de la convection dans ARPEGE

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ARPEGE

Modèle global opérationnel à Météo-France

- Résolution :
 - Grille gaussienne étirée et basculée (TL1798C2.2) : 5 à 24km
 - 105 niveaux verticaux
- Pas de temps : 240s
- Initialisation : 4dVar
- Prévisions : 5 prévisions par jour jusqu'à 114h

Paramétrisation de la convection profonde : Tiedtke (1989), Bechtold (2014)

- Schéma en flux de masse
- Fermeture en CAPE



Grille ARPEGE
TL1798C2.2

Représentation de l'organisation de la convection

Nouvelle variable pronostique représentant l'organisation convective: MO

- 0 : Convection floculaire
- 1 : Convection organisée (MCS)

Equation d'évolution :

$$\frac{dMO}{dt} = C_1 EvapRR - \frac{MO}{\tau_{MO}} + C_2 \bar{w}$$

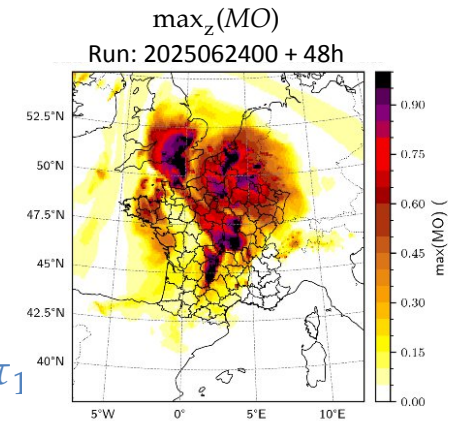
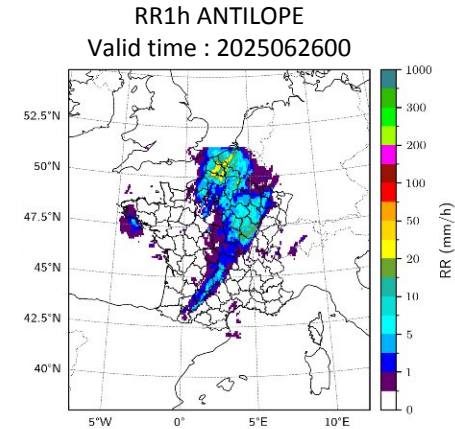
Piriou et al. (2007)

Mapes et al. (2011) ...

Advection de MO (3D) par la dynamique (schéma semi-lagrangien 3D)

Impact sur le schéma de Tiedtke :

- $E_{up} \propto e_1 (1 - \max_z(MO)) + e_2 \max_z(MO)$
- $\tau_{CAPE} \propto \tau_1 (1 - \max_z(MO)) + \tau_2 \max_z(MO)$
- Faible valeur de $MO \rightarrow E_{up}$ altéré d'un facteur e_1 et τ_{CAPE} d'un facteur τ_1
- Forte valeur de $MO \rightarrow E_{up}$ altéré d'un facteur e_2 et τ_{CAPE} d'un facteur τ_2



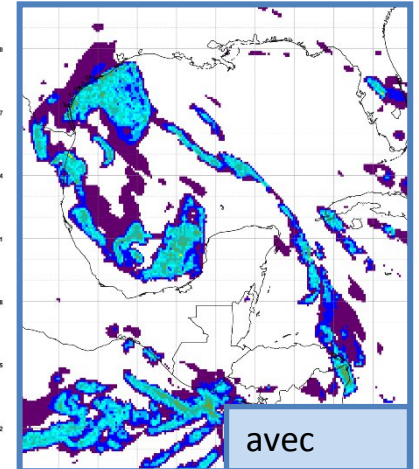
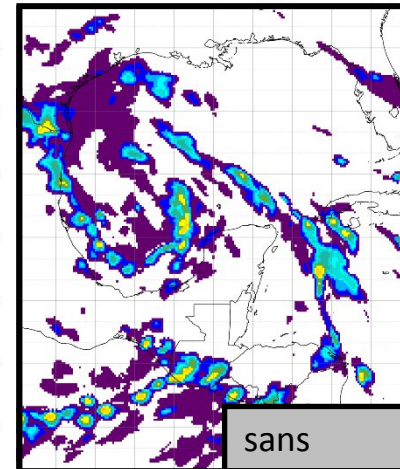
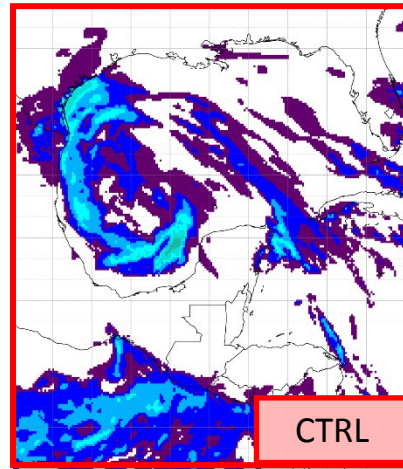
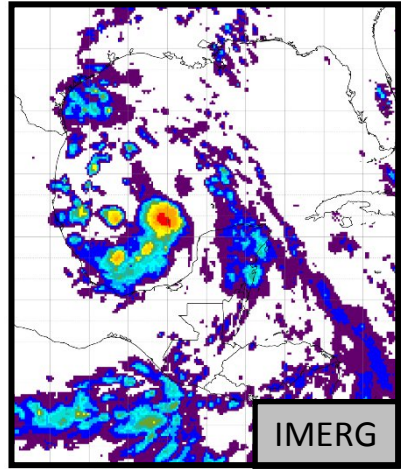
Impact du rajout du terme de vitesse verticale

$$\frac{dMO}{dt} = C_1 EvapRR - \frac{MO}{\tau_{MO}} + C_2 \bar{w}$$

RR1h

Run : 2024061900 + 14h

Valid Time : 2024061914



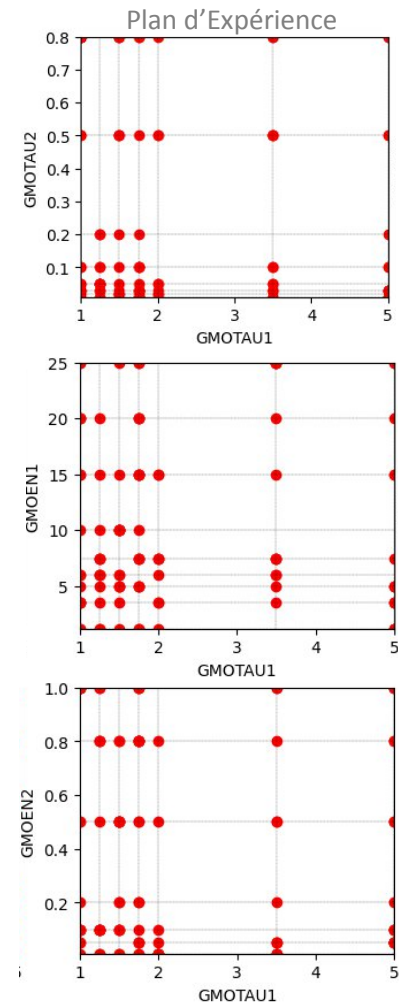
Moins d'orages point de grille

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Perturbation de Paramètres

Perturbation de e_1, e_2, τ_1 et τ_2 :

- Test de 112 jeux de paramètres différents tirés aléatoirement dans un Plan Factoriel Complet
- Production d'un ensemble de prévisions à 112 membres:
 - Run : 2025062400
 - Échéance : 72h
 - DDH pour chaque membre
- Recherche du membre avec :
 - ✓ meilleure fréquence de pluies sur 24h
 - ✓ bonne temporalité de la convection
 - ✓ meilleurs scores
- Comparaison à une simulation de contrôle sans MO : CTRL

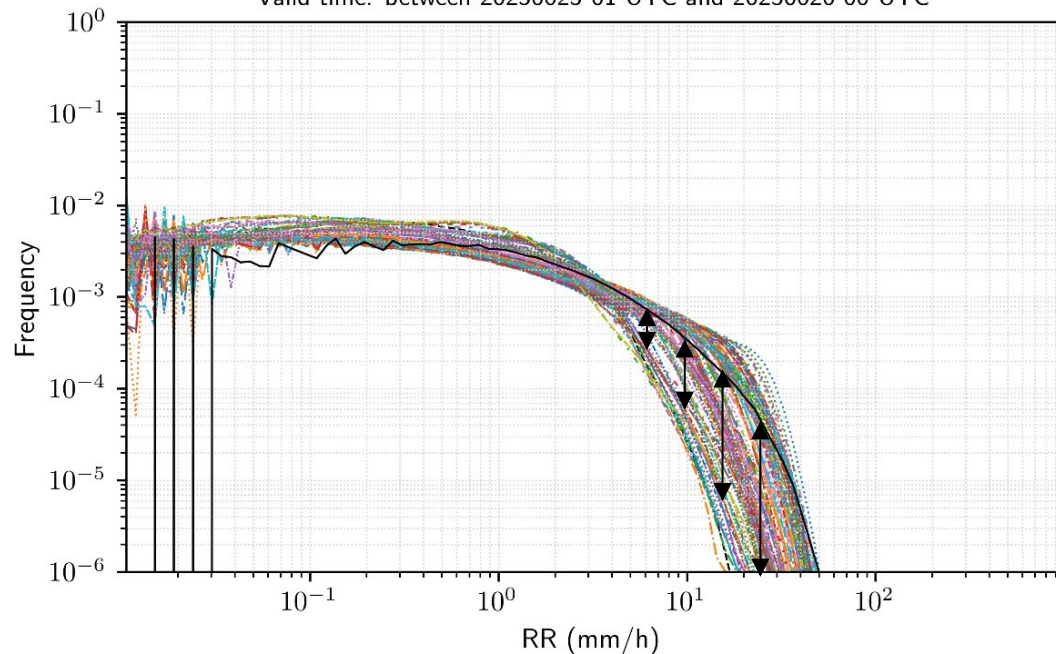


Comparaison de la fréquence de pluies cumulées sur 1h aux données IMERG

Frequency of RR1h

Initial time: 20250624 r00 UTC

Valid time: between 20250625 01 UTC and 20250626 00 UTC



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--- HGS_m0002:T1.10 T2.00 E1.12 E2.05	--- HGS_m0042:T1.15 T2.00 E1.25 E2.05	--- HGS_m0082:T1.35 T2.02 E1.25 E2.0
--- HGS_m0003:T1.10 T2.00 E1.20 E2.01	--- HGS_m0043:T1.15 T2.00 E1.20 E2.05	--- HGS_m0083:T1.35 T2.02 E1.12 E2.01
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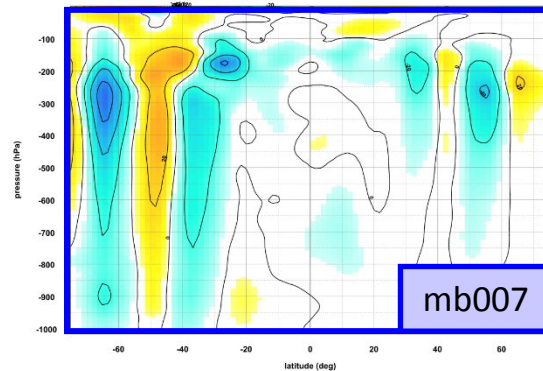
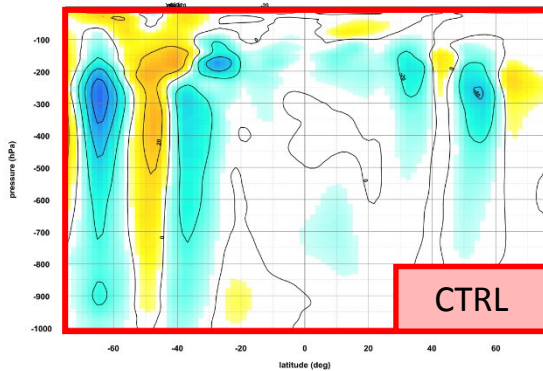
Calcul de l'erreur moyenne aux données satellitaires IMERG pour chaque membre

DDH : Diagnostique des Domaines Horizontaux

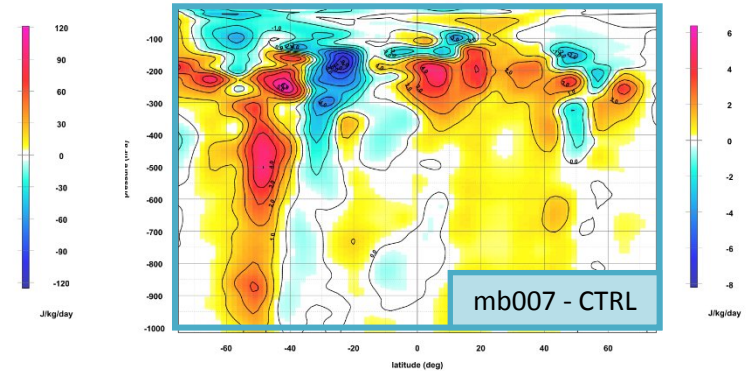
Outil pour réaliser des bilans (point de grille ou zonaux) :

- Bilan d'eau, enthalpie, énergie cinétique, moment angulaire, ...

Tendance moyenne d'énergie cinétique à 72h
Run : 2025062400

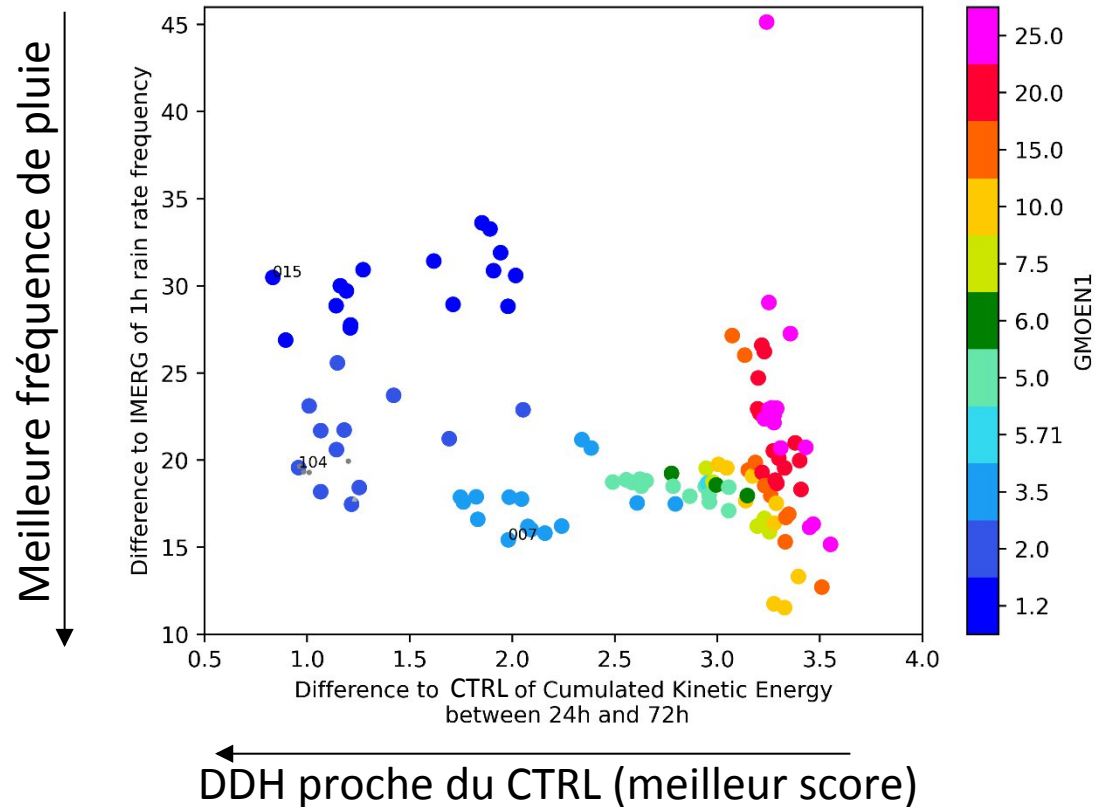


Différence avec le CTRL de la tendance moyenne
d'énergie cinétique entre +24 et +72h
Run : 2025062400

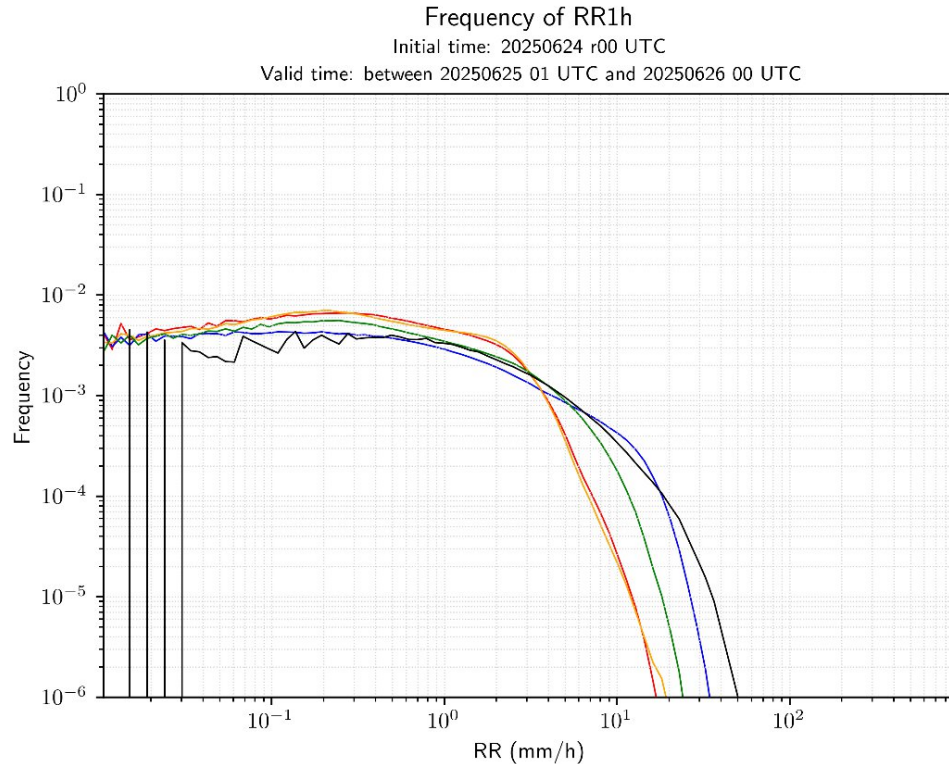


Calcul de la distance au CTRL de la
tendance de l'énergie cinétique à
72h pour chaque membre

Perturbation de Paramètres



Fréquence de pluies pour les 3 membres retenus

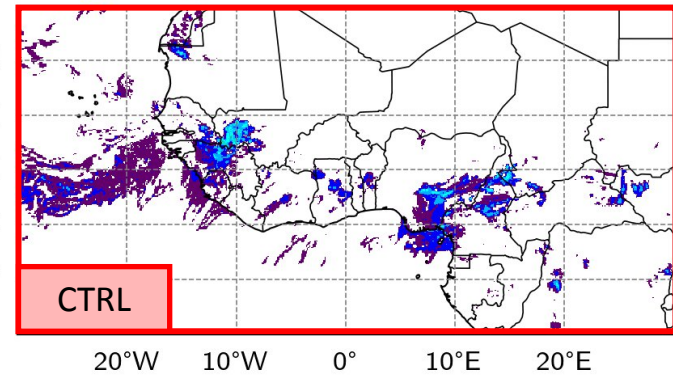
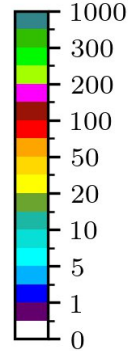
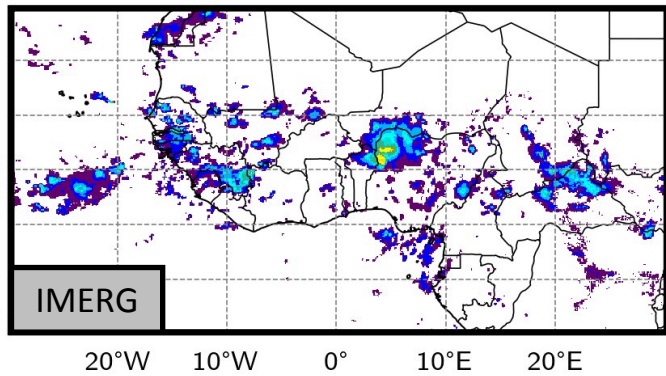


- ✓ mb007 : bonne fréquence de pluie
- ✗ mb015 : pas d'apport comparé à CTRL
- ✓ mb104 : bon compromis

Mobilité des systèmes convectifs

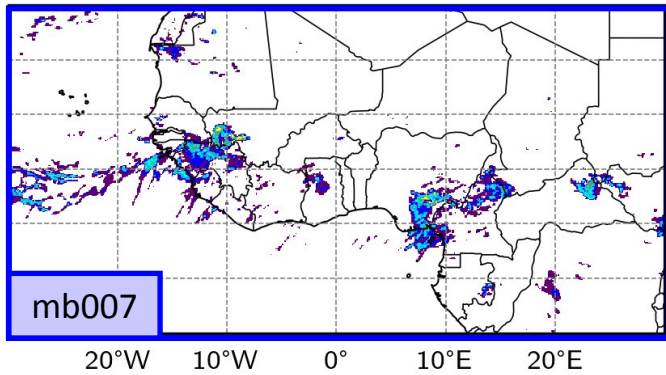
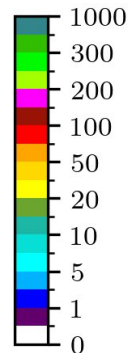
RR1h

Run : 2025090800 +24-48h



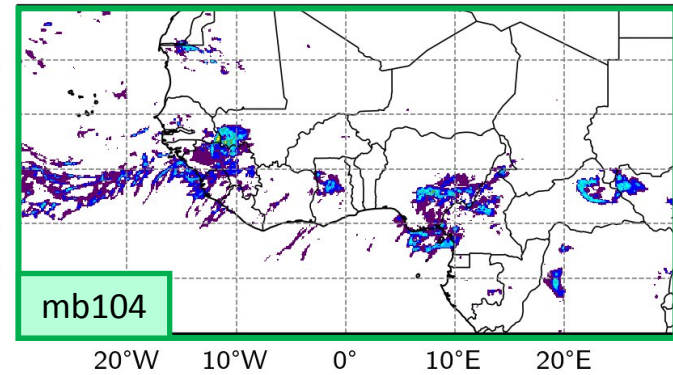
RR24 (mm/h)

RR24 (mm/h)



RR24 (mm/h)

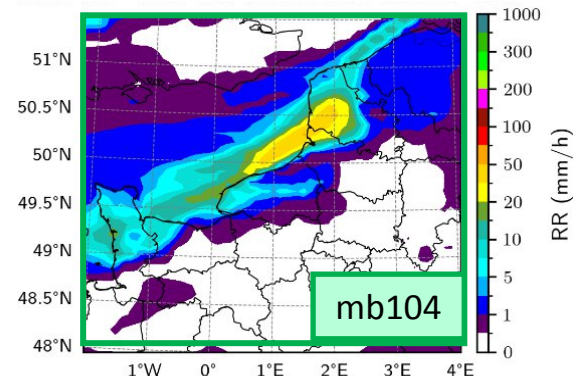
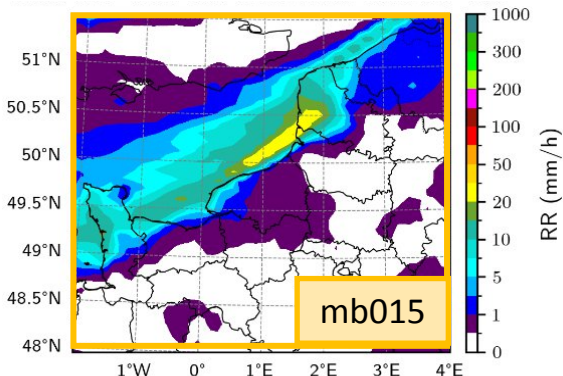
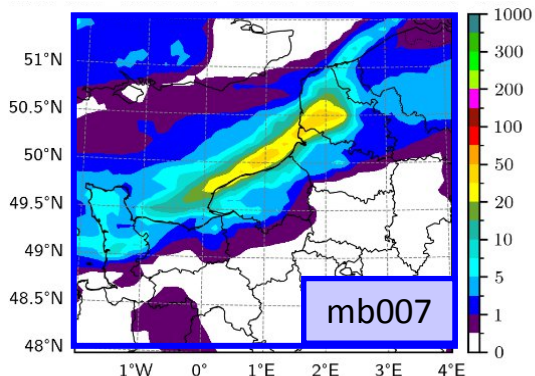
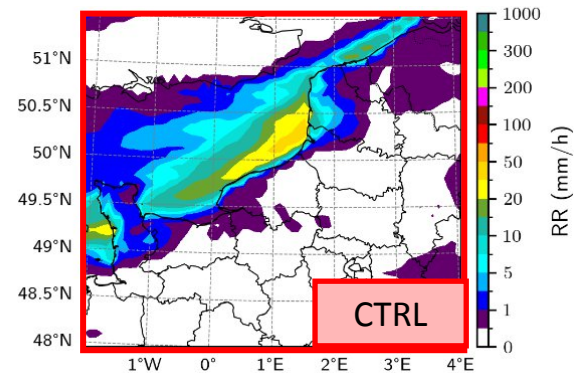
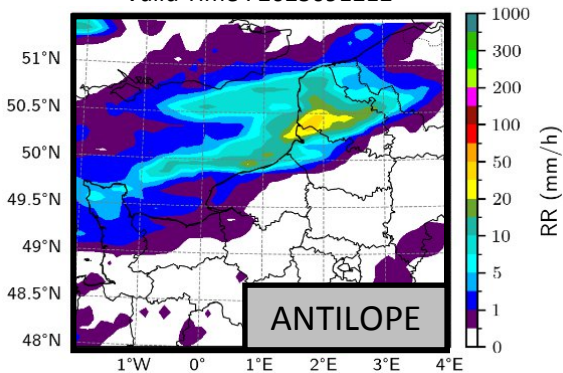
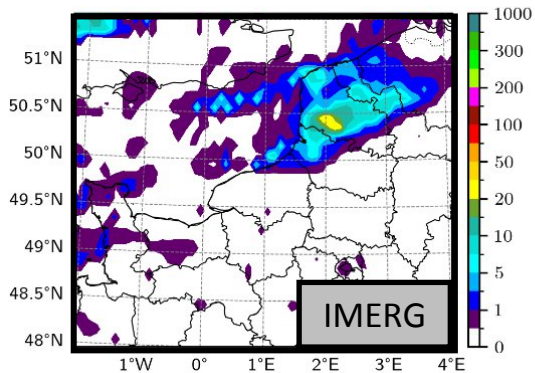
RR24 (mm/h)

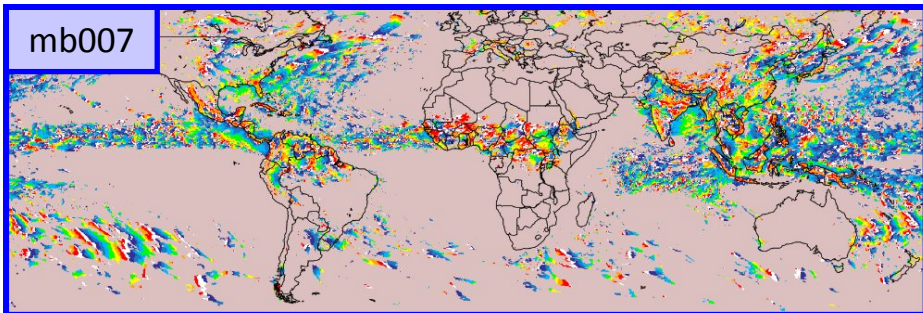


Pluies côtières

✓ Pluies côtières améliorées dues à l'advection de MO

RR12h
Run : 2025091000 +60h
Valid Time : 2025091212

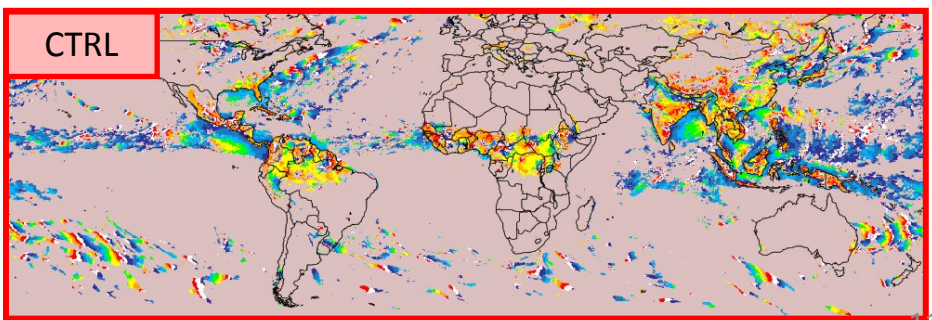
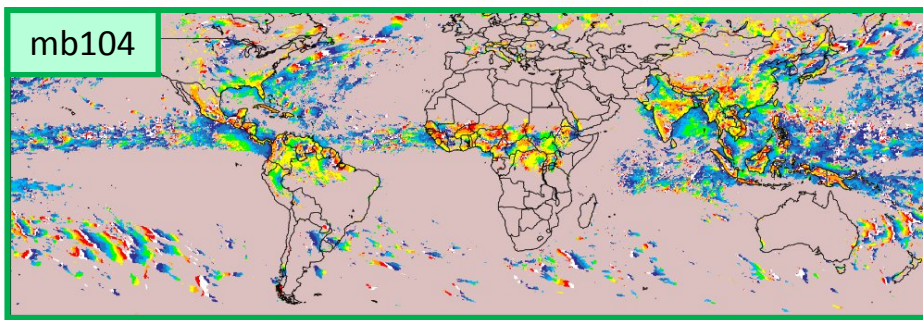
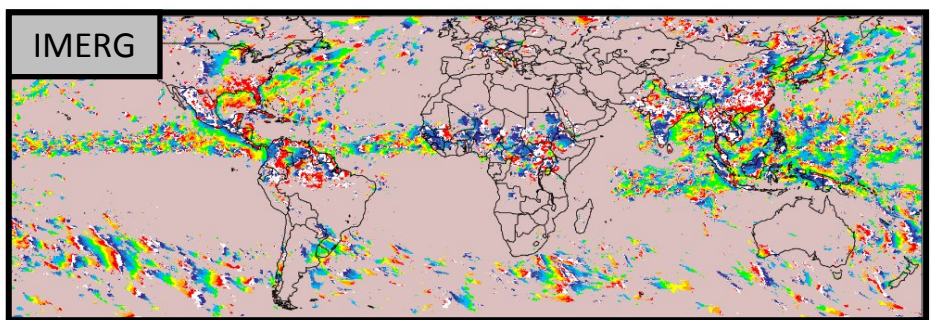
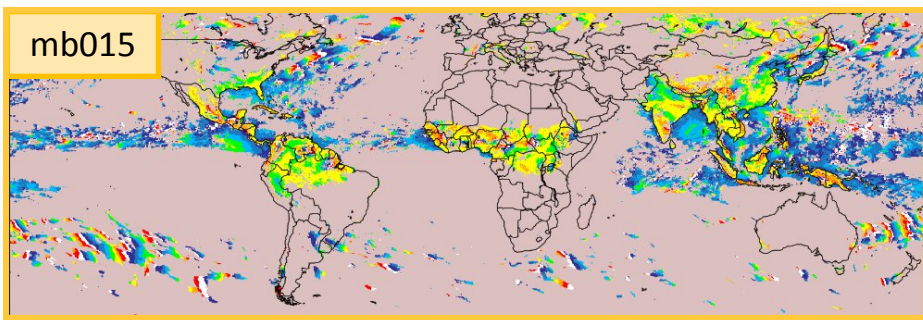
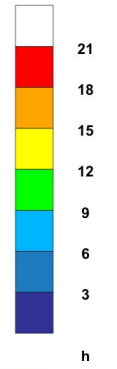




Temporalité du maximum de RR1h

Heure locale du maximum de RR1h entre +24 et +48h
20250801 – 20250831

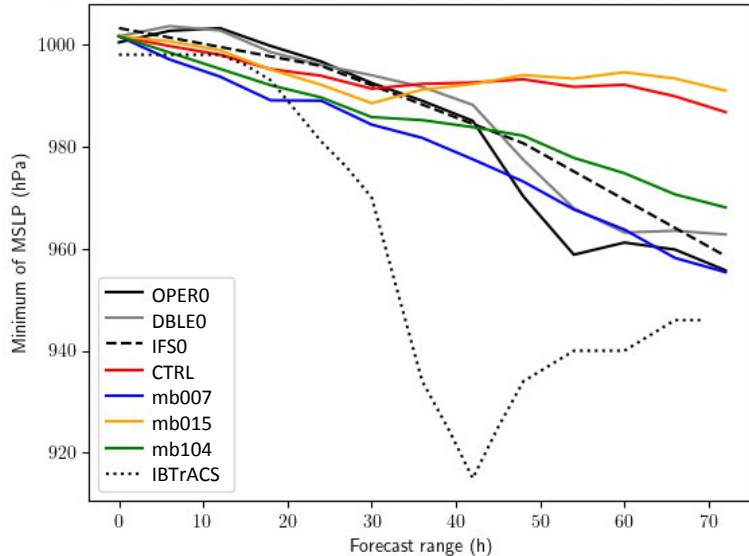
✓ mb007 : temporalité de la convection est améliorée sur continent (Afrique)
🚫 Pas d'amélioration en mer



Creusement des cyclones tropicaux et tempêtes extratropicales

Cyclone Erin

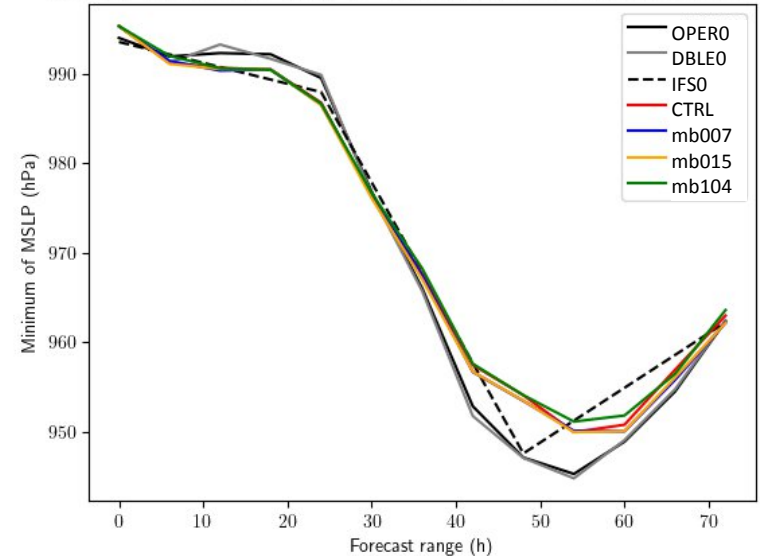
Run : 2025081500



- ✓ mb007 : bon creusement
- ✘ mb015 : pas d'apport comparé à CTRL
- ✓ mb104 : bon creusement

Tempête Amy

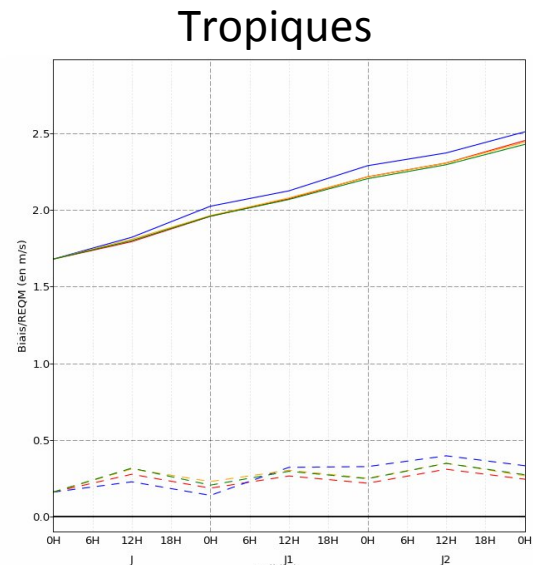
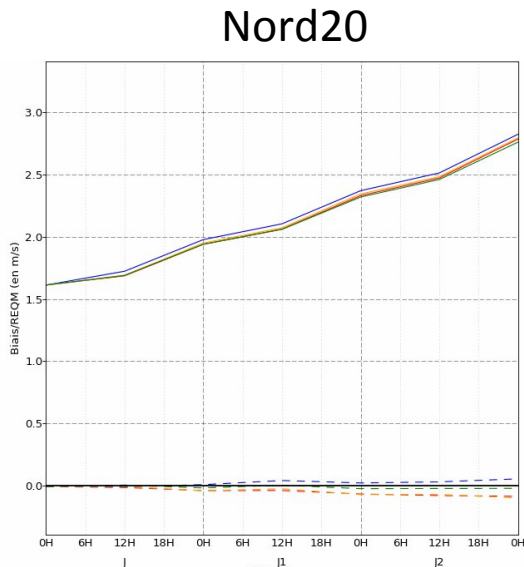
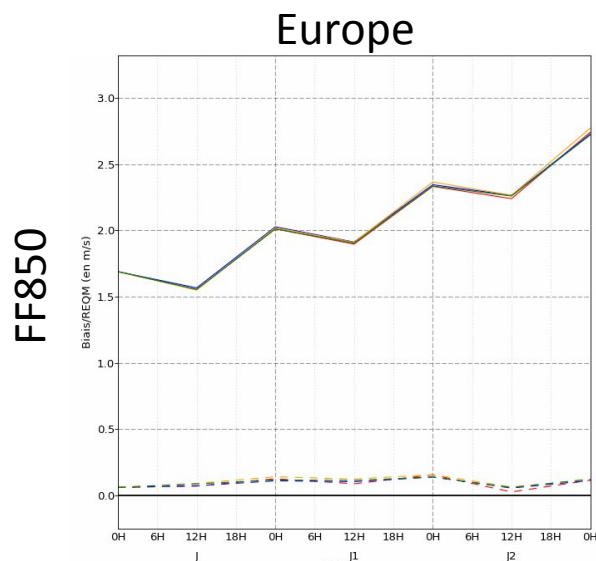
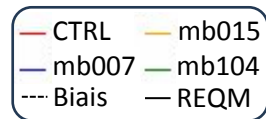
Run : 2025100200



Pas d'impact significatif de l'ajout de MO

Scores aux analyses IFS (Biais et REQM)

2025080400 – 2025083000 (26 jours)



Scores aux analyses IFS (Biais et REQM)

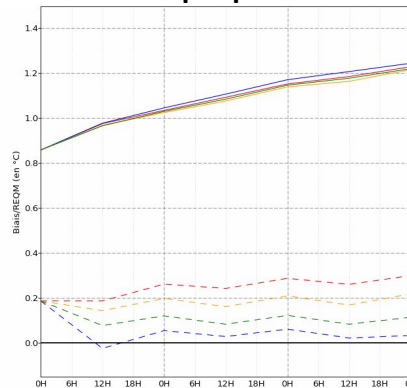
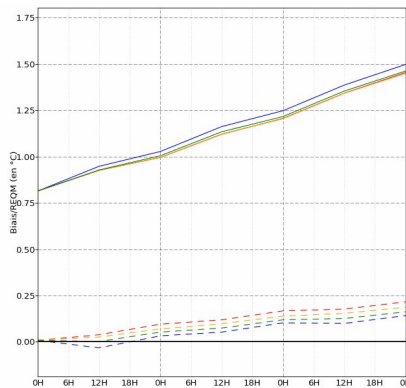
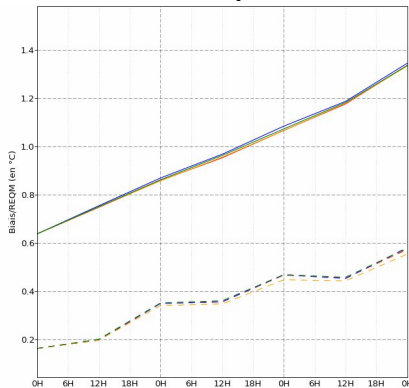
2025080400 – 2025083000 (26 jours)

Europe

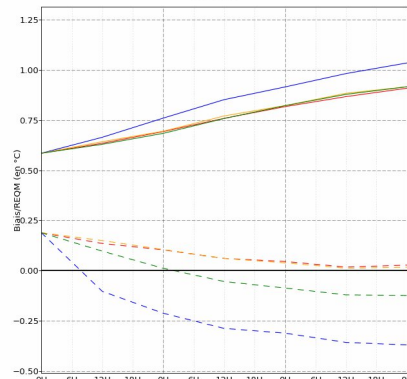
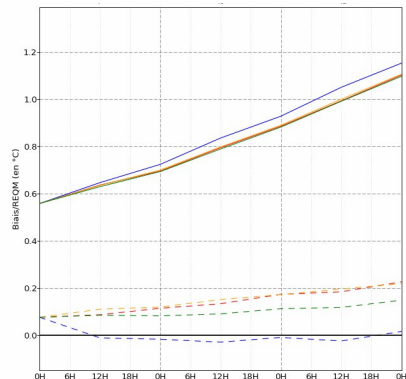
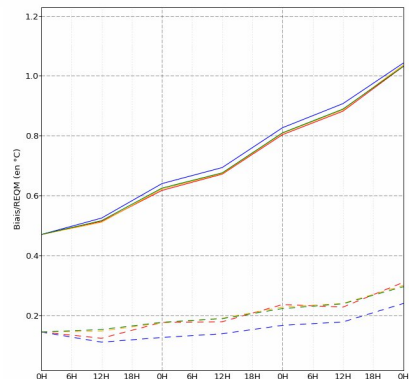
Nord20

Tropiques

T850



T700



- ✓ FF850
- ✓ T850
- 🏠 T700 sur tropiques

Conclusion et perspectives

Impact de MO sur les prévisions ARPEGE :

- Fréquence de pluies plus réalistes
- Systèmes convectifs mobiles
- Amélioration des pluies côtières
- Amélioration du cycle diurne sur continent (avec suppression de RCAPDCYCL; Bechtold et al. 2014)
- Meilleur creusement des cyclones tropicaux
- Scores au mieux neutres

3 jeux de paramètres (e_1, e_2, τ_1, τ_2) retenus :

- **mb007** : bonne fréquence des pluies et temporalité de la convection sur continent
- **mb015** : bons scores
- **mb104** : bon compromis (mais pb temporalité de la convection sur continent)

Perspectives :

- Biais froid dans les tropiques -> manque d'activité du schéma de Tiedtke
- Dépendance à la résolution : test en aquaplanète



Merci pour votre attention

Des questions ?