Tests des modèles ISBA et ARPEGE en mode forcé et nudgé

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CNRS CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE

METEO FRANCE
Toujours un temps d'avance

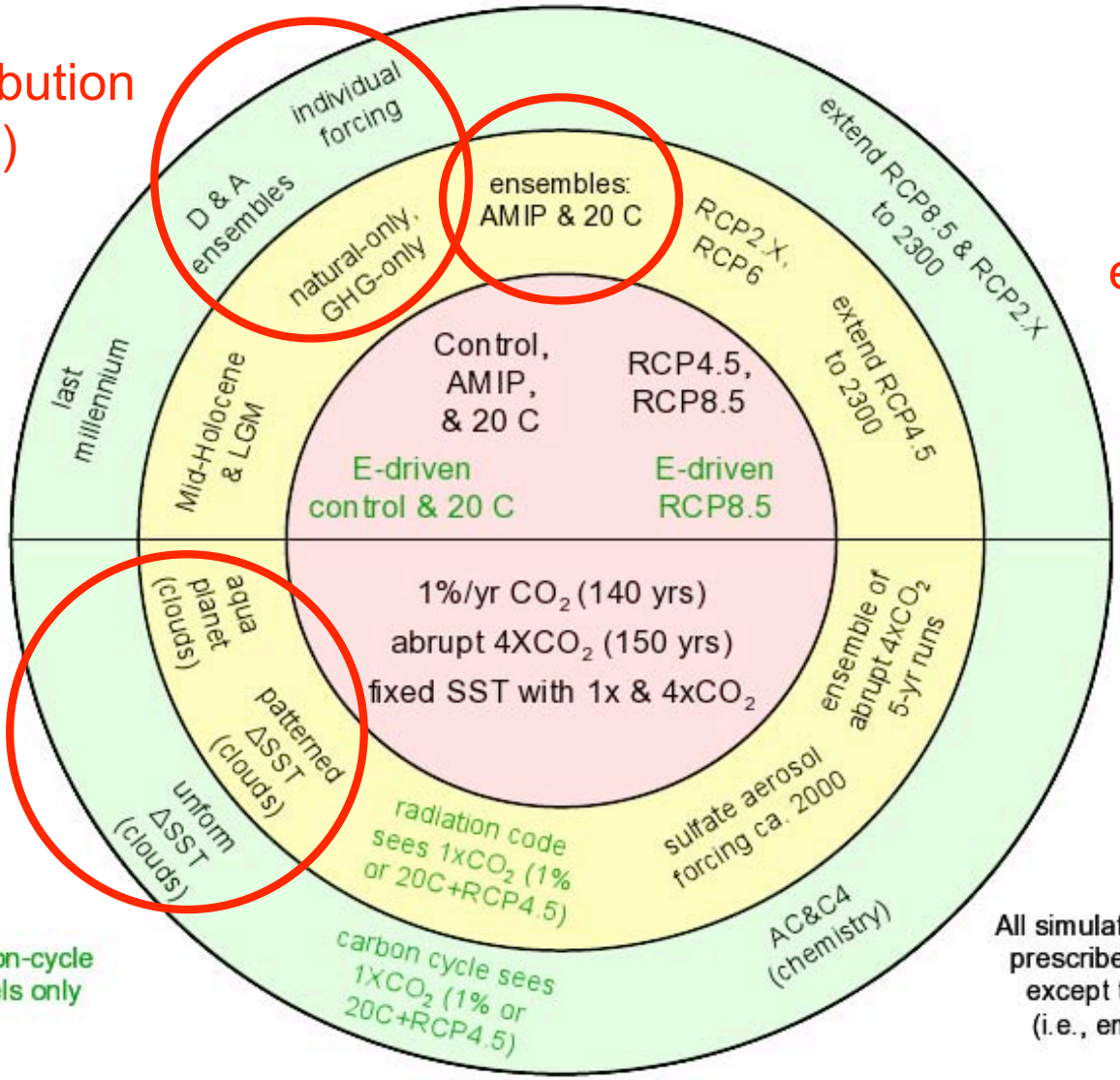
Les simulations CMIP5
Contributions envisagées de l'équipe VaDeRetro

Détection-Attribution
(A. Ribes)

Variabilité
climatique du
20ème siècle
(S. Tyteca)
et événements
extrêmes
(F. Chauvin)

Simulations
idéalisées
Rétroactions
nuageuses
(G. Bellon)

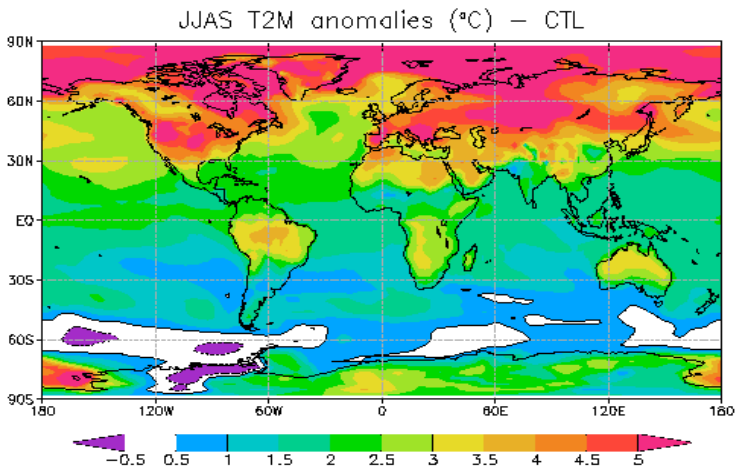
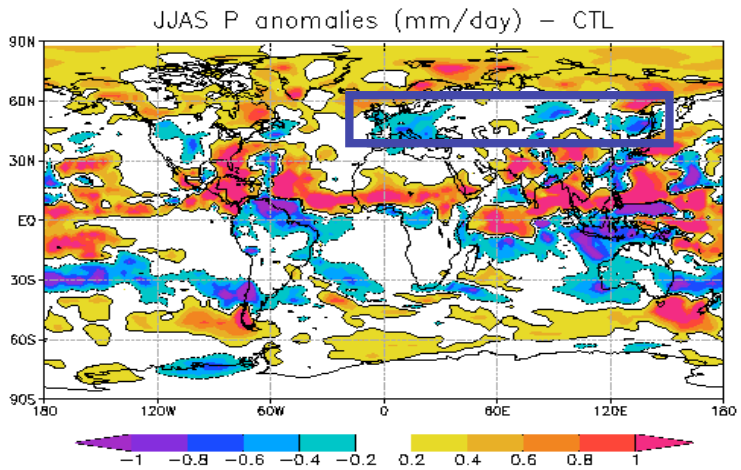
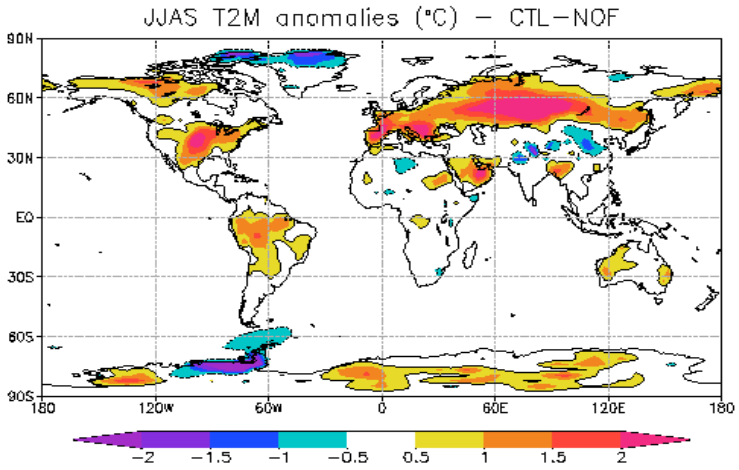
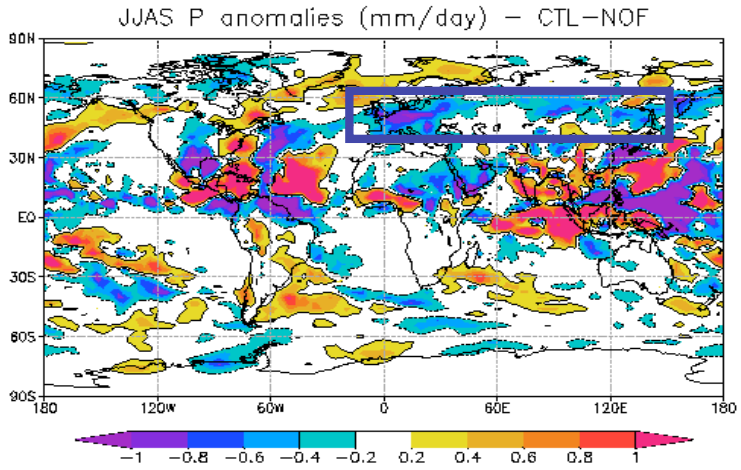
+ modélisation
des surfaces
continentales
(B. Decharme)



Coupled carbon-cycle climate models only

All simulations are forced by prescribed concentrations except those "E-driven" (i.e., emission-driven).

Importance des rétroactions continentales: la neige, le carbone, mais aussi l'humidité du sol

JJAS Δ	2-meter temperature (°C)	precipitation (mm/j)
Effet « 2xCO_2 »		
Rétroaction eau du sol		

D'après Douville et Rupa Kumar, Rapport CEFIPRA (2004)

ISBA en mode forcé: SnowMIP2
5x2 sites, 1 ou 2 hiver(s), 33 modèles dont ISBA

ISE
Boone et Etchevers (2001)

ISF
Douville et al. (1995)

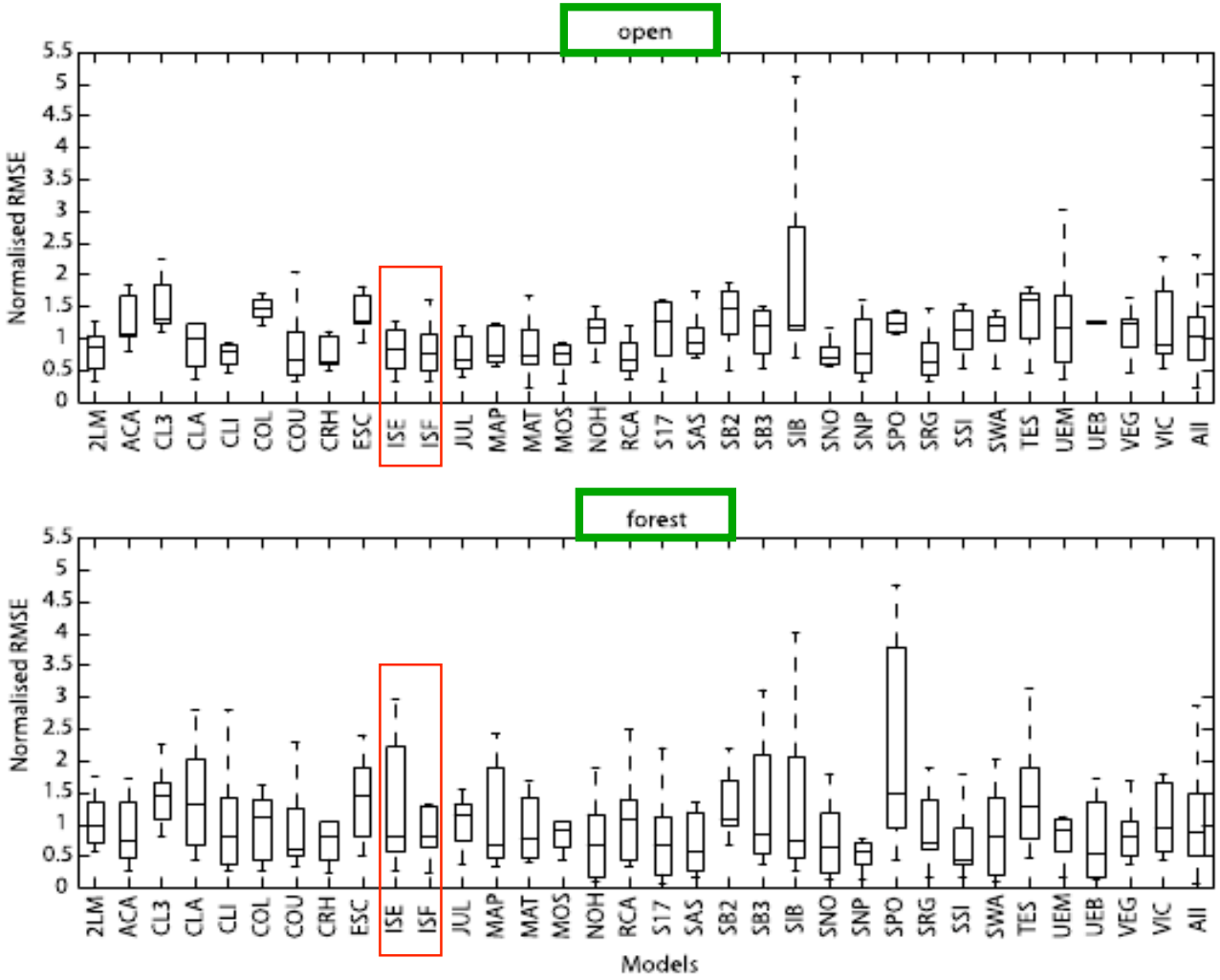


Figure 6. Box plot summaries [*Tukey*, 1977] describing the performance of individual models and all models, combined at all locations and years at open sites and forest sites. Each box has horizontal lines (solid) at lower quartile, median, and upper quartile values; whiskers (dashed lines) extend from the end of each box to 1.5 times the interquartile range; outliers beyond this range are omitted.

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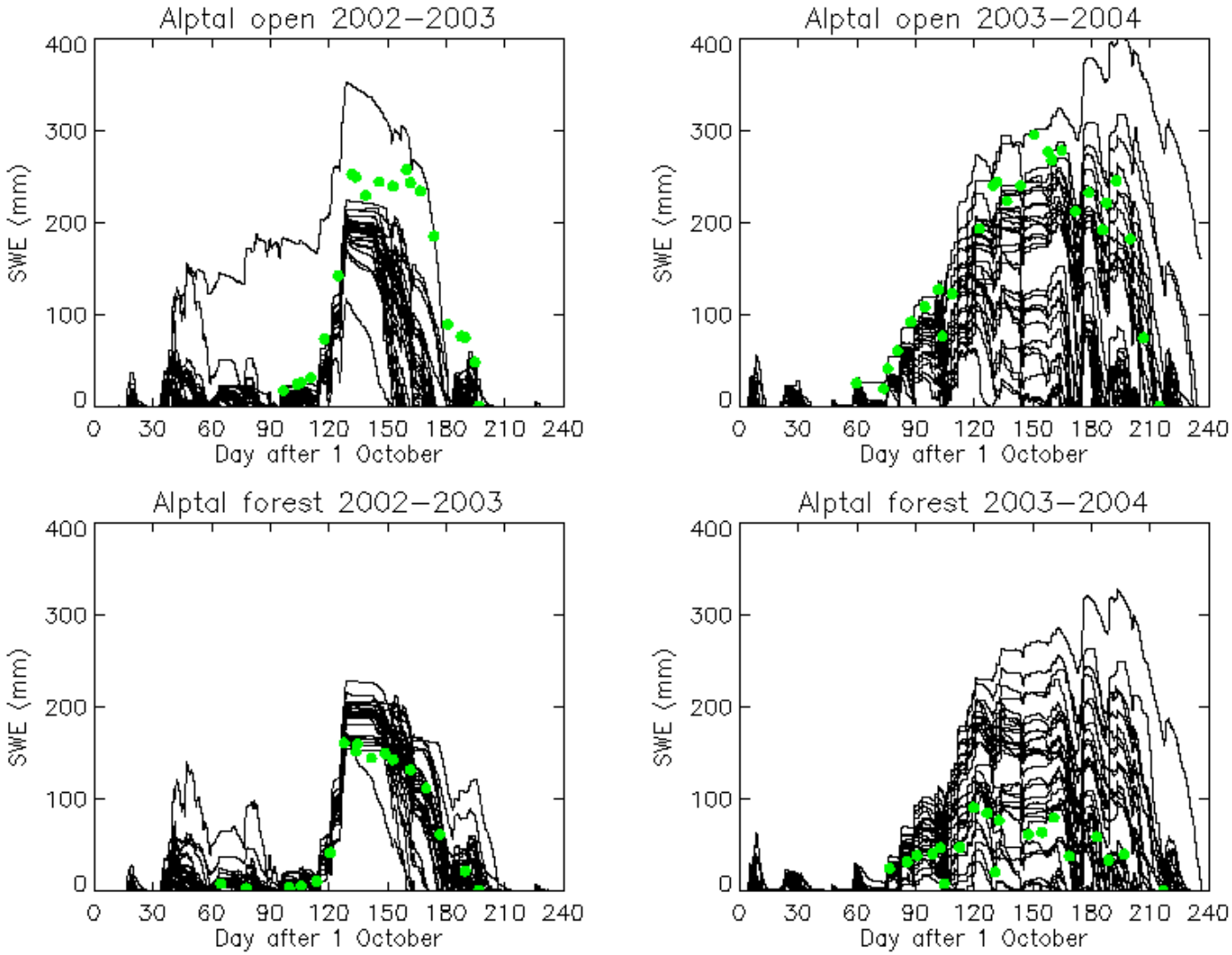
ISBA en mode forcé: SnowMIP2
De l'importance de la calibration dans les modèles



D'après Rutter et al. (2009)

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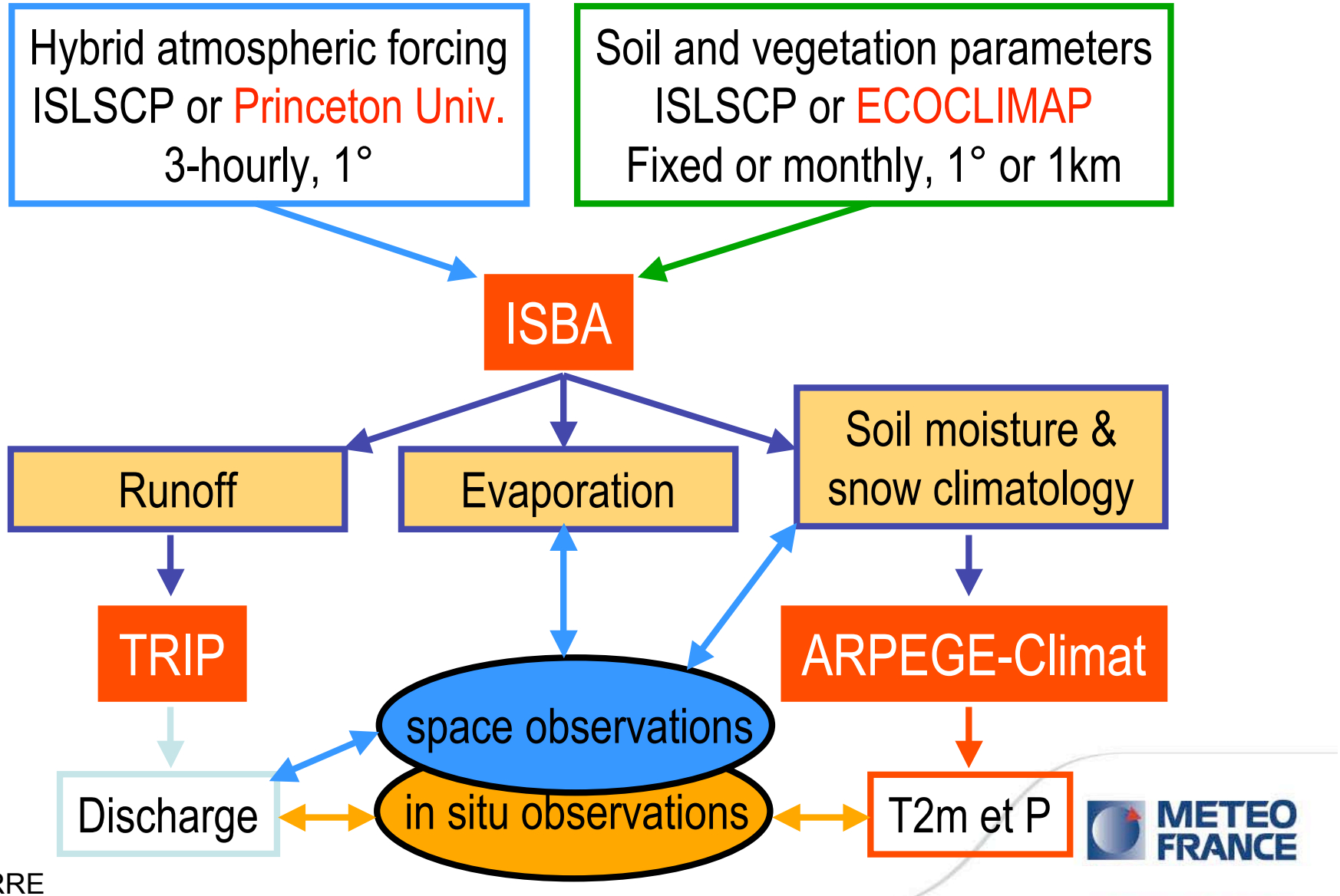
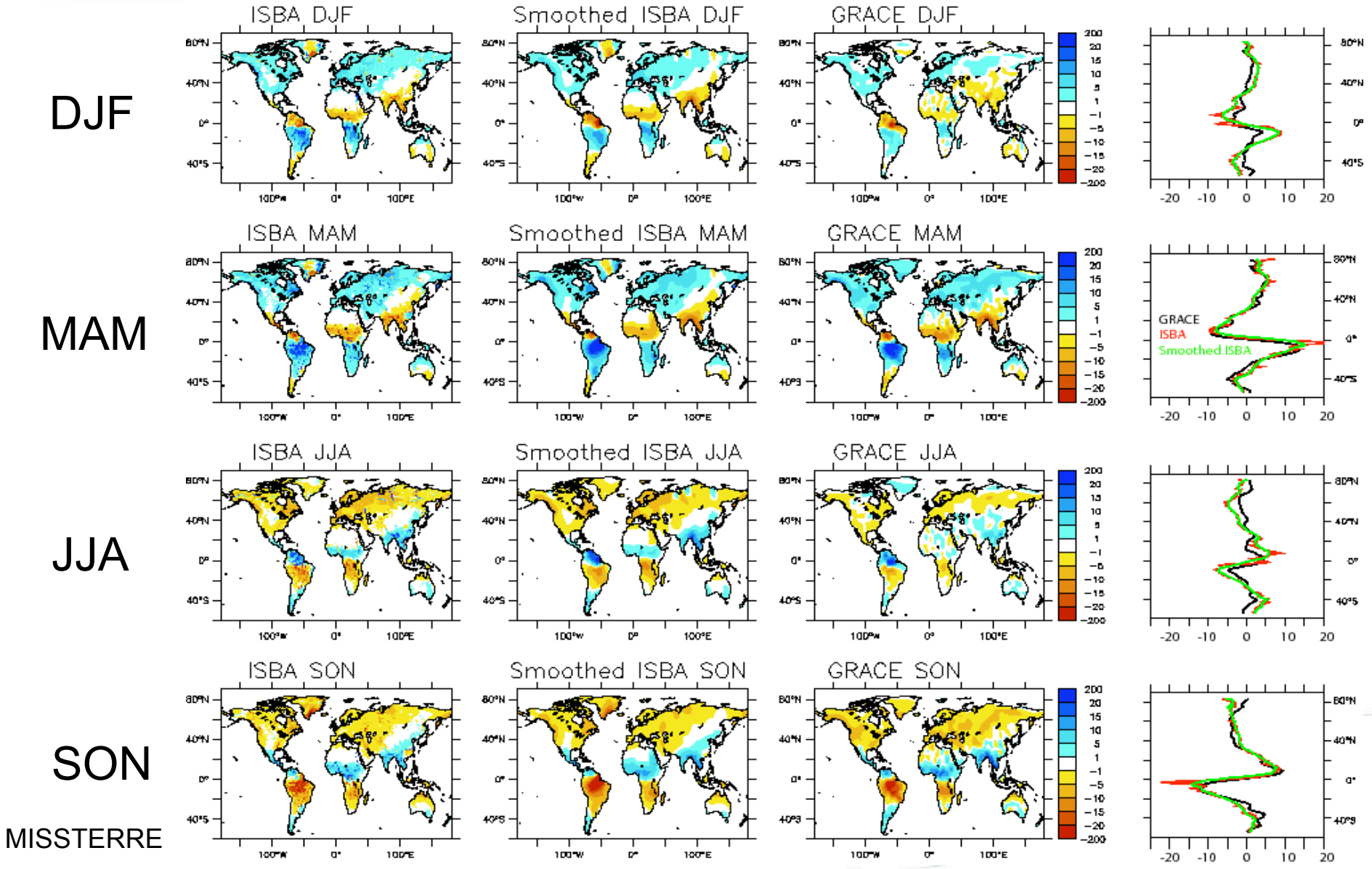
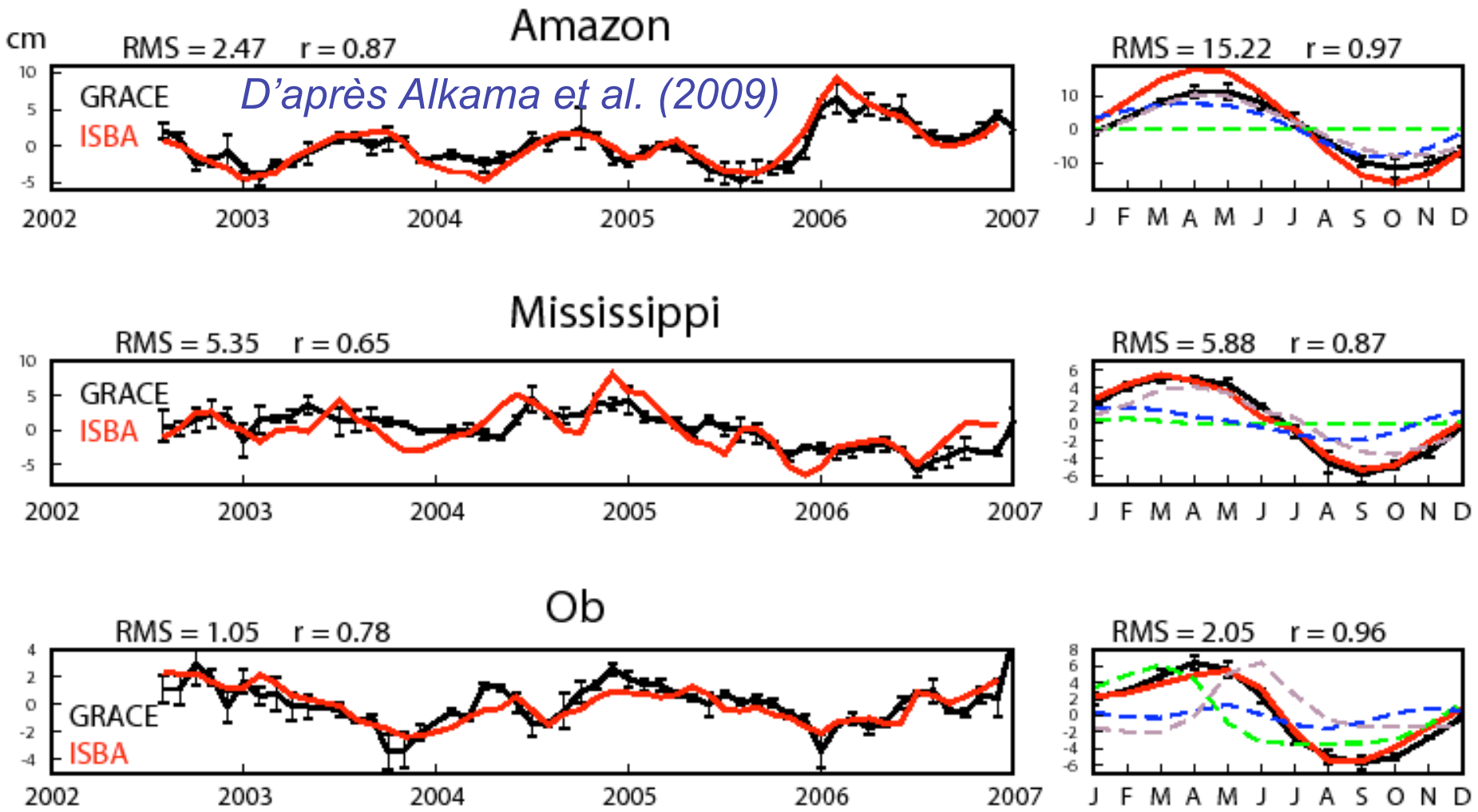
ISBA en mode forcé: validation globale



Validation par la gravimétrie (mission GRACE): variations saisonnières des stocks d'eau (kg/m²)

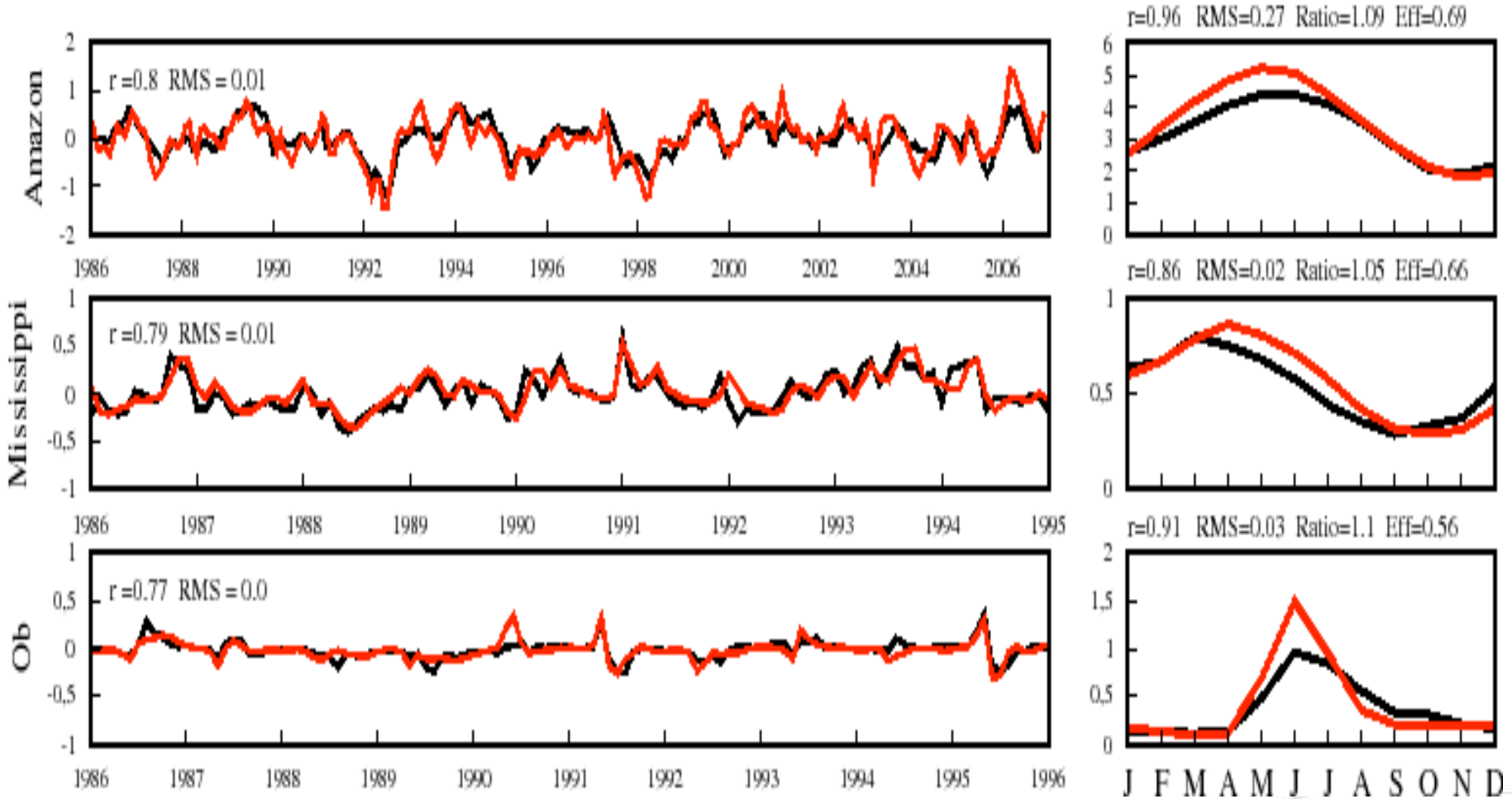


Validation par la gravimétrie à l'échelle des bassins cycle annuel moyen et anomalies mensuelles



ISBA = Soil moisture + Rivers water content + Snow

Validation par les débits à l'échelle des bassins cycle annuel moyen et anomalies mensuelles



D'après Alkama et al. (2009)

Le nudging en point de grille: un outil pour comprendre les erreurs du modèle ARPEGE (V4)

$$\delta X/\delta t = D(X) + P(X) - \lambda(X\text{-}Xref)$$

- λ varie selon:
  - la variable (plus fort pour la dynamique que pour T voire q)
  - x,y,z: masque 2D + profil vertical
  - l'échelle spatiale (en spectral) ou temporelle (filtrage préalable des ré-analyses ERA40) => outil intéressant pour étudier les *interactions d'échelles*

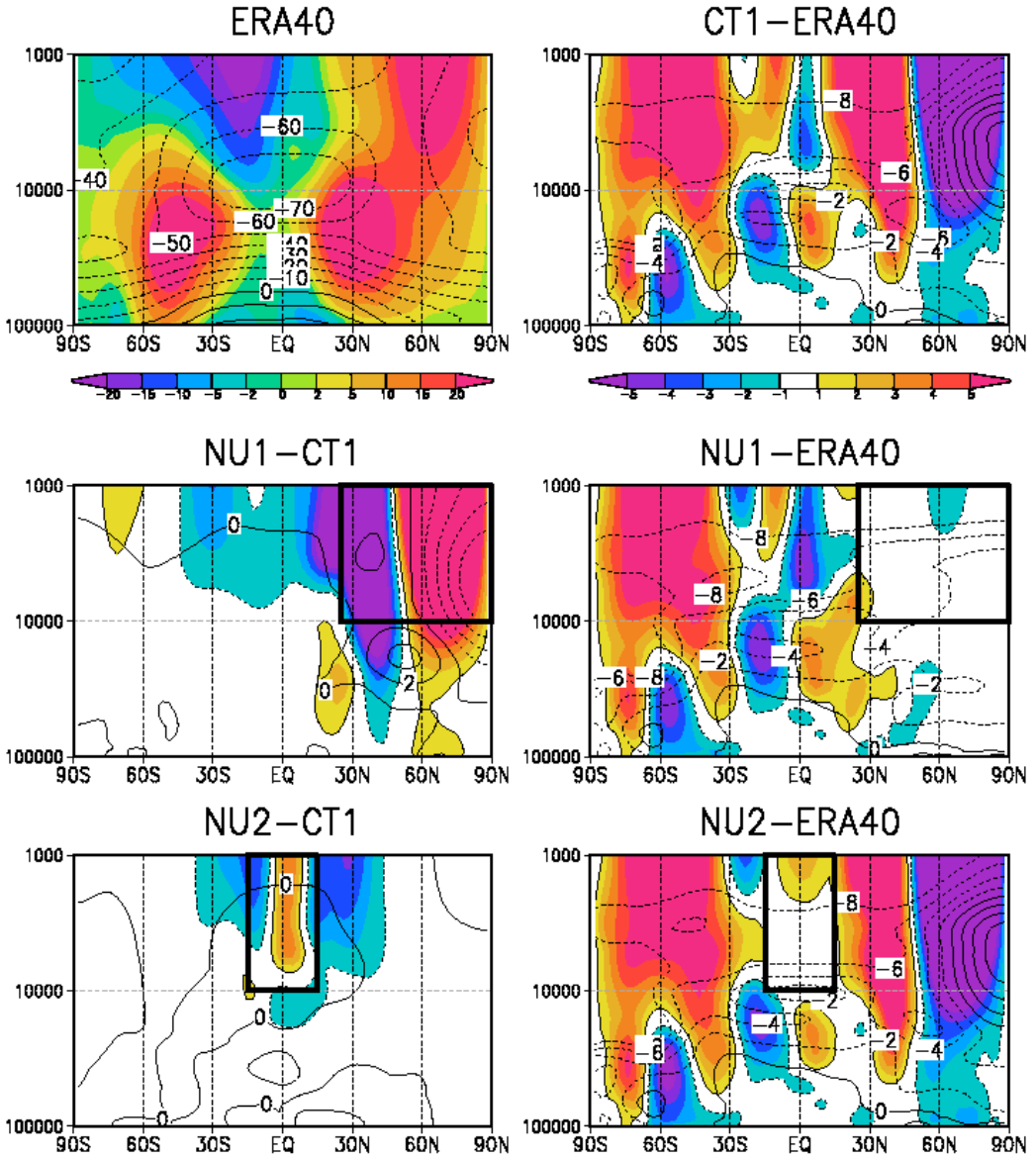
- Applications (domaine de nudging):
  - Hors Afrique de l'Ouest (AMMA, avec B. Pohl)
  - Tropiques (IRCAAM, avec S. Bielli)
  - Stratosphère (avec D. Saint Martin)

Nudging stratosphérique
Moyenne zonale DJF U (m/s) et T (°C)

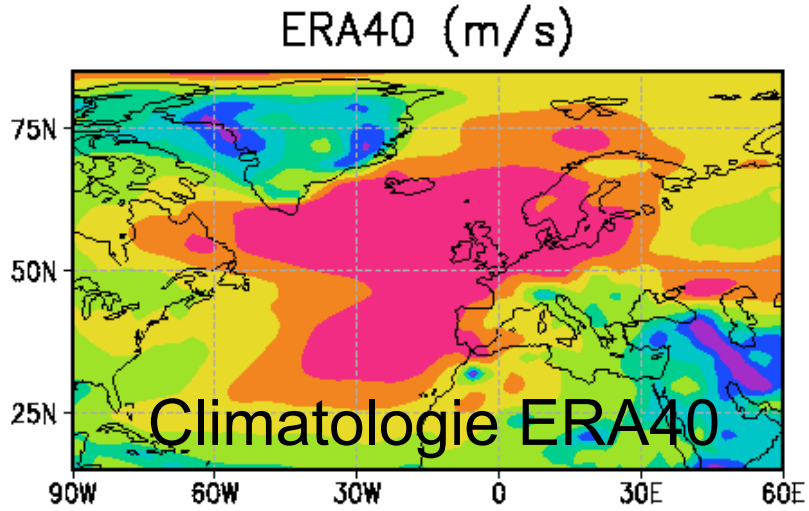
Climatologie ERA40
et biais du modèle
(30 ans sans nudging)

Nudging du vortex
stratosphérique polaire
(P<100hPa, Y>25°N)

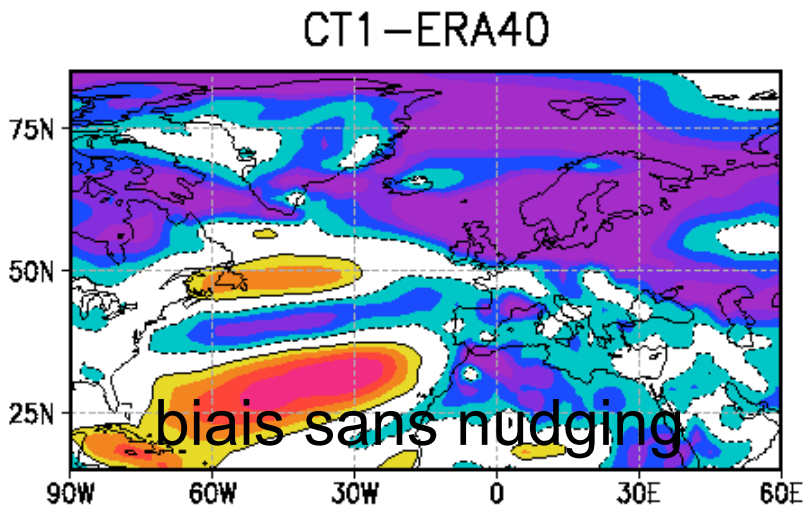
Nudging de la QBO
(P<100hPa, 15°S<Y<15°N)



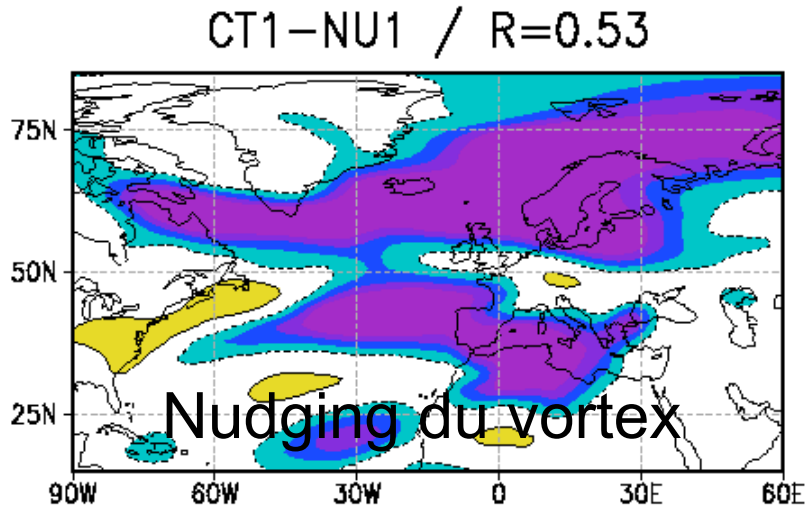
Nudging stratosphérique
Moyenne & écart-type DJF U850 (m/s)



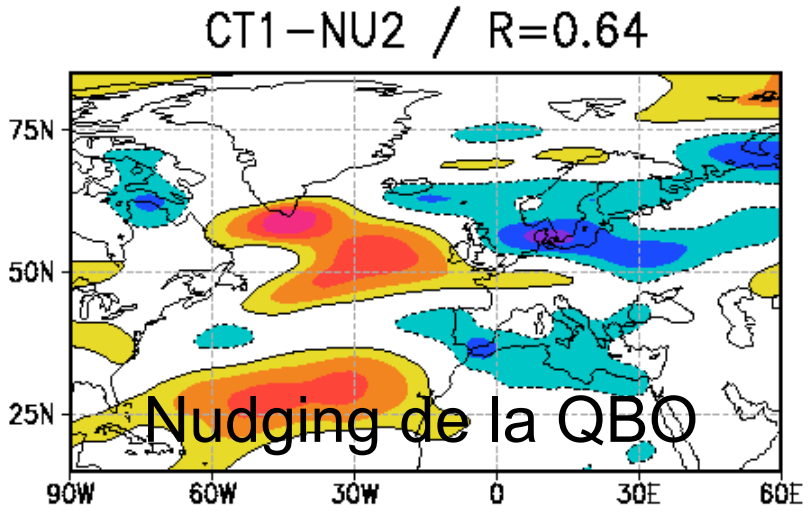
Climatologie ERA40



biais sans nudging



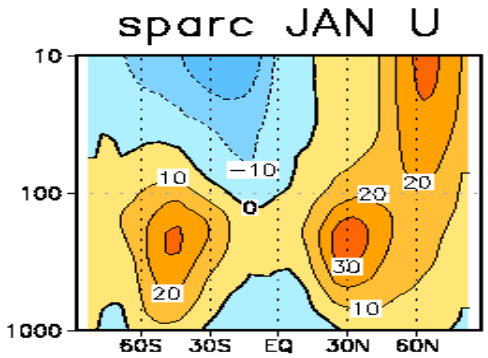
Nudging du vortex

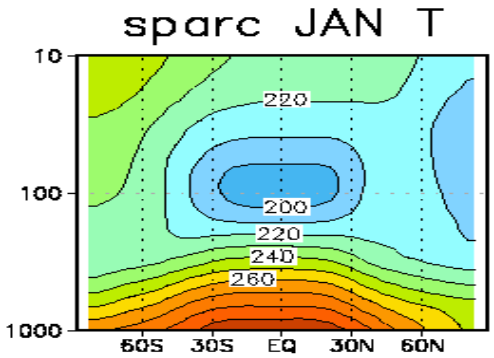


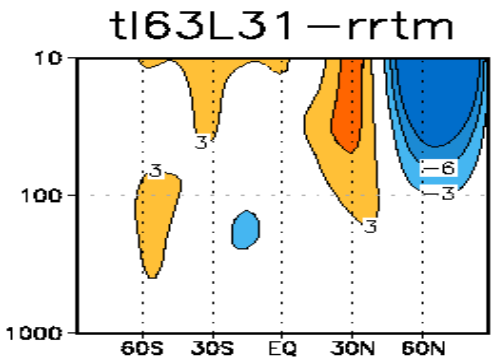
Nudging de la QBO

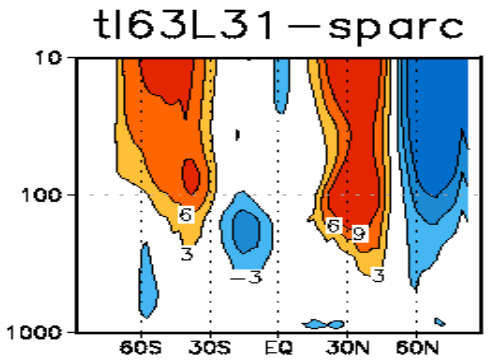
Sensibilité à la résolution horizontale et verticale
Moyenne zonale U (m/s) et T (K) – Janvier

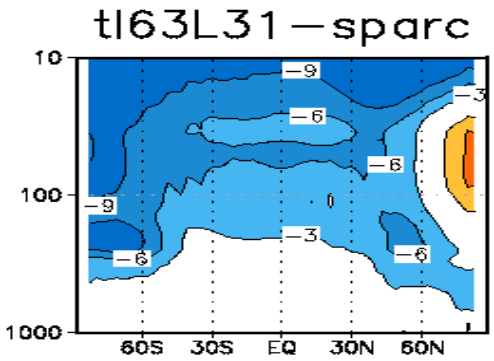
D'après D. Saint Martin
(en thèse au sein de
l'équipe CAIAC)

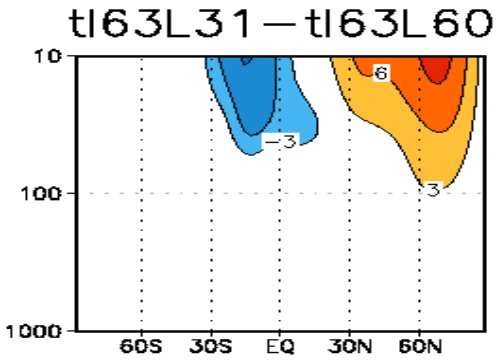


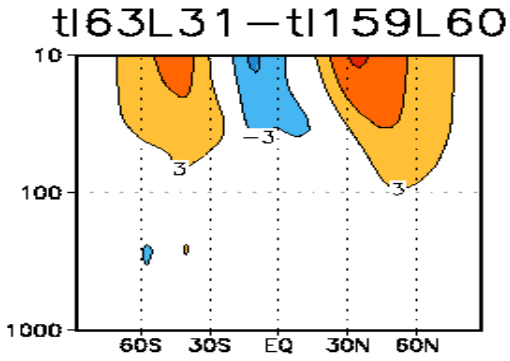


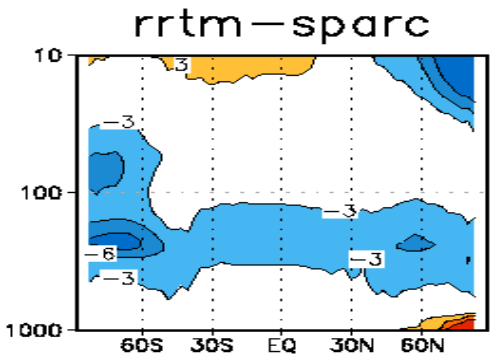




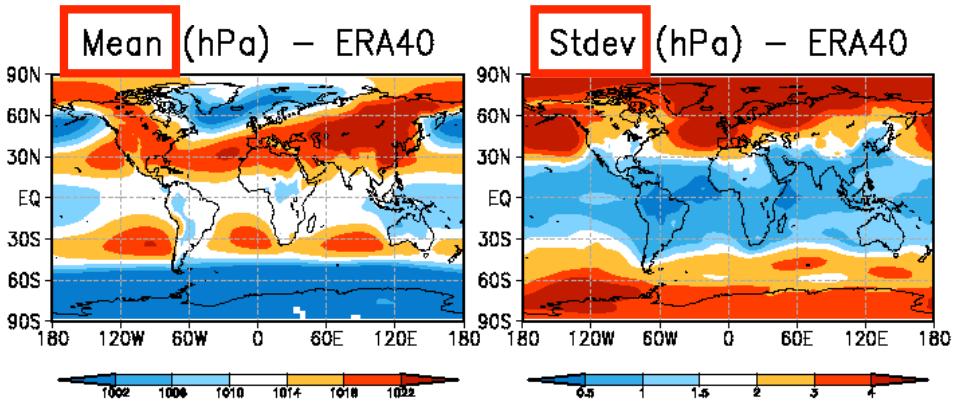


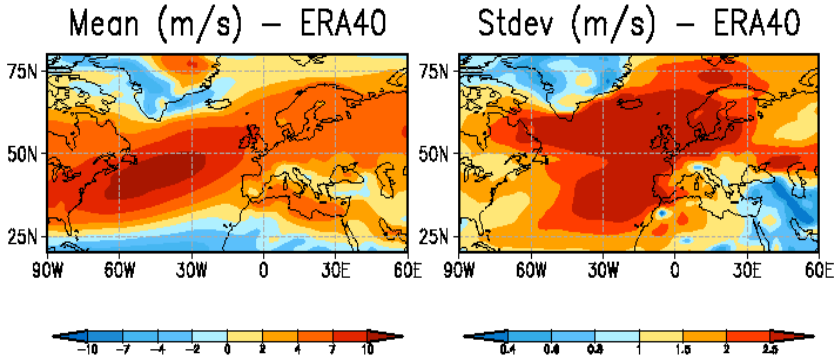


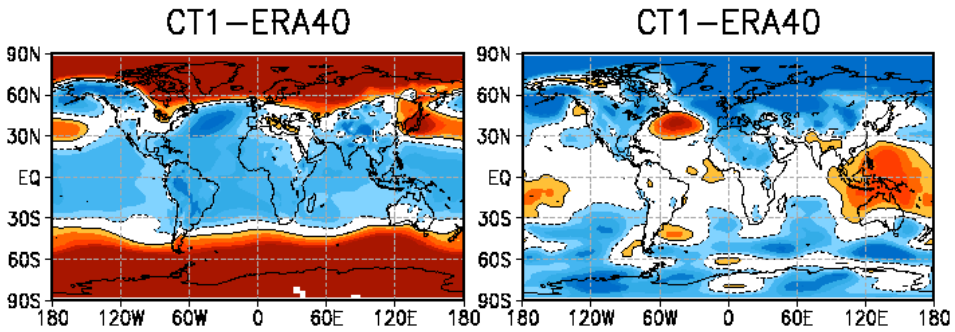


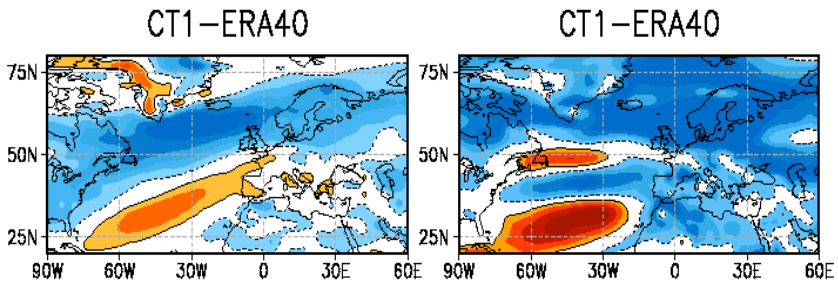


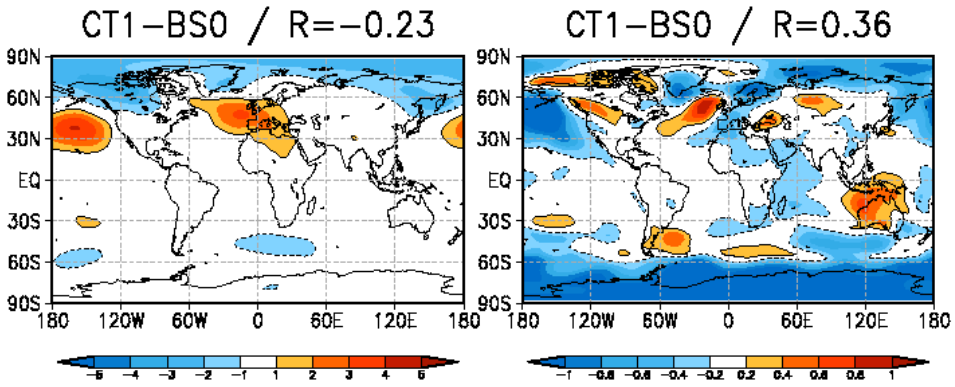
Résolution horizontale et verticale
Moyenne & écart-type DJF SLP (hPa) & U850 (m/s)

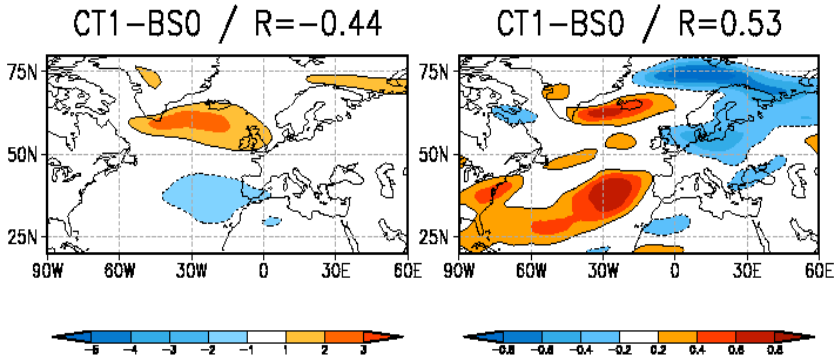












Conclusions

- Les rétroactions continentales (neige, carbone, mais aussi eau liquide dans sol, sous-sol, zones inondées) contribuent aux incertitudes sur les changements climatiques simulés à l'échelle régionale => utiliser SURFEX dans les simulations CMIP5;
- L'observation spatiale (micro-ondes passives, radar, lidar, altimétrie, gravimétrie) est un élément clé de la validation globale des modèles (ANR IMPACT BOREAL, RTRA CYMENT, projet FP7 EUCLIPSE en lien avec CFMIP);
- Le nudging en point de grille est un outil puissant pour comprendre les erreurs systématiques des modèles, mais aussi les interactions d'échelles et la variabilité climatique observée (FP6 AMMA, ANR IRCAAM, nudging stratosphérique, nudging en couplé);
- Une simulation réaliste de la stratosphère représente un enjeu important pour la prévision climatique à longue échéance et les scénarios du GIEC => utiliser une version stratosphérique (L60?) et RRTM pour les simulations CMIP5.

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Pour en savoir plus:

- ✓ Alkama R., B. Decharme, H. Douville, M. Becker, A. Cazenave (2009) Global evaluation of the ISBA-TRIP continental hydrology. Part 1: A twofold constraint using GRACE terrestrial water storage estimates and in situ river discharges. J. Hydromet. (à soumettre).
- ✓ Bielli S., H. Douville, B. Pohl (2009) Grid point nudging for understanding the West African monsoon variability and its remote effects. Climate Dyn., AMMA Special Issue (revised).
- ✓ Decharme B. and H. Douville (2007) Global Validation of the ISBA Sub-Grid Hydrology. *Climate Dyn.*, 29, 21-37, doi: 10.1007/s00382-006-0216-7.
- ✓ Decharme B., H. Douville, C. Prigent, F. Papa, F. Aires (2008) A new global river flooding scheme : Off-line validation over South America. *J. Geophys. Res.*, 113, D11110.
- ✓ Douville H., S. Bielli, M. Déqué, N. Hall, S. Tyteca, A. Voldoire (2009) Regional nudging in a global atmospheric GCM : A tool for evaluating the role of tropical teleconnections. J. Climate (à soumettre).
- ✓ Douville H. (2009) Stratospheric polar vortex influence on Northern Hemisphere winter climate variability. Geophys. Res. Lett. (à soumettre).
- ✓ Rutter N. et al. (2009) Evaluation of forest snow processes models (SnowMIP2). J. Geophys. Res., 114, D06111, doi: 10.1029/2008JD011063.

METEO FRANCE

SPARC – Stratospheric Processes And their Role in Climate (D'après Scaife 2009)

1 - Climate-Chemistry Interactions

- How will stratospheric ozone and other constituents evolve?
- How will changes in stratospheric composition affect climate?
- What are the links between changes in stratospheric ozone, UV radiation and tropospheric chemistry?

2 - Detection, Attribution, and Prediction of Stratospheric Change

- What are the past changes and variations in the stratosphere?
- How well can we explain past changes in terms of natural and anthropogenic effects?
- How do we expect the stratosphere to evolve in the future, and what confidence do we have in those predictions?

3 - Stratosphere-Troposphere Dynamical Coupling

- What is the role of dynamical and radiative coupling with the stratosphere in extended-range tropospheric weather forecasting and determining long-term trends in tropospheric climate?
- By what mechanisms do the stratosphere and troposphere act as a coupled system?

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Téléconnexions Tropiques-Extratropiques IRCAAM (http://www.cnrm.meteo.fr/ircaam/)

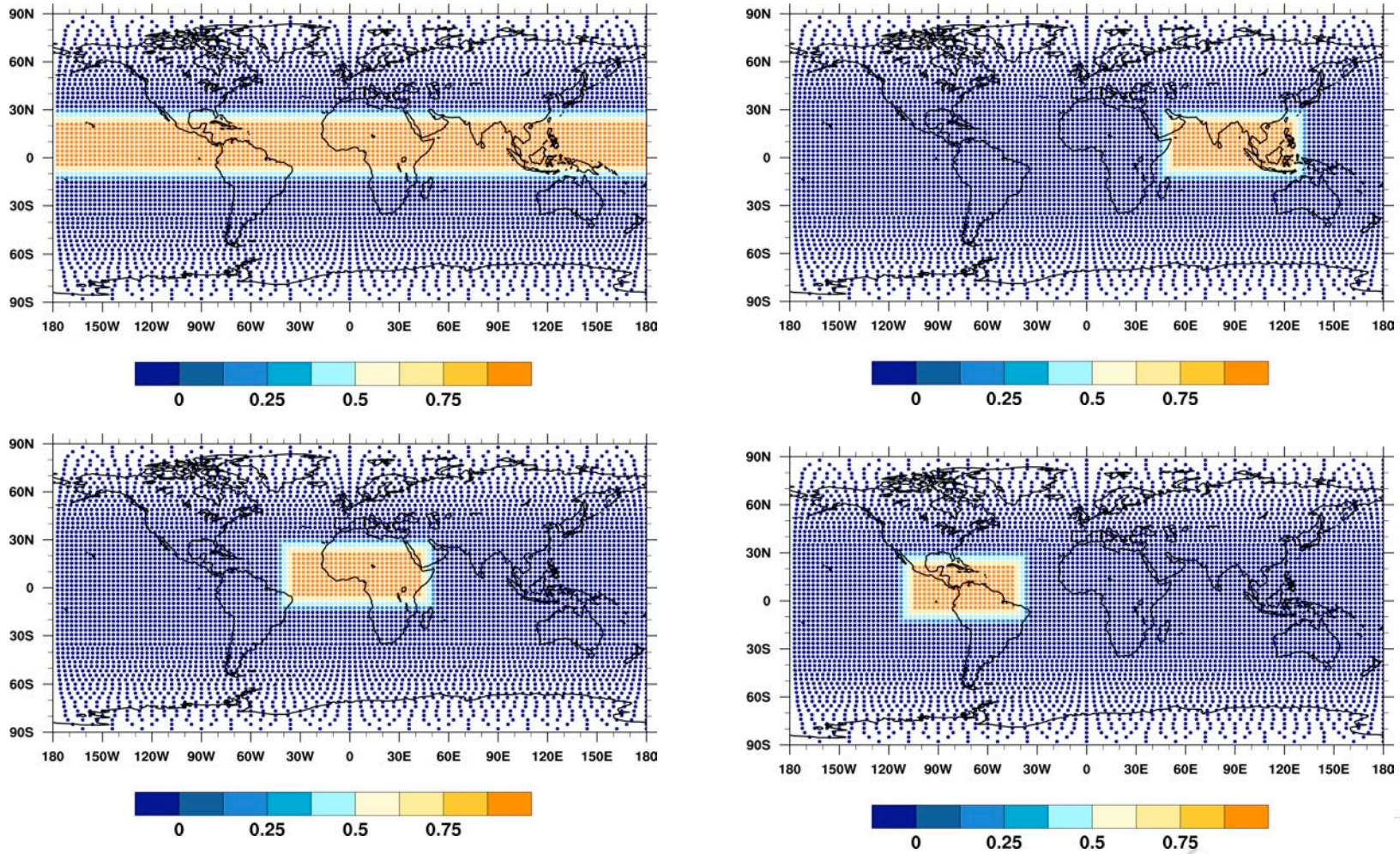

Figure 1: The four nudging masks used in the Tr, As, Af, and Am experiments respectively. Each pixel is a grid cell of the Arpege-Climat reduced gaussian grid.

Nudging dans la ZCIT (3 variantes): Impact sur la climatologie JJAS du Z500*

Figure 4: JJAS Z500 eddy component (m) climatology in the northern extratropics: a) ERA40 1971-2000 climatology, b) control experiment, c) model errors, d-f) impact of *tropical* nudging (R is the spatial correlation with the model errors). In c to f, shaded differences are significant at the 5% level.

D'après Douville et al. (2009)