ALADIN data assimilation activities

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METEO FRANCE
Toujours un temps d'avance

Content

- Arpège 4D-VAR, Arpège ensemble assimilation (AEARP) & outlook
- Aladin models, Arome-France & outlook

Part 1

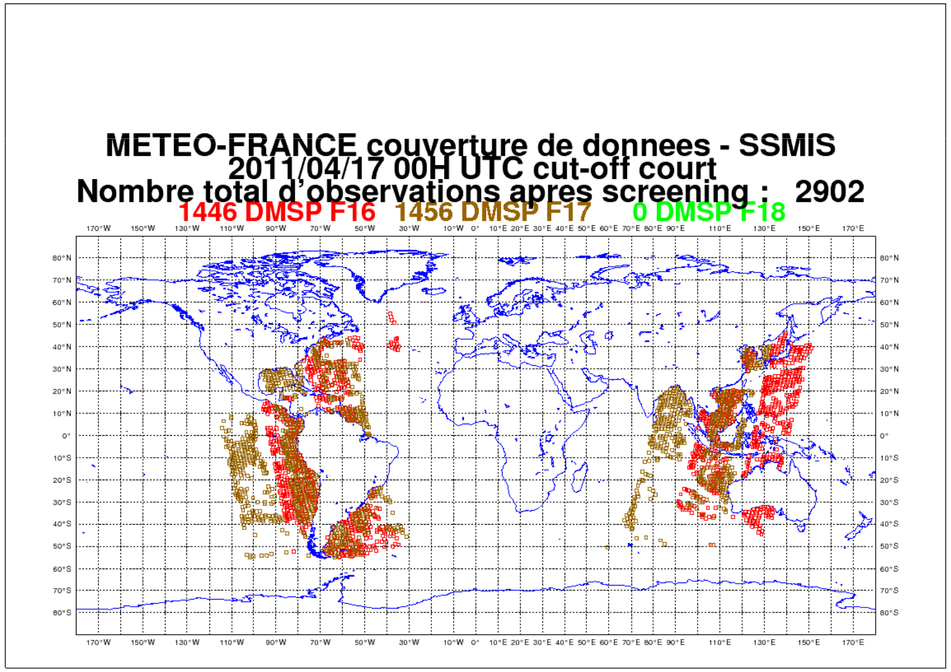
AEARP & ARPEGE

Main changes introduced in operations in September 2011

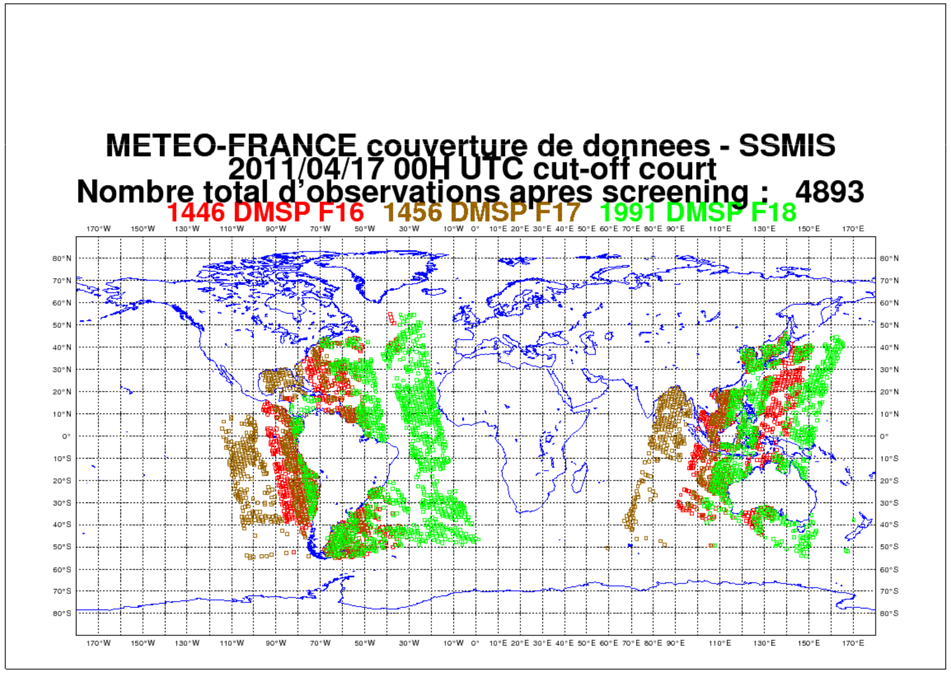
- Updated **coefficients in RTTOV for AIRS and IASI**
- cloudy AIRS data taken out of bias correction computation
- Assimilation of **ATOVS/RARS** « Regional ATOVS Retransmission Service »
- Assimilation of **SSMI/S on board DMSP F-18**
- Modification of computation of relative humidity for Synop when T<0°C
- Re-tuning in the stratiform condensation scheme of 4D-Var
- Modification of low resolution orography in 4D-Var
- **Modifs « anti-arpégeades »** in deep convection scheme
- Add a processus to take into account the **re-freezing of rain**

Assimilation of SSMI/S F18

SSMI/S obs assimilated in short cut-off of 2011/04/17 r0



OPER



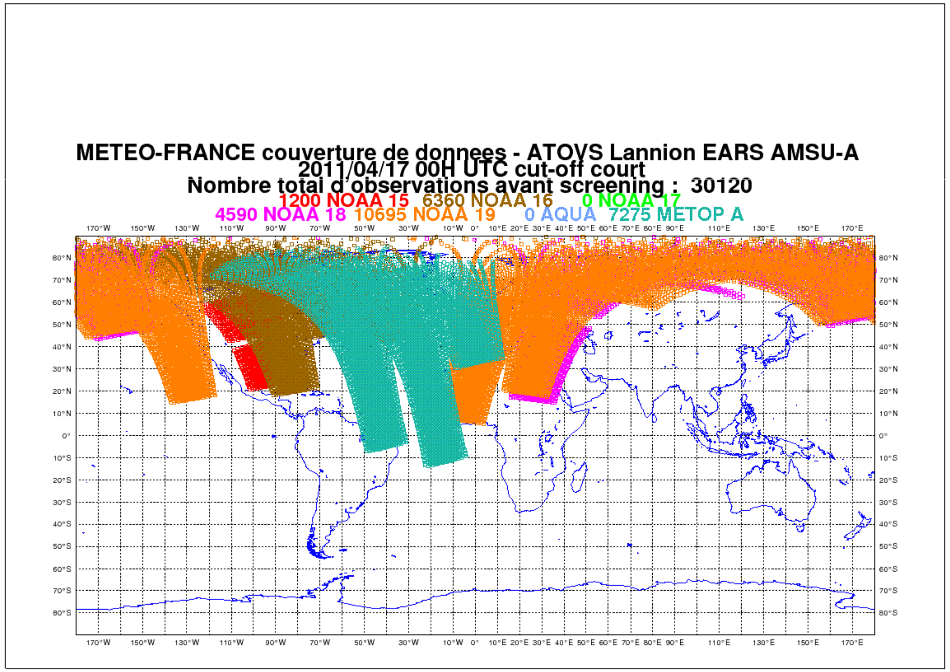
DOUBLE

⇒ Added value in assimilation because the orbit of SSMI/S F-18 is slightly different from DMSP F-16 and F-17

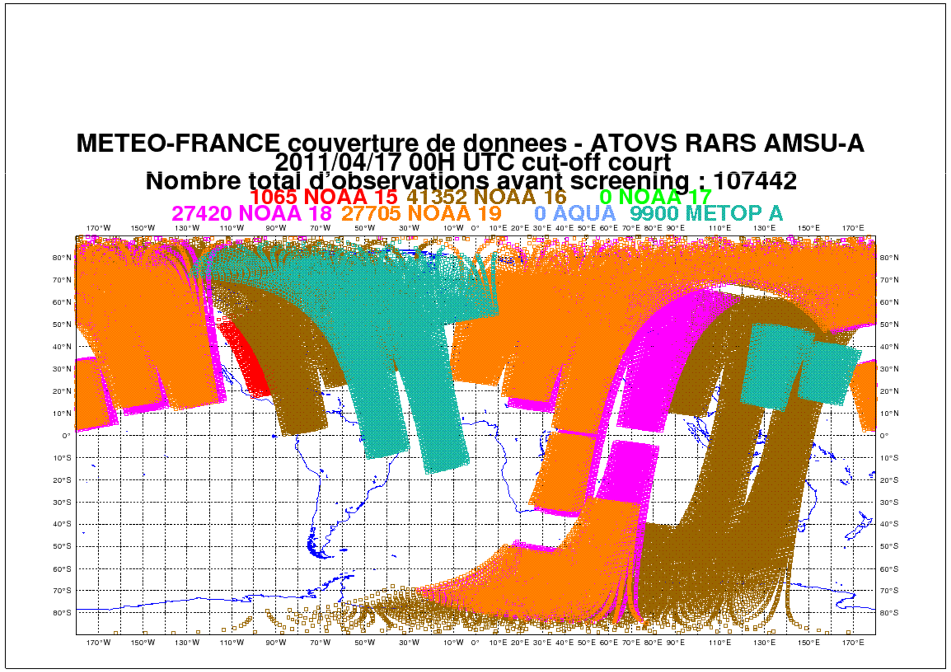
(E. Gérard)

Assimilation of ATOVS/RARS

ATOVS obs entering the short cut-off analysis of 2011/04/17 r0



Lannion EARS (oper & double)



RARS (double uniquement)

⇒ RARS throughput allows to recover about 1-2 % more AMSU-A and AMSU-B data; about 6-8 % more HIRS in long cut-off. These values increase to about 20 % in the short cut-off analyses.

(E. Gérard)

AEARP double (Assimilation d'Ensemble ARPège)

- ARPEGE changes are included in the AEARP 4D-VARs
- New clim files for high and low resolutions
- Decreased time step (1350 s => 1080 s) and intermittent call to radiation (instead of every time step)

PEARP (Prévision d'Ensemble ARPège)

- Adapted to changes in AEARP
- Adapted to the « anti-arpégeades » changes for those members using a convection closure based on humidity convergence.

(G. Desroziers, L. Berre, C. Labadie, L. Descamps)

Outlook for Arpège 4D-VAR

- Radiances over land (*on hold*)
- Cloud (and rain) affected radiances: CO2-slicing, assess benefit of model cloud water content for RTTOV-cloud
- Retuned σo's: AMSU-A, GPS-RO, TEMP, ASCAT;
- Increase of number of observations: IASI (tropospheric channels over sea, stratospheric channels everywhere), ground-based GPS from EGVAP;
- Assimilation of EARS/ASCAT winds;
- Revisited strategy for GPS ZTD blacklisting (allow more data to be assimilated);
- Start testing VarBC for GPS ZTD
- Simplified physics: convection and turbulence (stratiform precipitation and GWD already modified in 2010)
- Ensemble DA system: feed wavelet structure function parameters, inflation of B(variances) for model error
- Code system overhaul: towards object-oriented coding of the IFS/Arpège assimilation system (« OOPS ») => started with CY38

Part 2

Aladin & Arome-France

Modifications in ALADIN

- **ARPEGE changes** included in the ALADIN models
- **Move to SURFEX** in ALADIN-France, ALADIN-Réunion :

  - move to higher resolution physiographic datasets

  - 3-layer ISBA with prognostic PBL scheme « CANOPY », …

⇒Improved scores for RH2m, T2m in night time; 10m wind speed

- **5 Aladin 3D-VAR configurations**:
  - France: to be stopped in 2012
  - La Réunion: cyclone warnings in the Indian Ocean area
  - Polynesia, New Caledonia, French Antilles & Guyana: coupling with IFS

(G. Kerdraon, F. Bouyssel, F. Taillefer, G. Faure)

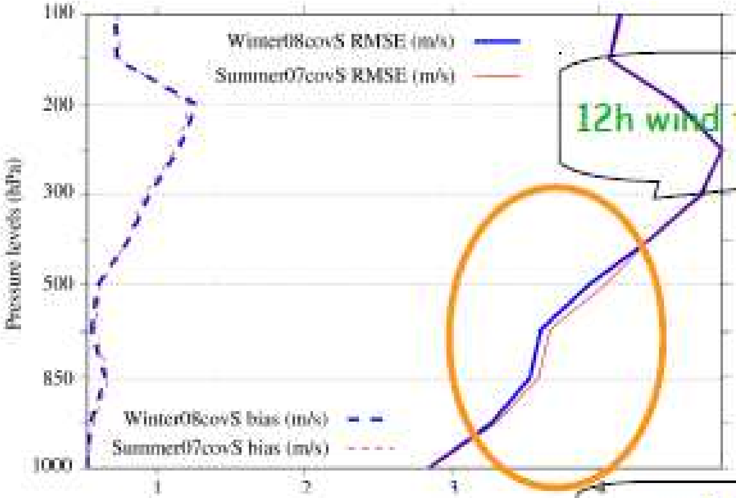
Impact study : On-line updating of the background error covariances on the ALADIN-France system (M. Monteiro*, L. Berre)

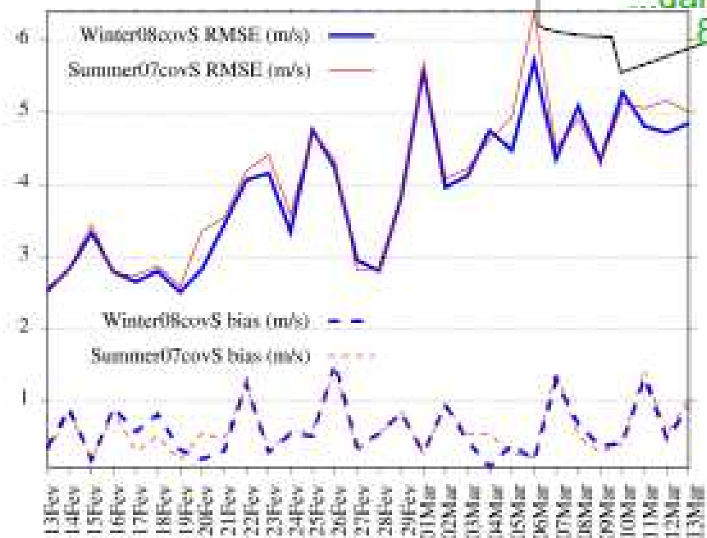
*IM, Portugal

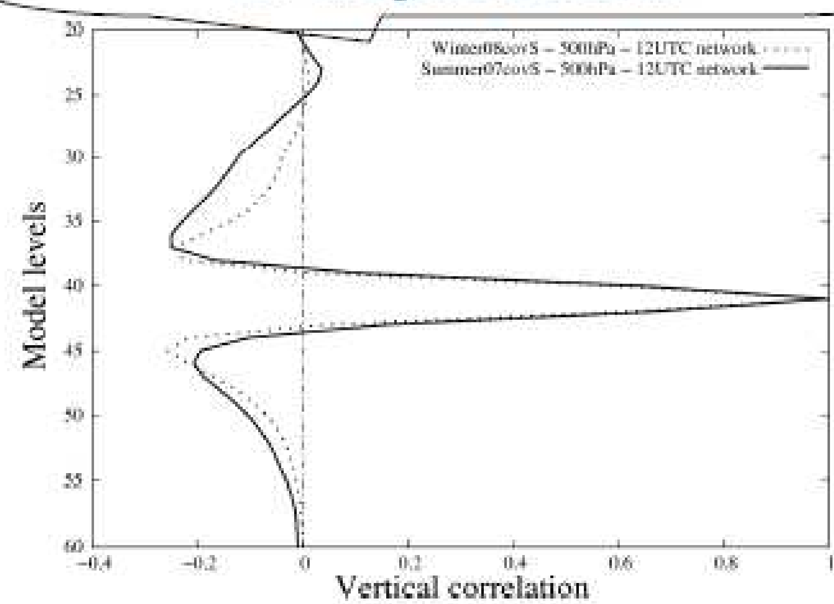
To be published : *Impact study on the use of time variations of regionally-averaged balanced background error covariances*

Published : *A diagnostic study of time variations of regionally averaged background error covariances*
J. Geophys. Res, doi:10.1029/2010JD014095

Results from the off-line to the seasonal on-line update

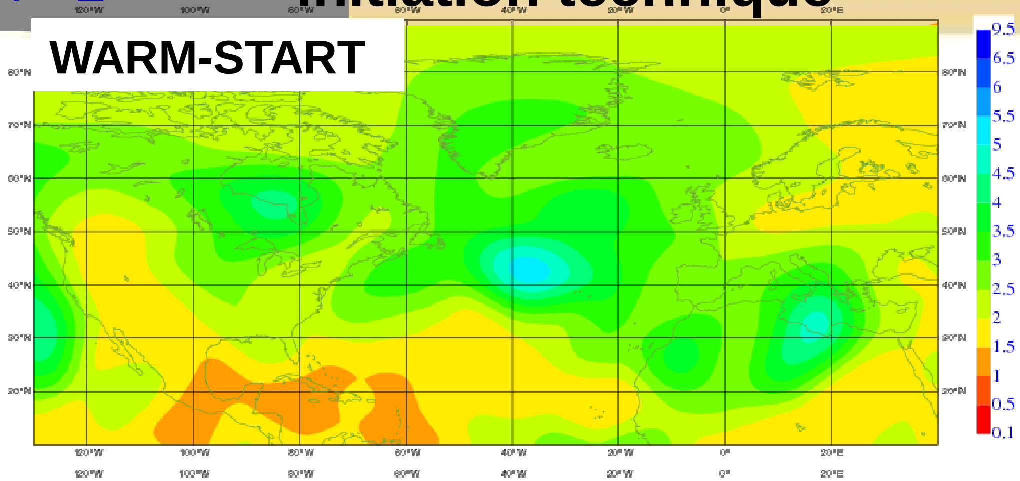






Dependence of spread on ensemble initiation technique

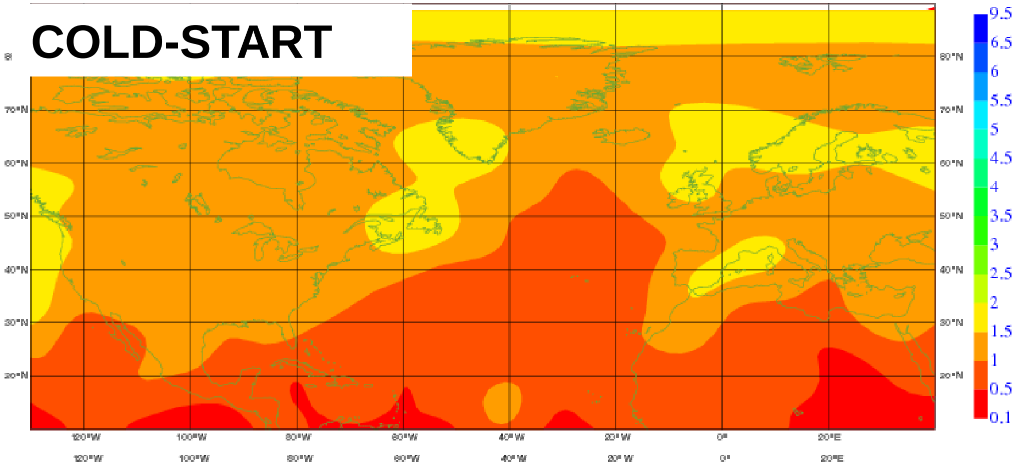
El Ouaraini, R., and L. Berre (2011), Sensitivity of ensemble-based variances to initial background perturbations, J. Geophys. Res.



This is the reference

(ensemble started 6 days before).

Note the max values over North Atlantic.

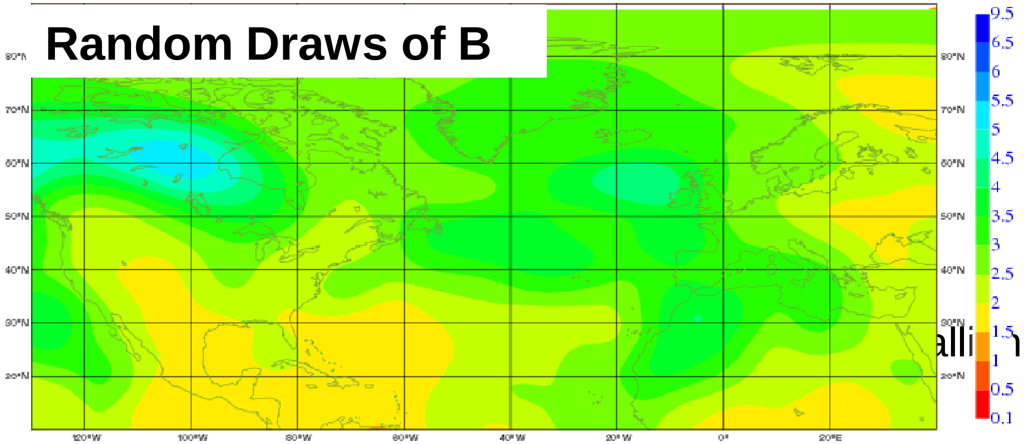


Average spread is too small and

data-density induced contrasts

are distorded (minimum values

over North Atlantic).



Average spread is realistic and

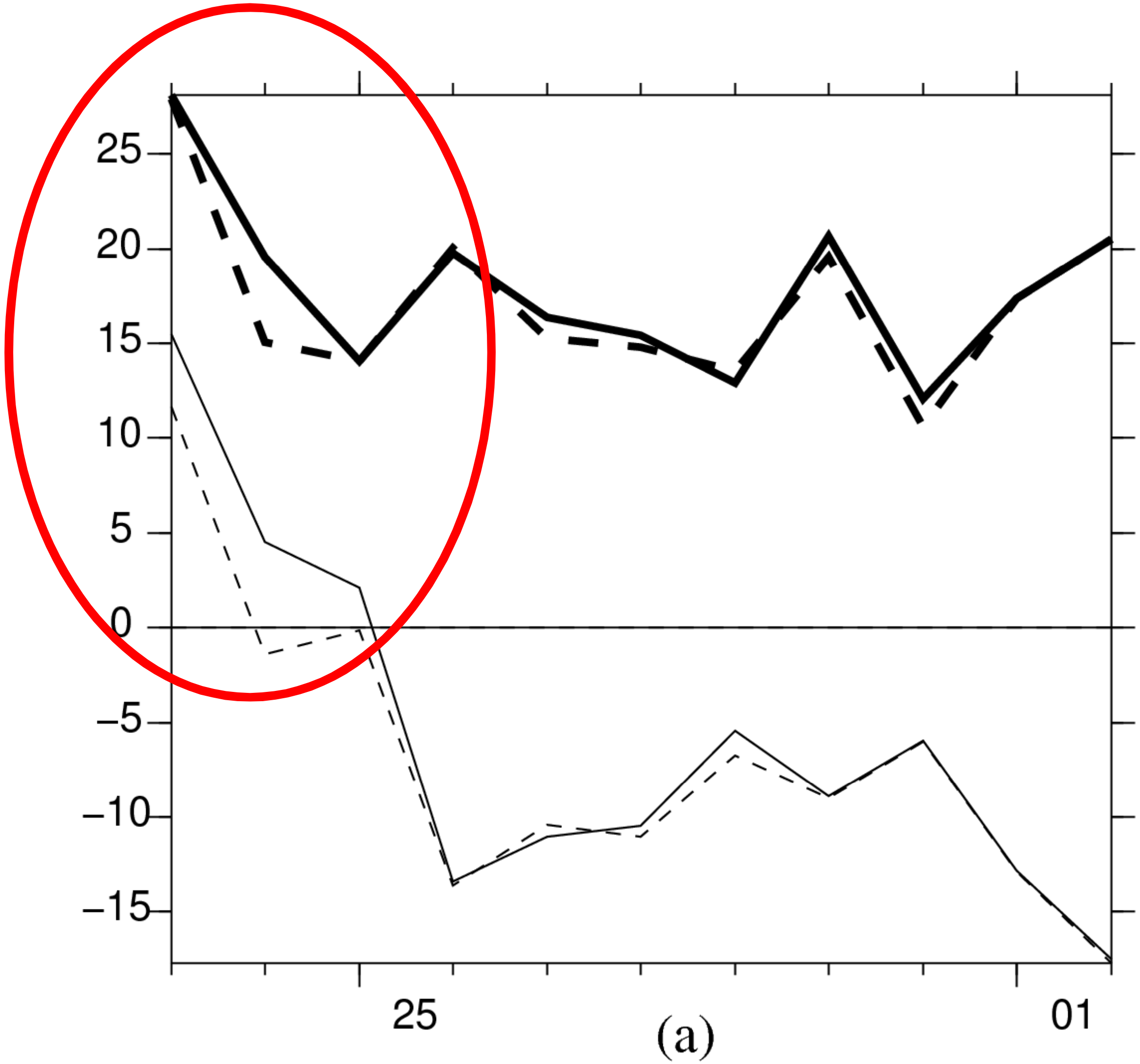
data-density induced contrasts

are well represented (max values

over North Atlantic).

Impact of associated σb's on 48h deterministic forecasts

El Ouaraini, R., and L. Berre (2011), Sensitivity of ensemble-based variances to initial background perturbations, J. Geophys. Res.



RMSE of 850 hPa geopotential at +48hCOLD-START (full) vs Rand B (dashed)

Modifications in AROME and R&D aspects

- **Modifications « observations ARPEGE »** included in AROME-France
- **experimentations with 1-hourly cycles (RUC)** : requires more investigation (spin-up, use of observations, …).
- **heterogeneous B matrix**: extended control vector to accommodate for different structure functions (in masked areas), Montmerle & Berre (QJRMS, 2010).
- **link with ensemble approach, EnsDA** : in Research mode
- **deformation of structures (using wavelets)** : in Research mode

Outlook for LAMs

- Use of ensemble assimilation information, situation-dependent aspects
- New tests with « Jk » term (weak constraint towards coupling data)
- Heterogeneous B matrix
- Radar: assess impact of windmill signals, evaluate assimilation of X-band radars from the RYTHMME network, radar data exchange within HYMEX, sensitivity studies towards the inclusion of a total precipitating hydrometeor content in c.v.
- *Assimilate more ground-based GPS* (re-visit blacklisting & VarBC)
- *Aladin applications at MF: assess benefit of denser observations*
- In partner countries: DA suite in Morocco and collaboration on satellite radiances, GPS and ensemble techniques; LAM wavelets for B (Belgium, A. Deckmyn); ensemble techniques (Portugal, M. Monteiro; Morocco, R. El Ouaraini)
- Code system overhaul: towards object-oriented coding of the IFS/Arpège assimilation system (« OOPS ») => started with CY38

Minu poolt on kõik, tänan teid kuulamast

How to get cloud and precipitation-dependent statistics?
Heterogeneous B

Adapting ideas of Courtier (1998) and Buehner (2008), to use more suitable background error statistics in precipitating and non-precipitating areas in CVT:

$$\delta x = \alpha^{1/2} B_{np}^{1/2} \chi_1 + \beta^{1/2} B_p^{1/2} \chi_2$$

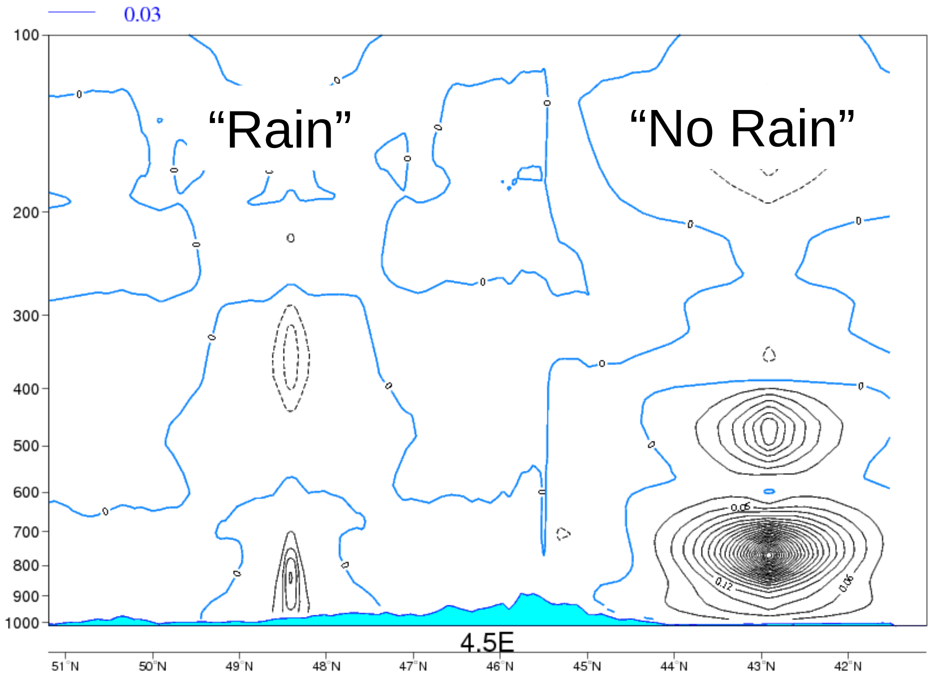
With: $\alpha^{1/2} = \mathbf{S M}^{1/2} \mathbf{S}^{-1}$ and $\beta^{1/2} = \mathbf{S}(\mathbf{1} - \mathbf{M}^{1/2})\mathbf{S}^{-1}$

$\mathbf{M}$: grid point mask deduced from observation (e.g radar reflectivities).

$\mathbf{B_p}$ and $\mathbf{B_{np}}$ being precipitating and non-precipitating background error covariances respectively.

⇒ Allows to consider simultaneously very different covariances that are representative of different weather regimes

⇒ Could be used in an ensemble flow-dependent B



Vertical Cross section of q increments
4 obs exp: Innovations of – 30% RH
At 800 and 500 hPa

Montmerle and Berre (2010)

Comparisons between structure functions

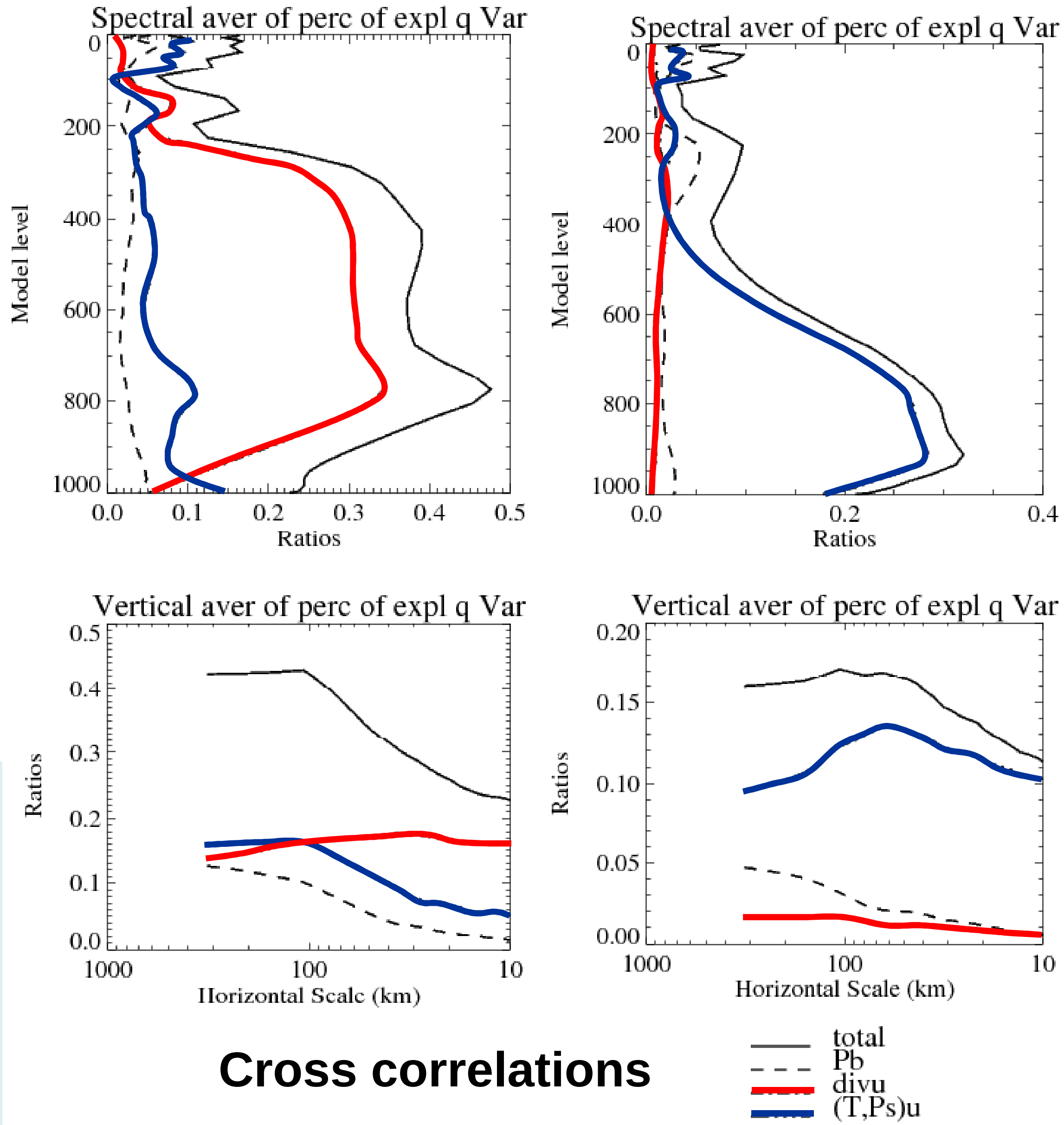
Multivariate formulation of errors:

$$
\begin{aligned}
\zeta &= \zeta \\
\eta &= \mathcal{M}\mathcal{H}\zeta + \eta_{\mathrm{u}} \\
(T,\ P_{\mathrm{s}}) &= \mathcal{N}\mathcal{H}\zeta + \mathcal{P}\eta_{\mathrm{u}} + (T,\ P_{\mathrm{s}})_{\mathrm{u}} \\
q &= \mathcal{Q}\mathcal{H}\zeta + \mathcal{R}\eta_{\mathrm{u}} + \mathcal{S}(T,\ P_{\mathrm{s}})_{\mathrm{u}} + q_{\mathrm{u}}
\end{aligned}
$$

In precipitating areas, $\sigma_b(q)$ is mostly explained by η_u at mesoscale, whereas it is almost univariate and linked to the mass field in clear air

$\Rightarrow$ B_p et B_{np} are characterized by very different structure functions that are coherent with the model's physic in precipitating and non-precipitating areas respectivelly

$\overline{\sigma}_b(q)$ $\mathbf{B}_{\mathrm{p}}$ $\mathbf{B}_{\mathrm{np}}$



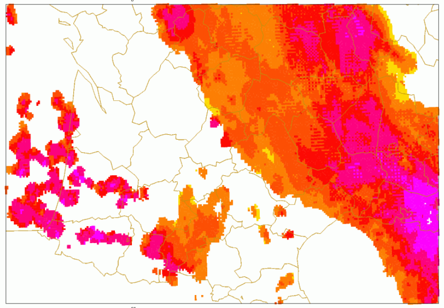
Cross correlations

Real case experiment

CNTRL: AROME oper + Reflectivities

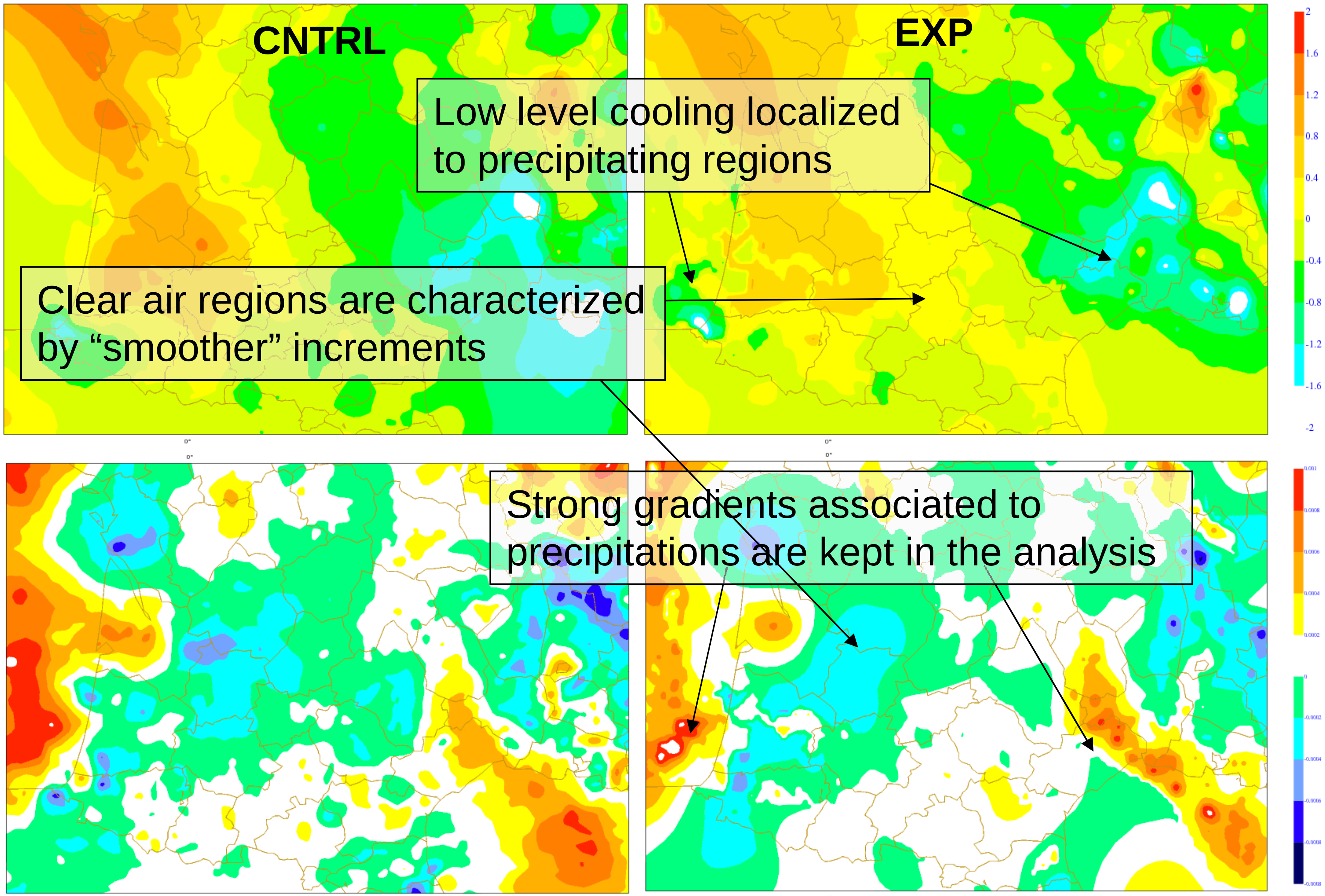
EXP: CNTRL using simultaneously (B_p, B_{np})

Mask deduced from observed reflectivities (zoom)

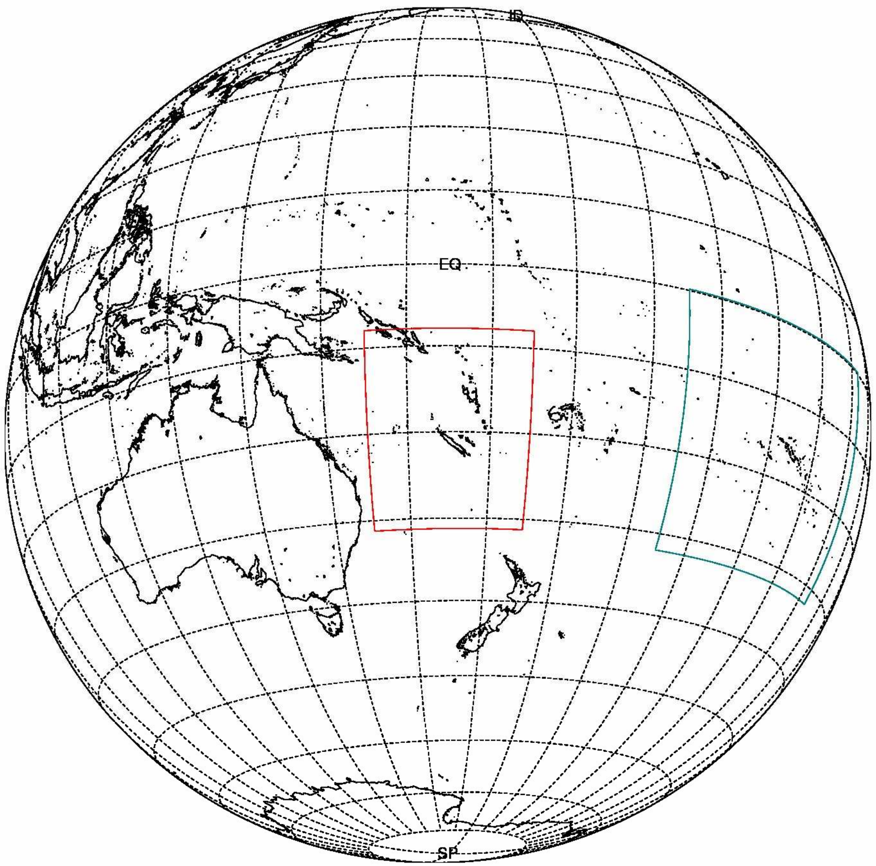


Inc(T)$_{950hPa}$

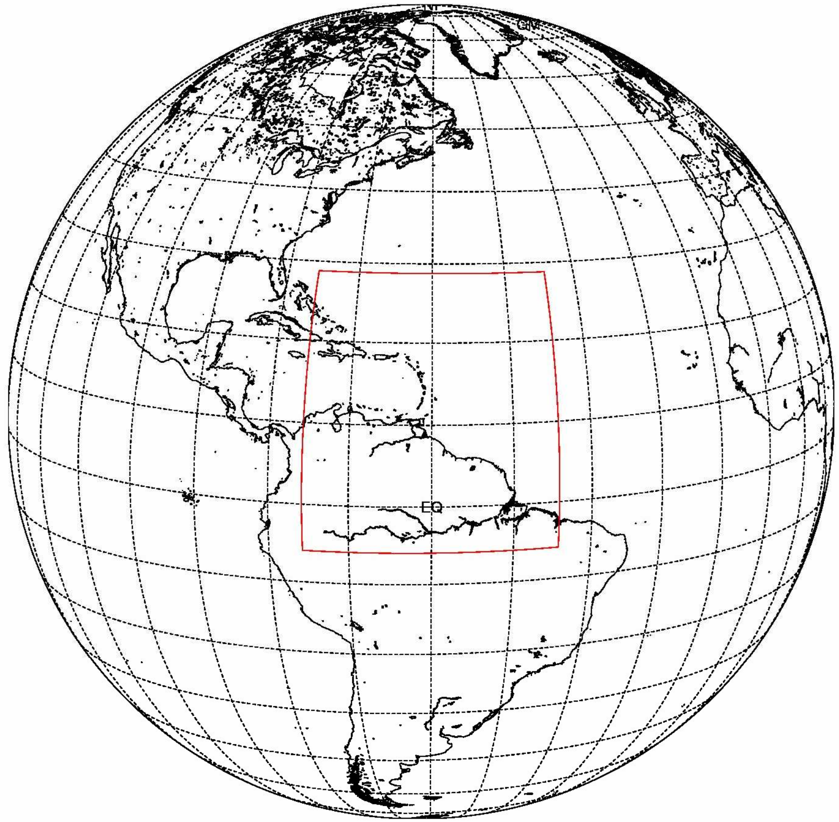
Inc(q)$_{800hPa}$



Aladin Outre Mer (Overseas models)



- Nouvelle-Calédonie
- Polynésie
- Antilles-Guyane



Configuration

- 3D-VAR assimilation cycle
- SURFEX surface model (and later its assimilation)
- 54 h forecast range at 00 UTC and 12 UTC
- for assimilation cycle: 6 h forecasts at 06 and 18 UTC
- time step = 450 s, 10 km, 70 levels (as Aladin-France)
- 3 h coupling frequency, using in nominal mode IFS data at 16 km resolution
- B matrix derived for each domain by sampling over differences of 6 h fcts of members of the Arpège Ensemble Assimilation system (AEARP, 6 members), over 29 days
- Observations as in Arpège: conventional (Temp, Pilot, Synop, Airep), satellites (NOAA15,16,17,18, Metop A, ERS-2, Aqua, GPS Radio occultation)