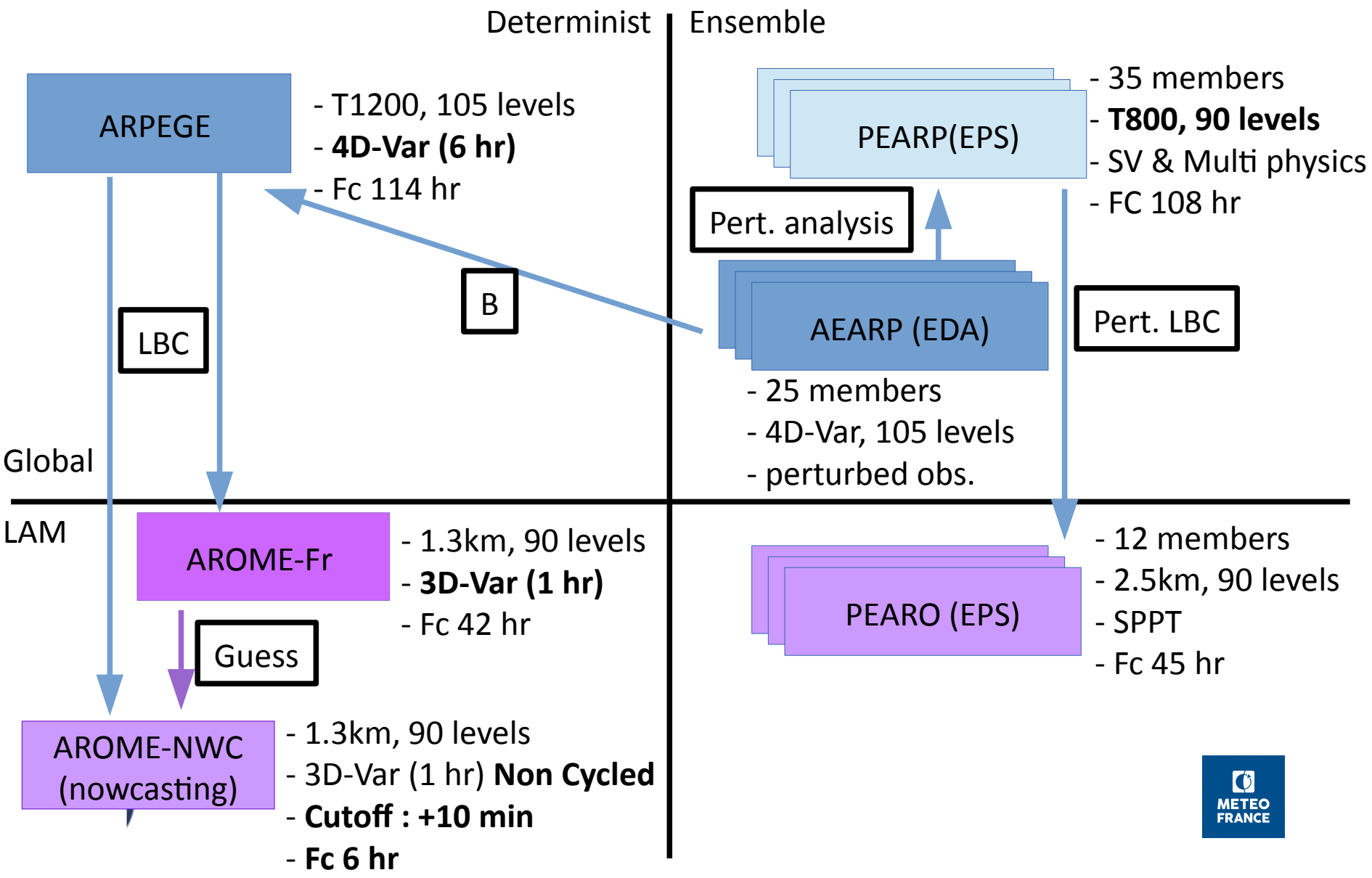
Recent achievements in the data assimilation systems of ARPEGE and AROME-France

P. Brousseau and many colleagues from (CNRM/GMAP)

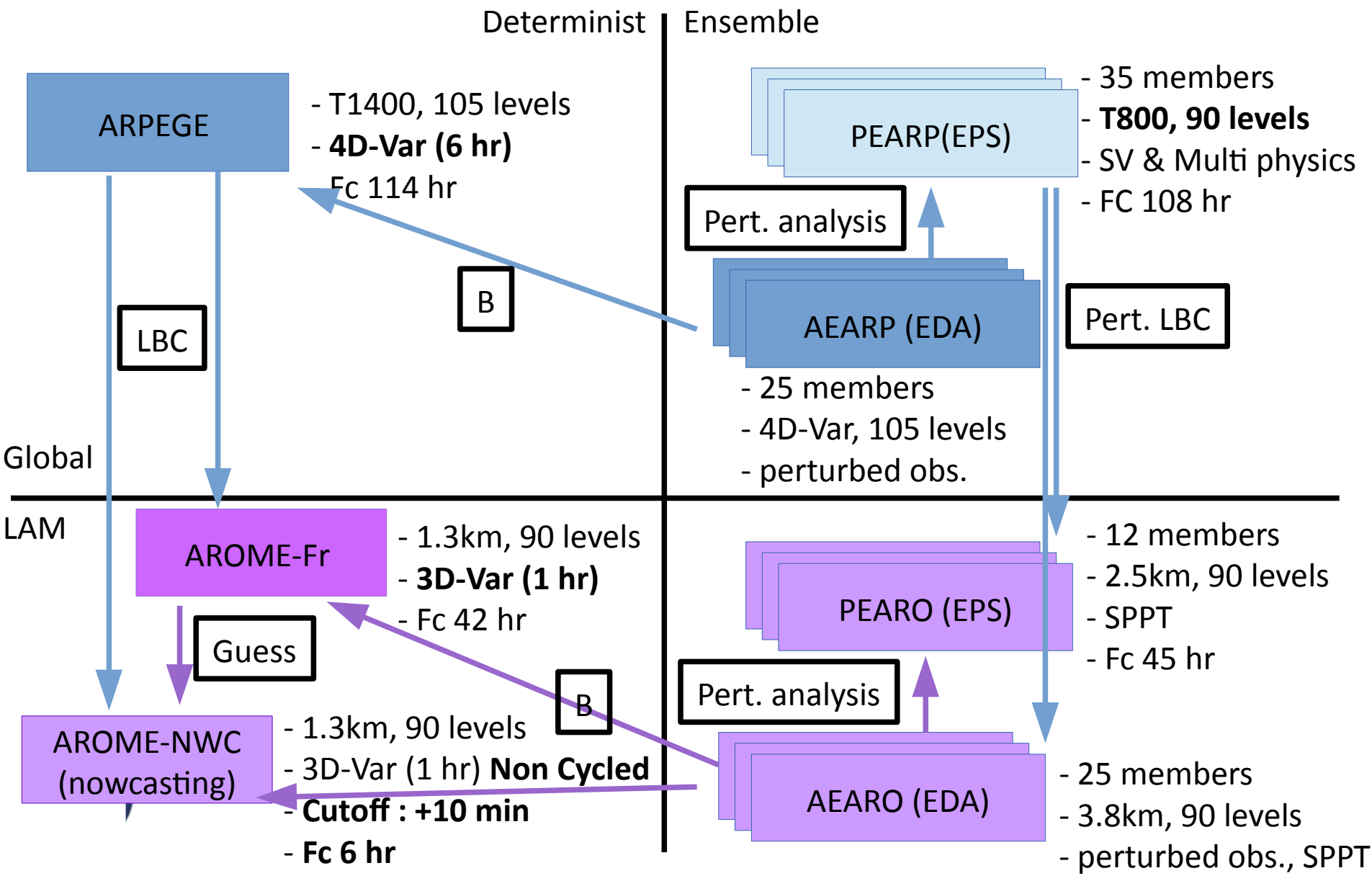
38th EWGLAM and 23 SRNWP Meeting

Rome, 04 October 2016

Meteo-France NWP system : Current situation



Meteo-France NWP system : Plans for 2018

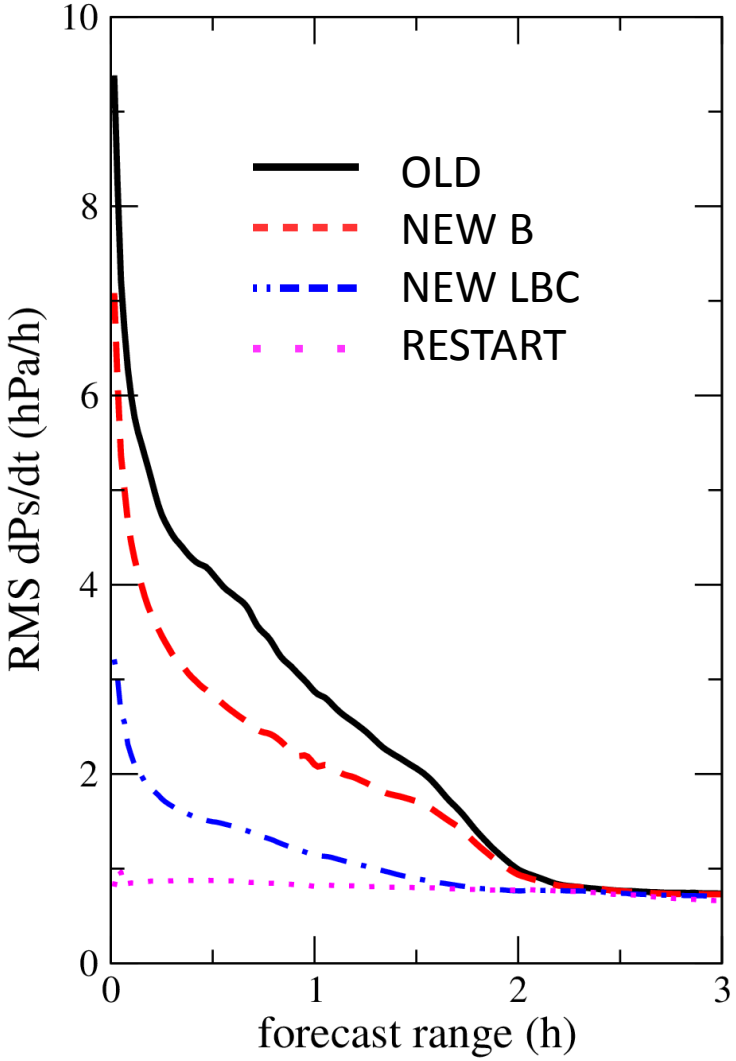


Plan

- The 1-h assimilation cycle
- The current e-suite
- Towards the use of a convective scale EDA

Spin-up reduction

- Spin-up reduction allowing 1-h assimilation cycle thanks to :



- a B matrix estimated from a forecast ensemble provided by an AROME EDA at the model resolution (instead of dowscaling of ARPEGE EDA) more representative of the model scales.

- the AROME analysis used as LBCs at initial time (avoid inconsistencies between the LBC from the global model and the model state inside the geographical domain)

- Residual spin-up du to imbalances between the analyzed fields (U,V,T,q and Ps) and other pronostics fields copied from the background, atmospheric and surface fields,...

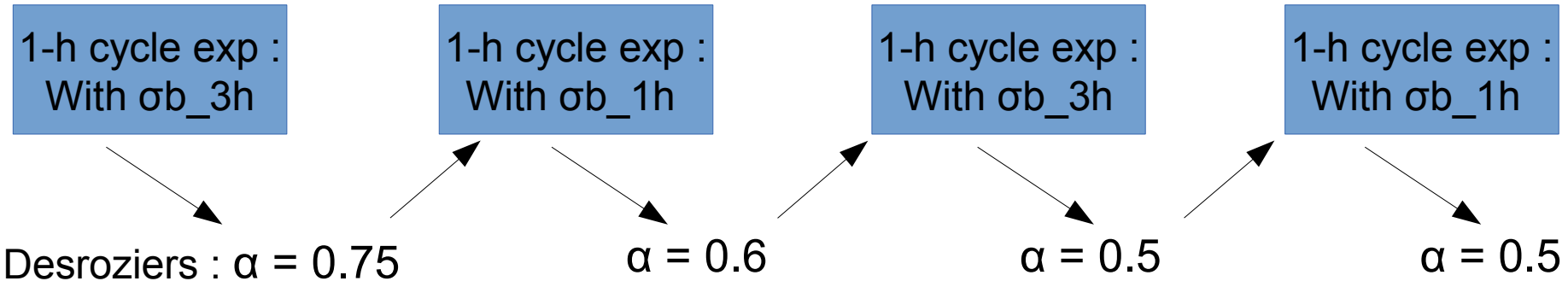
METEO FRANCE

The tunning of the background error covariances

- B estimated from a forecast ensemble provided by an AROME EDA at the model resolution using a 3-h cycle :

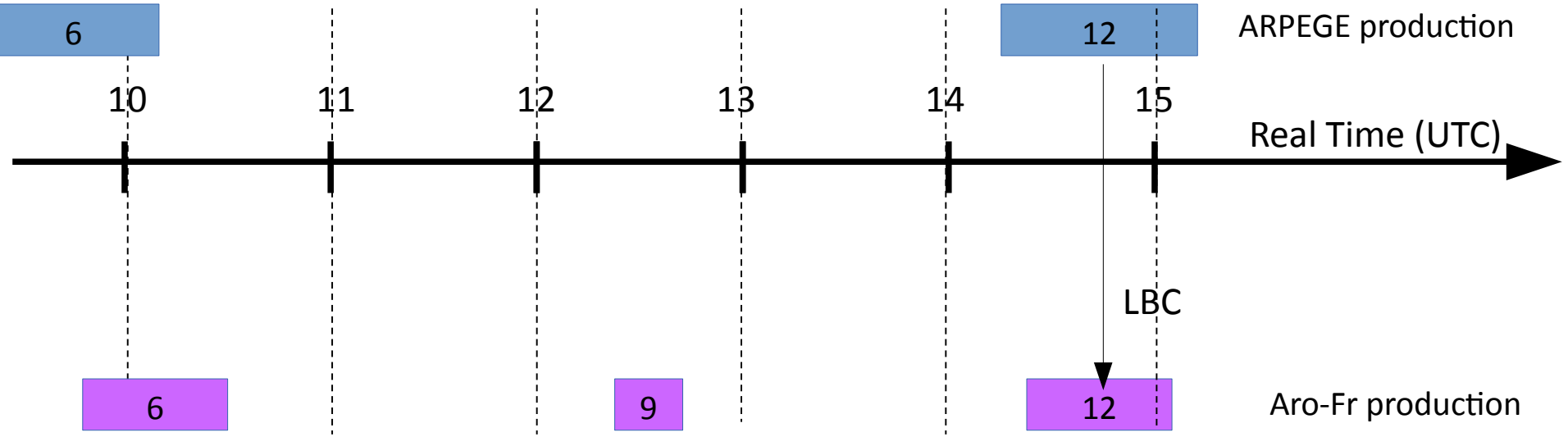
  - but σb_1h stronger than σb_3h : unexpected result

  - choice of using the 3h B matrix with reduced σb : σb_1h = α . σb_3h with α = 0.5 provided by the σb Desroziers's diagnostics in the observation space with an iterative process.



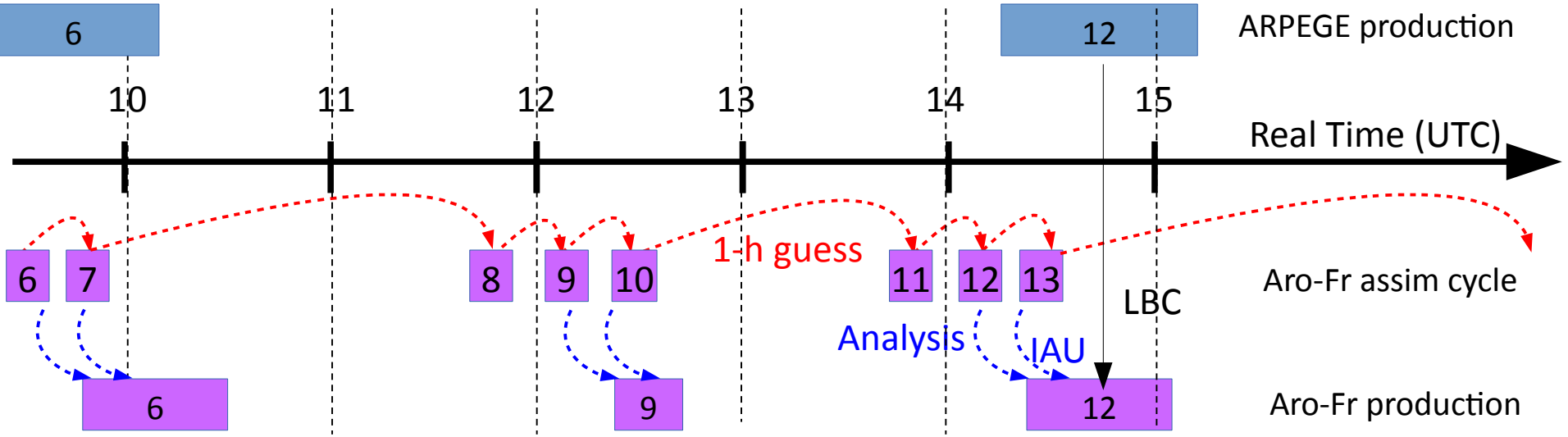
- α values evaluated in assimilation experiments : 0.5 provides better performances in terms of RMS(obs-guess) and scores on precipitation simulation

1-h Assimilation cycle implementation



- The 12 UTC AROME-Fr run uses LBC from the 12 UTC ARPEGE run starting at 14h15

1-h Assimilation cycle implementation

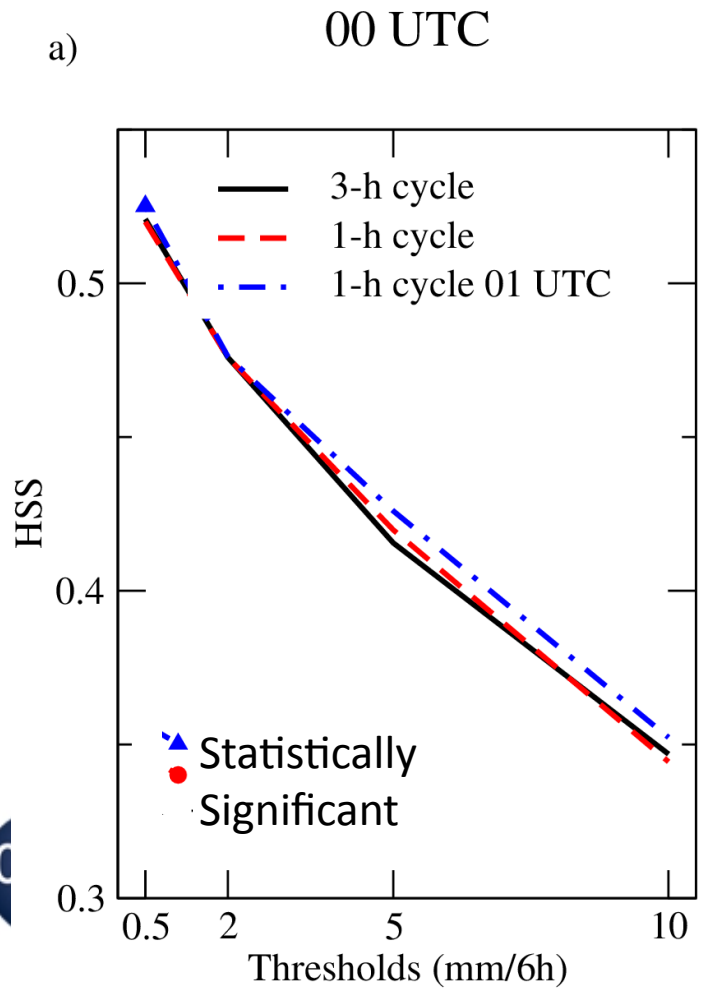


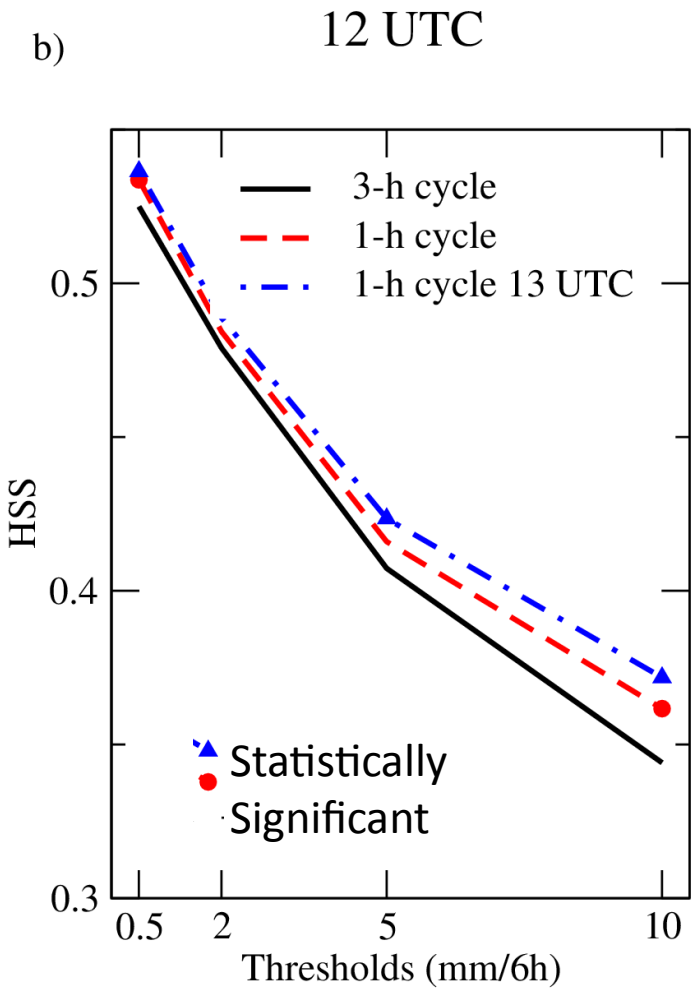
- The 12 UTC AROME-Fr run uses LBC from the 12 UTC ARPEGE run starting at 14h15
- At this time, the 11, 12 but also 13 UTC analysis can be performed with a reasonable cut-off
- The 12 UTC AROME-Fr forecast, starting from the 12 UTC analysis is updated with the 13 UTC analysis using Incremental Analysis update

=> IAU is not needed for its filtering properties, only to update the forecast

Precipitation forecast performances

- HSS for 6h cumulative rainfalls averaged over 6, 12, 18 and 24h forecast range against raingauges measurements from 15 july to 30 septembre for different thresholds.





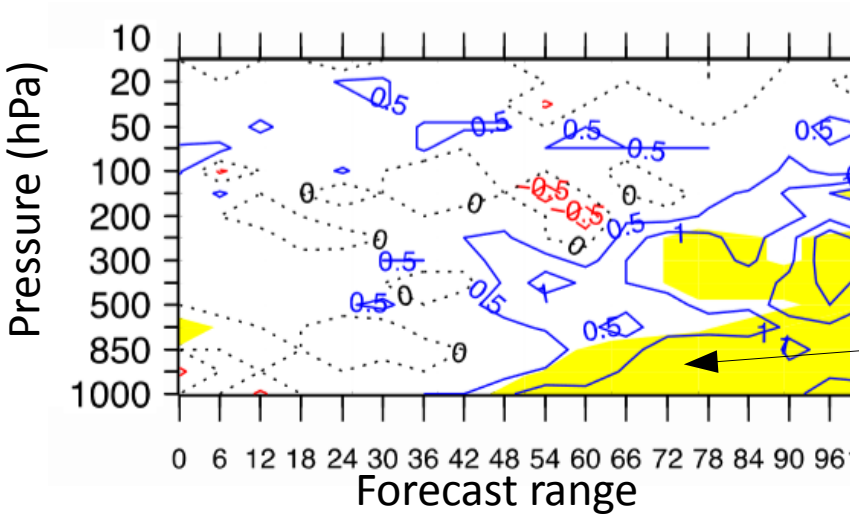
Plan

- The 1-h assimilation cycle
- The current e-suite
- Towards the use of a convective scale EDA

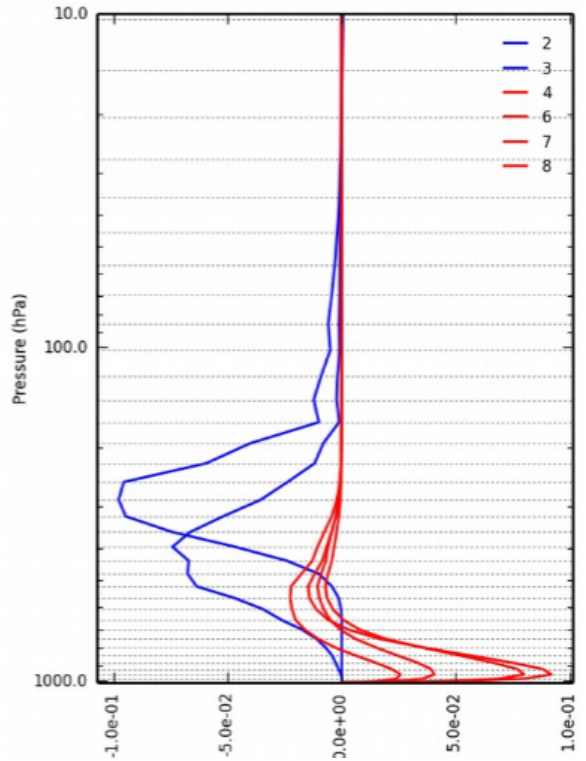
The current E-suite : Observations

ARPEGE/AROME :

- Assimilation of GMI (SSMIS like) on-board GPM Core (2 chanels at 183,31 GHz) and MWHS2 (MHS like) on-board FY3-C (3 chanels at 183,31 GHz)
- Assimilation of 4 window chanels from SEVIRI (chanels 4, 6, 7 and 8) over seas in ARPEGE



Wind RMSE difference against IFS analysis

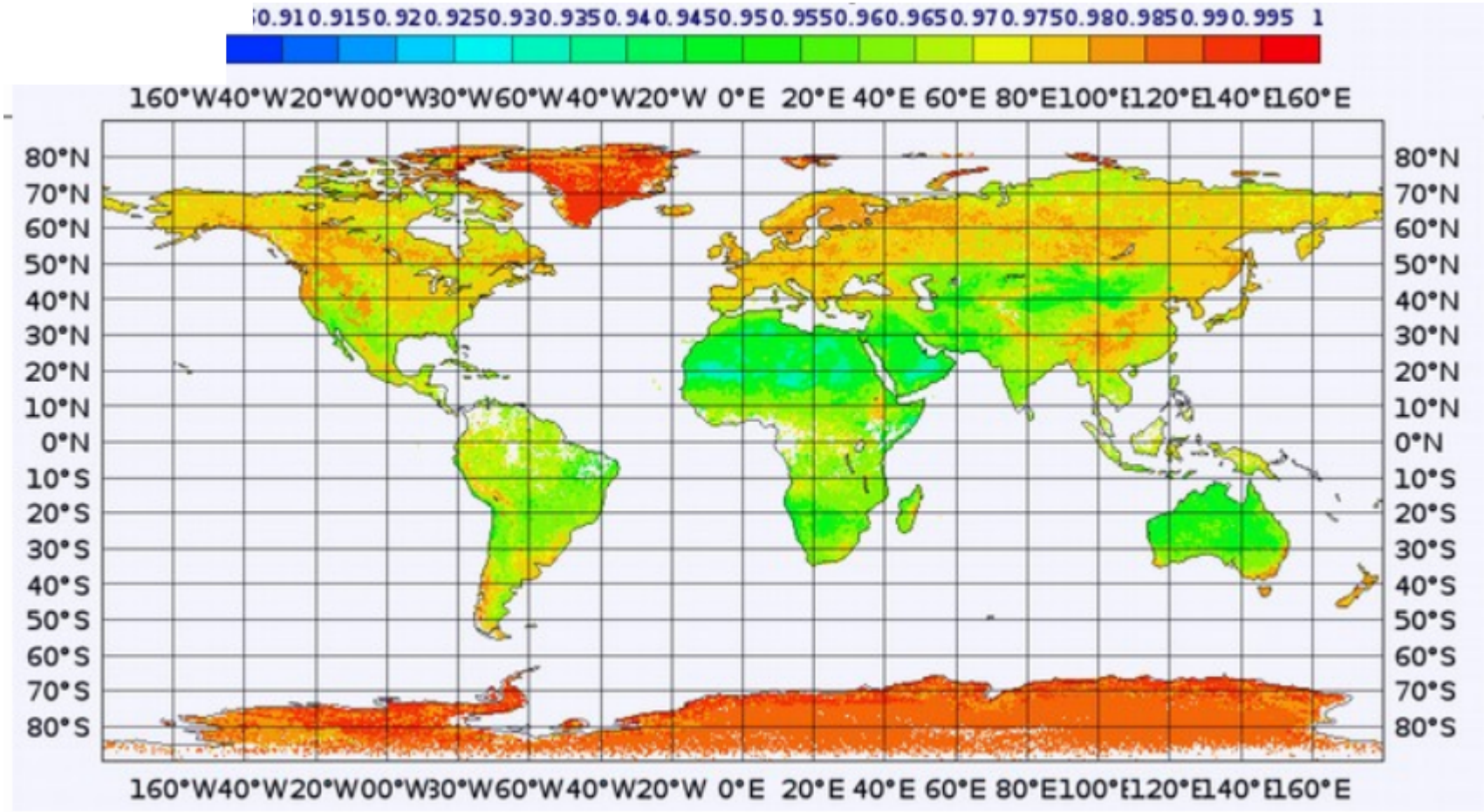


SEVIRI sensitivity to humidity

The current E-suite : Observations

ARPEGE/AROME :

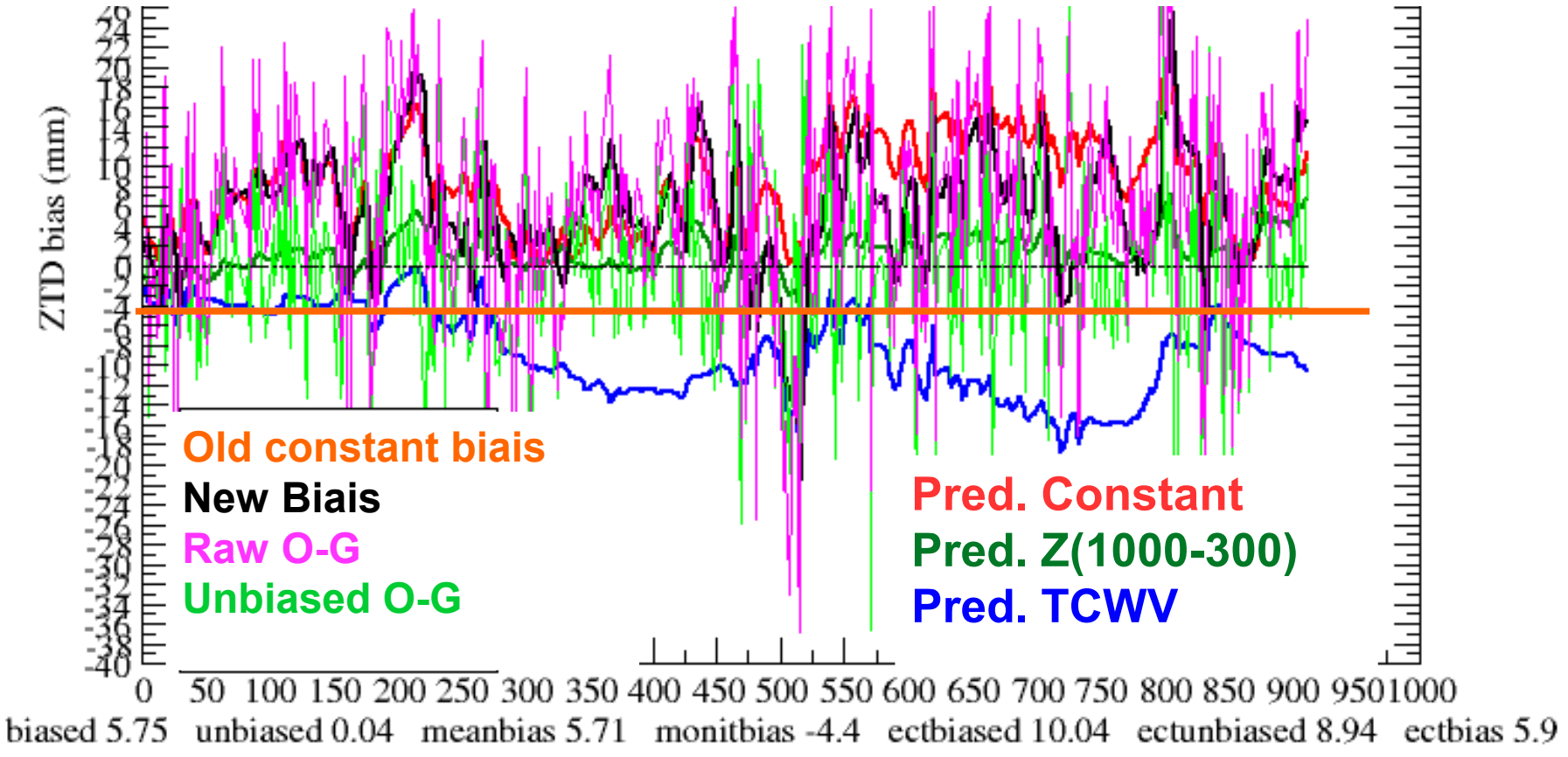
- Use of a monthly surface emissivity atlas (Wisconsin university) for each IASI channel over continental surfaces instead of a constant value



The current E-suite : Observations

ARPEGE/AROME :

- Use of a Variational bias correction for GNSS observations :
  - 3 predictors : constant, 1000-300 hpa thikness layer and TCWV



Plan

- The 1-h assimilation cycle
- The current e-suite
- Towards the use of a convective scale EDA

Convective scale EDA

- Currently : isotropic, homogeneous and climatological B matrix estimated with an offline EDA at the model resolution (1.3 km) only with perturbated observations

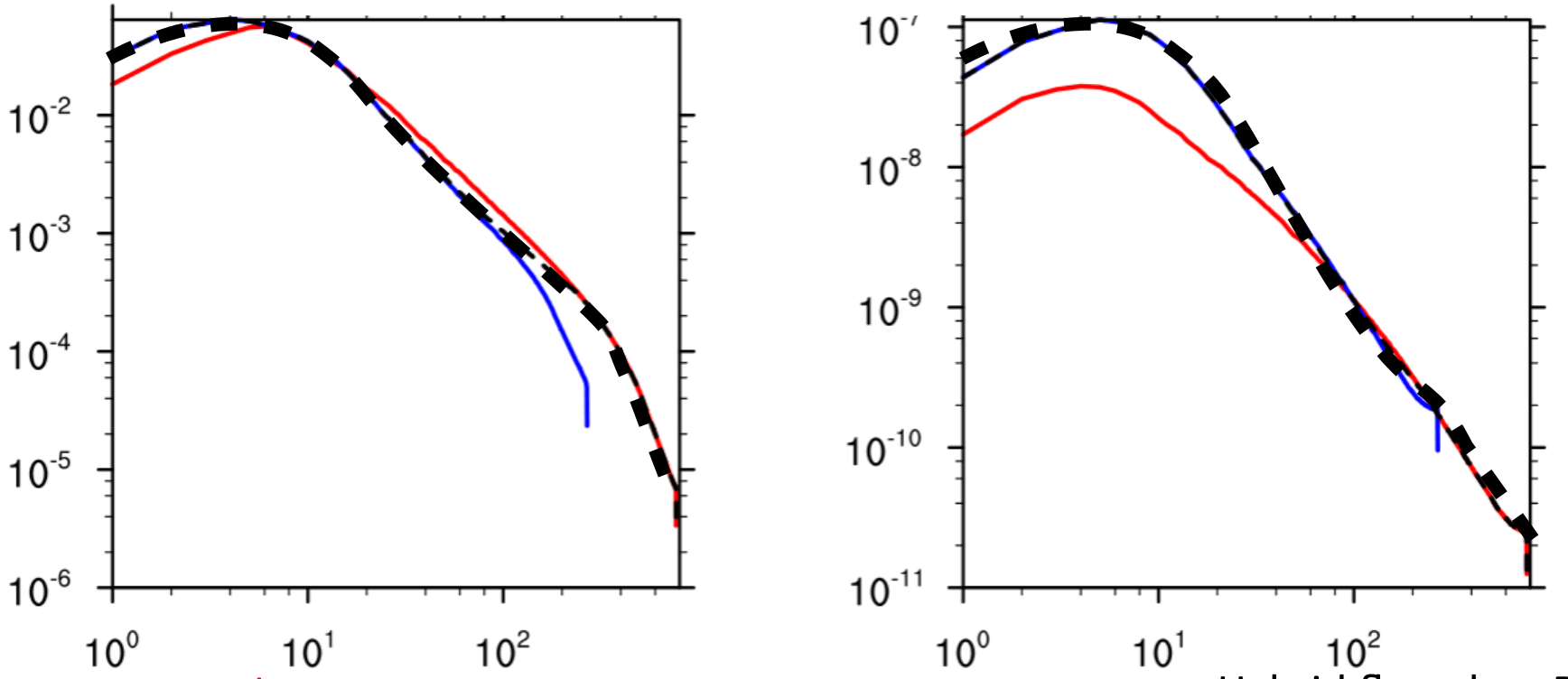
- As a first step toward an En-var system at Meteo-france : use of an operational convective scale EDA at a lower resolution (~3,8 km) with ~25 members :
  - perturbed initial conditions for the AROME based EPS (Raynaud et al 2015)
  - flow dependant B matrix for the AROME-france determinist 3D-Var

- Development of a new version of AROME EDA (Y. Michel) for operations
  - Observation perturbations
  - SPPT
  - SST and surface fields perturbation
  - multiplicative inflation scheme

B matrix hybridization

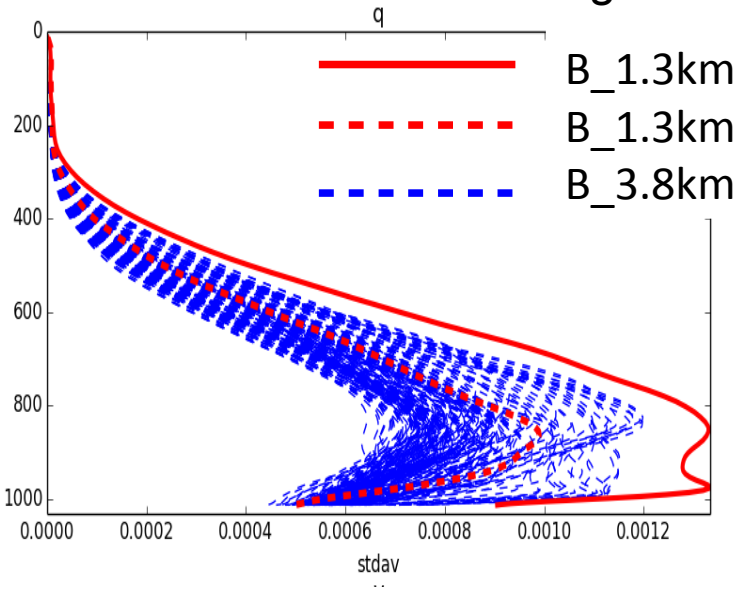
- To estimate B matrices for the determinist 3D-Var averaged over the 4 last assimilation times and refreshed every 3-h :
- Hybrid spectral covariances $Z(n) = [1-\alpha(n)]\, Z_{EDA}(n) + \alpha(n)\, Z_{CLIM}(n)$ with n : wave number

Spectral variance for T (left) and q(right) at 850 hPa



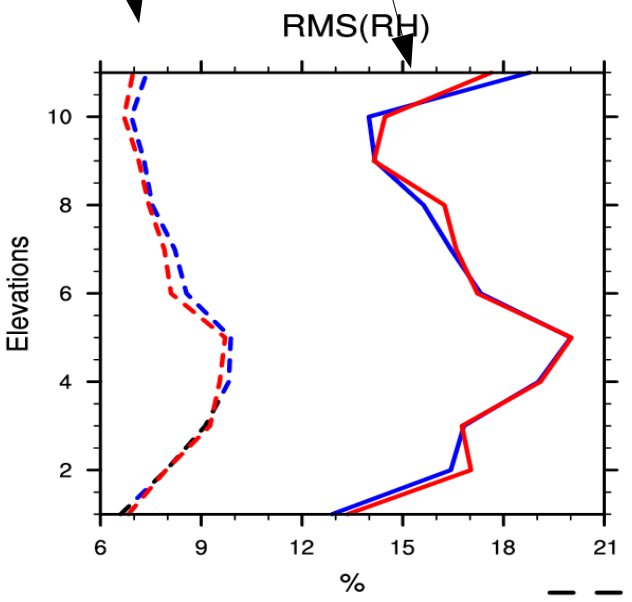
First results

- 1 month experiment (winter period) : Sigmab profiles from 3.8km EDA vary around the 1.3 climatological Sigmab estimated during a winter période

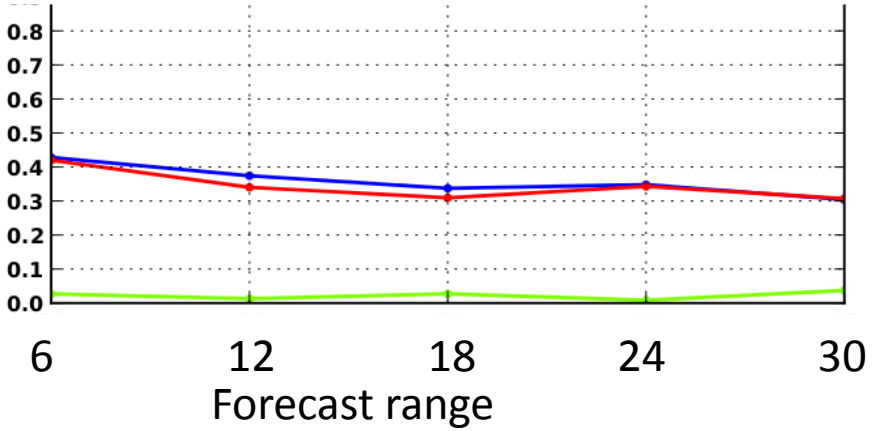


B_1.3km CLIM (operationnal)
B_1.3km WINTER CLIM (february 2013)
B_3.8km of the day from EDA estimated every 3 hr

O-A and O-G RMS profile for relative humidity pseudo-obs from radar reflectivities



HSS for 6h cumulative rainfalls 5 mm/6h threshold



Conclusions

- **Since April 2015 AROME-France system** uses a 1-h continuous assimilation cycle with a positif impact on the convective precipitation forecast (brousseau et al 2016, QJRMS)

- **Current E-suite :** important modifications in ARPEGE model (PCMT, surfex : see Claude's talk on thuesday) and slight changes in the DA system (mainly observations)

- **Towards an operational use of a convective scale EDA** :

  - providing perturbed initial conditions for AROME EPS (Raynaud et al 2015, QJRMS

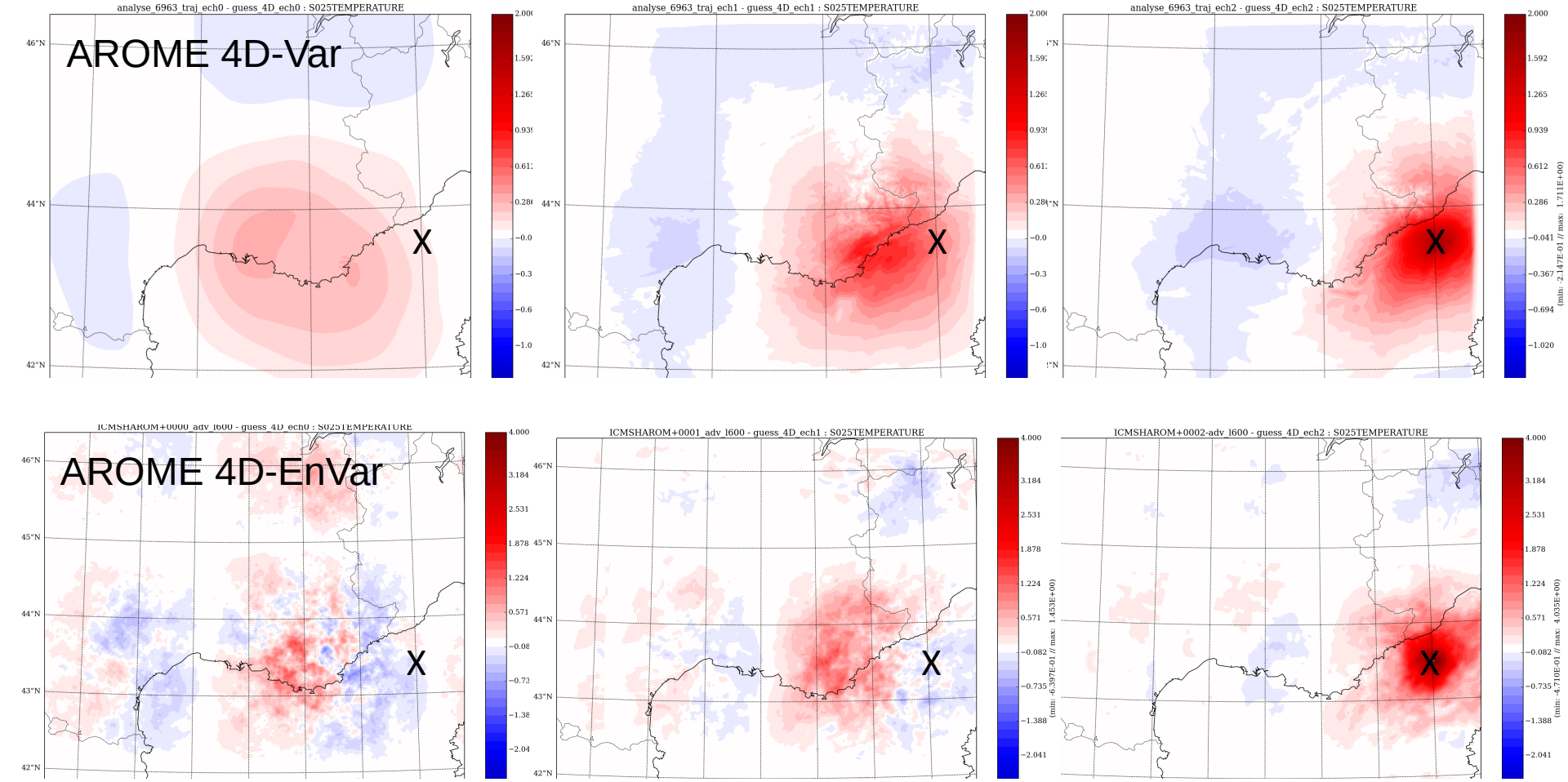
  - allowing to introduce flow dependant covariances in AROME 3D-Var

- **Developments of 3D/4D-Envar in the OOPS framework for ARPEGE and AROME**

Conclusions

- **3h assimilation window : single observation in the third timeslot : 4D-Var and 4D-Envar (100 members, localisation 200 km)**

Timeslot 1 Timeslot 2 Timeslot 3




Thanks for your attention
METEO FRANCE
Toujours un temps d'avance

Plan

- Frequency biais for 24 h cumulative rainfall against 4000 daily raingauges over france (climatological french network) averaged over 1 glissant year