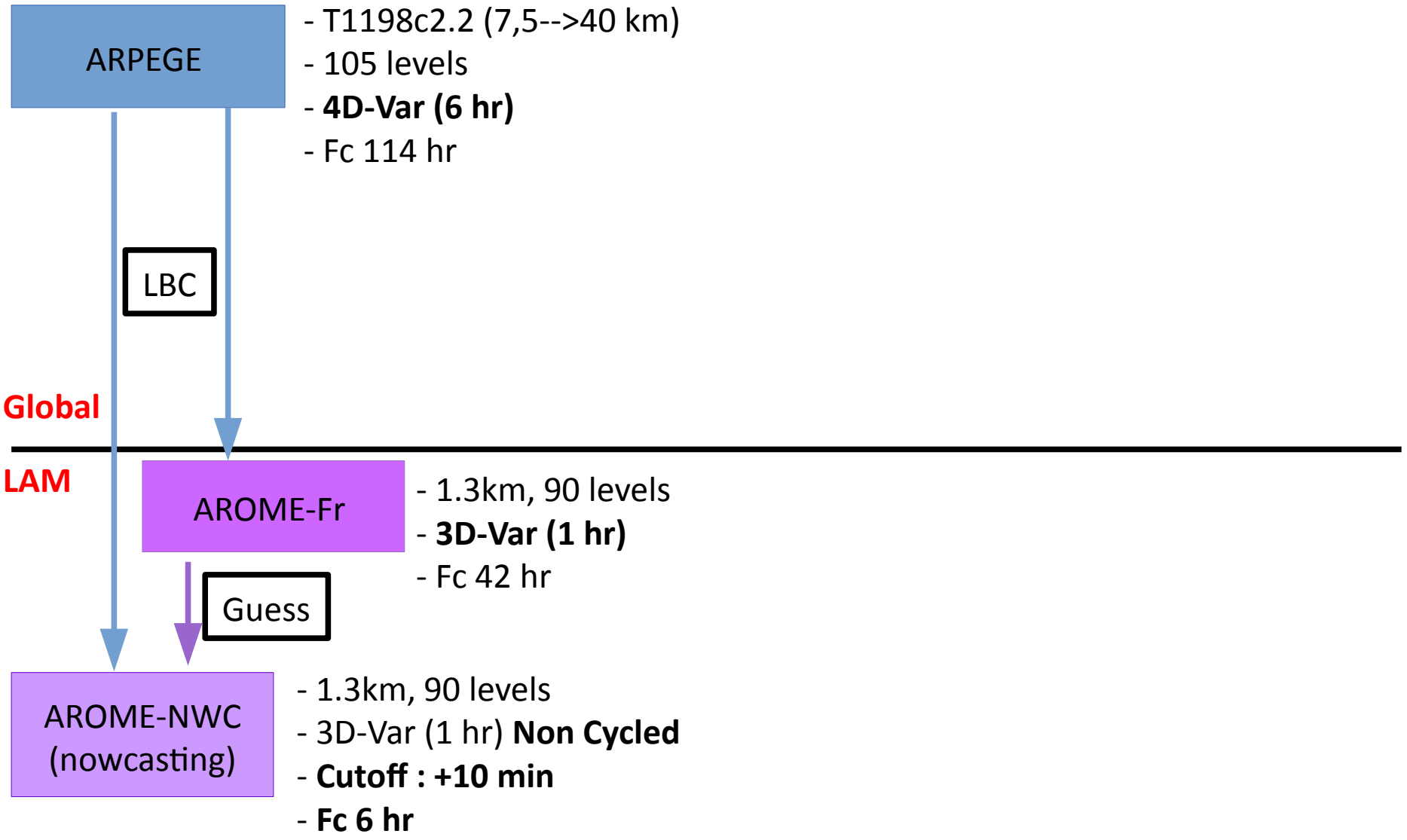
Recent achievements in the data assimilation systems at Meteo-France

C.Loo and many colleagues from CNRM/GMAP

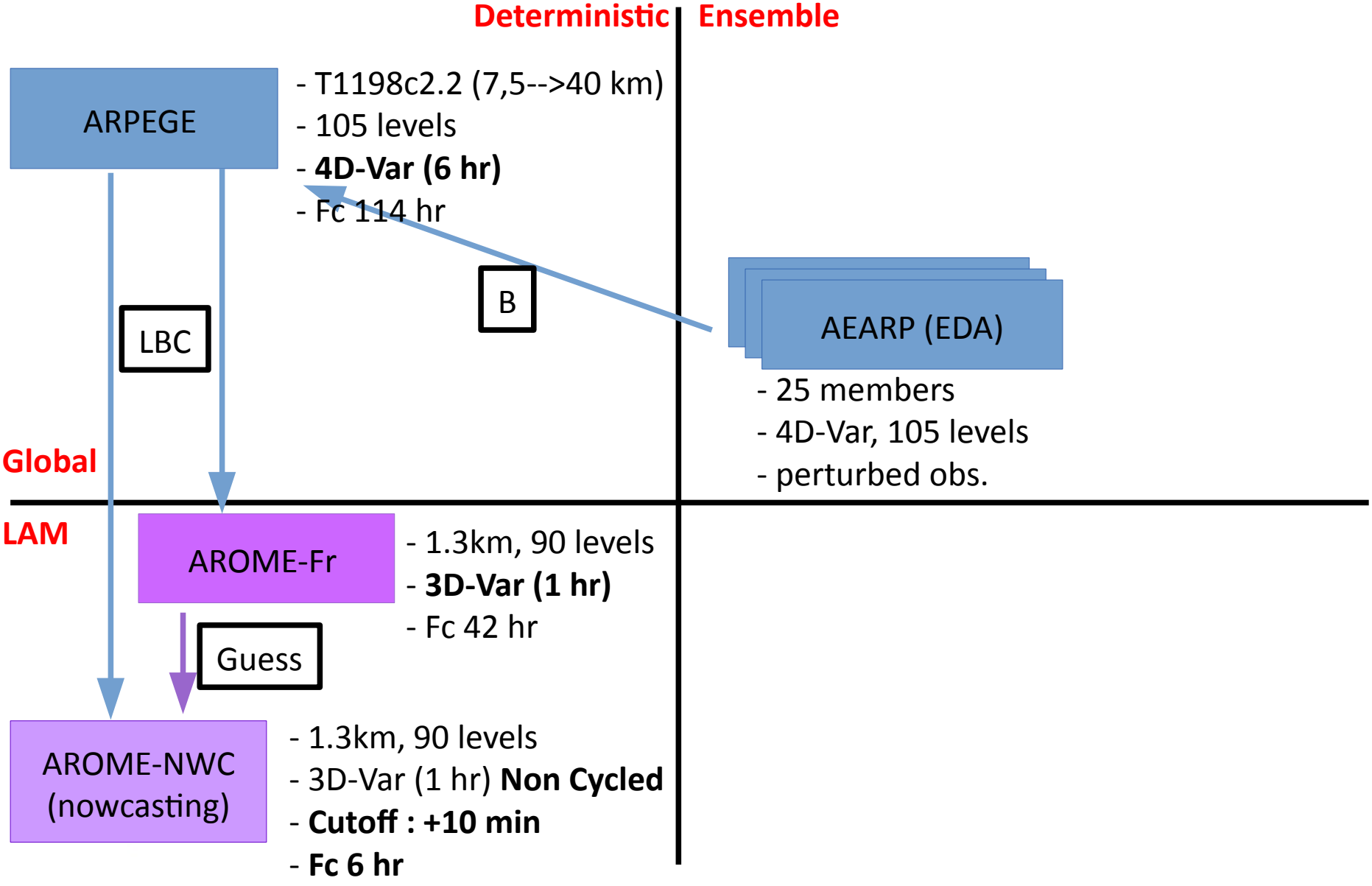
40th EWGLAM and 25 SRNWP Meeting
Salzburg, October 2018

Meteo-France NWP system : current situation

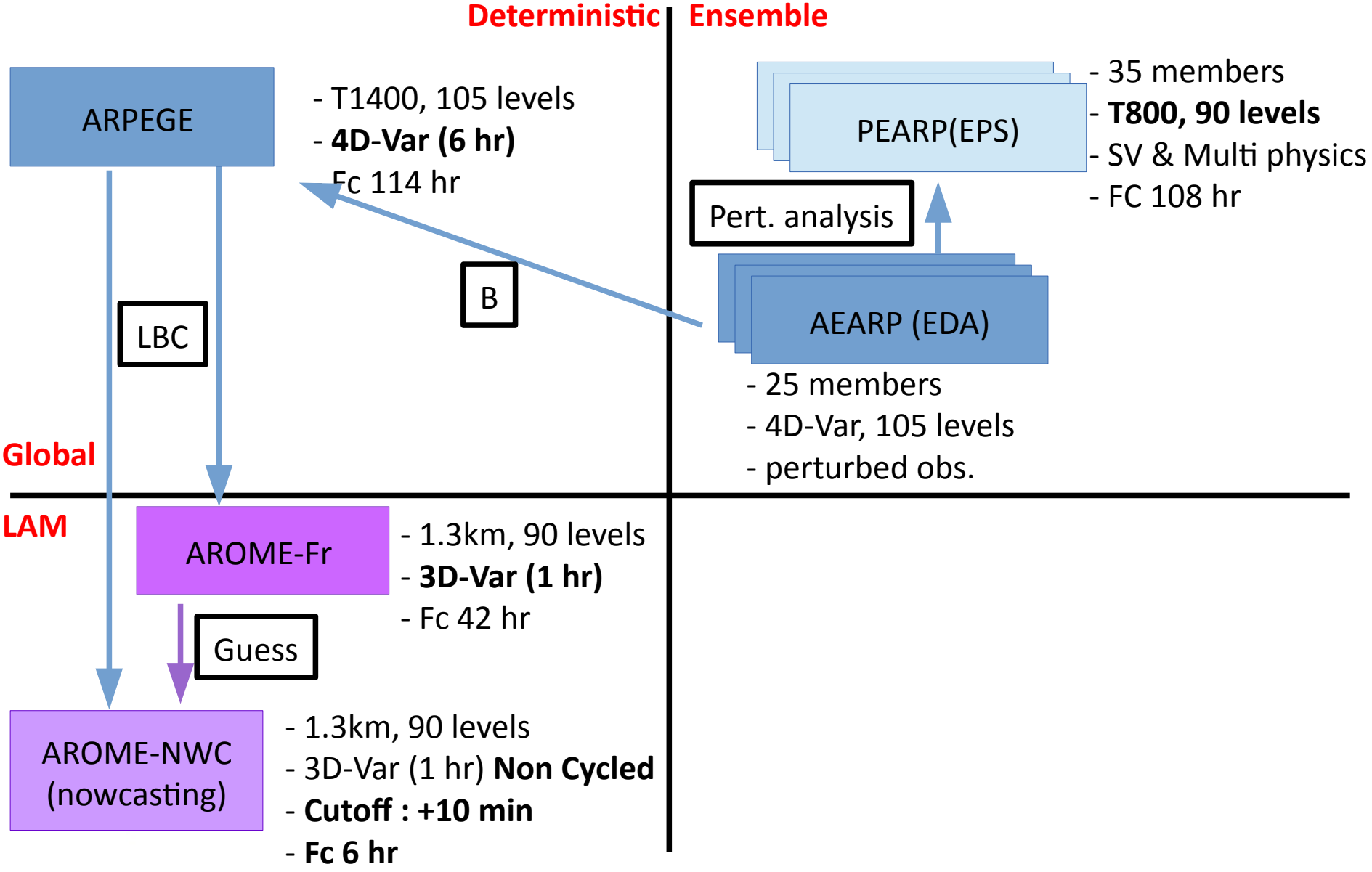
Deterministic



Meteo-France NWP system : current situation

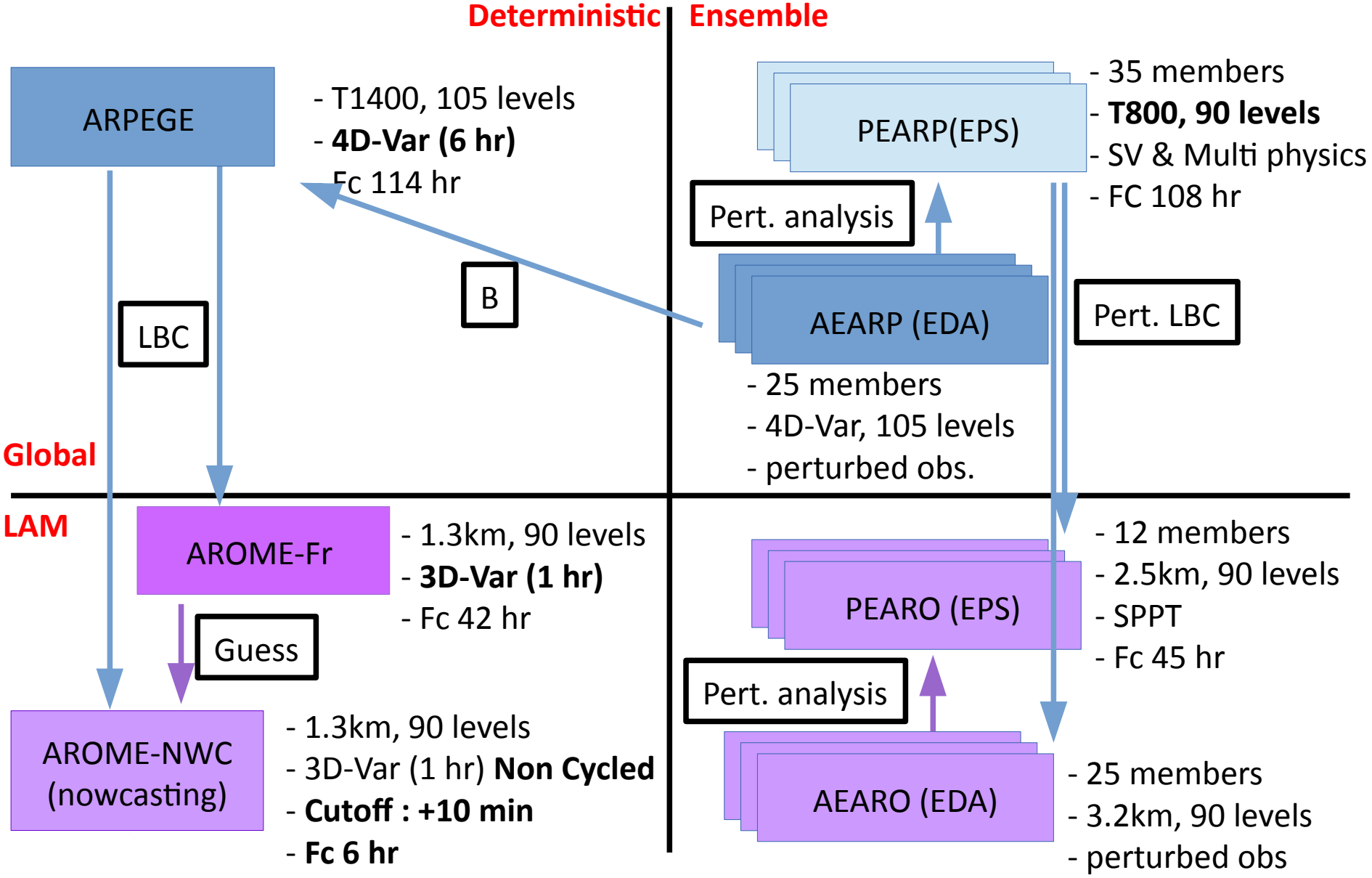


Meteo-France NWP system : current situation



P.Brousseau

Meteo-France NWP system : current situation

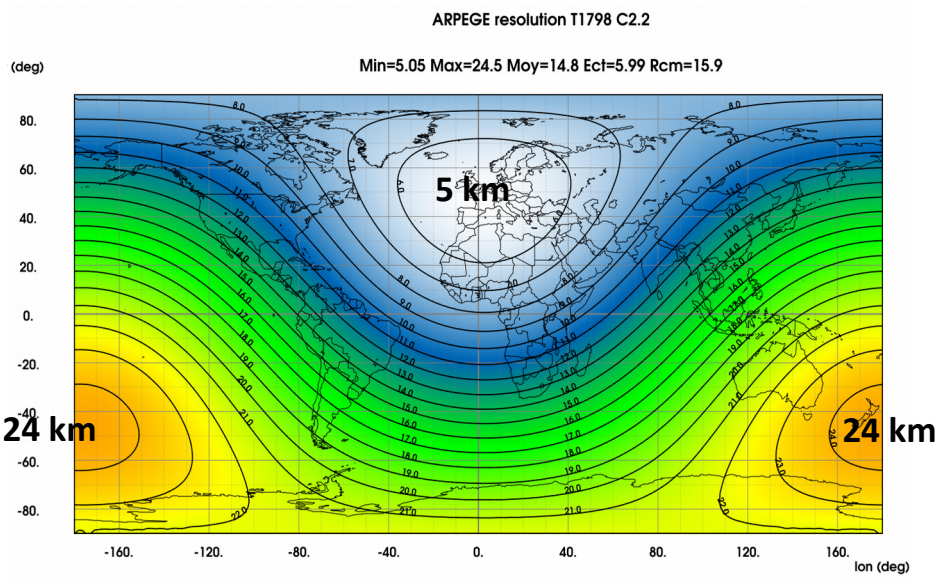


Plan

- **Evolutions of the Global system**
- Evolutions of the LAM system
- Conclusions

Meteo-France Global system : new version

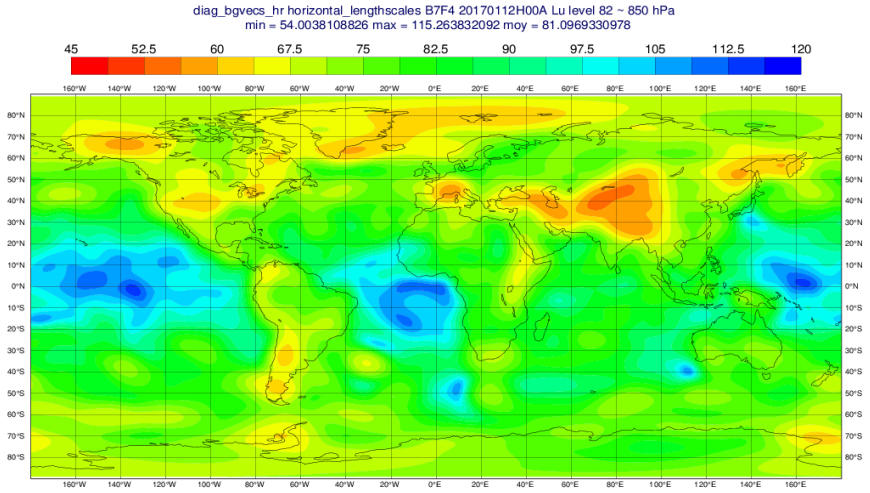
	Current version Cy42 surfex v7	New version Cy43 surfex v8
ARPEGE *Deterministic*	**Tl1198c2.2 L105 (7.5km on W Europe)** 4DVar (6h cycle): **Tl149c1L105** & **Tl399c1L105** 5 forecasts per day up to 114h	**Tl1798c2.2 L105 (5km on W Europe)** 4DVar (6h cycle): **Tl224c1L105** & **Tl499c1L105** 5 forecasts per day up to 114h
AEARP *(global EDA based on ARPEGE)*	**Tl479c1 L105** ; **25 members** 4D-Var (6h cycle): **Tl149c1 L105** Background covariances **averaged on 1.5 days** and **updated every 6h**	**Tl499c1 L105** ; **50 members** 4D-Var (6h cycle): **Tl1224c1 L105** Background covariances **averaged on 0.5 days** and **updated every 6h**

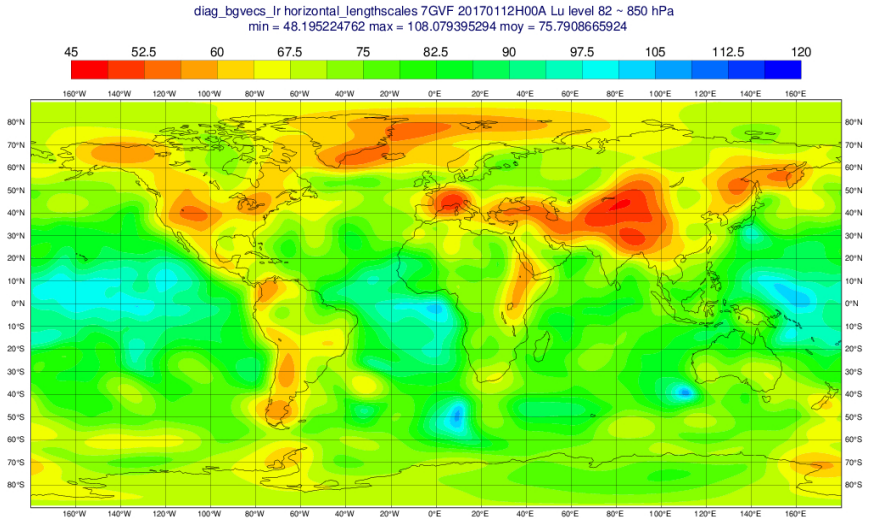


Meteo-France Global system : new version

Increase of increment resolution

Diagnosed
u length-scale
850 hPa
50 km (T399)





Diagnosed
u length-scale
850 hPa
40 km (T499)

Reduction of length-scales of background error correlations

↓

Small structures better analysed

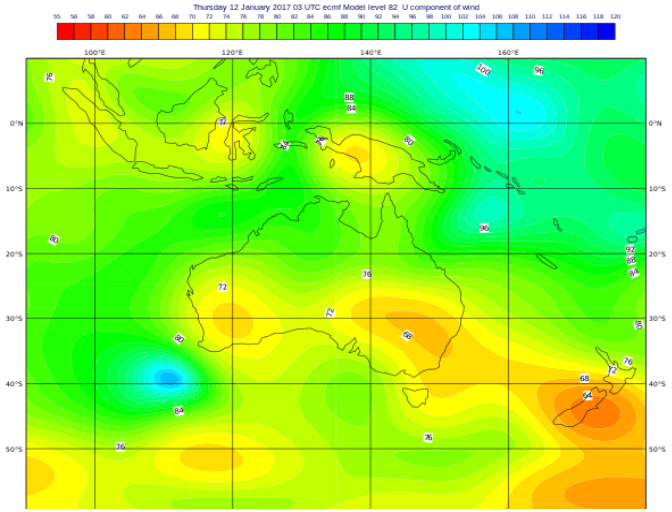
L.Berre

Meteo-France Global system : new version

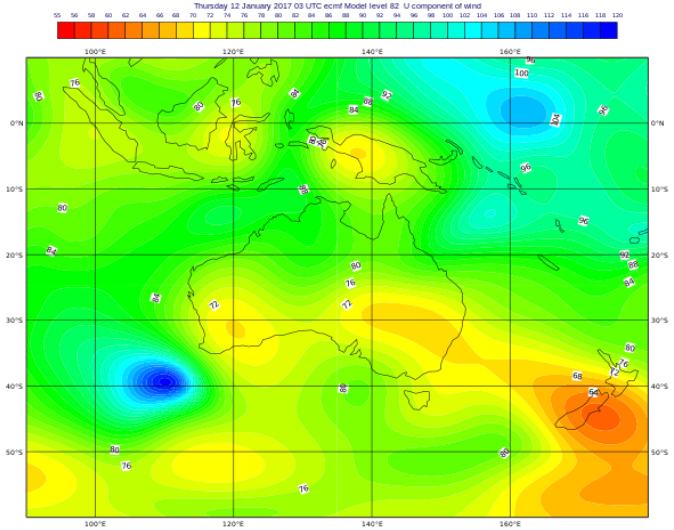
Decrease of time-averaging for correlations

(30h with 25 members / 12h with 50 members)

diagnosed u
length-scale
850 hPa
40 km (T499)
25 members



diagnosed u
length-scale
850 hPa
40 km (T499)
50 members



Local variations better represented

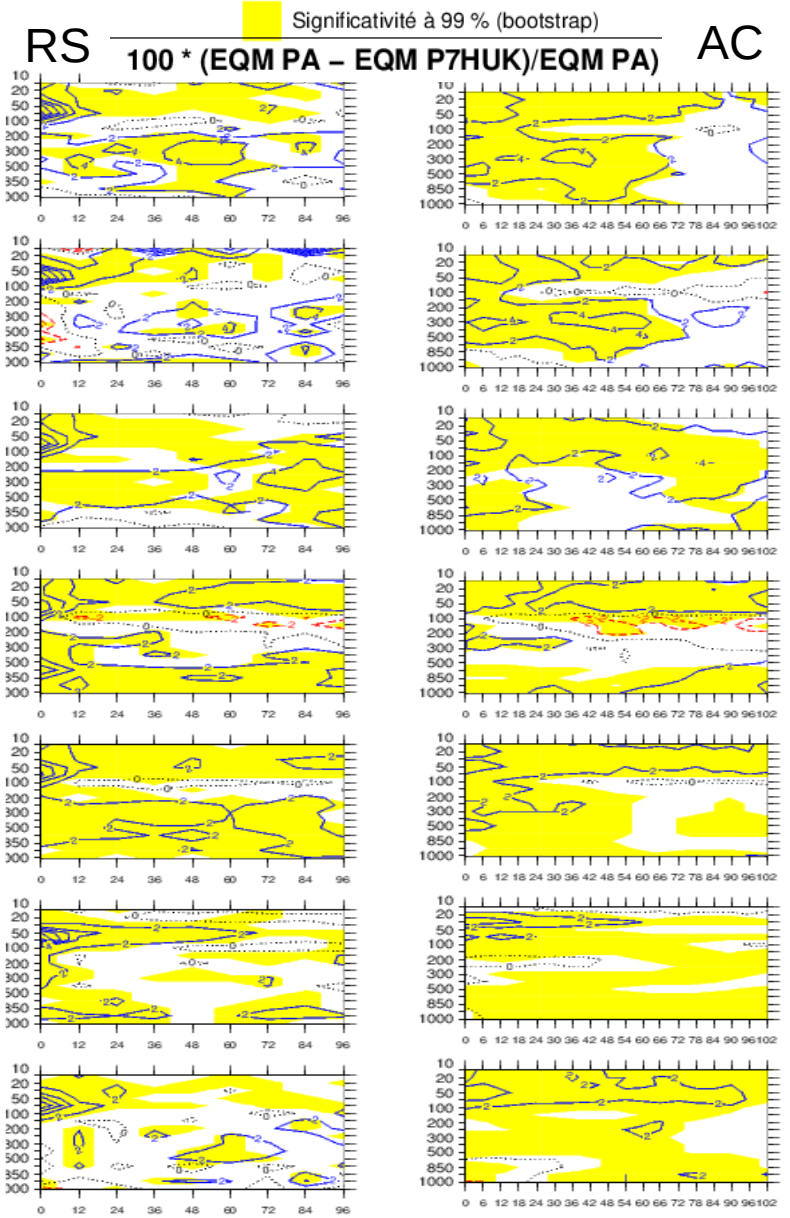
L.Berre

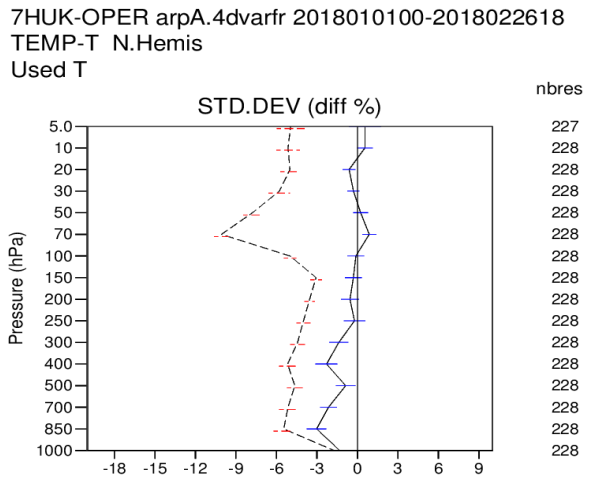
Meteo-France Global system : new version

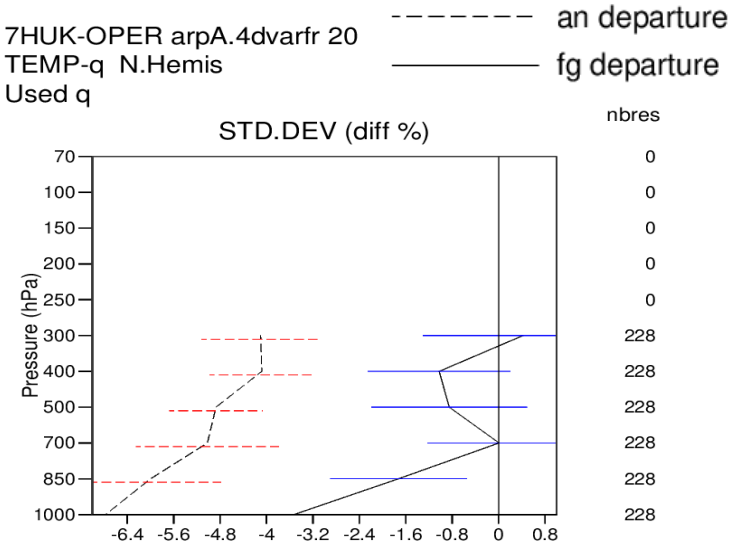
AEARP/ARPEGE HR

47 102 h simulations from 20180101 to 20180220

Wind







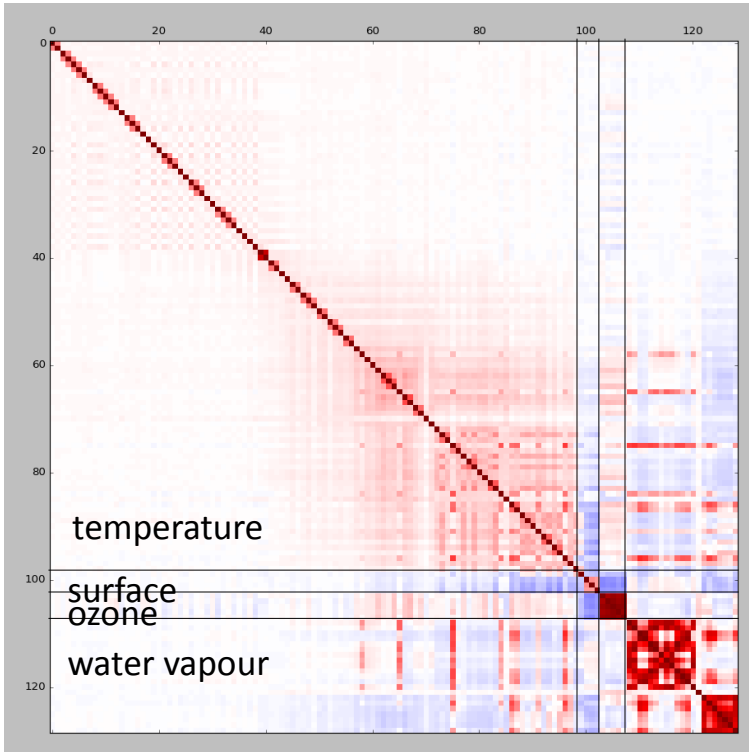
L. Berre, B. Ménétrier, P. Chambon, V. Guidard, C. Loo, L.F. Meunier, P. Moll, F. Suzat ...

Meteo-France Global system : new version

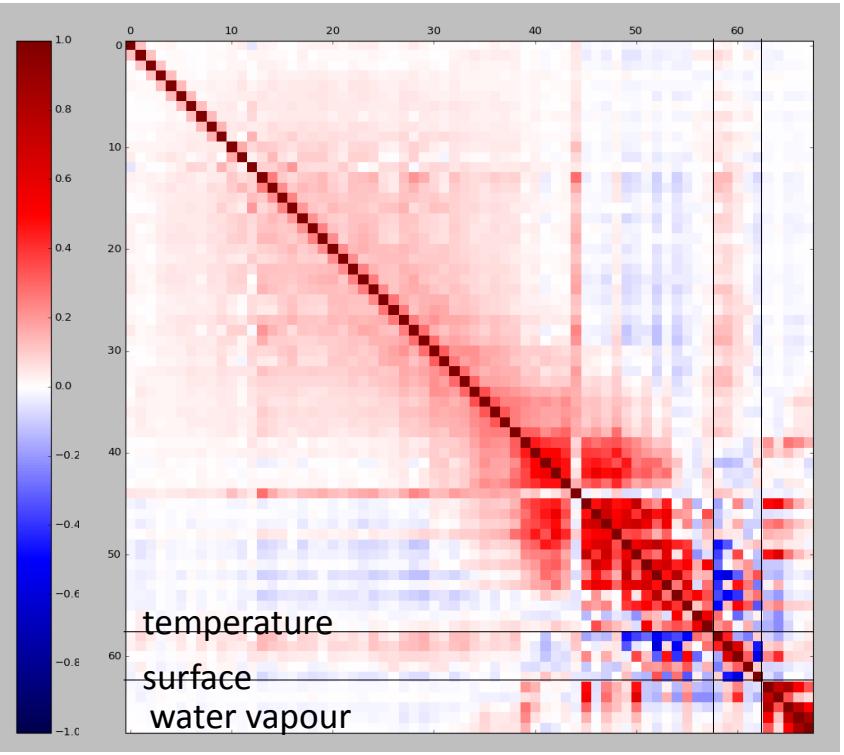
IASI and CrIS interchannel correlations

Estimated correlations from Desroziers diagnostics over 3 full days of global assimilations

IASI



CrIS



→ Introduce interchannel correlations
(but keep sigma_o unchanged)

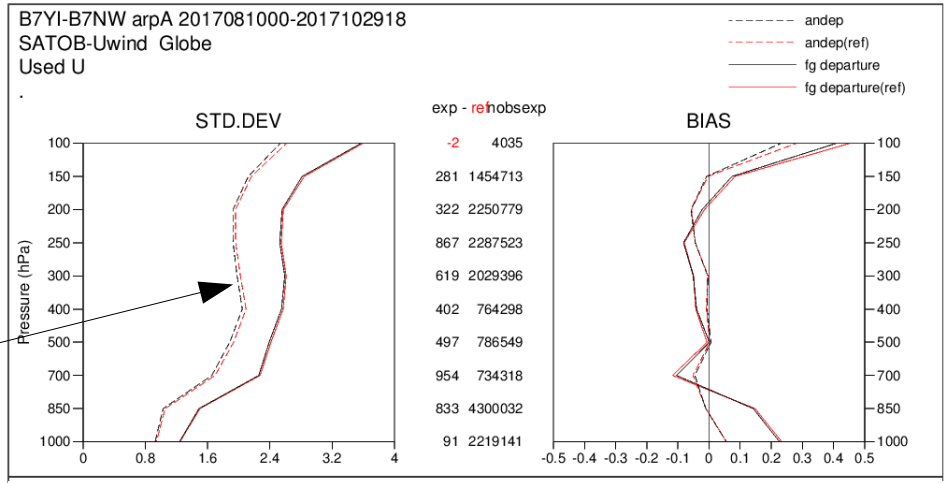
V. Guidard

Meteo-France Global system : new version

IASI ans CrIS interchannel correlations

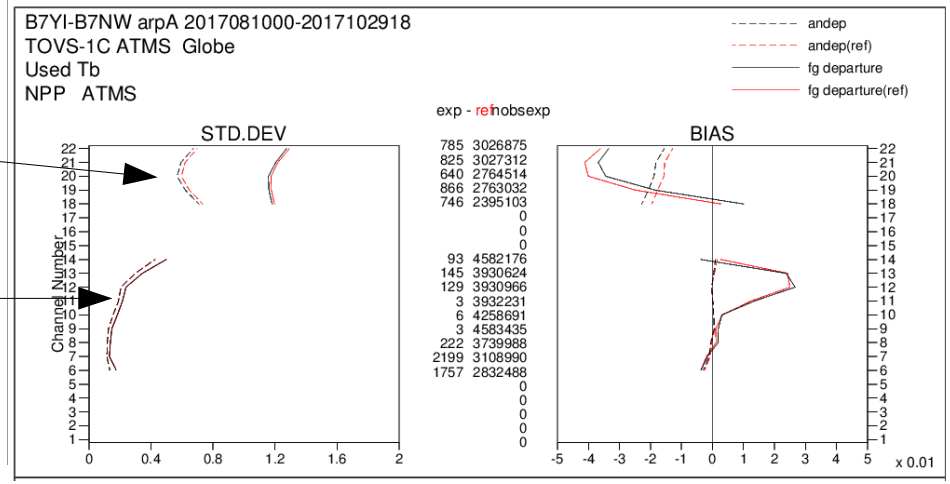
Evaluation : 4D-Var experiments during more than 2 month with (black) and without (red) interchannels correlations

Better fit on analyses for wind observations



Nice impact on microwave humidity channels

small impact on microwave temperature channels

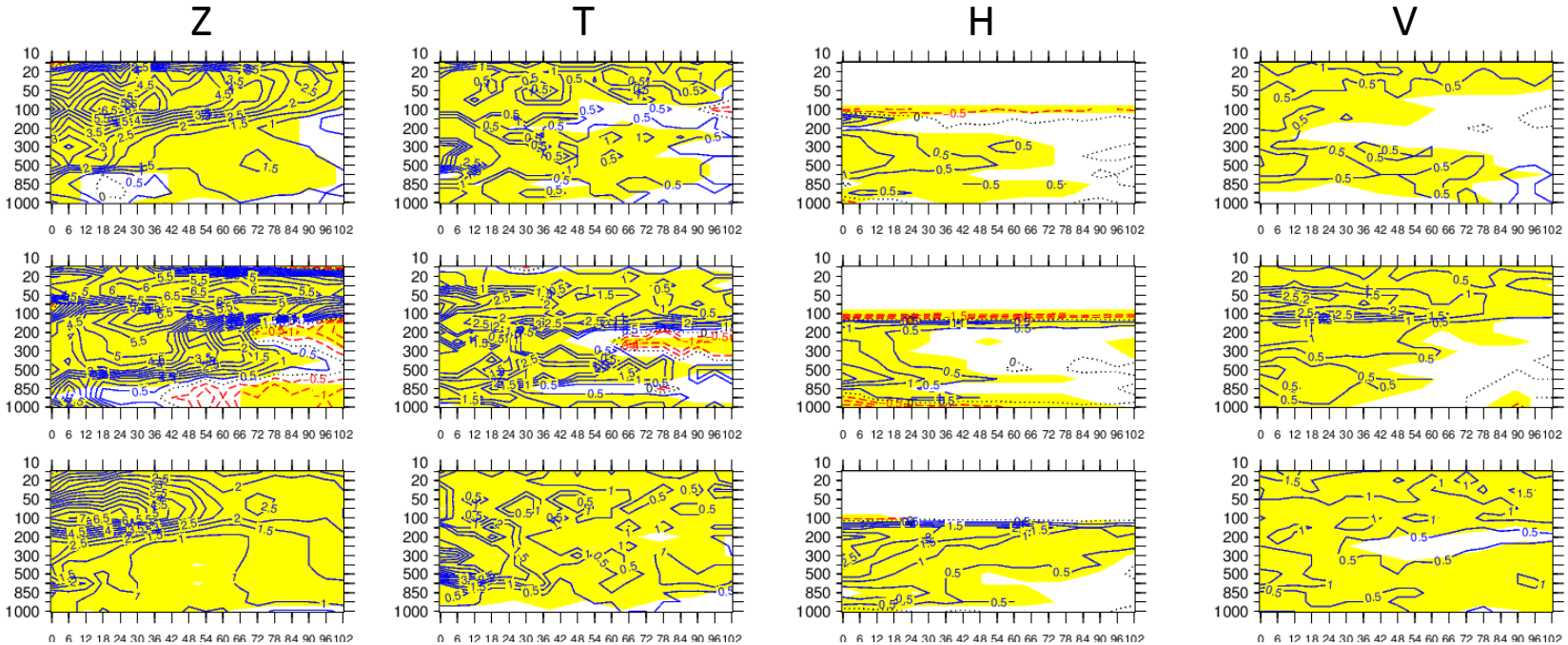


V. Guidard

Meteo-France Global system : new version

IASI ans CrIS interchannel correlations

Impact on the forecast skills / AC



Overall improvement for all parameters

V. Guidard

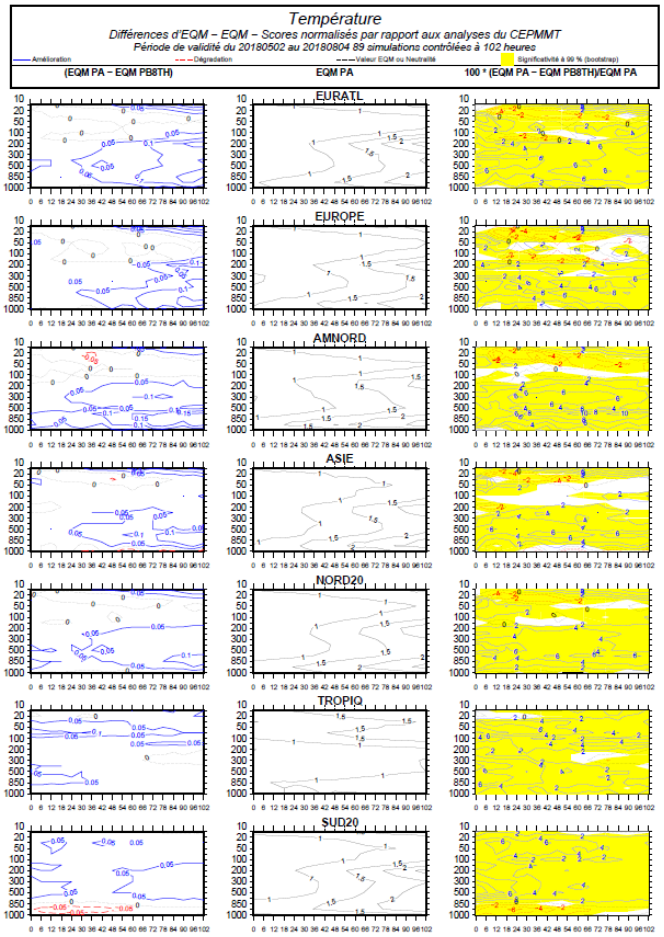
Meteo-France Global system : new version

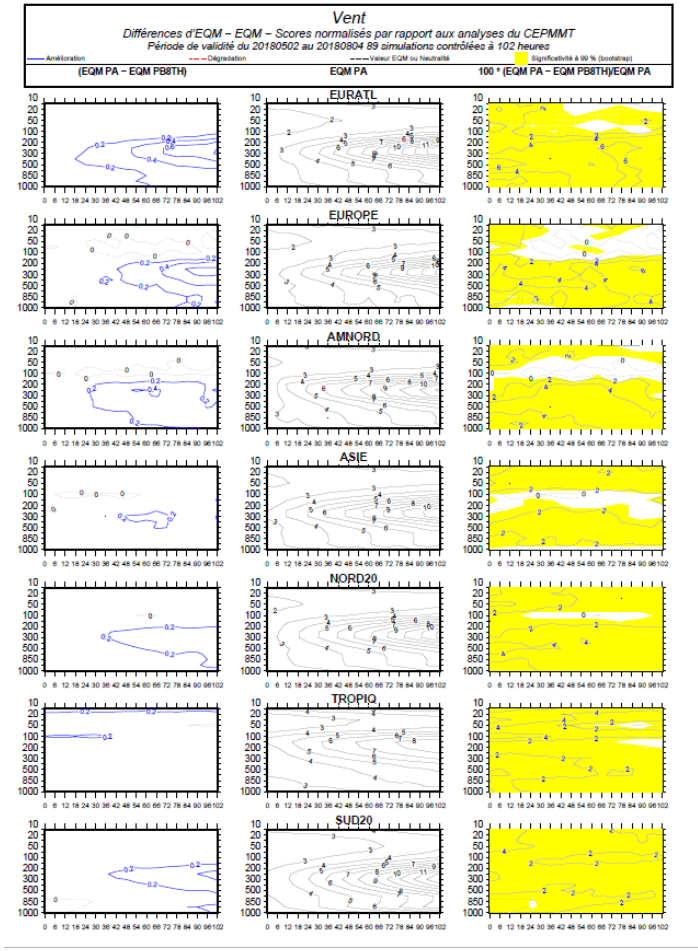
Forecasts scores

Evaluation with long 4D-Var during various periods

↓

Significant improvements





Normalized scores for EXP – OPER in comparison with ECMWF analyses over 3 months

Plan

- Evolutions of the Global system
- **Evolutions of the LAM system**
- Conclusions

Meteo-France LAM system : assimilation of IASI surface-sensitive channels over land

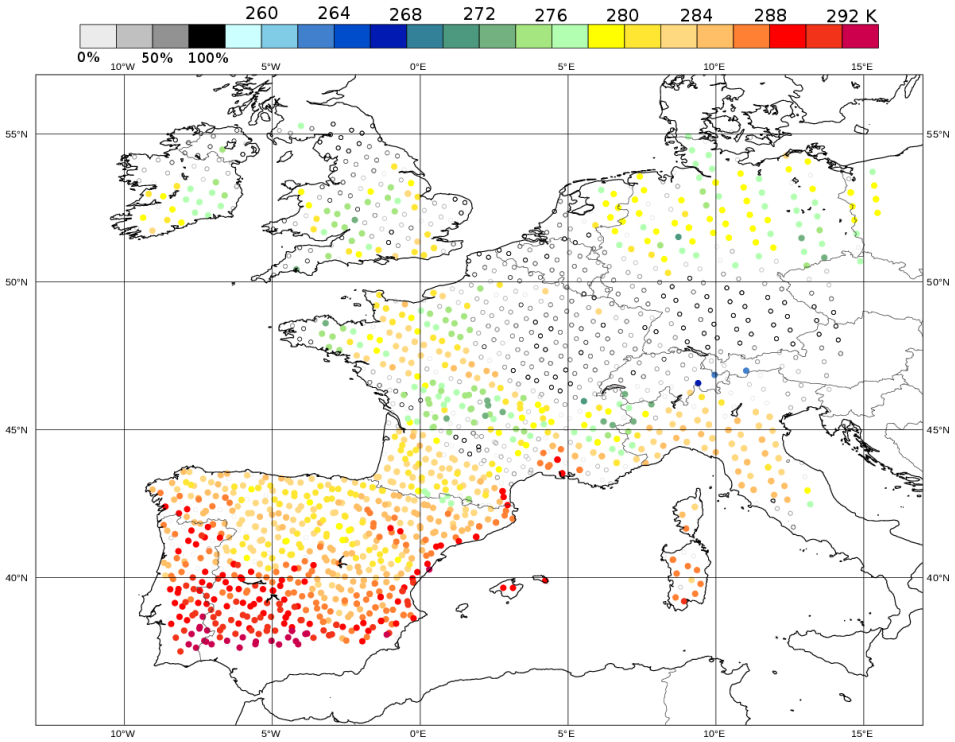
How to diagnose surface temperature over land in clear sky conditions ?

Land surface emissivity atlas (from U Wisconsin)

→ less channels assimilated over land than over sea

↓

Land surface temperature (LST) retrieved from IASI window channel 1194 (943.25 cm^{-1}) in clear sky



Example:
Land surface temperatures retrieved from IASI in clear sky pixels (colour scale, temperature is in Kelvin) and cloud cover within IASI pixel (grey scale, percentage) in AROME-F, 8 October 2017 at 21 UTC.

V. Guidard

Meteo-France LAM system : assimilation of IASI surface-sensitive channels over land

Number of IASI channels assimilated

	ARPEGE	AROME France
Current version	Over sea : 123 Over land : 77	Over sea : 44 Over land : 8
New version	Over sea : 123 Over land : 122	Over sea : 44 Over land : 43

Use retrieved LST to simulate all the other IASI channels

↓

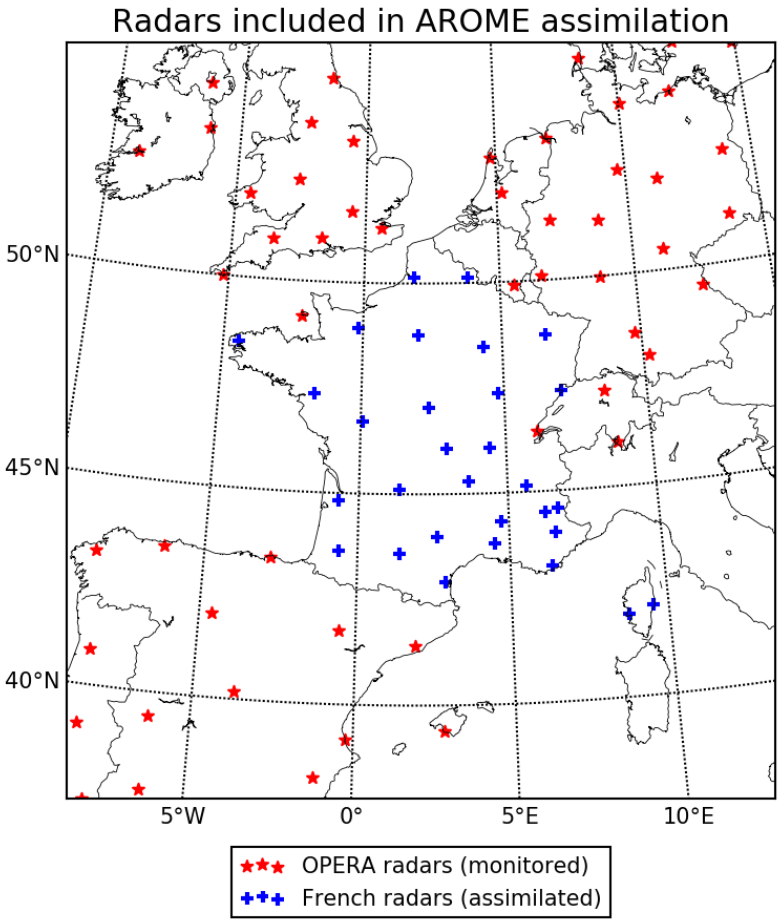
Assimilate same channel selection over land and over sea!

Meteo-France LAM system : assimilation of OPERA radars data in AROME

- 30 French radars (Meteo-France specific produc) are currently assimilated (in blue)

- The goal : monitoring and Operational assimilation of 62 European OPERA radars included in French AROME domain (in red)

- Definition of the OPTIMAL USE of OPERA radars data:
  - comparison between raw and filtered reflectivity for the “no rain” identification,
  - Doppler wind,
  - use of OPERA quality index.

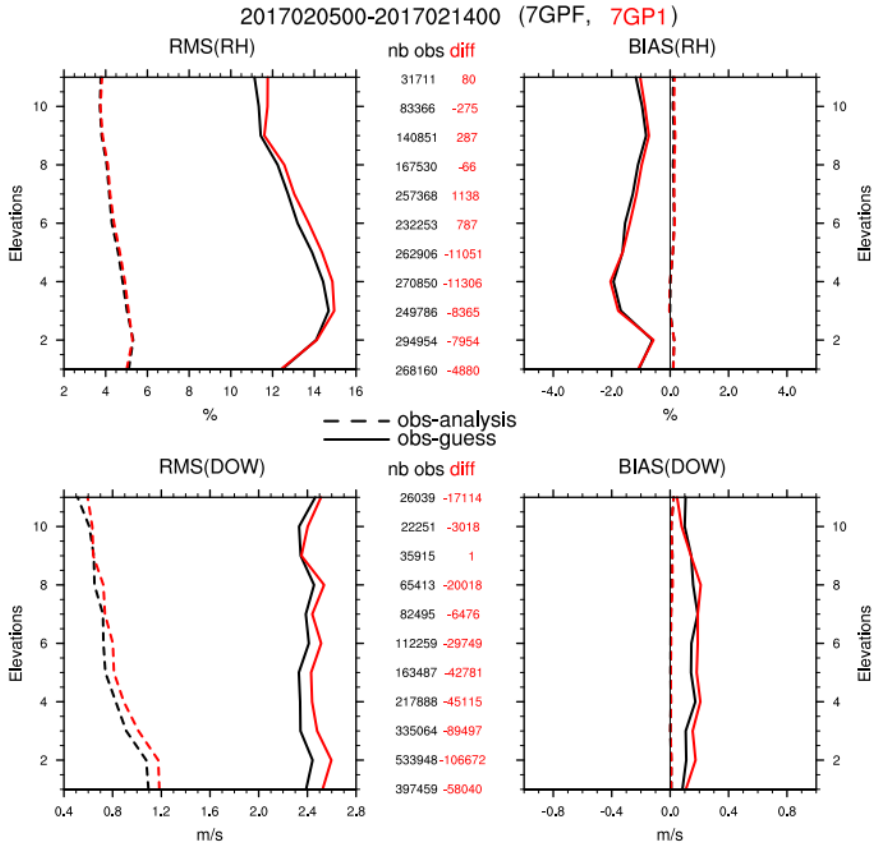


Maud Martet

Meteo-France LAM system : assimilation of opera radars data in AROME

- Validation towards operational configuration:
  - RED: without other OPERA radars
  - BLACK: OPTIMAL USE of other OPERA radars

- Statistics of departures (Obs. assimilated):
  - Better fit of guess of relative humidity retrievals against all radars (French and other OPERA radars)
  - Better fit of guess and analysis of radial wind against all radars (French and other OPERA radars)



Eric Wattrelot

Meteo-France LAM system : EDA at convective scale AEARO

- AROME uses isotropic, homogeneous and climatological **B** matrix estimated with an offline EDA (1,3 km) only with perturbed observations

- AEARO is an ensemble of cycled 3D-Var with perturbed observations and surface/lateral boundary conditions

- AEARO provides an ensemble of analyses and short-range forecasts that can be used to :
    - build flow-dependent background error statistics (**B** **m**atrix) for the deterministic AROME assimilation
    - initialize Ensemble Prediction System PEARO

Meteo-France LAM system : EDA at convective scale AEARO

	AROME-France	AEARO
Spatial resolution	1.3 km	3,25 km
timestep	50 s	100 s
Dynamical core	Non-hydrostatic	Hydrostatic
Domain size	1440 x 1536 L90	600 x 640 L90
Assimilation	Deterministic 3D_Var	Pertubed 3D_Var
frequency	1 h	3 h

Some tunings are still usefull to be used in deterministic AROME 3D-Var

AEARO is used in operations since this spring to initialize the ensemble forecast system PEARO

cnrs

METEO FRANCE

Conclusions

- **Significant update for the global system AEARP/ARPEGE**
  - 5 km resolution over France
  - improved resolution of analysis increments
  - 50 perturbed 4D-Var
  - More observations assimilated (IASI observations …)
  - interchannels correlations for IASI & CrIS...

  → Signifiant improvements → pre-operational this week

- **Evolutions for the LAM system AROME**
  - More observations assimilated (OPERA data, IASI over land…)

  → Good results
  - **EDA AEARO** → not already used in AROME 3D-Var

    → initialization of PEARO

- **Towards 4DEnVar**

Montmerle T, Michel Y,Arbogast E, Menetrier B and Brousseau P (2018) : A prototype 3D Ensemble-Variational Data Assimilation scale for the convective scale AROME model. QJRMS .

Thanks for your attention

Meteo-France Global system : new version
Scientific contributions

- Tuning in the dynamics (horizontal diffusion, SL iterations number)
- Tuning of convection scheme in ARPEGE
- Improved version of AROME microphysics scheme (to be confirmed)
- Tuning of sigma_b for humidity in ARPEGE-EDA
- Use of T2m and H2m over nature tail in surface analysis
- Variational bias correction for GNSS observations
- Assimilation of more IASI channels over land
- Assimilation of wind from ScatSat-1 (Ku band)
- Assimilation of AMVs from GOES-R (16)
- Monitoring of GNSS-RO on FY-3C
- Monitoring of AMSR-2 from GCOM-W1 (7 channels)
- Monitoring of ATOVS, ATMS, MWHS-2 DBNet data
- Monitoring of Doppler winds and radar reflectivities (European radars)
- Initialization of CMO-1D in AROME-Overseas with Mercator 4x per day
- News diagnostics: visibility, type of precipitations, ...

cnrs

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3DVar and EnVar for AROME in cy43

3DVar « OOVAR » validated against « MASTERODB » for all obs (incl. radar)
EnVars make use of perturbations from an AROME EDA at 3.25 km
Localization can be applied either in spectral or in grid-point space (rec. filters)
Interpolation operators can be applied to retrieve increments at the operational resolution (1.3 km)
Work on 4D-EnVar ongoing with advected localization
So far Hybrid w. 80 % ensemble gives the best forecast scores comp. to 3DVar

3DVar **0.5/0.5 3D Hybrid**