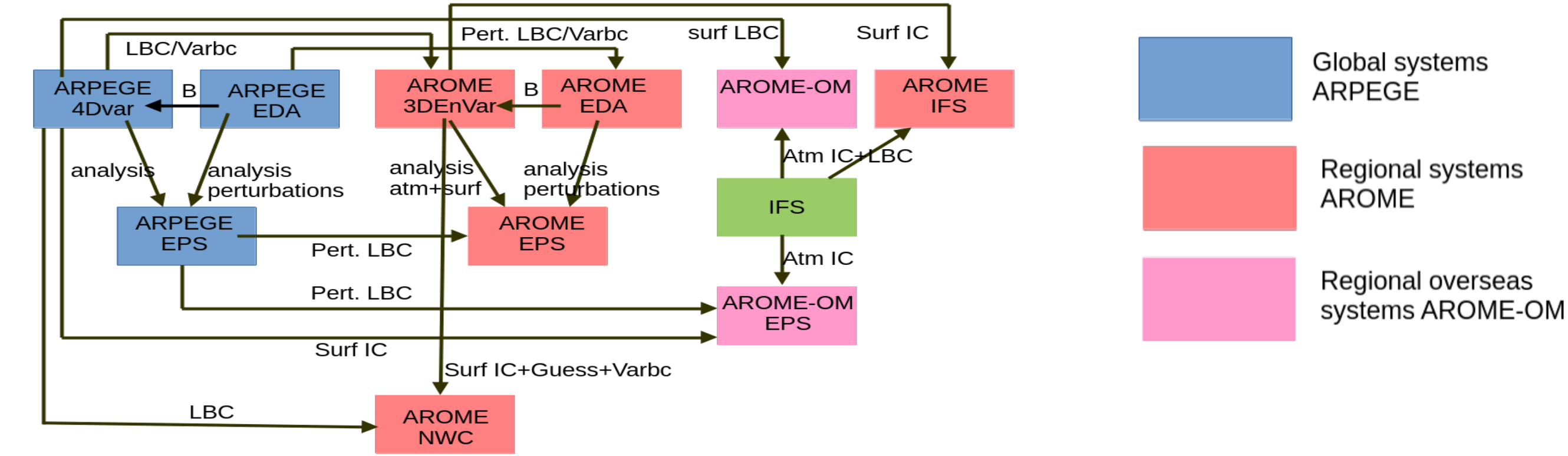


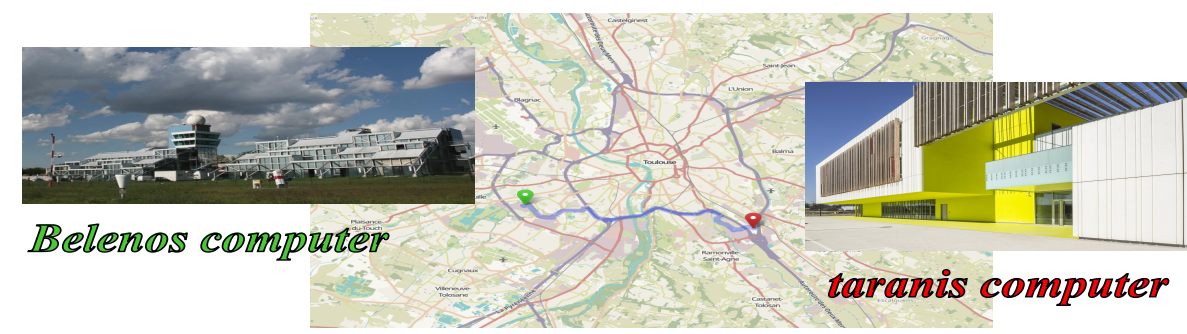
Overview of Météo-France NWP systems

Operational NWP systems



2 HPC, 2 implementations

In operations since February 2021



Migration to next HPC is planned in 2027

No upgrade during the 6 year contract

Each HPC: ATOS BULL Sequana XH2000

2292 computing nodes

2 AMD Epyc Rome processors
with 64 cores at 2.25 Ghz
10.39 PFlops
peak performance

Global operational NWP systems based on ARPEGE

operational suite: *cy48t1_op1* (since mid october 2024)

ARPEGE (determinist)

- Hybrid 4DVar (OOPS) with 6hr cycle : TI224 c1 & TI499 c1
- Anisotropic flow-dependent B matrix from ARPEGE-EDA (50% wavelet + 50% localised ensemble B
- Observations**: "all sky" assimilation of microwave obs (MHS, MWSH2, GMI, AMSR2), ATMS from NOAA-21, ABI from GOES-17, update of R matrix for IASI, GNSS-RO (GRACE-C, Sentinel-6, Spire), WIGOS adaptations
- Physics**: EcRad (McIca solver) radiation scheme, microphysics tunings, Surfex v8.1, use of SST from Mercator-Ocean GLO12, solar eclipse
- Dynamics**: use of WENO interpolations for T and Q in stratosphere

ARPEGE-EDA

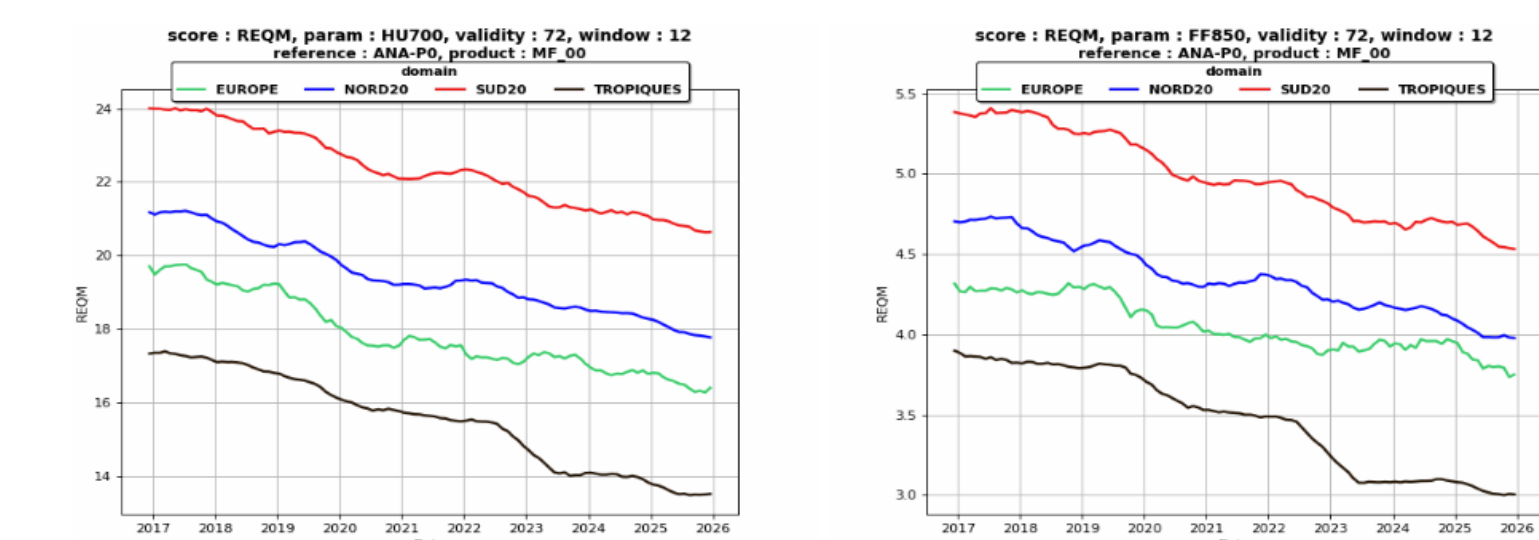
- TI499 c1 / 600 s timestep
- 4DVar (OOPS) with 6hr cycle (TI224 c1)
- 50 members
- observation perturbations and model error inflation

ARPEGE-EPS

- 34 perturbed members + control
- 4 forecasts per day
- Initial perturbations from ARPEGE-EDA+SV
- random perturbed parameters + TKE, GWD, 2 convection schemes (Tiedtke+PCMT), microphysics, oceanic fluxes, solar radiation

Common features (except otherwise noted)

- TI1798 c2.2 (5 to 24 km)
- 240s timestep
- 105 levels (10 m to 0.1 hPa)
- 102 hr forecast lead time



ARPEGE RMSE evolution for 72h vs own analysis (1 year rolling) : continuous improvement in all areas : Europe, North/South hemisphere and the tropics. Since 2017, equivalent average gain of about 12h predictability time

Next e-suite for Global NWP systems in cy49t1_op1

e-suite in may 2025, switch in operation in autumn 2026

- Physics**: Ocean Mixing Layer (1D model) to enable SST to evolve (ARPEGE/EPS/EDA)

Observations

- surface winds from Scatterometers on board HY-2D and Oceansat3
- review of AMV assimilation with new adjustments and new observations (winds from MetOp low-orbiting moving satellites)
- Mode-S data from EMADDC

wind data impacting surface to upper air

- CrIs FSR, GOES-18/ABI, FY-3E/MWTS-3 (monitoring) → new T and Hu profiles
- satellite snow cover IMS data → first satellite data for surface analyse

evaluation in progress

launch 2025-07 and 2025-08

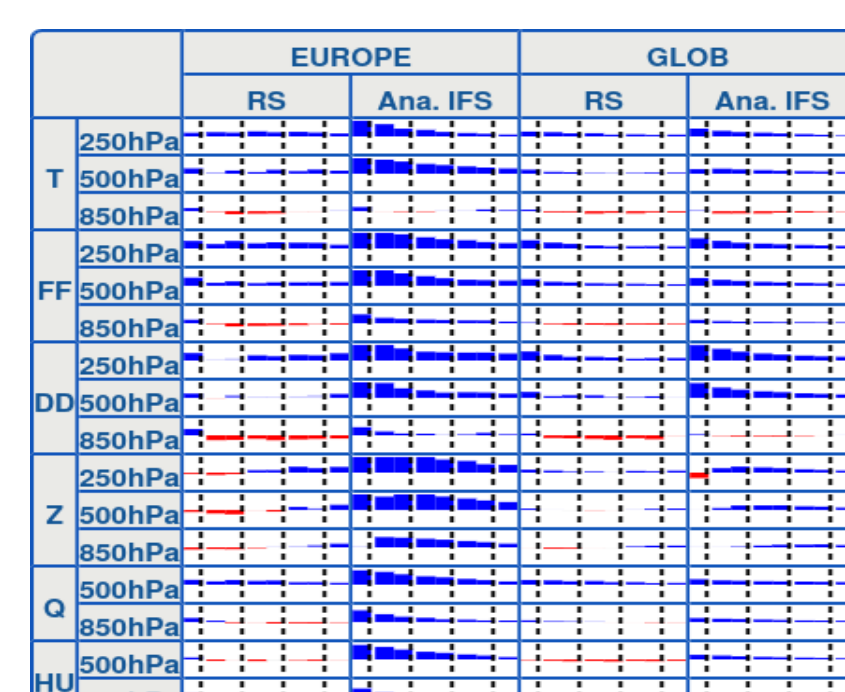
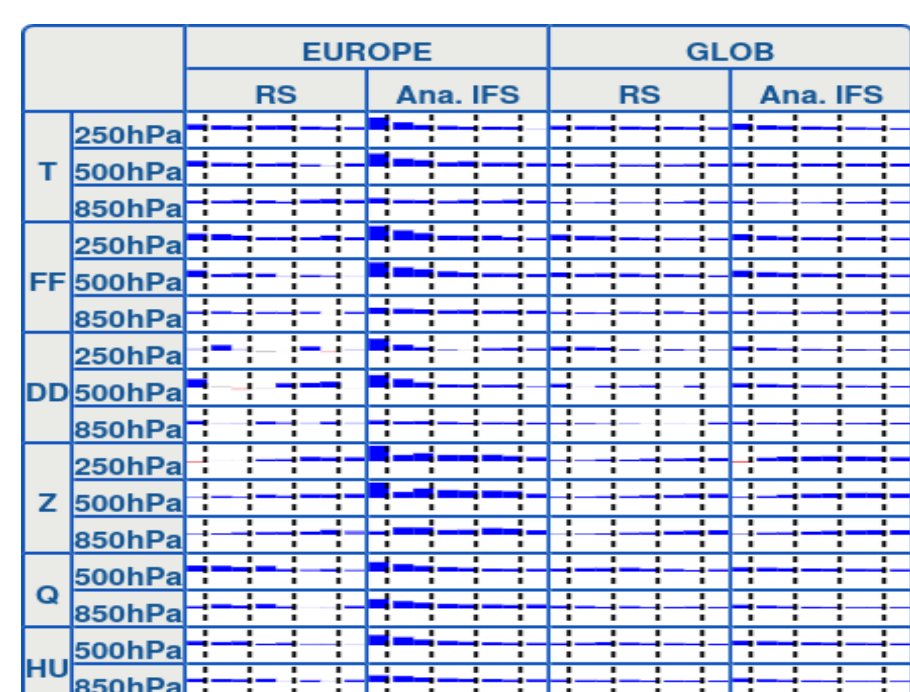
- ARPEGE-EDA**: RPP on 30 model parameters → Improved EDA perturbations & covariances

- ARPEGE-EPS**: singular vectors removed & perturbations of initial surface state via EDA (T2m, Hu2m & whole ocean water column)

ARPEGE Dbl versus Oper 20250316-20260324

max 10%

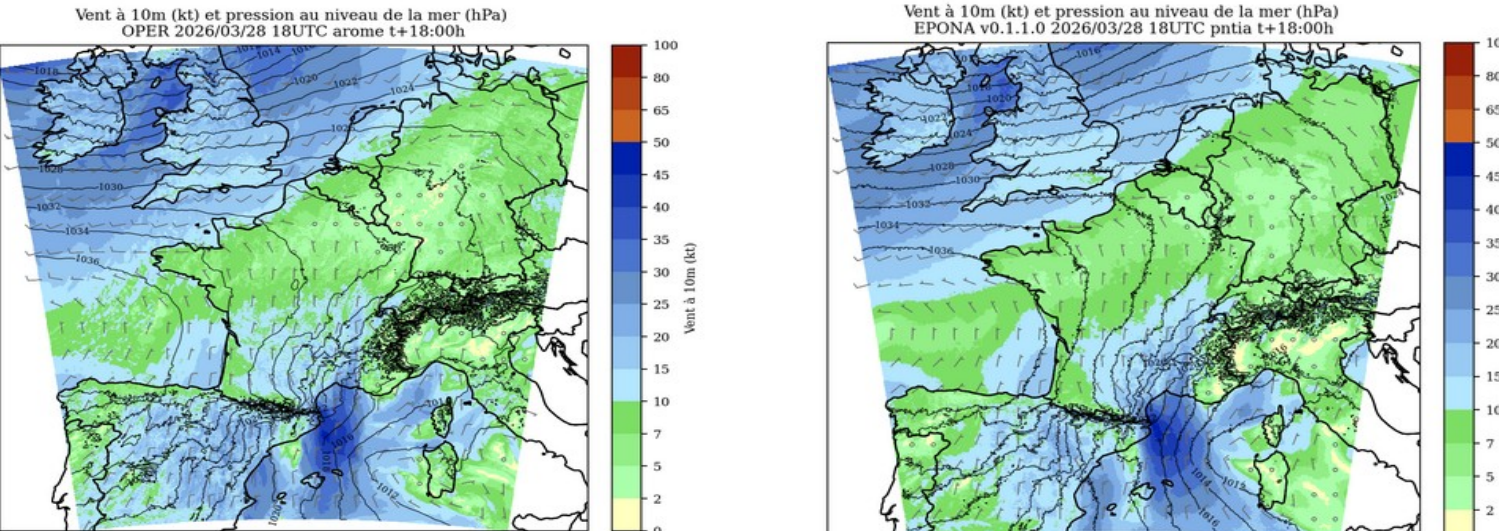
ARPEGE-EPS Dbl versus Oper 20250401-20260322



Towards an AI model for regional forecasting

- Météo-France is fully committed to the open-source Anemoi framework

- A stretched-grid model with refined resolution over the Arome domain has been developed in Anemoi (following the Bris strategy of Met Norway), using 4 years of operational AROME analyses (2020-2024)



Training process, including pre-training with ERA5 (stage A/B) and high-resolution fine-tuning with AROME (stages C/D)

Forecasts of surface pressure (isolines) and 10-m wind speed (color), launched on 20260328 18 utc and valid on 20260329 12 utc. AROME (left) and stretched-grid model (right)

Ongoing activities

- Further refine the stretched-grid model using ARRA, the AROME reanalysis (1962-2020)
- Develop a probabilistic stretched-grid model (CRPS training)
- Stochastic downscaling from ARPEGE to AROME using a diffusion approach

courtesy Laure Raynaud

Regional operational NWP systems based on AROME

operational suite: *cy48t1_op1* (since mid october 2024)

AROME-France (determinist)

- 3DVar (OOPS) with 1h cycle +IAU
- EcRad+aerosol/ozone climatologies (CAMS), Surfex v8.1, SST Mercator-Ocean Glo12
- scatterometers HY-2B & HY-2C, Mode-S from EMADDC, GNSS-RO (GRACE-C, Sentinel-6, Spire), ATMS from NOAA-21, MWSH2 from FY-3E, WIGOS adaptations
- 8 forecasts per day

AROME-EPS

- 25 perturbed members + control
- 4 forecasts per day (+ 51hr)
- Initial perturbations from AROME-EDA
- SPPT
- LBCs from ARPEGE-EPS
- random surface perturbations

Common features (except otherwise noted)

- 1.3 km, 50s timestep
- 90 levels (5m to 10 hPa)
- 51 forecast lead time
- uncycled forecasts in single precision

AROME-EDA

- 3.25 km, 100s timestep
- 3DVar (OOPS) with 3h cycle
- 50 members

AROME-IFS

- downscaling of IFS
- Arome surface
- 4 forecasts per day

AROME-NWC (Nowcasting)

- 3DVar, guess from 3dvarfr, 10' cut-off
- 24 forecasts per day (+6hr)

AROME-Overseas (AROME-OM)

- 5 domains, use of mixed precision
- 4 forecasts per day (+78hr on demand)
- Downscaling of IFS with prior "warmup"
- Use of Arpege surface (continent)
- 1D ocean model

EPS AROME-Overseas (AROME-OM-EPS)

- 5 domains, 2 runs per day (+78hr on demand)
- 15 members (LBC=ARPEGE-EPS) + 1 control (LBC=ARPEGE) at 2.5 km, hydrostatic
- Use of IFS as unperturbed initial conditions
- Boundary conditions + initial perturbations : ARPEGE-EPS
- Model errors via SPPT + Perturbation of surface + ocean layers

Next e-suite for Regional NWP systems in cy49t1_op1

e-suite in autumn 2025, switch in operation in autums 2026

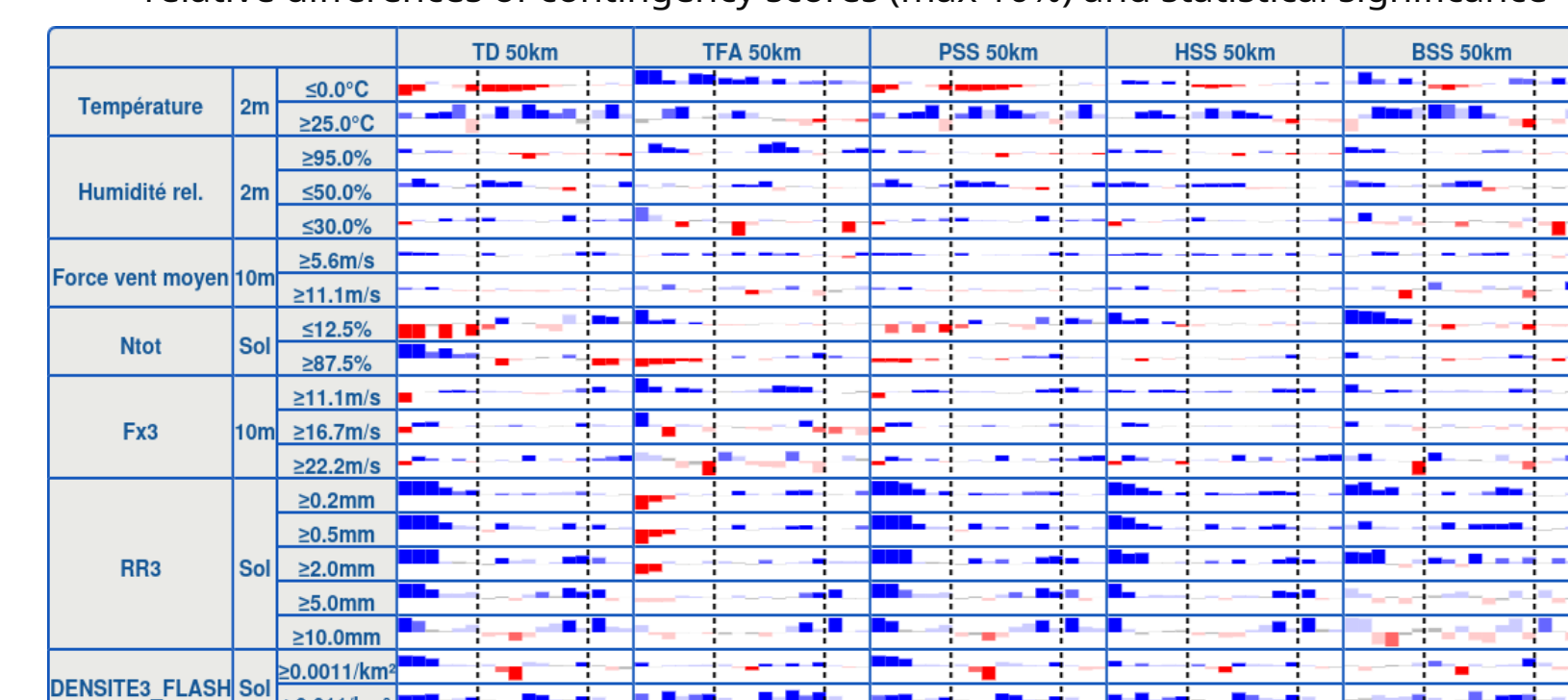
- Assimilation**: 4DVar+SDL (AROME) and 3DVar+SDL (AROME-EDA)

- Physics**: account taken of the deposit to reduce overestimation of cloud water content in fog

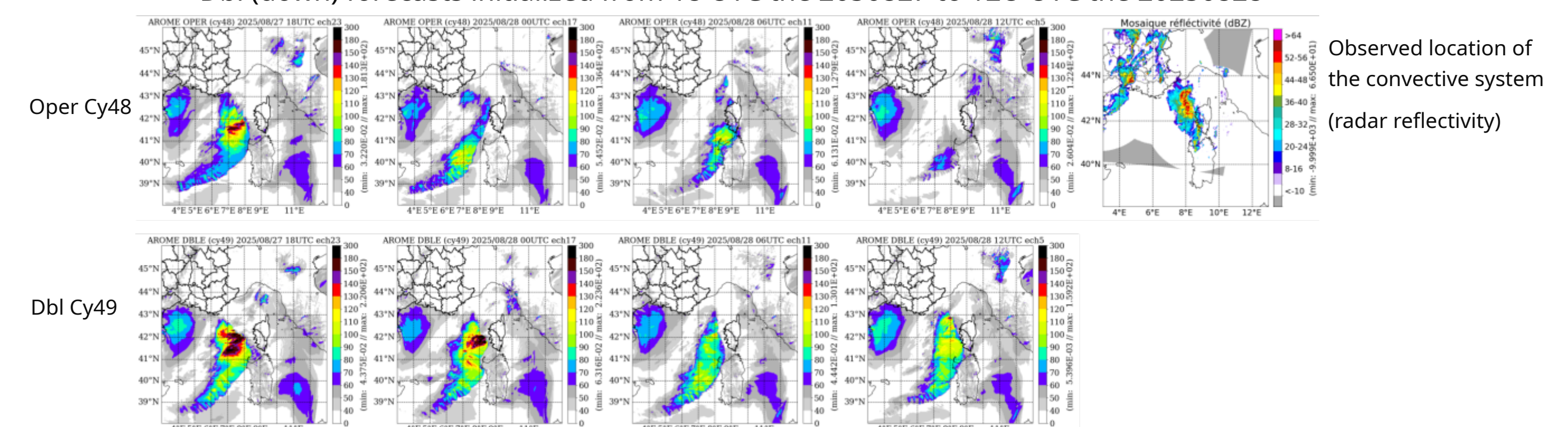
Observations

- Mode-S from EMADDC with new white list and adapting weighting
- direct assimilation of ground-based radar reflectivities
- surface winds from Scatterometers on board HY-2D
- review of AMV assimilation with new adjustments and new observations (winds from MetOp low-orbiting moving satellites)

AROME France Dbl versus Oper 20250725-20260324
relative differences of contingency scores (max 10%) and statistical significance

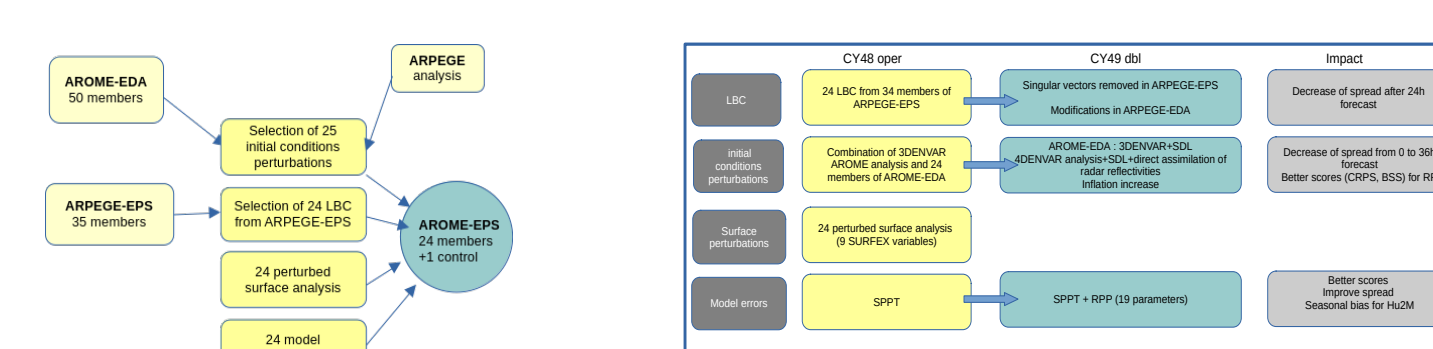


Wind gusts valid 17UTC the 20250828 simulated by AROME France Oper (up) versus Dbl (down) forecasts initialized from 18 UTC the 20250827 to 12U UTC the 20250828



AROME-EPS

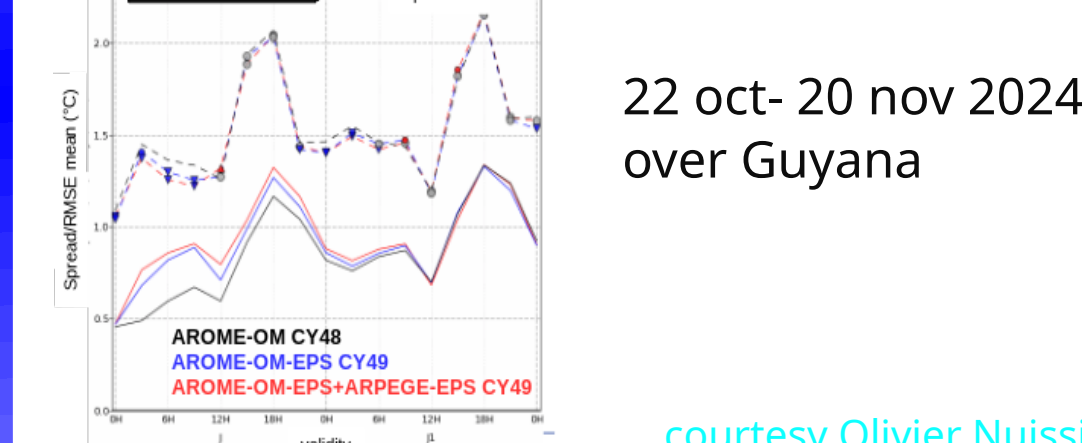
AROME-EPS Dbl versus Oper 10 apr-16 jun 2025 (max 10%)



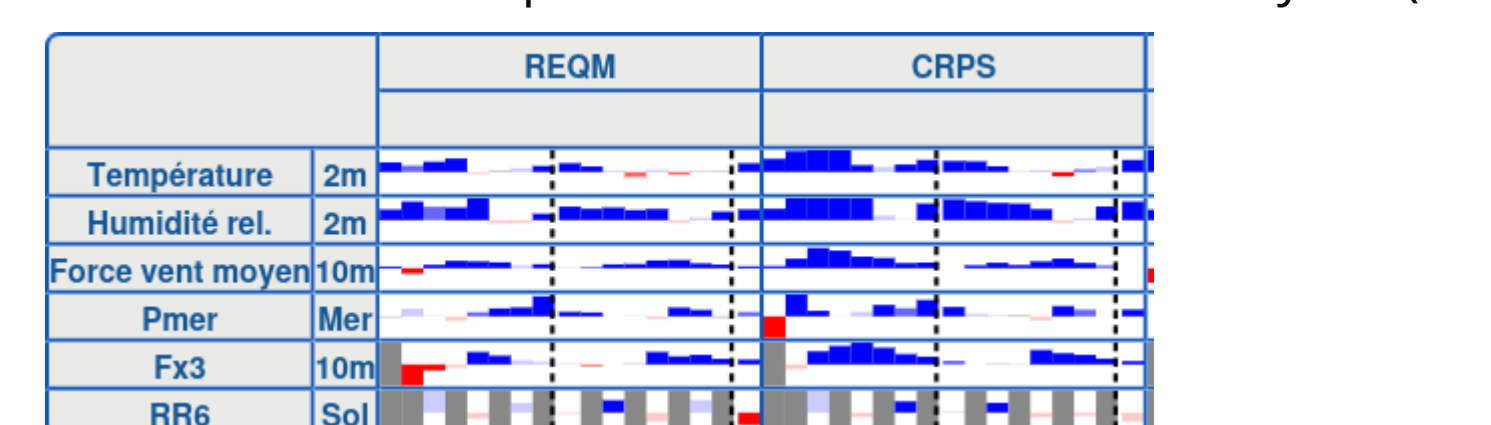
courtesy Grégory Roux

- AROME-OM-EPS**: use IAU to improve initial perturbations from ARPEGE-EPS

AROME-OM-EPS Dbl versus Oper 22 oct- 20 nov 2024 over Guyana (max 10%)



courtesy Olivier Nuissier



Collaborative work of DESR/CNRM/GMAP

contact cecile.loo@meteo.fr

6th ALL STAFF WORKSHOP ACCORD
13-17 April 2026 MARRAKECH

