Status of Météo-France convection-permitting EPS

Laure RAYNAUD

Météo-France - CNRM/GMAP/RECYF

ALADIN-HIRLAM Strategy Workshop
27 April 2016 - Toulouse

1 - Why convection-permitting EPSs ?

- Predictability of the atmospheric flow at convection-permitting scales is intrinsically low
  $\Rightarrow$ there is a need for probabilistic prediction at an early range
- Convective-scale EPSs are under development in a number of NWP centers, based on high-resolution limited-area models (e.g., COSMO-E EPS, COSMO-IT EPS, Harmon-EPS, AEMET-γ-SREPS)
- Examples of operational convective-scale EPSs : COSMO-DE EPS (2.8km), MOGREPS-UK (2.2km), WRF-based ensembles
- In this context, Météo-France is currently developing a convective-scale EPS, based on the AROME-France model.

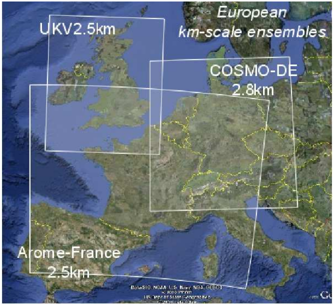
1 - The AROME-France model

- AROME-France is the **non-hydrostatic limited-area convection-permitting model** operational at Météo-France since December 2008
- The current configuration uses a **1.3km horizontal resolution** and **90 vertical levels**
- The analysis is provided by a **hourly 3D-Var scheme**
- In the near future an **AROME ensemble prediction system** will complement this deterministic version of AROME.

1 - Objectives of AROME-EPS

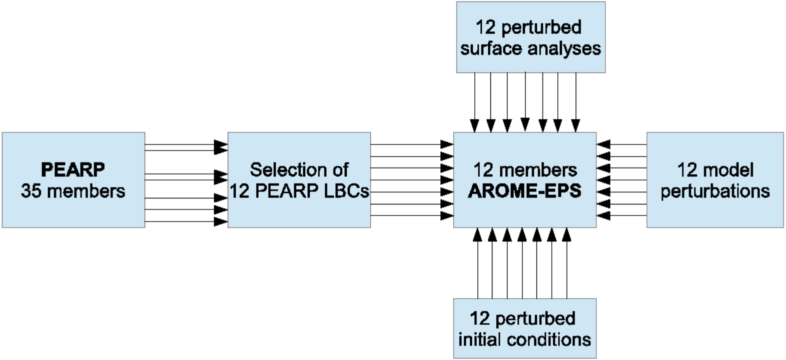
- Provide **high-resolution probabilistic forecasts** for the prediction of small-scale **high-impact phenomena**, e.g. heavy precipitating events, fog, strong winds etc.
- In addition to existing lower-resolution EPSs (e.g. Météo-France PEARP system, ECMWF EPS)
- Provide probabilistic atmospheric forcings to downstream systems (e.g. hydrology, flood, air traffic control)
- In operational use **by the end of 2016**
(1 production/day in research mode since August 2015).

- Same configuration as the AROME-France model except the horizontal resolution : **2.5km** (instead of 1.3km)
- **12 perturbed members**
- **2 productions/day** (at 9h and 21h UTC), up to a **45h lead time**
- Lateral boundary conditions provided by PEARP (35 members - 10km resolution over France)



Each member of the AROME-EPS is built by perturbing a standard AROME forecast in order to represent the main sources of uncertainty regarding :

- initial conditions
- lateral boundary conditions
- surface conditions
- the model.



1 - Perturbation strategies

▷ Initial conditions : downscaled PEARP perturbations are added to the AROME-France analysis following

$$x_i = x_a + \alpha(z_i - \overline{z_i}),$$

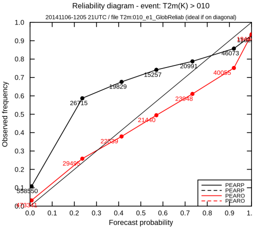
x_i initial condition of member i
x_a AROME-France deterministic analysis
z_i initial PEARP perturbation of member i
α vertical amplitude modulation.

▷ Lateral boundary conditions : "clever" selection of PEARP members based on a **clustering algorithm** (Nuissier *et al.*, 2012).

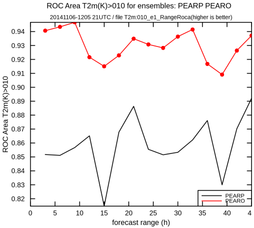
▷ Surface conditions : **auto-correlated random perturbations** are applied to various aspects of the SURFEX surface model (Bouttier *et al.*, 2015) for some *physiographic* - vegetation index, vegetation heat coefficient, leaf area index, land albedo, land roughness length - and *prognostic variables* - **SST, soil temperature and humidity**, snow depth.

▷ Model errors are represented with the **SPPT scheme** (Stochastic Perturbation of Physics Tendencies, Bouttier *et al.* (2012)).

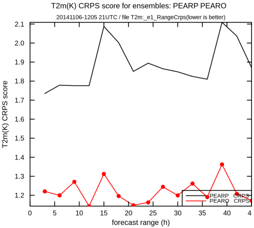
2 - Objective evaluation : AROME-EPS vs PEARP



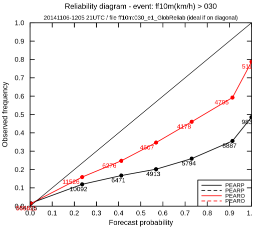
(a) T2m - Reliability



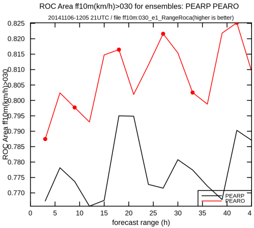
(b) T2m - Resolution



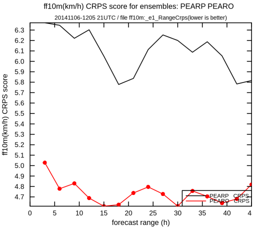
(c) T2m - CRPS



(d) ff10m

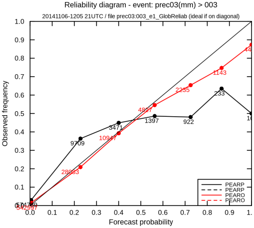


(e) ff10m

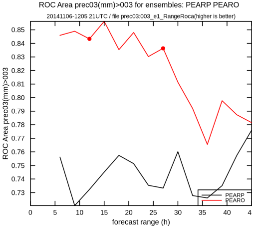


(f) ff10m

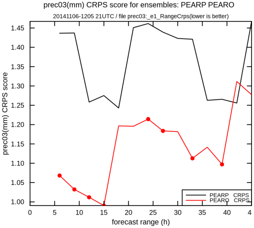
2 - Objective evaluation : AROME-EPS vs PEARP



(a) rain 3h - Reliability



(b) rain 3h - Resolution



(c) rain 3h - CRPS

⇒ **AROME-EPS outperforms PEARP for surface variables.**

3 - Subjective evaluation : feedbacks from forecasters

Following several training sessions and forecasting exercises :

- Dispersion of AROME-EPS sometimes too large $\Rightarrow$ linked to overdispersion of LBCs ?
- Ensemble probabilities (raw and neighborhood) useful to target the area of high-impact weather
- Quantiles useful to estimate intensities
- Some regular problems of under-estimation of regional winds (same in Arome deterministic model)
- Under-estimation of heavy rainfall compared to Arome deterministic run $\Rightarrow$ because of the coarser resolution and small ensemble size ?
- On average, AROME-EPS useful in $\sim$ **30**% of the examined cases.

4 - What's next ?

▷ **Next objectives at Météo-France :**

- Introduce initial perturbed states from an Arome EDA (∼ 2018, Raynaud and Bouttier, 2015 ; Bouttier *et al.*, 2015).
- Increase ensemble size by time-lagging of 2 or 3 successive ensemble runs out of 4/days (Raynaud *et al.*, 2014)

▷ **Currently being discussed :**

- Reduce the resolution gap with the deterministic AROME model ⇒ increase the horizontal resolution up to 1.3km, depending on computing power evaluation ?

▷ **Longer time topics, open to discussion :**

- Development of appropriate tools to enable actual useful product generation, e.g., optimal quantiles/decision thresholds, improved neighborhood methods, object processing of precipitation, user-oriented tailored output
- Ensemble calibration ⇒ need for large data sets
- Improve representation of model error, e.g., revised SPPT, stochastic parametrizations.