The NWP systems at Météo-France

27th ALADIN Wk & HIRLAM ASM 2017, Helsinki, 3-6 April 2017

ARPEGE-ALADIN-AROME suites

CY41t1-op1, operational since December 8, 2015 :

ARPEGE-oper: T1198 with a stretching factor of 2.2 and 105 levels. First level at 10m. This gives a resolution of 7.5km over France. The time step is 360s. The 4DVAR operational suite uses 2 outer loops. The first one is 40 iterations at T149 C=1 with a time step of 1350s, the second one 40 iterations at T399 C=1 with a time step of 900s.

AROME-oper : 1.3km L90 (1440x1536x90 grid), with dt=50s :

- Include ORORAD (slopes, shadows) effects on SW radiation adapted from Senkova et al. (2007)
- Reduce radar data thinning from 15km to 8km (both reflectivities and Doppler winds)

CY42-op1\op2, e-suite since autumn 2016, to be operational in May 2017 :

ARPEGE E-suite, main changes :

- Use of the externalized surface scheme SURFEX in ARPEGE
- New convection scheme PCMT (Prognostic Convection Microphysics and Transport) : Piriou et al. (JAS 2007), Guérémy (Tellus 2011), Lopez (QJRMS 2002), Fig. 1&2
- Assimilation of new microwave sensors : MWHS2 on FY3-C (chinese satellite), GMI on GPM-Core (US satellite)

AROME E-suite, main changes (same modifications as in ARPEGE for observations) :

- New cloud optical properties
- Code and system optimizations, new diagnostics
- Re tuning of wind gusts (Fig.3)

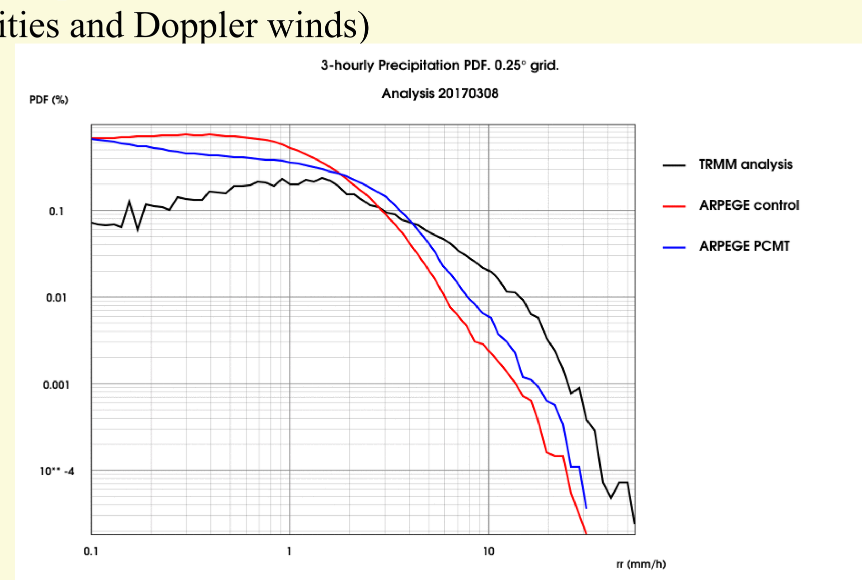


Figure 1 : The frequency of precipitation and their intensity is improved with PCMT, with less events of light precipitation and more events of heavy precipitation. The figure shows the frequency curves for 3h cumulated rain, derived resp. from TRMM data, operational Arpège and experimental Arpège with PCMT, for the forecast of 8 March 2017. The frequency plot is for all forecast ranges and for the whole global domain

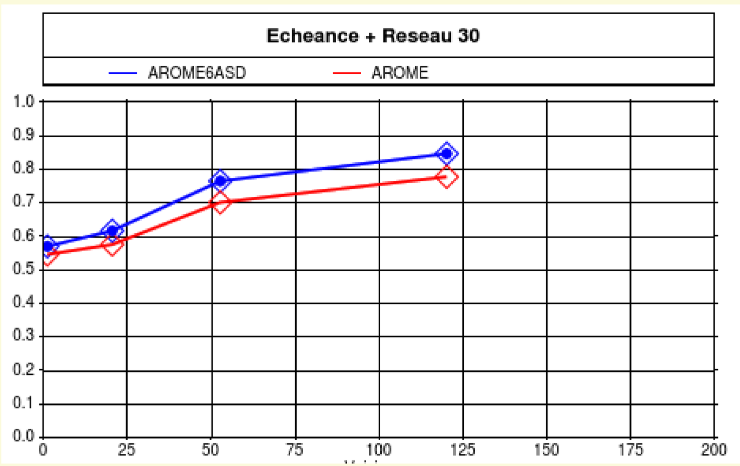
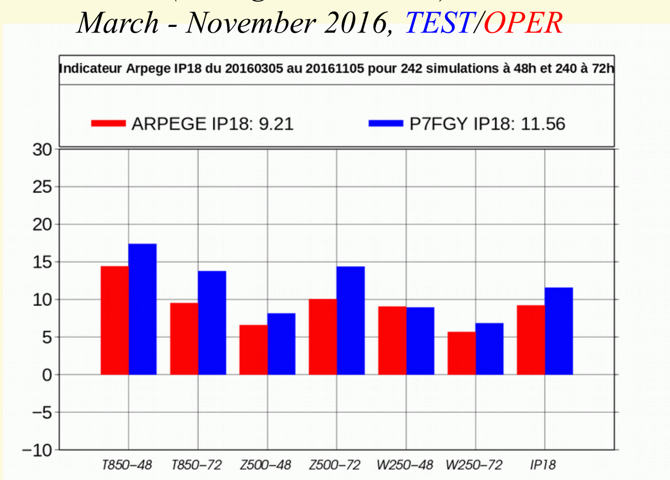


Figure 3 :BSS of 6h > 80 km/h wind gusts at FC0+30 (July 2016-January 2017) as a fonction of neighbouring in km (TEST/OPER)

Figure 2 :Synthetic quality index (IP18) based on T850, Z500, 250 hPa wind RMSE : IP18 = 1. - RMSE / RMSE_ref (the higher, the better). March - November 2016, TEST/OPER



AROME Overseas

Characteristics :

- Domains spread all along the Tropical belt (Fig.7)
  => more focused, than the Current ALADIN domains, on the point of interests : 2.5 millions inhabitants, 115 000 km2
- 2.5km resolution
  => all the more important for small and rugged islands (Fig. 8)
- total number of grid-points multiplied by 3 for a cost 30 times higher (with 60s time step).
- Explicit deep-convection, ICE3 micro-physics
- **In operation since February 11, 2016**

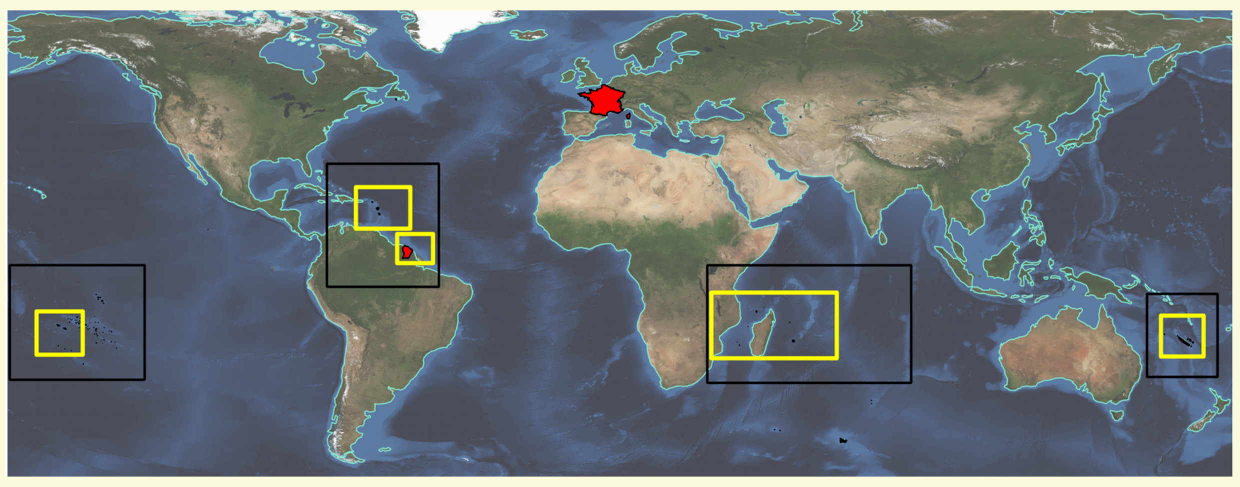
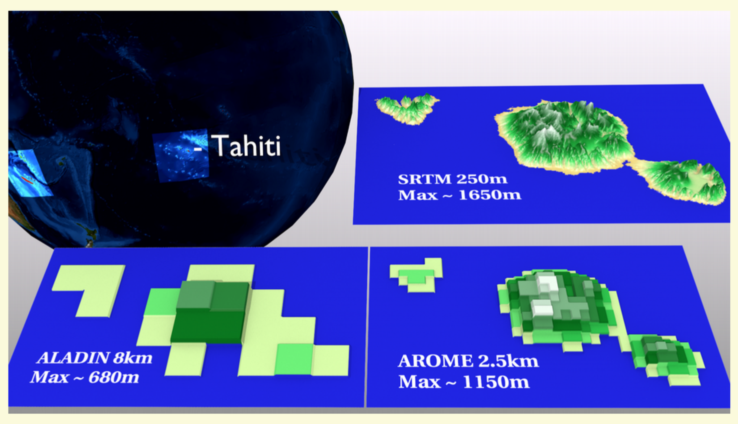


Figure 7: AROME overseas domains (in yellow) and operational ALADIN domains (in black)

Figure 8 : Tahiti orography (in ALADIN and in AROME)



Added value of AROME for heavy rain events

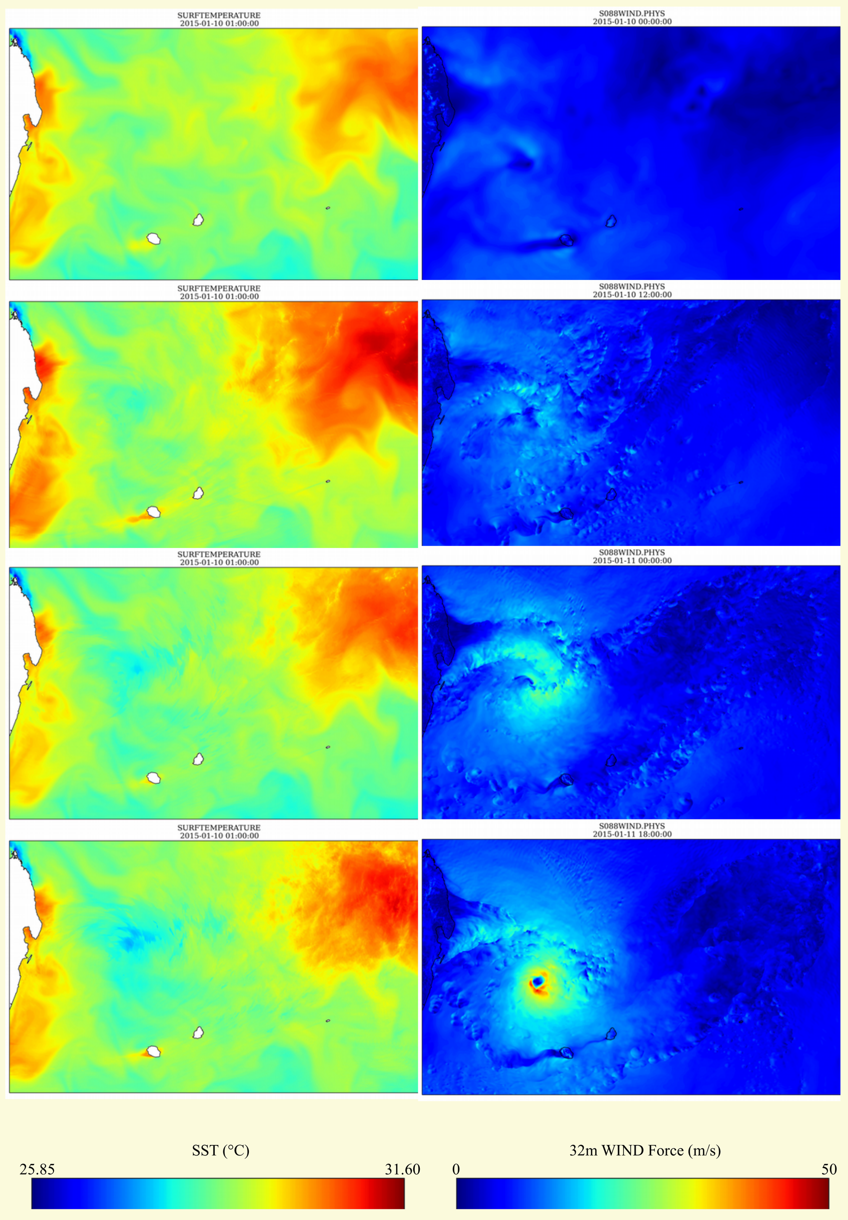
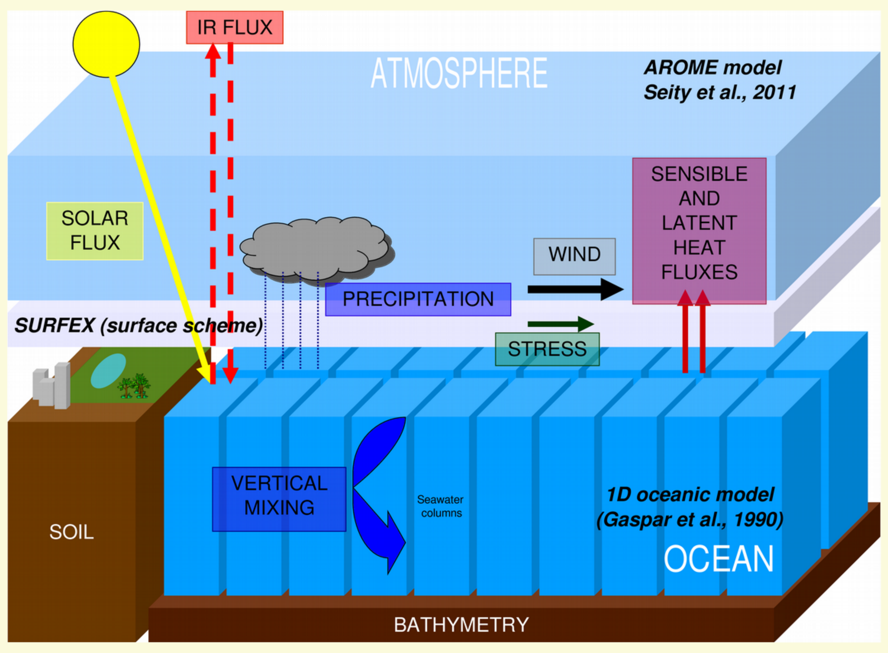


Figure 10 : AROME over Indian Ocean, Tropical Cyclone Bejisa, AROME +42h forecast based on 2013/12/31 0h run Initial ocean fields : Mercator-Ocean PSY4 model, 1/12°

Current e-suite CY42-op1:

- Interactive coupling with a 1D ocean model (Fig. 9)
  => promising results on Bejisa case (Fig. 10)
- Evaluate a method in order to reduce the « spin-up » time of AROME in the first forecast hours
- Increase of Arome Antilles domain
  => will encompass Haiti

Figure 9 : Coupling between AROME and 1D oceanic model



PEARP : MF short-range Ensemble Prediction System

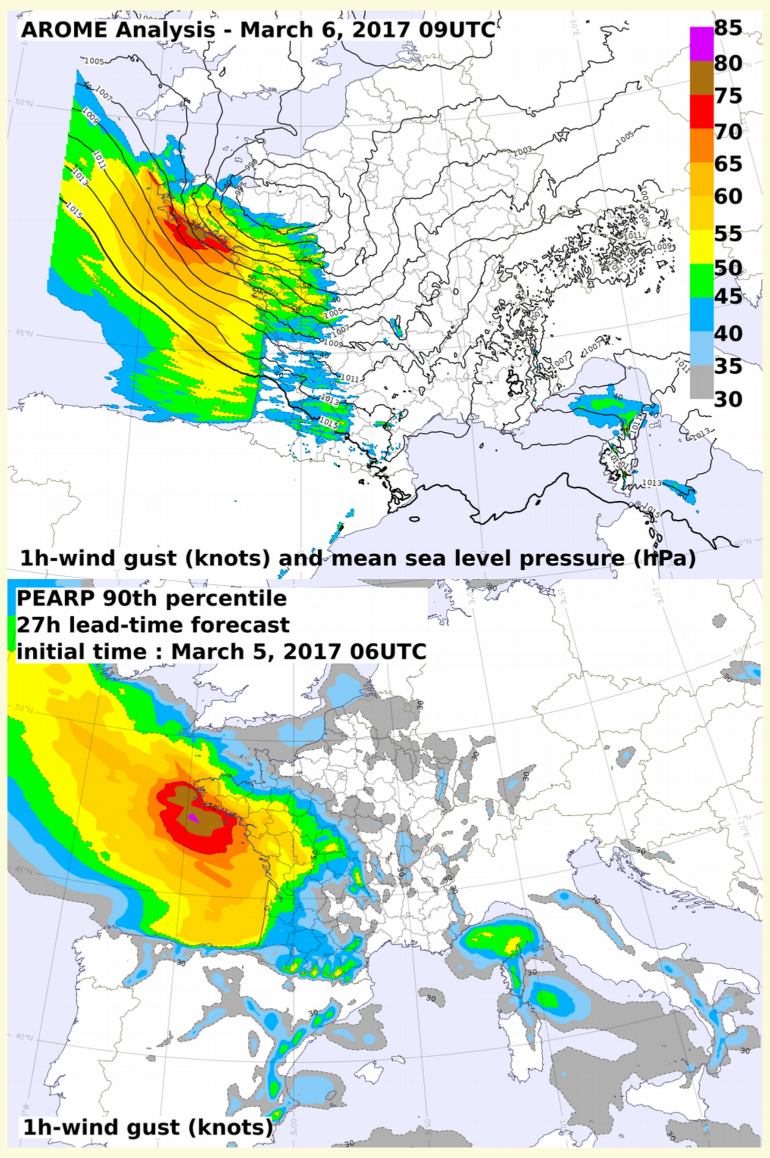


Figure 4 : An example of the ability of the global mesoscale hydrostatic ensemble system PEARP to capture an extreme storm event (March 6, 2017) over France.

Ref: Descamps L., Labadie C., Bazile E., Joly A., Arbogast P., Cébron P., 2014. PEARP, the Météo-France short-range ensemble prediction system, QJRMS

PEARP general characteristics (operational suite)

- Implemented in MF since 2004
- **Global ensemble** performing forecasts up to 4.5 days
  * Running at 06UTC and 18UTC
- Uses the operational global NWP model ARPEGE and benefits from its **variable horizontal resolution** (~10km over France, 60km on the opposite side of the globe)
  * comparable to **LAM-EPS over France**
- **35 members** (including the control member)
  * Perturbations to the initial conditions are computed by combining 25 background states and the mean from **MF Ensemble Data Assimilation (AEARP, Berre et al. 2007)** with **singular vectors**
  * Model error is represented by a set of 10 different physical packages including that of operational ARPEGE model

AROME-NWC: a high resolution model for nowcasting

AROME-NWC general characteristics (operational since December 8, 2015)

- implemented in December 2015 and available to forecasters since March 2016
- 1 run every hour, up to 6 hour range, with outputs every 15 minutes
- 1,3 km resolution, 50 s time step, 90 levels
- 3D-VAR assimilation, with 10 minute cut-off time (window [-10 min, +10 min])
- guess from AROME-France, similar model with 30 minute cut-off time
- boundary conditions from the ARPEGE global model
- delivery 20 minutes after cut-off time
- designed mainly for surface condition forecasting (rainfall, snow, fog, gusts, humidity and cloudiness)

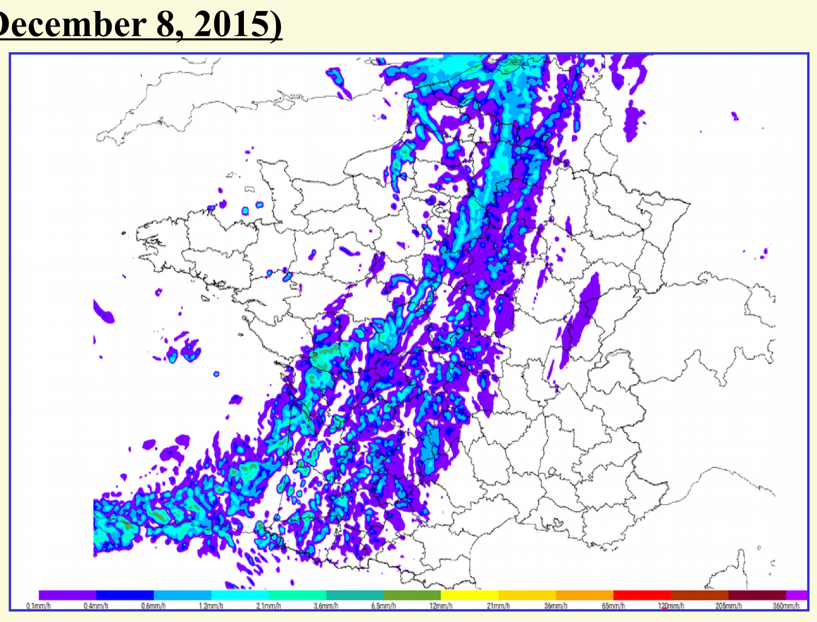
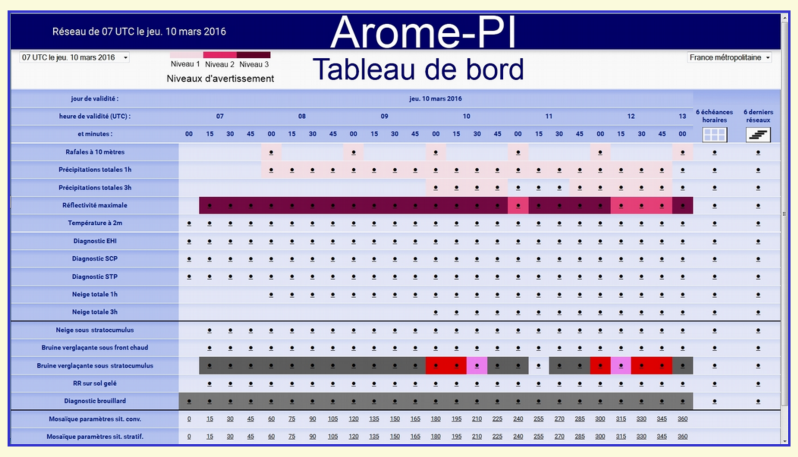


Figure 5: 5 hour forecast of the maximum reflectivity with AROME-PI for the 28th November 2015 at 00.15 UTC

This very high rate of production makes a systematic use of the outputs difficult. Therefore a scoreboard helps the forecasters: for a given selection of parameters, it shows different colours corresponding to different levels of warning and helps to look at the forecasts only when useful. For a given date, several forecasts started from different initial dates are available. Then the forecaster is able to look at different solutions given by the model for this given date, which can be seen as a "poor man ensemble forecast".

Figure 6: The scoreboard proposed to the forecasters for a quick look at the most critical parameters of the current forecast



AROME-FRANCE Ensemble Prediction System

See ALADIN-HIRLAM Newsletter n°8, Jan.2017, AROME-France convection-permitting EPS, F. Bouttier at al

The configuration (operational production since October 2016):

Same model as the deterministic L90 AROME-France suite, except for the horizontal resolution (2.5km in the ensemble, 1.3km in AROME-France). Runs twice a day, at 09 and 21 UTC, to provide forecasts up to a 45h range. 12 members.

Ensemble perturbations : clustered boundary conditions from the PEARP global ensemble, centered PEARP initial perturbations, SPPT stochastic model perturbations, comprehensive surface perturbations.

Applications : choice of best model by human forecasters, decision aid for severe weather events (e.g. heavy precipitation, convection, gusts, winter conditions), probabilistic weather forecasts, forcing of flood models, air traffic management.

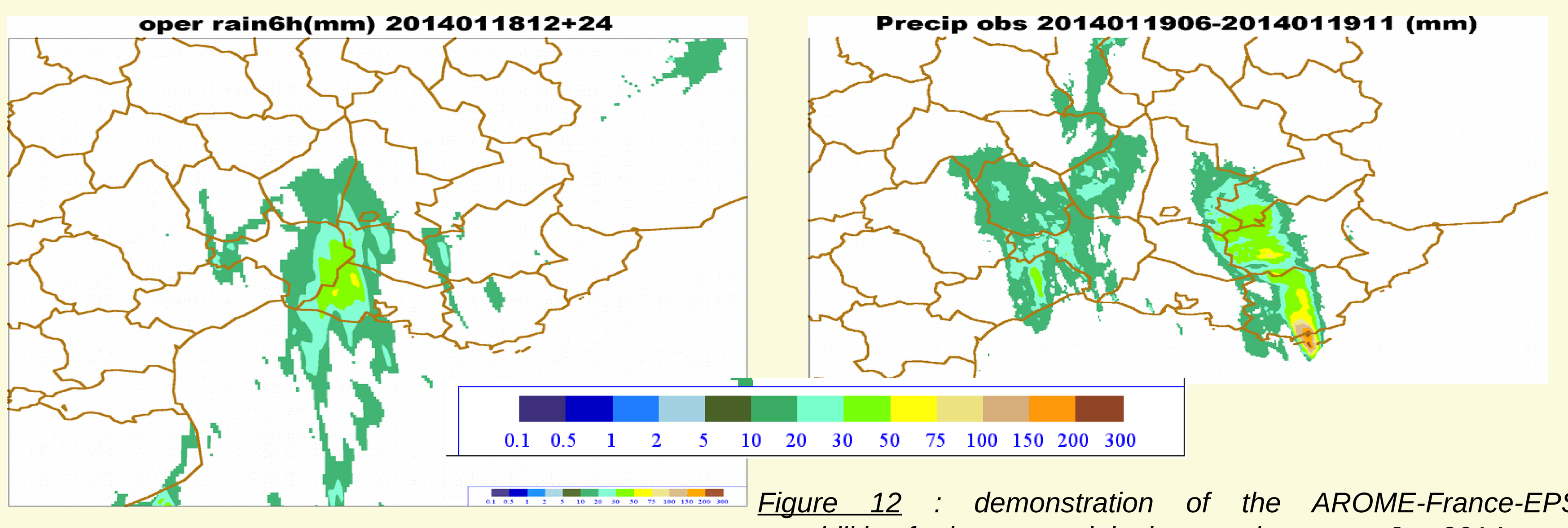
Recent research results:

Extensive validation using HyMeX SOP1 data shows that it not important to have consistent initial and lateral boundary perturbations => use of ensemble data assimilation (EDA) for initial perturbations or cheaper alternative (to add small-scale random noise to the initial conditions) with improvment over the simple downscaling from a larger-scale ensemble.

Surface perturbations improve the ensemble performance; explicit surface perturbations are necessary.

Spatial correlations of ensemble forecasts are highly sensitive to the correlations of surface perturbations, at low levels. The correlation sensitivity to SPPT correlation structures, or to correlations in the initial perturbations, seems to be negligible after a few hours.

The introduction of a **tolerance in space and time** when computing the precipitation probabilities, can be proven to improve the forecast scores, by filtering small-scale noise and increasing the apparent ensemble size.



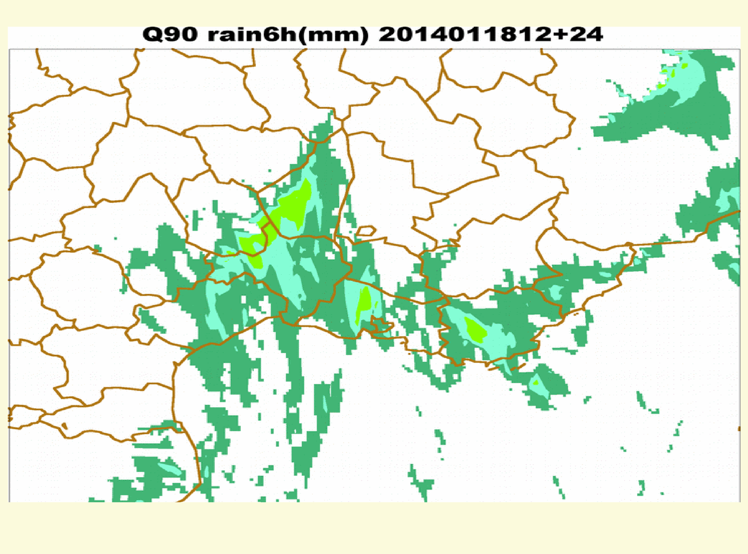


Figure 12 : demonstration of the AROME-France-EPS capabilities for heavy precipitation warnings, on a Jan 2014 case.
Top right: observations of 6-h rain accumulation (orange area; max actual raingauge obs is 140mm/6h).
Top left:24-h prediction of the same event by the operational AROME-France deterministic system. The heavy precipitation zone is misplaced.
Bottom left: 24-h AROME-France-EPS prediction of the 90% quantile of the rain PDF: underestimated intensity but risk of severe precipitation over Var much better indicated than in AROME-France and more consistent AROME-France-EPS forecasts in time.