24th ALADIN Wk & 2014 HIRLAM ASM
Bucharest, 7-10 April, 2014

THE NWP SYSTEMS AT METEO-FRANCE

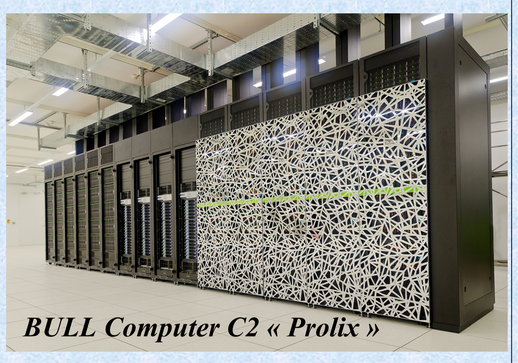
with contributions from the CNRM/GMAP staff
Météo-France

METEO FRANCE

cnrs

New HPC at MF

From NEC to BULL Computer C1 « Beaufix »



BULL Computer C2 « Prolix »

Centre National de Calcul Météopole, Toulouse

522 TFlops peak performance
56 racks **bullx DLC**
1008 nodes
Fat Tree InfiniBand FDR
Lustre **2 Po, 69 GB/s**
Disks storage 209 TB

Computer C1 (09/2013)

Operational & research platform since January 14, 2014

2,85 PFlops peak performance
56+45 racks **bullx DLC**
1800 nodes
Fat Tree InfiniBand FDR
Lustre **3,57 Po, 138 GB/s**
Disks storage 400 TB

Computer C3 (05/2016)

Research

2014 2015 2016

Operational

Espace Clément Ader Montaudran

513 TFlops peak performance
55 racks **bullx DLC**
990 nodes
Fat Tree InfiniBand FDR
Lustre **1,53 Po, 46 GB/s**
Disks storage 135 TB

Computer C2 (03/2014)

Open to researcher users since February 27, 2014

2,85 PFlops peak performance
55+45 racks **bullx DLC**
1800 nodes
Fat Tree InfiniBand FDR
Lustre **2,55 Po, 92 GB/s**
Disks storage 135 TB

Computer C4 (11/2015)

ARPEGE-ALADIN-AROME operational suite

CY38T1-op1, oper since 2nd Jul. 2013=CY38T1-op2 (on Bull), oper since 14th Feb. 2014 :
Compared with previous CY37T1_op1 suite :

- 4D-Var ARPEGE assimilation system: wavelet approach for a flow dependent B matrix from a data assimilation ensemble
- OBS : More satellite observations used :
  from new instruments : Suomi-NPP/ATMS + CriS radiances, Oceansat-2/OSCAT winds, CSR from GOES-13 and GOES-14, METOP-B instruments (IASI, AMSU-A, MHS, GRAS, ASCAT)
  from current instruments : METOP-A/GRAS, METOP-A/IASI WV channels, Aqua/AIRS, METOP-A/MHS
- AROME 3D-Var : additional AMSU-A radiances, METEOSAT-10/SEVIRI radiances over land, Doppler winds from one X-band radar (Mt Maurel)
- PHYSICS : ARPEGE-ALADIN : changes to the shallow convection scheme, improved description of surface properties over ice caps (thermal inertia, albedo, roughness length)
  AROME : surfex v7.2, SBL scheme switch off over sea, new clim files for post-processing domain (orography).

Preparation of High Resolution ARPEGE-AROME configurations:

- **ARPEGE** : T1198 with a stretching factor of 2.2 and 105 levels. First level at 10m (17m in present operational configuration). This gives a resolution of 7.5km over France. The proposed time step is 360s.
  The 4DVAR experimental suite will use 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.
- A futur version of **AEARP** is also in test with a resolution of T479 C=1 and a time step of 720s.
- **AROME** :1,3km L90 (1440x1536x90 grid), with dt=45s (PC iterative scheme used)
- Daily experimental runs (without data assimilation) since June 2012 with encouraging results: no numerical pbs, more realistic convective cells, precipitation scores improved.. Ongoing work on data assimilation part (B calculation, 1 h cycle), dynamics/physics tunings.

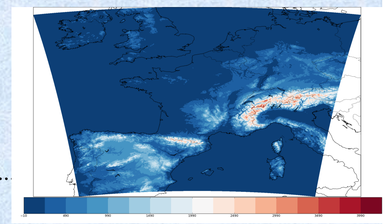


Figure 1 : AROME 1,3km orography from GMTED 250m

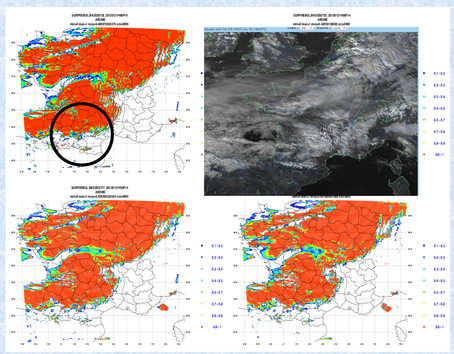


Figure 2: 31st January 2013 14 TU low level cloudiness (orographic waves well captured by AROME 1,3km)
top left : AROME1,3kmL90, top right : Satellite observation,
bottom left : AROME2,5kmL90, bottom right : AROME2,5kmL60

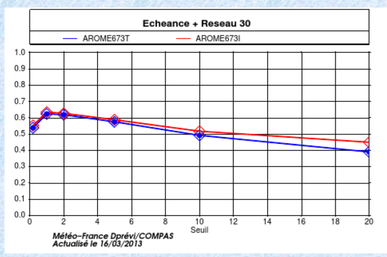


Figure 3: 24H cumulated rainfall BSS (P30-P6) on 48 days (selected for their high lightning activity during summer au autumn 2012), 673U=AROME2,5 L60, 673I=AROME1,3L90

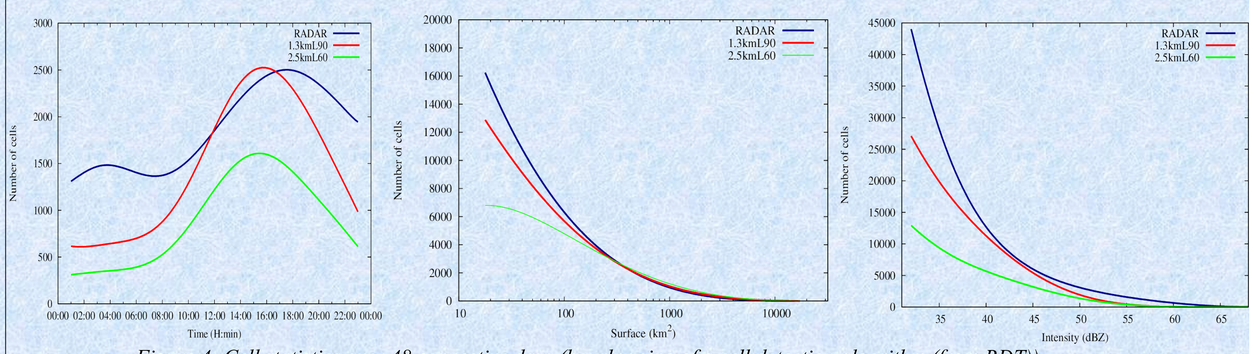


Figure 4: Cell statistics over 48 convective days (hourly using of a cell detection algorithm (from RDT))

AROME Ensemble Prediction system

(daily R&D runs of PEARO under OLIVE planned in 2014, operations in 2015) :

- AROME-France model running every 6 hours to ~40-h range
- ~10 members at 2.5km resolution (vs 1.3km for the deterministic AROME-France end 2014)
- Perturbations :
  *initial upper-air: rescaled & centered perturbations from global PEARP ensemble (with 8km local resolution)
  *initial surface: correlated random perturbations of SST, soil moisture/humidity, snow, physiographies
  *lateral boundary conditions: 10 members selected from the 35-member PEARP ensemble (by clustering)
  *model error: SPPT (stochastic perturbation of physics tendencies), similar to ECMWF EPS
- Current research:
  *calibration, verification of radar reflectivities, validation in context of hydrology & air traffic management
  *study of forecast error correlations & coupling with EDA

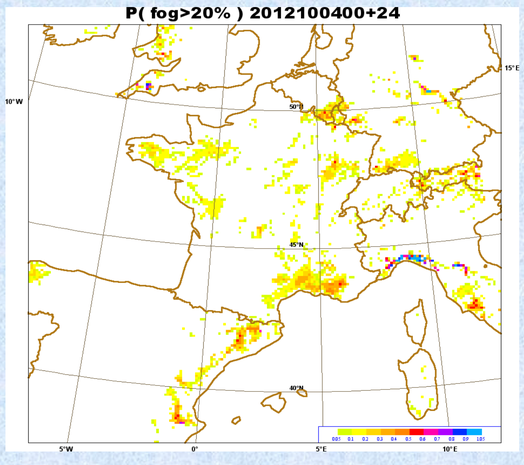


Figure 5: fog probabilities derived from a lagged (10+10 members) PEARO ensemble.

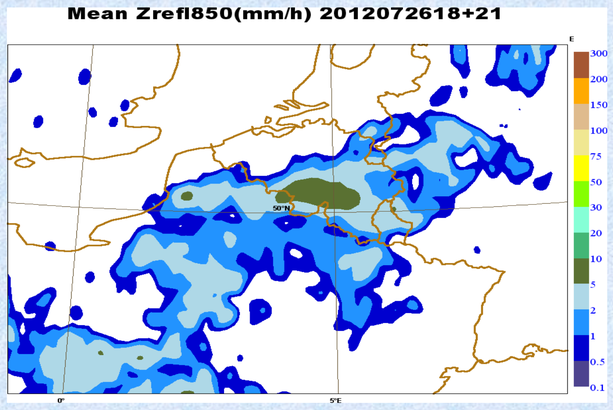


Figure 6: ensemble mean prediction of 850hPa reflectivity on a thundery day, spatially smoothed by pooling together the neighbouring forecast PDFs within a 25-km radius. This alleviates the inability of the ensemble to sample all possible cloud location errors, due to the small ensemble size.

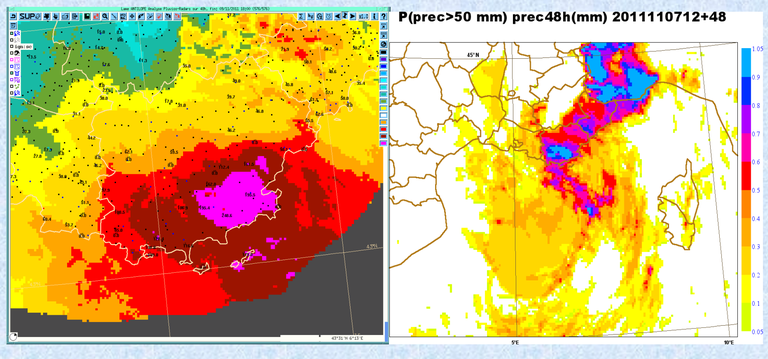


Figure 7: left, (raingauge+radar) analysis of precipitation accumulated over 48h during Medicane Rolf. The pink area delineates precipitation larger than 100m. Right, forecast probabilities predicted by a 48h-run of the PEARO ensemble. There also are high probabilities of exceeding 100mm (not shown) over the relevant area.

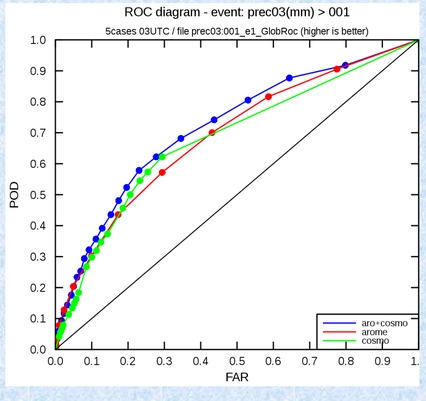


Figure 8: ROC diagram for 3-h precipitation, compared between PEARO (red) and DWD's COSMO-DE-EPS (green), over a common area. Both ensembles exhibit similar performance.

AROME Airport : Nowcasting with a High resolution Configuration of AROME

The configuration :

In the context of SESAR (Single European Sky Air traffic management Research) program, the AROME-airport configuration was set-up. It starts with a rapid refreshed AROME assimilation at 2.5 km (on the red domain from figure 1), using every observation available each hour and using the most recent AROME-France forecast as first guess (hence no cycling is performed in the AROME-airport system). Then a high resolution forecast on a 500m resolution model is performed on the green domain of figure 9, this domain being centred around the CDG airport. This subkilometric forecast provides a very refined wind forecast as shown in figure 10. The final goal is to produce boundary conditions to a Wake-Vortex prediction model.

The experiment :

During an experimental campaign that took place in autumn 2012, forecasts were provided with AROME-airport to feed a wake-Vortex prediction model. In re-run mode observations from two additional wind profilers were used. Figure 11 shows the scores in terms of root-mean-square error compared to 10m wind observations between AROME-France (green line) AROME-airport on the large 2.5 km domain in red and AROME-airport at 500m in blue.

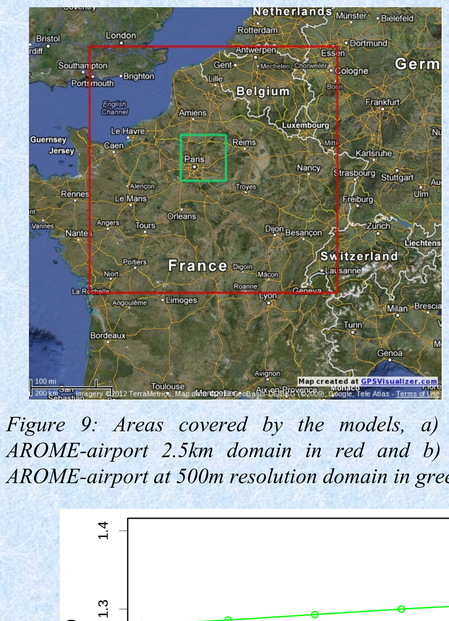


Figure 9: Areas covered by the models, a) the AROME-airport 2.5km domain in red and b) the AROME-airport at 500m resolution domain in green.

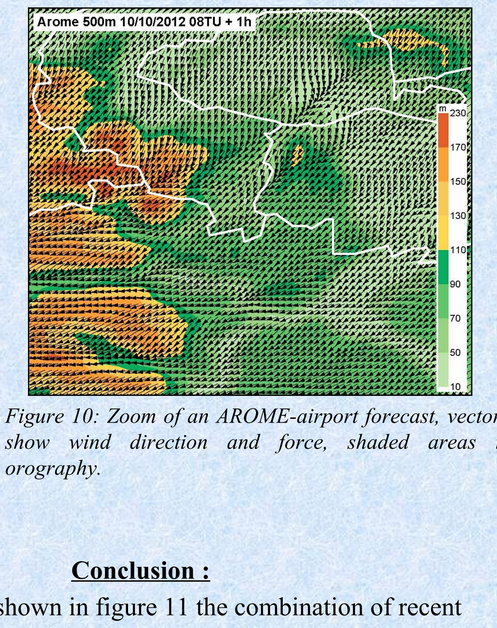


Figure 10: Zoom of an AROME-airport forecast, vectors show wind direction and force, shaded areas is orography.

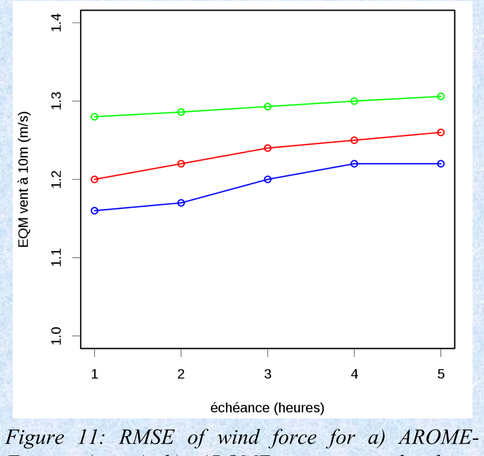


Figure 11: RMSE of wind force for a) AROME-France (green) b) AROME-airport on the large domain at 2.5 km (red) and c) AROME-airport at 500m resolution. X-axis is the forecast range in hours.

Conclusion :

As shown in figure 11 the combination of recent observations, additional profilers and hectometric resolution helped improving the wind forecast around CDG airport during a dedicated experimentation and so should improve wake-vortex forecast with the final goal of reducing the landing/take-off delay.

Future experimentations should confirm this behaviour.