Application and verification of ECMWF products 2010

METEO-FRANCE – J. Stein, G. Beffrey, N. Girardot, P. Laveau and F. Pouponneau

1. Summary of major highlights

- Implementation of 3 limited area models ALADIN over tropical areas coupled to IFS

2. Use and application of products

2.1 Post-processing of model output

2.1.1 Statistical adaptation

Millions of local forecasts of weather parameters are produced daily through statistical adaptation of NWP output. Main methods are multiple linear regression (MLR) and linear discriminant analysis (DA). MOS (model output statistics) is generally preferred to PP (perfect prognosis). Kalman filter (KF) is applied when relevant. The production is described in table 1.

Note the new production of grid point total cloud cover forecast based on a statistical adaptation using satellite data as predictand.

Deterministic model T1279

Parameter	Method	Domain	No. of Sites	Steps
Tri-hourly 2m Temperature	MLR (MOS) +KF	France	2781	+3h to +180h by 3h
Daily extremes 2m temperature	MLR (MOS) +KF	France	2781	D to D+6
10m Wind Speed	MLR (MOS)	France	861	+6h to +180h by 3h
10m Wind Direction	MLR (MOS)	France	822	D to D+6
Total Cloud Cover	MLR (MOS)/LDA	France	164	+12h to +180h by 3h
Total Cloud Cover	LDA	France	GRID 0.5x0.5	0h to +156h by 3h
Tri-hourly 2m relative Humidty	MLR (MOS) +KF	France	1269	+6h to +180h by 3h
Daily extremes 2m rel. Humidity	MLR (MOS) +KF	France	1269	D to D+6
Tri-hourly 2m Temperature	MLR (MOS) +KF	World	6010	+6h to +180h by 3h
Daily extremes 2m temperature	MLR (MOS) +KF	World	6010	D to D+6

Table 1: Statistical adaptations for the deterministic high resolution model

EPS

Statistical adaptation is applied to individual ensemble runs (table 2). Methods are the same as for the deterministic model output but pseudo-PP (statistical equations computed during the first 24 hours then applied to the other corresponding steps) is preferred to MOS. VAREPS is used and Météo-France provides local forecast (temperatures) up to 14 days.

EPS Ensemble mean and individual members

Parameter	Method	Domain	No. of Sites	Steps
Tri-hourly 2m Temperature	MLR (pPP) +KF	France	2761	+3h to +360h by 3h
Daily extremes 2m temperature	MLR (pPP) +KF	France	2761	D to D+14
10m Wind Speed	MLR	France	792	+6h to +240h by 3h +246 to +360 by 6h
Tri-hourly 2m relative Humidty	MLR (pPP) +KF	France	1146	0h to +240h by 3h
Daily extremes 2m rel. Humidity	MLR (pPP) +KF	France	1146	D to D+10
Tri-hourly 2m Temperature	MLR (pPP) +KF	World	3338	+0h to +360h by 3h
Daily extremes 2m temperature	MLR (pPP) +KF	World	3338	D to D+14

Table 2: Statistical adaptations for the EPS

EPS Distribution

Calibration is applied to the EPS distribution in order to optimize reliability. Operationally, a calibration based on rank diagrams is used for 10m wind speed and total precipitations. Bayesian Model Averaging (BMA) calibration is under development and will be used for temperatures at the end of the year.

Monthly forecast

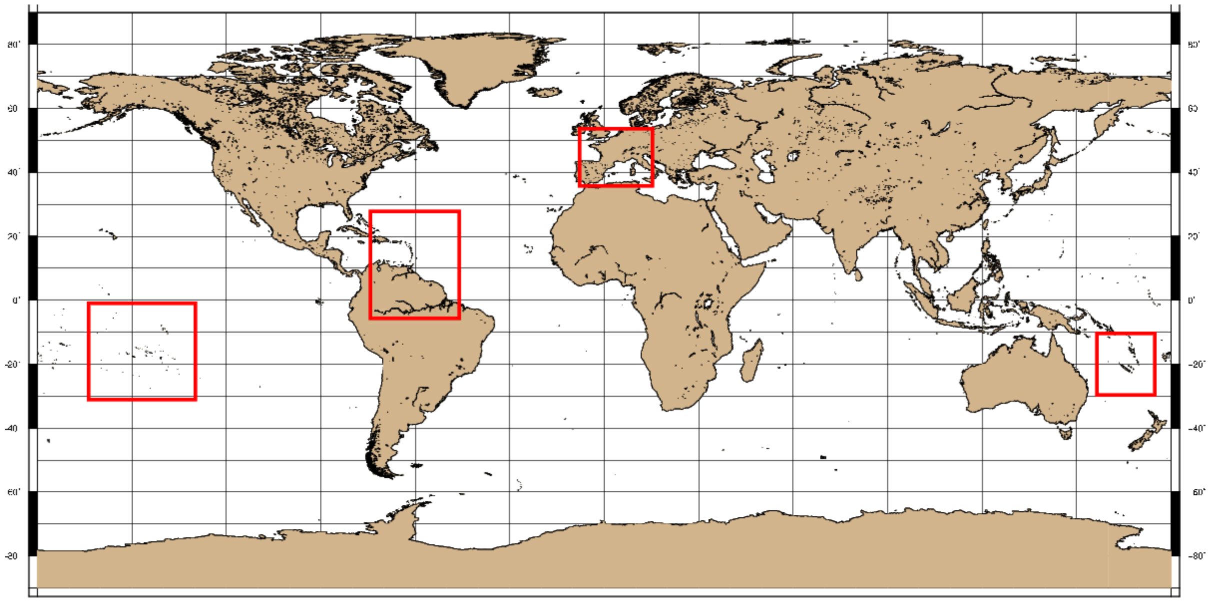
Statistical models are also applied to the monthly forecasts up to 32 days (table 3). These locally corrected forecasts allow to couple electricity consumption models.

Parameter	Method	Domain	No. of Sites	Steps
Tri-hourly 2m Temperature	MLR (pPP)	France	1056	+0h to +768h by 3h
Daily extremes 2m temperature	MLR (pPP)	France	1056	D to D+31

Table 3: Statistical adaptations for the monthly forecasts

2.1.2 Physical adaptation

The first physical adaptation is performed by the limited area model (LAM) ALADIN which operates over western Europe (Figure 1a). This models performs a dynamical adaptation of the IFS forecasts using a higher horizontal resolution of 7.5 km. Objective scores have been computed for the surface parameters measured by European surface stations and compared to the IFS forecasts. The rms is improved for the temperature at 2m AGL with a reduction between 10 % to 20 % depending on the lead time (Figure 1b). This improvement is likely due to the more detailed orography and to a different turbulence and soil scheme. It is reduced to 10 % for wind at 10 m AGL and the results are comparable for the relative humidity at 2m AGL.



(b)

Figure 1 Geographical extension of the ALADIN models coupled to IFS

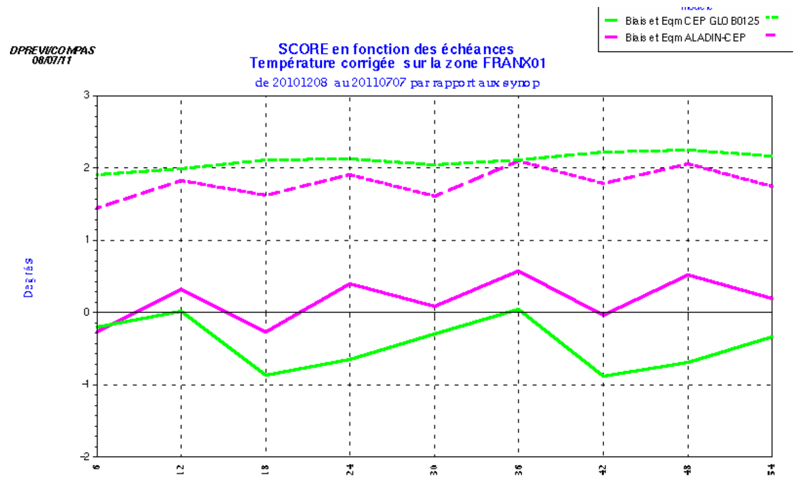


Figure 2 Rms (dotted lines) and bias (full lines) against the surface data observations included in the domain FRANCE in Kelvin for the temperature at 2m AGL forecasts performed by the ALADIN-ECMWF (pink) and IFS (green). The scores are plotted against the lead time (in hours) of the simulations. The comparison is performed from 08/12/2010 to 07/07/2011.

Three new LAM ALADIN have been operated by Météo-France to provide high-resolution forecasts for tropical area including French territories (Figure 1a). Their horizontal resolution is equal to 8 km. A 3DVAR assimilation scheme similar to ALADIN-France has been developed for these three LAM with 6 hours temporal windows. Two daily runs are performed at 0 and 12 UTC taking their boundary conditions in the IFS runs starting 6 hours before. The maximum lead time is 54 hours. The surface conditions are interpolated from the surface analysis of the French global model ARPEGE. The verification of the LAM is performed in the same way as for ALADIN-ECMWF and shows some small increases of the rms in comparison to IFS (not shown) but the dimension of the temporal sample (1 month) is too small to draw any definitive conclusion.

2.1.3 Derived fields

Derived fields like probabilities, tubes and EFI are used by the forecasters via the Synergie workstation or the ECMWF web site.

Probabilities for specific thresholds are also calculated and available for the forecasters, for example significant wave height of at least 3 m or 9 m.

2.2 Use of products

3. Verification of products

3.1 Objective verification

3.1.1 Direct ECMWF model output (both deterministic and EPS)

The verification presented last year of the trajectories of the tropical cyclones forecasted by the EPS in the Indian Ocean is accepted for publication in Weather and Forecasting (*Dupont et al* 2011).

3.1.2 ECMWF model output compared to other NWP models

3.1.3 Post-processed products

3.1.4 End products delivered to users

3.2 Subjective verification

3.2.1 Subjective scores (including evaluation of confidence indices when available)

Monthly forecast verification

The monthly forecasts of 2m-temperature anomalies have been assessed by the forecasters since November 2004. A sample of 330 elements is available covering the period from November-2004 to April-2011.
For every week, the marks vary from A to D with the following meaning :
A: good localisation and intensity of the anomaly,
B: slight differences (localisation and/or intensity) between observed and forecast anomaly,
C: anomaly forecasted but not observed (miss) or (more frequently) anomaly observed but not forecasted (false alarm),
D: observed anomaly opposite to the forecasted anomaly.

The proportion over the whole period of each mark for week 1 to week 4 is plotted in Figure 6.

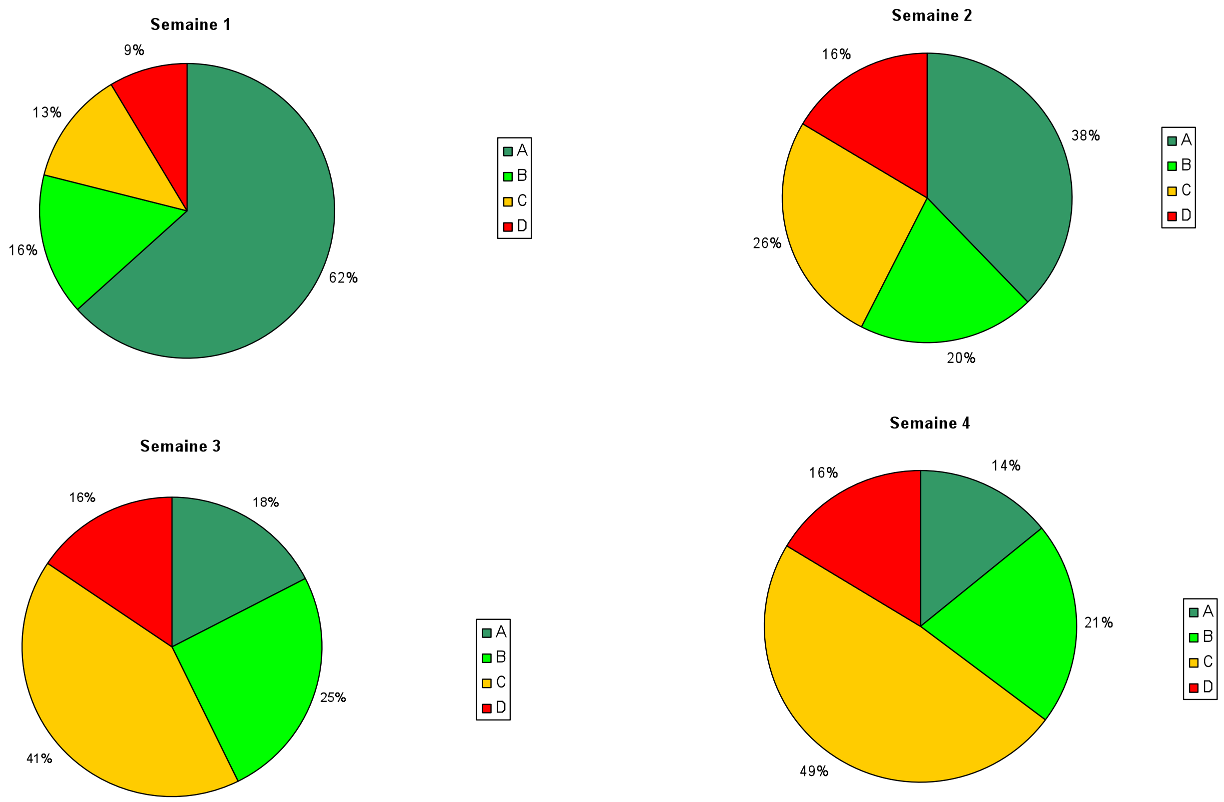


Figure 3 Proportions of subjective notations for the forecast of the anomalies over France monthly temperature at 2m AGL from November 2004 to April 2011 (sample size = 330).

The forecast quality is very good for week 1 and good for week 2. For the weeks 3 and 4, there are more bad forecasts than good ones. This is mainly due to the important number of C marks, which often correspond to misses where there is no signal in the forecast and an observed anomaly. If we remove the cases where there is no signal in the forecast, the number of good forecasts becomes around 58% for week 3 and 52% for week 4.

Note that the proportion of bad forecasts (D marks) is very similar from week 2 to week 4.

	Week 1	Week 2	Week 3	Week 4
A	4	2	1	2
B	5	1	2	1
C	1	5	5	4
D	3	5	5	6
Total	13	13	13	13

Table 4: Proportions of subjective notations for the forecast of the anomalies over France monthly temperature at 2m AGL from 28 june to 26 september 2010

Table 4 corresponds to the period from 28 june to 26 september 2010 and it shows that the summer period was well forecasted for week 1, but not for longer time ranges. The main problem is quasi-permanent warm anomalies that did not verify.

3.2.2 Synoptic studies

4. References to relevant publications

T. Dupont, M. Plu, P. Caroof and **G. Faure** 2011: Verification of ensemble-based uncertainty circles around tropical cyclone track forecasts. *Weather and Forecasting*. doi: 10.1175/WAF-D-11-00007.1