Application and verification of ECMWF products 2011

Agencia Estatal de Meteorología – AEMET

1. Summary of major highlights

A couple of major highlights can be mentioned regarding the use of ECMWF models at AEMET.

- The first one is related with the collaboration on objective verification of numerical models started between Carlos Santos, from AEMET, and Anna Ghelli from ECMWF/OD. Two papers are the first result of this job.
- From last spring AEMET decided, after some parallel tests, that its high resolution HIRLAM operational runs (0.05 deg resolution) will be nested directly on ECMWF model. Formerly they were nested on AEMET low resolution HIRLAM run (0.15 deg).
- Use of ECMWF fields in the generation of the Digital Forecasting Data Base, DFDB, from H+72 up to 192, mainly precipitation and temperature. Future changes from ECMWF perspective and DFDB: increasing the temporal range, H+48 – H+240, and the inclusion of deterministic Tmax and Tmin. Ocean waves as well as precipitation and snow probabilistic forecasts will be also included from H+06 - H+240.

2. Use and applications of products

2.1 Post-processing of model output

2.1.1 Statistical adaptation

- Application of Analogue Method, AM, to estimate the probability of precipitation from deterministic ECMWF model (12 UTC run), D+1 to D+3 in 24h periods (07-07 UTC).
- Use of Analogue Method from EPS, EPS-AM, to estimate the probability of precipitation from D+1 to D+7 (12 UTC run) in 24h periods (07-07 UTC).
- Adjustment of EPS precipitation probabilities for 6, 12 and 24h periods based on the ratio between the probabilities of EPS and EPS-AM in the common period 06-06 UTC.
- Maximum and Minimum temperatures predictions (D+7) using EPS mean and surface observations of 40 previous days to correct the bias.
- Estimation of the potential snow-rain limit considering from ECMWF deterministic model output, up to D+7.
- Estimation of probability of snowfall considering the EPS-AM precipitation probability and the probability of snow-rain limit (D+3).
- Estimation of probability of thunderstorms using deterministic ECMWF model Total of Totals Index, TT, and EPS-AM precipitation data from D+3 to D+7.

2.1.2 Physical adaptation

All the boundary conditions for the LAM short range NWP AEMET operational models (euro Atlantic HIRLAM ONR, 16km; HIRLAM HNR, 5km, over Iberia and surroundings; and HIRLAM CNN, 5km, over Canary Islands) are now directly taken from the ECMWF operational runs.

Experimental HARMONIE runs, daily with 11km resolution, and occasionally, with 2.5km resolution, are also directly nested to the ECMWF outputs. HIRLAM models use their own assimilation, HARMONIE versions run in adaptation mode. This direct nesting performs well even for 2.5 km.

Daily experimental multimodel Short-range Ensemble Prediction System (SREPS) uses ECMWF model as one of the boundary condition global models to initialize the system. Two runs a day (00 and 12 UTC) uses 12 hours-old ECMWF run.

2.1.3 Derived fields

In operational duties, a large amount of ECMWF products from medium to monthly range are used. We use both the deterministic model and EPS system for medium range weather forecast. EFI products are used as much as probability maps to access the warning areas in our early warning system of high impact weather events, called "Meteoalerta".

Moreover, and extraordinary report (not available on our public web server) based on EPS monthly probabilistic system, is made once a week.

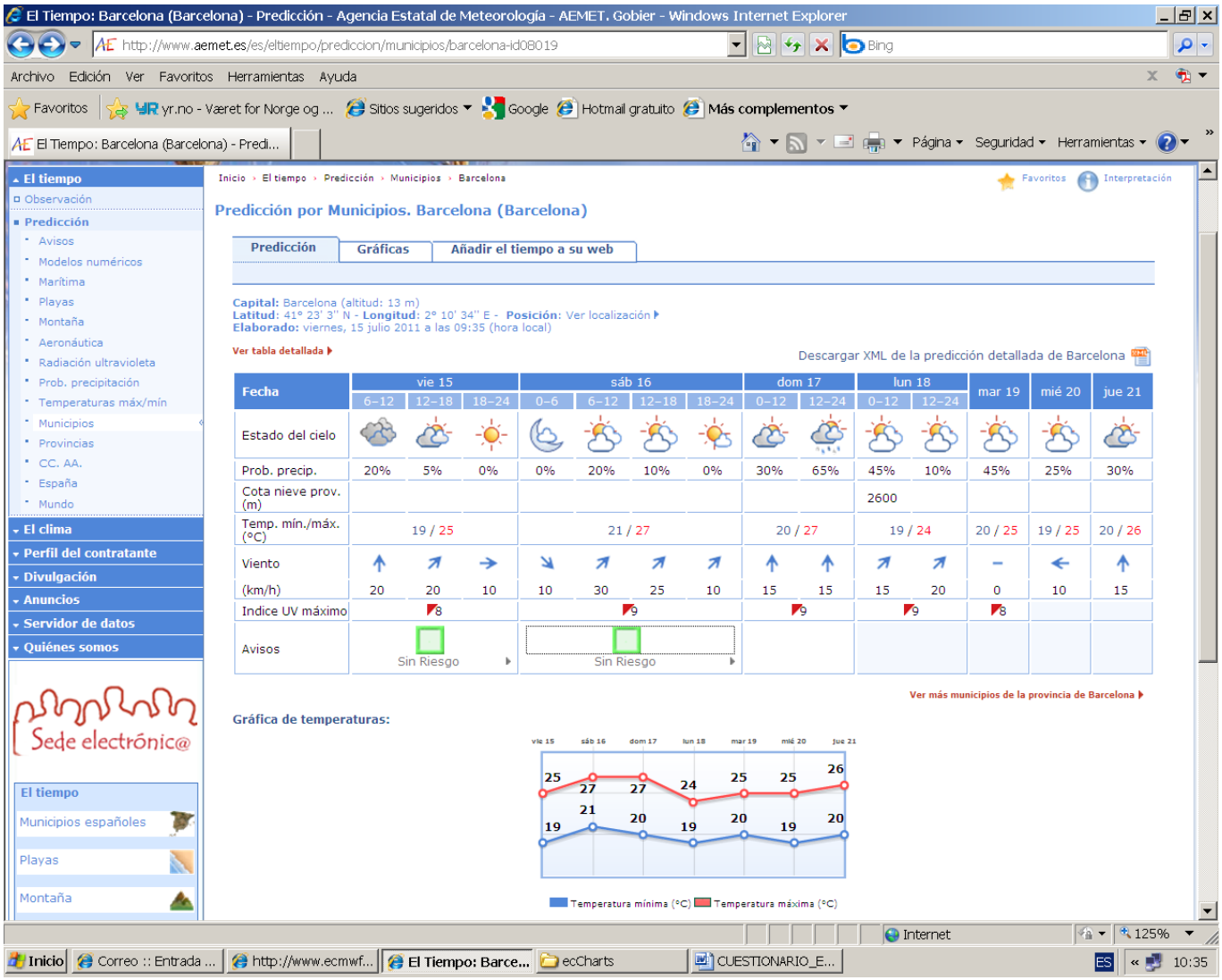
Other activities and products are related to:

- Comparison of high resolution deterministic model with the EPS Control model in Spanish area.
- Specific Spanish clustering of ECMWF EPS in two specific Spanish areas, the Iberian Peninsula /Balearic Islands and Canary Islands.
- EPS probabilities that various meteorological parameters, from atmospheric EPS, surpass defined thresholds in two specific Spanish areas, from D+1 to D+10 or D+15.
- EPSgrams.
- Wave EPS probabilities that significant height of wind waves and total swell, exceed defined thresholds in specific Spanish areas.
- PCP and T2m anomalies and probabilities in the upper a lower terciles from monthly forecast.

2.2 Use of products

- Frontal diagnosis parameters: TFP, THW, etc.
- Aeronautical and maritime products.
- Pseudo-sounding graphics from deterministic model using pressure levels.
- Wind gust estimation maps.
- Specific parameters for diagnosing thunderstorms potential: CAPE, LI, CIN, convergence zones, SRH, etc.,
- We have been using and testing the ecCharts and we sent the beta test evaluation report. We found that the ecCharts suite is a very useful and convenient web based tool for operational forecasting. The graphic interface is very easy to use, and the layer-oriented work, made it a flexible application.
- The VarEPS/monthly probabilistic system is used at the AEMET every Friday to elaborate an interdepartmental report for the next four weeks for other purposes, such as Hydrological surveys.
- Many ECMWF products, as the "Extreme forecast index" (EFI), are used for public warnings of severe weather for short-range forecasts. ECMWF forecasting products are a good guideline for those warnings.
- The ECMWF deterministic and probabilistic model outputs are used extensively by the duty forecasters and also to produce a wide range of automatic forecasts as is shown in the next image from our external web site:

  http://www.aemet.es/es/portada



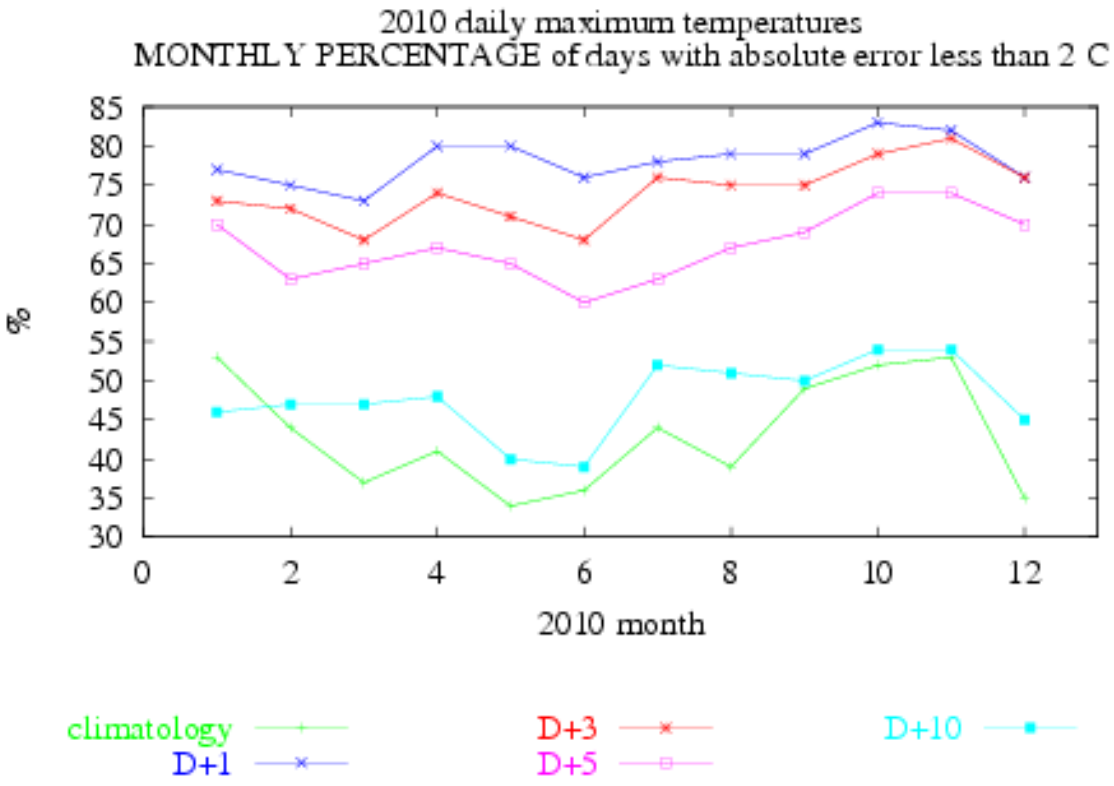
3. Verification

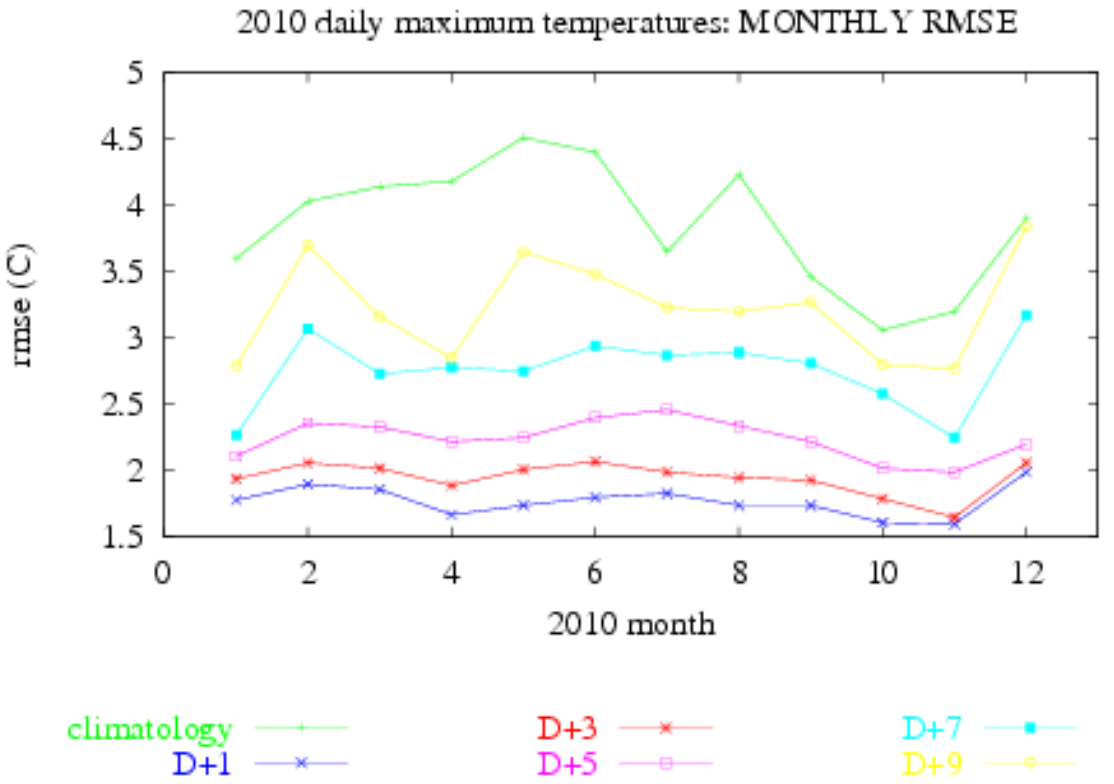
3.1 Objective verification

3.1.1 Direct ECMWF model output (both deterministic and EPS)

Post-processing of EPS 2m Temperature in Spain.

EPS 51 members forecasted 2m Temperature at 00, 06, 12 and 18 UTC are interpolated at each of the synoptic observatories of Spain. Its mean is calculated and corrected with the mean of the errors (forecasted – observed) from previous days. This procedure is also applied to the daily extreme temperatures as illustrated in the next graphics: monthly percentage of the days with absolute errors less or equal than 2ºC from 2010 applying Tmax and Tmin.


2010 daily maximum temperatures
MONTHLY PERCENTAGE of days with absolute error less than 2 C
%
2010 month
climatology
D+1
D+3
D+5
D+10


2010 daily maximum temperatures: MONTHLY RMSE
rmse (C)
2010 month
climatology
D+1
D+3
D+5
D+7
D+9

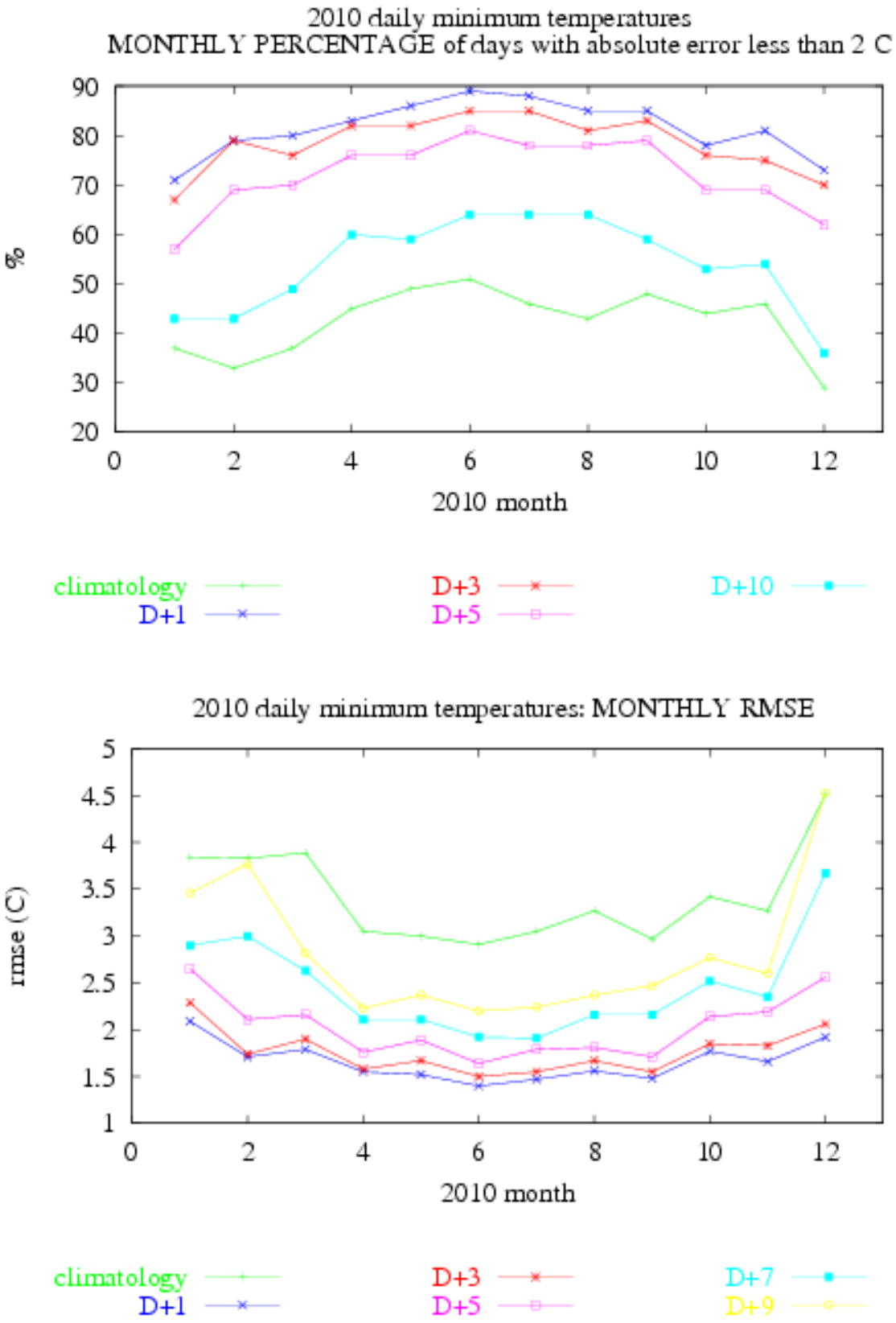


Figure 2 Monthly percentage of daily extreme temperatures (maximum and minimum) with absolute error ≤ 2ºC and RMSE from EPS and post-processing at 51 synoptic observatories in Spain.

3.1.2 ECMWF model output compared to other NWP models

Fig 3 presents a sample of the routine comparison between the ECMWF model output and the operational HIRLAM ONR (Euro Atlantic area) and HIRLAM HNR (Iberia and surroundings area) for the period April- mid May 2011. The LAM model scores clearly better for 2 meter temperature, but this is not the case (not shown) for MSL pressure where the ECMWF forecast shows similar scores even for the first 36 hours.

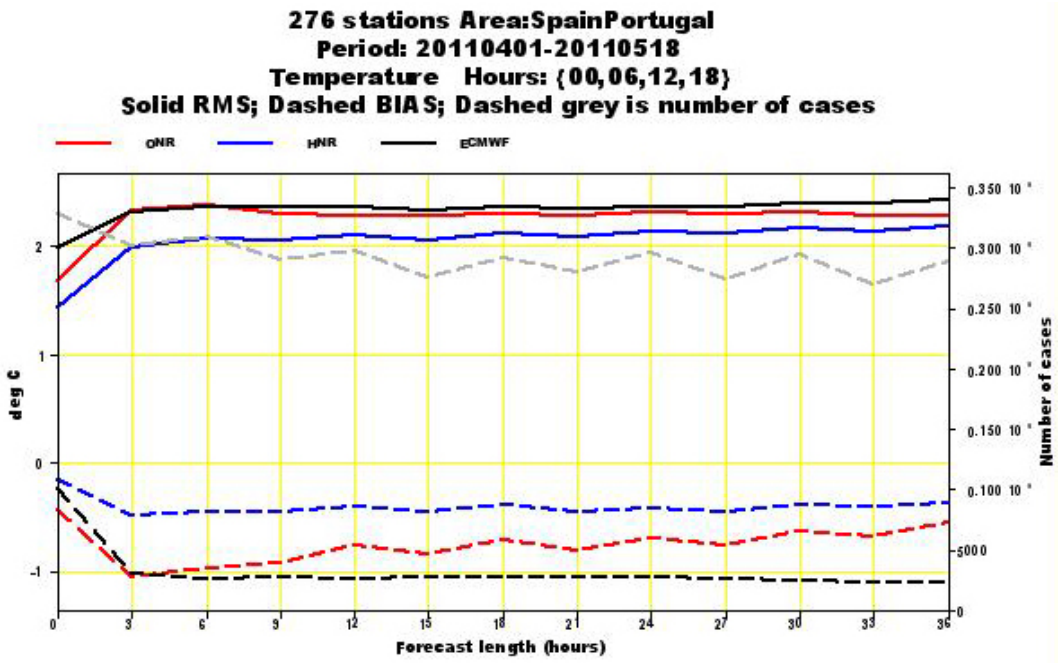


Figure 3 Shows wind speed comparison among the Lanzarote island aeronautical observatory, the ECMWF model output, and outputs from HIRLAM CNN, 5km, and HIRLAM HARMONIE, 2.5km versions, not operational the last one, run over the Canary Island region for a 3-day experimental period in February 2010. The ECMWF model performs well even in the short term.

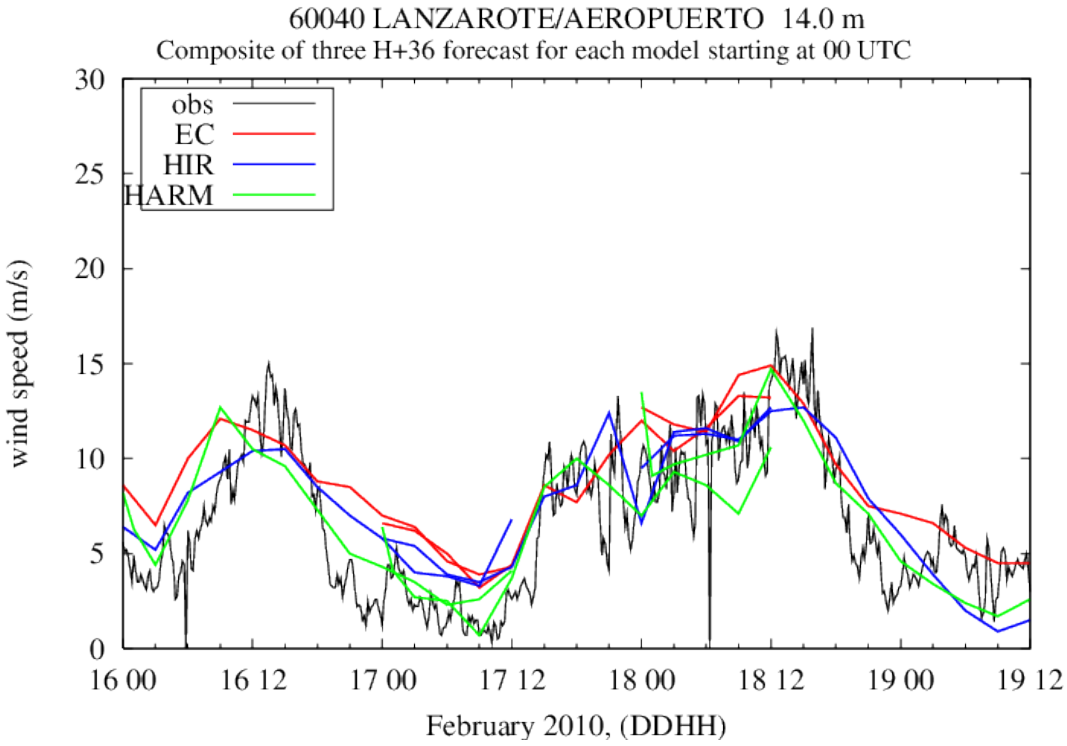


Figure 4 Daily verification of ECMWF, HIRLAM and HARMONIE wind speed forecast for the Lanzarote Airport (Canary Islands).

The most relevant differences among the three models are found for precipitation forecasts, mainly the convective one. ECMWF model forecasts precipitation over more extended areas but with smaller amounts than the higher resolution models.

There are two projects AEMET is doing in collaboration with ECMWF. In particular Carlos Santos and Anna Ghelli are working together in two items:

One of them is an assessment of the impact of observational uncertainty in verification results for ensemble precipitation forecasts. This study compares performance of ECMWF EPS and AEMET-SREPS. The resulting paper has been recently accepted for publication in QJRMS: Santos and Ghelli 2011:"Observational probability method to assess ensemble precipitation forecasts".

Another one is the application of new feature oriented techniques for verification of QPF using the novel method called Structure Amplitude Location (SAL). First tests show interesting results comparing T799, T399, HIRLAM 0.16 and HIRLAM 0.05 in Central Europe and Spain during 2009. Laura Ferranti collaborates as well, introducing a clustering technique to stratify results. Results are not yet prepared for publication.

3.1.3 Post-processed products

See point 3.1.1.

3.1.4 End products delivered to users

No end products different from Direct Model Output are delivered to users.

3.2 Subjective verification

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

From the daily technical discussions at the National Prediction Centre (CNP) we can conclude that high resolution deterministic model, underestimates the CAPE index (compared with observed lighting and with the limited area Hirlam model also), especially in the last spring, as much as the convective precipitation in light dynamic forcing situations.

On the other hand, and related to the EPS, we have observed that the model consistency has improved a lot and the model dispersion is less that it used to be in the past.

3.2.2 Synoptic studies

Evaluation of the behaviour of the deterministic and EPS forecasts in severe weather situations:

- Two case studies in Canary Islands in February 2010: heavy precipitation (1–2 February) and intense cyclogenesis events (16–18 February). See figures below.
- Aguilar de la Frontera (Cordoba), 16 August 2010: a flash flood case study.

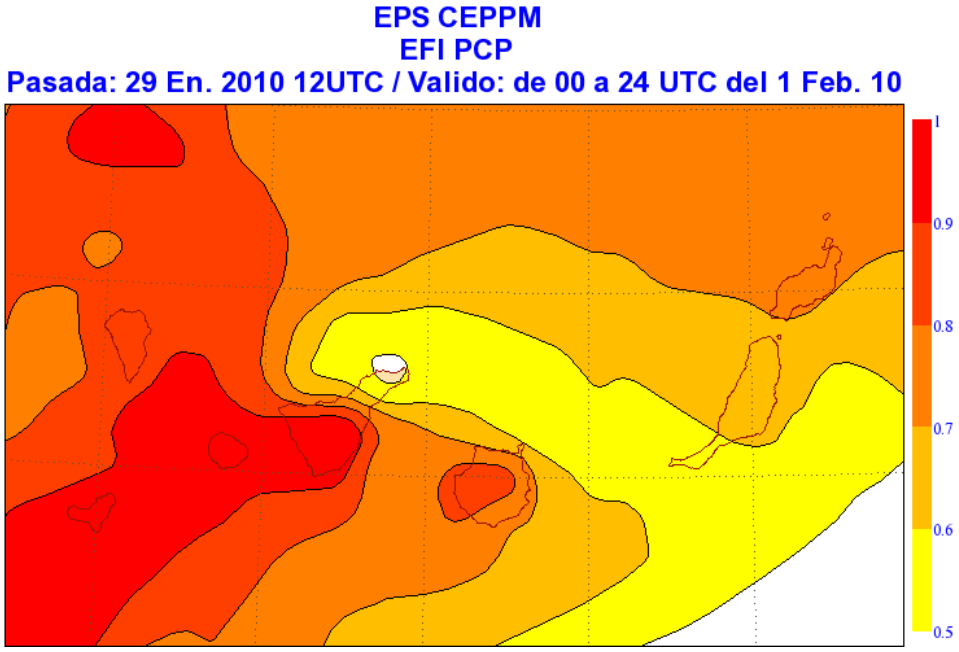


Figure 5 EFI (Extreme Forecast Index) of 24 h precipitation from 29 January 2010 run 12 UTC, valid to the 1st February 2010, 00–24 h.

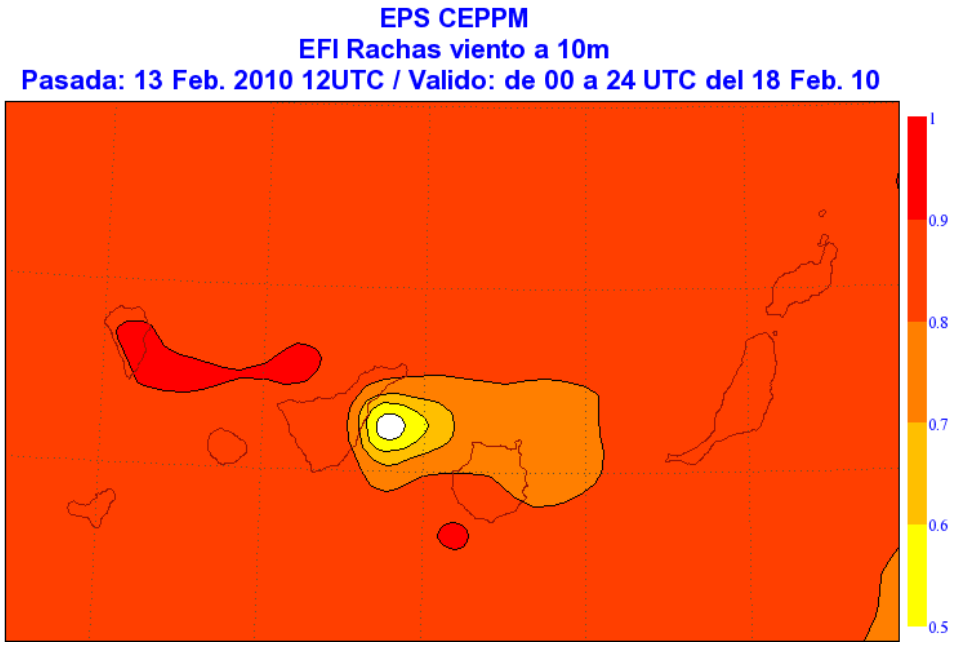


Figure 6 EFI of 10 m wind gusts from 13 February 2010 run 12 UTC, valid to the 18th February 2010, 00–24h.

From the 1st to the 2nd and from the 16th to the 18th February 2010, important hazardous events affected Canary Islands. In the first case, extreme convective rains and local flash floods caused important damages in many places. In the second case, strong winds and gale-forced gusts affected the Islands. Some airports were closed and some zones were collapsed during several hours. Deterministic and EPS models offered “valuable signals” for these hazardous events. The first case will be presented at ECSS 2011 Conference in Palma de Mallorca.

4. Reference to relevant publications

Santos C. and **Ghelli A**. (2011) "Observational probability method to assess ensemble precipitation forecasts". Acepted for publication at QJRMS.

Tellus (2011)

TELLUS

Predictability of short-range forecasting: a multimodel approach

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