Application and verification of ECMWF products 2009

AEMET – Spain

1. Summary of major highlights

- Maintenance and improvement of the AEMET Intranet website whith products from ECMWF VarEPS that is used as the main operational tool for medium range forecasters.
- Use of ECMWF products for generation of Digital Forecasting Data Base, from H+72 up to 192, and post-processing output: precipitation and temperature predictions.
- Use of ECMWF deterministic model for boundary conditions of our HIRLAM deterministic NWP operational model.
- Use of ECMWF deterministic model as boundary conditions of our multimodel Short Range Ensemble Prediction System. We run HIRLAM, COSMO, HRM, MM5 and UM using boundaries from ECMWF.
- Dynamical downscaling of Sistem3 seasonal forecasts with the Rossby Centre Atmospheric model (RCA).

2. Use and application of products

In operational duties, a large amount of ECMWF products from medium to monthly range is used. We use both the deterministic model and VarEPS system for medium range weather forecast. To produce a map for warnings in our early warnings for high impact weather system, called "Meteoalerta", we use the EFI products as much as probability maps. Moreover, and extraordinary report (not available on our public web server) based on VarEPS monthly probabilistic system, is made once a week. Other activities and products are related to:

- Comparison of high resolution deterministic model with the VarEPS control model in Spanish area.
- Specific Spanish clustering of VarEPS.
- VarEPS probabilities for various meteorological parameters in two specific Spanish areas.
- VarEPSgrams.
- PCP and T2m anomalies and probabilities in the upper a lower tercils from monthly forecast.

2.1 Post-processing of model output

2.1.1 Statistical adaptation

- Statistical method based in analogues (ANALO) for adapting ECMWF seasonal forecast of precipitation to local scale in Spain.
- Application of Analogue Method, 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 VarEPS, VarEPS-AM, to estimate the probability of precipitation from D+1 to D+7 (12 UTC run) in 24h periods (07-07 UTC).
- Adjustment of VarEPS precipitation probabilities for 6, 12 and 24h periods based on the ratio between the probabilities of VarEPS and VarEPS-AM in the common period 06-06 UTC.
- Maximum and Minimum temperatures predictions (D+7) using VarEPS 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 VarEPS-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 VarEPS-AM precipitation data from D+3 to D+7.

2.1.2 Physical adaptation

- Boundary conditions for LAM Short Range numerical prediction (HIRLAM, operational and HARMONIE, experimental).
- Boundary conditions for dynamical downscaling of seasonal forecasts with the Rossby Centre Atmospheric model.
- Boundary conditions to drive the Limited area models (HRM (DWD), UM (UKMO), HIRLAM, LOCAL Model (Cosmo Consortium) and MM5 (USA) in the AEMET Short Range Ensemble Prediction System, SREPS, project.

2.1.3 Derived fields

- Specific Spanish clustering of ECMWF VarEPS.
- EPS Probabilities for various meteorological parameters in two specific Spanish areas: The Iberian Peninsula /Balearic Islands and Canary Islands.
- Total cloud estimation from VarEPS (up to 7 days).

2.2 Use of products

Use of ECMWF products for deriving:

- Frontal diagnosis parameters: TFP, THW, etc.
- Aeronautical and maritime products.
- Seudosounding graphics from deterministic model using pressure levels.
- Wind gust estimation maps.
- Specific parameters for diagnosing thunderstorms potential: CAPE, LI, CIN, convergence zones, SRH, etc.,

3. Verification of products

3.1 Objective verification

3.1.1 Direct ECMWF model output (both deterministic and EPS)

Post-processing of VarEPS 2m-temperature in Spain.

VarEPS 51 members forecasted 2m-temperature at 00, 06 12 and 18 UTC is 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 graphic with the monthly and 12-month moving percentage of less or equal than 2ºC error from 2001 up to the present time.

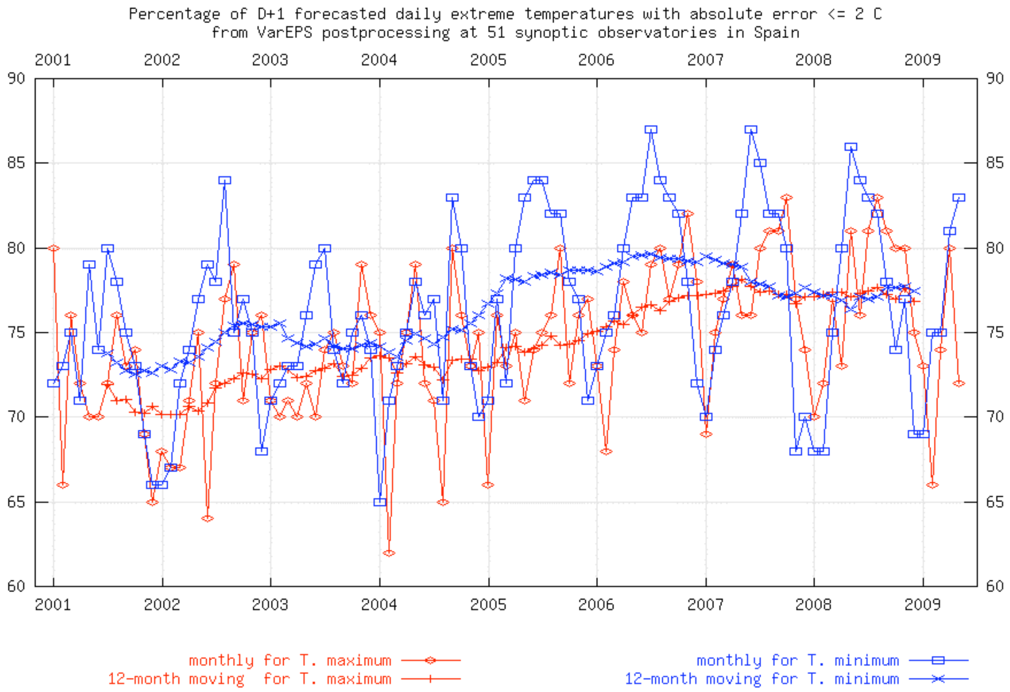

Figure 1. Percentage of D+1 forecasted daily extreme temperature with absolute error ≤ 2ºC from VarEPS postprocessing at 51 synoptic observatories in Spain.

3.1.1.1 *Seasonal forecast*

Figure 2 shows results for precipitation seasonal forecasts from System3, RCA (dynamical downscaling model) with 1-lead time.

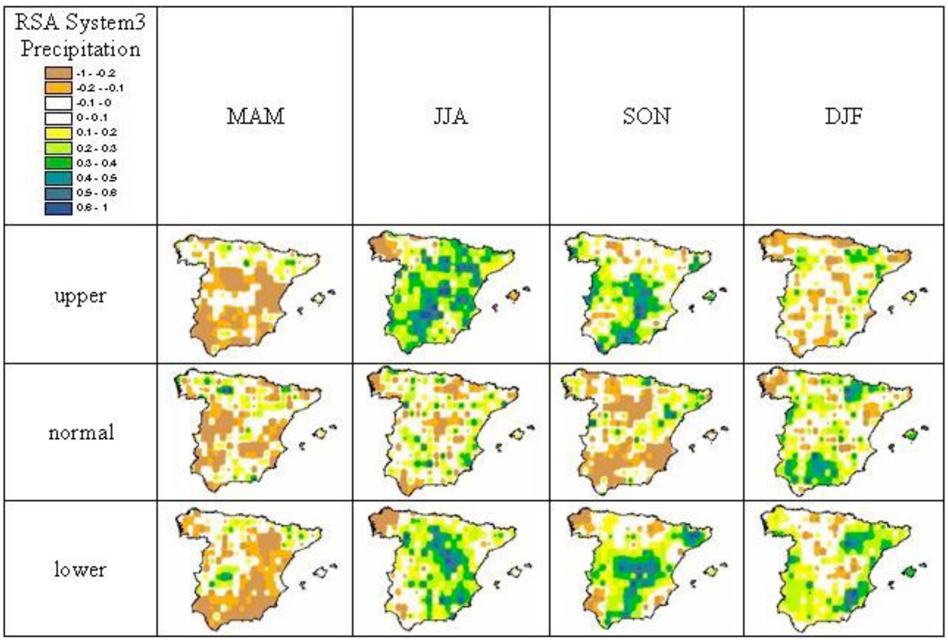

Figure 2. RSA values for System3 precipitation seasonal forecast over the Peninsular Spain verified against observations interpolated at a 254 point mesh (resolution 0.5º) for the events dry, normal and wet and seasons MAM, JJA, SON and DJF.

3.1.2 ECMWF model output compared to other NWP models

3.1.3 Post-processed products

A comparison of ECMWF EPS (51 members and the first 21 members) with AEMET SREPS can be seen in the Figure 3, below. It shows the Monthly Brier Skill Score of 24 hours accumulated precipitation (VT: H+54) using observations from the European Climate networks upscaled to 0.25 degrees lat x lon for the year between May 2007 and May 2008.

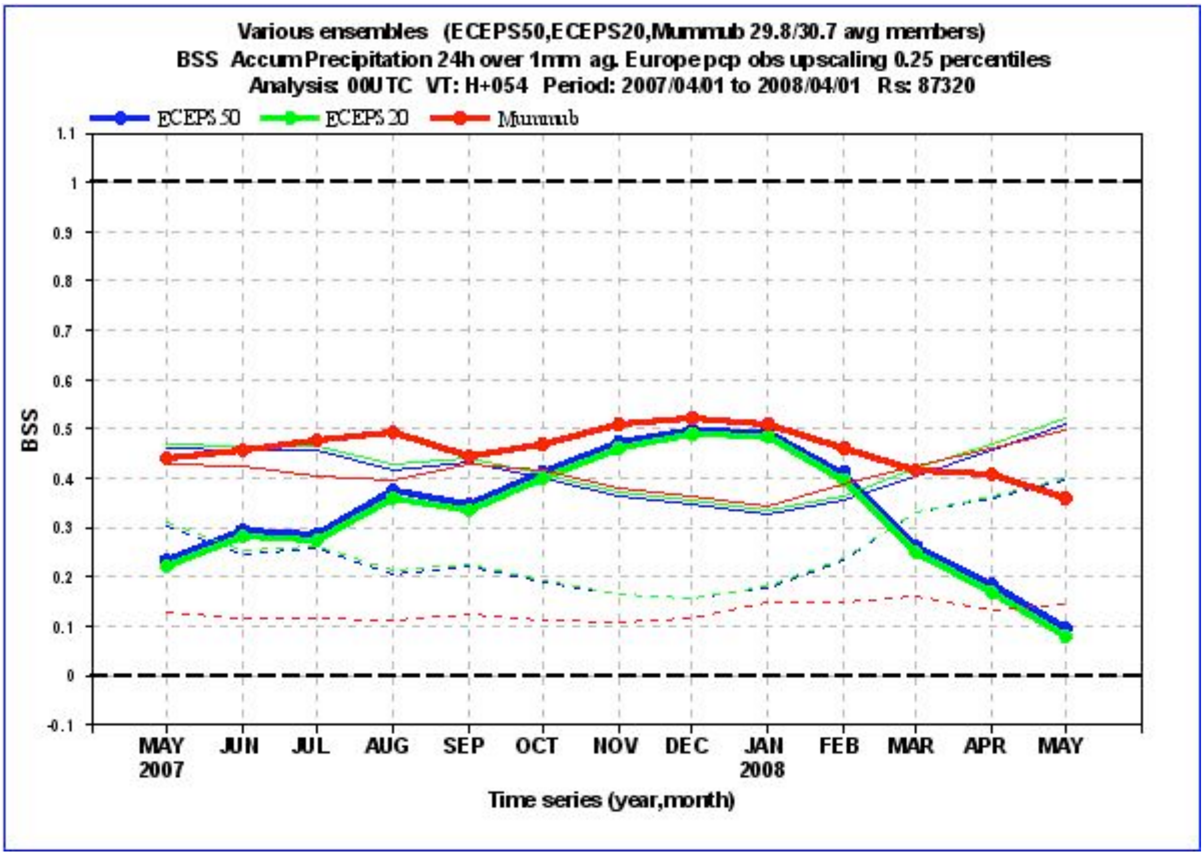

Figure 3. A comparison of ECMWF EPS (51 members, in blue, and the first 21 members, in green,) with AEMET-SREPS (in red).

3.1.4 End products delivered to users

3.2 Subjective verification

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

3.2.2 Synoptic studies

Evaluation of the behaviour of the VarEPS in severe weather situations:

- 8-10 January 2009 snowfalls: a case study (figure 4)
- 24-25 January 2009 explosive cyclogenesis: a case study (figure 5)

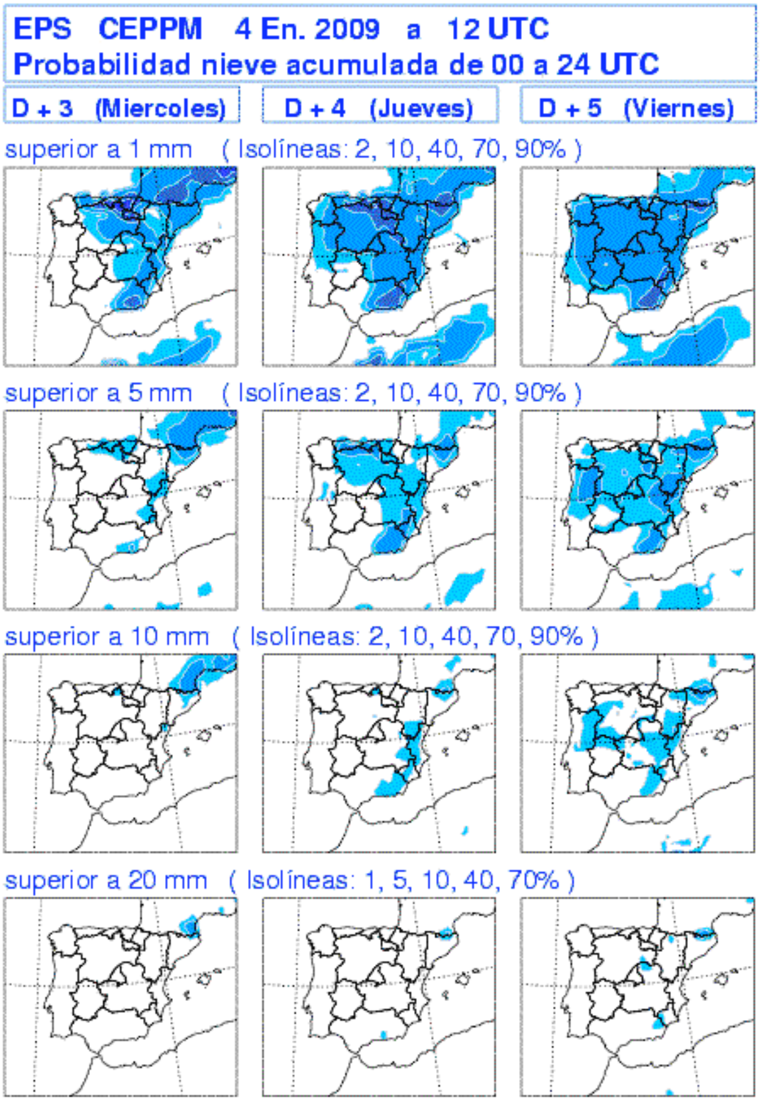

Figure 4. Operational maps of forecast snow probabilities, accumulated in 24 h for different thresholds (1,5,10 and 20 mm), from 4th January 2009 VarEPS run: D+3, D+4 and D+5.

From 8 th to 10 th of January 2009, important snowfalls affected many Spanish geographical areas, especially the regions of Madrid, Castilla & León and Castilla-La Mancha (Spanish central plateau) with the persistence and thickness of solid precipitation. Up to twenty-five centimetres of snow were reported in some places. On 9th of January the snowfalls caused great social and media impact due to the fact that they took place in the early hours in the Madrid metropolitan areas, affecting both air traffic and land transport. The “Madrid-Barajas” airport was closed and the city was collapsed during several hours. VaerEPS model offered “relevant signals” for this hazardous event.

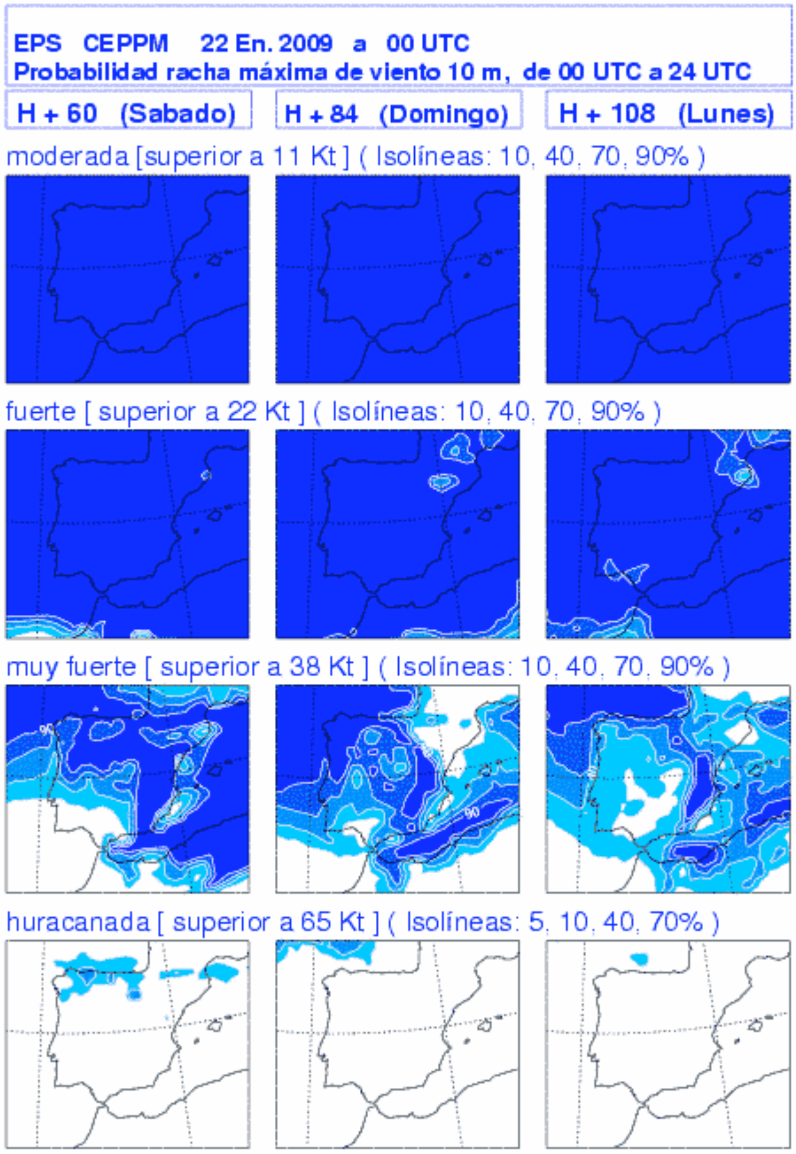

Figure 5. Operational maps of forecast maximum gust probabilities, in 24 h period and for different thresholds (11 kt, 22 kt, 38 kt and 65 kt) from 22th January 2009 VarEPS run: H+60, H+84 and H+108.

On 23th and 25th of January 2009, the extra-tropical cyclone Klaus crossed the north of Spain and the south of France producing several deaths and generalized damages. The Atlantic depression underwent a process called explosive cyclogenesis (when a surface cyclone deepens at a rate higher than 1 hPa/hr over 24 hours, approximately) in front of the Spanish Atlantic coasts.