Application and Verification of ECMWF Products 2019

AEMET

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1. Summary of major highlights

2. Use and application of products

In AEMET, forecasters use the atmospheric and ocean-wave components of the ECMWF IFS on a regular basis. The use of ecCharts is also common among forecasters. The IFS is used to produce automatic products for different users, such as Defence, Civil Protection, Aviation and General Public.

2.1 Direct Use of ECMWF Products

- Production of maps for forecasters of short, medium, extended and seasonal range forecasts, and for our website.
- EFI and SOT maps from IFS ENS are used as an early warning for possible extreme events, especially in medium range forecasts. They are used in combination with clusters and probability maps for different thresholds and variables.
- As an input to AEMET Digital Forecast Database (BDDP), with other NWP models (see 2.2.2)

2.2 Other uses of ECMWF output

2.2.1 Post-processing

- 2m temperature: IFS HRES (both 12 and 00 UTC runs) 2T grids are statistically downscaled to generate 1km grids for the next 10 days. The method uses a bias correction ('exponential decay correction' based on observed temperatures from the automated Spanish network) and an altitude correction (from a 1 km altitude grid) and is applied to both the 'Peninsula/Baleares' and the 'Canary Islands' areas.
- Production of thermodynamic diagrams and hodographs from pseudo soundings with all the hybrid levels of IFS HRES up to 120 hours using a tool fully developed in AEMET.
- Direct irradiance: calibration of the direct irradiance provided by the IFS ENS using a quantile regression method to improve its spread for the short range (1-2 days ahead) for specific geographical locations.

2.2.2 Derived fields

- 5 km grid: We adapt the original resolution of IFS fields (HRES and ENS) to the 5 km “standard” resolution of our Digital Forecast Database (BDDP), used for producing automatic products. In this BDDP we use forecasts from several models; HRES is generally used from H+48 ahead and ENS is used from H+0.
- Every day for both 00 and 12 runs, we generate 6 or less objective clusters in two specific areas (Peninsula/Baleares and Canary Islands), for a 15 day period using the new clustering method developed in the ECMWF (Ferranti et al, 2014).
- We produce probability maps for cloudiness, rainfall, snow, CAPE, wind, wind gusts, temperature and temperature variations.
- We also obtain other derived fields for several specific uses (turbulence indices, 0 ºC wet bulb temperature altitude, etc.)
- Automatic products (from BDDP) in text and pictogram formats which include deterministic and probabilistic information are generated for AEMET´s website.
- Snowpack evolution analysis in order to assess snowfall (Spain and synoptic regions). The difference in the snowpack depth analysis between the lasts two HRES runs is generated in order to evaluate possible snowfall in the last 12 hours. This process is extended to 24, 48 and 72 hours.

2.2.3 Modelling

- Deterministic integrations using HARMONIE-AROME model:
    - IFS HRES forecast cycles at 00, 06, 12 and 18 are used as boundary conditions for the HARMONIE-AROME limited-area model.
    - We run HARMONIE-AROME at 2.5 km every 3 hr with 48 hours forecast length. For the initial condition, the first guess is constructed using the large scale from IFS HRES and the small scale from HARMONIE-AROME (blending method).
    - We maintain a HARMONIE-AROME 2.5 km deterministic run in a smaller domain as a Time Critical facility at ECMWF computers which is used as poor man ensemble and as backup for the local integrations.
    - We run HARMONIE-AROME at 1 km resolution for local costal domains in dynamical adaptation mode using IFS HRES as initial condition.

- We use IFS HRES forecast fields as forcing of the CTM MOCAGE and its dispersion model version MOCAGE-ACCIDENT. MOCAGE is a multi-scale chemical transport model that can be configured with up to three nested domains and it is used by AEMET to provide air quality forecast over Spain through a license agreement of use with Météo-France. The configuration used comprises a global domain at 2º resolution, a continental domain (40ºW-26ºE and 24ºN-60ºN at 0.5º resolution) and a regional domain (15ºW-10ºE and 33ºN-45ºN at 0.1º resolution). In the operational execution we use IFS HRES forcing (surface and up fields at model levels) for the global and continental domains and Harmonie-Arome forcing for the domain of higher resolution but, actually, we are running an experimental version that uses IFS HRES forcing for all the domains. We also run MOCAGE-ACCIDENT for giving response to civil protection authorities in environmental emergencies over different areas and at different resolutions. We use IFS HRES forecast fields (horizontal winds, temperature, specific humidity and precipitation at model levels) as forcing for global domain at 1º resolution and for continental domain at 0.2º resolution.

3. Verification of ECMWF products

3.1 Objective verification

3.1.1 Direct ECMWF model output (both HRES and ENS), and other NWP models

Objective verification of IFS HRES forecasts are regularly performed using AEMET mesoscale surface network and comparing with the limited area models for forecasts lengths up to 48 hr.

- 2m temperature shows a clear negative bias which is larger in spring
- Good wind forecasts (currently better than HARMONIE-AROME) but clear underestimation of wind speeds above 10 m/s
- IFS HRES precipitation forecasts seems limited to a maximum of 60 mm/12 hr
- Diurnal cycle of precipitation: Occurs 3 hr earlier than observed with a mean maximum between 12-15 UTC instead of the 15-18 UTC maximum which is observed.
- Verification against soundings show a slight improvement of IFS HRES forecasts compared to HARMONIE-AROME forecasts.

Global and direct irradiance forecasts (SSRD and FDIR fields) from the IFS HRES and the IFS ENS have been verified against observations from the RRN, the Spanish radiation network, for the years 2015 to 2018. These predictions have been compared respectively with forecasts from Harmonie-Arome (the deterministic area model run in AEMET), and gSREPS. It has been found that Harmonie-Arome and IFS HRES have similar performance. On the other hand, gSREPS is more accurate than IFS ENS predicting the direct irradiance for the short range (using CRPS as the score to compare them). IFS ENS is penalized by its low spread in the first days of forecast.

3.1.2 Post-processed products and end products delivered to users

IFS ENS direct irradiance forecasts have been calibrated (see 2.2.1) for the years 2015 to 2018, and compared to gSREPS. The calibrated forecasts show a better spread and a big improvement of CRPS, getting a similar performance to gSREPS.

3.1.3 Monthly and Seasonal forecasts

3.2 Subjective verification

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

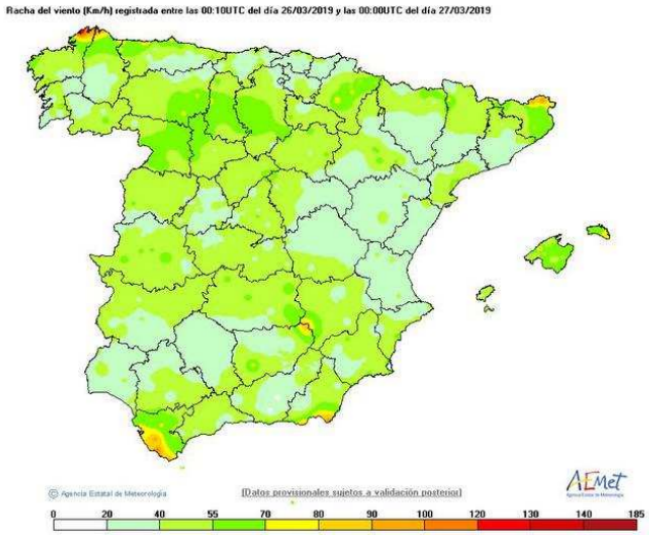
- Precipitation underestimation in events with orographic rainfall enhancement and/or heavy convective rainfall.
- Overestimation of wind gusts in elevated areas and sometimes underestimation in low elevated areas in valleys. (The case study included in section 3.2.2 is related to this issue)
- Jumpiness between consecutive runs of the model.
- IFS HRES-WAM: Near the Atlantic coast, underestimation of wave height. In high sea, with waves over 6 meters.

3.2.2 Case studies

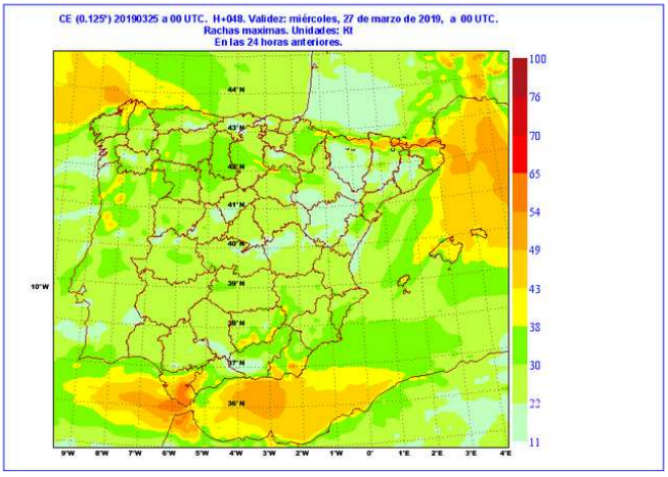
On march 26th wind gust were overestimated over the Pyrenees and the Gibraltar Straight. This overestimation is often observed over mountains (Pyrenees).

Racha máxima de viento

OBSERVADO



HRES-IFS



4. Requests for additional output

New point rainfall products are showing promising results and their improvement and consolidation, particularly with the inclusion of orography, will be very welcomed.

5. Feedback on ECMWF "forecast user" initiatives

AEMET will need to look in more detail to the information available in the Forecaster User Portal. The web-based Forecaster User Guide is much more user-friendly than the previous format was.

6. References to relevant publications

7. Structure of these Reports)