Application and Verification of ECMWF Products 2021

AEMET

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1. Summary of major highlights

It is expected that a more detailed description of any items included here will appear in section(s) below.

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)
- The permalink access to products is widely used and extremely useful. Its availability in the new catalog will be warmly welcomed.

2.2 Other uses of ECMWF output

Describe the different ways in which you use ECMWF forecasts indirectly, in the following categories:

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.
- NivoGraM: A web app that shows the evolution of different postprocessed fields, related to snow and snow cover, for 72 hours.

2.2.3 Modelling

Deterministic integrations using HARMONIE-AROME model:

- IFS HRES early delivery 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 with 3 hr analysis cycles and 72 hours forecast length at 00, 06, 12 and 18 utc. 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 backup for the local integrations.

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 and aerosol 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.

The AEMET wave prediction system is based on a local area configuration of the ECMWF CY45R3 (ECWAM) global wave model. It consists of a single nesting that receives forcings and hourly boundary conditions from the model that is operationally executed in the ECMWF. The spatial resolution has been increased to 4 km to capture in greater detail the evolution of wave energy as it interacts with obstacles and shorelines. The system runs with a 72-hour scope twice a day (at 00 and 12 UTC).

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 HRES in the Short Range (0-48):

- 10 m wind: overall positive bias of around 0.4 m/s except over mountains where we find a negative bias of –0.6 m/s for stations above 1000 m.
- 2 m temperature: negative bias from –0.2 to –0.5 ºK.
- Cloud cover: compared with synops, we find a small negative bias of –0.2 to –0.5 octas.

3.2 Subjective verification

3.2.1 Subjective scores

- Precipitation underestimation in events with orographic rainfall enhancement and/or heavy convective rainfall.
- 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 october 29th 2020 we reported to the ECMWF ServiceDesk the under-prediction of wave heights over the Atlantic (not the first case). The response came with the following explanation: the under-prediction was likely due to a combination of too low winds (transitioning tropical cyclones are notoriously difficult to handle) and not enough response by the wave model. ECMWF wave model expert plans to use this case to test out new versions of wind-wave coupling that have been under-trial.