

NEW High Performance Computer

A new BULL supercomputer is being installed.

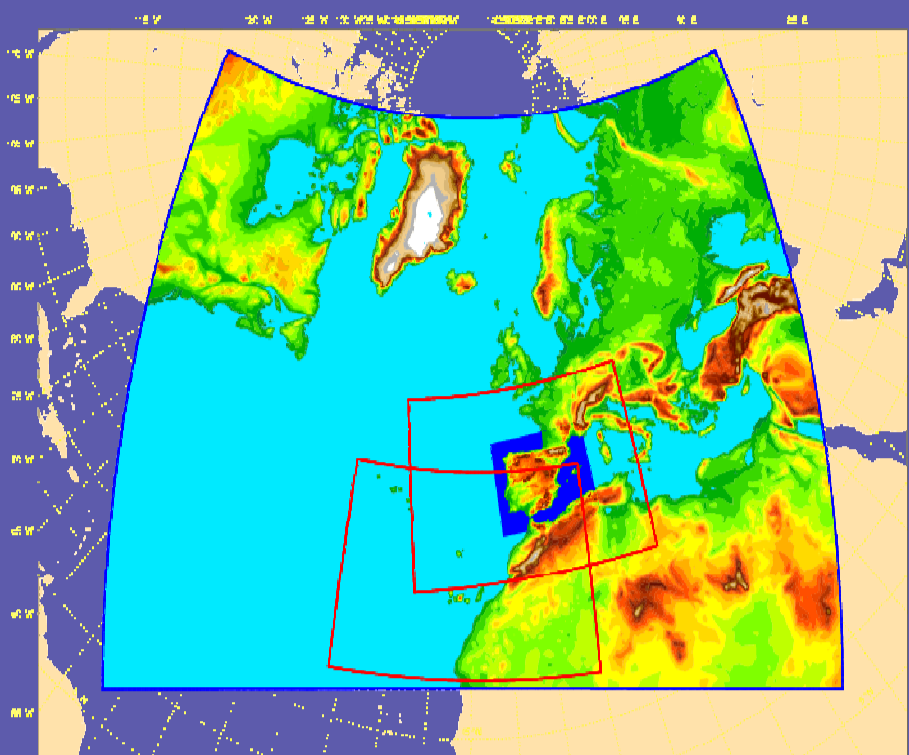
- Currently a small transition system has been installed. The system allocates operations based on HIRLAM deterministic model and the environmental model MOCAGE. It also allows daily HARMONIE runs in a not too large domain.
- In the coming months the 1st Phase on the supercomputer will be installed with 3456 processors what will allocate 2 deterministic runs of HARMONIE/AROME in bigger domains and a small ensemble system of 10 members.
- The 2nd Phase in 2016 will have 7760processors and will allow to implement the complete **γ-SREPS**



The HIRLAM Suite

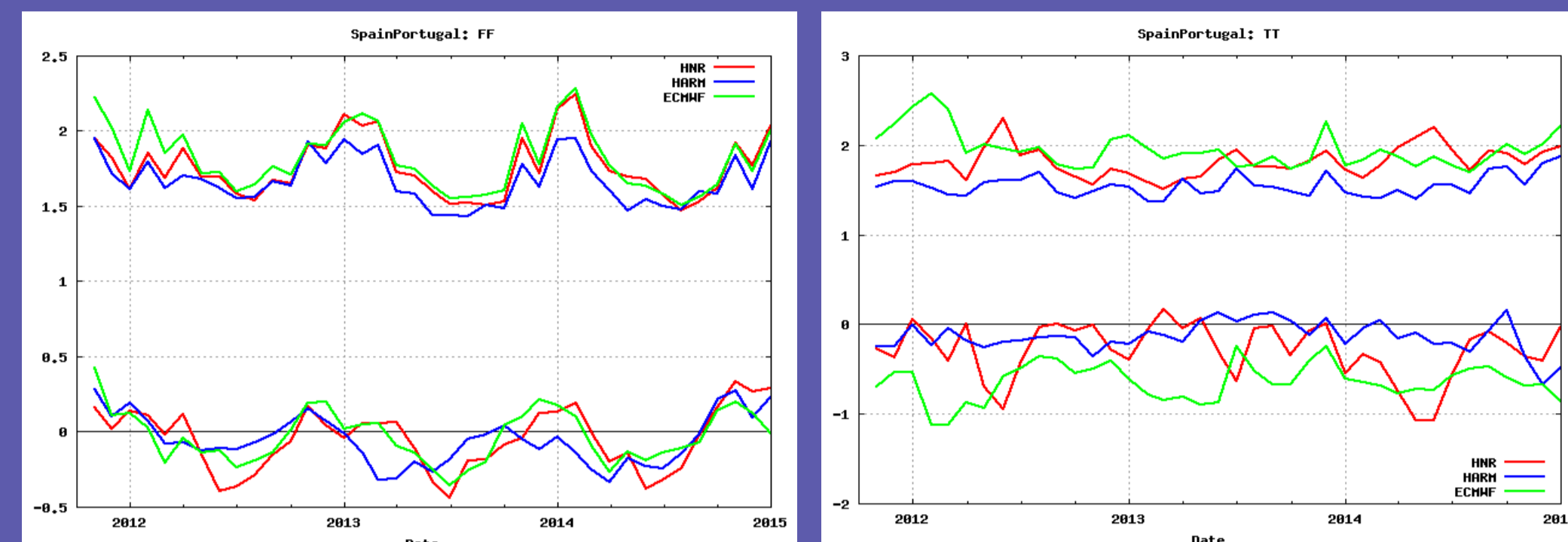
3 domains using **HIRLAM v7.2**:

- ONR** (0.16deg,lat x lon 582x424, ts 600 sec)
- HNR** and **CNN** (0.05deg,lat x lon 606x430, ts 240 sec)
- Four runs at 00, 06, 12 & 18 UTC
- 40 levels in the vertical (more resolution in the PBL)
- SL Dynamics ISBA
- 3DVAR assimilation ECMWF Blending



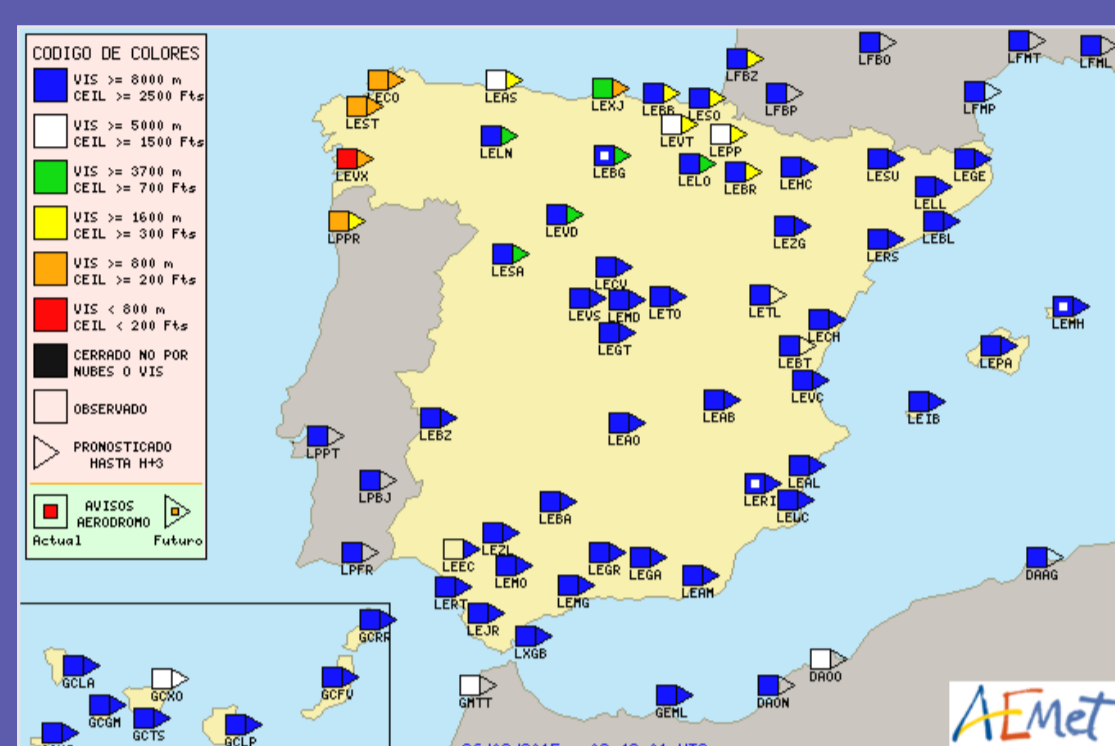
Historical Verification

Long term verification charts for wind and temperature show that Harmonie high resolution model performs better than HNR and ECMWF.



HIRLAM Applications: Aeronautical products

Graphical applications are developed using Hirlam forecasts. Products like predicted soundings and another aeronautical information.



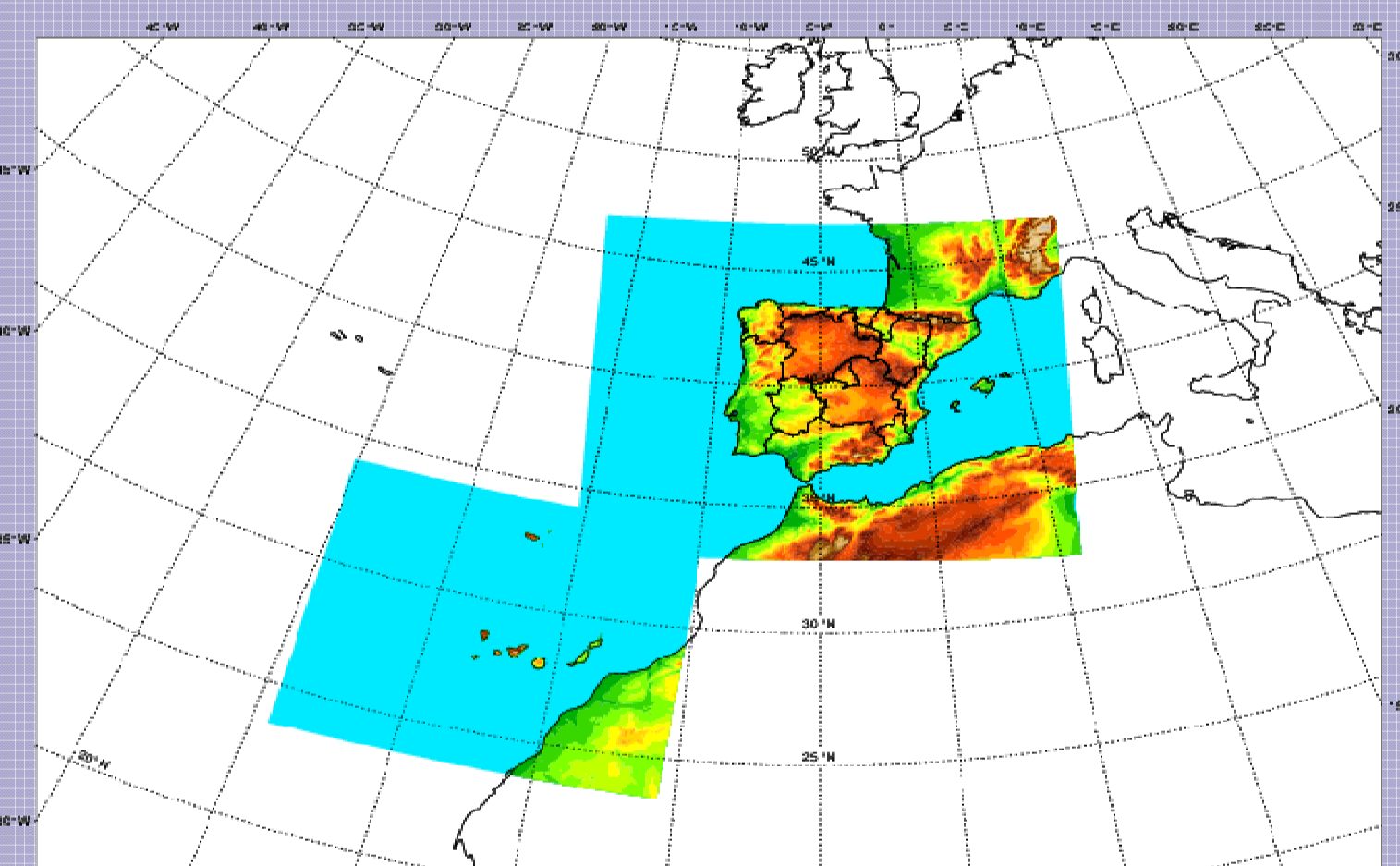
External Users

All the post processing are currently based on **gl**.

- Government Institutes:
- Nuclear Security.
 - Fluvial and Hydrological management.
 - Transports Monitor: Maritime, train and road traffic.
- Energy Companies:
- Electric and Gas Companies.
 - Solar farms.
 - Eolic parks.
 - Meteorological Institutes.
 - Meteorological Consultors.

OPERATIONAL CONFIGURATION

- HARMONIE system in **AROME configuration** is run at ECMWF 4 times per day with a forecast length of 48 hours for 2 geographical domains (Iberia and Canary Islands).
- Model set up based on Cycle 38h1.2 :
 - **2.5 km resolution 65 Levels**
 - **ALADIN NH dynamics**
 - **Surface analysis: Canari-OI.**
 - Upper Air initialization
 - **3DVar with conventional obs 3 hr cycle** for the Iberian domain. +1:10 cutoff time
 - **Blending** with ECMWF H+6 and 6 hr cycle for the Canary domain
- Boundaries: Direct nesting in ECMWF forecasts
- Surface processes using **SURFEX** (ISBA tiling)
- Unified **scheme shallow convection** (EDMFM)
- **Explicit deep convection**
- **ICE-3 microphysics** with 3 prognostic precipitation species



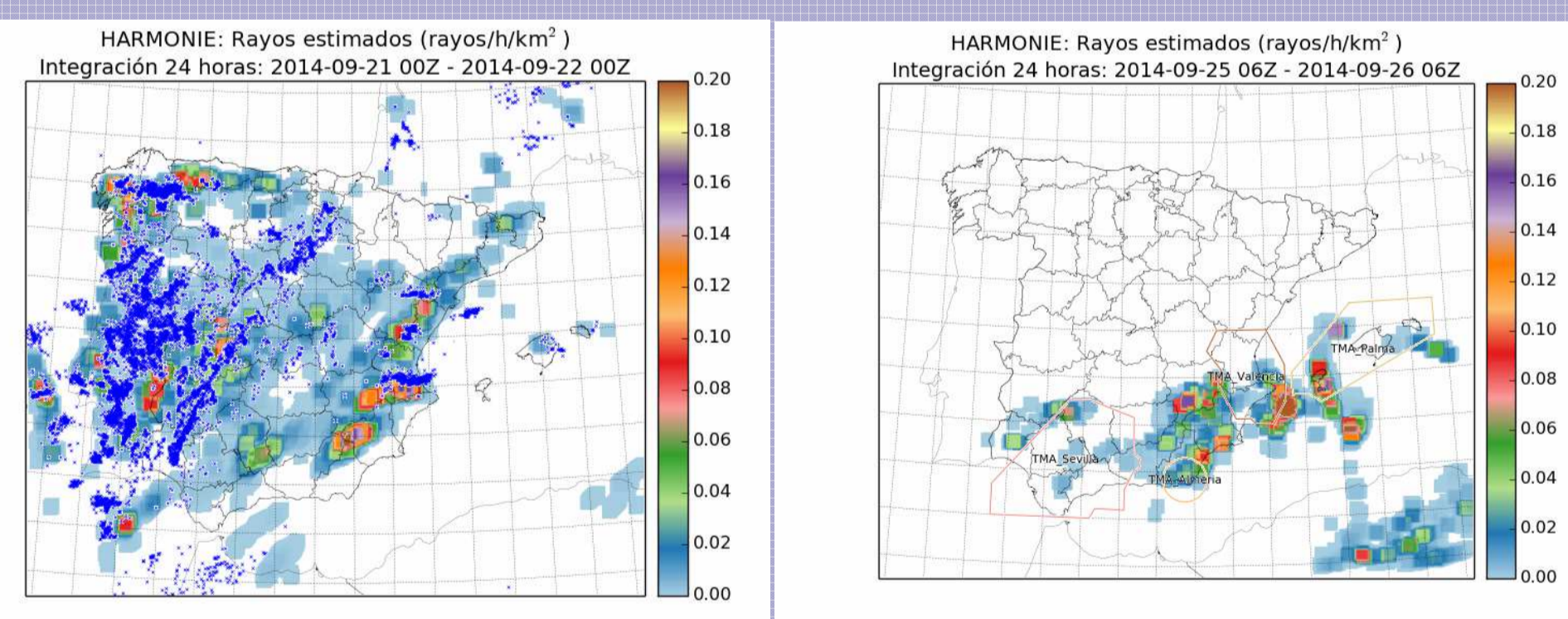
Operational domains at 2.5 km resolution

RESULTS

- **Clear added value of HARMONIE/AROME on near surface variables** compared with models of larger scale (HIRLAM and ECMWF)
- **Improvement of wind forecasts** which have been successfully used for sailing forecasts.
- **Clear improvement of fog forecast** but with many false alarms. Work on progress to improve fog and low clouds in the model.
- **Significant improvement of precipitation forecasts** including spatial distribution and amount of precipitation but revealing uncertainty in the prediction of small scales suggesting the need of ensemble approaches.
- **Operational forecasters and other users are increasingly using the model.** Currently in the processes of migrating the applications and post-processing from HIRLAM to HARMONIE.

LIGHTNING DIAGNOSTIC

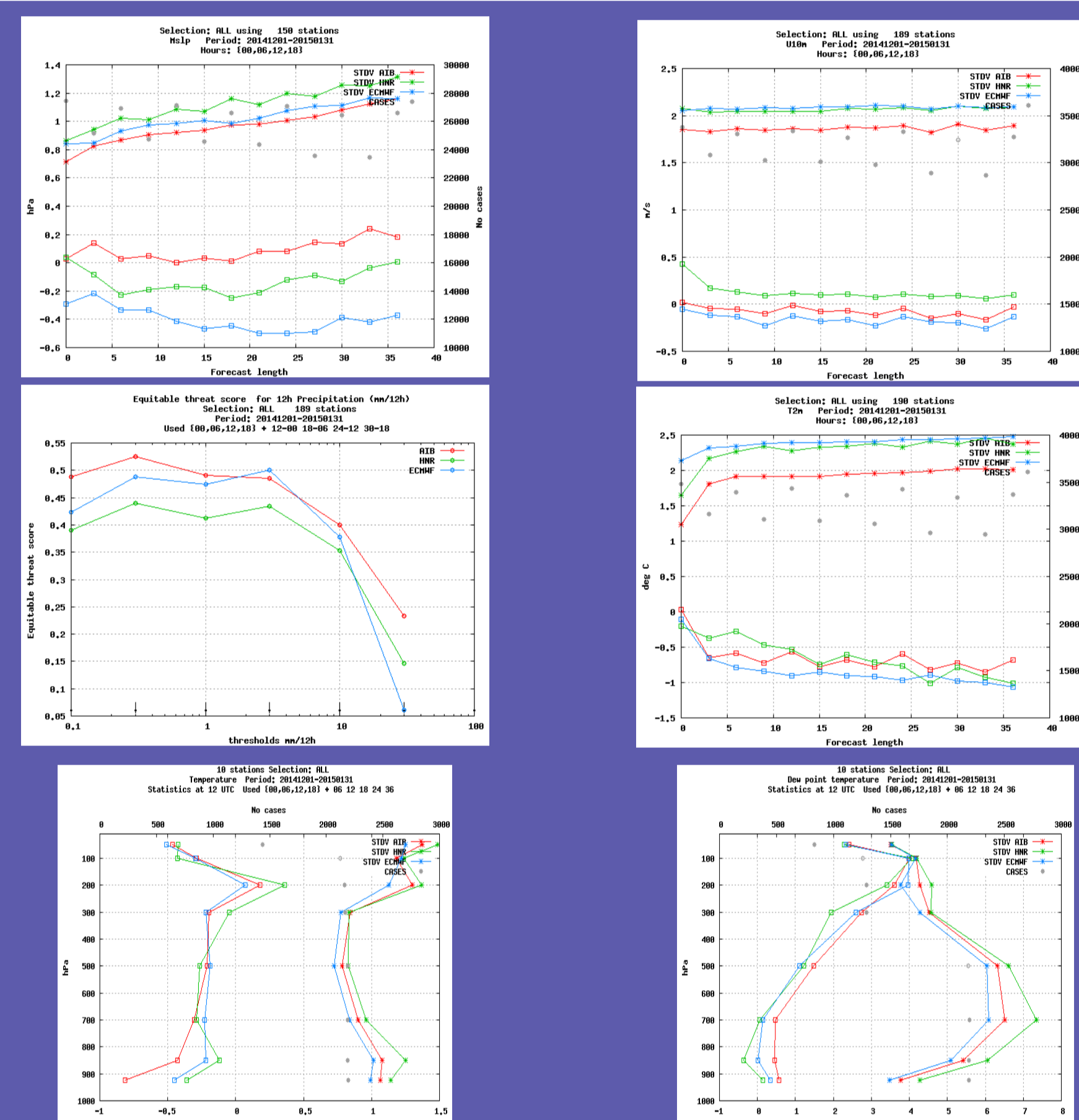
- **Lightning density** based on vertical integrated graupel following KNMI approach adapted to AEMET lightning network
 - Performance depends very much on the representation of convection in the model but in general it is a good estimator of lightning activity
 - A tool has been developed to generate warnings for aviation



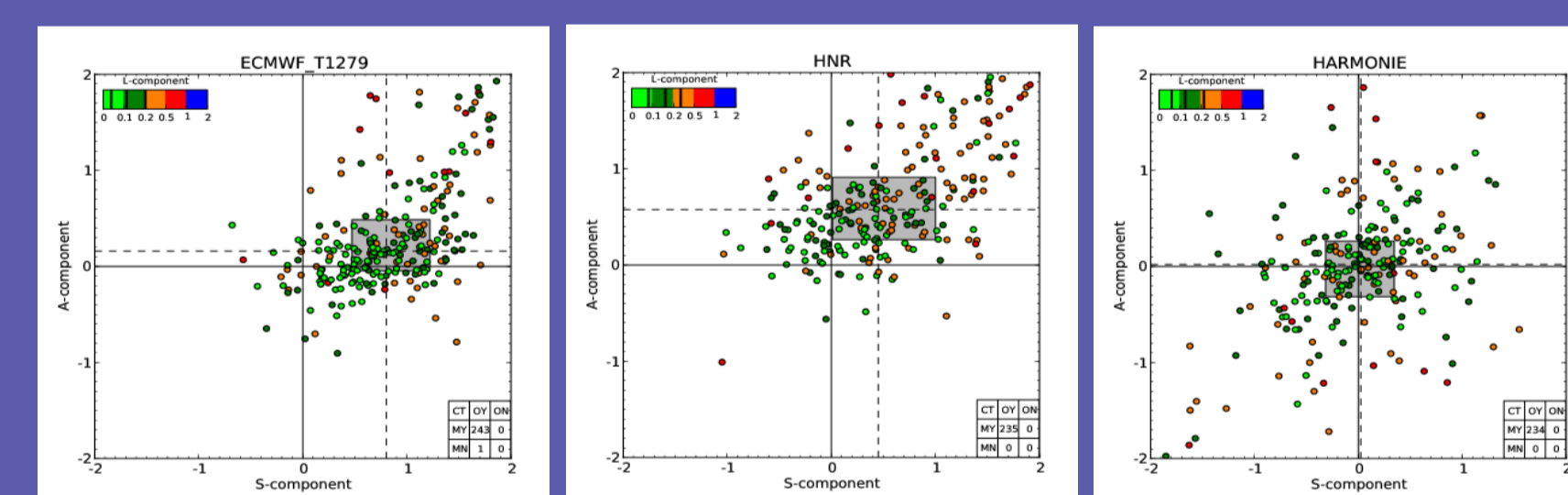
Simulated lightning density in 24 hr compared to actual cloud-to-earth discharges (blue crosses)

Simulated lightning density and TMA warnings for different airports

HARMONIE VERIFICATION



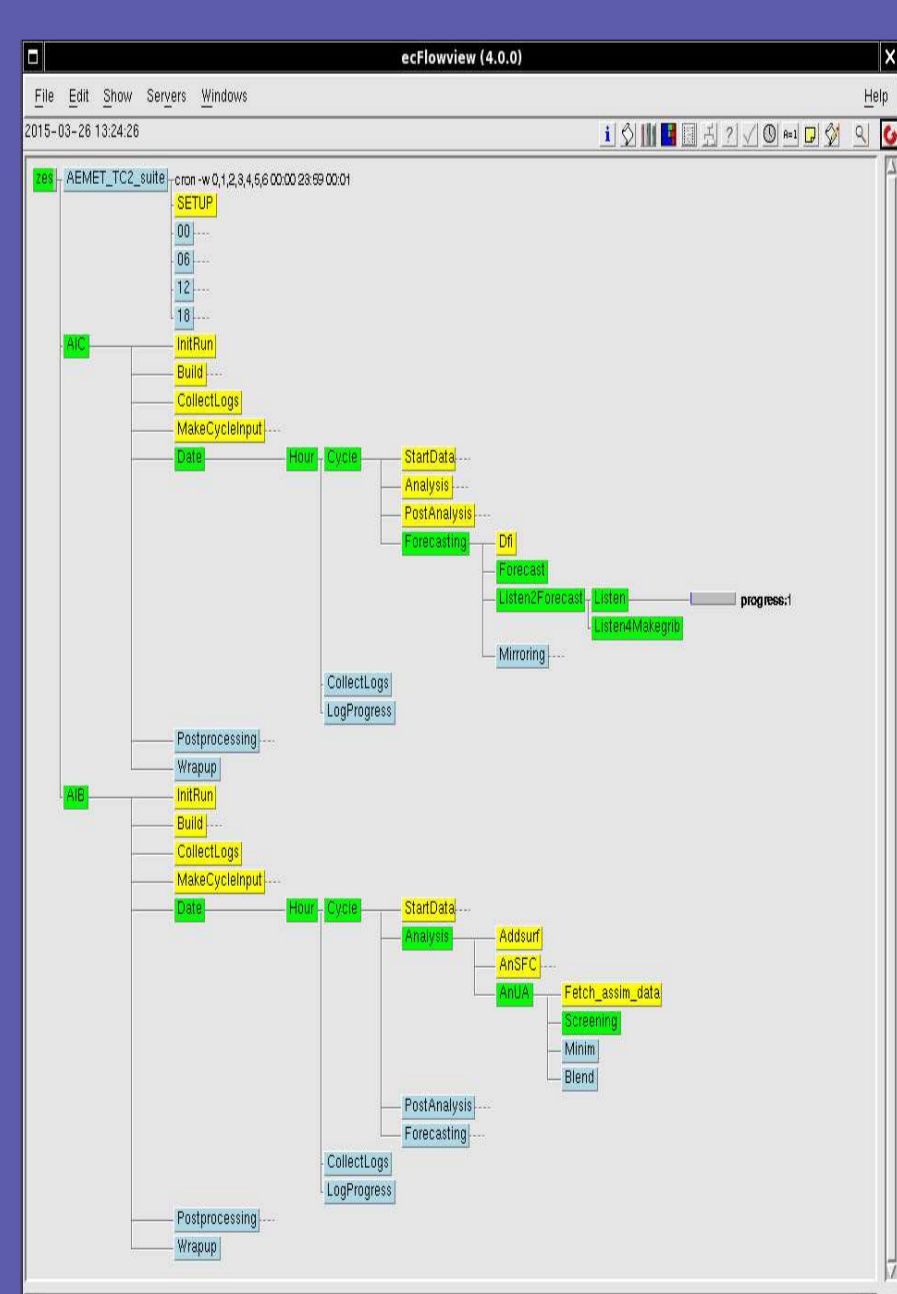
For upper level fields, errors in HARM are lower than in HIR 0.05 but worst than in ECMWF model



SAL verification allows comparison precipitation forecasts from models with different resolutions as observations are upscaled to model resolutions. HARM results seems to be quite good.

Towards a TC2 operational application at ECMWF

The **mSMS** system has been replaced by an **ECFLOW** system which is the one that drives the integration. The main motivation for this change is that it is a requirement from ECMWF in order to be operated as a **TC2 application** but at the same time ECFLOW is more flexible and powerful than mSMS.



ENVIRONMENTAL FORECAST: MOCAGE

MOCAGE is a Global Chemical Transport Model developed by Météo France and used at AEMET to make chemical weather forecasts and calculate the evolution of the dispersion of hazardous material released to the atmosphere (volcanic ashes, radioactive matter, etc). It allows nested domains (up to three, additional to the global one). Over Iberia and Balearic Islands AEMET runs MOCAGE at a horizontal resolution 0.1 degrees. Besides, we participate in the FP7 MACC-III Project (Monitoring Atmospheric Composition and Climate-Interim Implementation) using MOCAGE to model the atmospheric composition in Western Mediterranean at 0.05 degrees (horizontal resolution). Meteorological forcings come from ECMWF IFS (GLOB22) and HIRLAM AEMET ONR (INML05) and HNR (INMH01 and MACCH3)

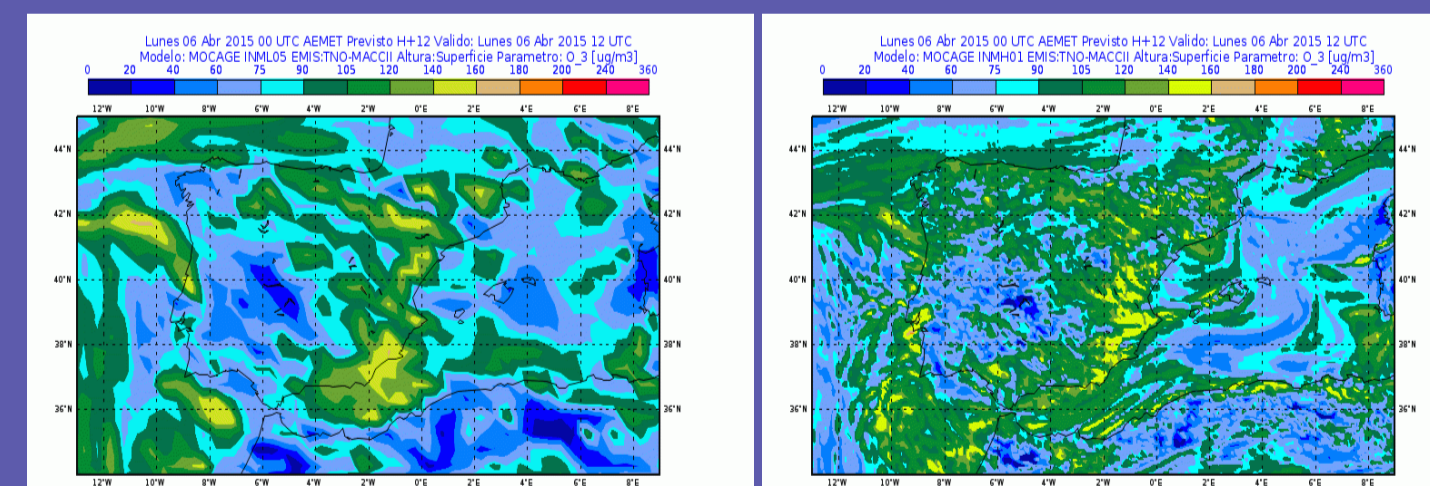
GLOB22 (GLOBAL 2 deg)

INML05 (0.5 deg)
INMH01 (0.1 deg)
Emissions:
IPCC + TNO_MACCII

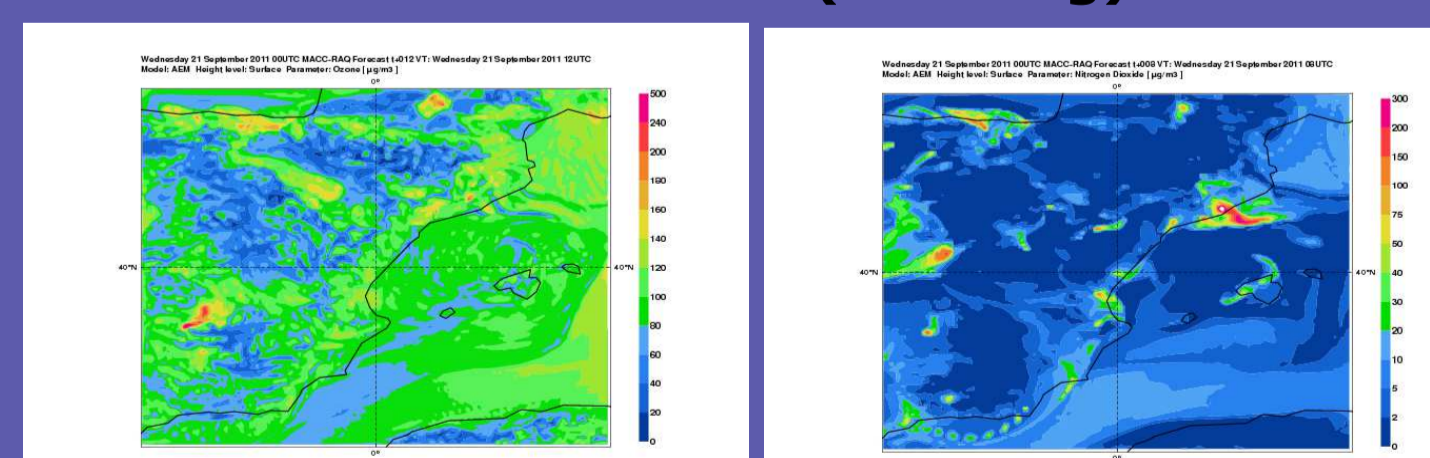
MACCH3 (0.05 deg)
MACC RAQ ENSEMBLE MEAN
(AS BOUNDARY CONDITIONS)
Emissions:
IPCC + GEMS_TNO

<http://www.gmes-atmosphere.eu>

INML05 (0.5 deg) Ozone INMH01 (0.1 deg)



Ozone MACCH3 (0.05 deg) NO2



WAVE FORECAST

AEMET is implementing the so-called **SPOC**, a Wave Forecast System for the North Atlantic Ocean and the Mediterranean Sea based on the 3rd generation **WaveWatch III Model**, developed by the NOAA's Marine Branch. It introduces new source terms (surf breaking, bottom scattering) and more accurate nonlinear wave-wave interactions routines. Full two-way multi-grid interactions are considered at the time step level and have a dynamic data structure. Wind forcing comes from HIRLAM and HARMONIE.

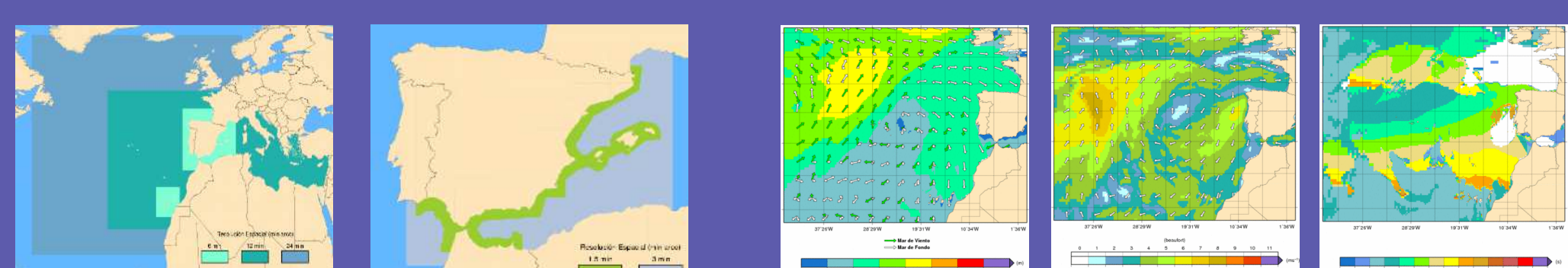
NESTING

Nested grids have been established in order to make a commitment between focusing at the Spanish coasts and the swell generation in the northwest Atlantic, as well as forecasting in a reasonable time. There are one low resolution module for the North Atlantic and Mediterranean, and four high resolution modules around the North, East and South of Iberia and the Canary Islands.

WAVE FIELDS

Users of Wave Forecasts are specially interested in these fields:

- Significant wave height and average wave direction, period and peak frequency;
- Wind speed and direction at 10m height;
- Field partitions into wind sea and primary and secondary swells.



REMARKS

- AEMET has acquired a new BULL high performance computer last year. Currently we are in the process to install the 1st phase of the system.
- The three operational Hirlam runs have been migrated to the BULL HPC.
- The Hirlam post processing runs now in a linux cluster using gl as the main tool.
- The Hirlam output files are used to forcing other operational models like MOCAGE (Global Chemical Transport Model) and WaveWatch III model (Wave Forecast System).
- Two Harmonie high resolution experiments run four times a day in ECMWF computers.
- Towards the operational Harmonie suite in AEMET.
 - Harmonie run on cca using ECFLOW, and a formal request was made to ECMWF in order to run it as a Time Critical Facility 2.
 - Harmonie is going to be run in the new BULL HPC along this year.