## Operational suite
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HARMONIE-AROME operational suite is based on v40h1.1 and it is one of the HARMONIE RCRs used to monitor the quality of the reference system:

- **2.5 km** runs 8 times per day with 48 hours forecast length and 15 min output
- 2 geographical domains (Iberian Peninsula and Canary Islands).
- 3DVar upper air analysis with 1:10 *cutoff* time including ATOVS and GNSS slant delay data
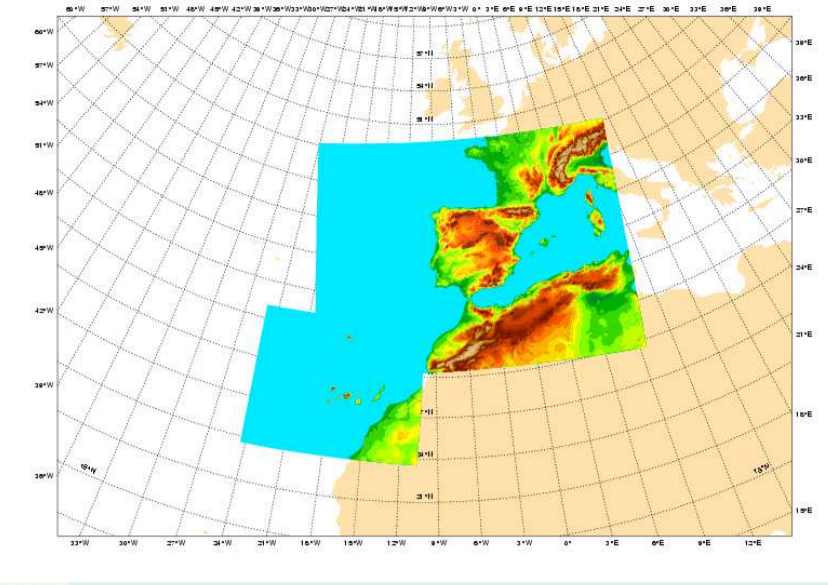
- **Surface data assimilation** with optimal interpolation.
- **AROME physics**: Explicit deep convection, SURFEX, ICE3 microphysics, HARATU turbulence and EDMFM shallow convection
- Run in AEMET's Bull computer having 324 Nodes and 168 Teraflops

Operational Verification

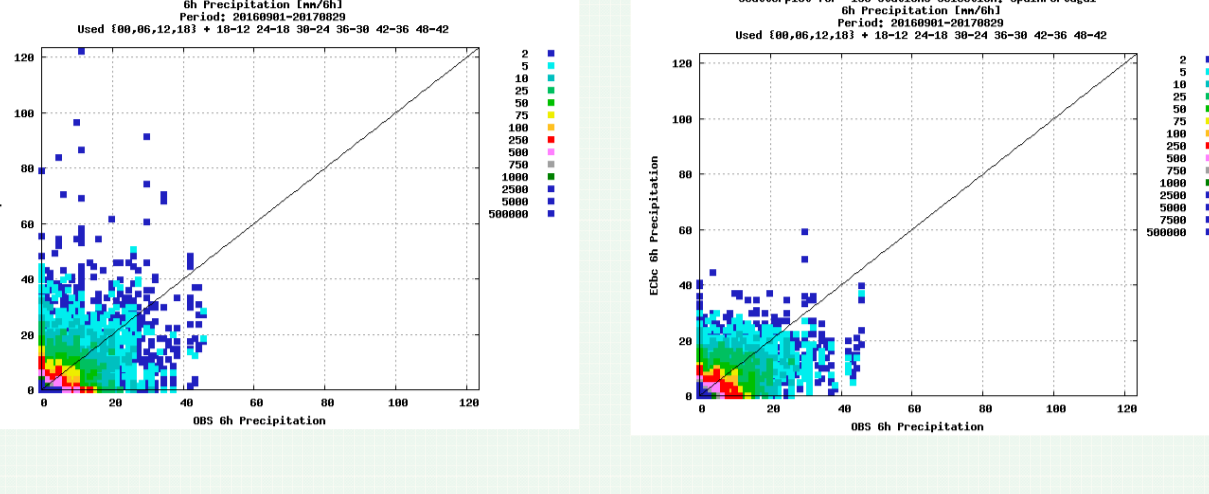**Verification against observations** (sep 2016- ago 2017): HARM-AROME v40h1.1, v38h1.1, ECMWF.
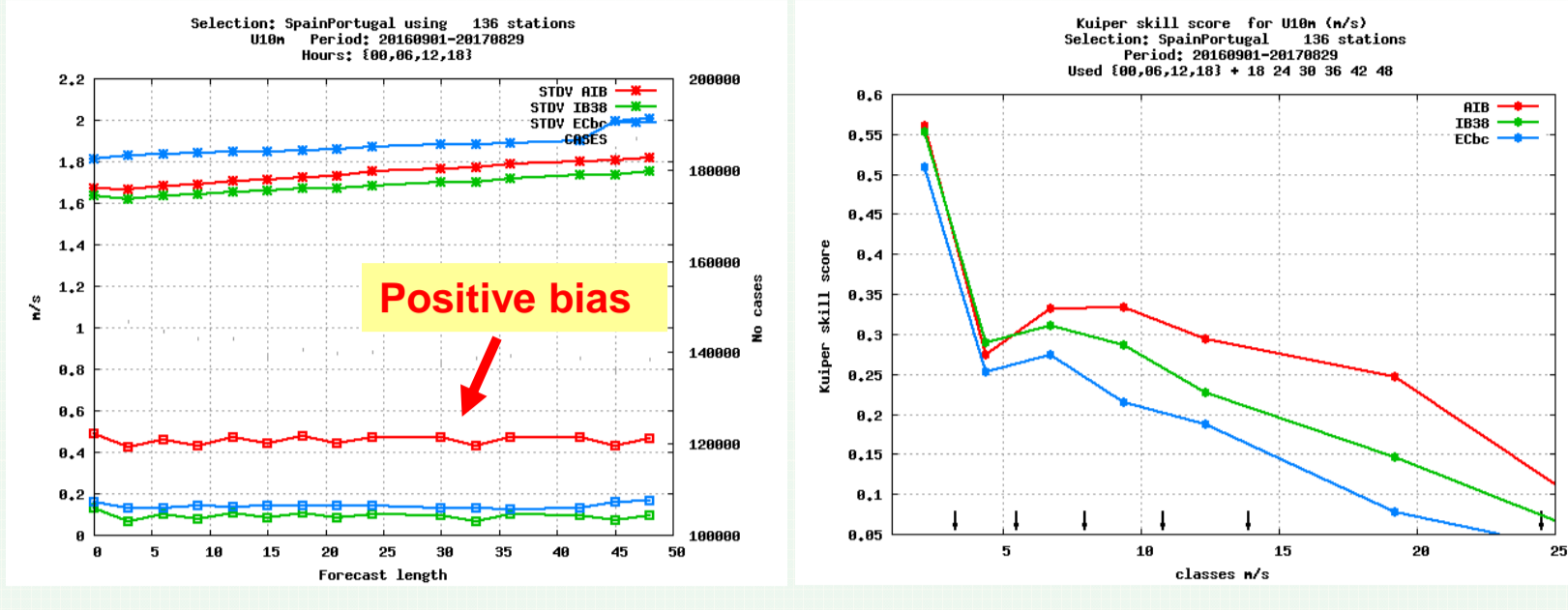
Positive bias

**10m wind.** Cycle 40h1.1 shows a clear positive bias but overall better results for wind speeds > 5 m/s
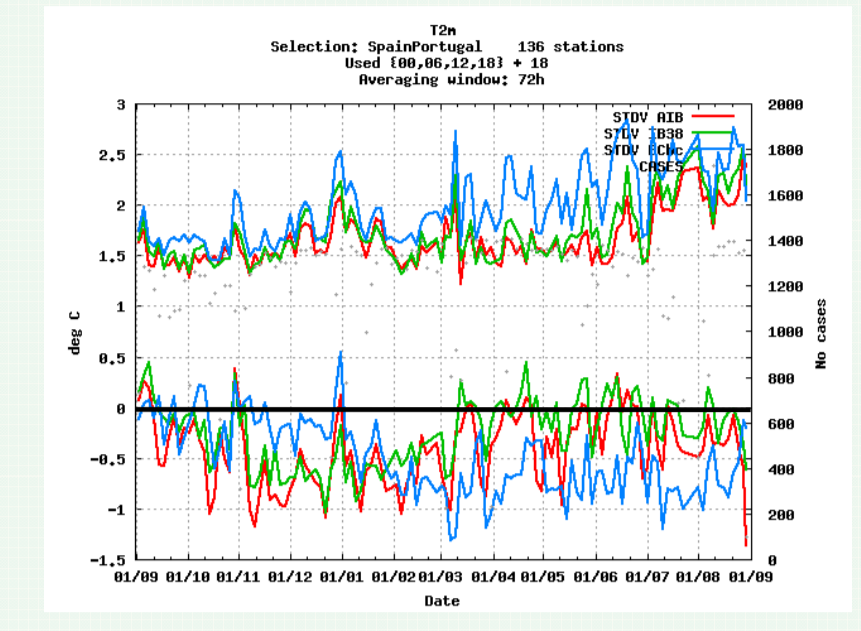
T 2m: Clear improvement in v40h1.1. The evolution of the errors shows a negative bias in spring and summer.

Precipitation. Scatter-plots of 6 hr acc. pcp for HARM-AROME (left) and ECMWF (right). As expected the intensities are lower for the ECMWF. In general ECMWF produce smoother fields with a tendency to overestimate the precipitation area.

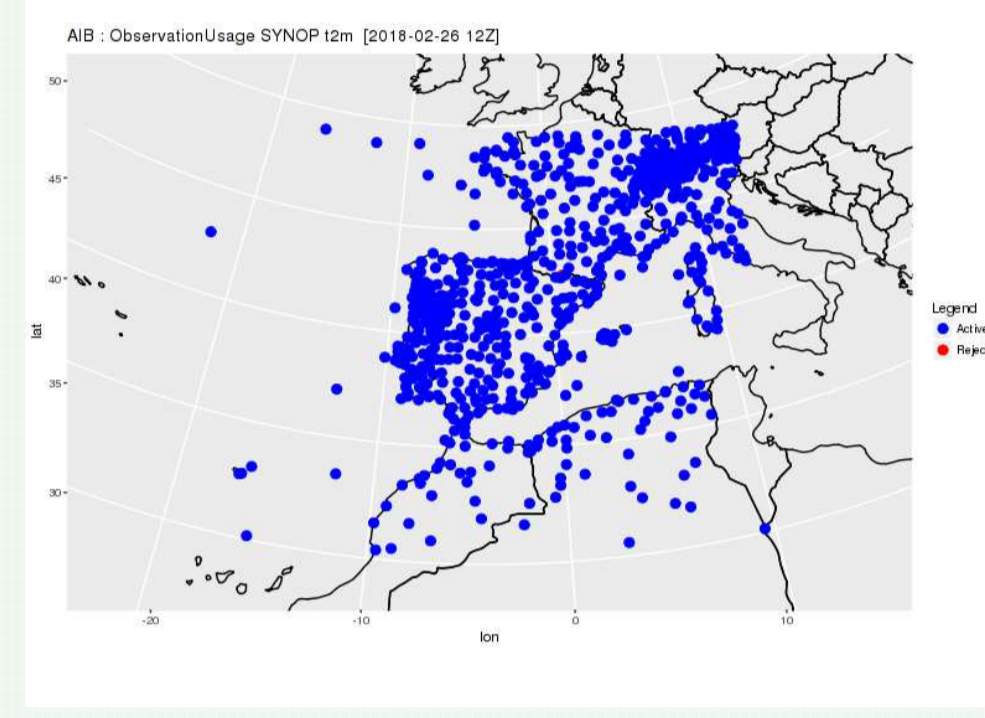## Update of ECOCLIMAP II
svianaj@aemet.es

Update inland water bodies over Iberian Peninsula in ECOCLIMAP data base

ECOCLIMAP 2.2
ECOCLIMAP 2.5
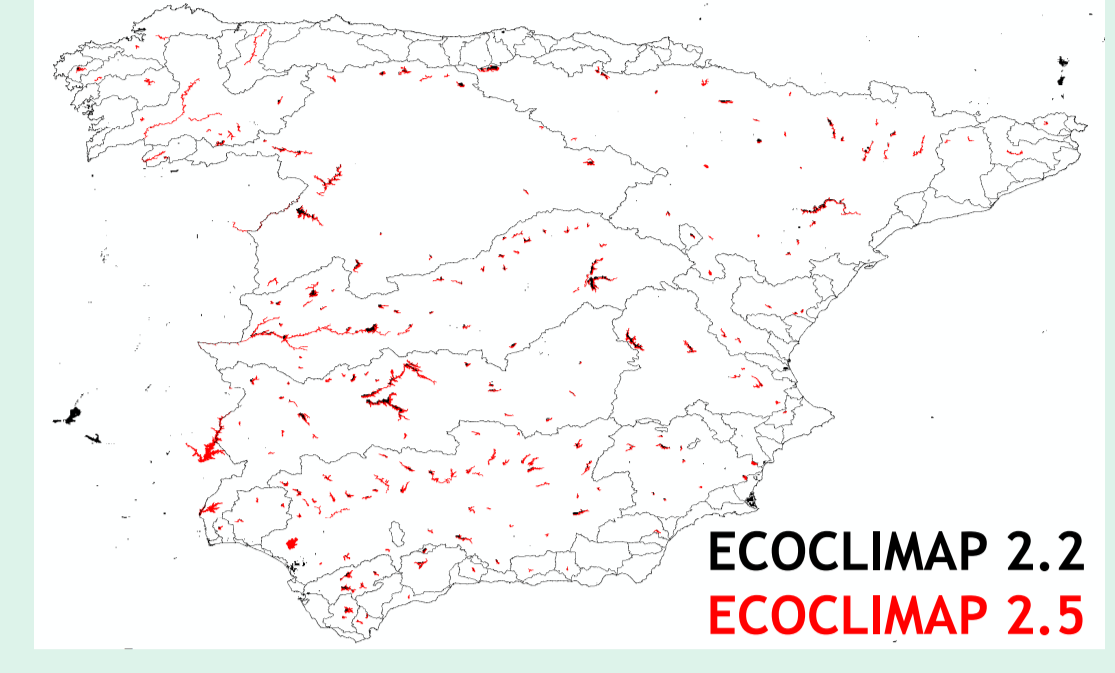
→ In ECOCLIMAP 2.5
http://www.umr-cnrm.fr/surfex/spip.php?article136
3248 km² ~ 0.6% of mainland Spain

Observations in the assimilation
jsosac@aemet.es

**Observations entering in the surface assimilation**

The number of surface observations entering in the assimilation has increased significantly thanks to the additional observations from the Portuguese mesoscale network (IPMA-AEMET collaboration)
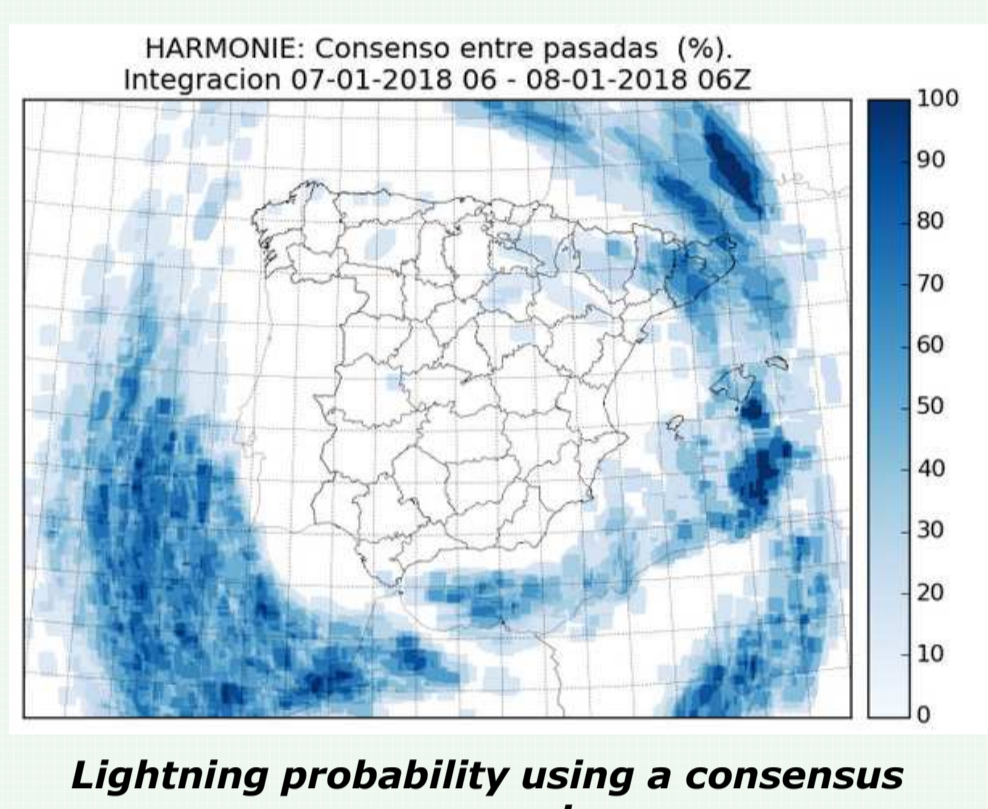
Lightning probability

Estimation of lightning probability for aviation

- Based on vertical integrated graupel following KNMI approach adapted to AEMET lightning network
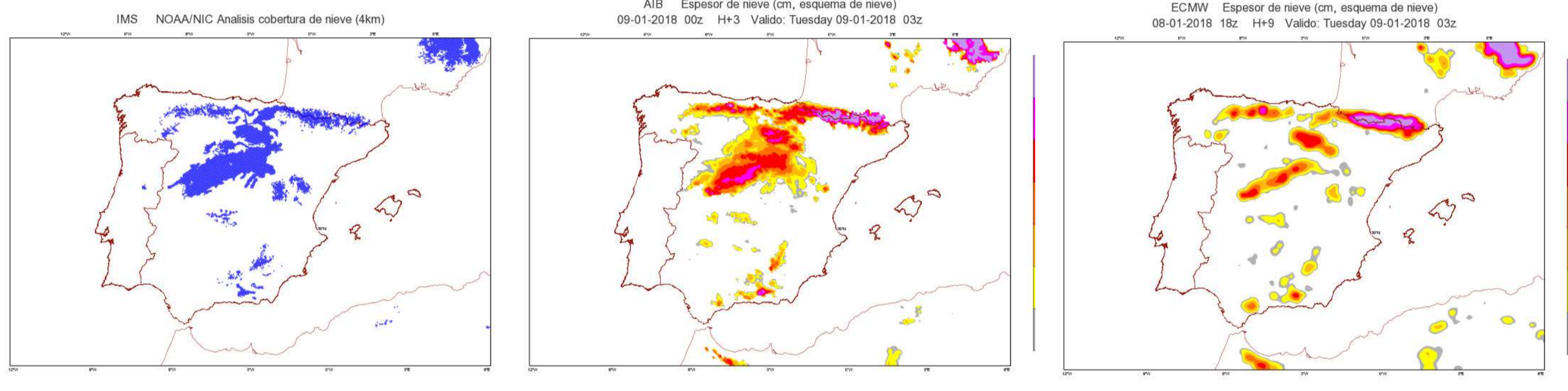- Consensus approach using integrations from several deterministic cycles
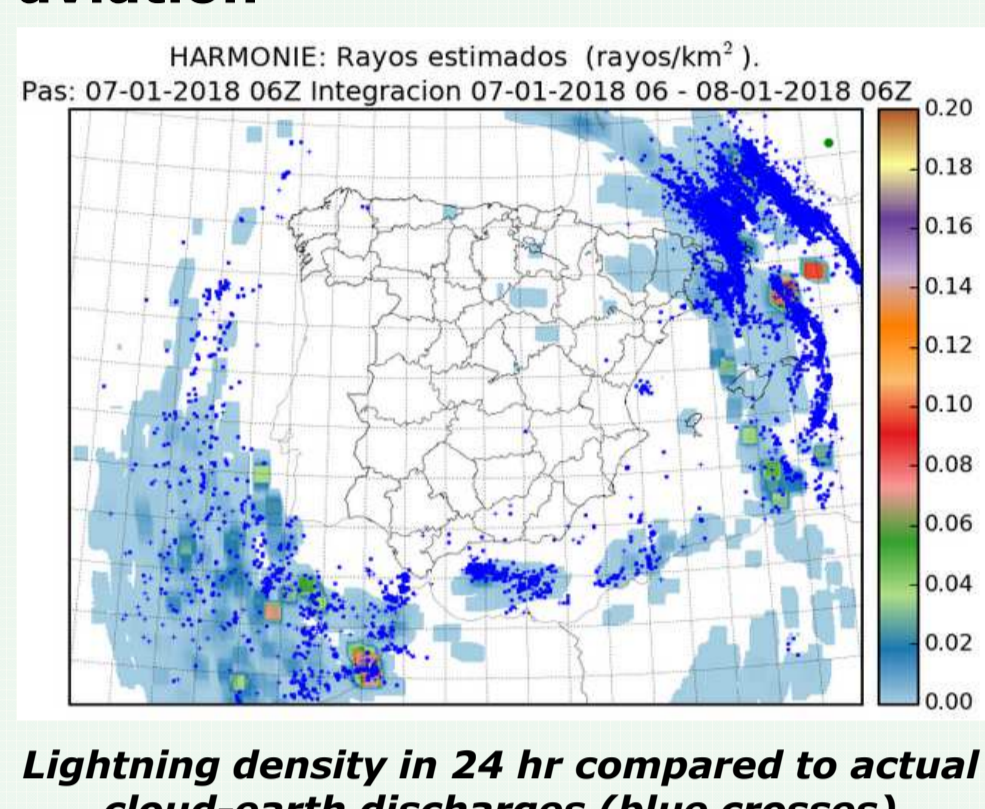
Lightning density in 24 hr compared to actual cloud-earth discharges (blue crosses)

Lightning probability using a consensus approach

Snow Analysis and forecast

Snow Analysis and Prediction

09-01.2018: (a) IMS NOAA/NIC snow cover analysis, (b) HARM-AROME snow depth (c) ECMWF snow depth

Snow analysis is only using SYNOP obs. that are scarce over the Iberian Peninsula. Nevertheless the analysis and the forecast works reasonably well. IMS data from *http://www.natice.noaa.gov/ims*

Very Fine Resolution forecasts

MSG HRVIS

2.5 km

1km linear

1km cubic

1 km forecasts over the Canary Islands what is a challenging test for the model due to the step orography. Comparison of 2.5 km reference forecasts with 1 km (linear and cubic grid). Cubic grid means lower spectral resolution and spends 30% less CPU time.

Realistic diurnal cycle of convection over land but convection happens at much smaller scale over the sea than observed. Linear and cubic grid simulations are similar but the one in cubic grid seems to be more noisy.

VarBC GNNS + ATOVS
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**Impact of applying VarBC only at 00 and 12 UTC for GNSS ZTD observations.** (J.Sánchez Arriola, J.Campins and B. Navascués)

- Varbc for gnss ztd observations applied only at 00 and 12 UTC when more anchor humidity observations are available.

ATOVS: 5 predictors every 24 hr

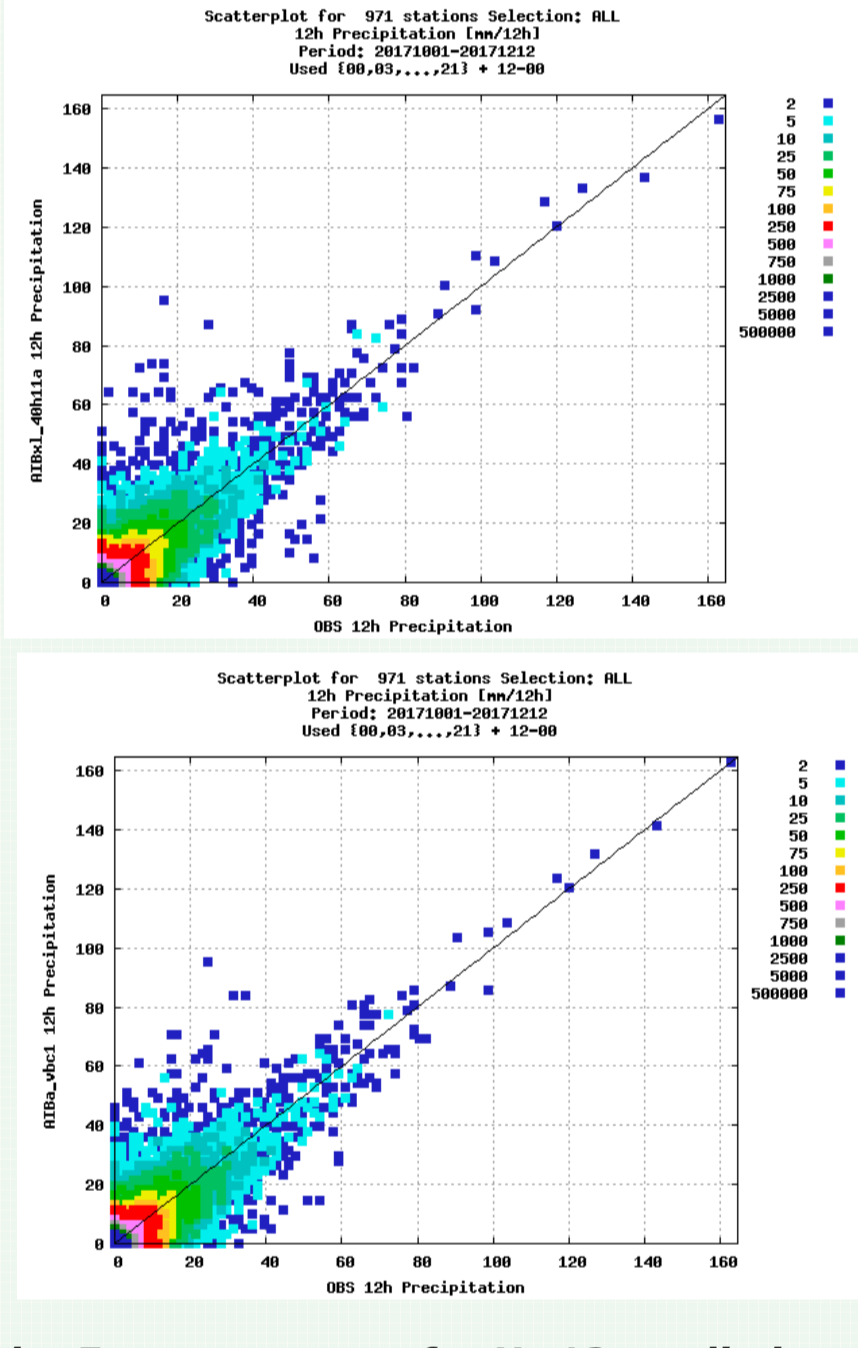**GNSS ZTD**: White Lists, VarBC: Offset predictor, **nfsobs=4**

Test period: Oct-Dic 2017 **CRL: cte offset at 3hr intervals AIBa_vbc1: cte offset every 12 h**
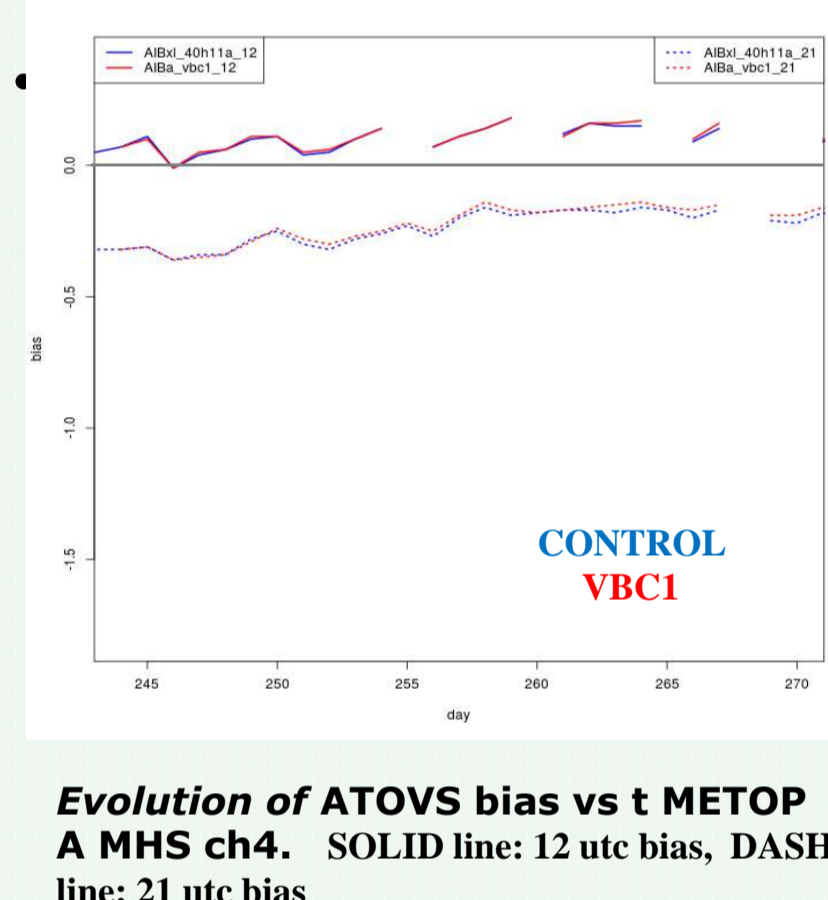
CONTROL
VBC1

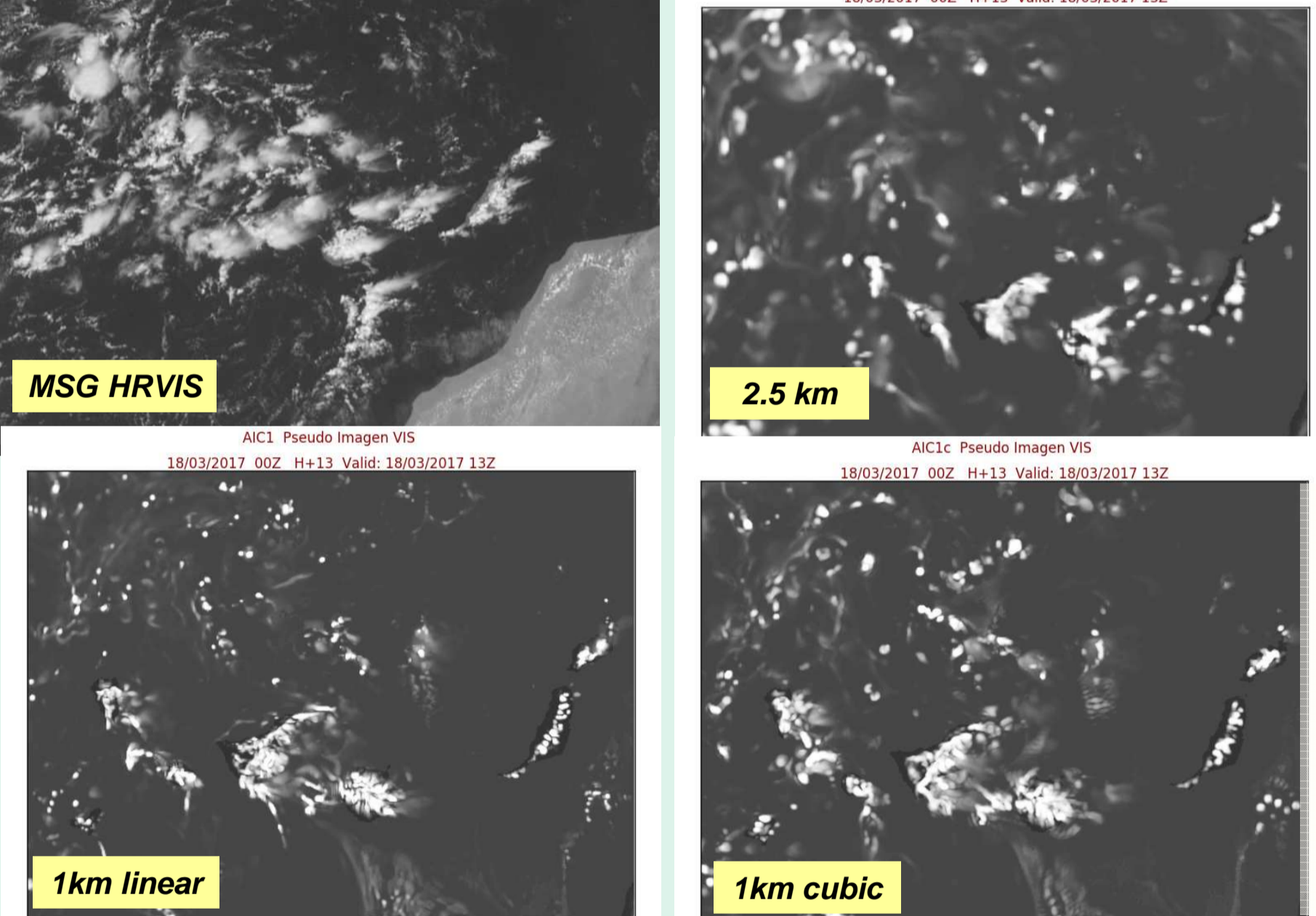*Evolution of ATOVS bias vs t METOP A MHS ch4. SOLID line: 12 utc bias, DASH line: 21 utc bias*
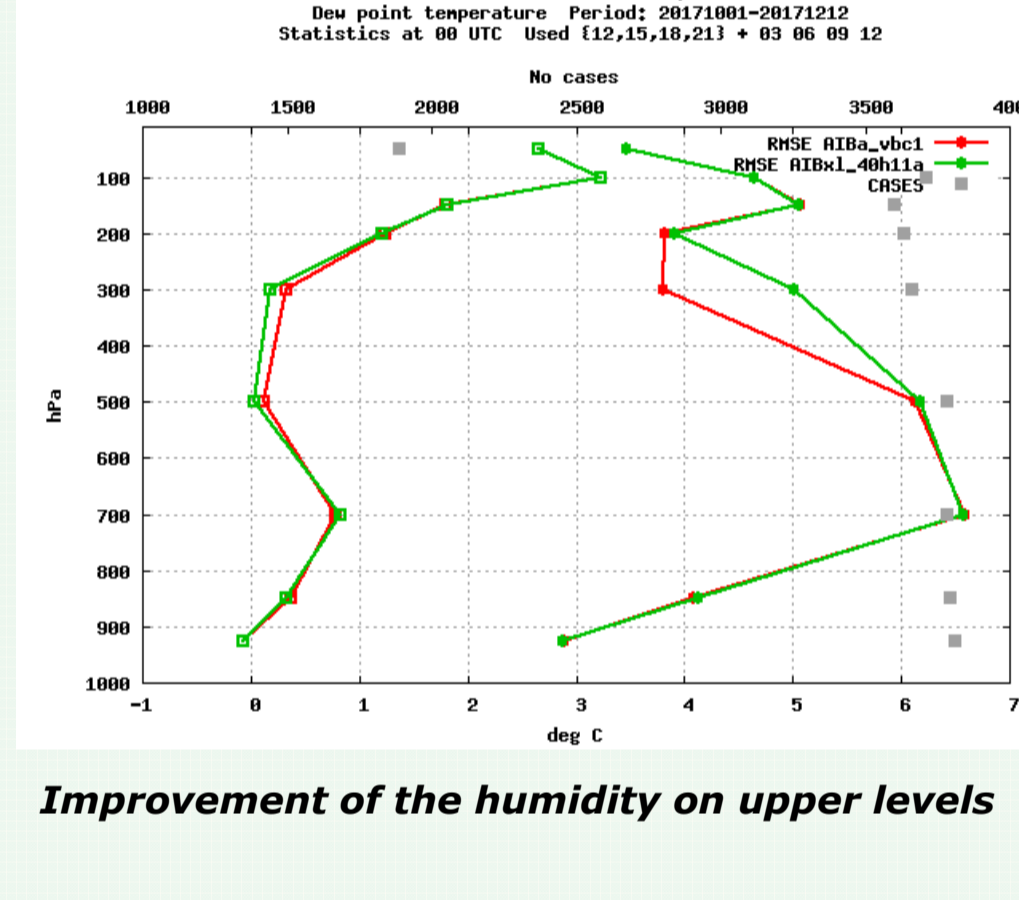
Improvement of the humidity on upper levels

- Overall small positive impact.
- But this good impact can be seen when we have many satellite data: during the evening (15, 18 and 21 UTC) and not in the morning (when we have very little sat data), so we find a positive feedback with MHS/AMSU-B data assimilation.

Obs-Forecast events for H+12 predictions comparig control (up) and VBC1 (down) showing some improvement on the distribution for the selective VBC1

GHI and DNI verification
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Verification of Global Horizontal Irradiance (GHI) and Direct Horizontal Irradiance (DHI) (C. Robles., M. Revuelta, J.L. Casado, I. Martínez) for HARMONIE-AROME and ECMWF models over the period Mar 2015-Feb 2017 using stations of the AEMET Radiation Network (**PreFlexMS project:** *http://www.preflexms.eu*). Predictions start at 00 UTC although in an operational context EC ones would be available later.

Direct Horizontal Irradiation
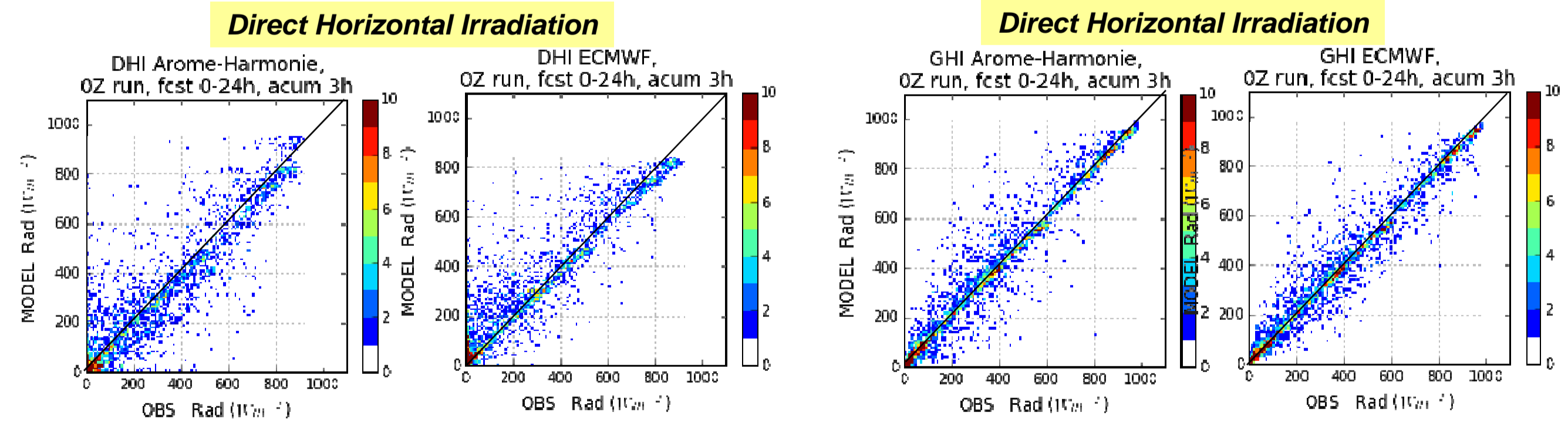
DHI and GHI for Badajoz (38.88 ºN, 7.01 ºW) 3-hr accumulations. ECMWF shows slightly less dispersion
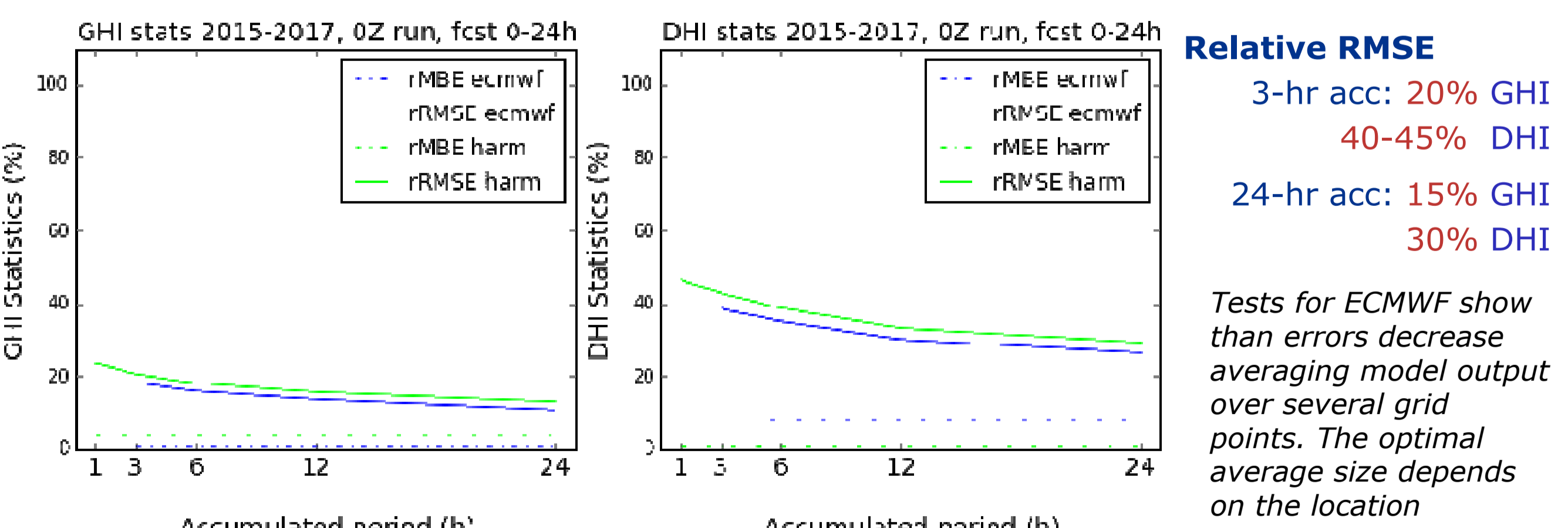
Relative RMSE
3-hr acc: 20% GHI
40-45% DHI

24-hr acc: 15% GHI
30% DHI

Tests for ECMWF show than errors decrease averaging model output over several grid points. The optimal average size depends on the location

Relative RMSE and BIAS for different accumulations. ECMWF model performs slightly better although HARM-AROME shows lower bias

PreFlexMS

Mesoscale EPS → γSREPS
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γSREPS 20-members EPS at 2.5 km resolution based on a Multi-model and multi-BC approach (J. A. Garcia-Moya, A. Callado and P .Esribá)

Multi-boundaries from 5 Global NWP models: ECMWF, GFS, CMC/GEM, JMA/GEM and ARPEGE

- Multi-model with 4 convection-permitting NH models: HARM-AROME, ALARO,WRF-ARW and NMMB
- e-suite: Daily runs, 36 hours forecast at 00 & 12 at ECMWF Cray from March 2016 without assimilation
  - Monitored through ECMWF ecFlow

Multi-BCs: ECMWF / IFS, NCEP / GFS, MF ARPEGE, JMA / GSM, CMC / GEM
Multi-NWP: HARMONIE-AROME, HARMONIE-ALARO, WRF ARW, NMMB

Snapshot of the foreseeable future operational interactive web page

Predictability goal: forecasting consistent uncertainties for:
  – Severe weather as heavy precipitation events
  – Socio-economical surface variables as T2m, RH2m, Winds, DNI, GHI, etc.
- To include LETKF assimilation or 3DVAR in 2018
- To become operational in summer 2018 in the AEMET BULL Computer four times a day
- Iberian collaboration with the Portuguese Met Service (IPMA)

For details see **AEMET-γSREPS: convection-permitting EPS** *poster*

Additional activities

- Geijo, C.: Balancing Initial Conditions with Variational Constraints. First Results with 3D-Var and LETKF (talk)
- Martín-Pérez, D.: Update of number of cloud droplets using MACC outputs (talk)
- García-Moya, J.A.: Verification of hourly precipitation using OPERA dataset (talk)
- Hernández, A.: Simulated MSG SEVIRI imagery from the HARMONIE-AROME model (talk)
- Santos-Atienza, I.: Assessment of HARM-AROME model at 1.0 km over the Spanish coast for wind forecast (talk and poser)
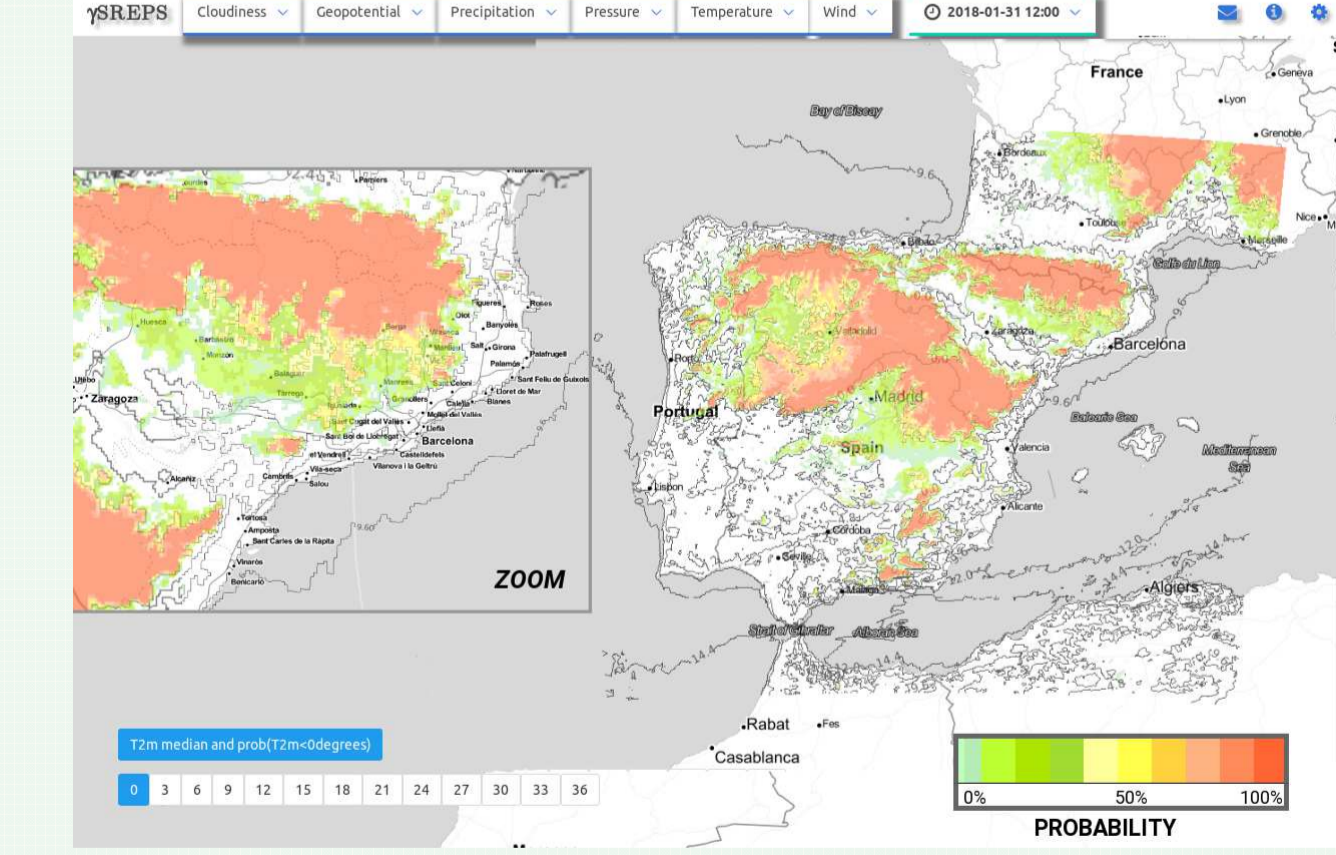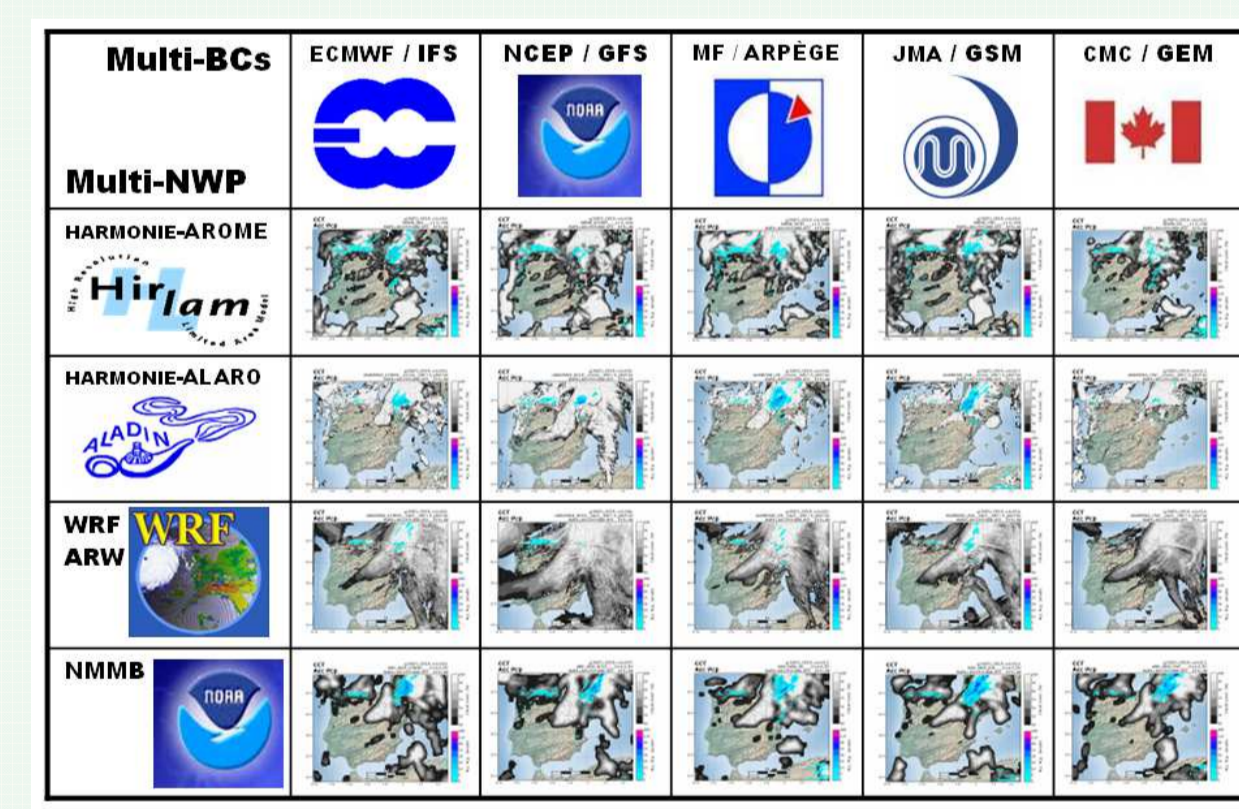- Martínez-Sánchez, M. et al.: AEMET-gammaSREPS: current operational status (poster)

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Highlights

➢ Aemet runs HARMONIE/AROME v40h1.1 from the **ALADIN-HIRLAM Shared System** in the local HPC.

- These runs are **Regular Cycle of Reference (RCR)** for the HARMONIE System
  - 3-hr cycles including assimilation of GPS/GNSS and ATOVS data.
  - Improved monitoring and verification of the system
- Clear added value on near surface variables compared with models of larger scale (HIRLAM and ECMWF)
- Significant improvement of precipitation forecasts but the model tends to underestimate summer convection.
- Lightning forecasts are quite realistic

➢ ECOCLIMATE data updated for inland waters over the Iberian Peninsula
➢ Tests applying VarBC on GNSS data only at 00 and 12 UTC show a small positive impact on humidity
➢ Snow analysis and predictions are relatively good despite the few observations entering in the analysis
➢ Tests at 1 km resolution trying to prepare the model for an enhancement in resolution. This is a challenging issue affecting many model components and needing a lot of computer resources.
➢ Verification of global horizontal irradiance (GHI) and direct normal irradiance (DNI) shows RMSE of 15% and 30% respectively (slightly worst than ECMWF for the same analysis cycle).
➢ A 2.5 km multi-model ensemble system is close to an operational state