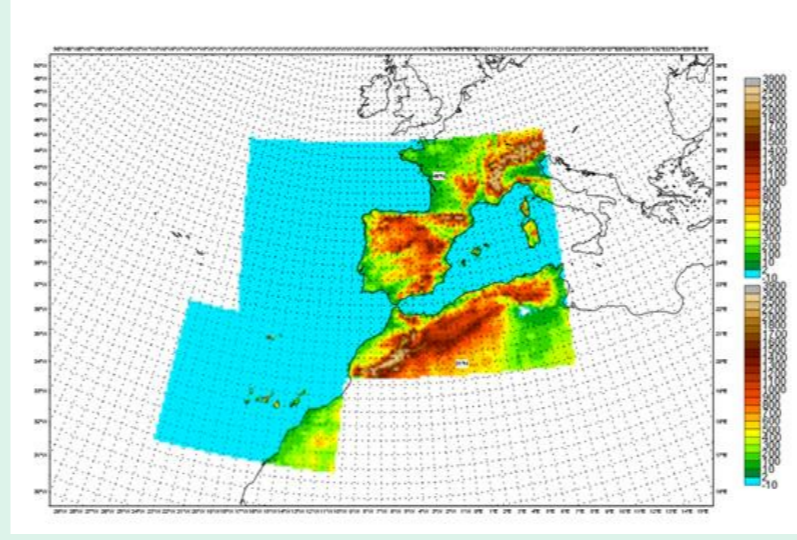


HARMONIE-AROME SUITE

HARMONIE-AROME v40h1.1 is **Regular Cycle of Reference, RCR** used by HIRLAM Consortium to monitor the quality of the reference system:

- **2.5 km** runs 8 times per day with a forecast length of 48 hours for 2 geographical domains (Iberian Peninsula and Canary Islands).
- **ALADIN NH dynamics** and **1-hr boundaries** from ECMWF
- **3DVar analysis** with **3hr cycle** incl. **ATOVS** and **GNSS obs.**

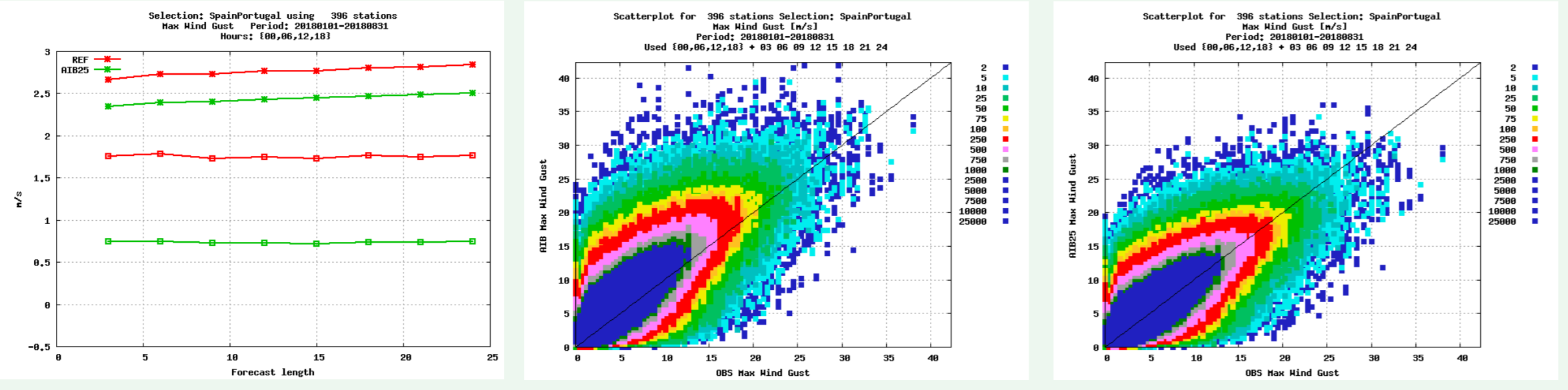


- **Surface data assimilation** with optimal interpolation.
- **AROME physics:** Explicit deep convection, SURFEX and ICE3 microphysics
- Unified scheme for shallow convection (**EDMFM**)
- Run in **BULL-ATOS** supercomputer 7760 processors with hyperthreading

Wind gust estimation
gmoralesm@aemet.es

The wind gust estimation is based on 10 m wind and the Turbulent Kinetic Energy

$$F_{gust} = F_{10m} \left[1 + \alpha \sqrt{\frac{TKE_{20m}}{F_{10m}^2}} \right]$$

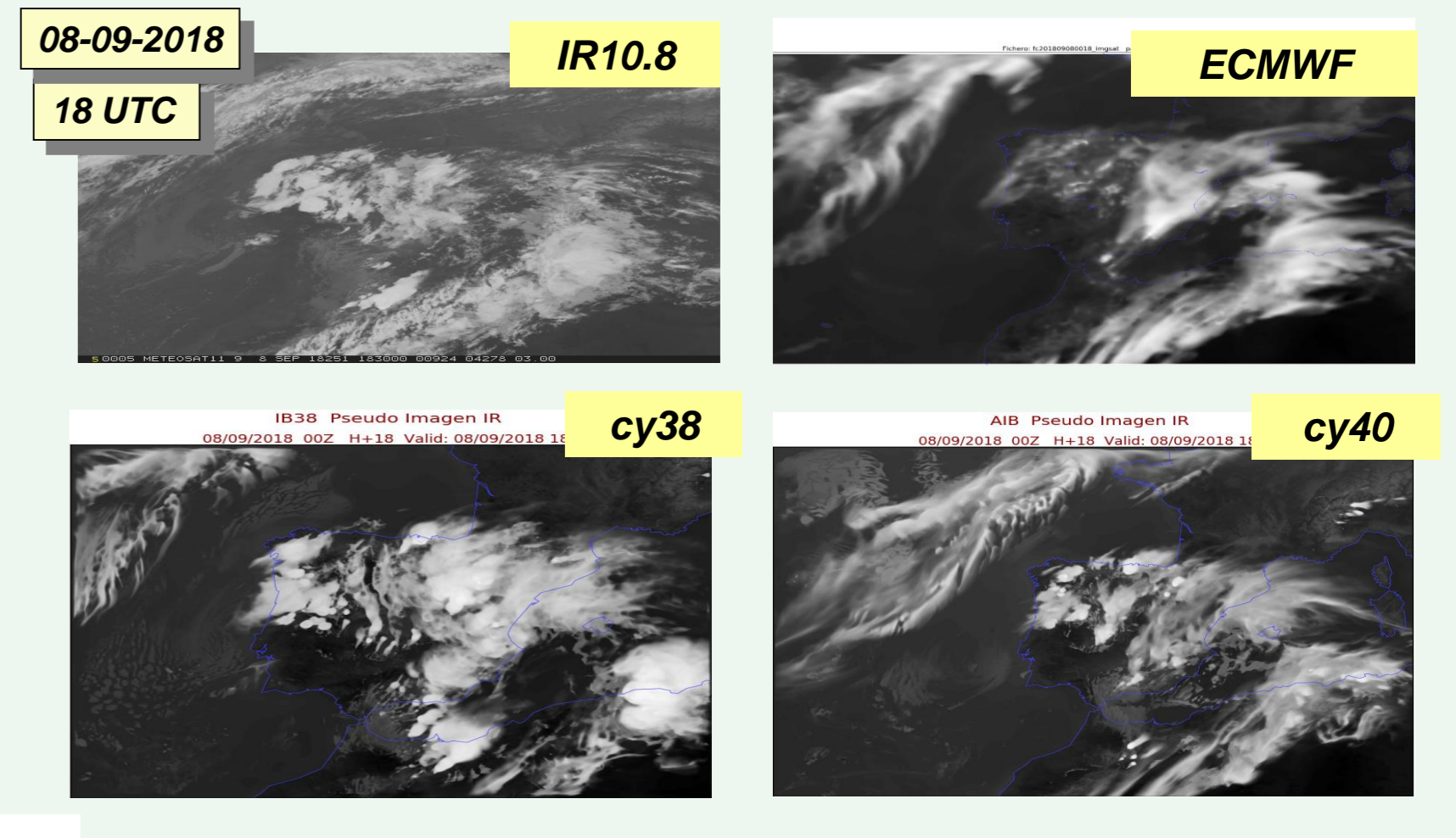


The roughness factor, α , has been decreased from 3.5 to 2.5 to decrease the positive bias and avoid to many false alarms. (a) STDV and BIAS of Reference and new setup, plots events observation-forecast for Reference (b) and new setup (c).

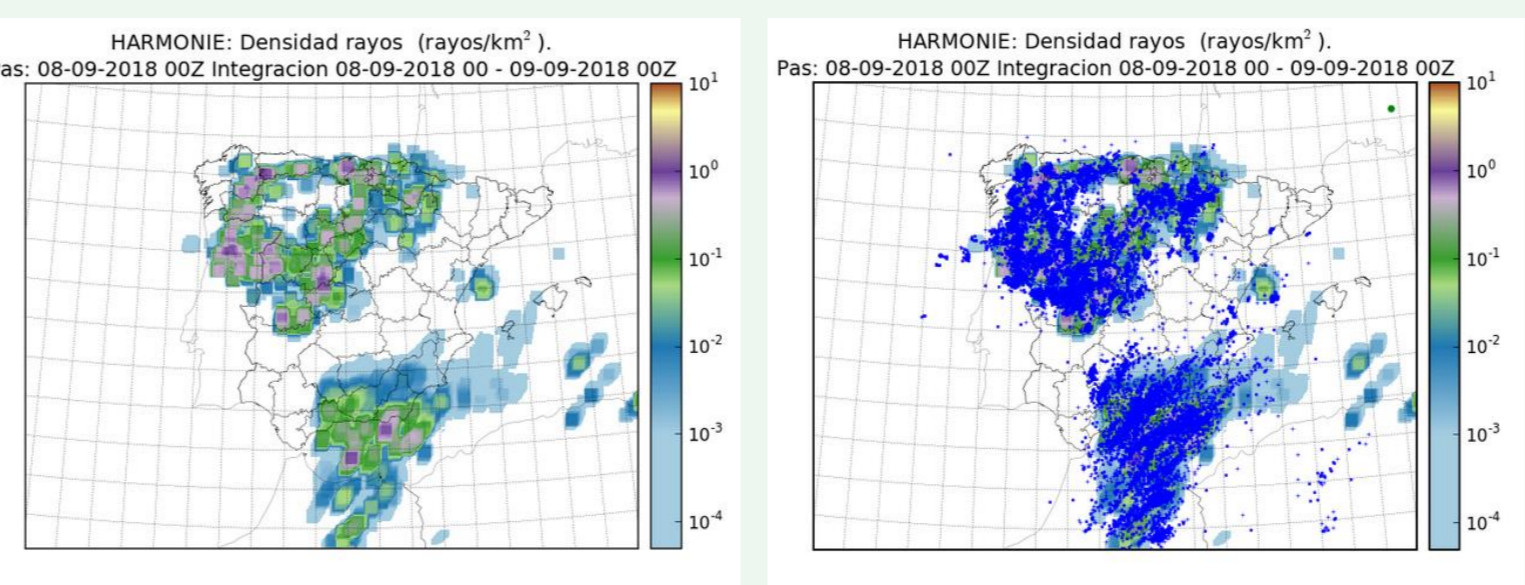
Convection
fcalvos@aemet.es

Comparison of simulated satellite images with MSG IR 10.8 observation. Despite the strong forcing of the case, the local errors are big.

Two versions of HARMONIE-AROME and the corresponding ECMWF forecast are shown (right panels). Cycle 38 seems to be too active whereas cycle 40 may underestimate its intensity. ECMWF clearly underestimates the convective activity.

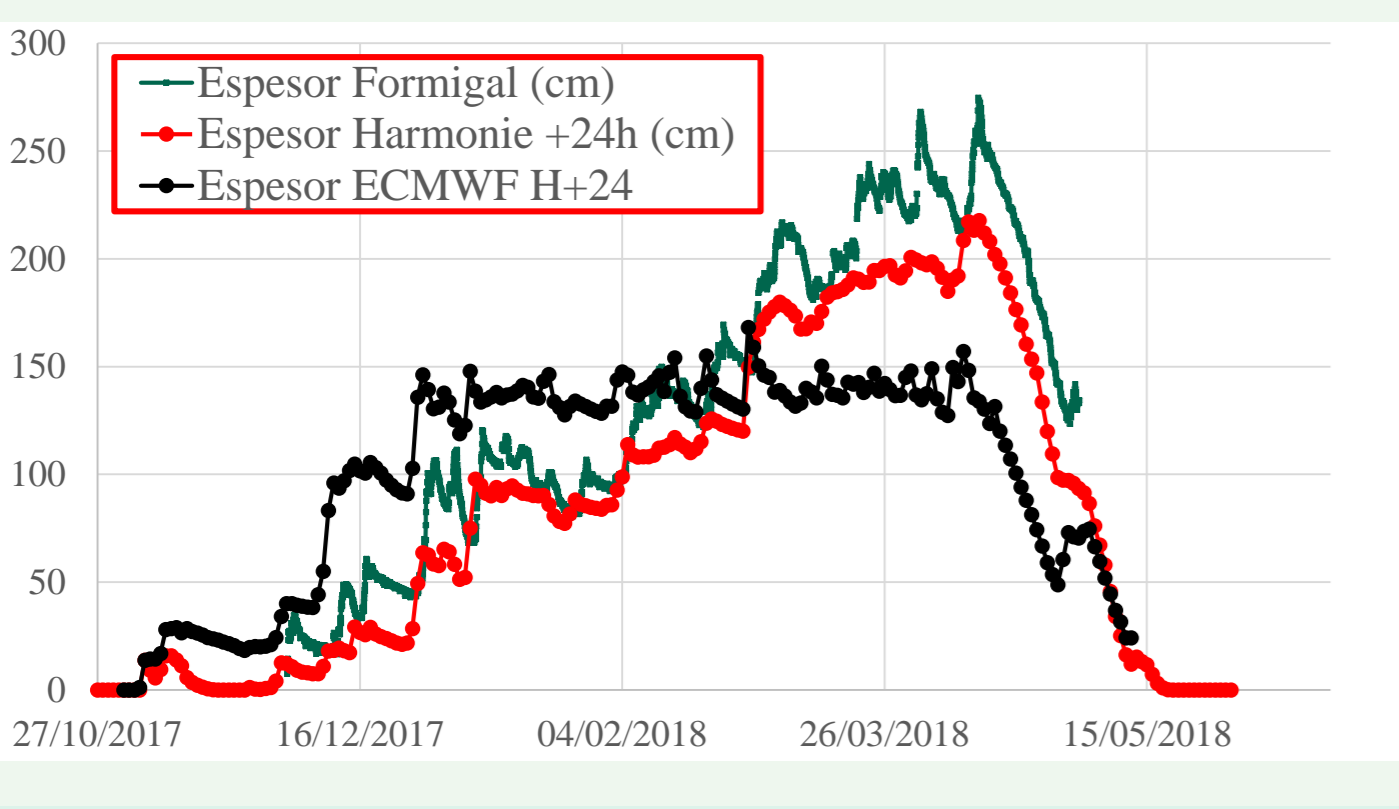
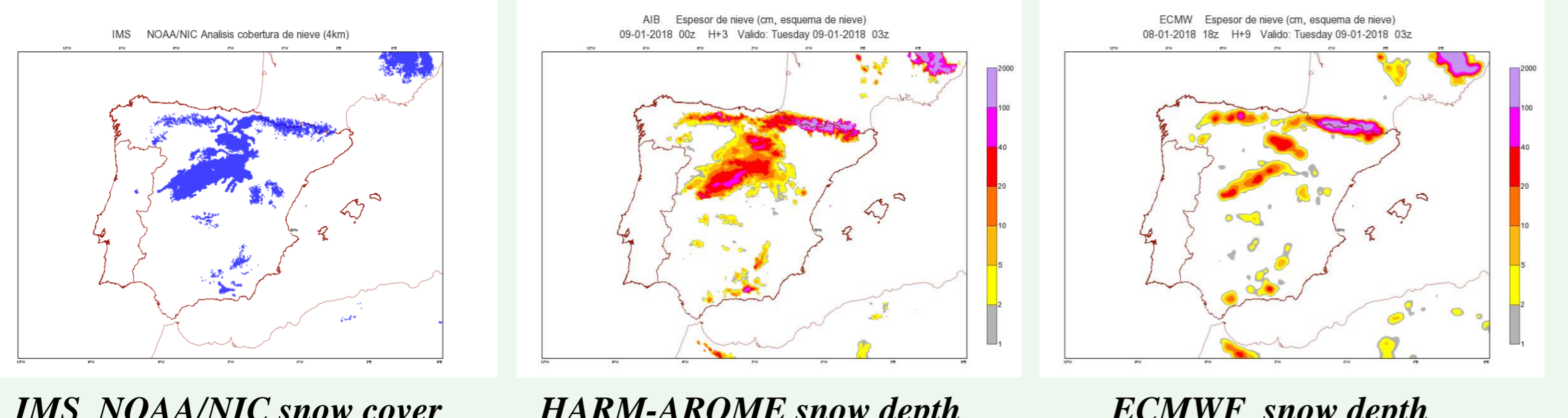


Lightning activity. On the other hand if we go to a larger scale (24 hr accumulation) we see that the convection representation is quite good in this case of strong forcing (left panels)



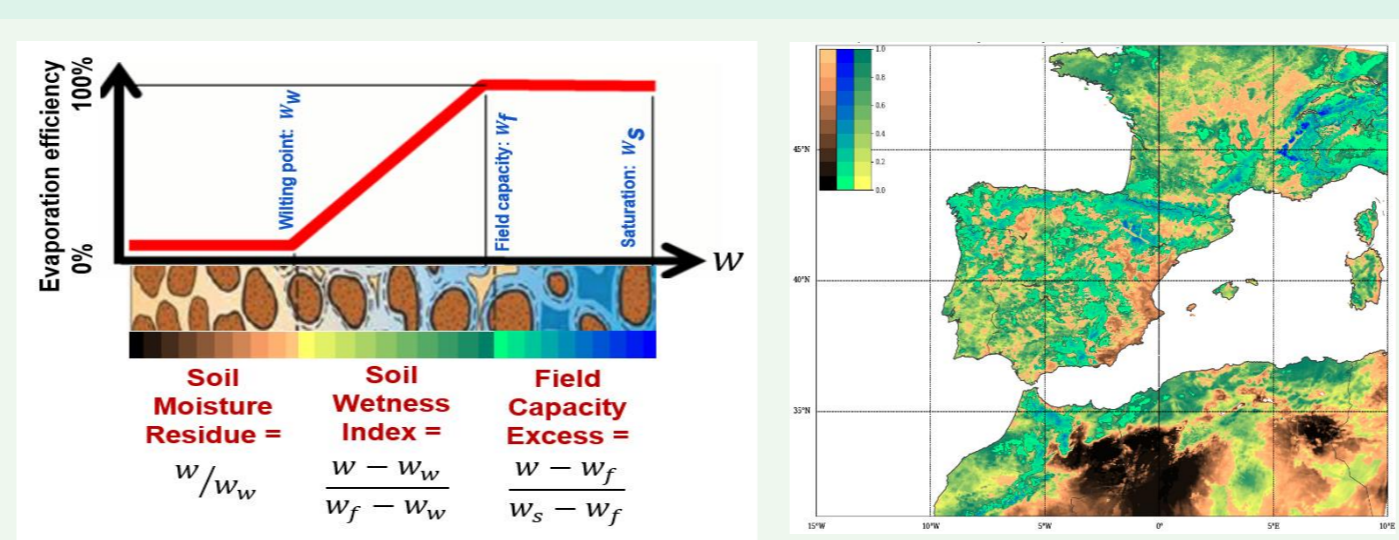
Snow analysis and prediction
fcalvos@aemet.es

Snow analysis follow an OI method using only SYNOP observations that are scarce over our domain. The parametrization follows Douville (95) with 2 forecast variables: snow depth and snow density



Snow depth evolution 2017/18 compared with observation at Formigal (1800 m) a reference WMO station. Both HARM and ECMWF underestimate snow depth but the underestimation is larger for ECMWF in spring which also melts the snow too early.

Surface
svianaj@aemet.es



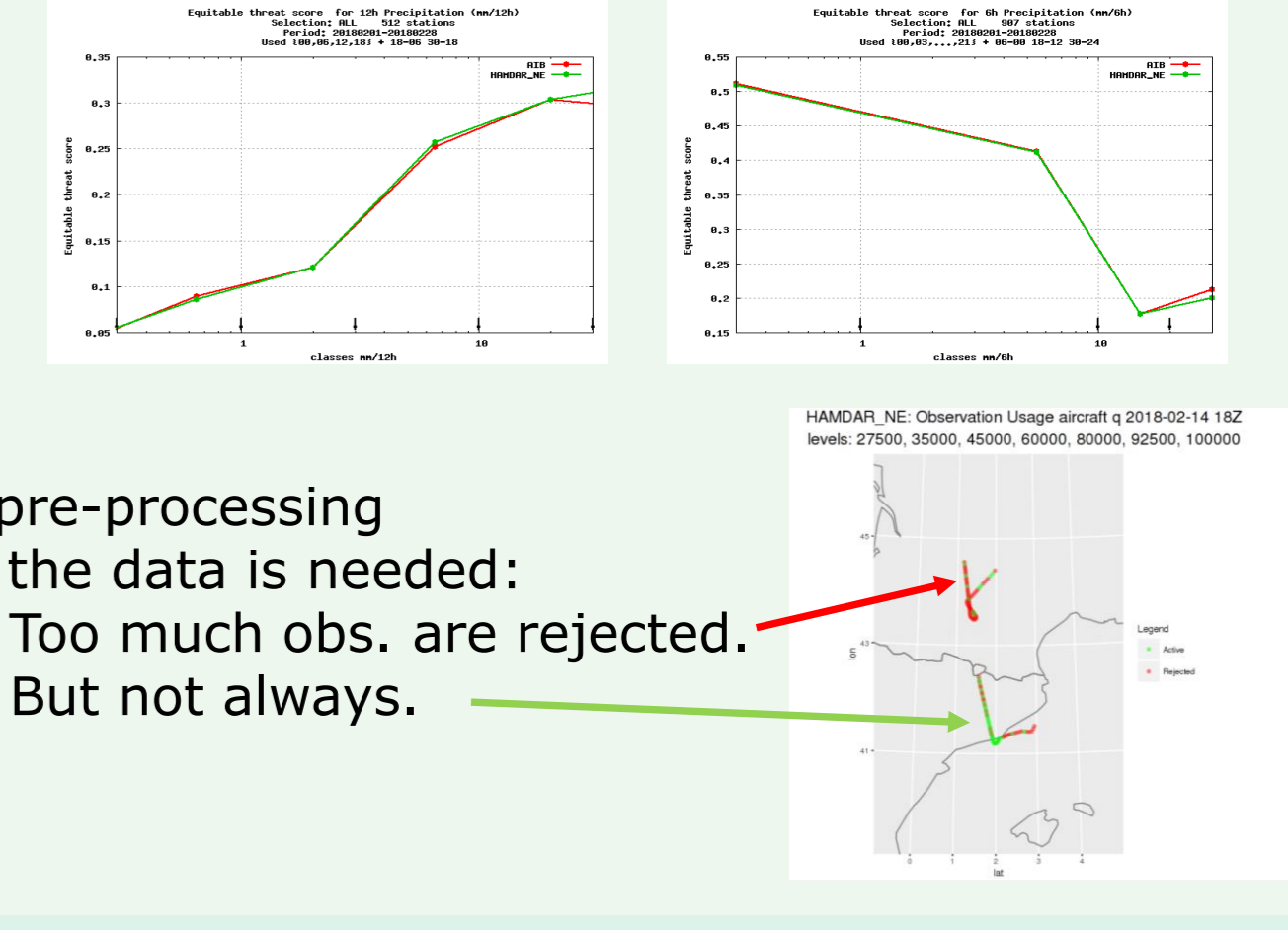
Soil moisture indexes relate soil moisture (w) to soil characteristic points (wilting point, field capacity, saturation). These are plotted operationally for the three soil layers in order to monitor the soil status in the model and its possible relation to atmospheric biases.

The figure on the right shows humidity indexes in the root layer on April 11 2018, when snow-melt in Ebro river catchment area and a period of heavy rain caused major floodings in NE Spain.

E-AMDAAR q, D.A.
mdiezma@aemet.es

Humidity data of E-AMDAAR are been tested. Results:

- Neutral impact in surface.
- Not clear in precipitation or in the vertical profile.



Use of CAMS Aerosols
dmartinp@aemet.es

Use of CAMS aerosol to obtain Cloud Condensation Nuclei (CCN) in HARMONIE-AROME.

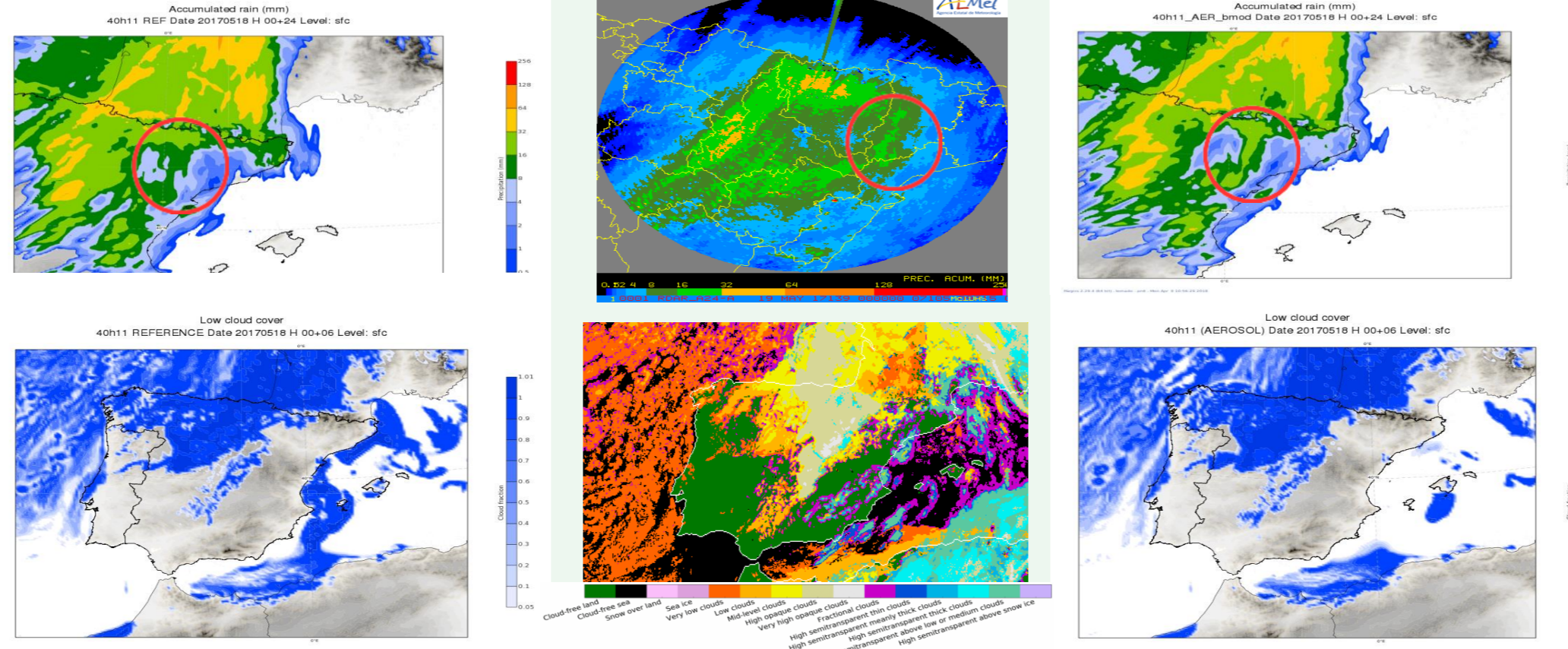
- Microphysical parametrization scheme.
- Currently the number of CCN in HARMONIE-AROME is constant depending on whether the point is over sea or over land.
 - Four aerosol mixing ratio (MR) fields (three sea salt bins and one sulphate) from CAMS are included in the first guess and boundary conditions.
 - The MR fields are advected by the model.
 - From the MR, using a log normal distribution, the number of CCN is calculated.
 - The processes affected by this change are: autoconversion (cloud droplets → rain droplets), cloud droplet sedimentation and collision of cloud liquid.

Impact:

- In general, there is an increment of the precipitation.
- Increment of high clouds
- Removal of low clouds of uncertain origin in the model.

Future work:

- It is needed a simple parametrization for rain out of aerosols.



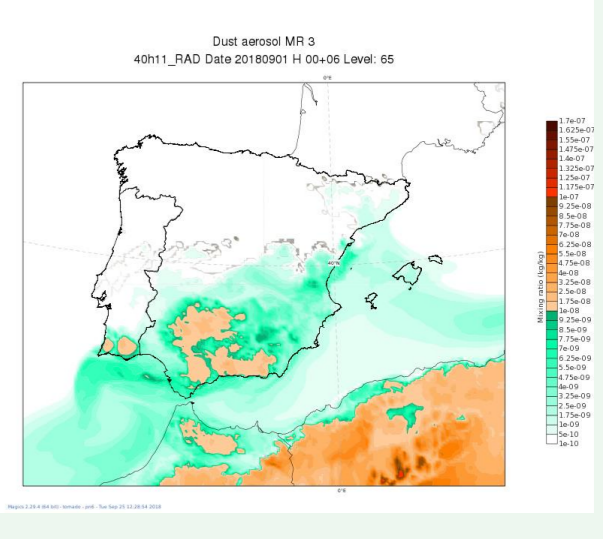
24 H accumulated rain compared with that from RADAR obser.

There is a band of precipitation that is higher when the condensation nuclei are modified with CAMS data and agrees better with Radar.

- Removal of low clouds of uncertain origin in the model.
- low cloud cover reference
 - Cloud type from SAFNWC
 - low cloud cover with CAMS

Radiation scheme:

- Currently a prescribe vertical profile of AOD's is considered.
- From the 11 aerosol types, near real time profiles of AODs can be obtained



Name	Short Name	Units	Parameter D
Sea Salt Aerosol (0.03 - 0.3 um) Mixing Ratio	aerm01	kg kg-1	210001
Sea Salt Aerosol (0.5 - 5 um) Mixing Ratio	aerm02	kg kg-1	210002
Sea Salt Aerosol (5 - 20 um) Mixing Ratio	aerm03	kg kg-1	210003
Dust Aerosol (0.03 - 0.55 um) Mixing Ratio	aerm04	kg kg-1	210004
Dust Aerosol (0.55 - 0.9 um) Mixing Ratio	aerm05	kg kg-1	210005
Dust Aerosol (0.9 - 20 um) Mixing Ratio	aerm06	kg kg-1	210006
Hydrophobic Organic Matter Aerosol Mixing Ratio	aerm07	kg kg-1	210007
Hydrophilic Organic Matter Aerosol Mixing Ratio	aerm08	kg kg-1	210008
Hydrophobic Black Carbon Aerosol Mixing Ratio	aerm09	kg kg-1	210009
Hydrophilic Black Carbon Aerosol Mixing Ratio	aerm10	kg kg-1	210010
Sulphate Aerosol Mixing Ratio	aerm11	kg kg-1	210011
SO2 precursor mixing ratio	aerm12	kg kg-1	210012
Volcanic ash aerosol mixing ratio	aerm13	kg kg-1	210013
Volcanic sulphate aerosol mixing ratio	aerm14	kg kg-1	210014
Volcanic SO2 precursor mixing ratio	aerm15	kg kg-1	210015

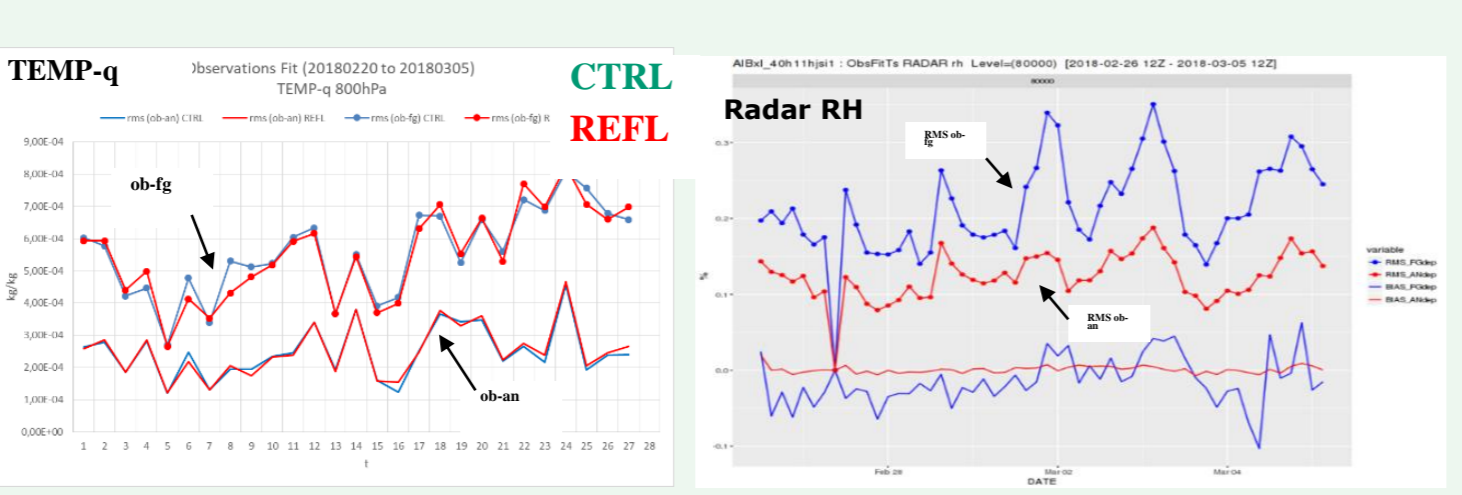
Radar reflectivity D.A.
jsancheza@aemet.es

Impact of the assimilation of radar reflectivity observation on AEMET Harmonie-AROME

- **Spin-up period:** 2-16 feb 2018. Bias coeff GNSS ZTD adjustment
- **Period of study:** 16 feb -5 mar 2018
- **2 experiments Cy40h11:** 3DVar, 3h cycle
 - 1) **CTRL:** CONTROL, NO radar + conventional obs, GNSS ZTD, ATOVS
 - 2) **REFL:** CTRL + opera radar reflectivity (Spain +Portugal)

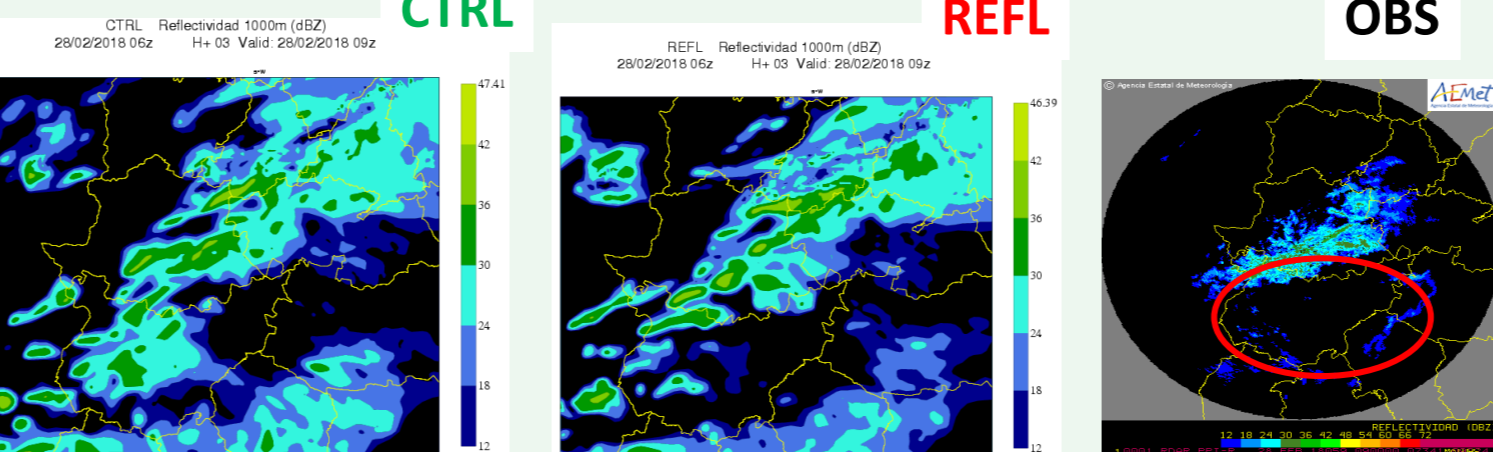
Fit of obs to fg and analysis:

The analysis reduces the distance to obs for all humidity variables, and radar rh has no bias.



CASE of study: 28 feb 2018 09UTC

REFL exp is more realistic in some cases than CONTROL

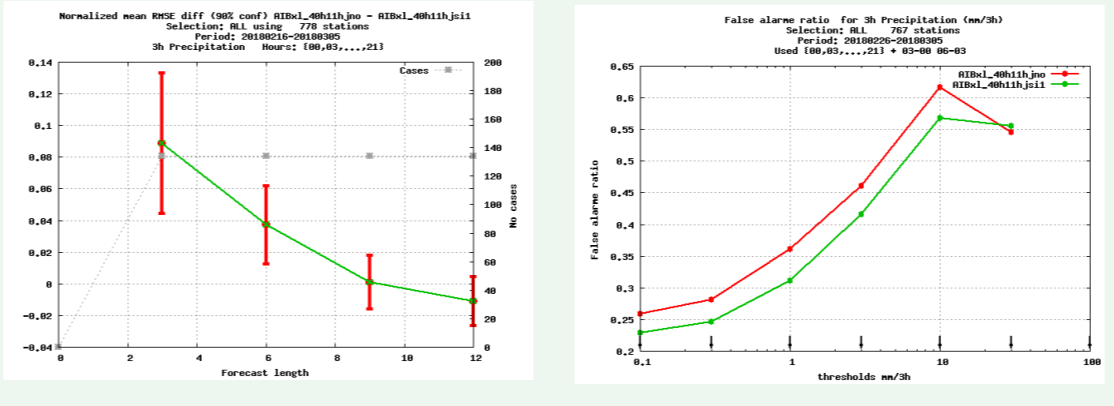


Conclusions:

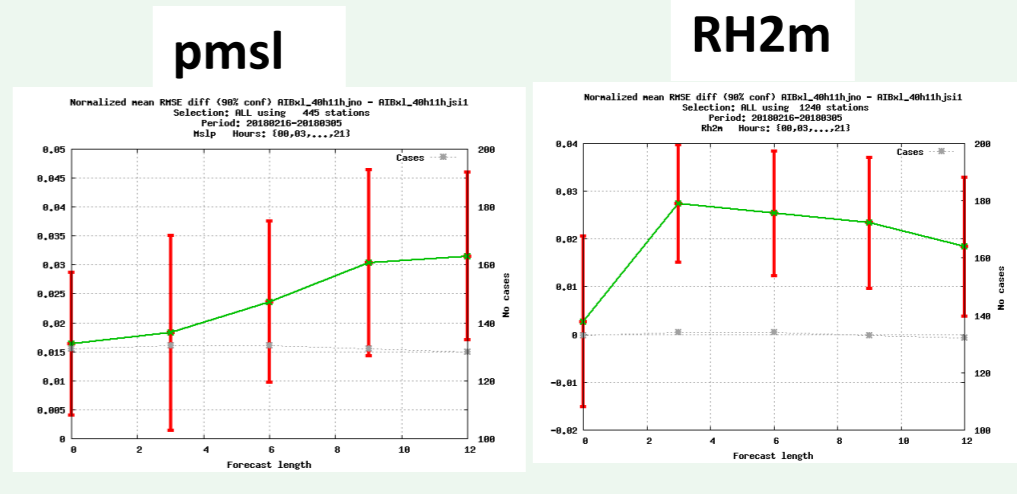
- The impact of the assimilation of opera radar reflectivity obs has been tested in the operational Harmonie-AROME in AEMET for a period of study in Winter 2018.
- A small positive impact has been obtained mainly at 3h acc pcp for short range forecasts, mainly due to the reduction of False Alarm Rate.
- These observations contribute to get a better analysis and help to the VarBC scheme to correct the satellite humidity observations also assimilated by this run.
- This result makes this observation to be useful for Nowcasting with this operational suite in Aemet.
- This study will continue with longer period and more case studies.

• **3h Acc pcp Pcp:**
(RMSE_CTRL - RMSE_REFL) / RMSE_CTRL

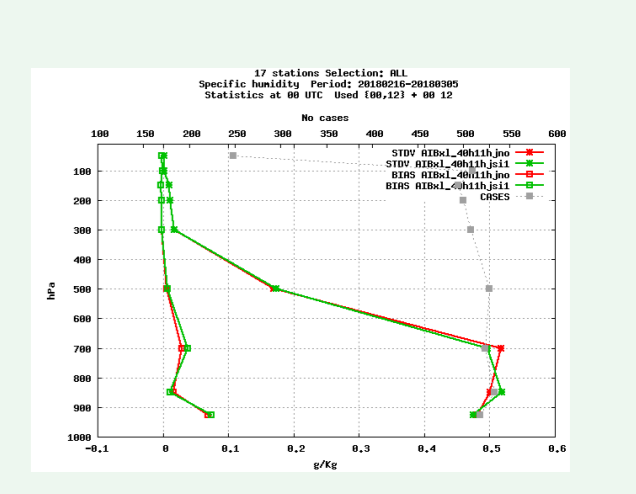
Positive impact for 3h acc pcp for H+3 and H+6 fc, due to a decreasing of FA rate.



• **Sfc variables**
Positive impact



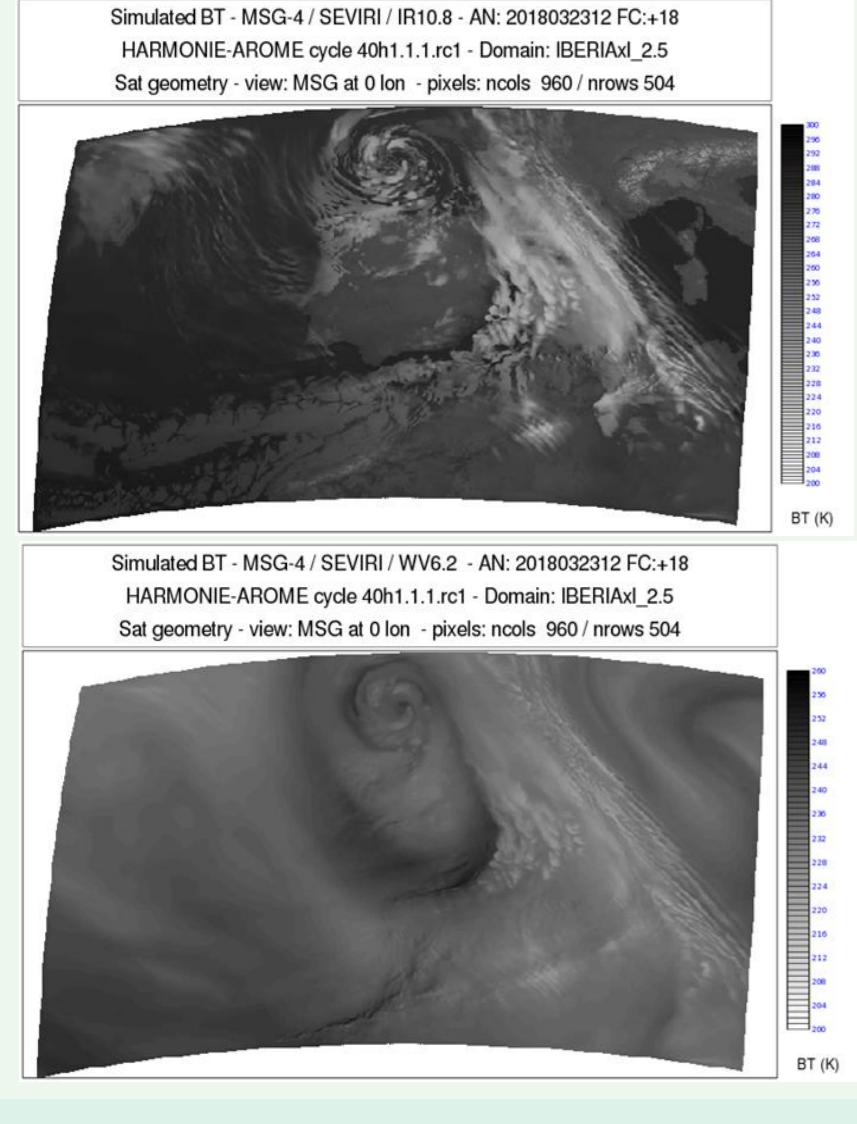
• **TEMP q variables**
Neutral impact



Simulated MSG SEVIRI
ahernandez@aemet.es

Simulated MSG SEVIRI imagery from the HARMONIE-AROME high-resolution NWP model: applications in AEMET

- HALSSI: HARMONIE-AROME Simulated Satellite Imagery
- Applications in NWP model development.
- Applications in operational forecasting.



Mesoscale EPS → YSREPS
acalladop@aemet.es

YSREPS Mesoscale convection-permitting LAM-EPS at 2.5 km resolution based on a Multi-model and multi-BC approach

Multi-boundaries: ECMWF, GFS, CMC, JMA, ARPEGE
Multi-model: HARMONIE-AROME, HARMONIE-ALARO, WRF-ARW, NEMS (WRF NMMB)

Daily run, 48 hours forecast at 00 & 12 UTC at ECMWF Cray from March 2016 over Iberian Peninsula

To run over Canary Islands in autumn 2018 in the new AEMET BULL Computer two times a day (00 & 12 UTC)

Iberian collaboration with the Portuguese Met Service (IPMA) and with MétéoFrance AROME-EPS group

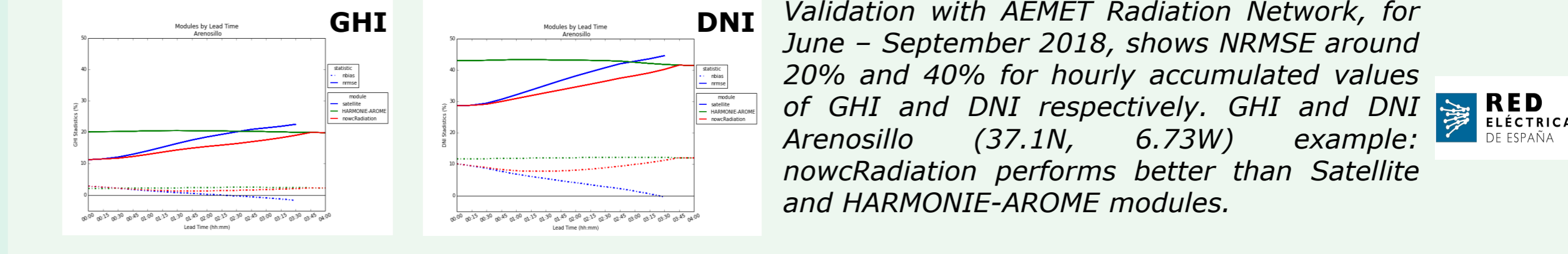
Pre-operational interactive web page for operational forecasters



nowcRadiation
arodriguezm@aemet.es
mmartinez@aemet.es

nowcRadiation is a project developed by AEMET for the Spanish Transmission System Operator, Red Eléctrica de España, to improve hourly Global Horizontal and Direct Normal Irradiances (GHI and DNI) forecasts in solar power plants.

- MSG/SAF-HARMONIE hourly GHI/DNI seamless-nowcasting up to 4 hs every 15 mins.



Highlights

- **Radar assimilation using reflectivities from OPERA.**
 - Operational setup achieving a small positive impact on the precipitation forecasts during the first hours of the integration.
- **'Assimilation' of CAMS aerosols in the model.**
 - 4 types passed to the microphysics as condensation nuclei having a small but positive impact on low clouds and precipitation. 11 types for the radiation under study.
- **Simulated MSG SEVIRI imagery from HARMONIE-AROME forecasts, using RTTOV v12 radiative transfer model.** The tool is in development, and seems promising for diagnostic and verification. Focus on IR10.8 and WV6.2, but supports the 12 channels.
- In order to validate snow forecast the snow cover analysis from IMS NOAA and the snow observations from a reference mountain station has been used. Despite the simple snow analysis and parameterization, the model produces good results.
- A nowcasting tool for radiation has been developed combining NOWSAF products and HARMONIE-AROME forecasts.