AEMET NWP activities

Javier Calvo

With contributions from

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IPMA NWP, 26-27 nov 2018

Outline

- About AEMET
- The HARMONIE-AROME system
- Operational set-up
- NWP activities
- Operational collaboration

AEMET structure

- Staff (2018): 1197
  - Madrid headquarters: 371
  - In 17 Regional centres: 826
  - 50 % with special work schedule (operational prediction, observation, airports)

HPC Bull 128 Tflops, 7776 cores

The ALADIN-HIRLAM Shared System

In 2006 HIRLAM and ALADIN started a collaboration on operational NWP modelling with the aim to form a single consortium in 2021

HARMONIE-AROME is a configuration within this Shared System *(Bengtsson et al, MWR 2017)*

26 met services
~ 140 Full time staff

AROME-HARMONIE vs AROME-Meteo-France

- Differences in physics (not big)
  - Turbulence HARATU instead of CBR
  - Shallow convection: EDMF instead of EDKF
  - Microphysics: cold clouds, separation ice-water species
  - Setup in SURFEX

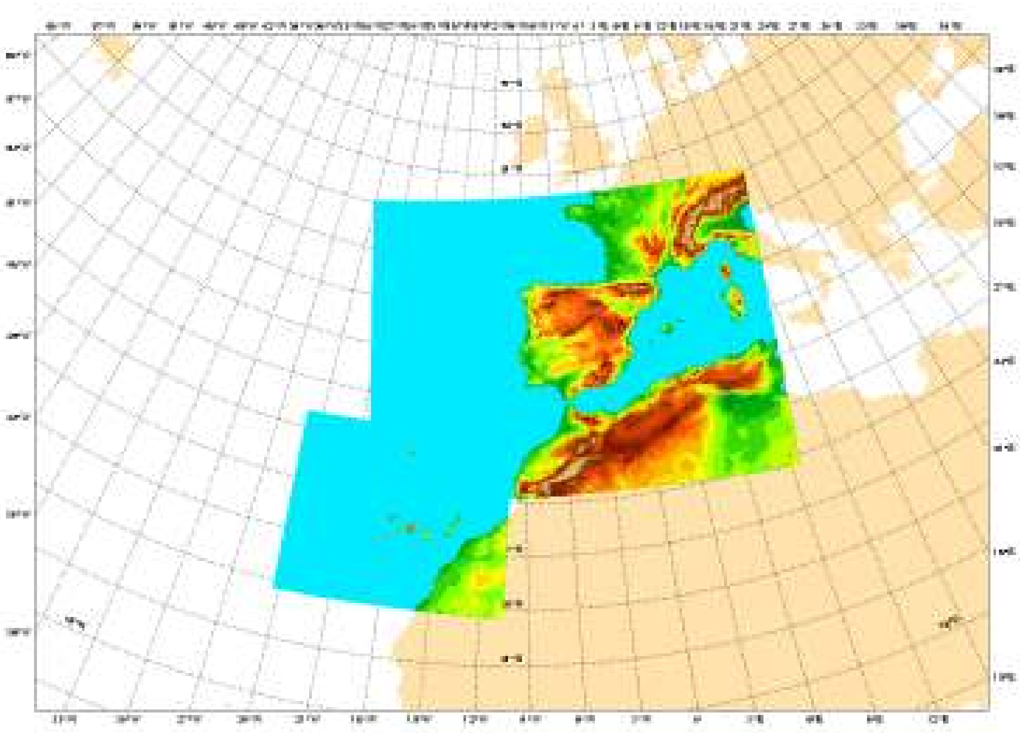
- Assimilation: There is not a standard version so far so differences may be significant

HARMONIE reference system

- There is a common reference system maintained at ECMWF computers build on top of Toulouse releases including
  - Data assimilation
  - Forecast model
  - EPS system
  - Monitoring and verification tools
- There is a meteorological validation and the reference system is operational at some Centers: (Regular Cycle with the Reference, RCR). For current 40h1.1 version: METCOOP and AEMET operational systems
  - Preprocessing and postprocessing tools not included in the reference system
  - Local implementation is relatively easy and is responsibility of the different Met Services

Operational set up at AEMET

- Cycle 40h1.1
- 2.5 km, 65 levels
- 3DVAr 3hr assimilation cycle with 1:10 cutoff time
- H+48 forecast length with 15 min output for selected surface variables



Availability:

+ *2:40 Peninsula,*

+ *2:10 Canarias* from the analysis time

NWP team

- Around 15 persons including the EPS team (mainly in Barcelona)
  - Madrid and regional centres
  - A big part devoted to operational/user tasks
  - Several persons with partial contributions

R & D activities

- Data assimilation
  - ATOVS and GNSS GPS ZTD
  - Radar
  - AMDAR-humidity
  - New DA techniques
    - Correction of position errors
    - Variational constraints
  - LETKF
- Physics
  - Use of real time aerosols
  - SURFEX
- Verification
- EPS

ATOVS and GNSS zenit total delay

Jana Sánchez, Joan Campins, María Díez

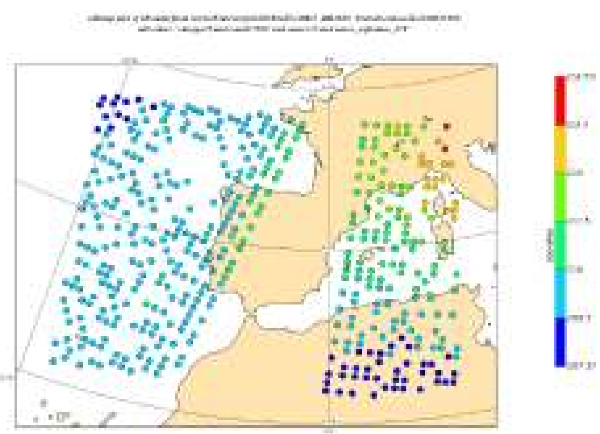
3DVar 3hr cycle, 1:10 cutoff time

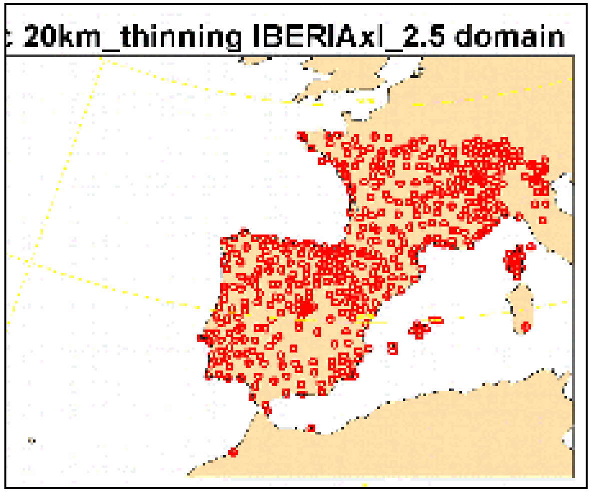
-GNSS ZTD observations from E-GVAP Program

-ATOVS: AMSU-A, AMSU-B or MHS from NOAA and METOP from EUMETCAST dissemination

- Variational Bias Correction (VarBC) is essential to adjust to obtain positive impact
    - At least 1 month of training for the Iberian domain and 2 for the Canary Islands due to the lack of anchor observations in this case
    - Depend on the actual obs. assimilations: Recalibration is needed including new obs.
- Thinning and setting of obs errors after a careful process

ATOVs





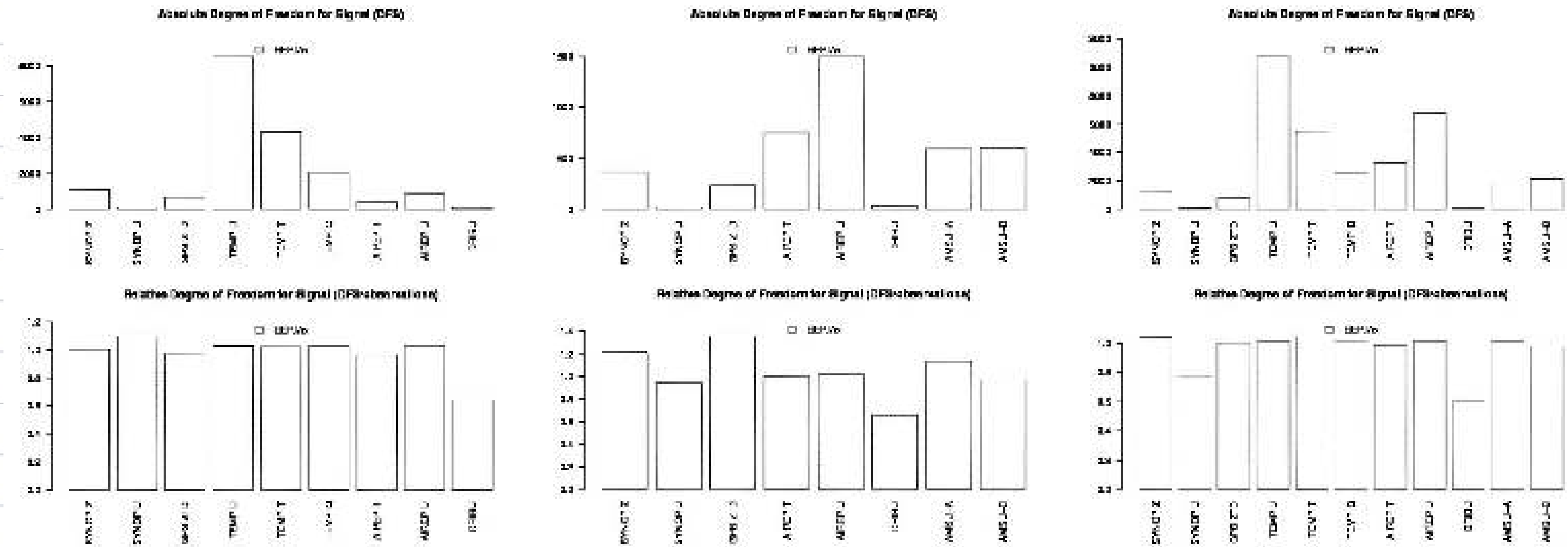
GNSS GPS ztd

OBSMON monitoring very important part!

Meteorological impact: Positive on humidity profiles and precipitation

Impact of different observations

- Statistic: Degrees Of Freedom for Signal (DFS)
  - Different impact at different times of the day



00 UTC No ATOVS

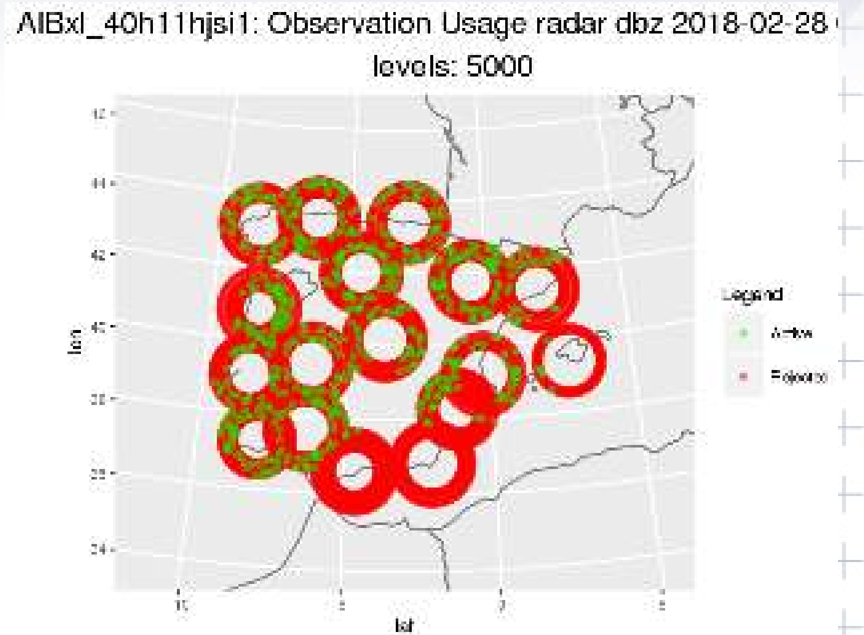
06 UTC No RS

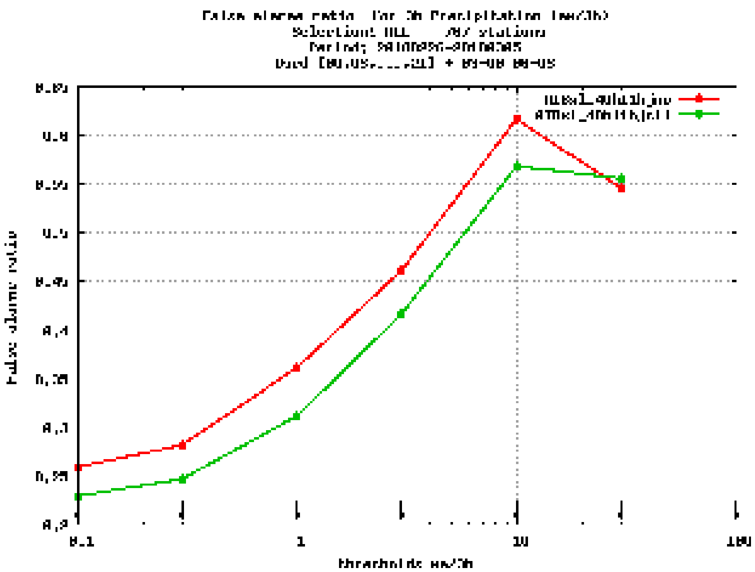
12 UTC

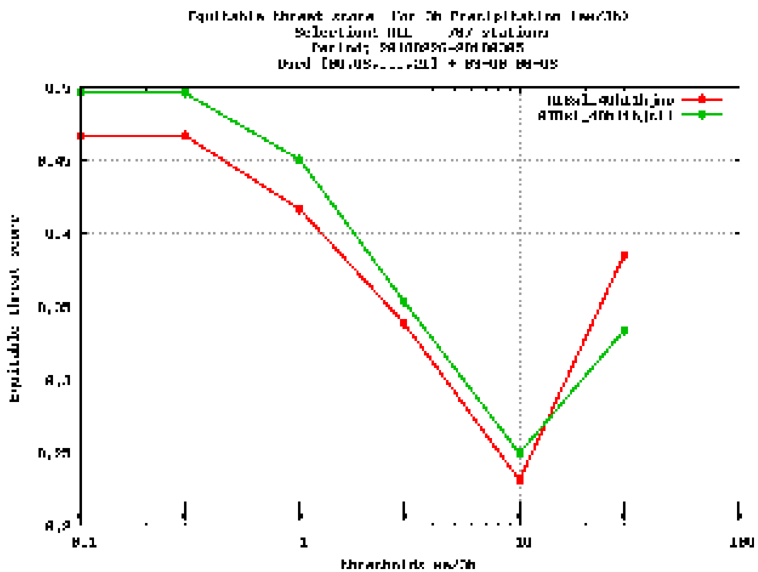
Radar Data assimilation

Jana Sánchez

- Radar data from OPERA: so far reflectivity (latter Doppler winds)
- Tested: 3 radars from Portugal + 15 from Spain
- Method: reflectivity is transformed to a 1D RH profile which is assimilated (*Caumont et al 2010*)
- Positive impact H+3/9 in humidity and precipitation



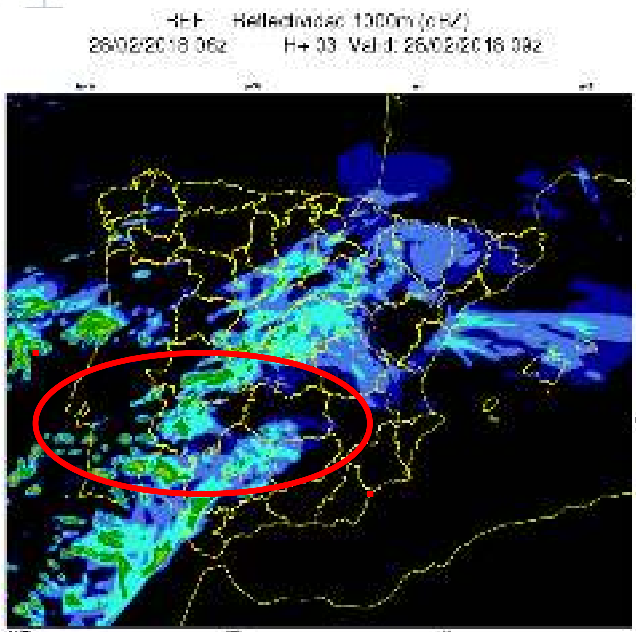


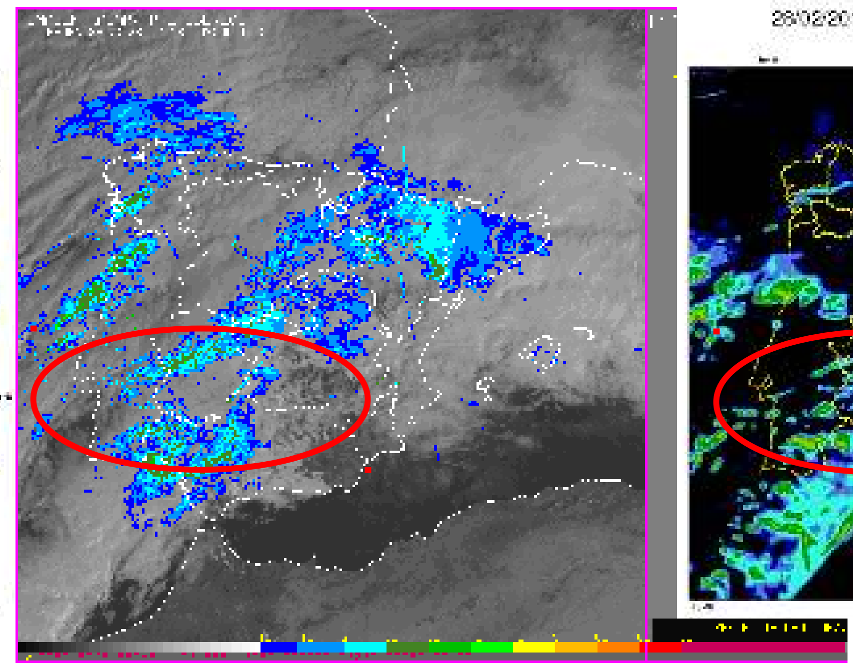


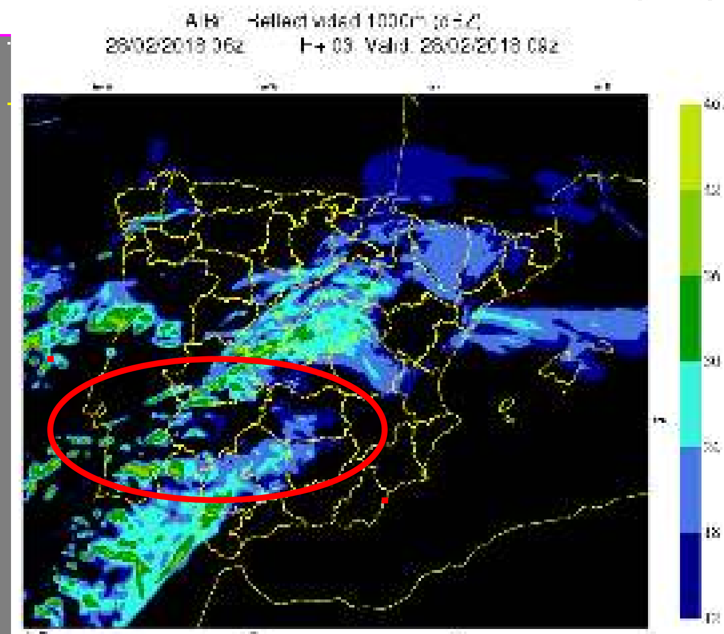
Radar Data assimilation

Jana Sánchez

- Small positive impact tending to produce fewer False Alarms







AMDAR humidity DA

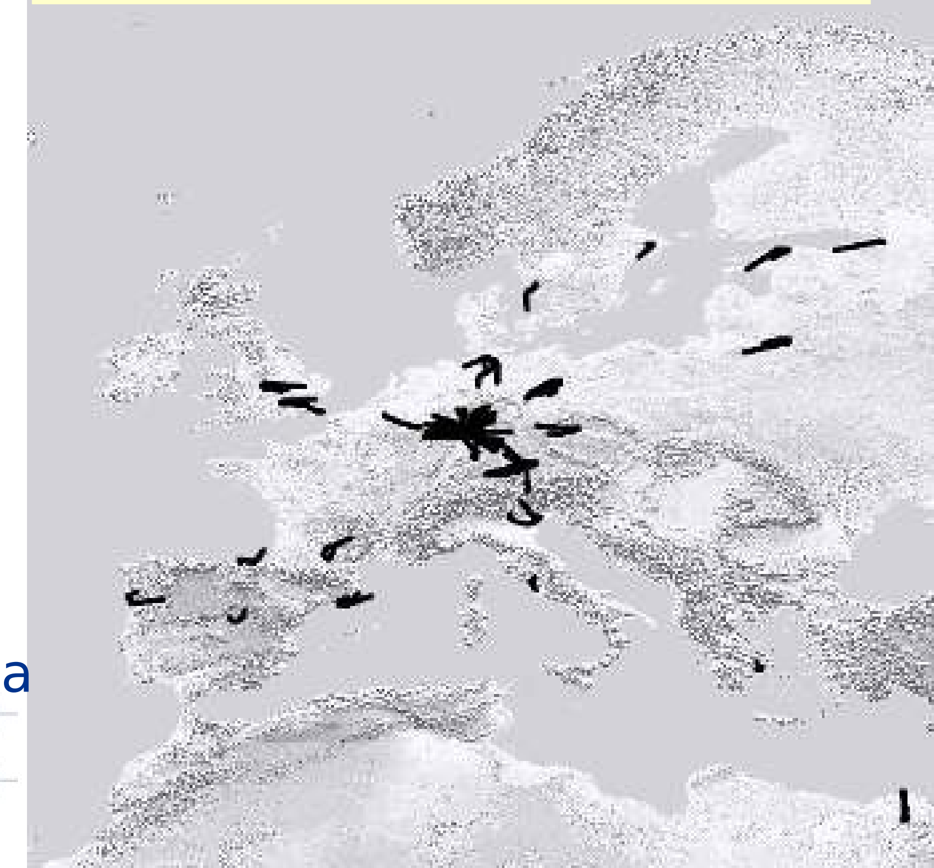
Joan Campins , María Díez

Study for EUMETNET:

Campins and Navascues, 2018: "Impact of E-AMDAR humidity observations ('conditional' FSOI assessment) in comparison to radiosonde data" (based on IFS assimilation statistics)

- As good quality as soundings
- Positive impact on ECMWF assimilation what is not always the case for RS over Europe
- Low coverage: only 9 Lufthansa planes in Europe
- Ongoing work assimilating AMDAR-q in the HARMONIE-AROME system
  - So far neutral or small positive impact but it seems there is room for further preprocesing of the data

E-AMDAR data available 29-05-2018



Other Observations coming

- ATOVS
- GNSS zenith total delay
- Radar data
- AMDAR-q
- IASI
- Scatterometer (Isabel Monteiro)
- SEVIRI
- AMVs
- MODE-S

Development of new DA techniques (1)

Carlos Geijo

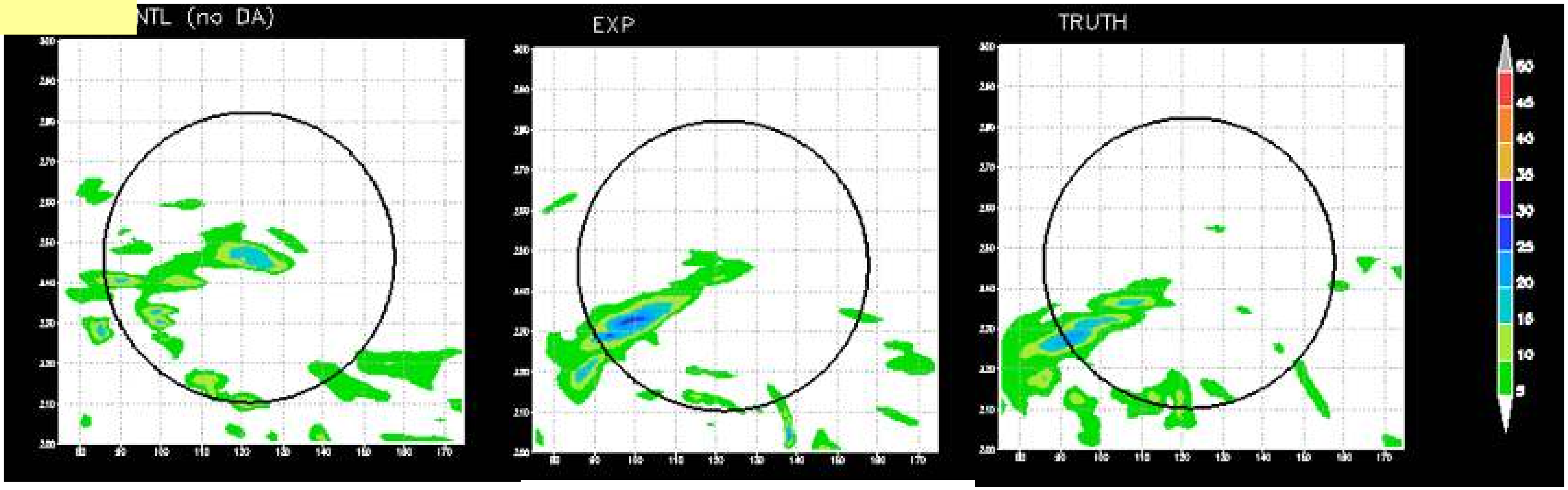
- Correction of position errors in the FG using radar images with the **Field Alignment technique** (*Ravela et al., 2007. Physica D230*)
  - Applied to Doppler wind (easier) and reflectivity
  - Positive impact in the first few hours of the forecast, but in general smaller than expected, not yet fully satisfactory
  - Need further tests, and also for some algorithm improvements (e.g. overlapping radars, balancing of FA increments)

20120928 18 H+3

CTRL (no DA)

FA

Madrid radar

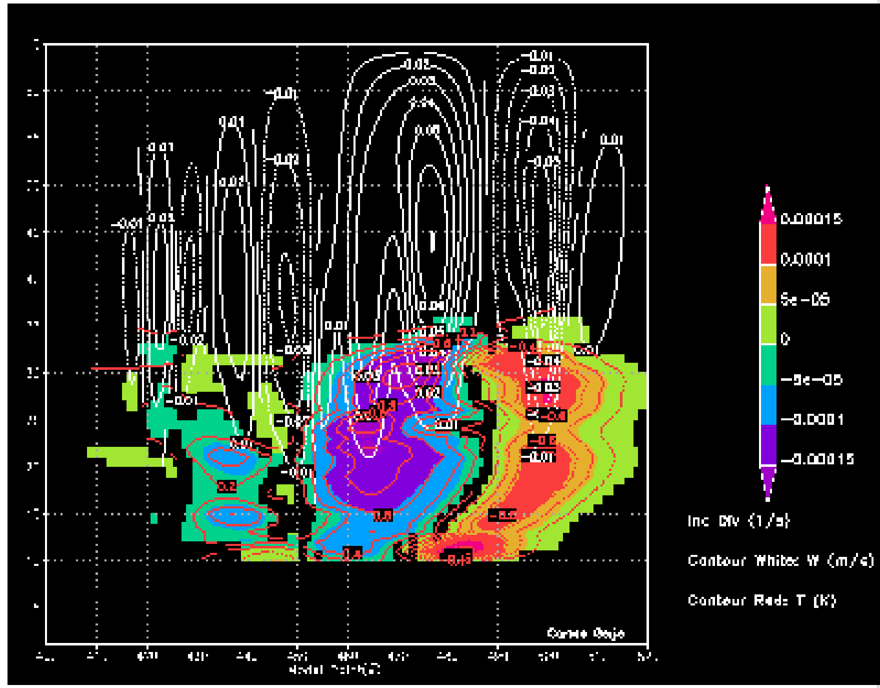


Development of new DA techniques (2)

Carlos Geijo

- Enforce balances in the analysed variables by means of a Variational Constraints method (*Geijo and Escribà, 2018: HIRLAM-ALADIN NewsLetter No.11*)

  - Solving Semi-Implicit sch. by means of Green Functions
  - Not including the spatial structure that comes from the obs. increments
  - Vertical velocity included
  - In principle is a flow-dependent method
  - Promising results in different contexts:
    - ✓ Field Alignment of Doppler wind img
    - ✓ LETKF (3hr cycle)
    - ✓ Comparison with statistical balances.
  - Currently working in its integration in HARMONIE-AROME cycle 40

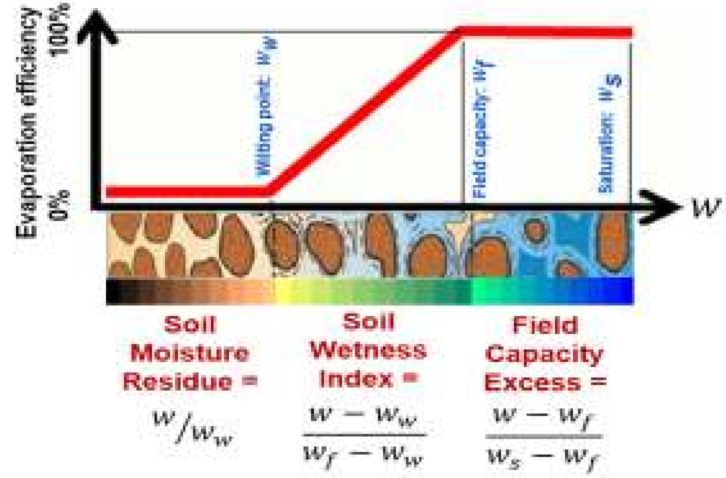


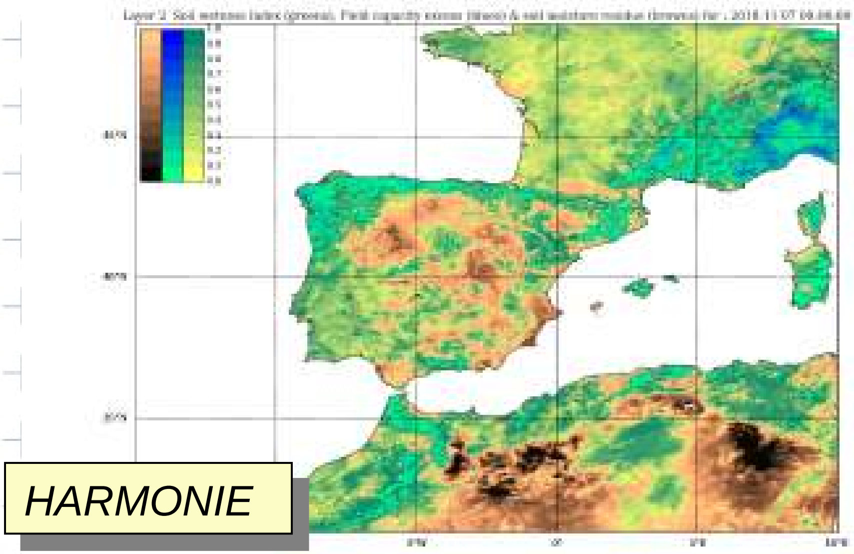
Radar wind analysis increments after FA and the Variational Constraints

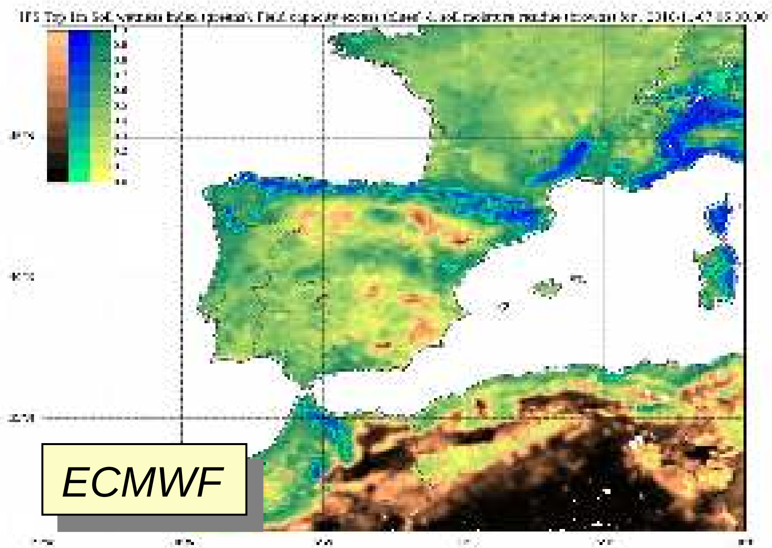
Surface processes

Samuel Viana

- Checking physiographic data bases (lake coverage)
- Test SURFEX options: NWP and climate mode
- Validation/monitoring of the hydrological cycle





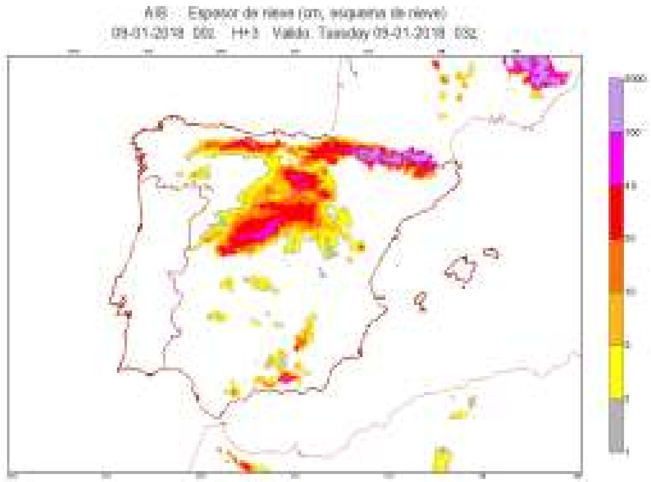


Soil moisture indexes relate soil moisture (*w*) to soil characteristics (wilting point, field capacity, saturation). These are plot operationally for the three soil layers in order to monitor the soil status in the model and its possible relation to atmospheric biases.

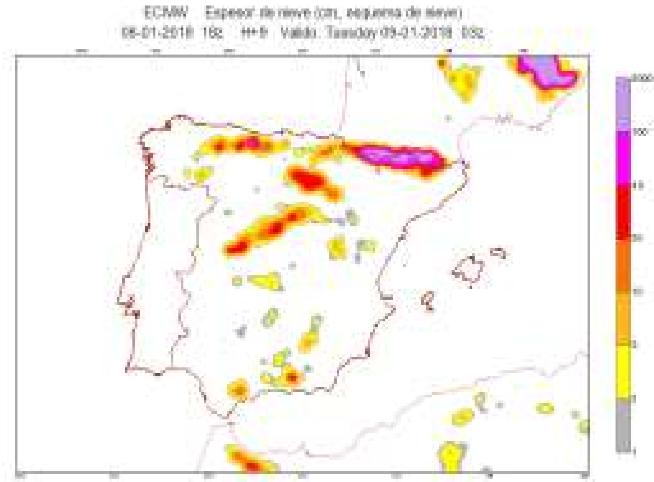
Snow analysis and prediction

OI method using only SYNOP observations that are scarce over our domain.
The parametrization follows Douville (95)

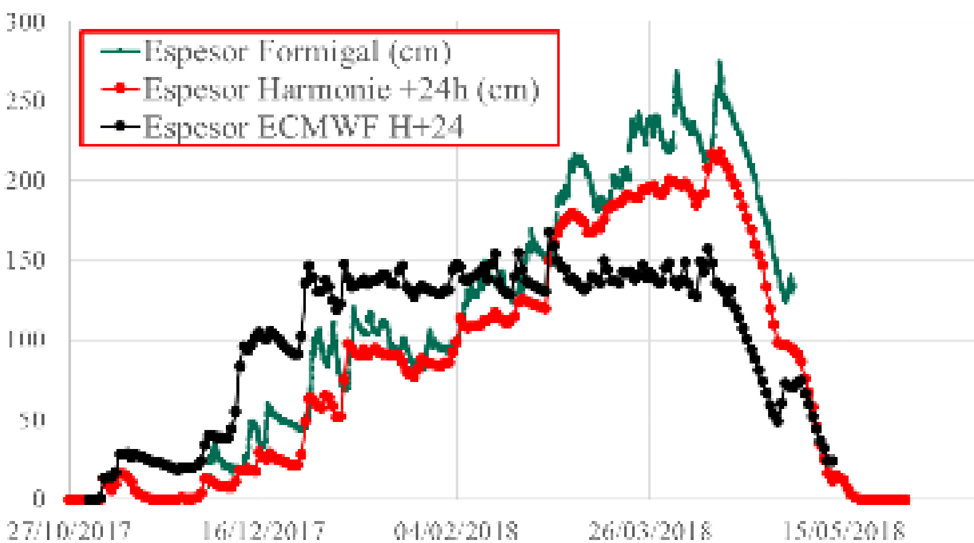
IMS NOAA/NIC snow cover



HARM-AROME snow depth



ECMWF snow depth



Snow depth evolution *2017/18 compared with observation at Formigal (Pirineos, 1800 m) a reference WMO station.*

CAMS aerosols → Cloud Condensation Nuclei

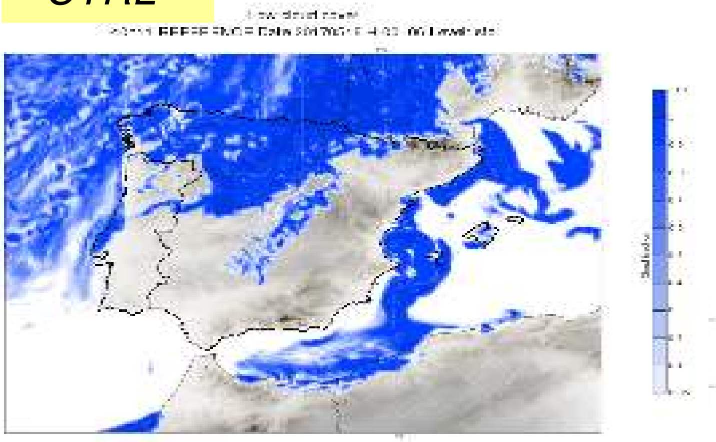
Martin, 2018: HIRLAM-ALADIN NewsLetter No.11

Daniel Martín

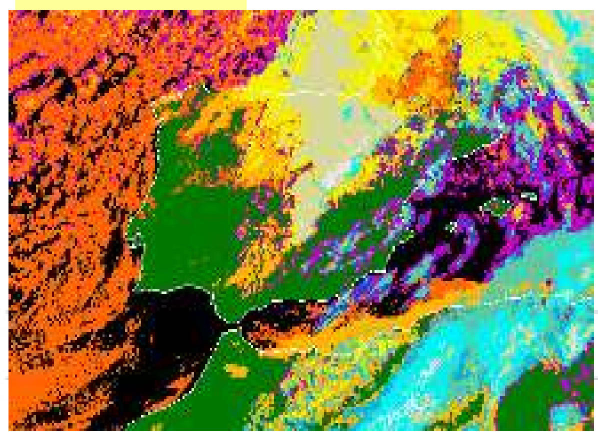
- Instead of constant values, use CAMS real time aerosols
- Microphysics: 4 aerosols (3 sea salt bins and 1 sulphate)
  - Infer number of CNN. Only advection by dynamics.
  - Processes affected: autoconversion (cloud droplets → rain droplets), cloud droplet sedimentation and collision of cloud liquid.

- Impact:
  - Increase ppt (in general)
  - Increase high clouds
  - Removal of some spurious low clouds

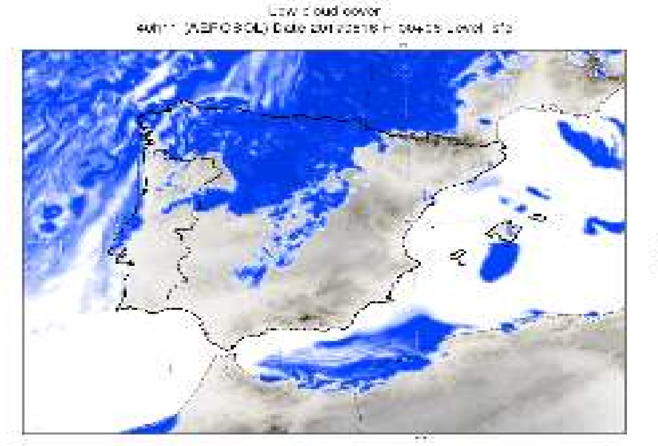
CTRL



NWCSAF



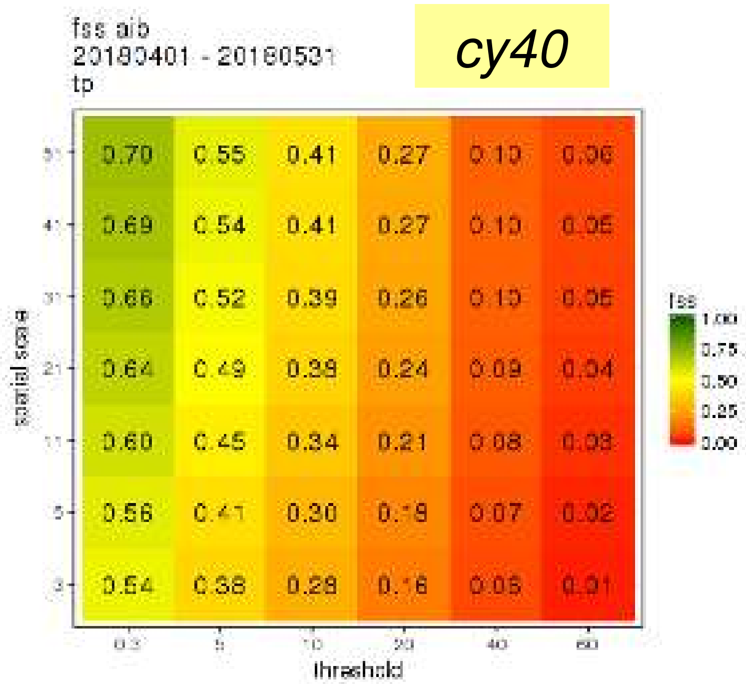
CNN from CAMS

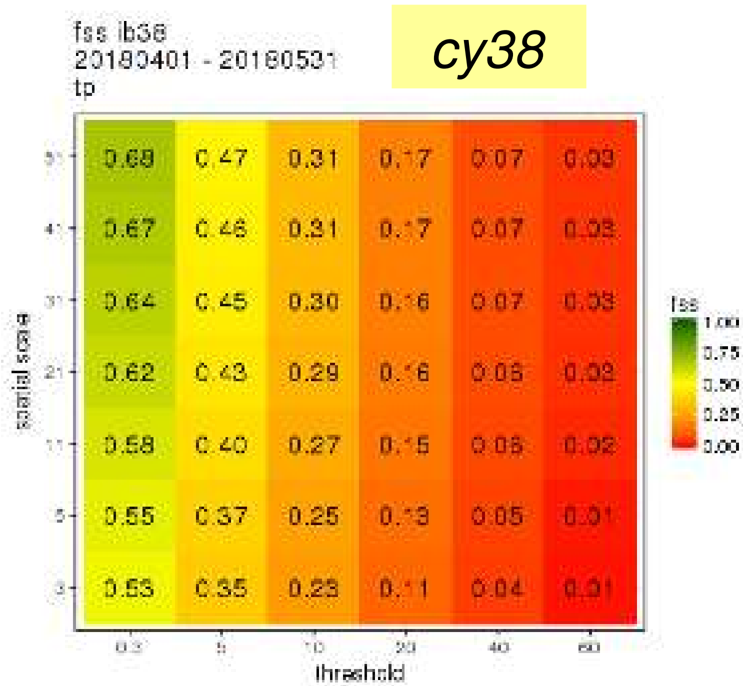


Spatial verification

Gema Morales

- Spatial verification complementary to point verification.
- Address the issue valuable spatial scale for a model
- Less sensitive to double penalty problem
- Example from HARP verification: *Fractional Skill Score* for 24hr ppt





Scores improve increasing the scale and seem to satúrate around 40-50 km.
Cy40 better than cy38 for all the thresholds

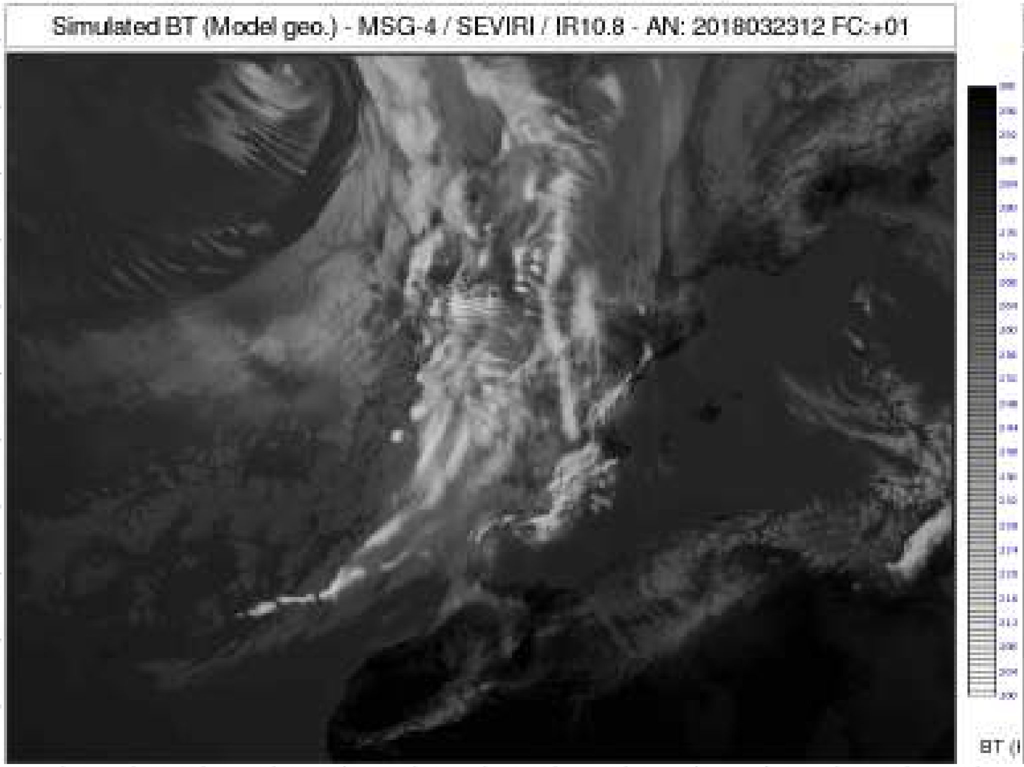
Simulated MSG images from HARMONIE-AROME

Ángeles Hernández

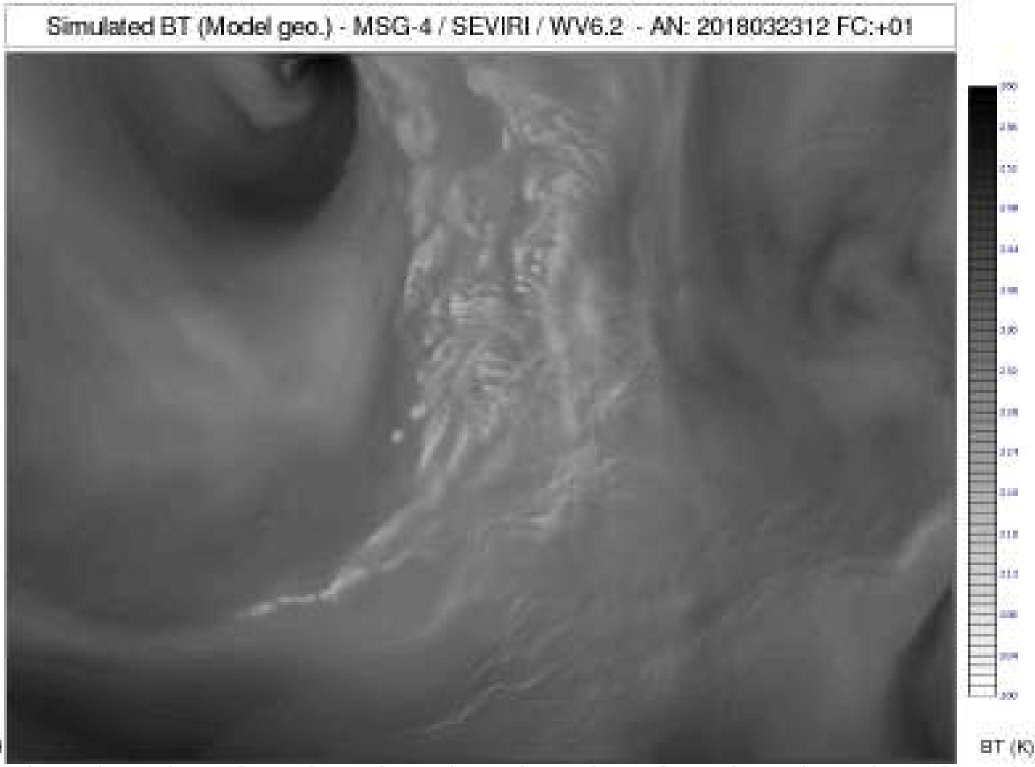
Hernández, A. et al, 2018. Proceedings of the 2018 EUMETSAT Meteorological Satellite Conference

HARMONIE-AROME 2.5 km operational run for 23-03-2018 12 UTC (Cyclone Hugo)

IR 10.8



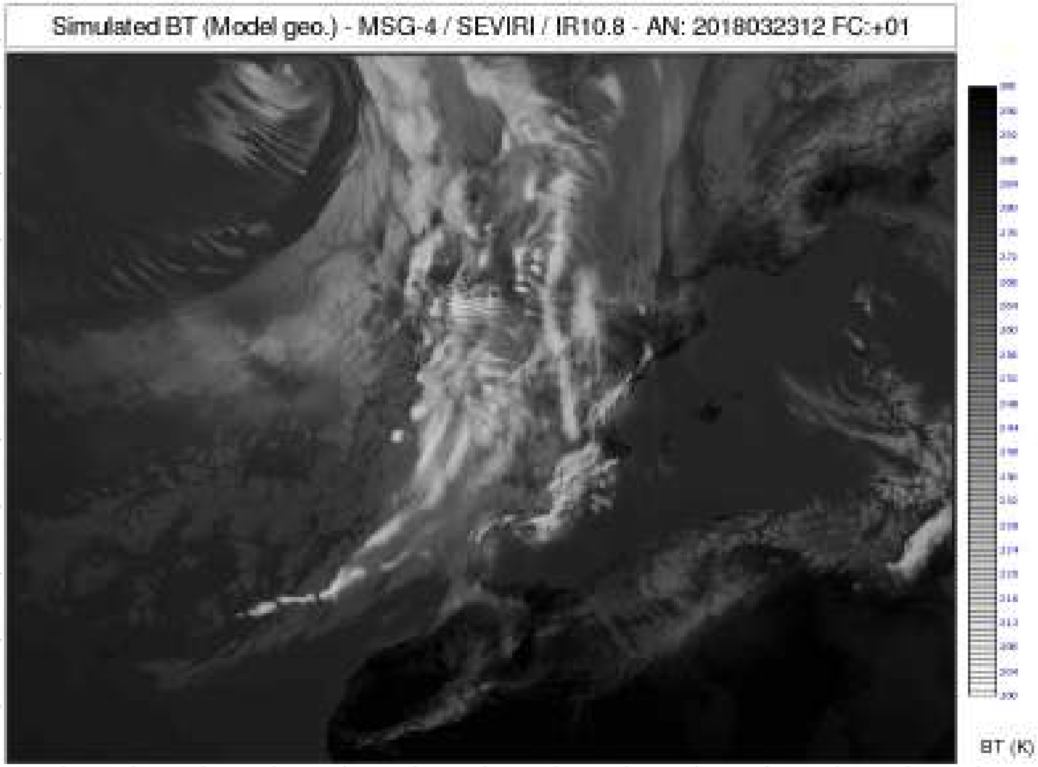
WV 6.2



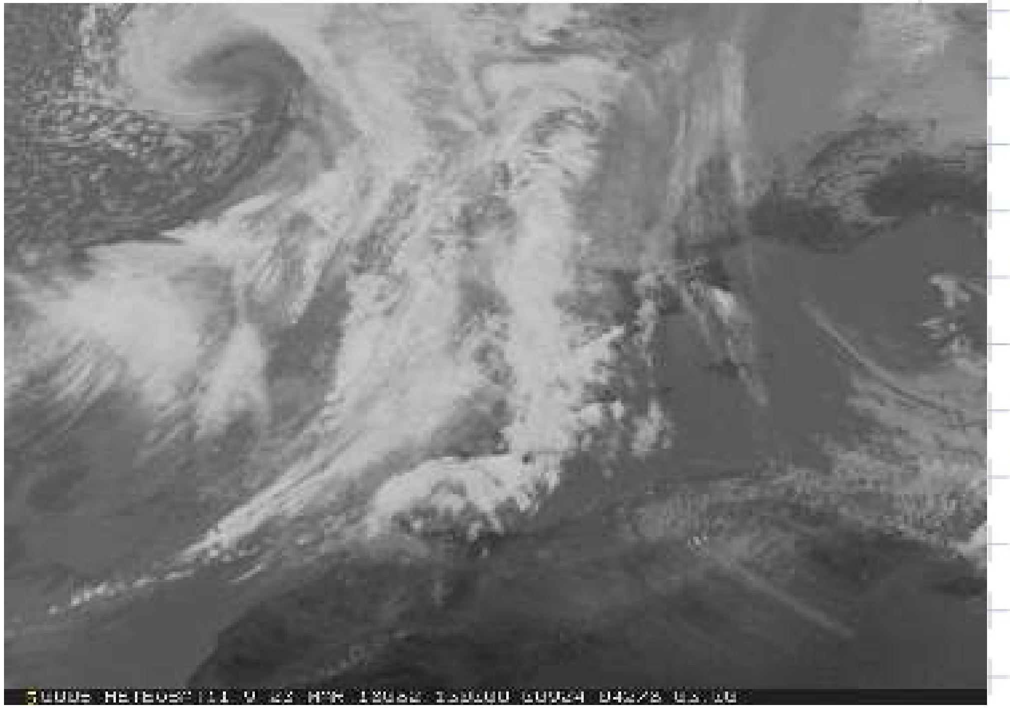
Simulated MSG images from HARMONIE-AROME

Comparison with observations for IR 10.8 (Cyclone Hugo)

HARMONIE H+01/24



MSG4 10.8

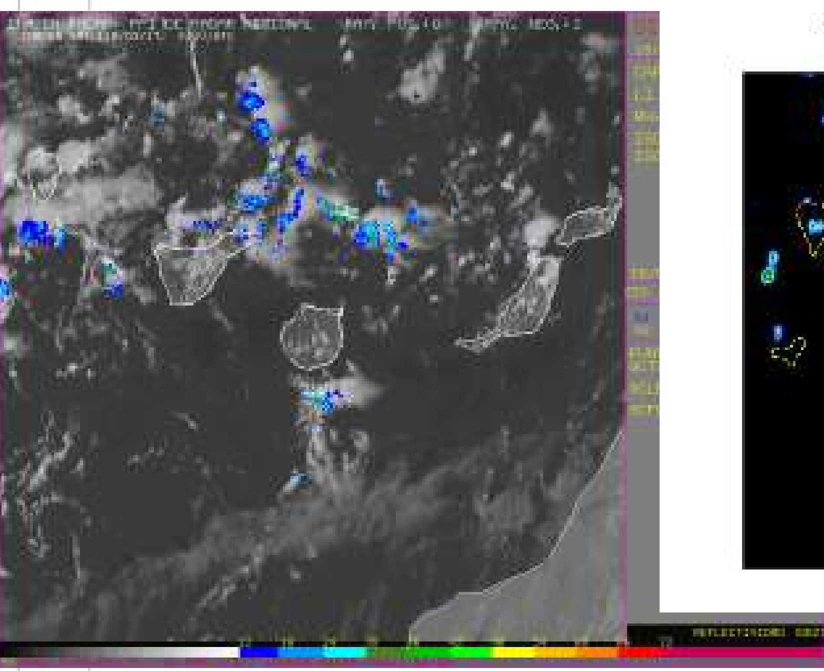


Kilometer and sub-km modelling

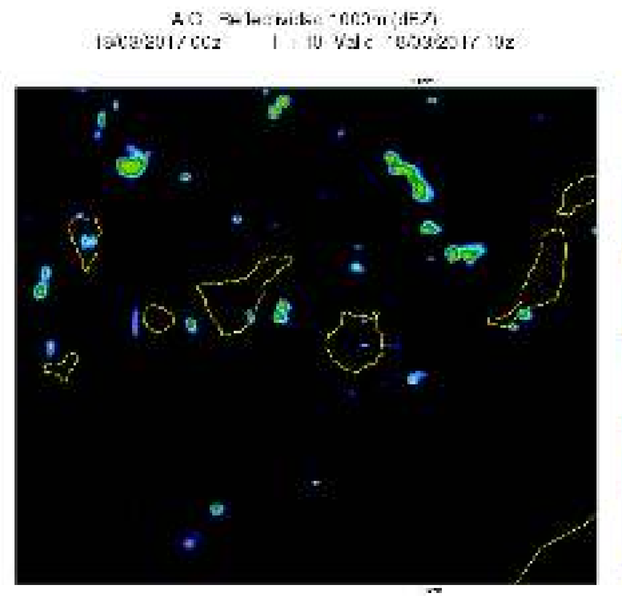
- Daily 1 km runs in dynamical adaptation mode for Harbour Administration (small coastal domains)
- Area of research with the target of having 'test bed' integrations over the Canary Islands to help to prepare the model for these resolutions

Very complex issue (many different aspects involved). Big computer resources

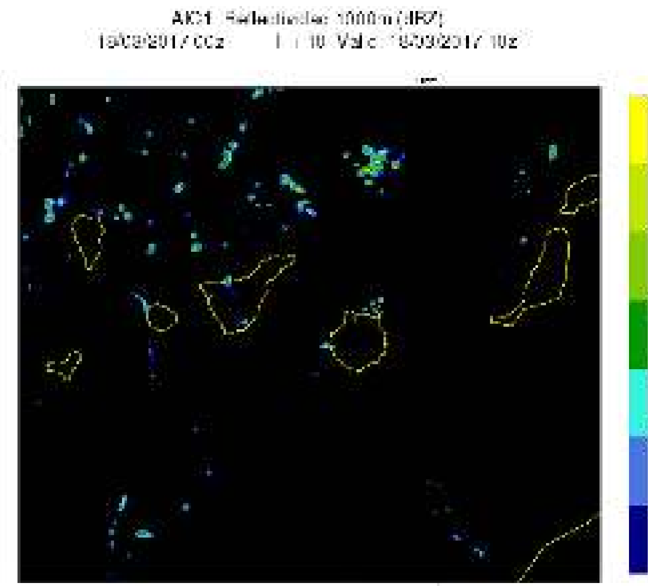
Sat + radar



2.5km



1km



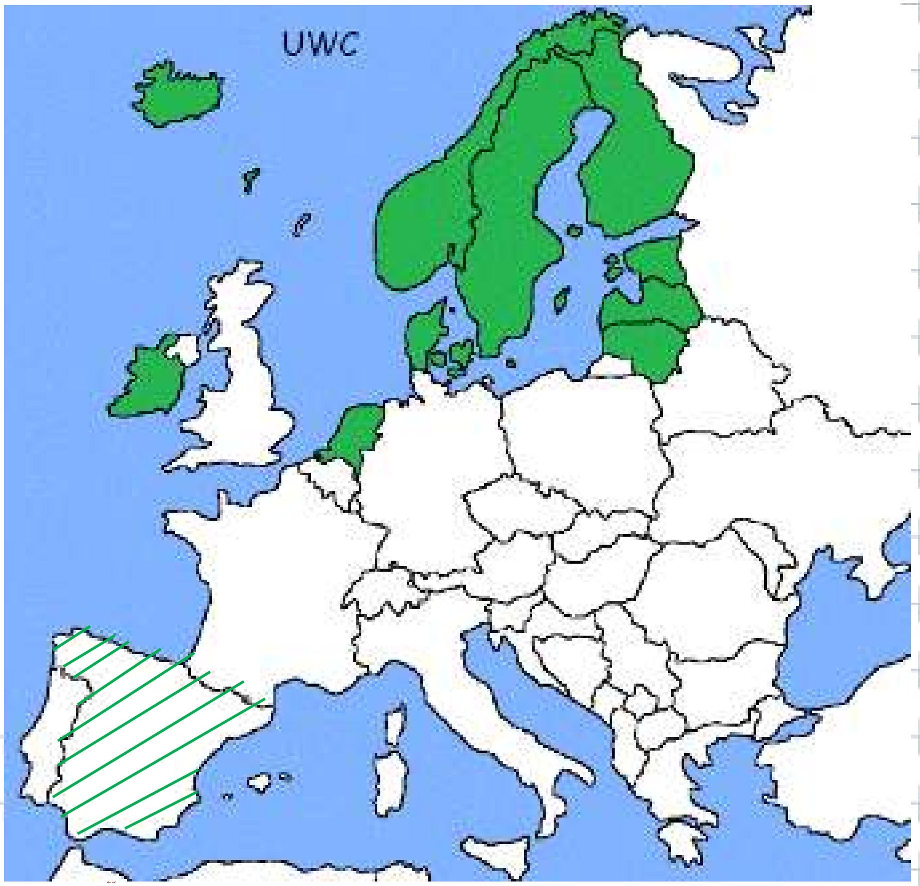
18 March 2017

Operational collaboration (1)

- After the successful experiences of METCOOP and LACE
- Operational convection-permitting needs EPS approaches =>ds big human and computer resources in a context of frozen budgets

- *United Weather Centers (UWC):* The goal is joint operational exploitation of a NWP system, including EPS, pre- and postprocessing
- Spain will joint as observer

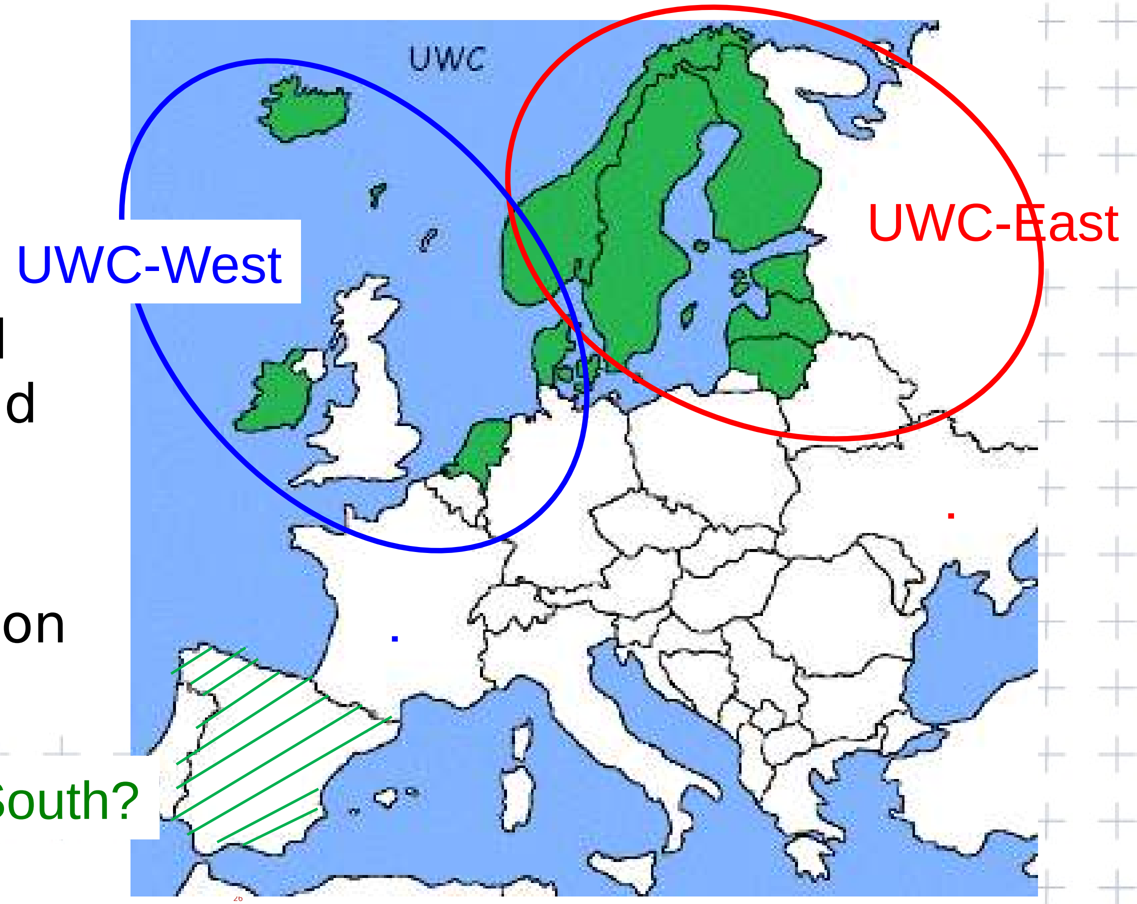
- A MoU already signed
- January 2028: Common HPC



Operational collaboration (2)

- Phase 0, 2018-2022:
  - UWC East: operational, integration Baltic NMSs
  - UWC West: preparing for operation
  - UWC South: Spain
  - UWC: coordination, establishing strategy for 2023-2027

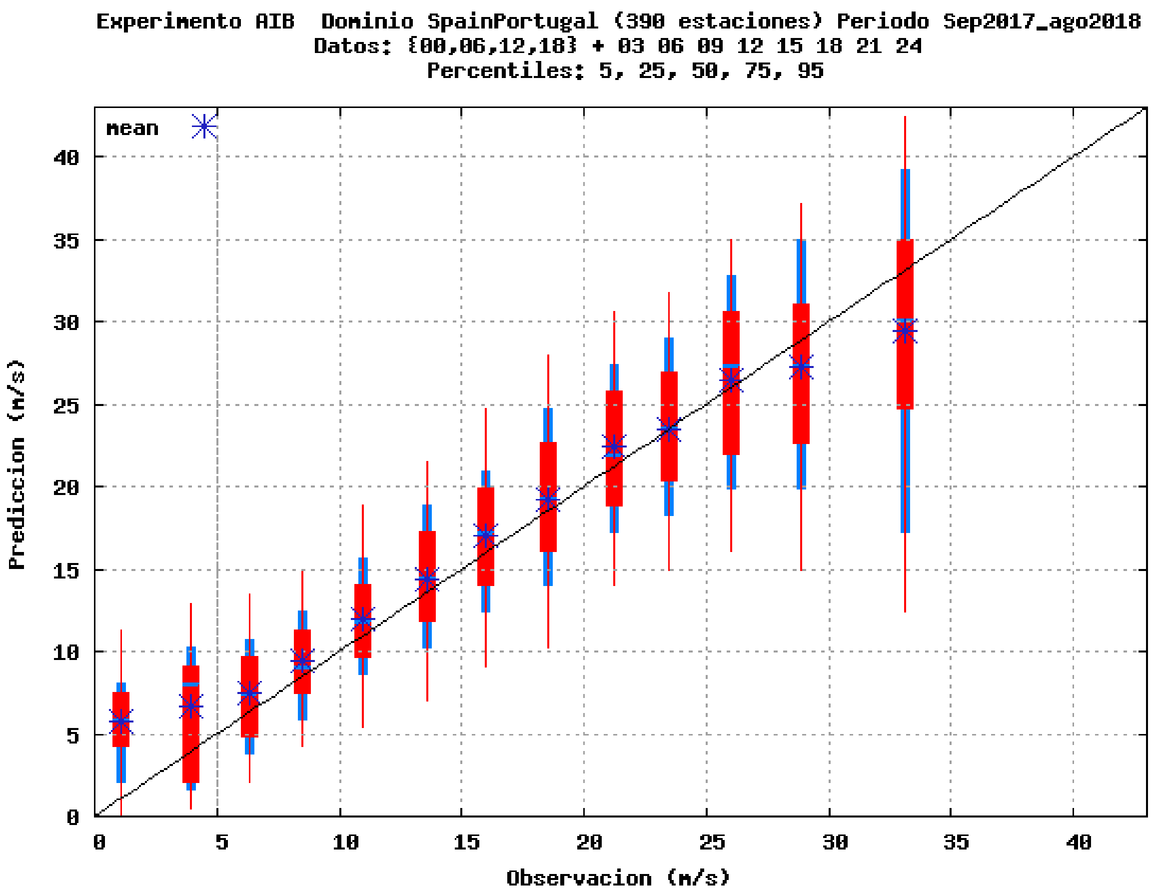
- Phase 1, 2023-2027:
  - UWC West: operational
  - UWC East: operational
  - UWC: preparing operational integration of UWC-West and UWC East
- Phase 2, 2028:
  - UWC: operational cooperation between all NMSs



Obrigado

Wind gust estimation

Period: Sep 2017-Aug 2018 (one year)



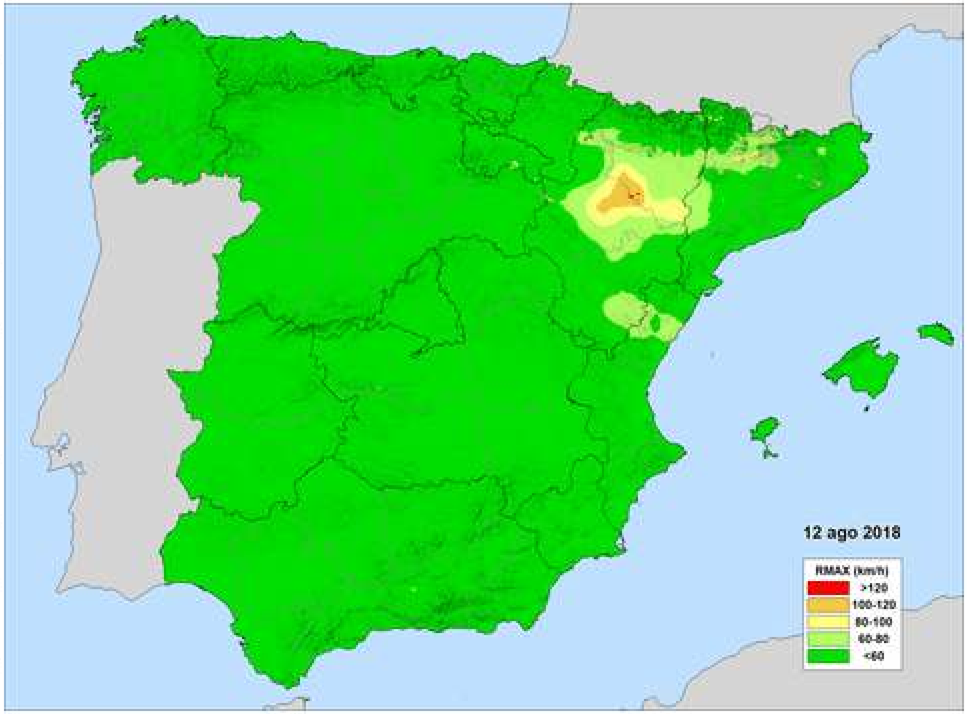
Distribution for different observed categories (hourly estimation)

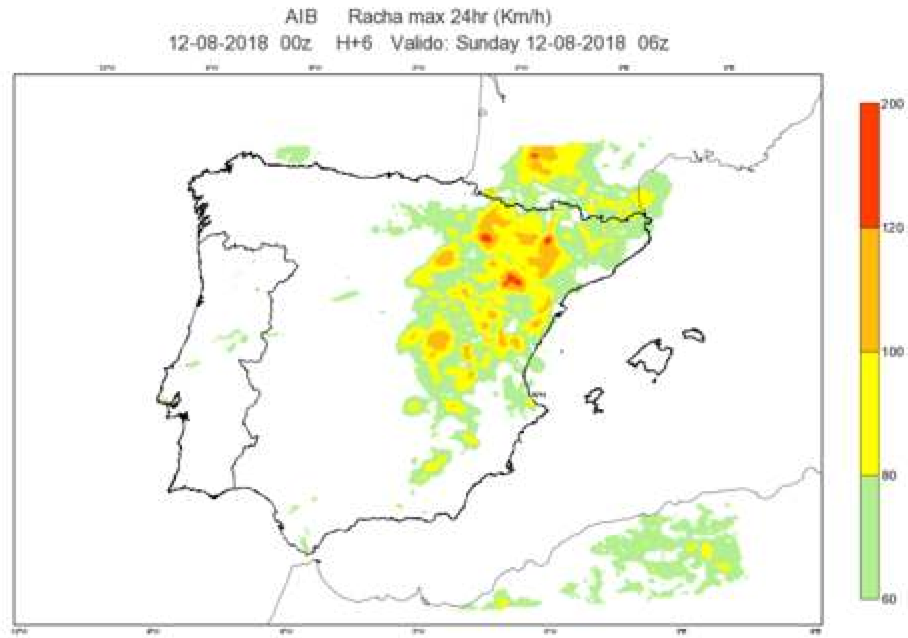
Wind gusts with severe convection

Case study: 12 aug 2018

Tempestad Ciclónica Típica (TCA) areas: Maximum Wind gusts in a day

Thresholds > 80 km/h, > 100 km/h, > 120 km/h





Overestimation with very active deep convection