AEMET operational suite: Regular Cycle of Reference for cycle 40

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AEMET HPC

Bullx B710 computer based on Intel Xeon 2697 V2 Ivy Bridge processors

- 168 Tflops peak performance
- 7760 processors

Determinist runs take 1/5 of the computer resources

TC runs at ECMWF

For backup purposes HARMONIE-AROME v38h1.2 is run at ECMWF with a smaller area for the Iberian domain and with 6 hr cycles.

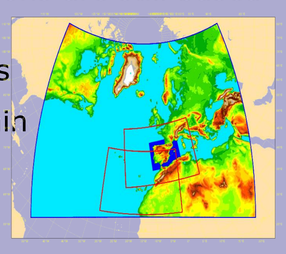
HIRLAM Suite

Many post-process products and applications are still based on the HIRLAM outputs.

3 **HIRLAM v7.2** domains with 6 hr cycles

- **ONR** 0.16deg H+72 over a big domain
- **HNR** and **CNN** 0.05deg H+36

Only 4 nodes dedicated to this runs

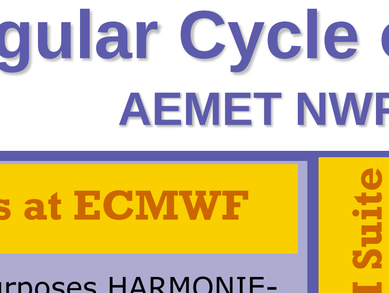


HARMONIE-AROME Suite at AEMET

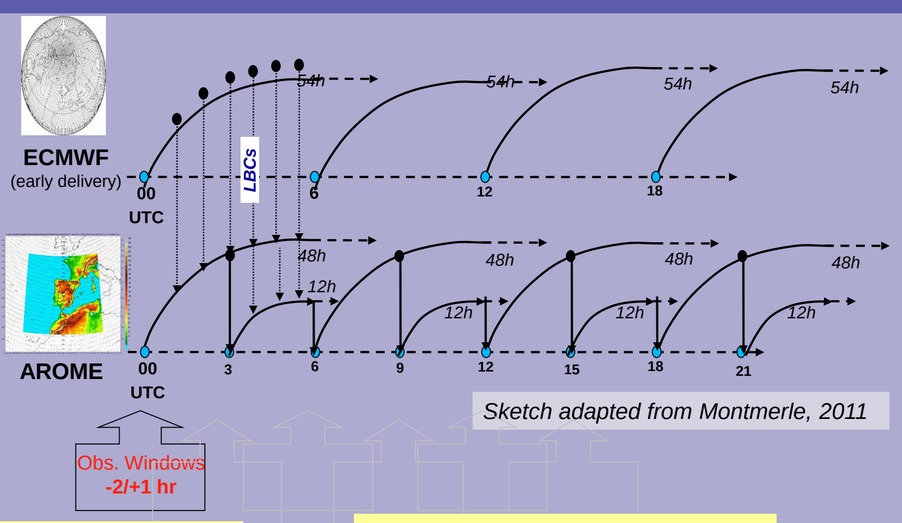
AEMET runs **HARMONIE-AROME** v40h1.1 from the ALADIN-HIRLAM Shared System in the BullX computer. This suite is used by HIRLAM Consortium to monitor the quality of the reference system (**Regular Cycle of Reference, RCR**)

The model is run at **2.5 km** runs 8 times per day with a forecast length of 48 hours at 00, 06, 12, 18 and for 2 geographical domains (Iberian Peninsula and Canary Islands). Runs at 03, 09, 15 and 21 only up to 12 hours.

- Configuration described in Bentgsson et al. 2017
- ALADIN **NH dynamics** and **1-hr boundaries** from ECMWF
- **3DVar analysis** with **3hr cycle** incl. **ATOVS** and **GNSS data**
- **Surface data assimilation** with optimal interpolation**.**
- **AROME physics**: Explicit deep convection, SURFEX and ICE3 microphysics
- **HARATU turbulence** and Unified scheme for shallow convection (**EDMFM**)



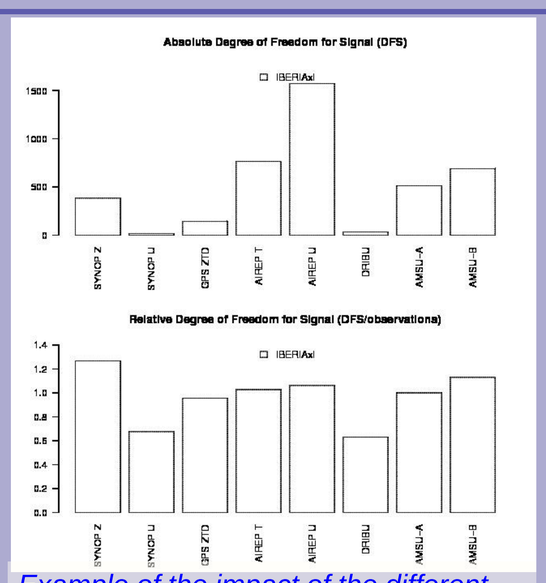
Operational domains



Sketch adapted from Montmerle, 2011

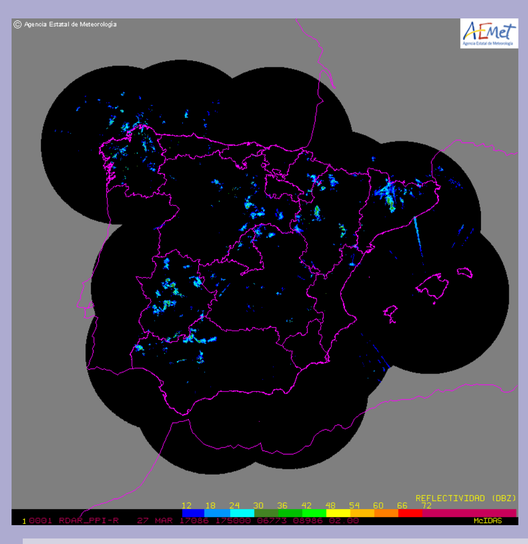
Cutoff time: 1:10

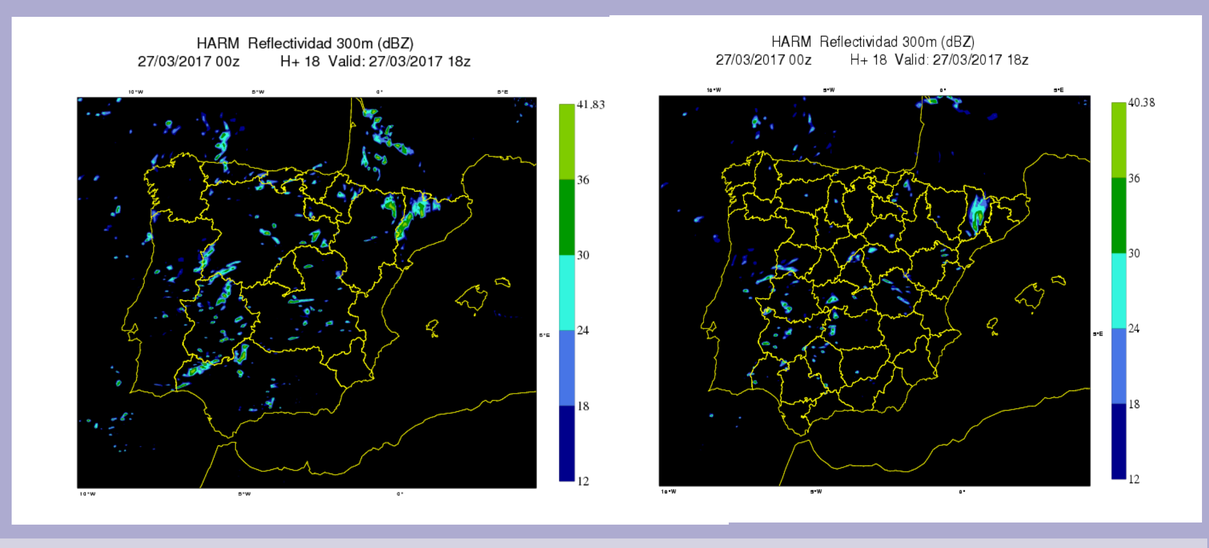
H+48 run available +2:45



Example of the impact of the different observations

Convection





Diurnal cycle of convection: Comparison of estimated reflectivities at 18 UTC for cycle 38 (middle) and cycle 40 (right) compared with radar observations. HARMONIE-AROME produces a good estimation of the convective activity. Cycle 40 tends to produce fewer cells and smaller maxima

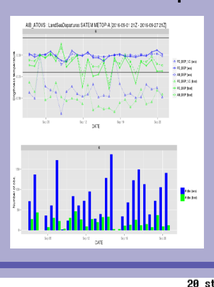
GNSS + ATOVS assimilation

Satellites used:

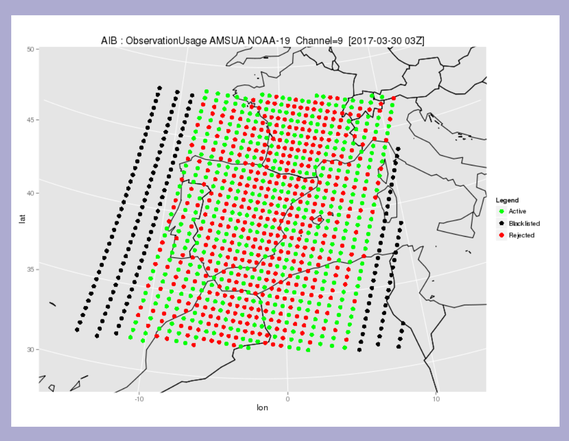
NOAA-18, NOAA-19, METOP-A & METOP-B

AMSU-A: Channels 6-9, except Channel 7 & 8 of NOAA-19 and METOP-A.

AMSU-B/MHS: Channels 3-5, except Channel 3 of NOAA-19.



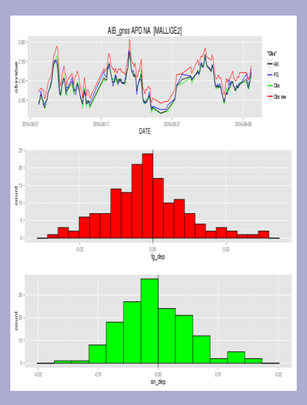
VarBC and assimilation diagnostics are examined by means of OBSMON



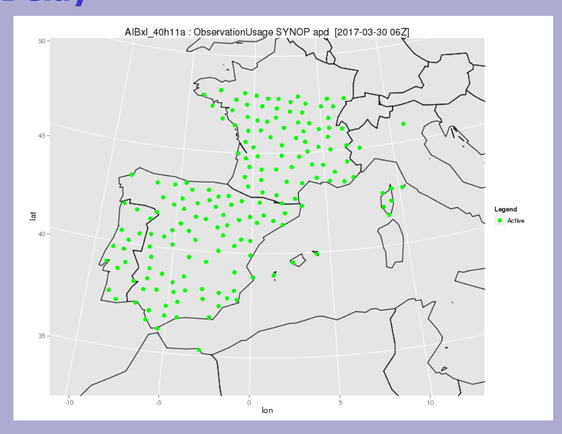
Observation selection for AMSU-A channel 6

Assimilation of GNSS Zenith Total Delay

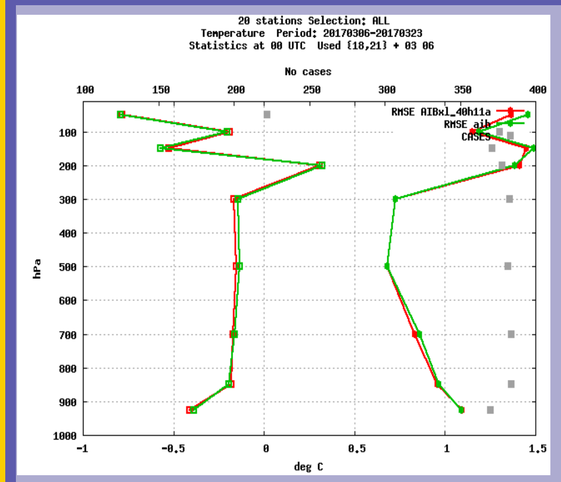
- 50 km thinning by means of a white list
- sigmao=0.02

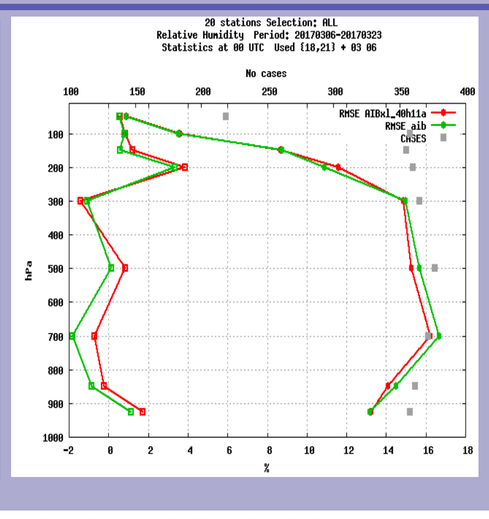


VARBC performing for one month run for MALLIGE2 site.



Selection of GNSS observations





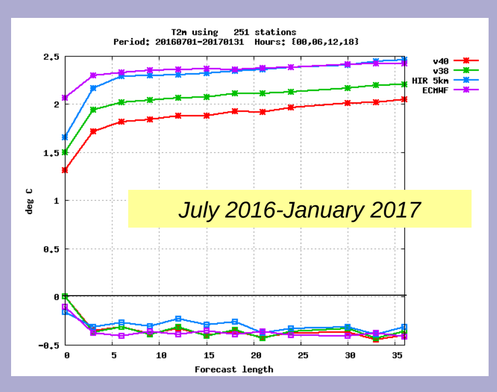
Verification against sounings comparing cycle 40 (red) including GNSS and ATOVS with cycle 38 (green) the later only with conventional observations. (left) RMSE and Bias of temp. (right) RH

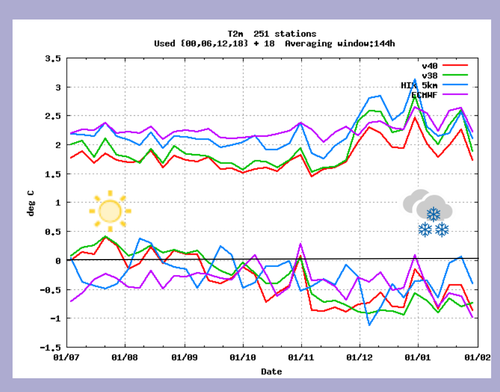
The added value of both GNSS ZTD data assimilation and ATOVS data assimilation has been proved having impact specially in the humidity variables and consequently in precipitation. Both observations tend to moisture the atmosphere (Campins et al, 2017). GNSS has more impact near the surface and ATOVS in middle levels. Key aspects for a successful combination of GNSS and ATOVS together are:

- Correction of observation biases using a VARBC approach. For the Iberian Peninsula domain about 1 month of training is enough. For the Canary Island domain with less observations and with more irregular time distribution, the period needed is much longer.
- Tuning of VARBC is an issue for humidity obs due to the lack of anchor observations: Only a few soundings (2 in the case of Canary Islands domain)
- Selection of ATOVS channels
- Assignment of obs error for proper balance between the different observations

More information on GNSS + ATOVS assimilation in Arriola et al. talk

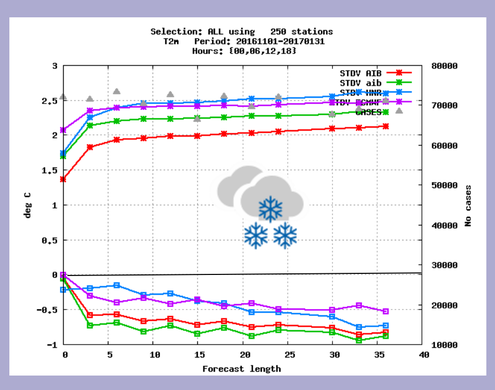
2m Temperature





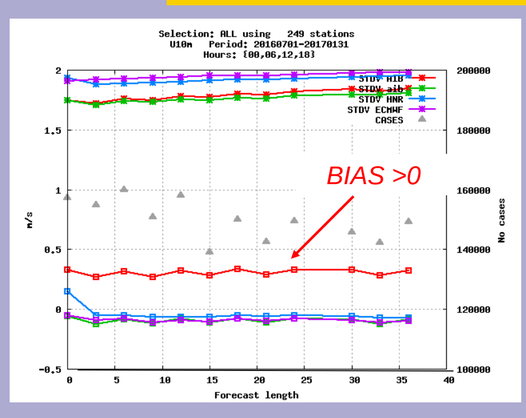
Verification against synop obs: (left) STDV and BIAS function of the forecast length (right) evolution of mean day error for the 7 months showing a small positive bias in summer and a clear negative bias from the 10th of September. The improvement with HARM-AROME is clear and cycle 40 improves cycle 38.

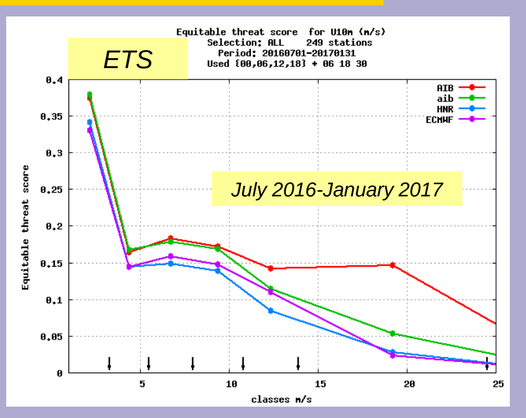
November 2016-January 2017



Verification for the winter months HARM-AROME shows a clear negative bias. This negative bias in T2m in AEMET domains is larger than in other domains as MetCoop domain.

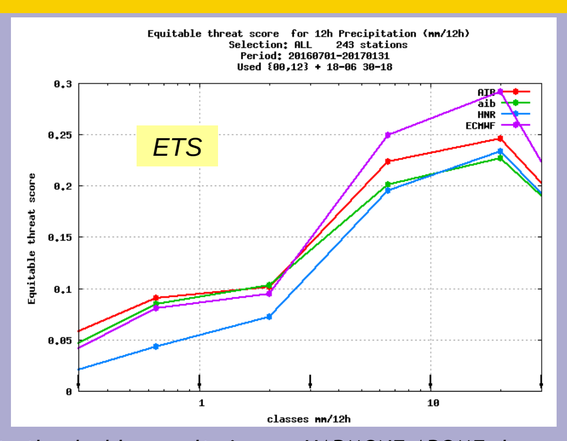
10m wind





STDV and BIAS function of the forecast length showing the positive bias of cycle 40 (right) ETS of wind speed for different wind categories. HARMONIE-AROME shows better scores than HIRLAM and ECMWf. Overall, cycle 40 improves cycle 38 being the HARATU turbulence the main responsible for this. The positive bias in cycle 40 is generally larger than the one present in MetCoop integrations.

Precipitation



Despite the double-penalty issues, HARMONE-AROME shows similar scores to ECMWF and better than HIRLAM. Besides, cycle 40h1.1 improves slightly cycle 38h1.2

Highlights

AEMET runs HARMONIE-AROME v40h1.1 from the **ALADIN-HIRLAM Shared System** in a BullX 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)
- Also there is a clear improvement in precipitation forecast
- Cycle 40h1.1 shows an overall improvement compared with cycle 38h1.2 with some remarkable differences:
  - Stronger winds
  - Smother and, in principle, more realistic precipitation fields
  - Less low level clouds, with higher cloud base and, in general, underestimation of the cloud cover (more in summer)
- Compared with MetCoop integrations, AEMET forecasts tend to have greater negative bias in 2m temperature and higher overestimation of 10 m wind.