NWP Activities at the AEMET (Spain)

Calvo J., Campins J., Diez M., Garcia-Moya J.A., Geijo C., Hernandez A., Hortal M., Martin D., Morales G., Sanchez J., Subias A.

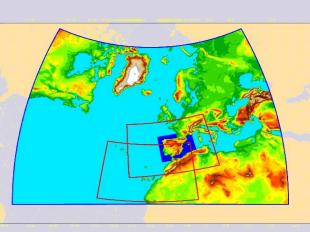**38th EWGLAM & 23nd SRNWP Meetings, 3rd/6th Oct. 2016 Rome, Italy**

MINISTERIO DE AGRICULTURA, ALIMENTACIÓN Y MEDIO AMBIENTE

AEMET — Agencia Estatal de Meteorología

NEW High Performance Computer

A new **BULL** supercomputer has been installed using Intel Xeon 2697 V2 Ivy Bridge processors.

- The computer is fully operated since early 2016.
- 7760 processors with hyperthreading allow implementing the-SREPS ensemble system and RUC of the HARMONIE system.

nimbus

HIRLAM Suite

3 **HIRLAM v7.2** suits with 6 hr cycle

- **ONR** 0.16deg H+72 over a big domain
- **HNR** and **CNN** 0.05deg H+36
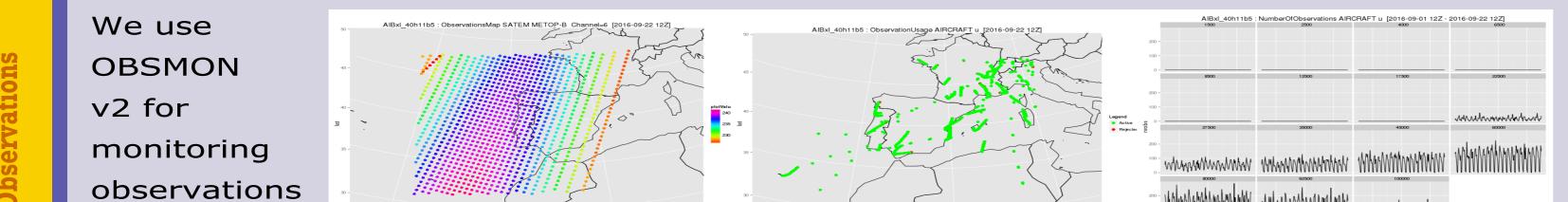
Many post-process products and applications are still based on the HIRLAM outputs.
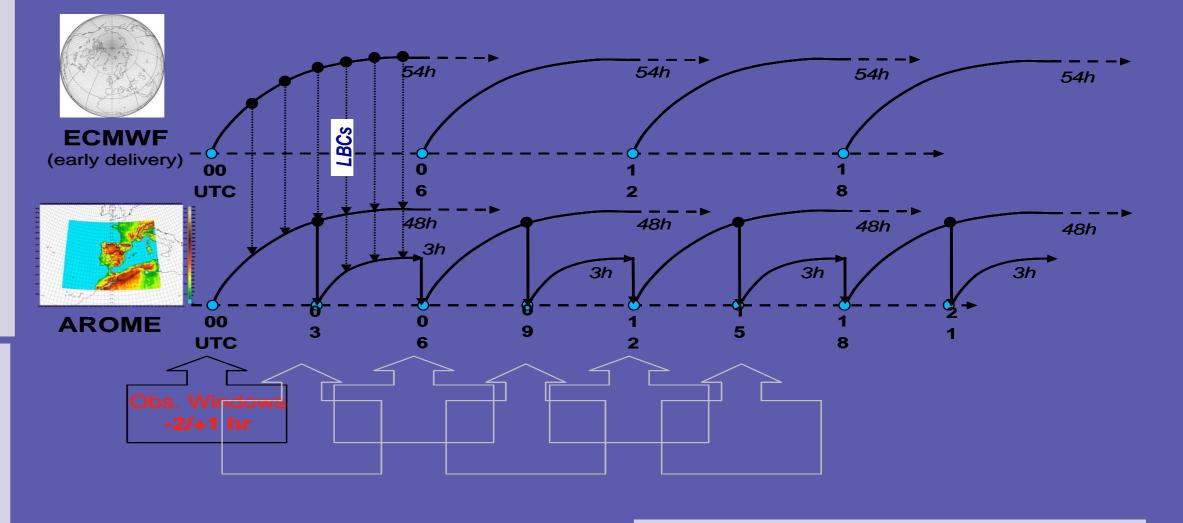
HARMONIE/AROME SUITE

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

HARMONIE/**AROME** 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).

- 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
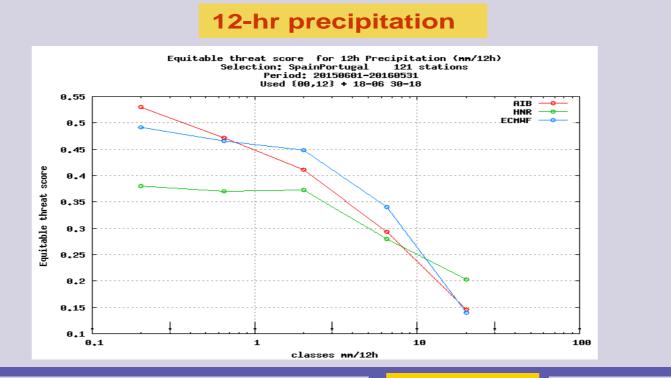- Unified scheme for shallow convection (**EDMFM**)

ECMWF (early delivery)

AROME

Sketch adapted from *Montmerle, 2011*

Monitoring Observations

We use OBSMON v2 for monitoring observations and analysis

Verification against obs.

Categorical verification for 1 year comparing ECMWF, HIRLAM 0.05 (HNR) and HARMONIE 2.5 km. The **Equitable Thread Score** shows the added value of HARM in variables near the surface. For the precipitation, it should be taken into account that the double penalty problem Penalizes the models with higher resolution.
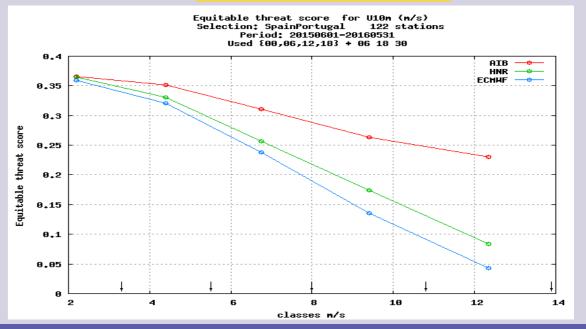
12-hr precipitation

T 2m

10m wind speed

ATOVS assimilation
jcampinsp@aemet.es,mdiezm@aemet.es
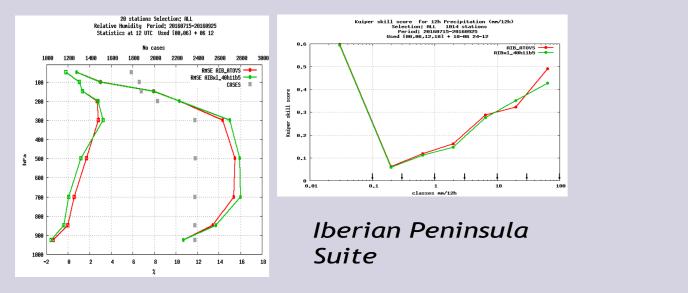
Assimilation of ATOVS over two domains.

- Satellites used:

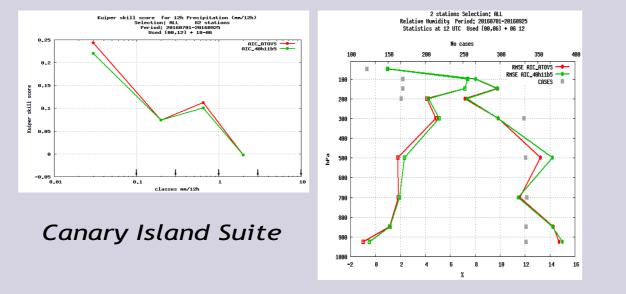 NOAA-18, NOAA-19, METOP-A & METOP-B

  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.

- Verification: The greatest impact is in the humidity variables.

- VARBC and monitoring.

VarBC and assimilation diagnostics are examined by means of obsmon

Iberian Peninsula Suite

Canary Island Suite

Future: test the assimilation of channels 5 and 10 of AMSU-A

GNNS ZTD assimilation
jsancheza@aemet.es
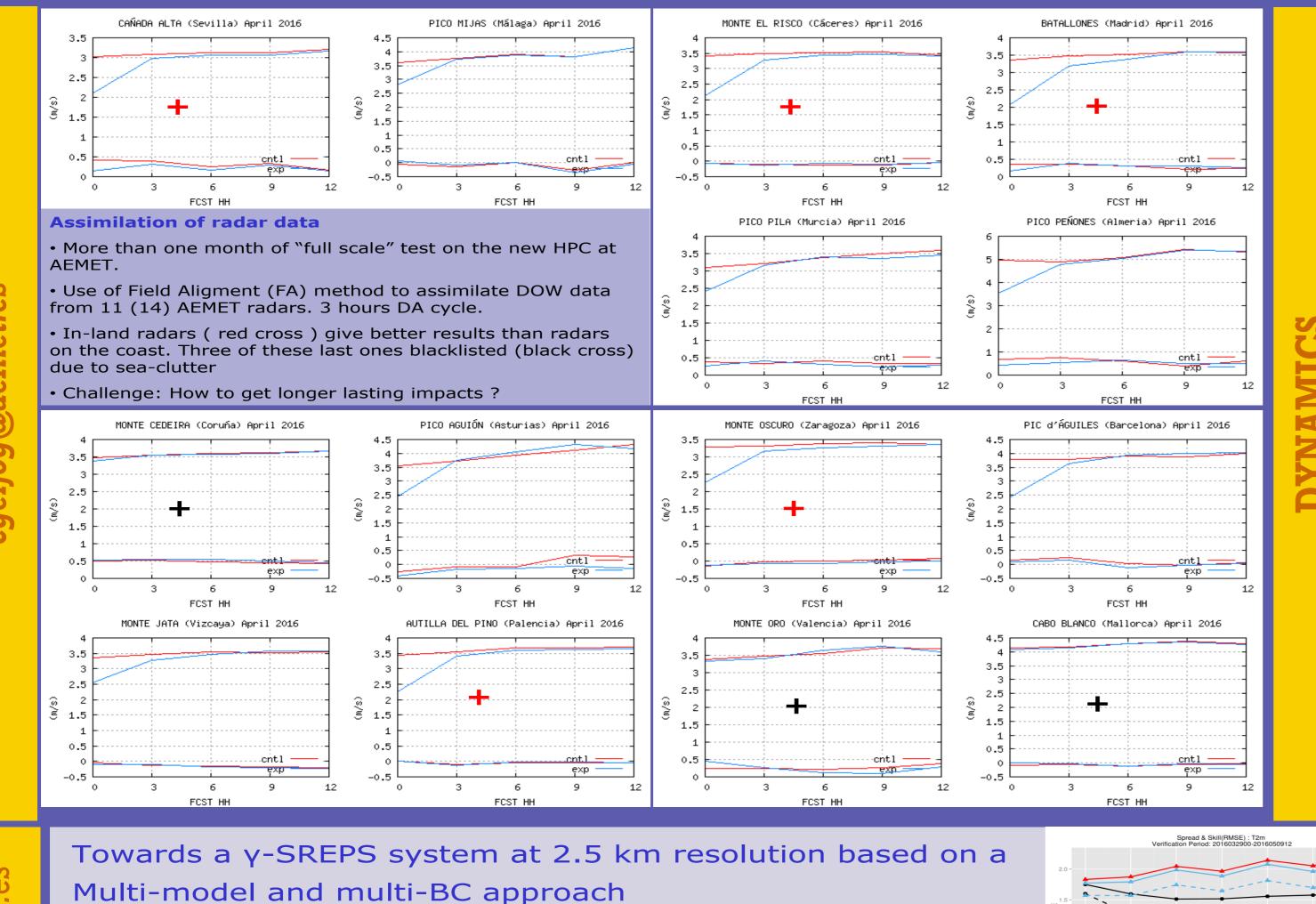
Assimilation of GNNS ZTD

Cy40h1.1b5, 3DVar with 3hr cycle. Verification for 3 months of parallel runs

- Gnss ZTD data

with 50 km Thinning and VarBC.

GNSS sites : 800

VARBC performing for one month run for MALLIGE2 site.

Kuiper Skill Score for 12 hr-precipitation

Verification of RH against soundings

Use of GNSS ZTD observations together with a VarBc (constant offset) has shown an improvement of short range weather forecasts, both in a statistical sense and in individual case studies.

Future: Try to decrease the Thinning distance and increasing the number of predictors of the VarBC scheme.
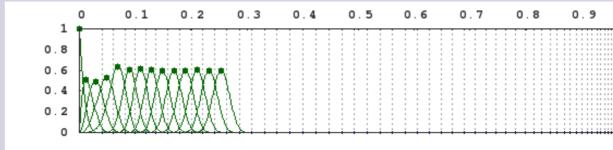
RADAR DATA ASSIMILATION
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CAÑADA ALTA (Sevilla) April 2016

PICO MIJAS (Málaga) April 2016

MONTE EL RISCO (Cáceres) April 2016

BATALLONES (Madrid) April 2016

Assimilation of radar data

- More than one month of "full scale" test on the new HPC at AEMET.
- Use of Field Alignment (FA) method to assimilate DOW data from 11 (14) AEMET radars. 3 hours DA cycle.
- In-land radars (red cross) give better results than radars on the coast. Three of these last ones blacklisted (black cross) due to sea-clutter
- Challenge: How to get longer lasting impacts ?

PICO PILA (Murcia) April 2016

PICO PEÑONES (Almería) April 2016

MONTE CEDEIRA (Coruña) April 2016

PICO AGUIÓN (Asturias) April 2016

MONTE OSCURO (Zaragoza) April 2016

PIC d'ÁGUILES (Barcelona) April 2016

MONTE JATA (Vizcaya) April 2016

AUTILLA DEL PINO (Palencia) April 2016

MONTE ORO (Valencia) April 2016

CABO BLANCO (Mallorca) April 2016

DYNAMICS
mhortal@aemet.es & asubiasd@aemet.es

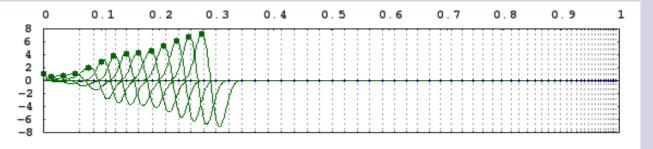The work in finite element method deals with two sets of vertical operators (nhvfe):

i) The first is given by the operators satisfying the **C1-constraint: (G*-1)(S*-1)=(N*-1)** present in the SI set of linear equations of the nh-model and which is needed in order to have a single prognostic equation in the vertical divergence "d" (known as the structure equation).
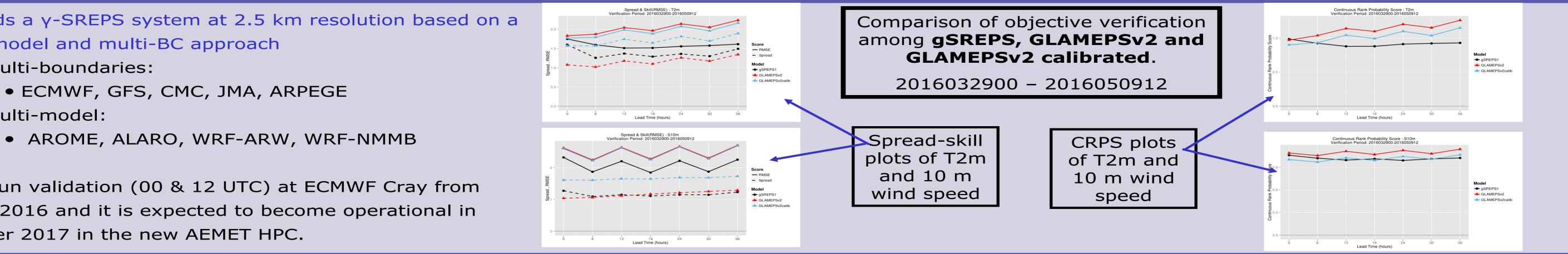
ii) The second set is given by the integral and derivative operators which should be invertible if the option **LGWADV** is on. The set of SI linear equations is written in terms of "d" but in the SL computations the variable used is the vertical velocity "w". Two transformations are needed in each time-step: integration in **"d"=>"w"** and derivation in **"w"=>"d"**. The Invertibility is needed in order to avoid the production of noise.

The computations of the above operators in nhvfe are shown in https://arxiv.org/abs/1601.03446 and tested in a branch over **HARMONIE cycle cy40h1**. The greatest difficulty in building the nhvfe operators is the match of the knots needed for the basis functions, whose maxima should be located in the set of levels. Two basis are shown: B-splines (i) and xi (ii).

The default set of **65 levels** is well adjusted, but the **optimization algorithm of knots to match the maxima** should be improved for a wider sets of vertical levels.

γ-EPS
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Towards a γ-SREPS system at 2.5 km resolution based on a Multi-model and multi-BC approach

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

Daily run validation (00 & 12 UTC) at ECMWF Cray from March 2016 and it is expected to become operational in summer 2017 in the new AEMET HPC.

Comparison of objective verification among **gSREPS, GLAMEPSv2 and GLAMEPSv2 calibrated.**
2016032900 – 2016050912

Spread-skill plots of T2m and 10 m wind speed

CRPS plots of T2m and 10 m wind speed

AMV assimilation
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- **AMVs** from geostationary Meteosat-10 represent a good observation system for assimilation in HARMONIE over Southern Europe, especially at times other than 00 and 12 UTC, because of the frequent availability and short latency.

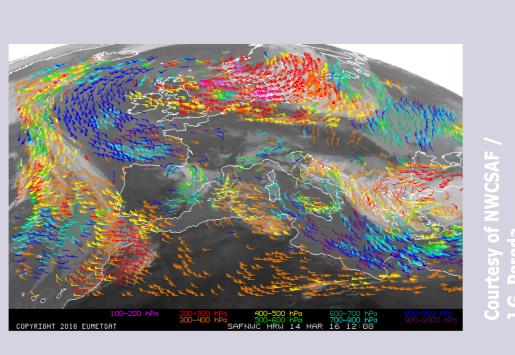- The **NWC/GEO** software (produced by the EUMETSAT SAF on support to Nowcasting) allows to generate AMVs locally, and to customize choices re AMV derivation.

- Ongoing work at AEMET to assimilate Meteosat-10 AMVs disseminated by EUMETSAT, and explore the assimilation of AMVs produced locally with the NWC/GEO software.

Courtesy of NWCSAF / J.G. Pereda

Highlights

Aemet runs HARMONIE/AROME v40h1.1 from the **ALADIN-HIRLAM Shared System** in the new 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)
- Clear improvement of fog forecast but with many false alarms.
- Significant improvement of precipitation forecasts including spatial distribution and amount of precipitation but revealing uncertainty in the prediction of small scales.
- 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

Research on:

- Radar data assimilation including correction for position errors (Field Alignment technique).
- Assimilation of 'High Resolution' AMVs using NWC SAF software.
- Dynamics: Vertical Finite Elements for the vertical discretization.
- Configuration of a 2.5 km Ensemble System based on a multi-model approach