GOBIERNO DE ESPAÑA
MINISTERIO DE MEDIO AMBIENTE Y MEDIO RURAL Y MARINO
AEMet Agencia Estatal de Meteorología

NWP Activities at the AEMET (Spain)

Calvo J., Cansado A., Díez M., Geijo C., Hortal M., Morales G.,
Morales T., Sánchez J., Santos C., Orfila B., Jiménez A.

34th EWGLAM & 19th SRNWP Meetings. Helsinki, Finland, 08-11 Oct. 2012

SYSTEM

Cray X1E

16 physical nodes X1E

8 MSP each : 1.2 GHz, 19.2 Gflops – 64 bits by MSP,

32 logical nodes (31 application nodes + 1 support node)

128 MSP / 512 SSP

512 GB memory

2.304 Tflops theoretical peak performance for applications

Cross-compiler based in linux cluster

OPERATIONAL SUITE

Maria Diez , mdiezm@aemet.es

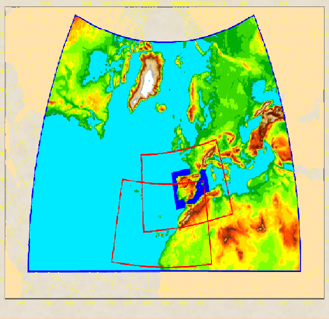
Hirlam operational runs on Cray X1E

3 **HIRLAM v7.2** experiments:

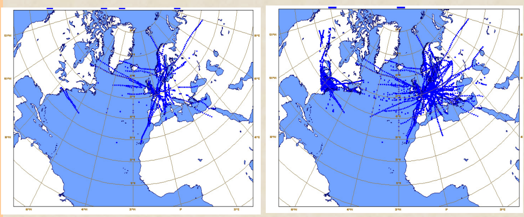
ONR (0.16deg,lat x lon 582x424, ts 600 sec)

HNR and **CNN** (0.05deg,lat x lon 606x430, ts 240 sec)

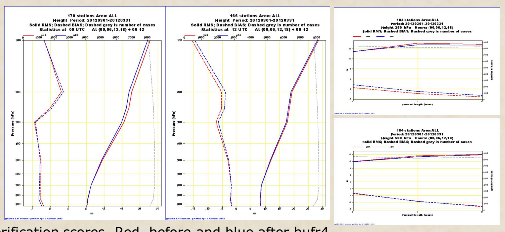
- Four runs at 00, 06, 12 & 18 UTC
- 40 levels in the vertical (more resolution in the PBL)
- SL Dynamics
- 3DVAR assimilation
- ISBA
- ECMWF Blending



Observations coded in bufr4 were introduced into the operational run in February 2012. This means an increase of the number of the assimilated observations, specially in the aircraft data. The impact was significant for geopotencial in high levels.



Number of aircraft data available before and after bufr4



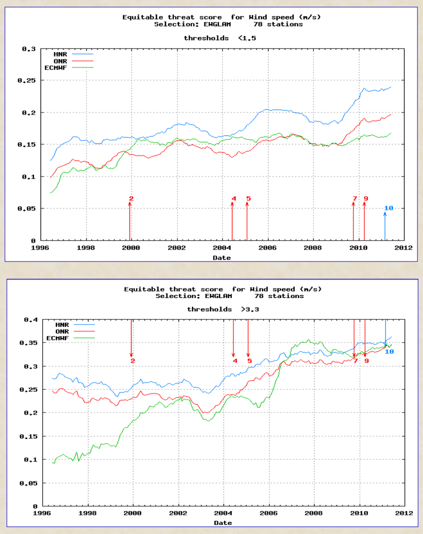
Verification scores. Red, before and blue after bufr4

Verification Hirlam(AEMET)/ECMEF

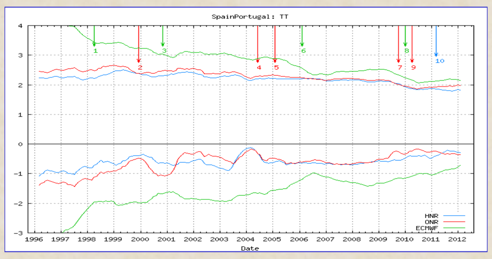
Gema Morales, gmoralesm@aemet.es

A historical verification has been carried out to compare the performance of the different limited area models, run in AEMET, over the last years. The scores show a continuous improvement in AEMET operational HIRLAM forecasts, attributable both to better global ECMWF forecast fields used as boundaries and to successive LAM upgrades. HIRLAM complements ECMWF global model forecasts in the short range and add value especially for some surface parameters .

Flag	Date	Model	Description of change
1	Apr 98	ECMWF	resolution: T319 (62 km) L31
2	Dec 99	HIRLAM	version: v4.6.2
3	Nov 00	ECMWF	resolution: T511 (40 km) L60
4	Jun 04	HIRLAM	version: v5.1.2
5	Feb 05	HIRLAM	version: v6.1.2 geometry & resolution: 0.16/0.05º 40L
6	Feb 06	ECMWF	resolution: T799 (25 km) L91
7	Oct 09	HIRLAM	version: v7.2
8	Jan 10	ECMWF	resolution: T1279 (16 km) L91
9	Apr 10	HIRLAM	Moist physics: KF-RK
10	Mar 11	HIRLAM HNR	Direct nesting into ECMWF



10 m wind speed ETS for categories <1.5 and >3.3 m/s



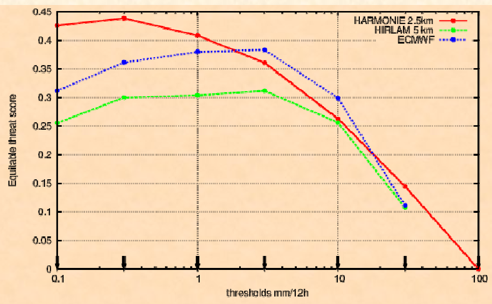
T2m bias and RMSE

HARMONIE/AROME quasi-operational

Javier Calvo, jcalvos@aemet.es

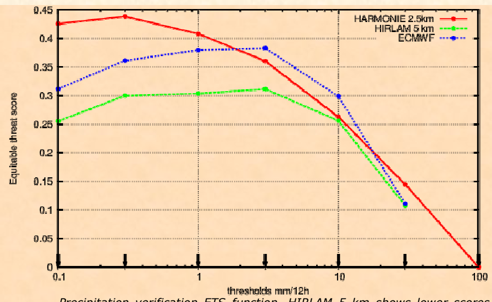
- HARMONIE system in AROME configuration is run 4 times per day with a forecast length of 30 hours. Model set up:
- NH dynamics
- 2.5 km resolution 65 Levels
- OI for surface fields and blending with ECMWF H+6 forecasts for upper air
- Direct nesting in ECMWF forecasts
- No parameterization of deep convection
- EDMF shallow convection
- ICE-3 microphysics with 3 prognostic precipitation species

ETS FF 10m



Wind speed verification for the period oct 2011-sep 2012. ETS function of the wind speed with a clear improvemtent due to the increase in the resolution.

ETS Precip



Precipitation verification ETS function. HIRLAM 5 km shows lower scores that ECMWF due to the double penalty problem but HARMONIE 2.5 km compares well with ECMWF.

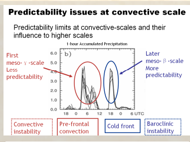
- Clear added value compared with HIRLAM and ECMWF specially for precipitation, wind and temperature.
- Despite the jump in resolution, direct nesting in ECMWF model performs as good as using HIRLAM or ALADIN as intermediate model.
- Surface analysis seems to be important but the upper air analysis has less impact if we only use convectional observations.
- Improvement of daily cycle of precipitation
- Predictability issues become important at this resolutions being important to have severeal realization of the model predictions to assess predictability

SREPS AND γ-SREPS

Carlos Santos, csantosb@aemet.es

AEMET-SREPS provides high performance probabilistic forecasts at synoptic-meso-α scale, giving added value to our deterministic HIRLAM suites and assessing predictability in the Short Range over-performing ECMWF EPS. Current research on the transition to meso-gamma scale: the future **AEMET-γ-SREPS**. Predictability issues at convective scale are not trivial. Research lines include:

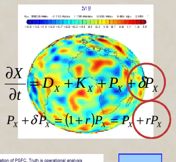
- Close cooperation with **GLAMEPS**
- Sampling uncertainties: LETKF (ICs), SPPT (model), perturbations LBCs
- DA and verification: High Resolution observations (radar, SEVIRI…)
- Calibration: Extended Logistic Regression
- Post-processing: specific SREPS-grams
- Verification: Neighborhood, Feature-based (SAL, MODE…)



SPPT

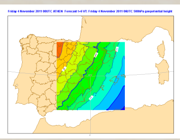
Stochastic Perturbed Parameterization Tendencies (**SPPT**, Buizza et al. 1999). A. Callado: 6 months visit ECMWF with G. Shutts assessing SPPT, later HarmonEPS experiments

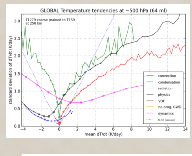
Multiplicative noise applied to each physics variable tendency (see figure)
Spectral spatial and time correlations (at ECMWF) **Harmon-EPS** experiment: to apply multiplicative noise (~SPPT) to physics temperature tendency independently to each grid point



$$\frac{\partial X}{\partial t} = D_X + K_X + P_X + \delta P_X$$

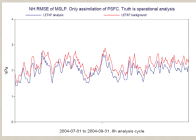
$$P_X + \delta P_X = (1+r)P_X = P_X + rP_X$$





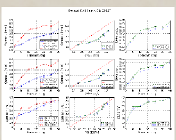
LETKF

Local Ensemble Transform Kalman Filter (**LETKF**, Hunt et al., 2007) P. Escribà: 6 months visit ECMWF with M. Bonavita, assessing EDA, hybrid 4D-Var/EDA and the EnKF implemented at ECMWF, later HarmonEPS experiments. The figure shows MSLP RMSE time series for the analysis and B with ECMWF IFS: analysis performs better than the background, showing that LETKF provides good ICs.

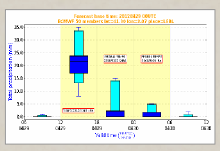


LBCs

To assess the impact of **LBCs** selection, spread-error balance for different global EPS or GCM combinations is computed, e.g. EPS ECMWF (as well as some subsets and tubing), GCMs from TIGGE and AEMET-SREPS. The figure shows an example with spread evolution, spread-error, and CRPS evolution. Though this spread is already known to be low, some combinations can be better.



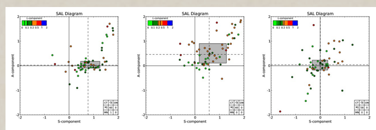
Postproc



For calibration, Extended Logistic Regression (ELR, Wilks, 2009) is tested. Specific SREPS-grams including TAF reports can help in SR forecast guidance.

Verif

Meso-gamma scales need new spatial verification methods, e.g feature-based that deal with patterns, to avoid problems like double penalty. Structure-Amplitude-Location method (SAL, Wernli et al., 2008) has been tested succesfully to assess HIRLAM, HARMONIE and ECMWF QPFs (figure). MODE (Davis et al., 2009) will be tested for ensemble forecasts.



ECMWF T1279 (17 km) HIRLAM 0.05 (5 km) HARMONIE 2.5 km

MOCAGE CTM

Alberto Cansado, acansadoa@aemet.es

MOCAGE is a Global Chemical Transport Model developed by Météo France and used at AEMET to make chemical weather forecasts and calculate the evolution of the dispersion of hazardous material released to the atmosphere (volcanic ashes, radioactive matter, etc). It allows nested domains (up to three, additional to the global one). Over Iberia and Balearic Islands AEMET runs MOCAGE at a horizontal resolution 0.1 degrees. Besides, we participate in the FP7 MACC-II Project (Monitoring Atmospheric Composition and Climate-Interim Implementation) using MOCAGE to model the atmospheric composition in Western Mediterranean at 0.05 degrees (horizontal resolution). Meteorological forcings come from ECMWF IFS (GLOB22) and HIRLAM AEMET ONR (INML05) and HNR (INMH01 and MACC3)

OPERATIONAL

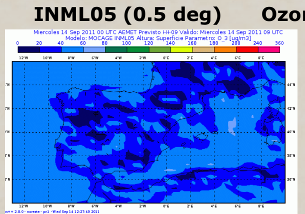
GLOB22 (GLOBAL 2 deg)

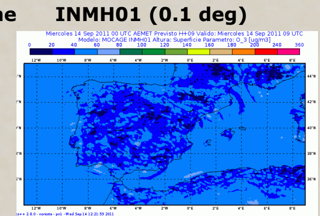
INML05 (0.5 deg)

INMH01 (0.1 deg)

Emissions: IPCC + GEMS_TNO

INML05 (0.5 deg) Ozone INMH01 (0.1 deg)





MACC-II PROJECT

MACCH3 (0.05 deg)

+

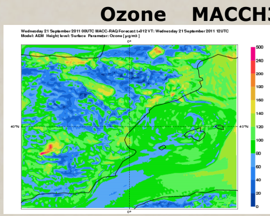
MACC RAQ ENSEMBLE MEAN

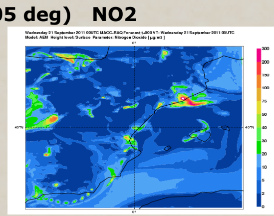
(AS BOUNDARY CONDITIONS)

Emissions: IPCC + GEMS_TNO

http://www.gmes-atmosphere.eu

Ozone MACCH3 (0.05 deg) NO2





> European Air Quality > EAQ forecasting and monitoring > Air Quality Forecasts > Mediterranean Zooms > AEM forecasts

R&D HARMONIE model

Improving mass conservation

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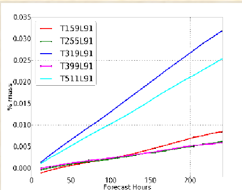
In the global model IFS, total dry air mass should remain constant throughout the simulation period, while in the limited-area HARMONIE this does not apply. The improvements in the conservation of dry air and total mass of the constituents of the atmosphere, verifiable in the IFS, should be applicable to the HARMONIE limited-area version because the dynamic kernel is the same for both models.

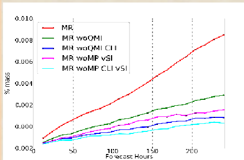
Experiments for T159L91, T255L91, T319L91, T399L91 and T511L91 resolutions were run in order to observe the evolution of total dry air mass throughout the simulation period (10 day). The modification carried out in the continuity equation prove that the correction of the over/undershooting errors introduced by the cubic interpolations to obtain the value of the bidimensional term worsens the conservation. It is better not to apply quasi-monotone interpolation (woQMI). Moreover, a bi-cubic-linear interpolation (CLI) for this term is better than the standard bi-cubic in terms of conservation.

If in the iterative algorithm to find the departure point of the SL trajectory we apply a smooth interpolation in the vertical (vSI) components of the velocity, this improves the conservation of the total mass of the dry air.

All modifications we run in the continuity equation did not degrade the other prognostic variables, when we applied the new alternative interpolations. Apart from that, the new interpolations for each resolution did not increase the computation time.



Reference model (RM) for T159L91, T255L91, T319L91, T399L91 and T511L91 experiments.



T159L91 experiment. Red line, reference model (RM); green line, RM without quasi-monotone (woQMI); blue line; MR woQMI and bi-cubic-linear interpolation (CLI), cyan line, MR woQMI and smooth interpolation in the vertical component of the velocity between the eta levels 1-36 and 62-76 (vSI); magenta line, MR woQMI CLI vSI

Assimilation of GB GNSS ZTD observations in HARMONIE 2.5 km

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WHITELISTING in GNNS observations

A Ground-Based GNSS station can be processed by different Processing Centres (PC) and so different measurements of Zenit Total Delay are delivered for each site.

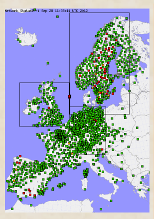
A selection of the best quality measurements for each site has been done by using WHITE LISTS in Harmonie 37beta2.

PROCEDURE:

The white listing has been based on observation minus background departures of at least one month passive runs with ZTD data.

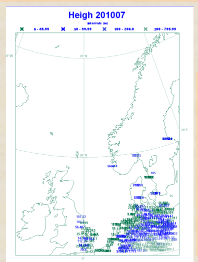
PCs involved: ASI, BKG, IGE, LPT, KNMI, METO, ROB, SGN and GOP1. (NGAA data not available).

Some 37beta2 Harmonie experiments over DK extended area have been performed with 'passive' assimilation of ZTD GNSS observations in order to get the statistics to create a White List.



EGVAP- EUMETNET european GNSS sites

NO Whitelisted obs: Height values.



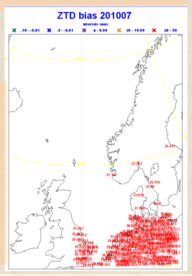
Distribution of the 372 GNSS obs from DKCOEXP area exp

CRITERIA to create the WHITE LIST:

1) The observation with less % of rejections by the Screening process (Gross error)
2) If there is more than one station with the same % of rejections, the one with the lowest Standard Deviation (SD) value.

Finally, from the 372 observations, only **262** combinations of station&processing-centre have been chosen for the White List, being therefore ready to be used for the impact studies for **August 2008** period.

Whitelisted obs (262): **Bias** values. July 2010



Although the Whitelisting process implies an improvement of the quality of the observations, high BIAS values are found, being therefore corrected with a **VarBC scheme** (on progress).

Research and Development Data Assimilation of Reflectivity Radar

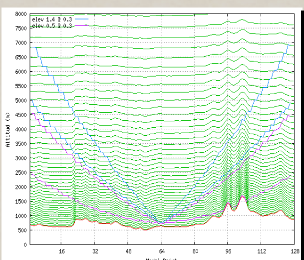
Carlos Geijo, cgeijog@aemet.es

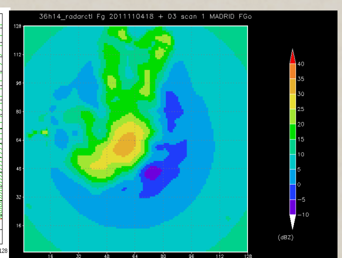
Radar reflectivity images offer a good opportunity to test the Field Alignment (FA) technique for correction of position errors (Ravela et al. 2007). This method was already tested with model fields used as pseudo-observations in a previous work with encouraging results (Geijo, 2011). The question of how the FA technique performs with real data remained however open.

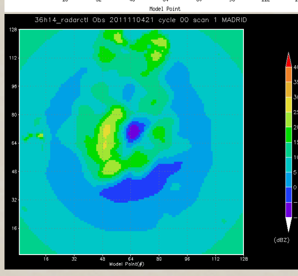
Recent work on reflectivity data from one C-radar of the AEMET radar network has shown that it is possible to correct successfully position errors of rain structures in HARMONIE-AROME short-range mesoscale forecasts, within a circular domain of 240 Km in diameter around the radar site.

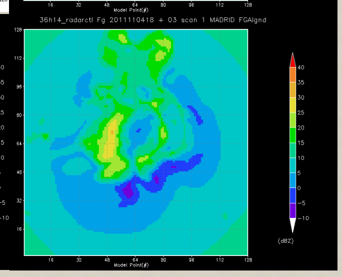
[*] Ravela,S ;Emanuel K. and McLaughlin D."Data Assimilation by Field Alignmnet" Physica D 230 (2007) 127-145 available online at www.sciencedirect.com

Carlos Geijo, "Data Assimilation by Field Alignment. Testing the Theory". HIRLAM Newsletters N58 (2011).





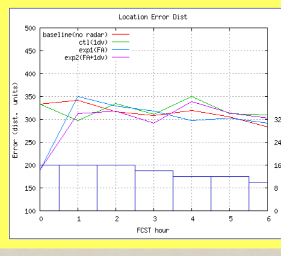




An example of the FA technique applied to radar reflectivity data is shown on the left. The upper right panel shows the pseudo-image before alignment, the lower left panel is the real radar data and on its right the model pseudo-image once corrected. Also on the top left the geometry of the problem is sketched.

The radar data used in this work comes from an AEMET network C–band radar situated near to Madrid (3.713W, 40.177N; emitter altitude 717m a.m.s.l). Between November 4th 11 UTC and 5th 20 UTC (2011) several rain bands associated to a typical winter frontal instability crossed the radar domain from West to East. About 16 short-range forecasts produced with and without the FA technique were verified using also the radar data and a new method for measuring position errors. This verification method works with clusters that delineate rainy structures on observations and forecasts and determines the disparity in positions between them.

Different tests with variations of the method indicate that the FA correction does not survive long in the forecasts (see right). The reasons for this state of affaires are several, including specific issues related not to the FA method itself but to the assimilation of reflectivity data in HARMONIE-AROME. We expect to continue with this research and achieve more satisfactory results in the next future.
A complete description and discussion of the results can be found in:



Carlos Geijo, "Assimilation of Radar Reflectivity Data using the Field Alignment Technique". HIRLAM Newsletters N59.