NWP Activities at the AEMET (Spain)

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MINISTERIO DE AGRICULTURA, ALIMENTACIÓN Y MEDIO AMBIENTE

Agencia Estatal de Meteorología

HARMONIE/AROME SUITE

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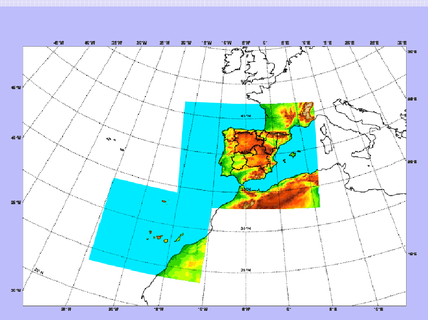
CONFIGURATION

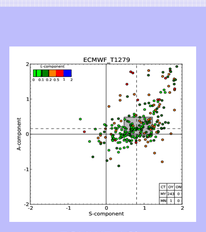
- HARMONIE system in **AROME configuration** is run 4 times per day with a forecast length of 48 hours for 2 geographical domains (Iberia and Canary Islands).
- Model set up baed on Cycle 37h1.2 :
  - **2.5 km resolution 65 Levels**
  - ALADIN **NH dynamics**
  - **Blending with ECMWF H+6** forecasts to **initialize upper air fields**. This increase a little the spin up in the first 6 hours.
  - Only **analysis of surface fields**. This allows a short cut off time (1/2 hour) and an early delivery of the forecasts.
  - Boundaries: Direct nesting in ECMWF forecasts
  - Surface processes using **SURFEX** (ISBA tiling)
  - Unified **scheme shallow convection** (EDMFM)
  - **Explicit deep convection**
  - **ICE-3 microphysics** with 3 prognostic precipitation species



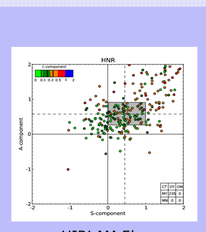
HARMONIE/AROME operational domains at 2.5 km resolution

PRECIPITATION

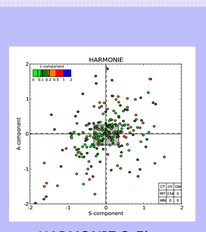
- Significant improvement of HIRLAM and ECMWF forecasts.
- With strong dynamical forcing the precipitation patterns and the amounts are generally correctly forecasted.
- With week forcing the uncertainty is greater but the diurnal cycle is well represented
- Any way the increase of the uncertainty at this scales suggests the need of ensemble approaches.



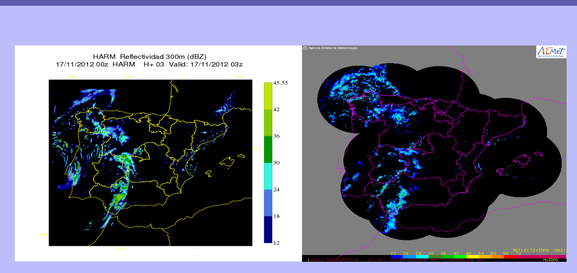
ECMWF 16km



HIRLAM 5km



HARMONIE 2.5km

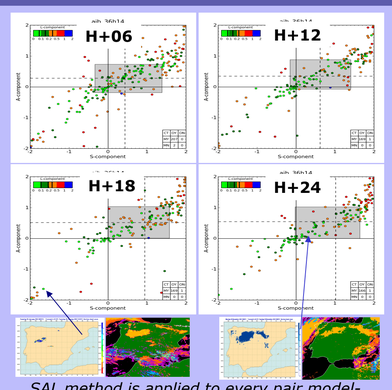


HARMONIE 2.5km *RADAR*

Spatial verification of precipitation using SAL for a period of 8 months. ECMWF forecasts show a small amplitude bias but tend to produce to large patterns, HIRLAM has smaller structure error but larger bias and HARMONIE shows small errors in terms of amplitude and structure (Thanks to C. Santos and A. Amo).

FOG

- Fog prediction still is a big challenge.
- A significant added value compared to ECMWF and HIRLAM models specially over land.
- Too many false alarms.
- Too persistent fog over sea.
- Very sensitive to initial state and model settings suggesting the uncertainty of this type of process.
- Work on progress to improve therepresentation of fog and low clouds in the model.



SAL method is applied to every pair model-obs verifying at the same hour: it correspons to one coloured point.

- Cloud field is complex to verify. Satellite products (from *SAF Nowcasting project*) were compared with HARMONIE output to validate results for fog and low clouds from a more objective and quantitative point of view.
- Structure-Amplitude-Location (SAL) gives information that can be used to assess model performance from a different perspective, complementing the classical verifications.
- SAL method applied to two months of data shows that **HARMONIE overestimate the fog/low-clouds** events at any forecast range. However, it is interesting the **underestimation of the model at 12 UTC**: during the daylight fog and low clouds are dissipated more than expected compared to observations (this last not shown).

CONCLUSIONS

- **Clear added value of HARMONIE/AROME** on **near surface variables** compared with models of larger scale (HIRLAM and ECMWF)
- **Improvement of wind forecasts** which have been successfully used for sailing forecasts.
- **Clear improvement of fog forecast** but with many false alarms. Work on progress to improve fog and low clouds in the model.
- **Significant improvement of precipitation forecasts** including spatial distribution and amount of precipitation but revealing uncertainty in the prediction of small scales suggesting the need of ensemble approaches.
- **Operational forecasters** and **other users** are **increasingly using the model**. Currently in the processes of migrating the applications and postprocesing from HIRLAM to HARMONIE.

RESEARCH AND DEVELOPMENT

PROGRESS ON RADAR DATA ASSIMILATION WITH FIELD ALIGNMENT

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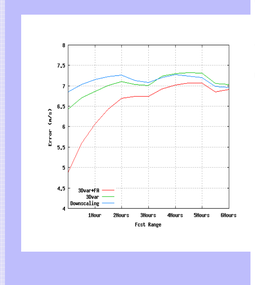
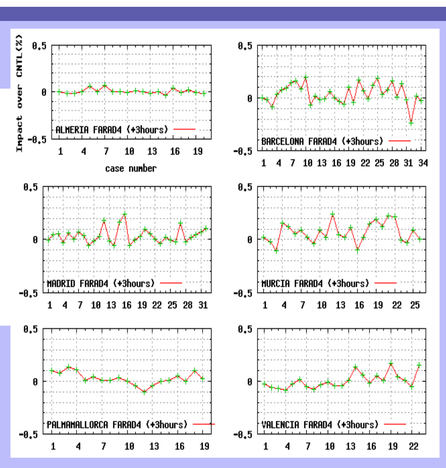
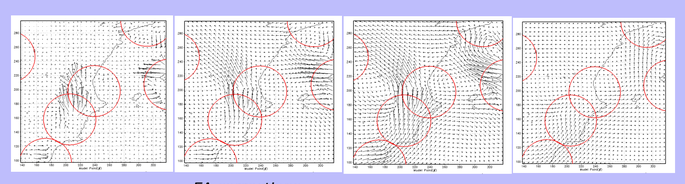
Work on this topic has progressed significantly in the last months. The main issues addressed during this time have been experimentation and recalculation of new error model covariances using a technique known as "Covariance Regularization in Inverse Space" (Ueno and Tsuchiya, 2009) and the necessary upscaling of FA corrections to improve the persistence of the initial conditions in the forecasts. This last item is chosen to illustrate this poster. The plots below these lines show the three stages of the assimilation method as implemented in these experiments. At the time of thinning and weighting the radar Doppler wind observations, the 3DVar step in this hybrid FA+3Dvar" method also uses information extracted during the FA step. Red circles indicate areas within radar reach.







Raw FA corrections | *FA corrections extrapolated using the improved structure functions* | *Aspect of the analysis after the last step, a standard 3DVar analysis* | *Result of a conventional 3DVar*

Verification Results

About 15 days during HyMEX SOP-1 period have been used to verify the experiments.

The parameter verified is "radial wind". The results are very encouraging. On average (up left), the positive impact reaches up to 6 hours. On a case-by-case analysis (up right), the impact is significantly positive (+20% over control, taken here as "downscaling") in a good number of occasions even after 3 hours. These results repr esent a clear improvement over preliminary results obtained in earlier experiments which did not upscale the FA increments. Further refinements and evaluations are under way.

ASSIMILATION OF GB GNSS ZTD OBSERVATIONS IN HARMONIE 2.5 KM

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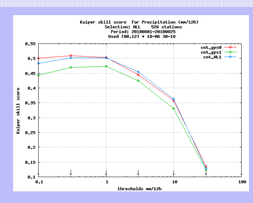
Some **impact studies assimilating gnss observations together** with **conventional** and **atovs** observations (with its varbc) have been performed by a 3h assimilation cycle, with **Harmonie Cy37h12,** over the extended *Danish domain* and for *august 2010.* The three following experiments have been studied.

1) Impact of using a White List of gnss observations

cnt_WL1

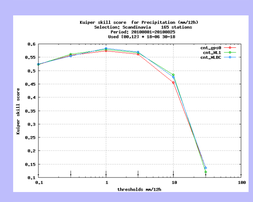
As it was done for previous Harmonie versions, some Cy37h12 experiment assimilating the available gnss observations *BUT filtered by a White List* that *includes 242 places* in total from different European processing Centres, hasve been done: **The impact of assimilating gnss is improved, in general, by using the White List.**



2) Impact of using a Static Bias Correction Scheme

cnt_WLBC

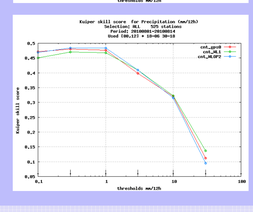
A new experiment using *White List* and a *Static Bias Correction* procedure for ZTD , has been performed over the same area and same period of august 2010. **Neutral impact has been found here.**



3) Impact of using a new ZTD Observation Operator

cnt_OP2

The current Hamonie *ZTD observation operator* is *missing the upper part of the real atmosphere* and so a mass of air that is important for the ZTD value calculations is also missed. Then *some changes* have been applied *to take this into account*. **A neutral to positive impact of new ZTD observation operator can be seen.**



CONCLUSIONS: Among the different Cy37h12 experiments tested assimilating gnss observations together with conventional and atovs, the one where the observation operator has been changed by adding an amount of ztd on the top layer, seems to be the one that may improve control some times for the period and area tested.

SREPS AND γ-SREPS

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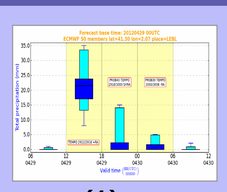
AEMET-SREPS provides high performance probabilistic forecasts at synoptic-meso-α scale, giving added value to our deterministic HIRLAM suites and assessing predictability in the Short Range over-performing ECMWF EPS. Current research on the transition to meso-gamma scale: the future **AEMET-γ-SREPS**. 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…)



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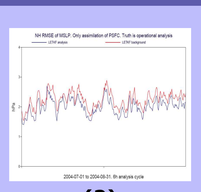

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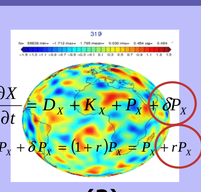

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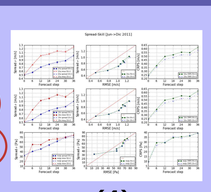

(4)

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

2) 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.

3) 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

4) 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.

WAVE FORECAST

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AEMET is implementing the so-called **SPOC**, a Wave Forecast System for the North Atlantic Ocean and the Mediterranean Sea based on the 3rd generation **WaveWatch III Model**, developed by the NOAA's Marine Branch. It introduces new source terms (surf breaking, bottom scattering) and more accurate nonlinear wave-wave interactions routines. Full two-way multigrid interactions are considered at the time step level and have a dynamic data structure. Wind forcing comes from HIRLAM AEMET ONR0.16, HNR0.05 and CNN0.05 at 10m height.

NESTING

Nested grids have been stablished in order to make a commitment between focusing at the spanish coasts and the swell generation in the northwest Atlantic, as well as forecasting in a reasonable time. There are one low resolution module for the North Atlantic and Mediterranean, and four high resolution modules around the North, East and South of Iberia and the Canary Islands.

WAVE FIELDS

Users of Wave Forecasts are specially interested in these fields:

- Significant wave height and average wave direction, period and peak frequency;
- Wind speed and direction at 10m height;
- Field partitions into wind sea and primary and secondary swells.