MINISTERIO DE AGRICULTURA Y PESCA, ALIMENTACIÓN Y MEDIO AMBIENTE

AEMet Agencia Estatal de Meteorología

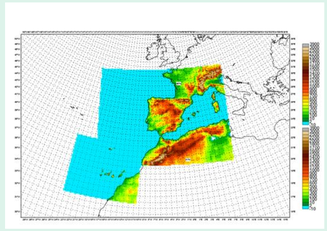
NWP Activities at the AEMET (Spain)

39th EWGLAM & 24nd SRNWP Meetings, 2rd/5th Oct. 2017 Reading, ECMWF

HARMONIE AROME SUITE

HARMONIE-AROME v40h1.1 is **Regular Cycle of Reference, RCR** used by HIRLAM Consortium to monitor the quality of the reference system:

- **2.5 km** runs 8 times per day with a forecast length of 48 hours 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 obs.**



- **Surface data assimilation** with optimal interpolation**.**
- **AROME physics**: Explicit deep convection, SURFEX and ICE3 microphysics
- Unified scheme for shallow convection (**EDMFM**)
- Run in **BULL-ATOS** supercomputer 7760 processors with hyperthreading

Operational Verification

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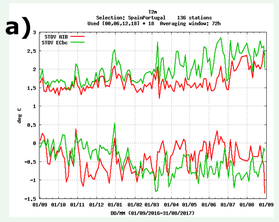
Period: sep, 2016- ago 2017

a) T2m (STDV,BIAS). Clear improvement of HARM-AROME(red) against ECMWF (green). AIB has the biggest problems in winter with a clear negative bias.

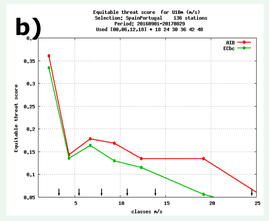
b) ETS of 10 m wind speed for different categories: The improvement is clear for wind speeds above 5 m/s

c) Scatter-plots, 6 hr AccPcp, for HARM-AROME (left) and ECMWF (right). As expected the intensities are lower for the ECMWF. In general ECMWF produce smoother fields with a tendency to overestimate the precipitation area.

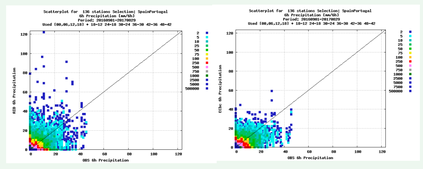
a)



b)



c)



Convection

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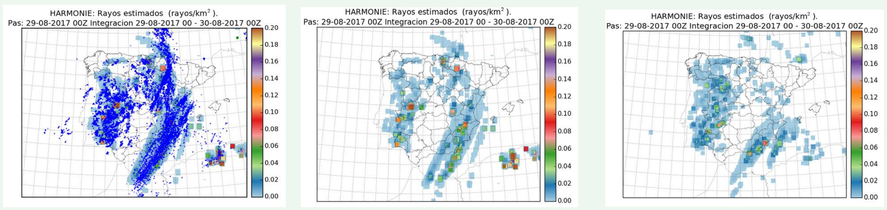

Estimated lightning density compared with observations for two model versions. Convection is very sensitive to model setting showing its stochastic behaviour. Operational 40h1 version (AIB) tends to produce smother fields than cycle 38h1(IB38). Although overall scores are better for 40h1, for the summer there is a clear underestimation of the convective activity (*plots courtesy of José A. Sosa*)

Clouds Verification

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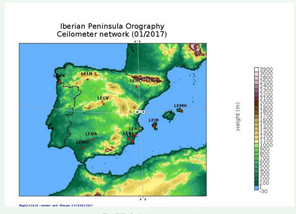
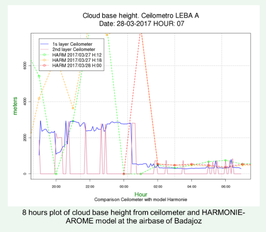
Comparison of cloud variables with ceilometer observations.

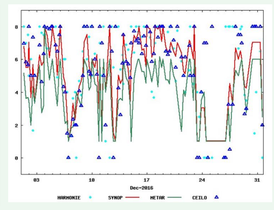
Cloud base height and cloud cover have been obtained from ceilometer-network at AEMET and compared with HARMONIE-AROME (cycle 40) outputs.
Statistics for 1 month (December 2016) show a positive bias in the cloud base height, probably due to lack of low clouds in the model.
Cloud cover from ceilometer is based on the algorithm by Larsson and Esbjörn (1995) and Wauben.
The different character of the cloud cover obtained from the ceilometers to the one from synop observations, gives different values for the statistical parameters but comparable results.



AEMET Ceilometer network



8 hours plot of cloud base height from ceilometer and HARMONIE-AROME model at the airbase of Badajoz



Time plot comparison of mean cloud cover from model HARMONIE-AROME, METAR, SYNOP and Ceilometer observations for december 2016.

Conclusions:
Ceilometer network is valuable for verification of the model. Update of the work in progress.

E-AMDAR q sensor

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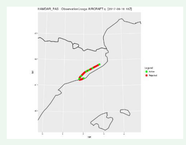
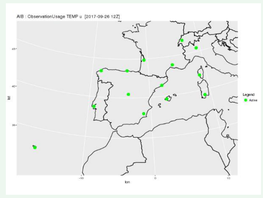
Assimilation of humidity measurements of E-AMDAR.

There are a lack of humidity upper air observations over South-West of the Iberia Peninsula, so the humidity E-AMDAR observations are very valuable.

Actually are testing:
- Technical issues.
- Bias of the observations.
- The usage of obsmon monitoring tool.





TEMPS available over the operational domain (AIB) at 12 UTC. Lisbon and Madeira stations only make observations at 12 UTC.

All the E-AMDAR bulletins with humidity information the 26th of September of 2017. This map is obtained at E-AMDAR monitoring portal https://eucos.dwd.de

Surface Developments

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Evaluation of next cycle's model bias in climate mode.

Next cycle of our HARMONIE-AROME system will use new surface physics options available in SURFEX 8 for snow (Explicit Snow scheme), soil (Diffusion scheme) and energy budget (Multi-Energy Balance) parameterizations.

New setup will be tested in "climate mode" over different domains. Model output climatology will be compared to reference data. Reference datasets validation: UERRA reanalysis (T2m, RH, MSLP, wind), AEMET's 5km objective analysis (pcp), ESA CCI Soil Moisture, etc.

Parameter tuning, namelist changes and/or code modifications will be made in order to try to reduce the identified biases.

The resulting model configuration will be used for coupling to surface data assimilation.

Aerosols

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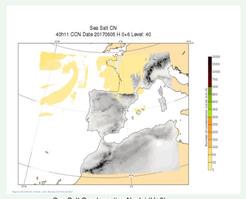
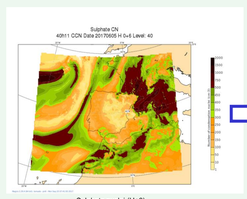
Preliminary approach for the use of aerosol fields in HAMONIE-AROME

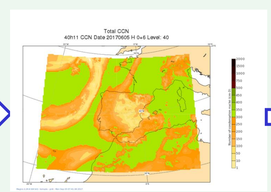
- The boundary conditions are taken from the C-IFS model (60 vertical levels).
- Sea Salt and sulphate mixing ratio fields have been included in HARMONIE-AROME 40h11 in order to modify the fixed values of CCN over sea and land used in the microphysic parameterization.
- These fields are exclusively advected inside HARMONIE-AROME.
- The previous values of CCN are taken as maximum values for the activated condensation nuclei in this preliminary approach.
- Distinction between sea and land condensation nuclei is skipped.



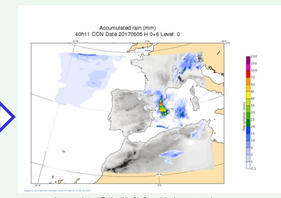
Sea Salt Condensation Nuclei (H+6)



Sulphate nuclei (H+6)

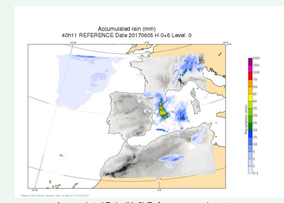


Total number of cloud condensation nuclei considered (H+6)



Accumulated Rain (H+6) Considering aerosols

Conclusions:
Little impact in the precipitation for the cases studied.
Parametrization needed for the activated condensation nuclei.



Accumulated Rain (H+6) Reference experiment

Mesoscale EPS → γ-SREPS

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

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

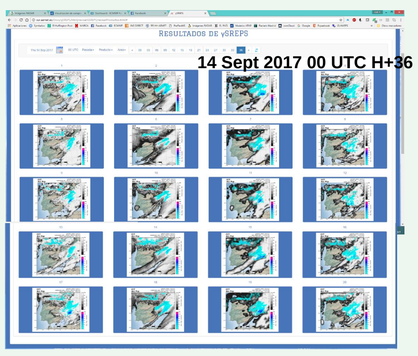
Daily run, 36 hours forecast at 00 & 12 UTC at ECMWF Cray from March 2016

To become operational in summer 2018 in the new AEMET BULL Computer four times a day (00, 06, 12 & 18 UTC)

Interactive web page for operational forecasters (in development)

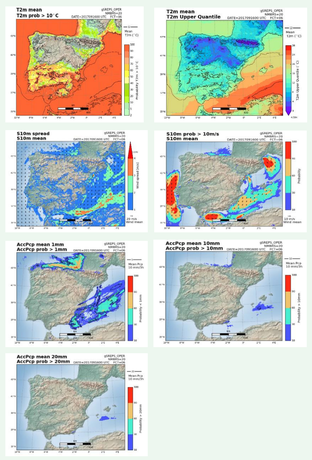
Iberian collaboration with the Portuguese Met Service (IPMA)

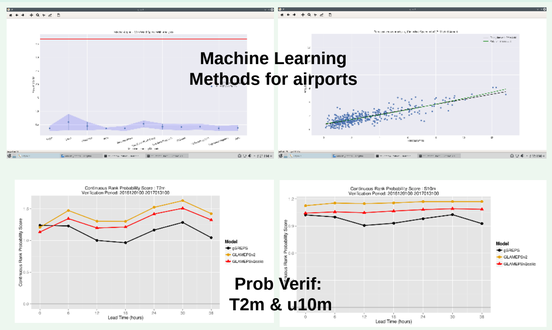
Global Models	Model	How they are			What we get				
		Hor Res (km)	Vert Levels	Type of levels	Hor Res (Km)	Vert Levels	Type of levels	Run	Int
	ECMWF	9	137	Hybrid	11 (0.10 deg.)	137	Hybrid	00 06 12 18	1
	GFS	13	64	Sigma	25 (0.25 deg.)	37	Pressure	00 06 12 18	1
	CMC	25	80	Hybrid	25 (0.24 deg.)	28	Pressure	00 12	3
	Arpege	7	105	Hybrid	10	60	Hybrid	00 06 12 18	3
	JMA	20	100	Hybrid	25 (0.25 deg)	86	Hybrid	00 06 12 18	3



14 Sept 2017 00 UTC H+36

Probabilistic Products





Future:
- **LETKF for IC perturbations**
- **Upgrade WRF-ARW to version 3.9**
- **Upgrade NEMS to version 3.0**
- **SPPT for model perturbations**
- **Statistical Calibration for surface parameters**
- **Special calibration using Machine Learning Techniques**

High Resolution Forecast

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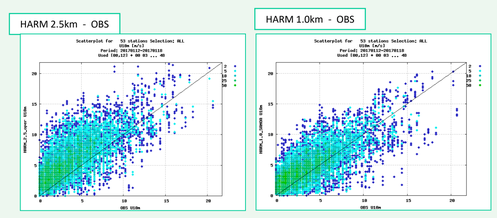
SAMOA Project consists of a meteorological and oceanographical support system for the Spanish National Harbour Authorities. The meteorological module aims to provide a very high resolution, 1km, 48 hours forecast for surface weather variables, especially winds, over harbour influence areas.

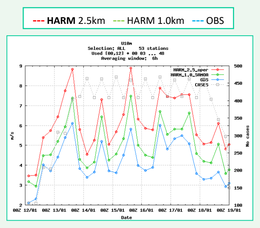
HARMONIE-AROME 40h1.1

- 1km resolution and 30" timestep.
- IFS 0.1º nesting.
- Dynamical adaptation.
- Original HARATU turbulence (update reversed).

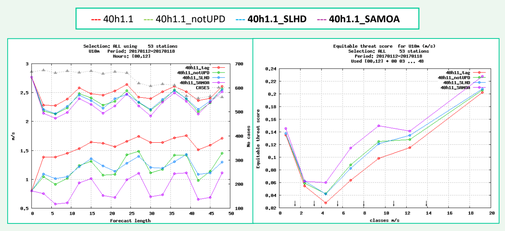
KEY contributions:
- Predictor-corrector scheme.
- Semi-lagrangian horizontal diffusion (SLHD) applied to hydrometeors and spectral variables but temperature.



Scatter plot of 10m wind observations-forecasts events for operational 2.5 km HARM-AROME (left) and for SAMOA 1.0 km HARM-AROME (right) over the Mediterranean area during a convective episode (12-18 January 2017).



Evolution of 10 m wind speed 6h averaged over the Mediterranean area: Operational 2.5 km HARM-AROME (red), SAMOA 1.0 km HARM-AROME configutarion (green) and observations (blue).



10 m wind speed verification against observations over the Mediterranean area during a convective episode (12-18 January 2017):(left) Standard deviation (*) and Bias (□) function of the forecast length and (right) Equitable threat score (ETS) for different categories. Individual impact of the reversed HARATU update (green) and SLHD activation (blue) respect to the tag version (red) and full SAMOA configuration (purple).

Conclusions
- **Good results for convective episodes and long periods at all areas.**
- **Need of predictor-corrector strategy for stability in dynamical adaptation mode.**
- **Very significant impact of SLHD at all areas.**
- **Domain dependent improvement with reversed HARATU update.**
- **Successful 500m first tests.**

SAMOA

GHI and DNI verification

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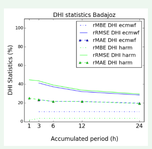
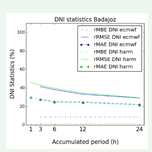
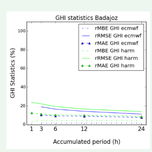
A verification of the global horizontal irradiance (GHI), direct horizontal irradiance (DHI) and direct normal irradiance (DNI) forecasted by the Arome-Harmonie and ECMWF models has been conducted as part of the H2020 **PreFlexMS project** (http://www.preflexms.eu). The predictions have been compared with observations taken in several stations of the AEMET Radiation Network, for the period Mar 2015 - Feb 2017. As an example, results for Badajoz (38.88N 7.01W) are shown, taking different accumulation periods (hourly to daily).

The rRMSE is around 20% for hourly and 15% for daily accumulated values of GHI, and 40% for hourly and 30% for daily accumulated values of DNI. It has been found that in general the ECMWF model performs slightly better than Arome-Harmonie, though the bias for Arome-Harmonie is lower

PreFlexMS







Highlights

- Aemet runs HARMONIE/AROME v40h1.1 from the **ALADIN-HIRLAM Shared System** in the local 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)
  - Significant improvement of precipitation forecasts but the model tends to underestimate summer convection.
- 1 km forecast over some coastal areas are produced operationally with added value for wind compared to 2.5 km simulations.
- Verification of global horizontal irradiance (GHI) and direct normal irradiance (DNI) shows RMSE of 15% and 30% respectively (slightly worst than ECMWF for the same cycle).
- Cloud verification against ceilometer data shows underestimation of cloud cover and overestimation of cloud base.
- A 2.5 km multi-model ensemble system is close to a operational state