NWP Activities at AEMET (Spain)

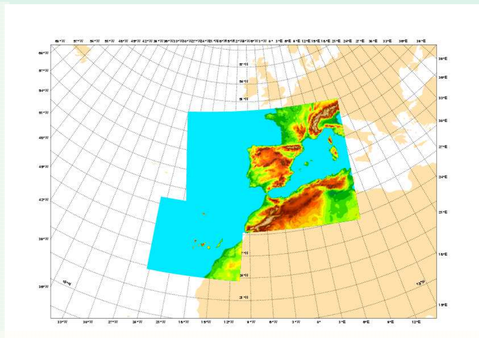
41th EWGLAM & 26th SRNWP Meetings, 30th Sep./3th Oct. 2019 Sofia (Bulgaria)

GOBIERNO DE ESPAÑA — MINISTERIO PARA LA TRANSICIÓN ECOLÓGICA — AEMet Agencia Estatal de Meteorología

OPERATIONAL SUITE HARMONIE-AROME

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. **radar reflectivities, 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

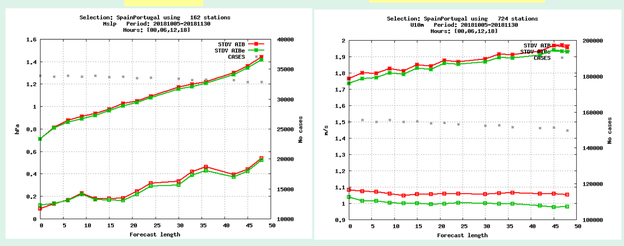
Mayor updates:

- Radar reflectivity using OPERA processing including Spanish, Portuguese and French radars
- Inclusion of humidity of the host model (ECMWF) in the blending process to form the First Guess
- Assimilation of T2m, q2m and wind in the 3Dvar
- Improvements in the GNSS and ATOVS blacklisting
- Increasing wind drag coefficient to enhance surface roughness

Verification against observations

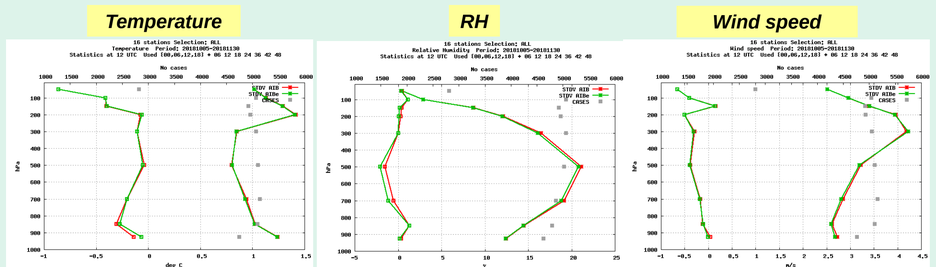
Verification against SYNOP stations shows improvements in most parameters. STDV and Bias for the Reference and New setup.

MSLP ***10m wind speed***



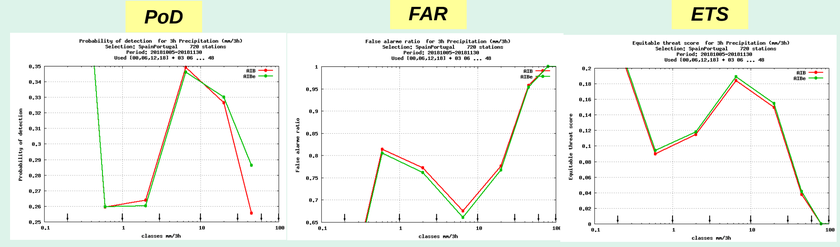
Verification against Soundings also shows a general improvement specially in the humidity profiles. STDV and Bias for the Reference and New setup.

Temperature ***RH*** ***Wind speed***



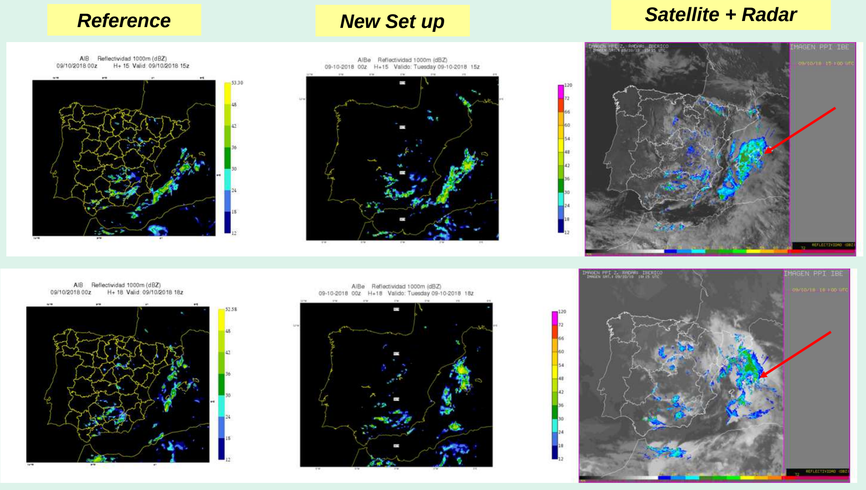
Categorical verification of precipitation against rain-gauges (3-hr accumulation) for the period oct-nov 2018. The New setup improves the Reference. Major impact from the radar assimilation is due to a decrease of the False Alarms.

PoD ***FAR*** ***ETS***



Sant Llorenç case

Reference ***New Set up*** ***Satellite + Radar***



Sant Llorenç des Cardessar case on 9th October 2018. A very harmful case in the SE of Mallorca causing 12 casualties. 150 mm were measured in 2 hours. The phenomena has a very small scale and hydraulic effects played a major role in the impact of the rain. The prediction is much better in the new setup. Anyway the exact location is not well reproduced because the scale of the phenomena is far from the model effective resolution.

Simulated Satellite Images

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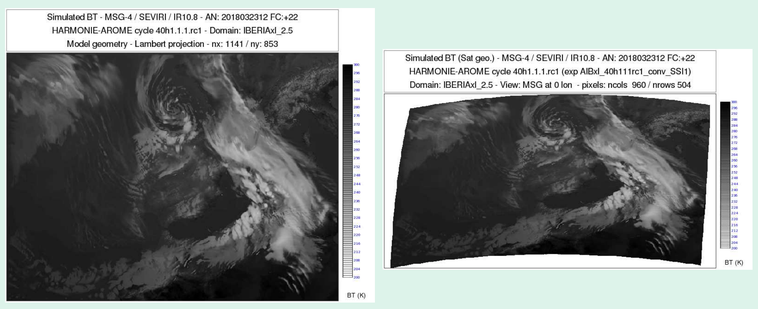
Simulated MSG SEVIRI imagery from the HARMONIE-AROME model output

- HALSSI: HARMONIE-AROME Simulated Satellite Imagery
- Using RTTOV Library. Offline application.
- Output in model geometry or native satellite geometry
- Very useful for diagnostic and forecasting purpouses
- Expected to be used for spatial verification in the near future



Simulated MSG IR images in model geometry (left) and in satellite geometry (right)

Mesoscale EPS → γSREPS

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γSREPS Mesoscale convection-permitting LAM-EPS at 2.5 km resolution based on a Multi-model and multi-BC approach

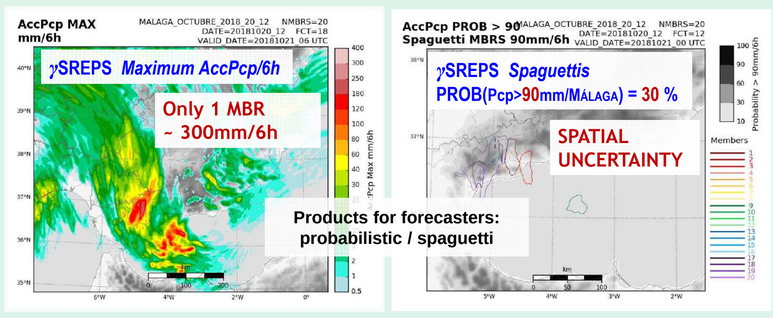
Daily run from March 2016 and semi-operational since November 2018 with dedicated web page

Characteristics:

- Multi-boundaries: **ECMWF**, **GFS**, **CMC**, **JMA**, **ARPÈGE**
- Multi-model: **HARMONIE**, **ALARO**, **WRF-ARW**, **NMMB**
- Up to 48 hours with 3-hour outputs
- 3 DOMAINS: 00&12UTC over Iberian Peninsula, 00UTC around Canary Islands and 00UTC around Livingston Island for Spanish Antarctic campaign

Collaborations with Portuguese (IPMA) and MétéoFrance AROME-EPS group

BCs	How they are			What we get (Every 3 hours – 00 and 12 UTC)		
	Hor Res (km)	Vert Levels #	Type of levels	Hor Res (Km)	Vert Levels	Type of levels
ECMWF	~9	137	Hybrid	~11 (0.1 deg)	137 [109]	Hybrid
GFS	13	64	Sigma	26 (0.25 deg)	47 [42]	Pressure
CMC	17-25	80	Hybrid	25 (0.24 deg)	28	Pressure
ARPÈGE	7.5 [France]	105	Hybrid	11 (0.1 deg)	28	Pressure
				10	70	Hybrid
JMA	20	100	Hybrid	26 (0.25 deg)	86	Hybrid



Future:

- Assimilation: LETKF
- Upgrade all NWP models
- Bigger domain over Iberian Peninsula
- Including a 5th model: GEM-LAM
- Calibration of surface parameters
- Specific end-user products: e.g. aeronautics

Scatterometer DA

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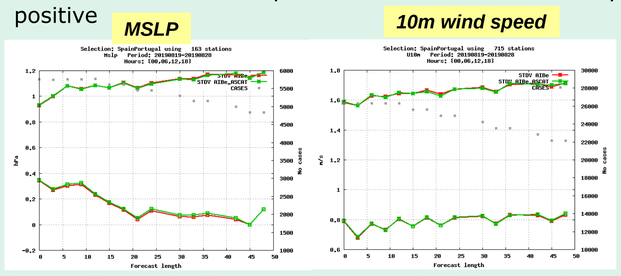
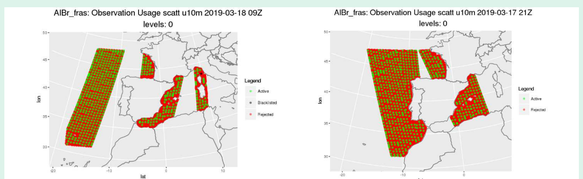
Assimilation of ASCAT data

- Working well after the work of Isabel Monteiro (IPMA)
- Under evaluation in a parallel suite: Small but mainly positive

MSLP ***10m wind speed***



STDV and Bias of Reference and ASCAT: Small but mainly positive impact



Mode-S EHS DA

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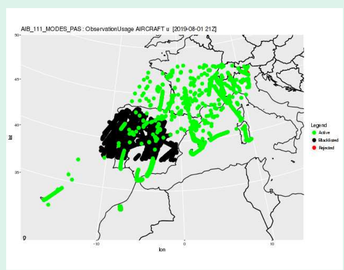
Assimilation of Mode-S EHS data: Preliminary tests

- Test data from the Spanish Trafic Control Authority (ENAIRE) is processed by KNMI and assimilated in HARMONIE-AROME.



*Example of AMDAR and **Mode-S** data*

- Technically working so we are ready to use more data.
- As expected, temperature has bias
- Thinning seems to be a key issue

Surface

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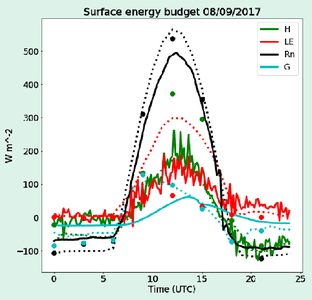
HCLIM43 Surface validation

- Harmonie is evolving towards an advanced surface physics:
  - ❑ Force restore → Soil diffusion scheme
  - ❑ 1 snow layer → Explicit Snow (12 layers)
  - ❑ Multi-energy Balance
- Accordingly, surface DA will become more complex.
- Studying surface biases in a no-DA setup (HCLIM43) will allow to understand the performance of the coupled system (sfc+atm) in order to reduce biases and thus the role of DA.
- A climate experiment is ongoing over Iberia based on harmonie-43h2.1-target1 settings + advanced sfc physics.
- Eddy-covariance data from a rural site will allow to explicitly validate fluxes along different seasons (see figure).



Observations (points) vs operational (solid) & climate run (dashed)

Sub-km

Km and sub-km modelling (asubiasa, dsuarezm@aemet.es)

- Test bed over the Canary Islands has been stablished.
- Technical problems have been solved and we are looking for the optimal dynamical configuration

Use of CAMS Aerosols

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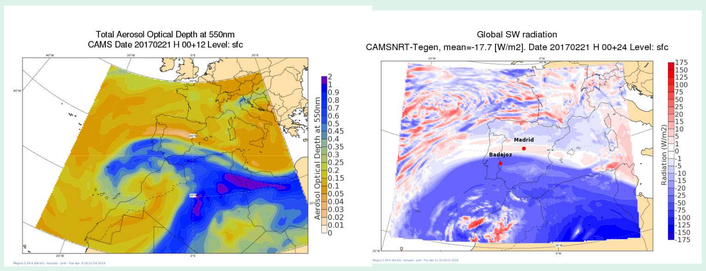
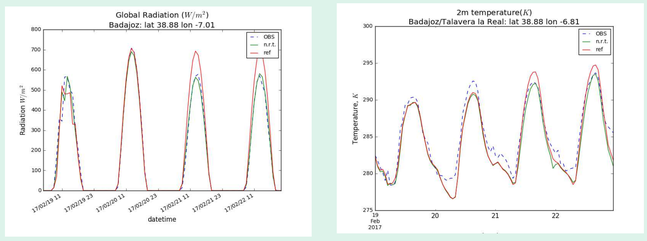
Use of near real time aerosol from CAMS in HARMONIE-AROME

- Microphysics: Modify Cloud Condensation Nuclei
- Radiation: Replace climatological vertical distributions of aerosols (Tegen) with impact on SW radiation



CAMS aerosol optical depth (left) on 21st Feb, 2017 and difference (CAMS-Tegen) of accumulated global SW radiation on the surface from HARMONIE-AROME simulation

- The use of CAMS n.r.t. aerosol in the radiation scheme shows a big improvement in the global radiation and 2m temperature in intensive dust events



Global radiation(left) and 2m temperature (right) at Badajoz station: Observation (dash), HARM-CAMS and HARM-Tegen

Rontu, L., Pietikäinen, J.-P., and Martin Perez, D.: Renewal of aerosol data for ALADIN-HIRLAM radiation parametrizations, Adv. Sci. Res., 16, 129–136, https://doi.org/10.5194/asr-16-129-2019, 2019.

Highlights

- Major update in the operational suite including
  - Radar reflectivities from OPERA.
  - Humidity from host model in the Large Scale mixing
  - Assimilation of T2m and RH2m in Upper Air analysis
  - Increase wind drag to decrease wind bias
  - Significant improvement is achieved in most parameters for all seasons
- Convective scale EPS, gSREPS, in pre-operational stage with positive feedback from operational forecasters.
- Under development:
  - Scatterometer assimilation: slightly positive impact
  - Mode-S EHS assimilation: Technically working
  - Improvement of DA algorithms: Variational Constrains and ELKF
  - Improvement of surface scheme: Use of climatic integrations for validation
  - Use real time CAMS aerosols in the model has a significant impact in dust intrusions
  - Km and Sub-km modelling: Canary Islands Test Bed stablished (working)
  - Tool to simulate MSG SEVIRI imagery from HARMONIE-AROME forecasts, using RTTOV v12 radiative transfer model.
  - Use of ECMWF's SAPP pre-processing software: Conventional obs implemented