# NWP Activities at AEMET (Spain)

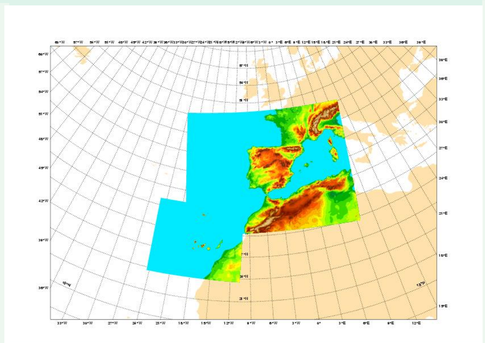
## Joint 30th ALADIN & HIRLAM Workshop ASM , 30th march-3th april 2020

VICEPRESIDENCIA CUARTA DEL GOBIERNO
MINISTERIO PARA LA TRANSICIÓN ECOLÓGICA Y EL RETO DEMOGRÁFICO
GOBIERNO DE ESPAÑA
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 hyper threading

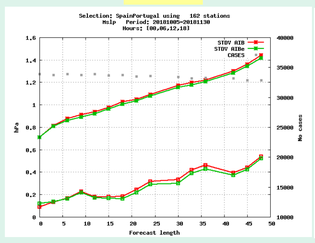
### Mayor updates:

- 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 2mT, 2mRH and wind in 3Dvar (upper air)
- Assimilation of Scatterometer 10 m winds
- Updates in the GNSS and ATOVS blacklisting /whitelisting
- Increasing wind drag coefficient to enhance surface roughness

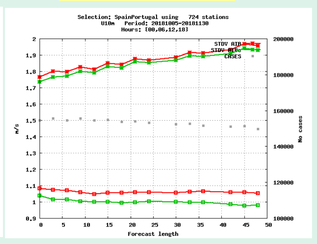
## Verification against observations

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

***MSLP***

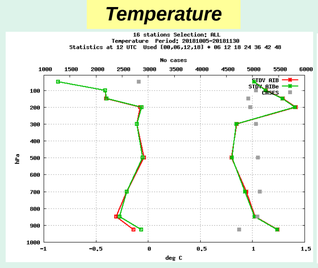


***10m wind speed***

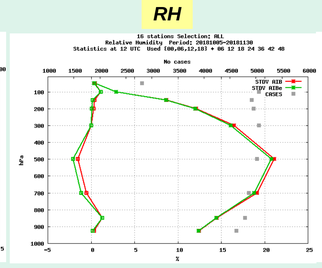


Verification against Soundings also shows a general improvement specially in the humidity profiles. STDV and Bias for the Reference and New setup.

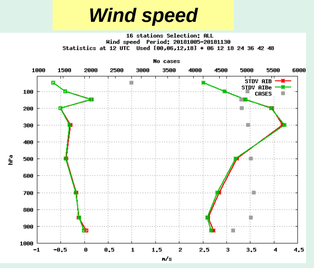
***Temperature***



***RH***

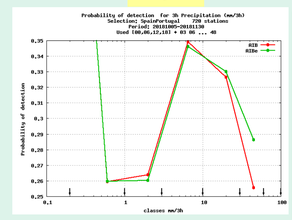


***Wind speed***

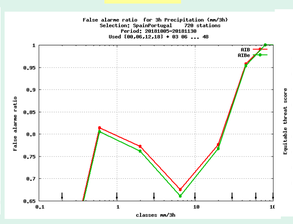


Categorical verification of precipitation against rain-gauges (3-hr accumulation) for the period oct-nov 2018. The New setup improves the Reference. Major impact from the **radar assimilation** is due to a decrease of the False Alarms.

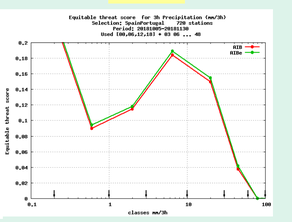
***PoD***



***FAR***

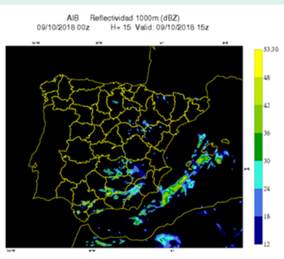


***ETS***

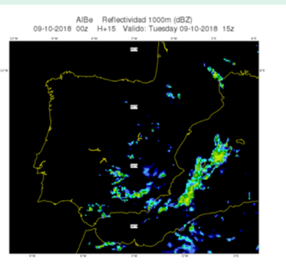


## Sant Llorenç case study

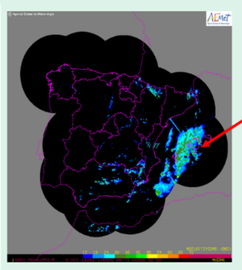
***Reference***



***New Set up***



***Radar***



Sant Llorenç des Cardessar case study on 9th October 2018. A very harmful causing 13 casualties took place in the NE of Mallorca Island. Around 150 mm of precipitations were measured in 2 hours. The phenomena had a very small scale and the hydraulic effects played a major role in the impact of the rain. It can be seen that the prediction is much better in the new setup. Anyway the exact location is not well reproduced in any of the runs because the scale of the phenomena is far from the model effective resolution.



## ASCAT 10 wind DA

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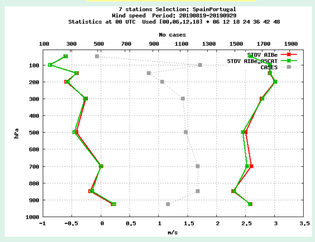
### Assimilation of ASCAT data

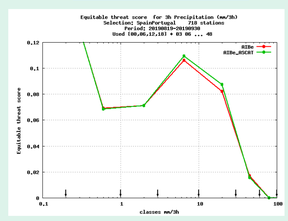
- Some tests have been performed in AEMET for different periods.
- Neutral to positive impact found, mainly in wind and 3h accumulated precipitation.

***Wind speed***



*Vertical profile of wind speed of Reference and ASCAT: Lower Standard Deviation in middle levels in case os asssimilating ASCAT Obs.*

***3h acc pcp***



*ETS of 3h accumulated precipitation of Reference and ASCAT: Small but mainly positive impact*

## 2mT & 2mRH in upper air DA , LSMIX-q

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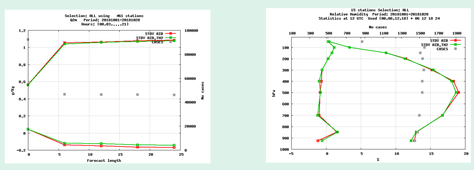
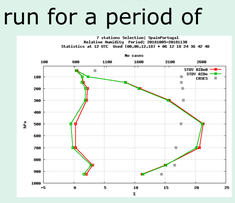
- Positive impact found in a parallel run for October 2018 when **assimilating 2mT and 2mRH in upper air** reducing screen level humidity bias and improving slightly the RMSE of humidity for low and middle levels. Besides, a small positive impact in precipitation is seen (not shown).



***Verification against observations*** *for* ***2 m specific humidity*** *and* ***upper air relative humidity*** *at 12 UTC, In red the operational version and in green the version including screen level assimilation in 3DVar.*

- **Large Scale Mixing also for specific humidity q** activated implied an improvement in vertical humidity and precipitation in a run for a period of two months.

***Verification against obs upper air RH*** *at 12 UTC Operational compared with the version with LSMIX q.*



## Single precisión Experiments

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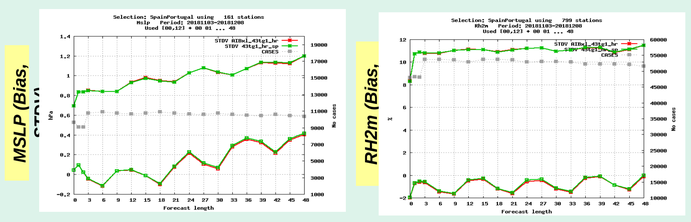
The experiments are performed using **cy43** of HARMONIE-AROME based on the work by Ole Vignes (*2019 ALADIN-HIRLAM Wrk*) that follows the work by ECMWF and Meteo-France. Only minor adaptations to the local computer were needed. Overall **Single Precision runs reduce elapsed time by 30%.** A parallel run for 1 month has been performed with 3-hr assimilation cycle and 48 hr forecasts.



***Verification against observations*** *for* ***MSLP*** *and* ***2m RH*** *for a period of 1 month. Comparison of Double Precision (red) with Single Precision (Green). The meteorological impact is very small.*

Martin and Subias, 2010: Single precision experiments at AEMET. *HIRLAM-ALADIN High Resolution and Nowcasting Workshop*

## Mode-S EHS DA status

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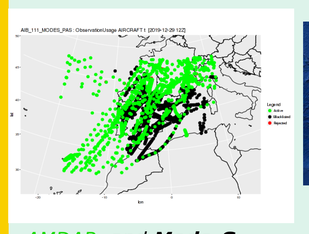
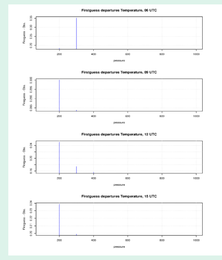
### Assimilation of Mode-S EHS data: Preliminary tests

Data from the Spanish Traffic Control Authority (ENAIRE) is processed by KNMI and assimilated in HARMONIE-AROME. Test data from 4 air traffic radar stations are used



*AMDAR and* ***Mode-S*** *data available*

*Radar station used.*



*The first guess departure for temperature of* ***MODE-S*** *is positive.*
*It is not the case for wind (not shown)*

- Thinning : duplicated flights must be removed
- Most of the data provided by **MODE-S** are between 150 hPa and 350 hPa.
- New version of the pre-processing will be available.

## AMDAR q DA status

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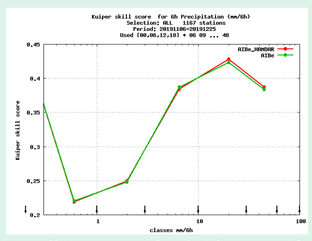
The lack of **TEMP** observations in the West side of the domain makes E-AMDAR observations really useful. Also ***Campins et al.,*** *2018* have demonstrated the positive impact of q from AMDAR observations in NWP. **But the number of aircraft with q sensor over our area is still very low** (less than ten per day).

An impact study have been done assimilating q of E-AMDAR over the AEMET operational domain **(AIBe_HAMDAR)** with the new suite **(AIBe):**

The pre-processing of AMDAR observations have been done using **SAPP.** The assimilation includes convectional observations (z, T2m & H2m for synop), ATOVS, GNSS and SCATT. Supersaturated observations are not include in the analysis.

*Slight improvement of* ***STDV*** *in q in middle levels, neutral for other variables and surface*



*Small improve for high rate of precipitation*

## IASI DA status

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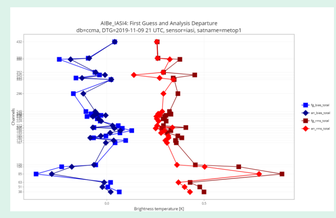
### Assimilation of IASI data

**1) Passive assimilation AIBe_IASI_3**

- VARBC: cold-start, 6 coeffs, NBG=2000
- 55 channels (following MetCoOp): 30 for the CO2 band, and 25 for H2O band
- Metop-A and Metop-B, cycles 09, 12, and 21 UTC
- Based on the new set-up

2**) Active assimilation AIBe_IASI_4**

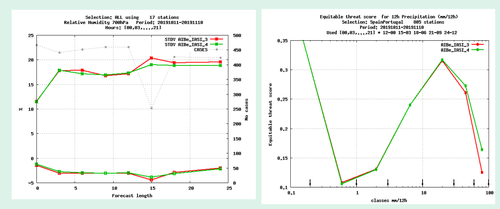
- Based on the AIBe_IASI_3
- Active: 25 CO2 channels active (MetCoOP selection except ch. 85, 333, 352, 384, and 432).
- Passive: ch. 85,333, 352, 384 and 432 and 25 H20 channels
- Only Metop-B, for 09, 12, and 21 UTC



*CO2 band channels assimilated*

**Verification** AIBe_IASI_3 vs AIBe_IASI_4

- Period: from 18th Oct to 11th Nov 2019
- Forecast length: 24h (15h) for principal (intermediate) cycles
- Surface: almost neutral impact, except for 12h acc pcp on large amounts (> 30 mm/12h)
- Temp: neutral impact, except for RH at middle levels
- In both cases, the active assimilation of IASI radiances implies a positive impact



*LEFT: Verification against soundings for 700 hPa RH: bias and stdv vs. forecast length*
*RIGHT: ETS for 12h Precipitation (mm/12h)*

## High resolution experiments over Canarny Islands

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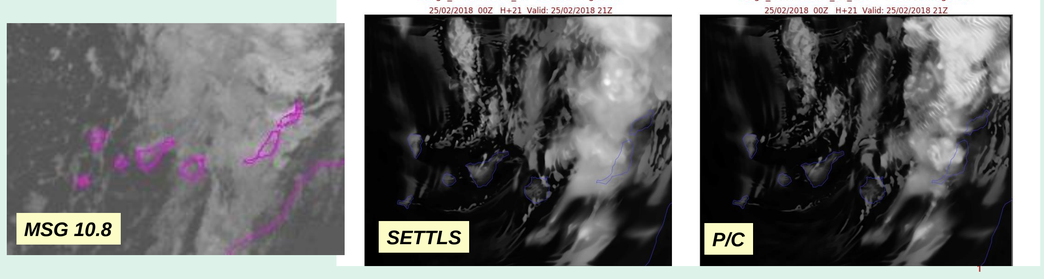
The Canary Islands with complex orography and very high steeps are a good test bed for testing resolutions of 1 km and below (*Subias et al, 2019: HIRLAM-ALADIN High Resolution and Nowcasting Wrk*). The main conclusions are:

- Sensitivity to the model grid: Little differences in the 2D fields, slight degradation of the scores with quadratic and cubic grids with some CPU savings
- Predictor/Corrector more noisy than SETTLS and worst scores
- AROME instead of IFS nesting: More variability, more convection and larger precipitation. Slightly worst scores. This would need further work.
- Single Precision: Significant reduction of CPU cost, little differences in 2D fields and in the scores (maybe some degradation near H+48).




*Simulated sat images for a H+21 forecast comparing SETTLS and Predictor/Corrector at 1 km resolution*

Our recommended settings at 1 km: SETTLS, SP an IFS nesting
On going work at resolutions below 1 km.

## Additional activities

- Escribà, Pau: gSREPS: AEMETgSREPS Forecasting uncertainty in AEMET operational forecasts (poster)
- Viana, Samuel: Experiments with roughness & ECOCLIMAP-SG (talk)
- Martín, Daniel: Update of the Use of CAMS aerosols in HARMONIE-AROME (talk)

## 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
  - Scatterometer 10 m wind assimilation: slightly positive impact
  - Significant improvement is achieved in most parameters for all seasons
- **AMDAR-humidity** and **IASI assimilation almost ready for operations**
- **On going work:**
  - Mode-S EHS assimilation: Technically working *(mdiezm@aemet.es)*
  - Radar Doppler Winds assimilation *(jsancheza@aemet.es)*
  - SEVIRI assimilation *(mdiezm@aemet.es, ajimenezd@aemet.es)*
  - Improvement of initial state on DA: Field Alignment and Variational Constrains *(cgeijog@aemet.es)*
  - Improvement of LETKF assimilation (pescribaa@aemet.es)
  - Operational use of ECMWF's SAPP pre-processing software *(mdiezm@aemet.es)*
  - Convective scale EPS, gSREPS: in pre-operational stage *(pescribaa@aemet.es, acalladop@aemet.es)*
  - High Resolutions versions (≤1 km) in dynamical adaptation for local applications *(fcalvos@aemet.es)*