NWP Activities at AEMET (Spain)
## 42nd EWGLAM & 27th SRNWP Meetings, 28th Sep./2nd Oct. 2020

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 4 times per day with a forecast length of 72 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. **AMDAR humidity obs, radar reflectivities, ATOVS, GNSS obs, ASCAT and IASI obs.**
- **Surface data assimilation** with optimal interpolation.
- **AROME phys**: Explicit deep convection, SURFEX and ICE3 microphysics
- Unified scheme for shallow convection (**EDMFM**)

Run in AEMET's BULL-ATOS HPC which includes 7760 processors
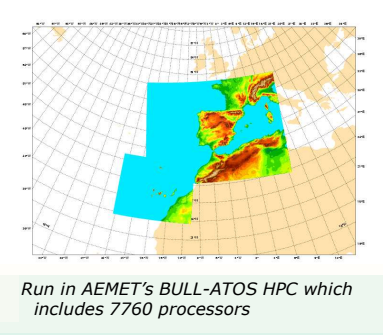
Latest updates:

- **SAPP Preprocessing** for conventional observations
- Forecast length up to 72 hr
- Assimilation of ASCAT and IASI data
- Radar reflectivity using OPERA from BALRAD preprocessing 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 and rh2m in 3Dvar
- Increasing wind drag coefficient to enhance surface roughness

Verification against observations

Verification against SYNOP stations Sep 2019-Ag 2020: HARM-AROME and ECMWF

T2m

ff 10m
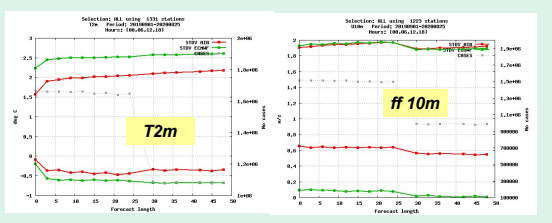
- Clear improvement of T2m
- Significant positive bias in 10 m wind speed (not seen in other HIRLAM countries) pointing to the need of an orographic parameterization
- Improvement of gusts although with a clear overestimation of convective ones
- Neutral impact in upper air fields

Categorical verification of precipitation against rain-gauges

DJF *MAM* *JJA* *SON*
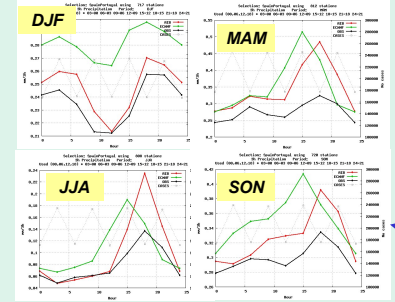
- Not straightforward comparison due to the resolution difference
- EC shows better ETS above 3 mm/12hr, clear positive bias below 10 and negative above.
- HARM has almost no bias below 10 and clearly positive above. Bigger differences are found in the convective seasons.
- The diurnal cycle is much better in HARM than in ECMWF as seen in the figures

Surface: Changes in Roughness lenght (Z_0)
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PATCH1: FAKETREES

- Included as an optional setting in harmonie-43h2.1
- The open-land patch (PATCH1) is modified with a "fake" % of forest (XFFAKETREE), with height XHFAKETREE
- PATCH1 becomes more **aerodinamically heterogeneous**, with a larger Z_0 after logarithmic averaging the old value with the FAKETREES area

$$\frac{1}{[ln(z/z'_{0P1})]^2} = \frac{1 - XFFAKETREE}{[ln(z/z_{0P1})]^2} + \frac{XFFAKETREE}{[ln(z/z_{0FAKETREE})]^2}$$

PATCH1>0.7

- It helps to alleviate the wind bias introduced by new sfc settings (XRIMAX>0, decreased LAI in ECOCLIMAP-SG)

PATCH2: Raupach's formulation

- It considers the concept of displacement height (d) in the vertical wind profile

$$U(z) = \frac{u_*}{k} log(\frac{z - d}{z_0})$$

- $Z_0 = f$ (Leaf Area Index). As vegetation becomes less sparse, Z_0 increases (decreases) with LAI for small (large) LAI
- With the current atm-sfc coupling, d+z₀ can be too close to the "forcing level" (~13m)
- More Z_0 developments are planned in RWP2021, including the introduction of a higher "**blending height**" and more complex Z_0 formulations which consider how roughness length is influenced by stability

Very High Resolution
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Km and sub-km modelling

Test bed over the Canary Islands (challenging orography) has been stablished with 1 and 0.5 km resolution in dynamical adaptation

2.5 km *1 km* *0.5 km*
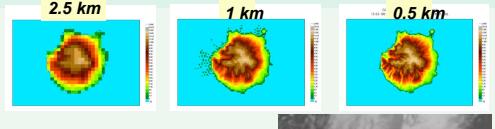
Looking for the most suitable configuration:

- Spectral truncation (linear, quadratic, cubic)
- Time scheme: SETTLS vs Predictor/Corretor
- Nesting strategy: IFS vs AROME 2.5 km
- Single/Double precision

SETTLS vs Predictor/Corrector at 1 km

MSG 10.8
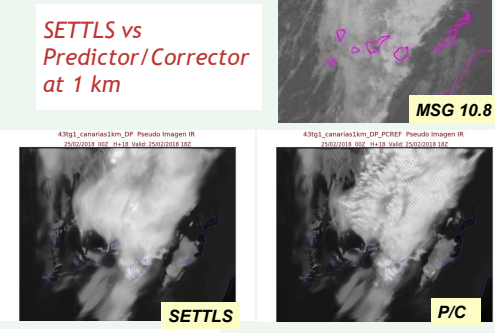
Our recommended setting at 1 km: SETTLS, SP an IFS nesting

Semi-Lagrangian diffusion seems to be helpul specially for the wind:
LSLHD_[SPD|SVD|T|W]=.TRUE.

SETTLS *P/C*

10m wind speed *T 2m*
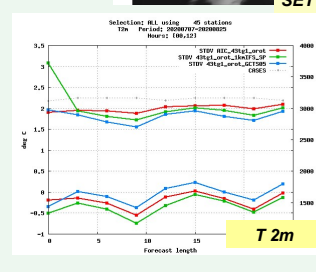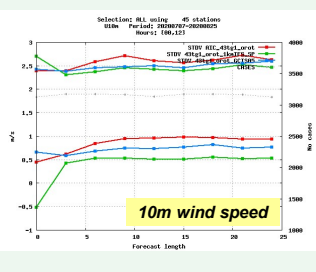
Verification against SYNOP:

2.5 km with 3DVar,

1 km and 0.5 km in dyn adaptation

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

Test case to study the impact of cloud condensation nuclei obtained from CAMS MMR on fogs and low clouds.
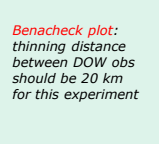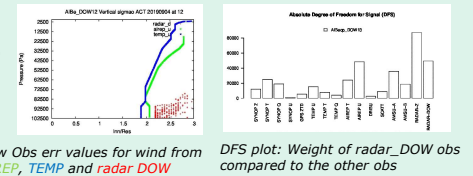

SAFNWC Cloud type 15-12-2020 at 00 utc

HARMONIE-AROME uses default values of CCN over sea (100 cm⁻³) and land (300 cm⁻³). When these values are modified using CAMS aerosols, it's been found:

- **Fake clouds** over the sea that are developed by the ctrl. experiment dissappear for experiments with very low CCN. When the value is increased fake clouds continue to appear but they don't develop so much.
- **Cloud water content is reduced** for lower concentrations of CCN (present values of cloud water in clouds in HARMONIE-AROME are too high compared with observation, Emily Gleeson communication).
- Very low CCN (around 10 cm⁻³) dissipate the clouds too early over land but values around 100 cm⁻³ seems to reduce the extension accordingly to the observation.
- A modification of the present default values of CCN or a **parametrization of CCN** seems to be necessary.

Radar Doppler Winds DA
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Assimilation of radar Doppler wind:
Impact studies based on cy40 including Doppler winds and reflectivities from BALTRAD preprocessing.

First try with:

1) Tuning of sigmao value depending on the distance from the radar, increasing its value.
2) Innovation rejection limit decreased 4 times

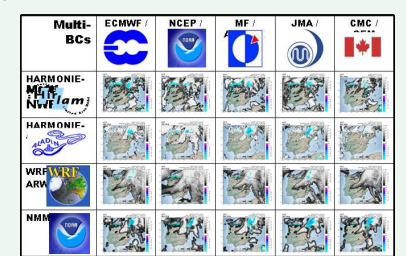Good impact on pcp, a neutral impact on T and neutral to negative on 10m winds have been found

New Obs err values for wind from AIREP, TEMP and radar DOW

DFS plot: Weight of radar_DOW obs compared to the other obs

Benacheck plot: thinning distance between DOW obs should be 20 km for this experiment

NOW working on:

1) Tuning of the thinning distance (Benacheck plots).
2) Tuning again the sigmao error acording with Desroziers Method.

SEVIRI WV data
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Assimilation of SEVIRI Water Vapor Channels (6.2 µm and 7.3 µm).

- In order to assimilate only clear sky information the Cloud Type and CTTP products of **NWCSAF** (version 2018) have been used. Variational Bias Correction applied. Obs available for all cycles

Cloud Type (CT)

Cloud Temperature and Top Pressure (CTTP)

Active observations

- After one month the impact is neutral excepct for relative humidity.
- Work on-going to adapt it to cycle 43h2.1 and to use emissivity maps in order to assimilate more channels.

Mesoscale EPS → γSREPS
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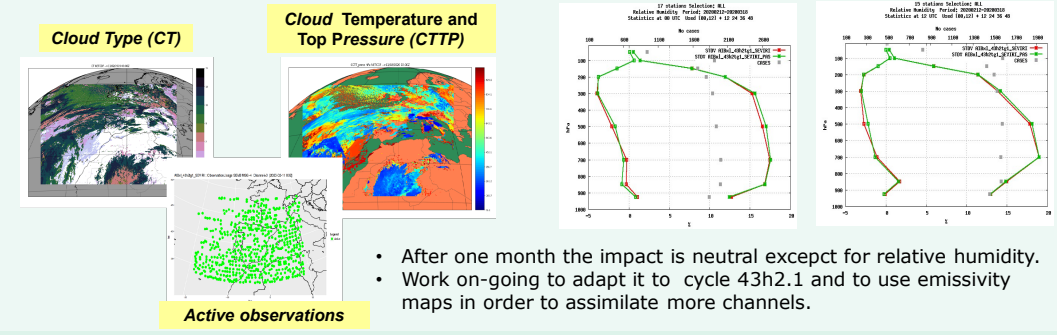### AEMET-γSREPS towards a *Time Critical Application* at ECMWF

The Plan is to run the system as TCA by the end of 2020

- Currently AEMET-γSREPS is running operationally at ECMWF HPCF twice a day up to H+60 on 3 domains: IBERIA, CANARY ISLANDS and LIVINGSTON (ANTARCTICA)
- It is a Short-Range EPS composed by 4 NWP-LAMs combined with 5 GCM (see Figure)

Recent improvements

- ARPEGE in model levels ingested operationally for Iberian Peninsula and Canary Islands
- ALARO model full-following ALARO reference configuration (thanks to Neva Pristov)
- Monthly auto-verification of the system and comparison with ECMWF-EPS

Future improvements

- Cycle the gSREPS members to do Surface Data Assimilation
- Calibrated EPSgrams for airports: AEROgrams
- Extreme Forecasting Index (EFI)
- Increasing Iberian domain
- Moving to 25 member LAM-EPS including GEM-LAM (Canadian NWP model)
- … and more

IASI data
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Data assimilation of IASI data

A selection of 50 IASI channels over land and sea are used
Clear air radiances from METOP-B at 09, 12 and 21 UTC (also at 00 UTC for Canary Islands)
Variational Bias Correction is applied with a warm-up period of 1 month
Comparing with observation a small positive impact is found

00 utc *12 utc*
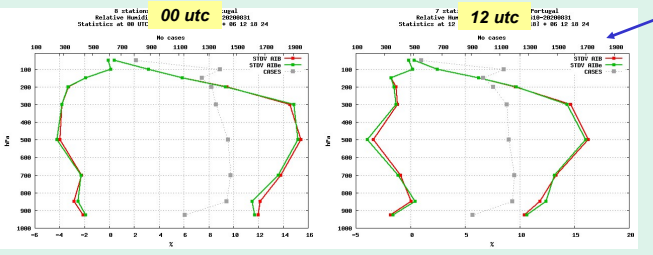
Verification Jun-Ago 2020 against soundings (Bias and RMSE): Operational version compared with the version including IASI Data Assimilation

- On-going work to adapt it to cycle 43h2.1

Highlights

- Updates in the operational suite including
  - SAPP preprocessing for conventional observations
  - Scatterometer assimilation: slightly positive impact
  - IASI Assimilation: positive impact
- Convective scale EPS running at ECMWF at 00 and 12 UTC with 60 hr forecast length. Expected to become a Time Critical Application at ECMWF soon.
- Under development:
  - E-suite base on cycle 43h2.1
  - Radar Doppler wind
  - SEVIRI assimilation
  - Mode-S EHS assimilation: Technically working
  - Improvement of DA algorithms: Variational Constrains and ELKF
  - Improvement of surface scheme: roughness formulation, more sophisticated options in SURFEX 8.1 as Diffusion scheme.
  - Use real time CAMS aerosols in the model that has a significant impact in dust intrusions
  - Km and Sub-km modelling: Canary Islands Test Bed stablished (real time)
  - Nowcasting suite