AEMET NWP Activities
46th EWGLAM and 31st SRNWP Meeting, 30th Sep-3rd Oct 2024, Prague

Deterministic e-suite

- e-suite based on HARMONIE-AROME cycle 46h1.1 [1]
- **2.5 km, 65L** runs 4 times per day with a forecast length of 72 hours for a **single unified domain** instead of 2 domains (Iberian Peninsula and Canary Islands). Main impact over the Canary Islands due to the increase of observations, specially satellite obs
- **Single precision** in the forecast model (may produce a small degradation in RH field)
- **3DVar analysis** with **3hr cycle** incl. AMDAR humidity obs, radar reflectivities, ATOVS, GNSS ZTD, ASCAT wind , IASI and SEVIRI obs.
- IFS humidity in the blending process (LSMIX). Assimilation of T2m and rh2m in 3Dvar
- SAPP preprocessing for conventional observations
- Radar reflectivity using OPERA from BALRAD preprocessing including Spanish, Portuguese and French radars (NIMBUS optional). Radar wind assimilated in passive mode.
- Increase roughness increasing heterogeneity of open land patch (FAKETREES)
- Orographic roughness parametrization OROTUR enabled (to alleviate a positive wind bias which is still too large)
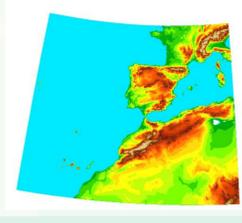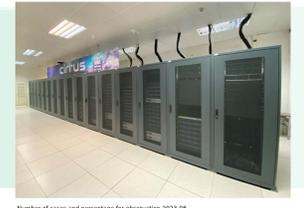
Enhanced Satellite Data Assimilation (jcampinsp@, mdiezm@)

- **Improve SEVIRI DA** following approach proposed by Guedj. et. al. (2011)[2] for improving the quality of the surface temperature. This allows to assimilate observations over land from the infrared and water vapour channels.
    - Slight improvement when using only WV6.2+WV7.3 with LST estimation on precipitation and RH.
- **Assimilation of ATMS and MWHS-2 sounders:** Small positive impact on the analyses, neutral to slightly positive in forecast

Nowcasting suite

- Operational since 10 Dec 2023 running over the Iberian peninsula and Balearic Islands. Based on Harmonie-Arome cycle 43h2.1.1 with 1.25 km resolution, Harmonie-Arome nesting, 3DVar hourly cycle with +23 min cut-off time. Using conventional observations + radar reflectivity + GNSS-ZTD (fast processing) + SEVIRI WV + Mode-S. H+12 in hourly cycles.

To benefit from the better obs coverage in the operational suite, every 6hr and H+2 First Guess from the host is used for upper air fields

Case study (03-09-2024):

In general the difference between the 3-hr deterministic suite and the hourly nowcasting suite is small but in some cases the benefit is clear

Initialization for NWP-NWC (cgeijog@)

Variational Constraints (VC), a new algorithm tailored made to filter noise in ALADIN-NH dynamics initial conditions

- ✓ Minimum overhead or computational cost over standard 3DVar (eq. to one time step). Enables analysis of NH dynamic variables vertical motion and pressure departure which are not provided by current 3DVar
- ✓ Shall be integrated in the operational AEMET-NWC suite
- ✓ Potential for RR/nudging applications in NWP-NWC
- ✓ Now verified and integrated into the HARMONIE repo at github.com/Hirlam (PR CY46VC#1095)
- ✓ The algorithm essential parameters configured by a short namelist NEMVARCONS. User documentation shall be added soon

More info at https://www.umr-cnrm.fr/accord/IMG/pdf/poster_carlos_geijo.pdf and references therein

Figure shows error growth curves for RR DA experiments (10 minutes cycling) with Römö (Danmark) Doppler LOS wind radar data. Thin lines correspond to experiments with VC, thick lines to NO-VC. The VC exps show clear smaller error increase rates and remove someover-fitting at to . It is also apparent the capacity of the VC algorithm to build signal coherently from consecutive RR DA cycles (absent without VC) and to improve the NWC forecast skill with respect to the NO-VC exps

Spatial Verification (proyecto1_de330@, jgonzaleza@, sviana@)

Using Spatial Verification to evaluate Very High Resolution forecasts

- Work done in the context of *Destination Earth* project
- Development of Python-based software for hourly verification (FSS & SAL) and comparison between high resolution experiments.
- In the **process of integration into Deode-Workflow**.

Case study:

- **FSS:** Better representation of the precipitation field from the experiment at 500 m spatial resolution (higher means), especially for high thresholds. DestinE 4.4 km does not reproduce the maximum hourly precipitation values estimated by OPERA radar.
- **SAL (not shown):** Both experiments produce slightly overestimated precipitation fields in whole verification domain, but for different reasons. Additionally, the extreme objects detected by DestinE 4.4 km are larger and flatter, yielding a worse structure value when compared to observation.

- Spatial verification is able to show the added value of the 500m simulations
- Main limitation is that supervision is needed in order to check the objects selected and the verification domain, specially for SAL what makes difficult to use it in an automatic manner

See also talk by González-Alemán: "Lagrangian evaluation of convective activity"

Contributions:
Javier Calvo, Alfons Callado, Joan Campins, María Díez, Pau Escribà, Carlos Geijo, Juan-Jesús González-Alemán, Juan-José Gómez, Antonio Jiménez, Daniel Martín, Gema Morales, Jose M. Pérez de Gracia, Jana Sánchez-Arriola, Samuel Viana

References:
[1] Morales et al. (2024): Evaluation of HARMONIE-AROME cycle 46h1 at AEMET. ACCORD Newsletter, 5
[2] Guedj, S., F. Karbou, and F. Rabier (2011), Land surface temperature estimation to improve the assimilation of SEVIRI radiances over land, J. Geophys. Res., 116, D14107, doi:10.1029/2011JD015776.
[3] Martín Pérez, D., Gleeson, E., Maalampi, P., & Rontu, L. (2024). Use of CAMS near Real-Time Aerosols in the HARMONIE-AROME NWP Model. Meteorology, 3(2), 161-190.
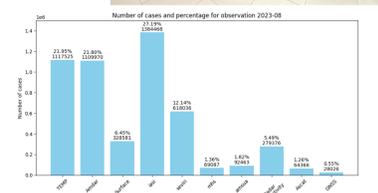
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Evident-ATOS-Bull High HPC updated
It is composed of two identical clusters each with 188 compute nodes mounted on Bull Sequana X440 A5 chasis. Each node with
- 2 AMD EPYC™7742 processors (64 cores)
- 256 GB DDR4-3200 memory
- 25% of the nodes with 384 GB

Use of satellite data

Satellite	MW T sounding	MW hum sounding	IR sounding
NOAA-18	AMSUA		
NOAA-19	AMSUA	MHS	
METOP-B	AMSUA	MHS	IASI
METOP-C	AMSUA	MHS	
MSG			SEVIRI

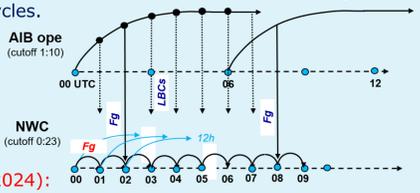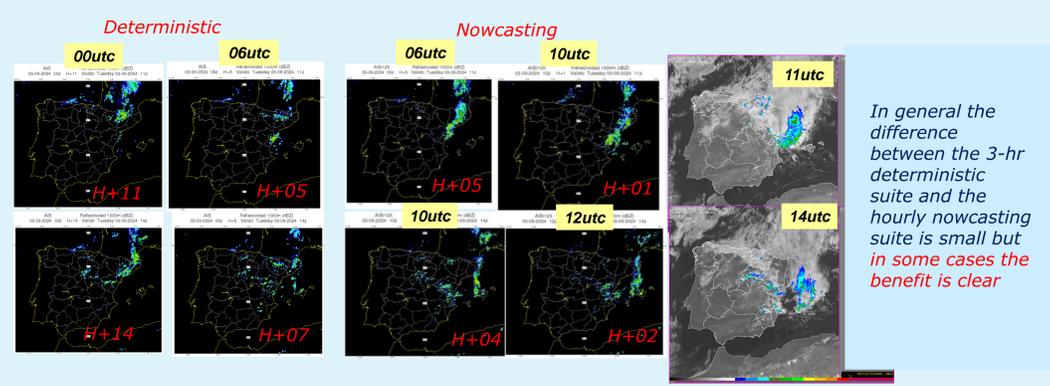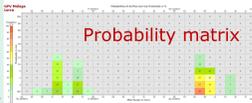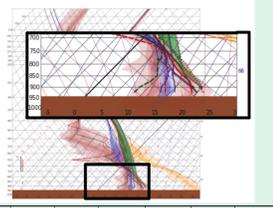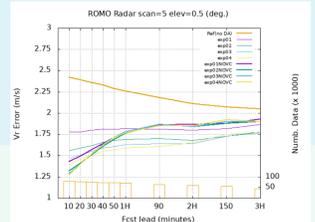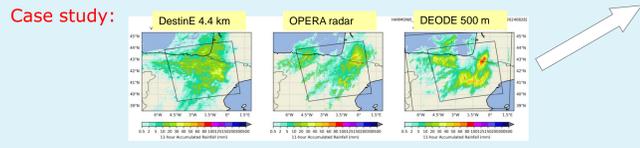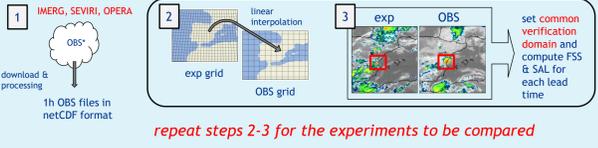| IASI CHANNELS	
CO2 High	38,51,63,85,104,109,167
CO2 Middle	173,180,185,193,199,205,207,212,224,230,236,239,242,243,249,296,386
CO2 Low	333,337,345,389,432
WV	2701,2819,2910,2919,2991,2993,3002,3008,3014,3098,3207,3228,3281,3309,3322,3438,3442,3484,3491,3499,3506,3575,3582,3658,4032

Number observations entering the Minimization during a month and relative distribution for the different types

AMSU-A: 6, 7, 8, 9
MHS: 3, 4, 5
SEVIRI: WV6.2, WV7.3

Mesoscale EPS (acallado@, jgomezn@)

AEMET-γSREPS

- Multi-model (4 mesoscale NWP models)
- Multi-boundary conditions (5 Global models)
- at 2.5 km on 3 domains: Iberian Peninsula, Canary Islands and Antarctica
- 2 cycles up to 72 hours each

Recent developments
- We decided to keep spatial resolution
- Vertical profiles + Zoom in lower levels
- Probability matrix

Vertical profiles + zoom

Probability matrix

Next steps
- Update LAMs:
    - WRF 4
    - Harmonies cy46
- Larger Iberian domain
- More members: new BCs (e.g. ICON) & new LAMs: (e.g. ICON-LAM, GEM-LAM)

Ongoing work!!!

4DVar activities (pescribaa@, jsancheza@)

Tunning of observation error in 4DVAR Cy46
- On going tunning of obs. error compared to 3DVar and using all operational observations in a large domain including Iberian peninsula and Canary Islands

Development of the OOPS Local Area 4DVAR in Cy48T3
Work progress quite well. Below 2 diagnostics show nice performance:
a) T increment evolution within the analysis window at level 39 of a single obs.

AMDAR T DA Some noise related to surface must be addressed.

b) evolution of the Jo and Jb cost functions for a 3335 conventional observations exp. (SYNOP, AMDAR and BUOY). 2 (1x,1x) outer loops (right figure).

Future work:
- Solve the noise problem
- Discuss with our colleagues in MF about our implementation and plans (next WW in Toulouse)
- Explore the merging of screening and minimization in a one single 4DVAR LELAM OOPS task
- Port the code modifications to HARMONIE CY49h2 release
- Careful check of namelists, input upper air and surface fields used, will be carried out and compared to CY49h2 MASTERODB
- Carry out performance tests with CY49T2h release, using the HARMONIE scripting system and comparison with MASTERODB LELAM 4DVAR
- Proper documentation will be written

NRT aerosols on HARMONIE-AROME (dmartinp@)

Use of near real time CAMS aerosols in NWP model

Impact on microphysics and radiation
- About a 23% increase in computing cost
- Improvement of the radiation in cloudy conditions.
- Siignificant impact in cases of desert aerosols advection.
- For strong precipitation events the system seems to give better results.
- Small impact for the rest of meteorological variables
- Plan to implement the system on-demand.

Further details in Martín Pérez et al.[3] "Use of CAMS near Real-Time Aerosols in the HARMONIE-AROME NWP Model"

Highlights

- ➤ A model update based on Cy46h1 and using a large unified domain including the Canary islands is ready to be used operationally. The meteorological impact of cy46h1 and the impact of the larger domain benefits specially the Canary Islands, we think due to the more observations ingested in the surroundings

- ➤ Using emisivities allows to use SEVIRI data over land but it only has a positive impact using water vapor channels.

- ➤ Single Precision seems to work well in cy46h1 forecasts and will be used in operations

- ➤ Nowcasting suite is running operationally. 1.25 km H+12 runs every hour with 23 min cutoff time. A poor man H+6 EPS can be built. For operational purposes, the early delivery is able to compensate the fewer obs entering the analysis. Several case studies have shown the added value of the NWC suite.

- ➤ Multi-model EPS (γSREPS). EFI and SOT for rain, snow, gusts, Tmax and Tmin included.

- ➤ Spatial Verification on precipitation is being tested using different data sources. It seems it has potential to compare forecasts of different resolutions and discriminate if high resolution simulations are able to improve coarse resolution runs. The drawback is that it needs supervision specially if SAL statistics are used.