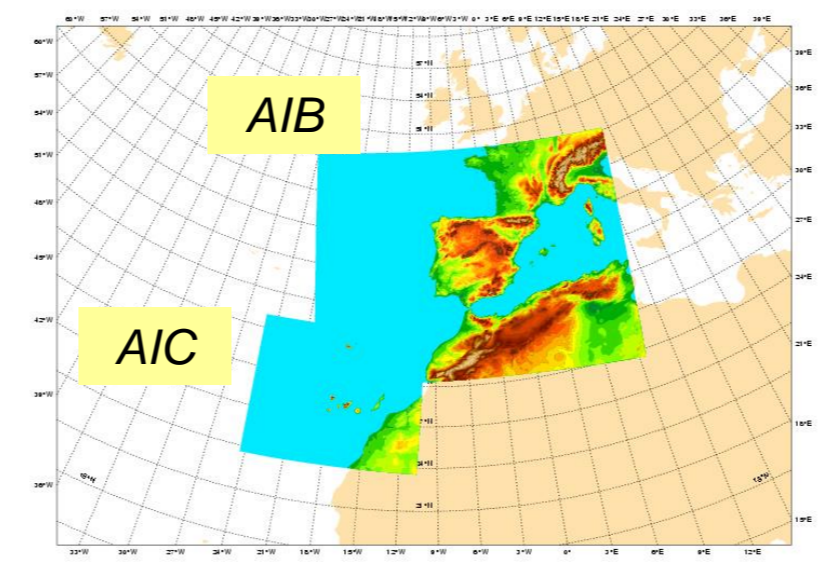


Deterministic Suite

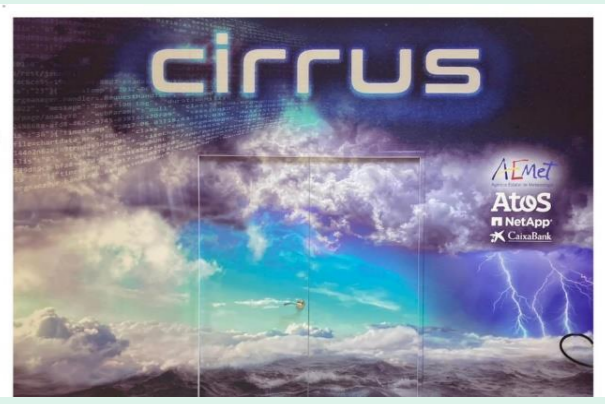
- Operational suite based on HARMONIE-AROME cycle 43h2.1.1
- 2.5 km** runs 4 times per day with a forecast length of 72 hours for 2 geographical domains (Iberian Peninsula and Canary Islands).
- 3DVar analysis with 3hr cycle** incl. AMDAR humidity obs, radar reflectivities, ATOVS, GNSS ZTD, ASCAT wind, 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.
- Radar wind assimilated in passive mode.
- Retuned scales in CANARI
- 2 patches for Nature tile and disabling Surface Boundary layer Scheme
- Max Richardson: XRISHIFT
- 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)



ATOS-Bull High Performance Computer updated It is composed of two identical clusters each with 188 compute nodes mounted on Bull Sequana X440 A5 chassis. Each node with

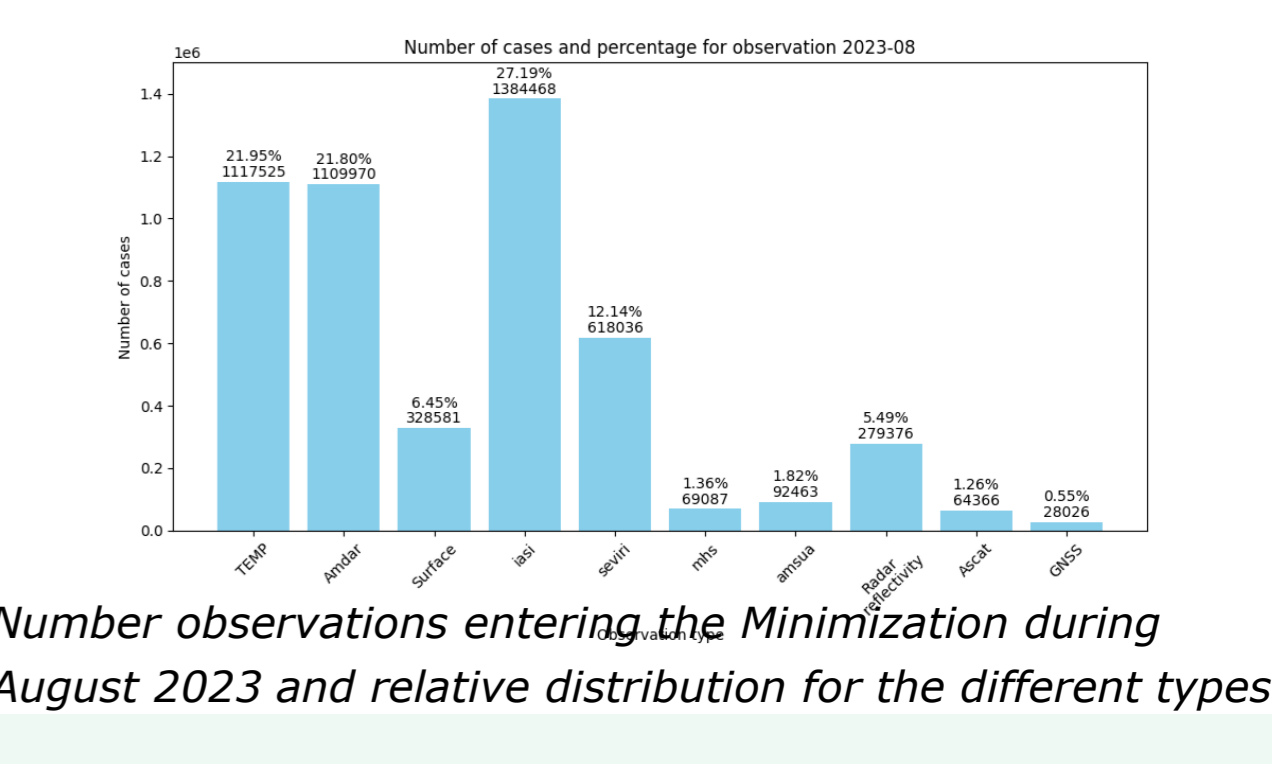
- 2 AMD EPYC™7742 processors (64 cores)
- 256 GB DDR4-3200 memory
- 25% of the nodes with 384 GB



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
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	2701,2819,2910,2919,2991,2993,3002,3008,3014,3098,3207,3228,3281,3309,3322,343,8,3442

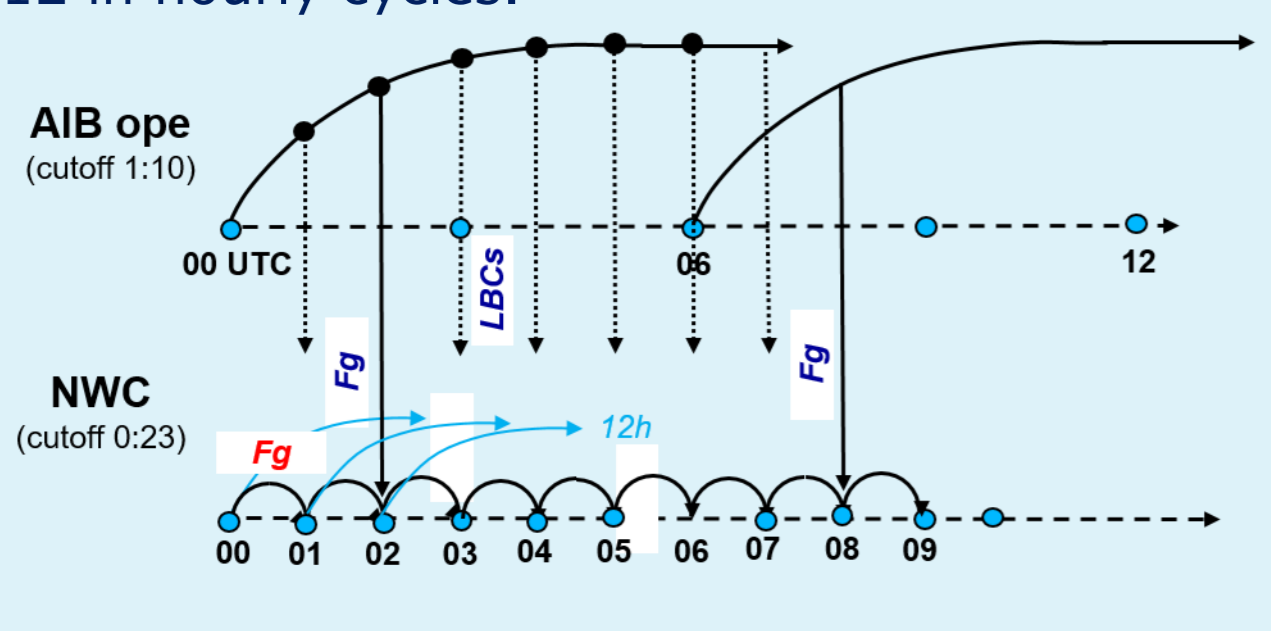


AMSU-A: 6, 7, 8, 9
MHS: 3, 4, 5
SEVIRI: WV6.2, WV7.3

Nowcasting suite

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.

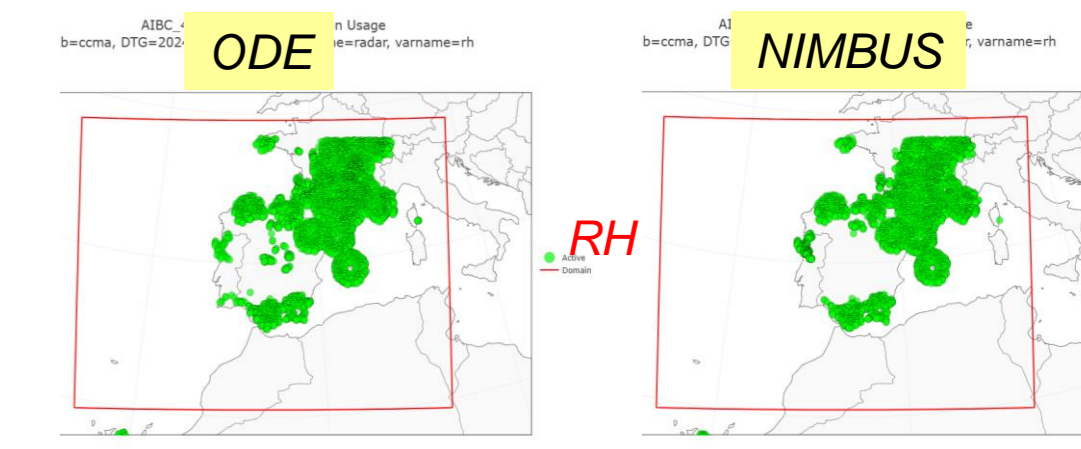


To benefit from the better obs coverage in the operational suite, every 6hr an H+2 First Guess from the host is used for upper air fields

Additional info in Díez-Muyo's presentation

OPERA NIMBUS processing, jsancheza@

- Very similar distribution of observational data
- Neutral impact on verification compared to ODE
- Aemet ready to use NIMBUS data operationally

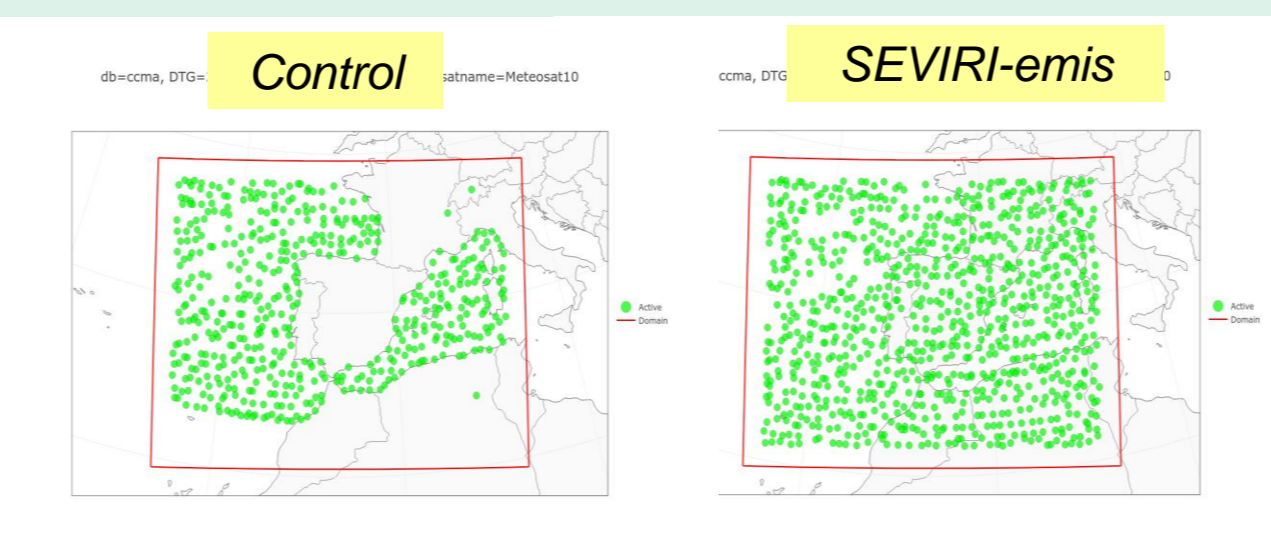
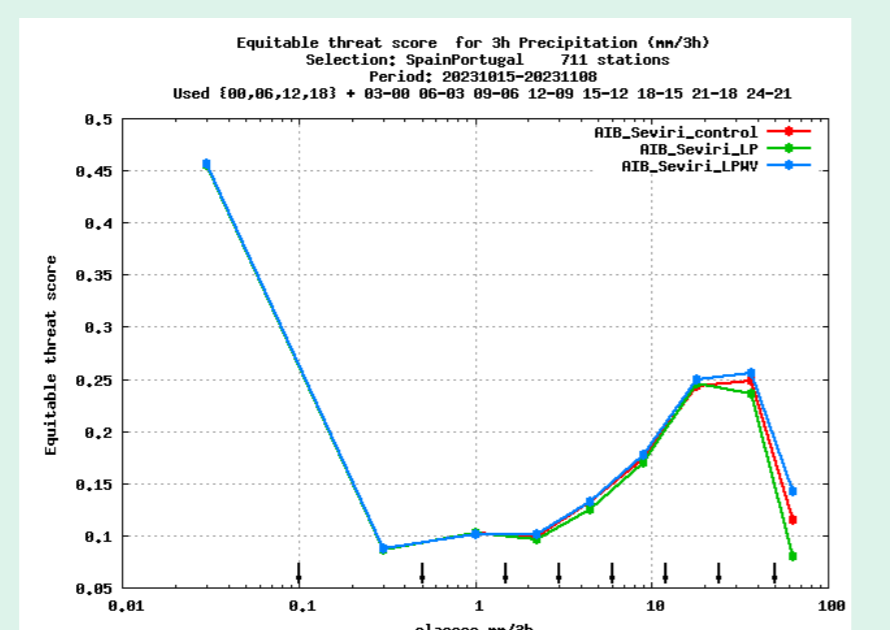


Enhanced Satellite Data Assimilation

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 vapor channels.

Tests based on Cy43.h.2.1.1 with 3hr cycling incl. Conventional+GNSS-ZTD+SCATT+Radar-Reflec+ATOVS IASI+SEVIRI. VARBC with 24hr cycling and 1 predictor (constant). In the operational suite (control) only WV channels over sea are assimilated.

- CTRL:** SEVIRI WV6.2 & WV7.3 over sea.
- AIB_Seviri_LP:** CTRL + SEVIRI WV6.2, WV7.3, IR8.7, IR10.8, IR12.0 and IR13.4.
- AIB_Seviri_LPWW:** CTRL + SEVIRI WV6.2, WV7.3.



Small impact in general with slight improvement of using only WV6.2+WV7.3 with LST estimation on precipitation and RH. We will continue exploring this technique but for the moment we plan to include it in the operational suite

Mesoscale EPS

AEMET-γSREPS

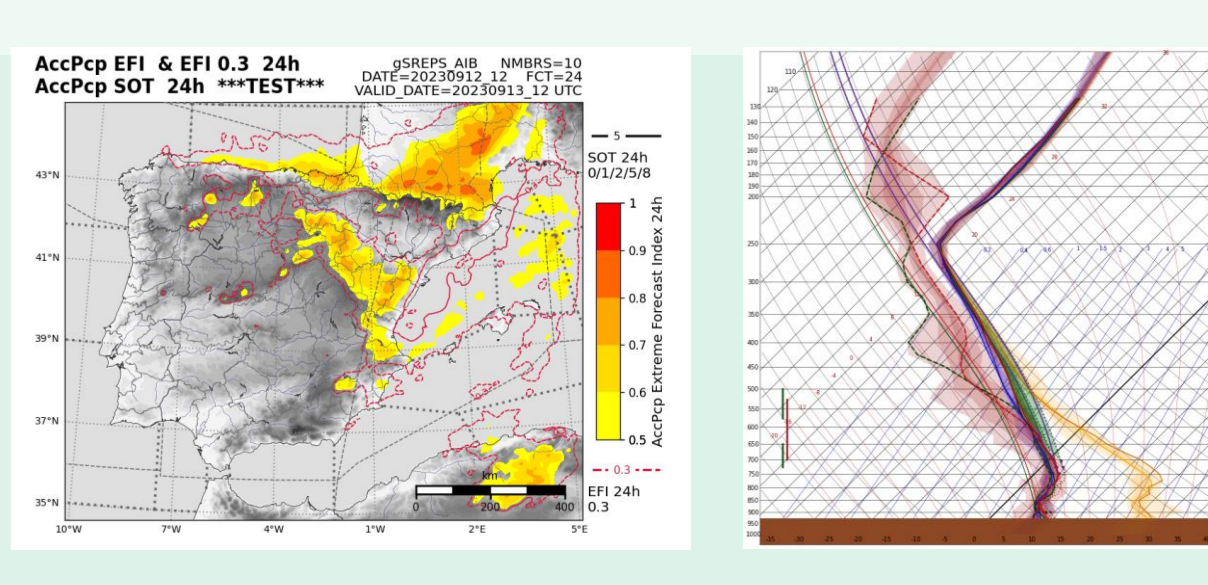
- Multi-model (4 mesoscale NWP models) and multi-boundary conditions (5 Global NWP models)
- at 2.5 km on 3 domains: Iberian Peninsula, Canary Islands and Antarctic

Recent developments

- Extended lead time to **72 hours** in all 3 domains
- All domains **2 cycles** at 00 and 12 UTC
- EPSgrams** on forecasters demand in airports, main cities, mountains and other locations of special interests
- EFI** (Extreme Forecast Index) and SOT for rain, snow, wind gust, T2m max and min, CAPE and other variables

Next steps

- Larger domains (probably at same resolution)
- More members: new BCs (e.g. ICON) & new LAMs (e.g. ICON-LAM, GEM-LAM)
- Auto verification suite with HARP
- New products:
 - Probabilistic vertical profiles
 - Dynamic visor for products (ADAGUC from KNMI)



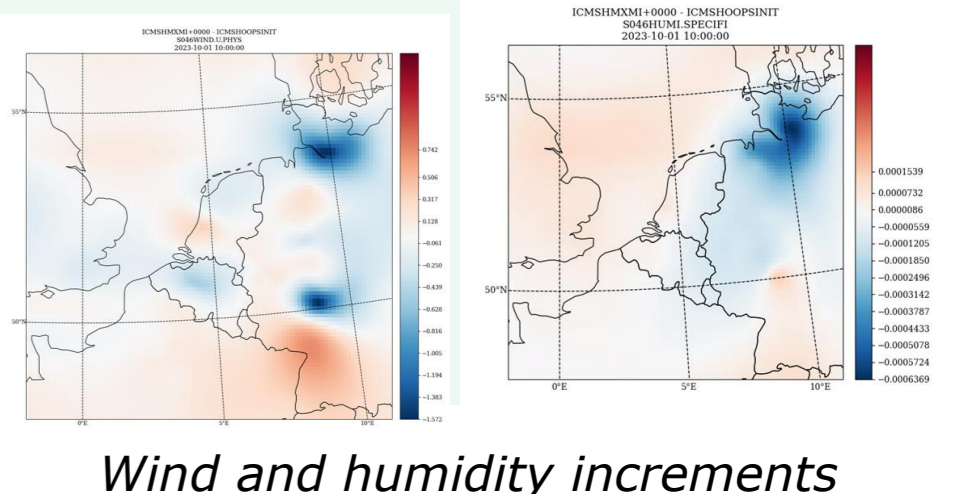
4DVar activities

Evaluation of 4DVAR in cy46h1rc1

- On going evaluation 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 for HARMONIE

- A 4DVAR minimization in OOPS using the IFS Cost Function is working, with the inner loops at the same resolution as the background

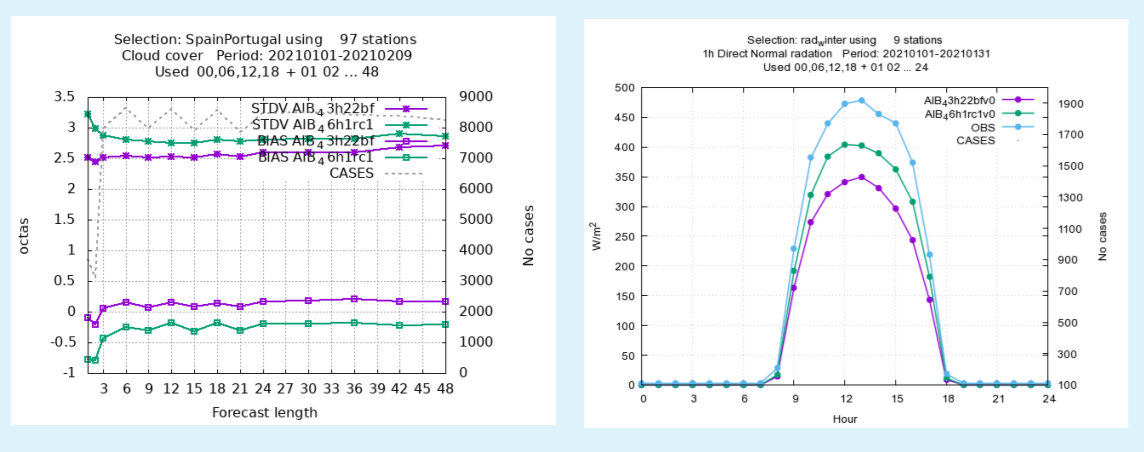


- Currently working on making available the use of the Meteo-France Cost Function, to eventually compare it with the IFS one.
- For more details see *Escribà et al. poster "OOPS Limited Area 4DVAR"*

Evaluation of cy46h1

Evaluation of cy46h1 (e-suite)

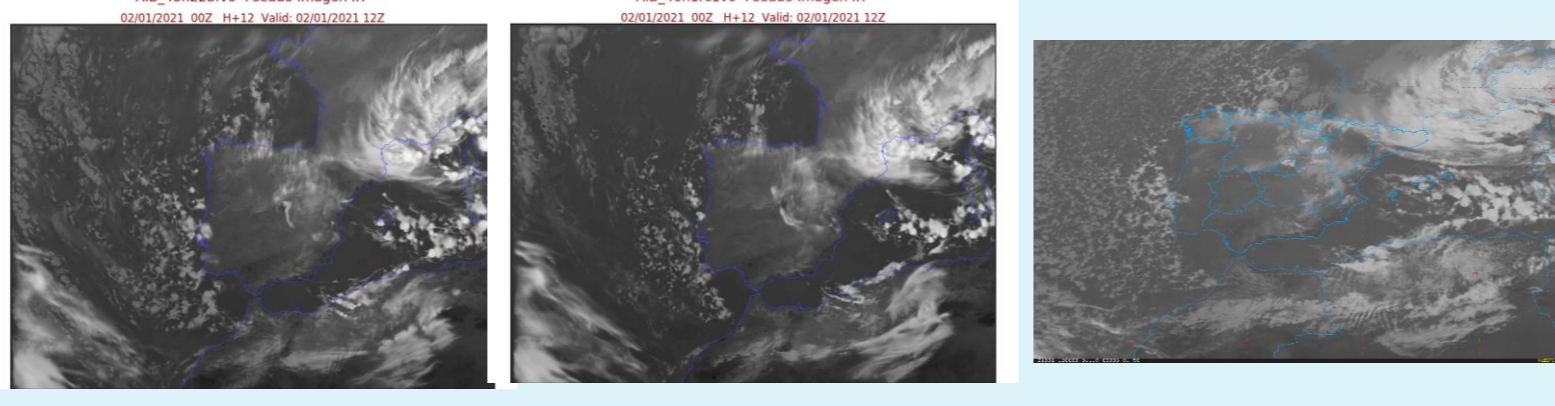
- Extensive evaluation compared to cy43h22 using all operational observations?
- Overall quite neutral impact
- Bigger impact is found in cloud cover due to the effect of a reduction of the variance term in the statistical cloud scheme RFRMIN(24)=2-5 1 produce a decrease in low cloud cover



STDV & Bias of Cloud Cover against synops (left) and diurnal cycle of Direct Normal Radiation for winter

- Single precisión in the Forecast model produces very similar results to DP saving 25% computing time and will be implemented operationally.
- Major advantage of cy46h1 is that it includes more advanced surface parameterization and DA, that are currently being evaluated.

The reduction of cloud cover has some impact on frequency and extension of fog but it is not clear if this is positive or not



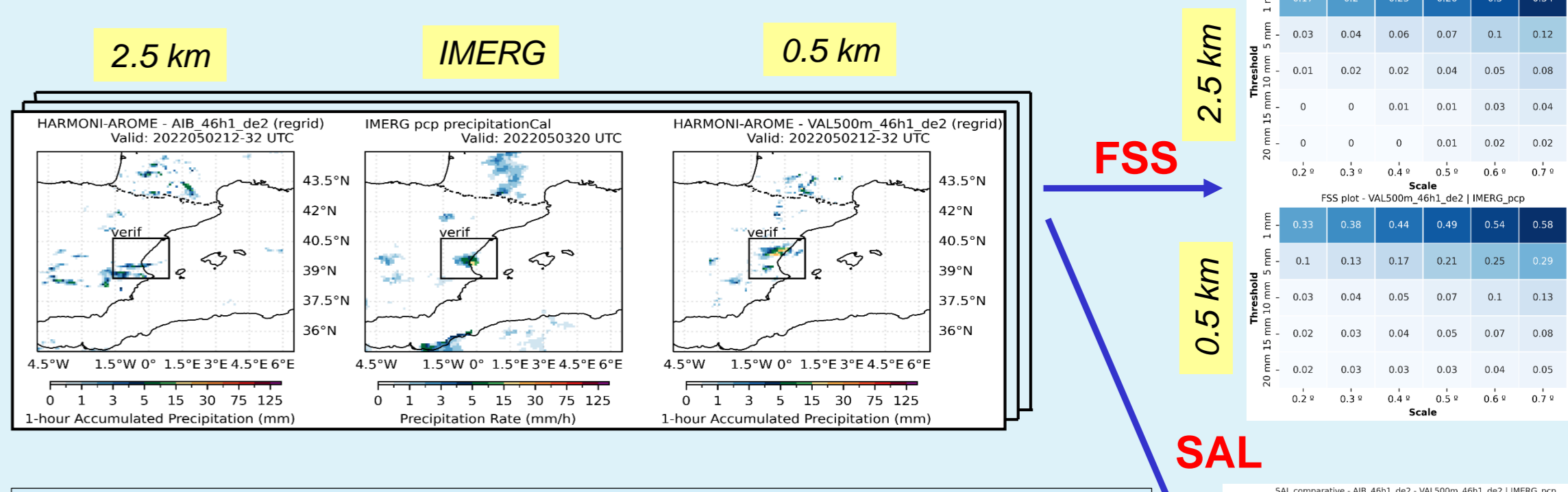
Simulated IR satellite image on the 2nd of January, 2021: cy43h21 (left), cy46h1(middle), Meteosat image (right)

	Winter	Autumn
MSLP		Δ
T 2m	▼	
10m wind	Δ	
10m gust	Δ	
Td 2m	▼	
Precipitation	Δ	

Spatial Verification

Using Spatial Verification to evaluate Very High Resolution forecasts

- Work done in the context of Destination Earth project
- Python based software
- Input data: IMERG sat precip. data, MSG SEVIRI IR data and OPERA data.
- Prepared for FSS and SAL statistics



- Spatial verification is able to show the added value of the 500 m 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

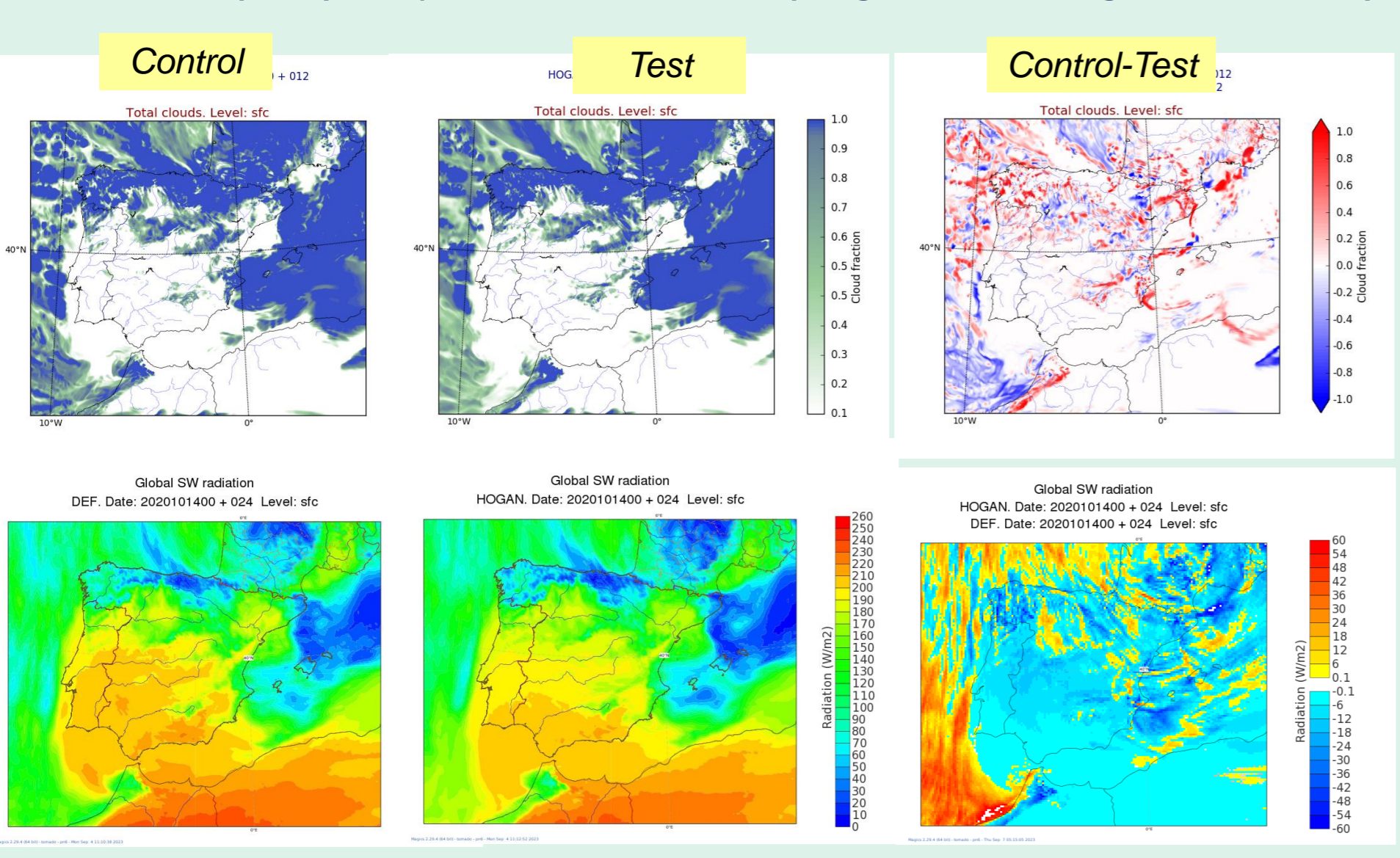
Additional info in González-Aleman's presentation

Cloud Overlap tests

Cloud overlap tests

- NOVLP=6 (control) maximum-random (Geleyn and Hollingsworth, 1979)
- NOVLP=4 (test): exponential-random (Hogan and Illingworth, 2001)

Cloud overlap function depends on the parameter NOVLP in NAERAD (lwc.F90)



Cloud overlap assumption within the vertical column has a strong impact on radiation what in practice makes it difficult to change it in the model

Cloud cover (upper panels) and 24 hr global radiation for 2020101400

Highlights

- 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. The early delivery is able to compensate the fewer obs entering the analysis. Main issue is that in general forecasts are very close to the deterministic operational ones.
- Aemet is ready to use OPERA NIMBUS data operationally
- Using emissivities allows to use SEVIRI data over land has a slightly positive impact assimilating water vapor channels. It will be implemented operationally
- Multi-model EPS (γSREPS). EFI and SOT for rain, snow, gusts, Tmax and Tmin included.
- Cy46h1 produces neutral impact and is ready to be used operationally. A big domain including Iberian peninsula and Canary Islands is planned to be run.
- Single Precision seems to work well in cy46h1 forecasts and will be used in operations
- Spatial Verification is being tested using different data sources. It seems it has potential to compare forecasts of different resolutions and show if high resolution simulations are able to improve coarse resolution runs. The drawback is that it needs supervision specially if SAL statistics are used.

Other activities

- Initialization and Impact Studies on Sub-Hourly Assimilation of Wind Radar Data in Harmonie-Arome. See Geijo's poster and Geijo (2023)³
- Testing a Dry Soil Layer scheme in SURFEX and Harmonie-Arome. See Viana et al. poster

References:

- 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.
- Morales et al. (2024): Evaluation of HARMONIE-AROME cycle 46h1 at AEMET. ACCORD Newsletter, 5
- Geijo (2023): Exploring Sub-Hour DA in HARMONIE-AROME. ACCORD Newsletter, 4

Correspondance address: fcalvos at aemet.es