VICEPRESIDENCIA TERCERA DEL GOBIERNO
MINISTERIO PARA LA TRANSICIÓN ECOLÓGICA Y EL RETO DEMOGRÁFICO
GOBIERNO DE ESPAÑA
Agencia Estatal de Meteorología

Operational Suite

- Operational suite based on HARMONIE-AROME cycle 43h2.1.1 updated [1] on 7th September 2021 to a new HPC cirrus and on 1st December 2022 to assimilate SERVIRI [2] data
- **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, Portu...
- Radar wind assimilated in passive mode.
- Retuned scales in CANARI
- 2 patches for Nature tile and disabling Surface Boundary layer Scheme
- Max Richardsson: XRISHIFT [3]
- Increase roughness increasing heterogeneity of open land patch (FAKETREES)
- Orographic roughness parametrization OROTUR [4] enabled (to alleviate a positive Wind bias which is still too large)

AIB
AIC
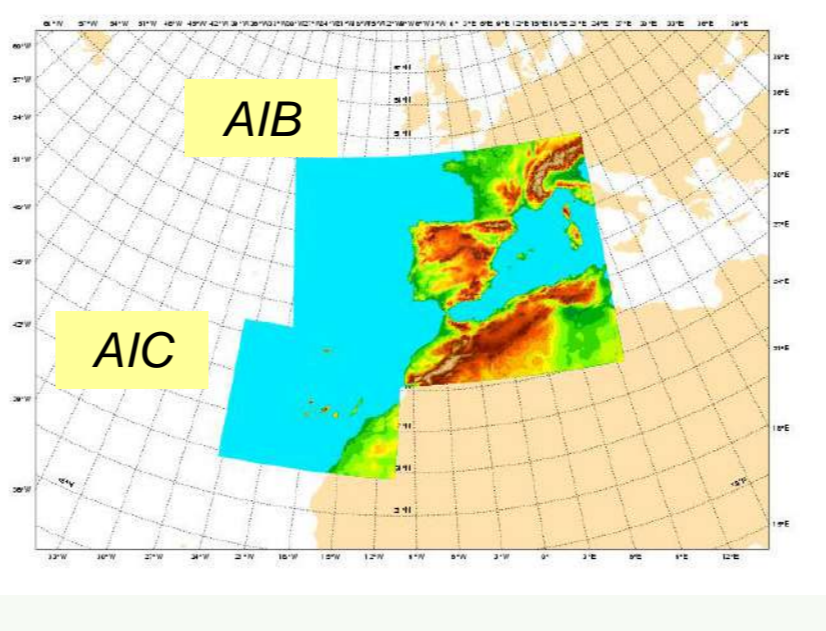
ATOS-Bull High Performance Computer available April 2021 (1st Phase) compose of two identical clusters each with
- 140 compute nodes mounted on Bull Sequana X440 A5 chasis. Each node with
  – 2 AMD EPYC™7742 processors (64 cores)
  – 256 GB DDR4-3200 memory
- The system will be enhanced in 2023 with 48 additional compute nodes

Satellite data used

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	IASI[7]
MSG			SEVIRI

[7] Under testing

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

	IASI channels
CO2 High	38,51,63,85,104,109,167
CO2 Middle	173,180,185,193,199,205,207,212,224,230, 236,239,242,245,249,296,386
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

SEVIRI data assimilation
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Sensitivity studies to assess the impact of SEVIRI DA[2]

- Tests based on Cy43.h.2.1.1 with 3hr cycling for the operational domains (AIB and AIC)
- Several periods with H+24 at 00, 06, 12 and 18 UTC
- SEVIRI radiances, WV6.2, WV7.3 and IR13.4, at all cycles over sea
- VARBC with 24hr cycling and 1 predictor (constant)

SEVIRI

Absolute DFS for various observation types. Nov 2021

Bias and standard deviation of ob-fg (IASI H2O)
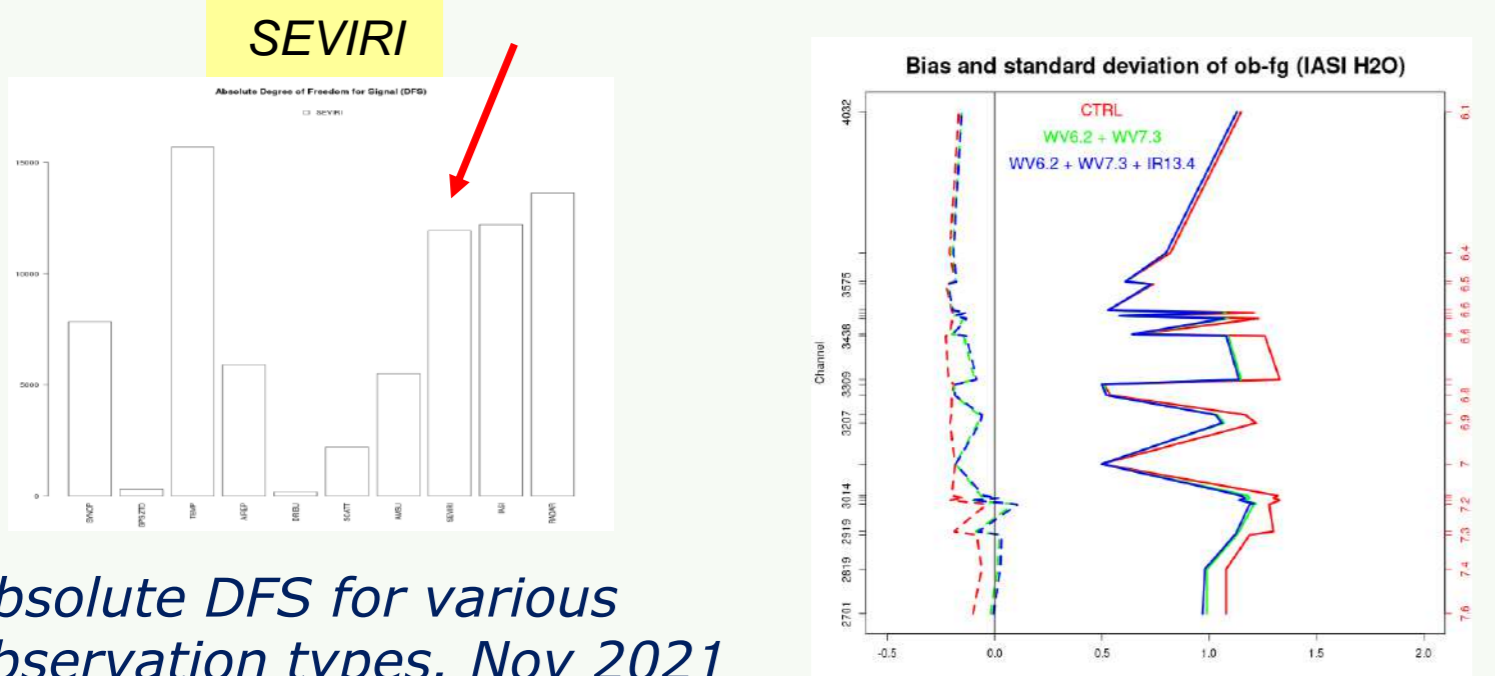
- **Ob-fg** bias and STDV improved not only for SEVIRI assimilated channels, but also for some MHS and IASI (H2O band) channels when SEVIRI radiances are assimilated.
- No impact on AMSUA and IASI (LW-CO2 band).

1) Small positive impact of assimilating clear-sky SEVIRI radiances, specially on RH profiles. Neutral in near surface variables
2) Bias correction is essential in the assimilation. One predictor (the constant offset), seems to be preferable.
3) The inclusion of IR13.4 has no impact. The treatment of this channel, contributing to the lower troposphere and influenced by the surface, is more complex and has not been included in the operational suite.

Nowcasting e-suite
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Nowcasting e-suite

- Real time suite running over the Iberian peninsula and Balearic Islands. The main characteristics are:
  - Harmonie-Arome cycle 43h2.1.1
  - 2.5 km of resolution, IFS nesting
  - 3DVar hourly cycle
    - Cut-off time -1h, +23 min
    - Conventional observations + radar reflectivity + gnss (fast processing)

Aircrafts | Radiosondes | Radar | gnss
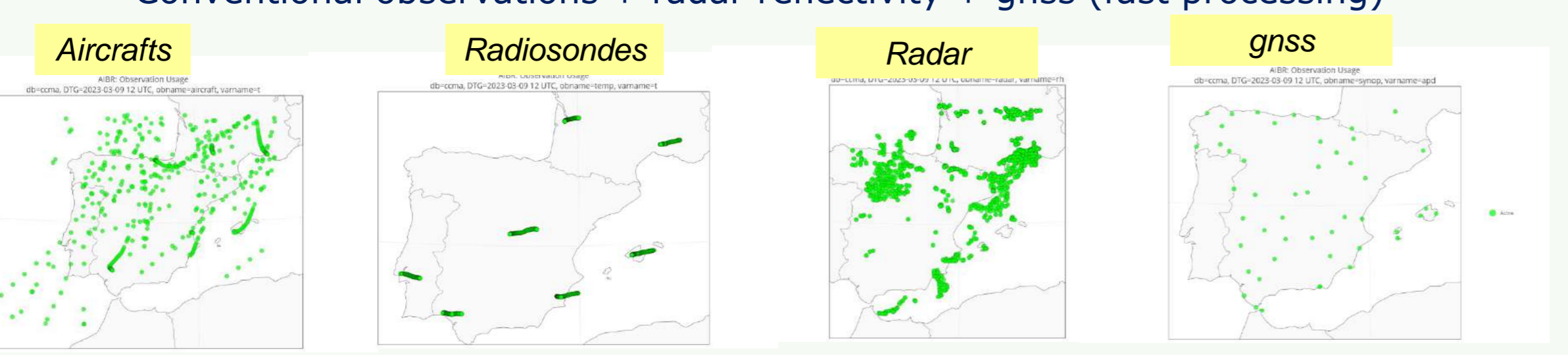
Example of observation use (2023-03-09 at 12 UTC): Better radiosondes and aircraft coverage than expected

Objective verification

MSLP | T2m | V10m | ETS ppt6hr
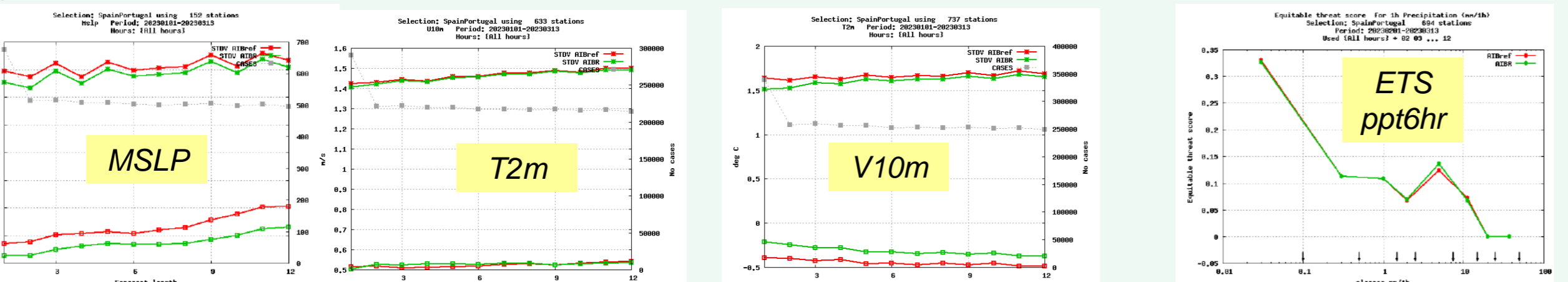
Comparison with operational cycles available at the same time: operational suite and nowcasting suite. Generally an improvement is seen for upper air RH. The lack of observation is compensated by the early delivery

On-going tests

- 2.5 vs 1.25 km: Improvement increasing the resolution
- Use of Mode-S EHS data
- Arome nesting. On-going test about different initial state strategies:
  - Complete independent cycles for the nested runs
  - Use host forecast as First Guess every cycle (to benefit from the additional observations ingested in the host)
  - Use host forecast as First Guess only every 6 hr

Spatial Verification
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Exploration of spatial verification metrics (SAL and FSS) with new observational datasets

Spatial verification is explored to evaluate sub-kilometer resolution simulations

HARM | MSG SEVIRI | SAL | FSS

2.5 km

500 m
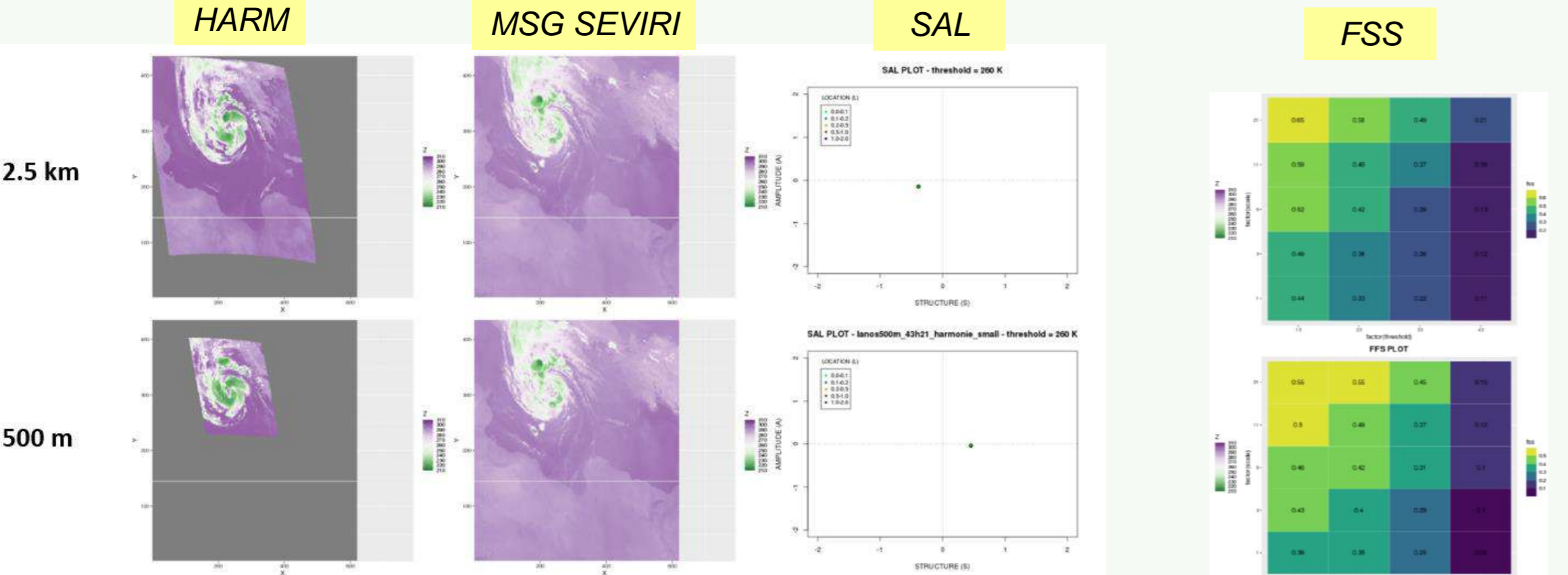
Comparison of simulated and observed IR 10,8 Brightness Temperature for Medicane Ianos. Note that HARMONIE-AROME BT are based on gl[6] (not using a radiative model). From these images SAL and FSS scores for different scales and thresholds are computed

E-suite Unified domain

Towards a unified domain (AIB+AIC)

- E-suite under test based on cy43.h.2.2.1 (updated version) aiming a big operational domain (1296x1152) including current operational domains for Iberian peninsula and Canary Islands
- It allows an increase of data for assimilation, specially from satellite
- It will facilitate management of operational workflow

T2m | V10m | ETS ppt6hr
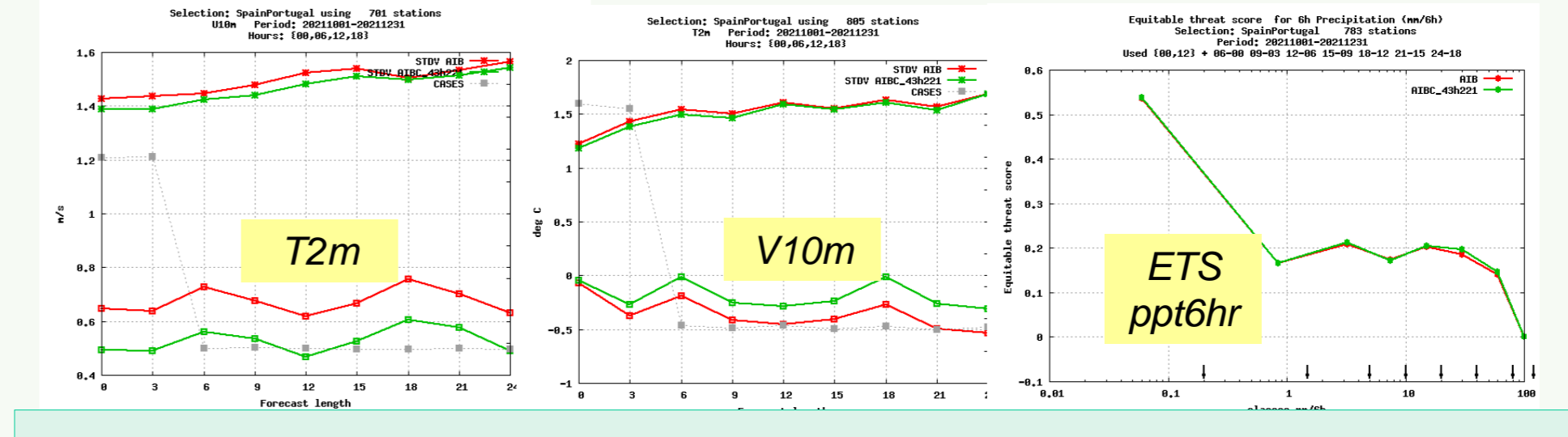
Objective verification for Iberian peninsula and Balearic Islands for the period Oct-Dec 2021 (upper plots) and Apr-May 2022 (lower plots): AIB operational domain and AIBC_43h221 unified domain. STDV and Bias function of forecast length and 6hr precipitation ETS for different categories. And overall improvement is seen. The improvement is also seen for the Canary Islands

T2m | V10m | ETS ppt6hr
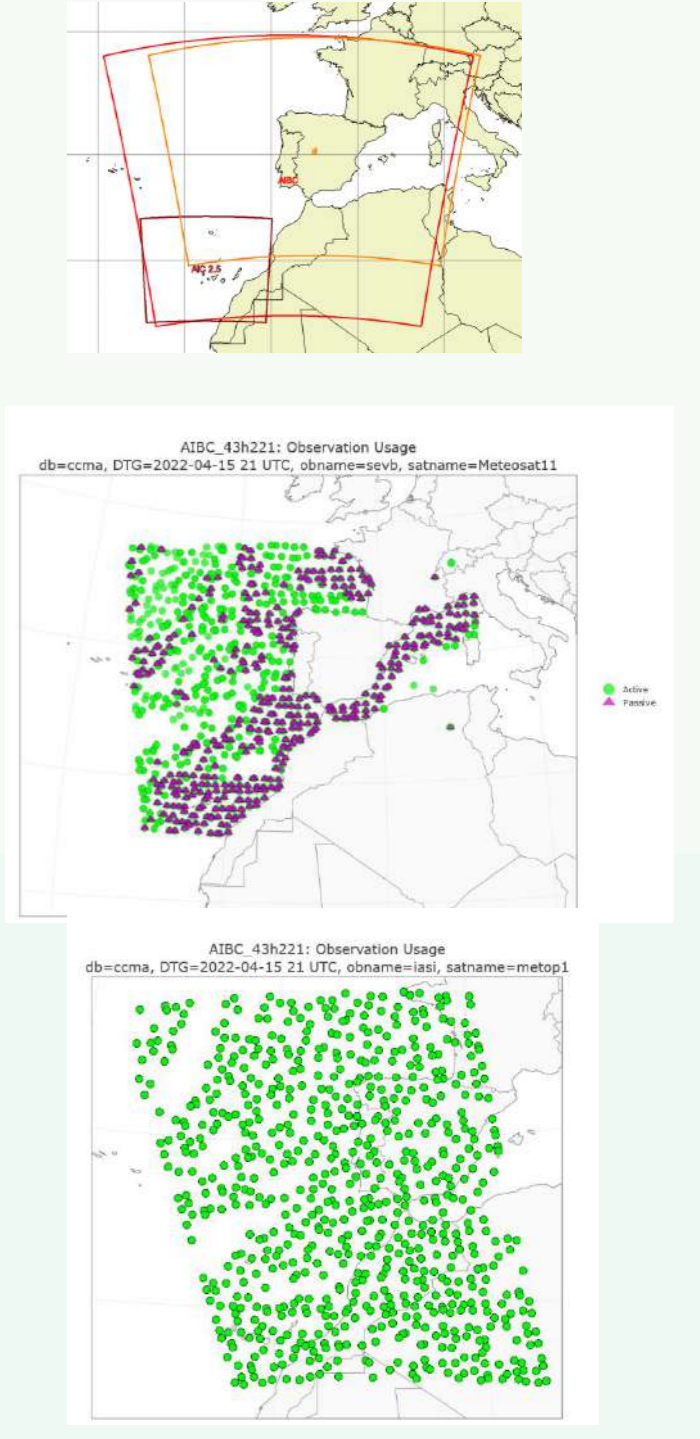
Example of observation use for 15 april 2022 at 21 UTC: SEVIRI (upper plot) and AMSUA (lower plot)

Simulated satellite images
mmartinez@

Simulated satellite images

MSG-4 | ECMWF | HARMONIE-AROME
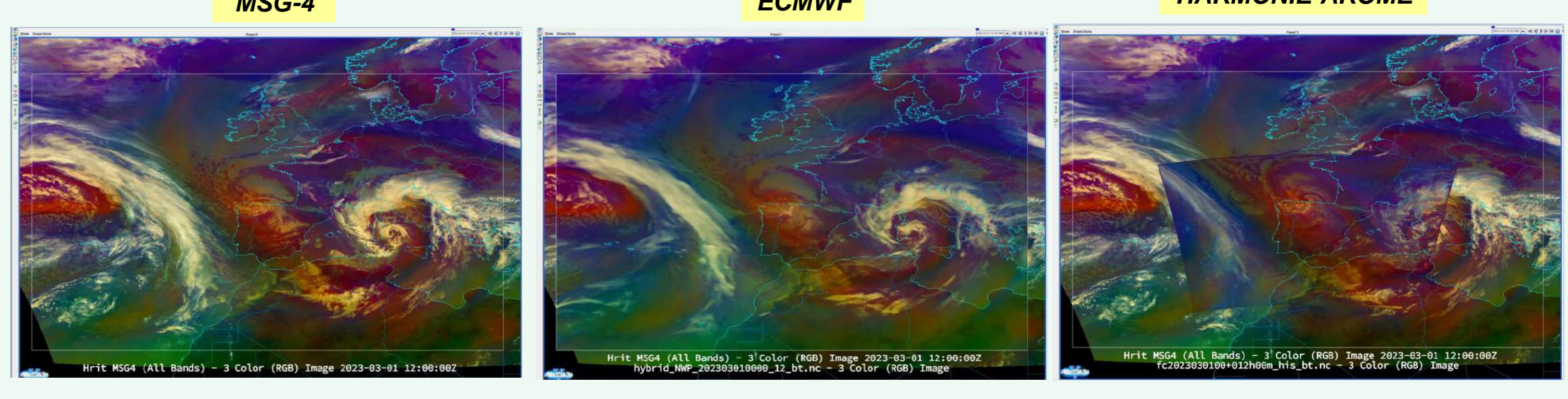
Simulated Satellite Images (RGB composite) valid 01/03/2023 at 12 UTC: MSG-4 (left), ECMWF (center) and HARMONIE-AROME (right, smaller domain). Model images are shown on top of MSG-4 images. *It seems HARMONIE-AROME has a deficit in cloud ice*

In the framework of NWC SAF project, *AEMET PGE00* software[5]* is being adapted for generation of realistic synthetic satellite data from operational NWP models using RTTOV-13.0. The Airmass RGB is composed from data from a combination of the SEVIRI WV6.2, WV7.3, IR9.7 and IR10.8 channels. This is a powerful tool for NWP validation and monitoring and will be run routinely at AEMET.

Roughness Sublayer Validation

Validation of RSL scheme in SURFEX OFFLINE forced with ICOS stations and in coupled mode (CY46h1)
(svianaj at aemet.es metodija.shapkalijevski at smhi.se)

- RSL OFFLINE runs with standard ISBA (FR) and ISBA-DIF+MEB (MEB) systematically improve H and U*, with frequent benefits also for LE, when compared to the reference runs (REF).

Bilos, UTC | Svartberget, UTC | Hyltemossa, UTC
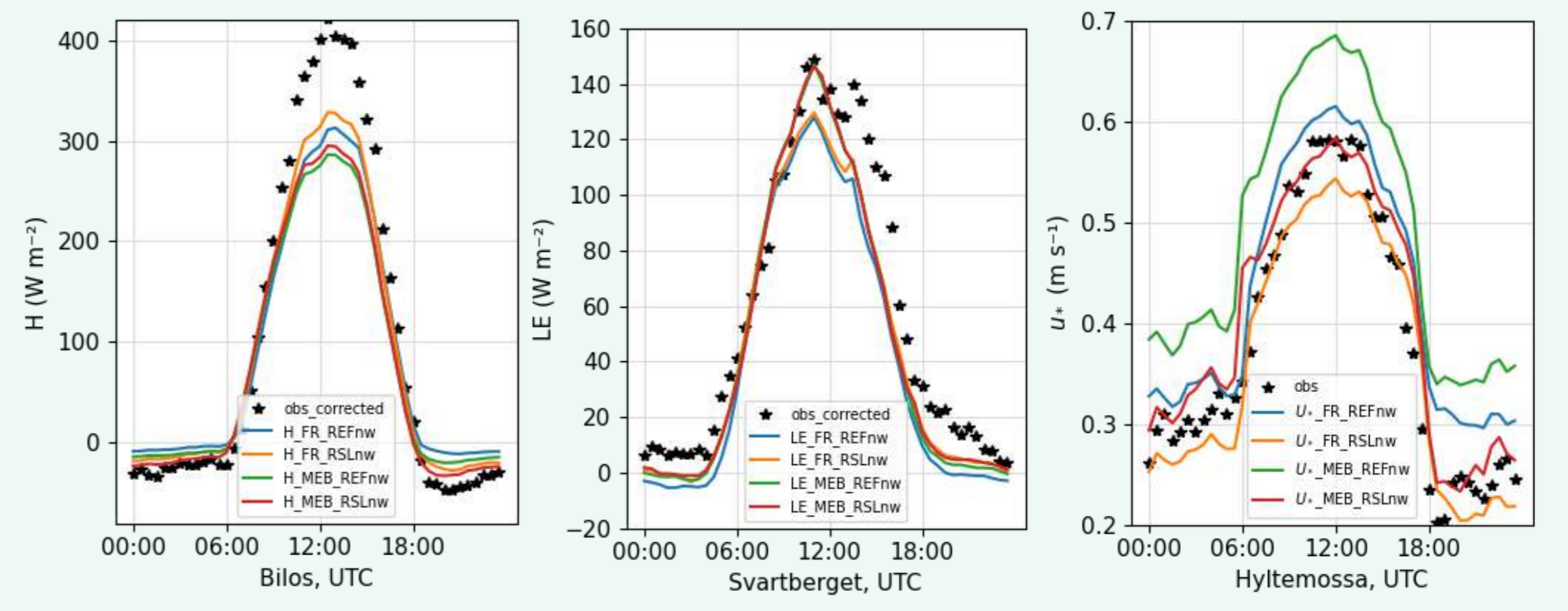
- RSL diagnostic equations produce a clear improvement in wind diagnostic over forests.
- Temperature diagnostic doesn't show systematic improvement and is mainly restricted to nighttime.
- The improvements are not fully translated into the coupled 3D runs (bottom right), mainly due to differences in the sfc-atm coupling (under investigation).

Bilos, UTC | Hyltemossa, UTC | Hyltemossa_3d, UTC
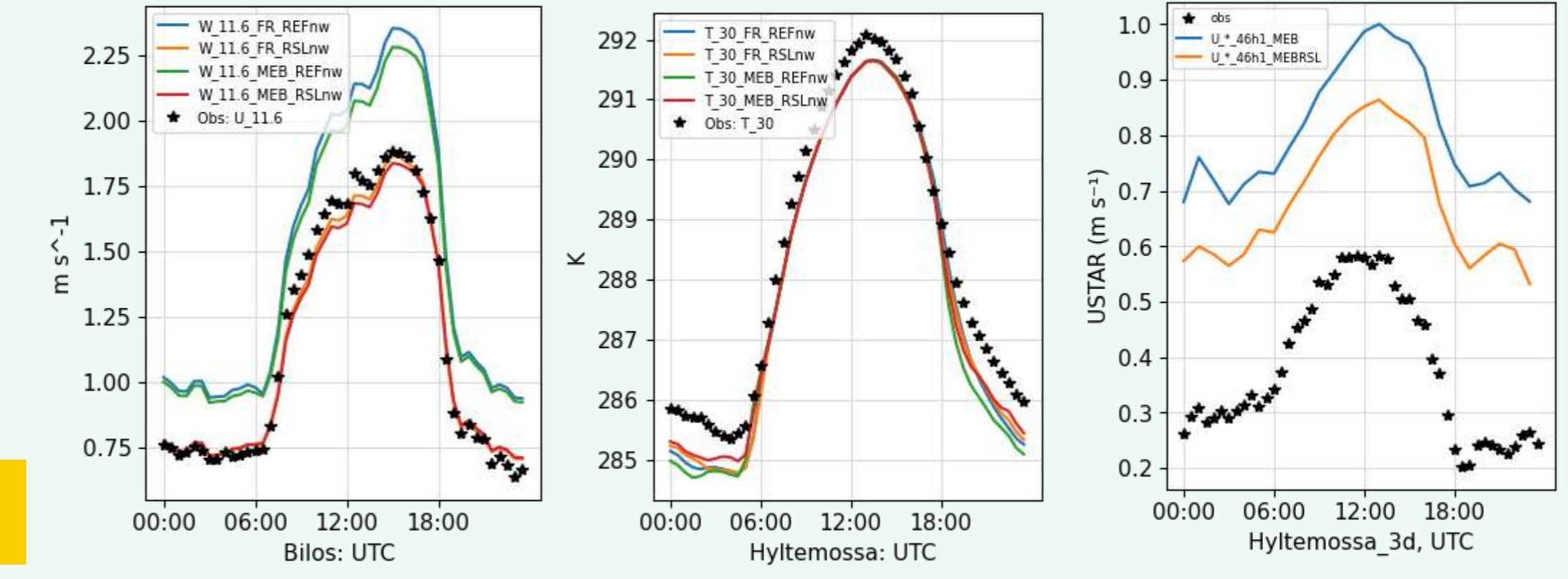
Highlights

➢ Operational DA of SEVIRI data
  - After a careful tuning and data selection, channels WV6.2 and WV7.3 are assimilated operationally. Other channels as IR13.4 may be added latter. Overall a slightly positive impact is found.
➢ Towards a unified domain for Iberian peninsula and Canary Islands
  - New structure functions have been computed and GNSS and satellite data have been calibrated for the new domain
  - It will increase the amount of data entering the DA and facilitate the operational management
  - It improves the results (a version update is also included)
➢ Nowcasting e-suite running in real time
  - H+12 runs every hour with 23 min cutoff time
  - Using conventional obs, radar reflectivity and fast processing GNSS. More obs available than expected
  - The early delivery is able to compensate the fewer obs entering the analysis
➢ Simulated satellite images
  - Different satellite channels can be simulated using RTTOV-13.0
  - Realistic synthetic images are produced in real time
  - Powerful tool for model evaluation and monitoring. An ice cloud deficit has been identified in operational HARMONIE-AROME
  - It is expected to use them for objective spatial verification

References:
[1] Calvo et al. (2021): Evaluation of HARMONIE-AROME cycle 43h2.1 at AEMET. ACCORD Newsletter, 2
[2] Campins et al. (2022): Assimilation of clear-sky SEVIRI radiances in AEMET HARMONIE-AROME model. ACCORD Newsletter, 3
[3] Homleid, M. (2022). Improving model performance in stable situations by using a pragmatic shift in the drag calculations - XRISHIFT . ACCORD Newsletter, 2.
[4] Rontu, L. (2006): A study on parametrization of orography-related momentum fluxes in a synoptic-scale NWP model. Tellus A: Dynamic Meteorology and Oceanography
[5] Martinez M. A. (2022). Update on MTG era preparation. Convection Working Group Workshop hybrid Budapest+online 2022-05-16 to 2022-05-20. Link to PowerPoint pptx file in NWCSAF web page.
[6] Tijm, S. (2004). Hirlam pseudo satellite images. HIRLAM newsletter, 46, 59-64.

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