

Radiance assimilation in AEMET Harmonie-AROME model operational run

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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

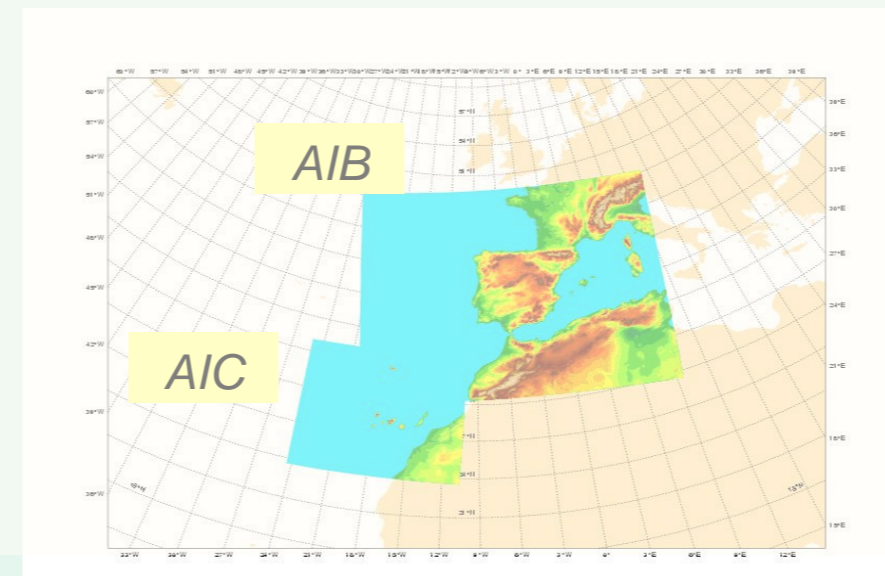
- **2.5 km** runs 4 times per day with a forecast length of 72 hours for **2 geographical domains** (Iberian Peninsula and Canary Islands).
- **3DVar analysis with 3hr cycle** incl. AMDAR humidity observations, radar reflectivities, ATOVS(AMSUA and AMSUB/MHS instruments), GNSS ZTD, ASCAT wind, IASI and SEVIRI obs.
- IFS humidity in the blending process (LSMIX). Assimilation of T2m and rh2m in 3Dvar

Operational AIB domain: OPERATIONAL / RESEACH / PRE- OPERATIONAL

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

Satellite	00	03	06	09	12	15	18	21
NOAA-18	P			P	P			
NOAA-19				P				P
METOP-B				D	D			
METOP-C				D	D			
MSG		D	D	D	D	D	D	D

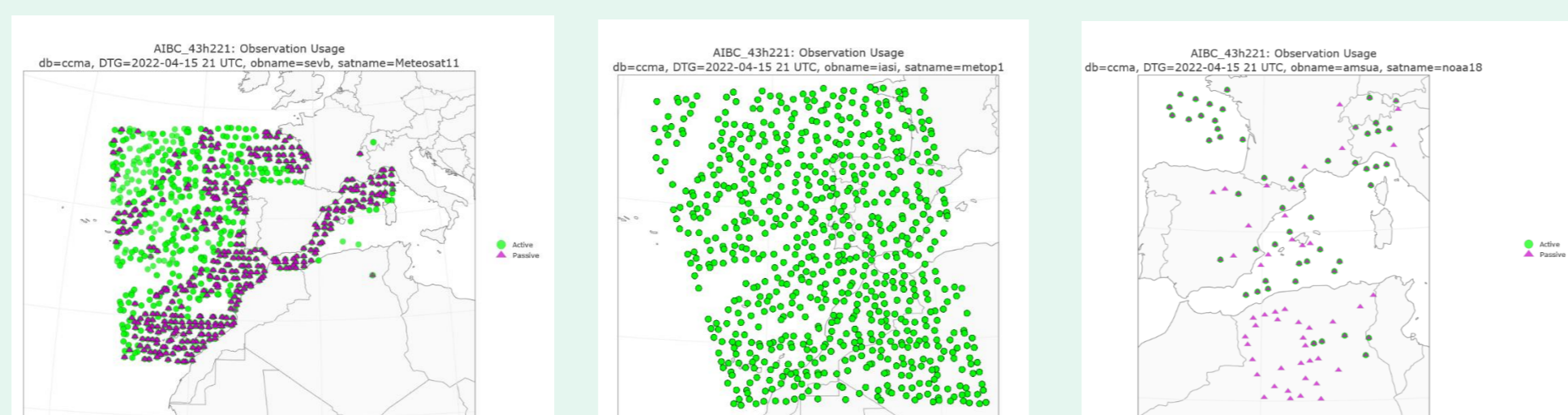
AMSUA: 6, 7, 8, 9, MHS: 3, 4, 5, SEVIRI: WV6.2 and WV7.3, IASI (table below)



- SAPP preprocessing for conventional observations
- Radar reflectivity using OPERA from BALTRAD 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 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)

PARALELL Big domain AIBC covering Iberian Peninsula+Balearic Islands+ Canary islands

Example of the Coverage of assimilated observations, 15 April 2022: Seviri (meteosat11), IASI(metop1) and amsua(noaa19) at 21h over big AIBC domain.



ATOS-Bull HPC System

ATOS-Bull High Performance Computer available from 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
 - It increases the computer capacity at least 8 times. The system will be enhanced in 2023 with 48 additional compute nodes

Improved cloud detection for IASI-METOP-B & METOP-C by the use of the IR cloud detection monitoring tool

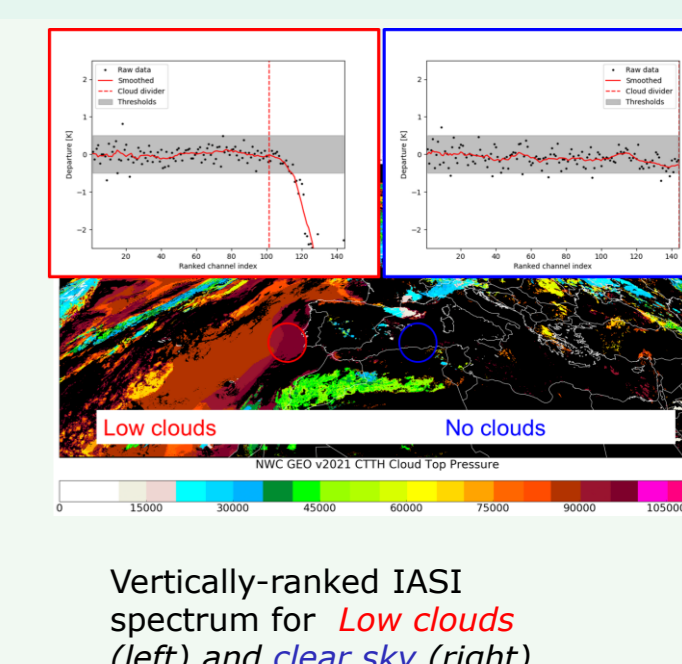
Campins, J. and Navascues, B. (2021): Assimilation of IASI radiances in AEMET operational suite. ALADIN-HIRLAM Newsletter, 16.

Assimilation of clear-sky IASI radiances operational since 15th December 2020.

Current setup: Only Metop-B, IASI: 55 channels (30 in Band=1 CO2 and 25 in Band=3 H2O), Active assimilation all except 85, 333, 352, 432.

New Goal: use the Cloud Detection Monitoring Tool (R. Eresmaa, FMI) to diagnose the performance of the cloud detection scheme for IASI radiances in AEMET and the addition of Metop-C.

IASI channels	
CO2 High	38,51,63,85,104,109,167
CO2 Middle	173,180,185,193,199,205,207,212,224,230,236,2
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



Vertically-ranked IASI spectrum for Low clouds (left) and clear sky (right)

New tests HARMONIE-AROME cycle 43h2.1.1

New set-up for Metop-B & C
138 channels for CO2 band and 25 for H2O band.
Active: 28 and 25 for CO2 and H2O respectively.

AIB_43h211_IASI (CONTROL)

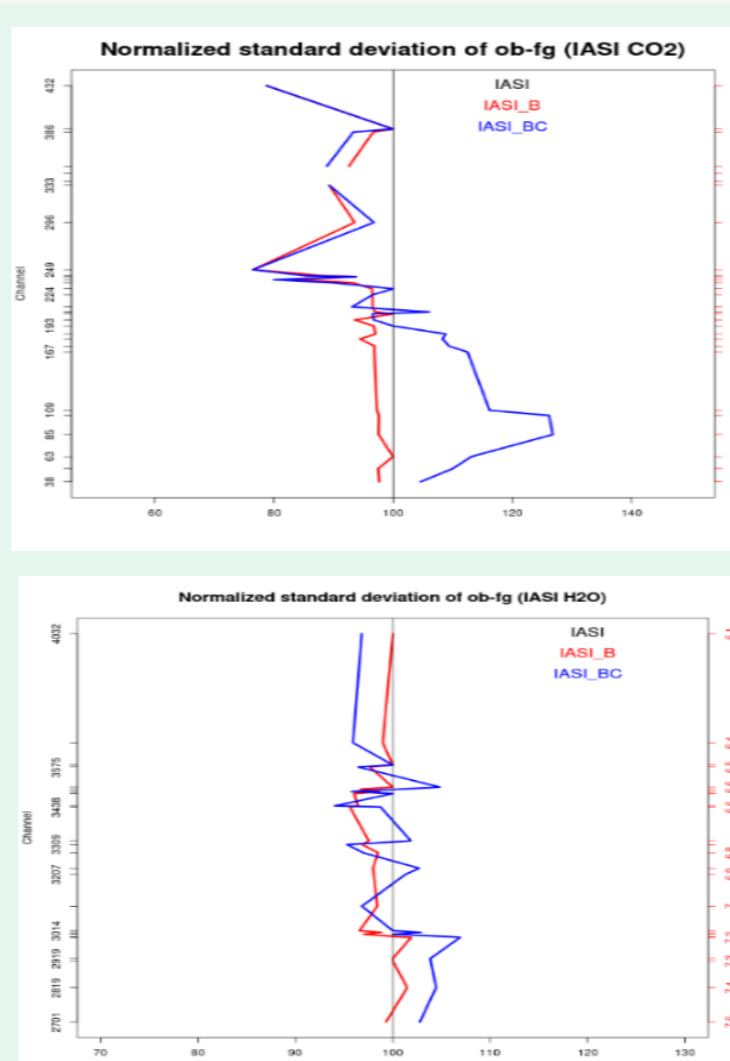
Metop-B; Operational set-up for IASI.

AIB_43h211_IASI_B

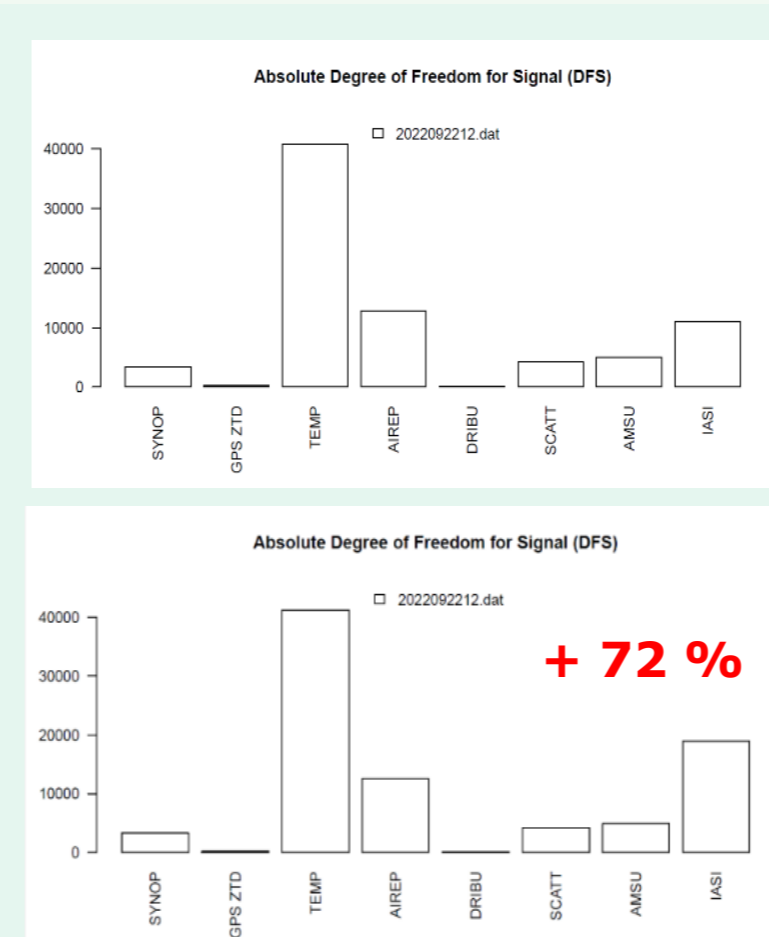
Metop-B ; New set-up for IASI.

AIB_43h211_IASI_BC

Metop-B + Metop-C; New set-up for IASI.



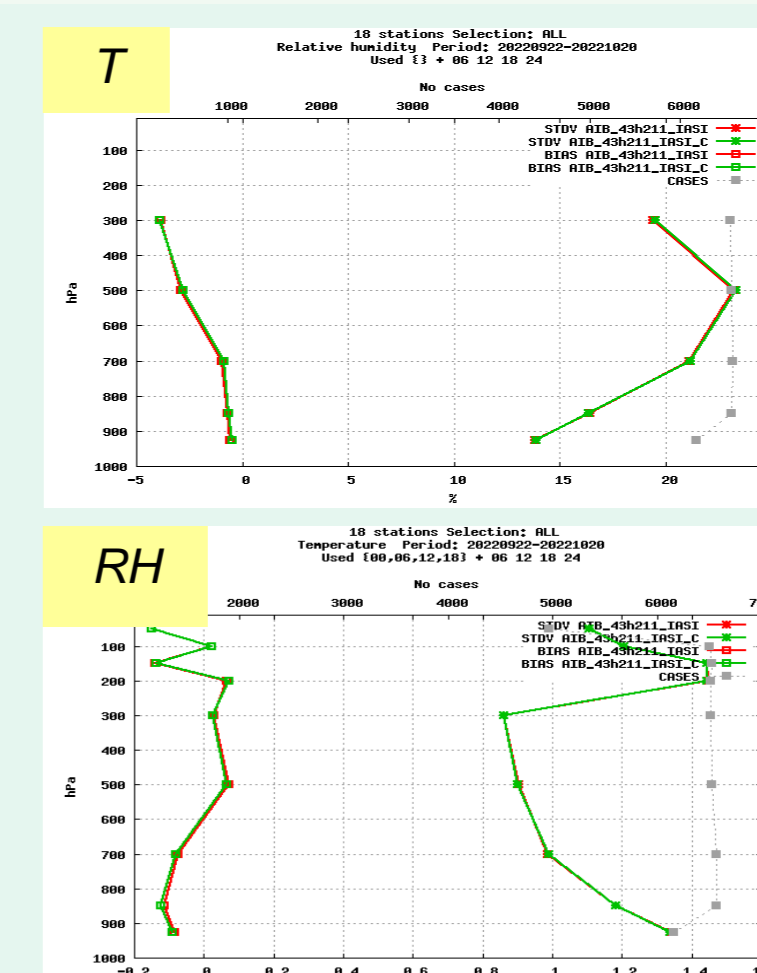
Normalized o-b vertical profiles of IASI, METOPB and both METOPB&C for CO2 and H2O.



Impact on the analysis

Positive impact when MetopB and neutral impact adding MetopC

DFS plot show how IASI obs impact is 72% higher in the analysis CONTROL vs MetopB&C.



Impact on the forecast

Neutral impact for surface and upper level parameters.

Conclusions after all the experiments.

Better distribution of channels with the new set up. But although some positive impact in the analysis can be seen, a neutral impact in forecast has been found. More investigations and some tuning is needed.

Assimilation of clear sky SEVIRI radiances in Harmonie-AROME

Campins, J., Díez, M., Jiménez, A. Navascues, B. (2022): Assimilation of clear-sky SEVIRI radiances in AEMET HARMONIE-AROME model. ACCORD Newsletter, 2

Assimilation of clear-sky SEVIRI radiances operational since 15th December 2022.

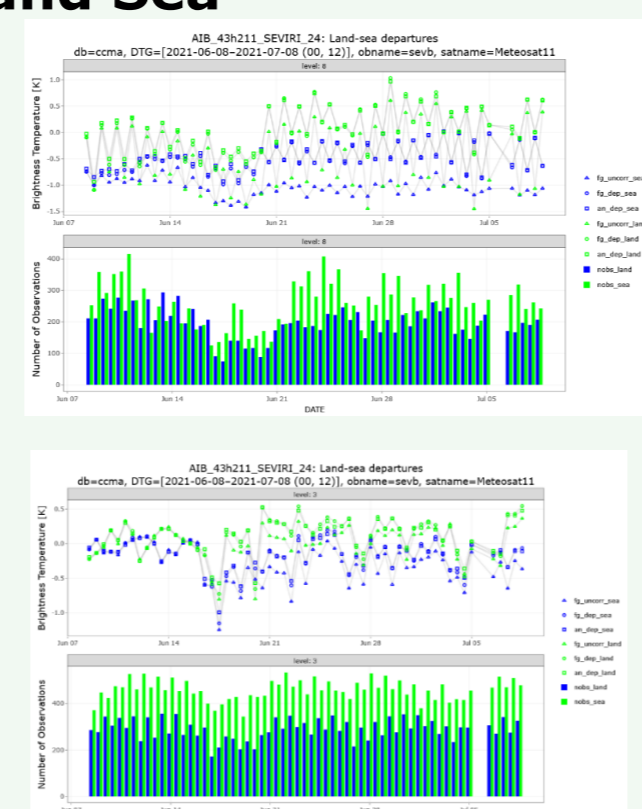
Current setup: MSG (meteosat-11), 8 IR and 4 VIS channels (IR 3.9,WV6.2, IR8.7, IR9.7, IR10.8, IR12.0, IR13.4) , Spatial resolution 3 km

Preprocessing: 1 pixel of 5, Clear-sky radiances, Cloud detection based on cloud-mask and cloud-top from NWC SAF.

Initial tests with default configuration

Harmonie-AROME Cy 43h211, Spatial thinning ~ 65 km, **Land and Sea**

- VarBC: NBG = 5000, 5 predictors, 24 h cycling
- Cold-start, passive
- Channels: WV6.2, WV7.3 and IR13.4
- AIB and AIC domains



Impact of Initial Tests:

- Different bias correction over sea and land (see figures).
- Objective verification showed a detrimental impact .
- So, necessary blacklisting the data over land.

Conclusions after all the experiments

- 1) The impact of assimilating clear-sky SEVIRI radiances was positive on the analyses and the forecasts in any all those experiments that assimilated SEVIRI radiances (compared to CONTROL).
- 2) As bias correction is an essential task in the assimilation, the simplest choice, that is one predictor (the constant offset), seems to be preferable.
- 3) The inclusion of IR13.4 has no impact on the analyses and the forecasts. Besides, this channel has an important contribution from the surface and low troposphere, which may not be accurately enough described by the forecast model, and again the conservative choice seems the best option.

New tests HARMONIE-AROME cycle 43h2.1.1

No land obs, NBG=2000

SEVIRI_WV_1p: 1 predictor; WV6.2 and WV7.3

SEVIRI_WV_5p: 5 predictors; WV6.2 and WV7.3

SEVIRI_WV_IR_1p: 1 predictor; WV6.2, WV7.3 and IR13.4

CONTROL: no SEVIRI

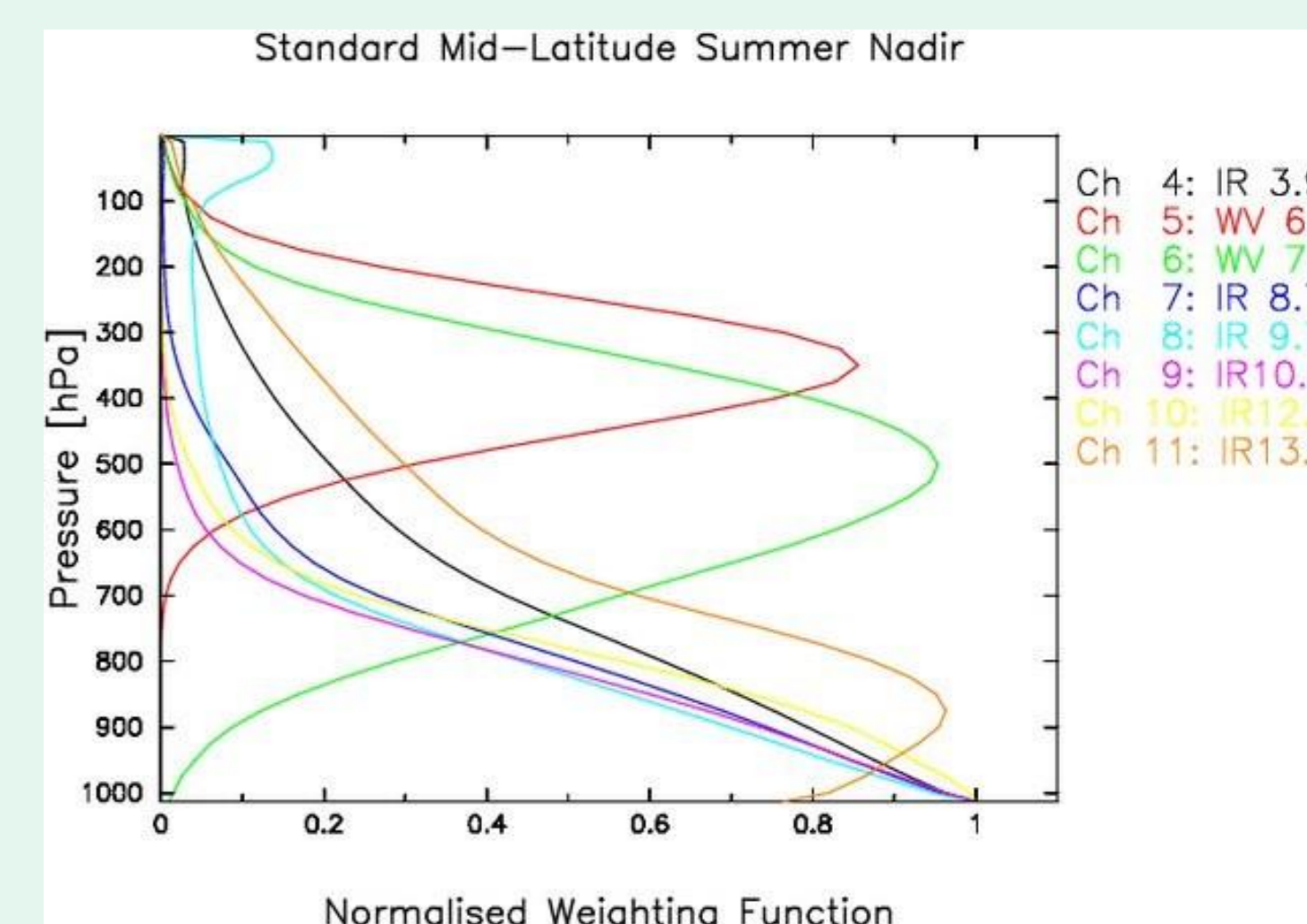
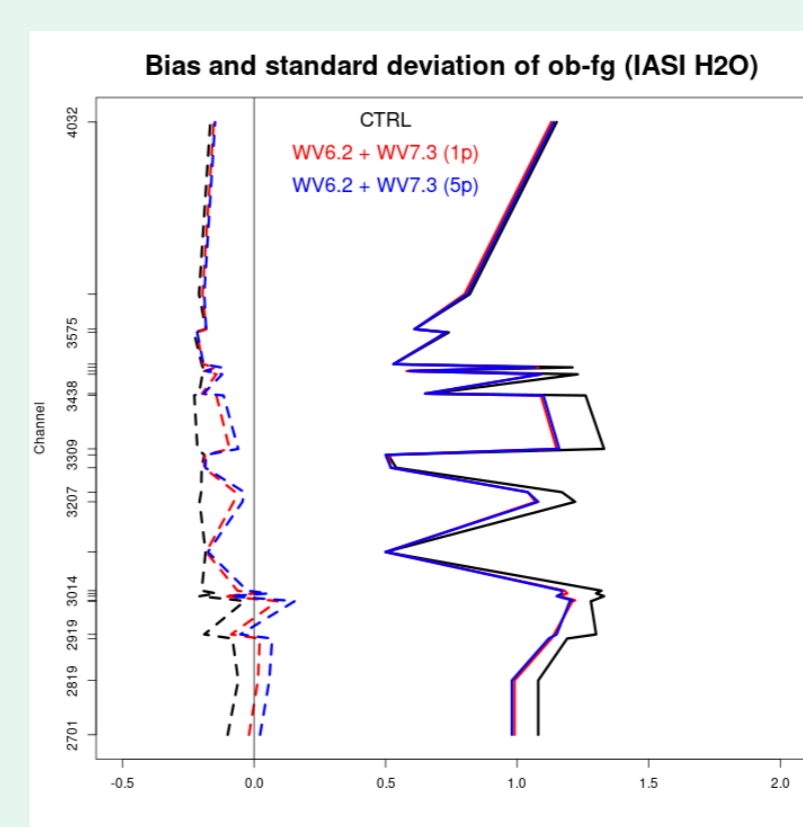
Two domains AIB and AIC

Two study periods: dry season (Summer) and rainy period (November for AIB and February/March for AIC)

Impact of new tests on the analysis

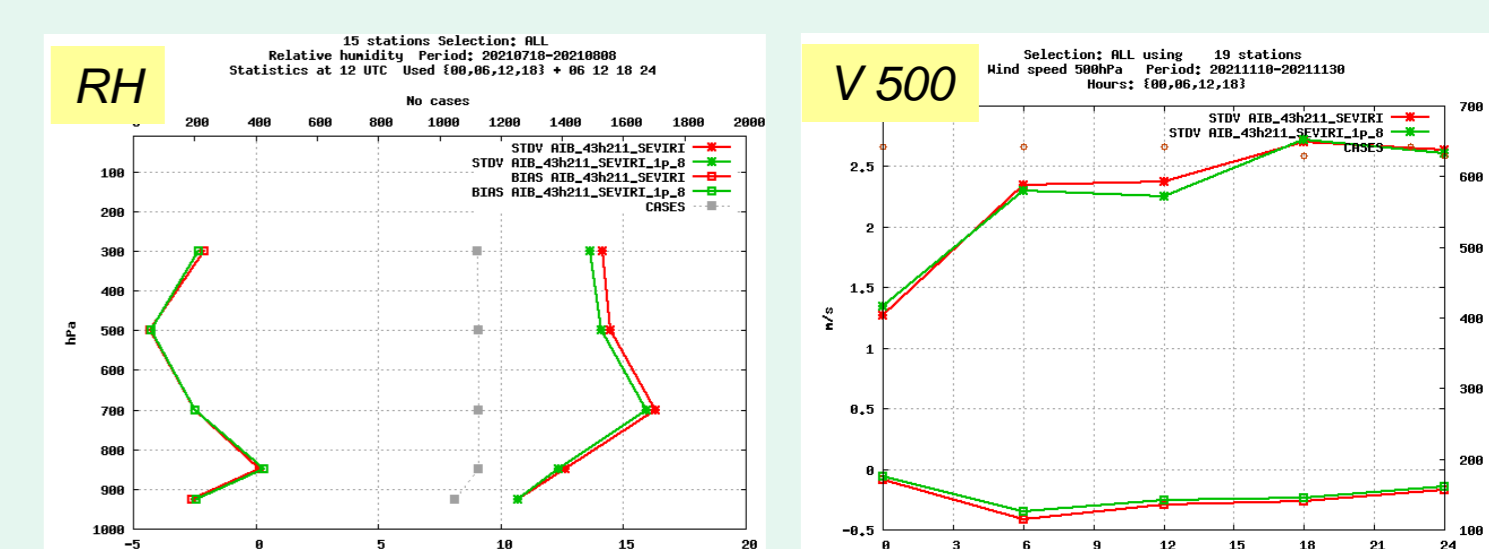
Bias and standard deviation of first guess departures for other observations (as for MHS and IASI humidity channels) were improved when SEVIRI radiances were assimilated.

Same improvement for 1 and 5 VarBC predictors.



Impact of new tests on the forecast

Neutral for surface and upper level parameters, except a slight positive impact on mid-level relative humidity and wind speed in both domains.



Bias and standard deviation of: vertical profile of RH forecasts at 12 UTC (left panel) and wind speed at 500 hPa along forecast length (right panel) for CTRL and SEVIRI.

Currently SEVIRI observations are being assimilated actively in AeMet HARMONIE-AROME cycle 43h2.1.1 :

The set-up used for SEVIRI_WV_1p, based on a single VarBC predictor for SEVIRI radiances and that only assimilates data from WV6.2 and WV7.3 channels over sea, is actually running in the operational AEMET HARMONIE-AROME model for both domains.

Future work

Future work to be implemented in the operational suite based on HARMONIE-AROME in AEMET:

- Assimilation of Microwave radiances from Polar NOAA satellites with ATMS instrument.
- Assimilation of Microwave radiances from Polar Feng-Yun-3 with MWTS-II y MWHS-II instruments.
- Assimilation of CrIS radiances from NOAA satellites.
- Assimilation of low peaking channels from microwave and infrared.
- Assimilation of WV channels from MTG-I.
- Assimilation of IRS of MTG-S.

OPERATIONAL SUITE HARMONIE-AROME

IASI data assimilation

SEVIRI data assimilation