ACCORD

A Consortium for COnvection-scale modelling Research and Development

HIRLAM High Resolution Limited Area Model

Progress in HARMONIE-AROME satellite data assimilation

Roohollah Azad, Fabrizio Baordo, Joan Campins, Per Dahlgren, **María Díez**, Reima Eresmaa, Stéphanie Guedj, Magnus Lindskog, Swapan Mallick,Isabel Monteiro, David Schönach, Eoin Whelan

5th ACCORD All Staff Workshop
31 March - 4 April 2025, Zalakaros and hybrid

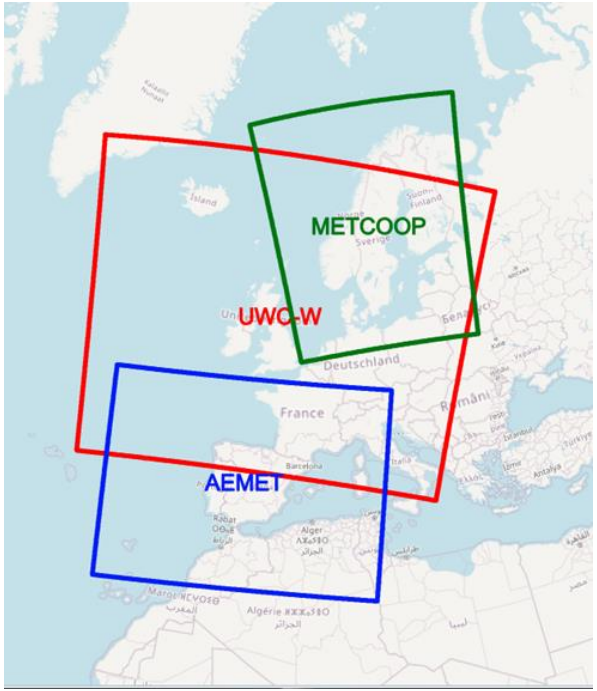
GOBIERNO DE ESPAÑA
VICEPRESIDENCIA TERCERA DEL GOBIERNO
MINISTERIO PARA LA TRANSICIÓN ECOLÓGICA Y EL RETO DEMOGRÁFICO
AEMet Agencia Estatal de Meteorología

Outline

- Introduction
- Review of satellite usage
- Improved use of existing instruments/satellites
- Newly introduced instruments/satellites
- Preparation for data from new missions
- Summary and conclusions

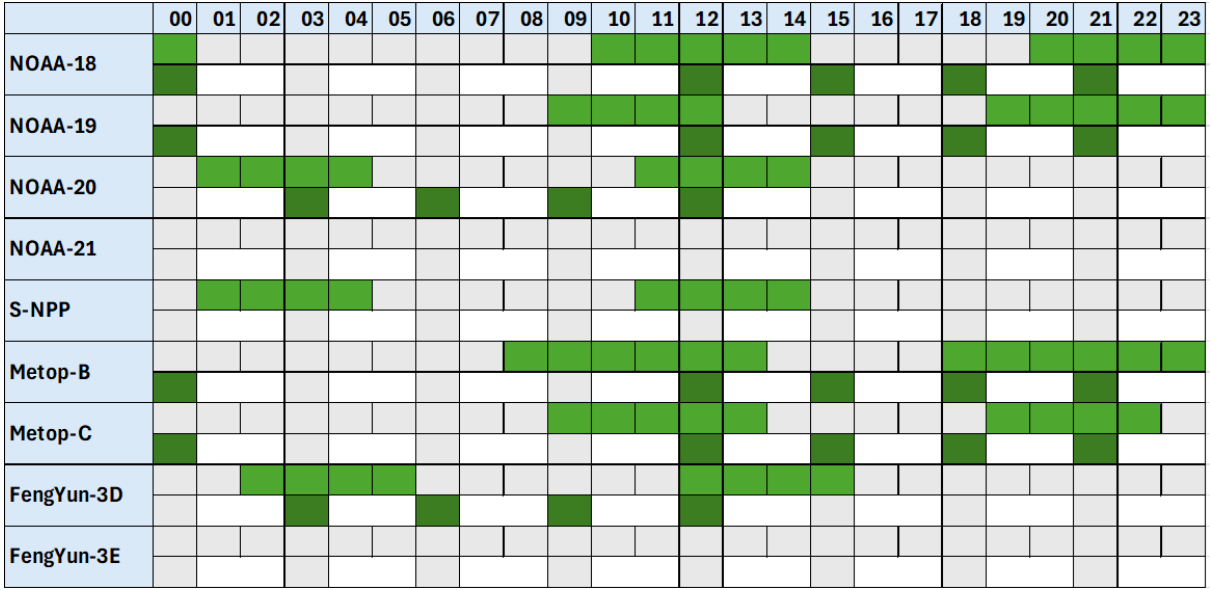
Introduction

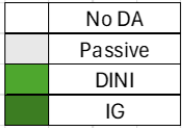
- The Hirlam countries organize their operations in three Unifed Weather Centers.
- All of the centers are using satellite observations in their operational suites.
- The topic of this presentation is review the usage of the different satellites and sensors and show ongoing work.

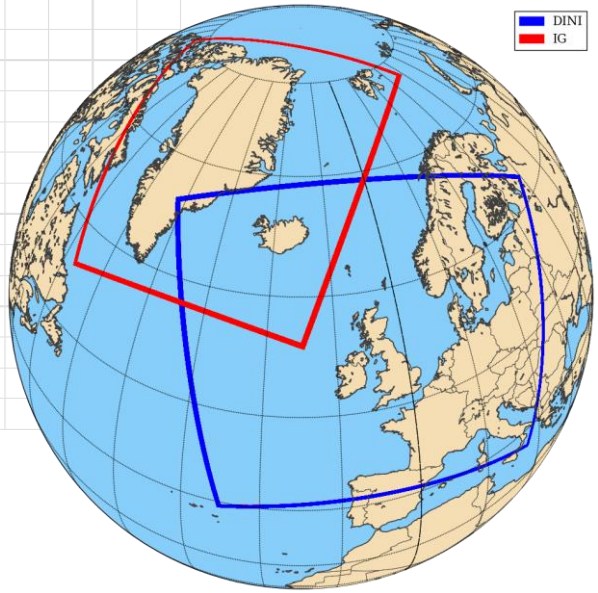


Thanks to Jana Sánchez

Satellite usage at UWC West







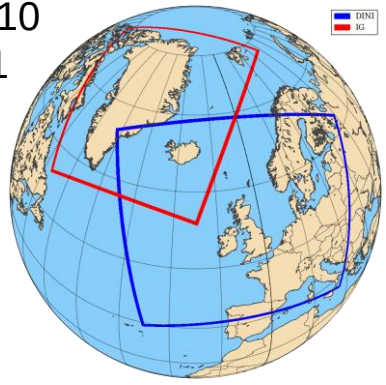
- NOAA-21 and FY-3E still passive
- Satellite usage controlled by blacklist only

Isabel Monteiro & Eoin Whelan

ACCORD
A Consortium for COnvection-scale modelling Research and Development

Satellite usage at UWC West

- Satellite usage controlled by blacklist only for two domains
- Make use of ODB entry to “flag” domain
- NDOMAIN (Bator) → datastream@satbody (ODB)
- DATASTREAM used in blacklisting
  - domdini=10
  - domig=11




```
        ! Monitor upper stratosphere channels
        if PRESS in (15) then fail(EXPERIMENTAL); endif;

        if (DATASTREAM = domdini) then
          if SATELLITE_IDENTIFIER in (225) then
            if (NANTIM/10000) notin(1,2,3,4,11,12,13,14)  then fail (EXPERIMENTAL);endif;
          endif;
          if SATELLITE_IDENTIFIER in (224) then
            if (NANTIM/10000) notin(1,2,3,4,11,12,13,14)  then fail (EXPERIMENTAL);endif;
          endif;
        elif (DATASTREAM = domig) then
          if SATELLITE_IDENTIFIER in (225) then
            if (NANTIM/10000) notin(3, 6, 9, 12)  then fail (EXPERIMENTAL);endif;
          endif;
          if SATELLITE_IDENTIFIER in (224) then
            if (NANTIM/10000) notin(3, 6, 15)  then fail (EXPERIMENTAL);endif;
          endif;
        else
          fail (EXPERIMENTAL);
        endif;
!
! NOAA-21  (226) >> monitor
!
        if SATELLITE_IDENTIFIER in (226) then fail (EXPERIMENTAL);endif;

      endif;  ! SENSOR = ATMS
```

Updated satellite usage at MetCoOp

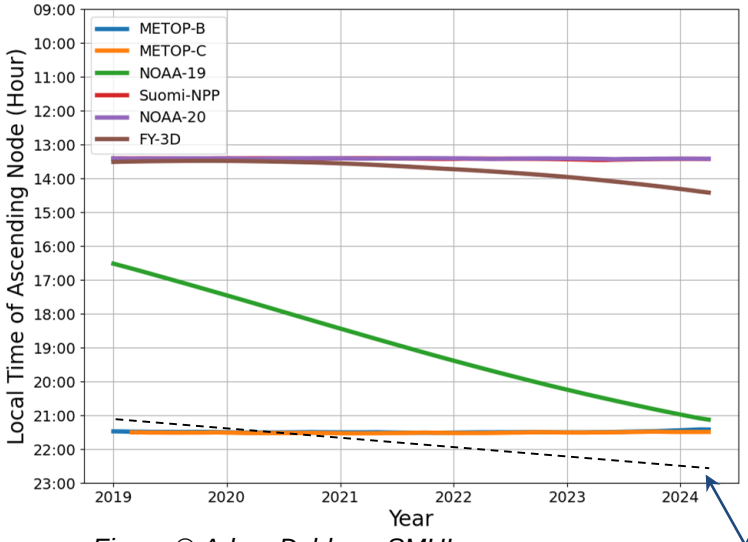


Figure © Adam Dybbroe SMHI

-Assimilation hours were updated in September 2024 for those satellites that are in drifting orbits:

- NOAA-18 (instrument: AMSU-A)
- NOAA-19 (AMSU-A and MHS)

-Also in September 2024, started the operational assimilation of new satellite data:

- NOAA-21 (ATMS)
- FY-3E (MWHS-2)

-The use of S-NPP (ATMS, CrIS) was discontinued in December 2024

Updated satellite usage at MetCoOp

Key:

+ New use of data

Continued use

- Discontinued use

Still no use of data

Analysis times (UTC)

	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
NOAA-18										-									-					+
NOAA-19							-							+		-						+		
NOAA-20																								
NOAA-21	+	+	+	+	+	+			+	+	+	+	+	+										
S-NPP	-	-	-	-	-	-			-	-	-	-	-	-										
Metop-B																								
Metop-C																								
FengYun-3D																								
FengYun-3E						+	+	+	+					+	+	+	+	+						

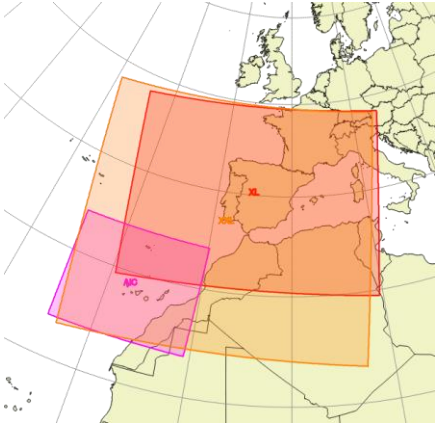
- From 11th Sept. 2024 onwards, there is active assimilation of satellite data <u>at all analysis times</u>

Satellite usage at Aemet

	00	03	06	09	12	15	18	21
SEVIRI								
NOAA-18								
NOAA-19								
METOP-B								
METOP-C								
Suomi-NPP								
NOAA-20								
NOAA-21								
FengYun-3D								
FengYun-3E								

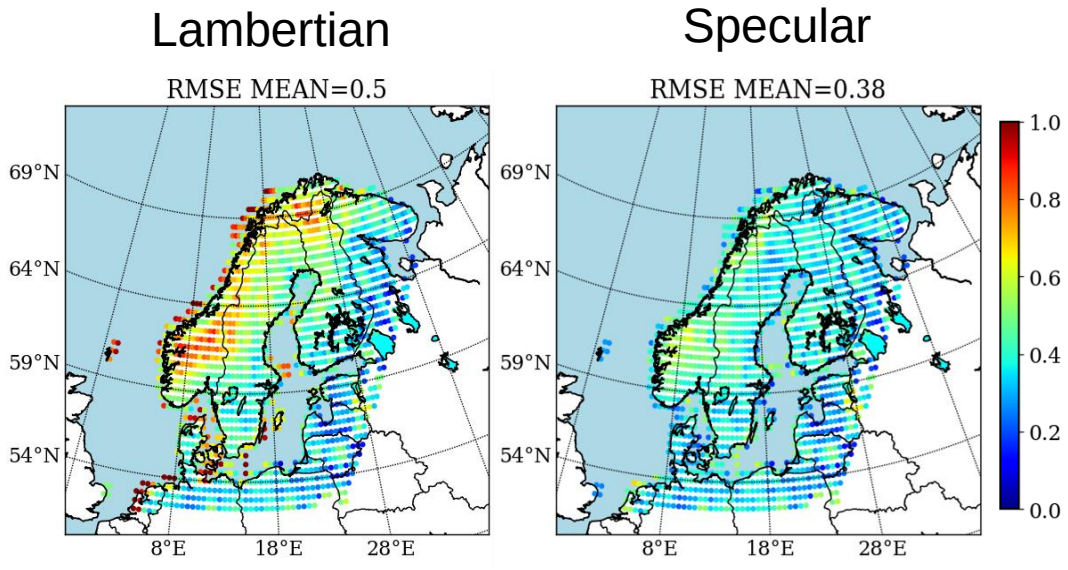
Operational Suite

Pre-operational Suite

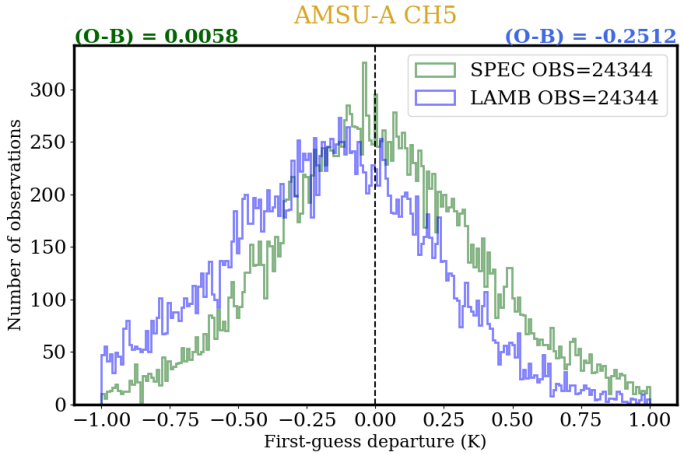


- FengYun-3E is passive at this moment.

Impact of Lambertian and Specular Reflection on Microwave Radiances Assimilation



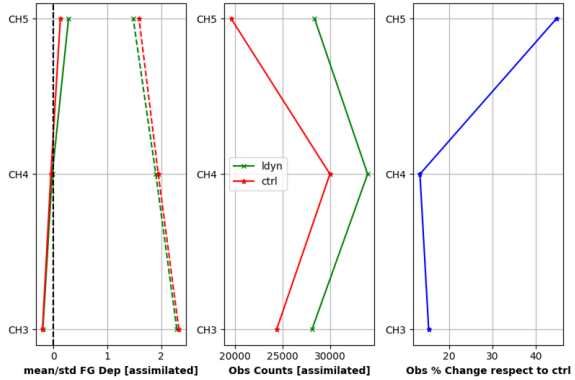
Spatial distribution of gridded (0.5x0.5) root mean square error (RMSE) of brightness temperature (in K) for two different scenario Lambertian and Specular reflection after bias correction of AMSU-A channel-5 for 12 UTC assimilation cycle and from 02-30 April 2024.



Histograms of first-guess departure in terms of brightness temperature (O-B, in K) before bias correction using Lambertian and Specular reflection for AMSU-A channel-5 for 12 UTC assimilation cycle and from the month of April 2024. The numbers in each panel represent the mean values of (O-B), along with the total number of observations.

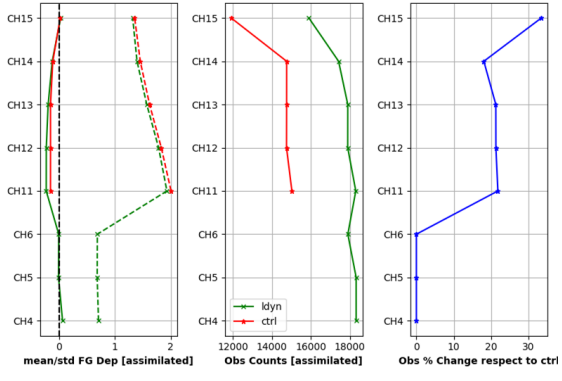
Swapan Mallick, Magnus Lindskog & Stéphanie Guedj

UWC West: Low-peaking channels



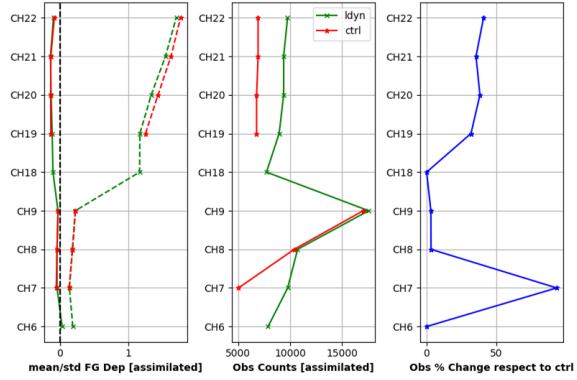
MHS
Metop B/C; NOAA 19

MWHS2
FY-3D



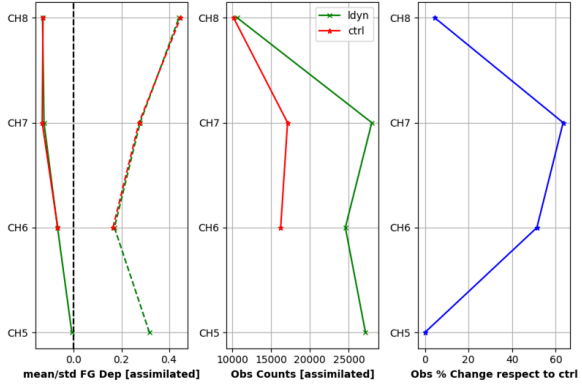
Observation fits
Assimilated FG DEP
Land+Sealce
20241201 - 20241228
(HH=00,03,06…)
Winter

Obs % change:
- 100*(ldyn-ctrl)/ctrl
- 0 where ctrl has blacklisted channels



ATMS
NOAA 20

AMSUA
Metop B/C; NOAA 18/19

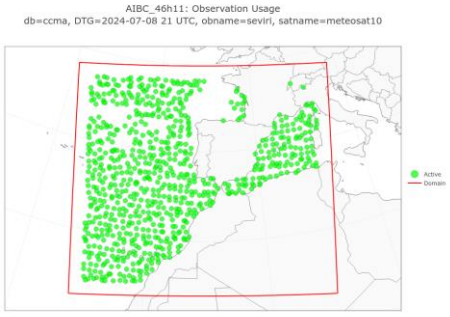


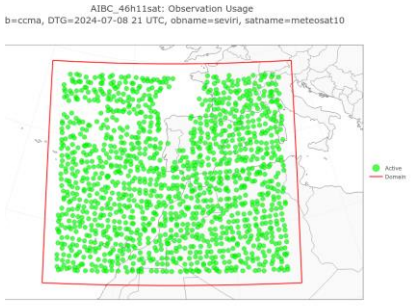
ACCORD
A Consortium for COnvection-scale modelling Research and Development

Aemet: Low Peak Channels

SEVIRI

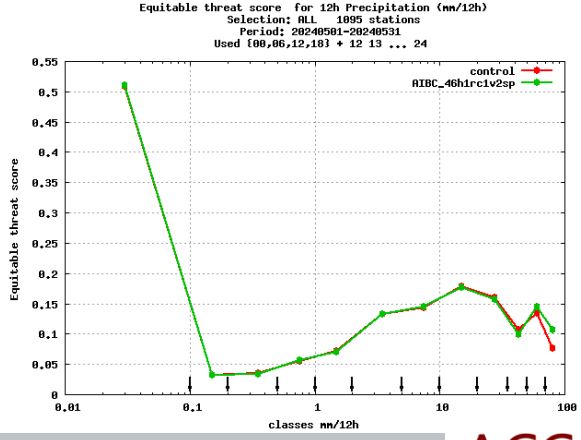
- Although WV channels are very high, we notice a diurnal cycle that makes an inconsistencies of the VARBC's predictors.
- We assimilate WV ch's only over the sea
- Using the retrieval of skin temperature procedure it's possible to assimilate also over land..





MW Sensors (ATOVS)

- The emissivity retrieval allows to assimilate ch 5 of AMSU-A and also improve the quality of the assimilation of ch 5 of MHS.
- Impact is neutral expect the precipitation that is light positive.



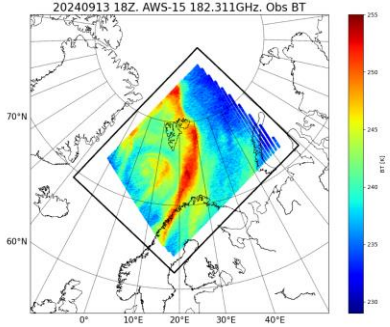
Joan Campins & María Díez

Arctic Weather Satellite (AWS)

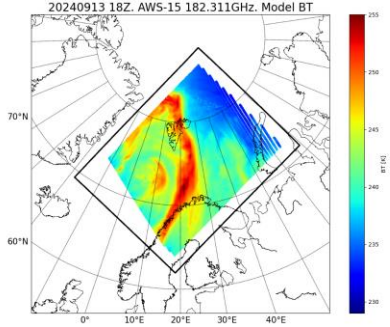
- AWS is a prototype satellite mission for a possible future constellation called: STERNA
- AWS is a small satellite carrying one instrument
- 19 channel MW sounder
- 8 temperature sounding channels at 50GHz
- 5 humidity sounding channels at 183 GHz
- 4 humidity and cloud sensing channels at 325GHz

- Launch 16 August 2024
- MET Norway and SMHI are participating in early evaluation of AWS
- Assimilation, passive mode, in HARMONE-AROME cy43

Observed BT



Model BT



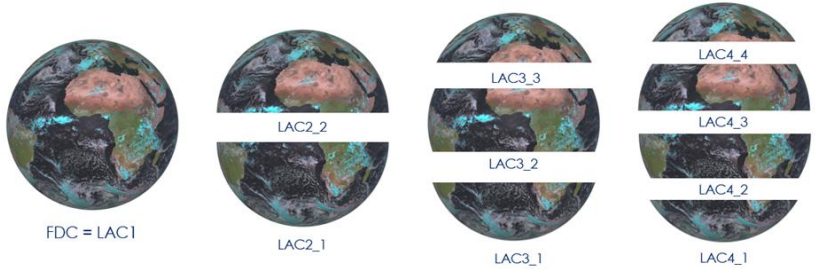
Per Dahlgren & Stéphanie Guedj

ACCORD
A Consortium for COnvection-scale modelling Research and Development

Flexible Combined Imager (FCI)

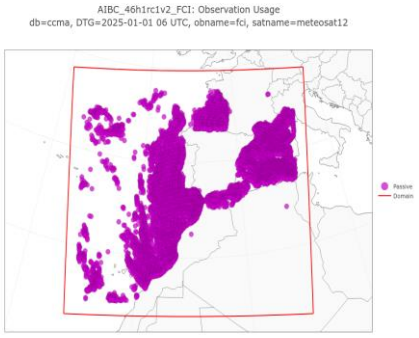
- FCI is the Imager instrument that replace SEVIRI in MTG.

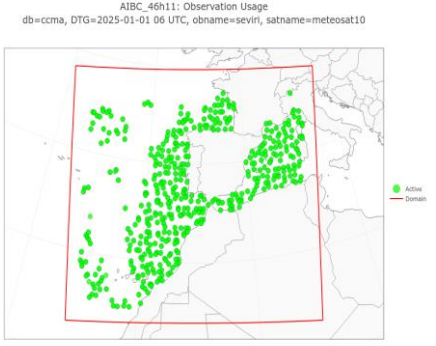
SEVIRI	FCI
full disk 15 min	full disk 10 min
11 ch's + HRV	16ch's
2VIS 3km	5VIS 1km
1NIR 3km	3NIR 1km
2WV 3km	2WV 2km
6IR 3km	6IR 2km



FCI Full Disk and Local Area Coverage source: Eumetsat.

- First tests are started over the spanish domain.
- Thanks to Meteo France staff that shared their advances.





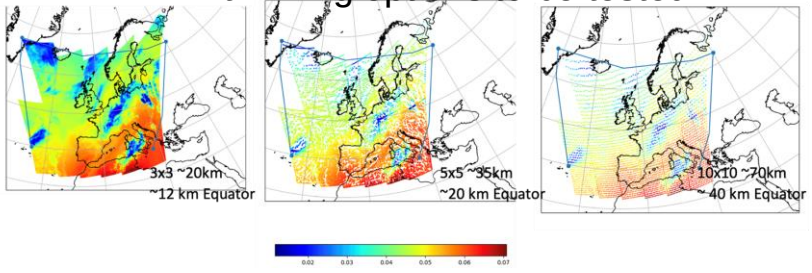
UWC West: Preparing to MTG-IRS to operations

DK, IR, IS and NL operational domain.

Data reception and pre-processing:

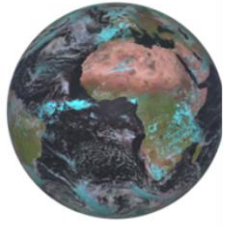
- Only LAC4 and selected dwells (31 to 39,46 to 53, and 57 to 63) will be processed.
- **IRSPP** used to obtain MTG-IRS **reconstructed radiances** in BUFR format.
- Data volumes reduced by channel selection and thinning at IRSPP level.

- thinning options to be tested:



Implementation in the Data Assimilation system:

- Channel selection, thinning strategy and observations errors - collaboration with Météo-France.
- Code developments are technically ready (collaboration with ACCORD consortium).
- Cloud detection - based on the McNally & Watts scheme (using the LWIR band, similar to CrIS).
- Use the 4D-Var configuration to take full advantage of time frequency.



RD
Convection-scale modelling
opment

Ongoing research at MetCoOp/UWC West/AEMET

- MetCoOp:
  - The assimilation of geostationary imager radiances (SEVIRI, FCI) at high latitudes
    - Active assimilation of SEVIRI in a preoperational Cy46 suite since January 2025
  - Aiming at fast introduction of the AWS microwave sounder data
  - All-sky assimilation of cloud-affected radiances from the microwave sounders in a Cy46 3D-Var system
  - Optimizing the setup of Variational Bias Correction (VarBC)
  - General improvements in the handling of infrared radiances (IASI, CrIS)
- UWC West:
  - Low-peaking channels
  - MTG-IRS preparations
  - Use of observations in 4D-Var
  - MW sounders: implementation and testing All-Sky in 4D-Var Cy49
- Aemet:
  - Low-peaking channels.
  - Work ongoing for cloud detection for the infrared sensor (IASI,CrIS)
  - Finish FCI setup.

Summary and conclusions

- The three UWC will have polar satellite radiance observations in all cycles.
- Low peak channels assimilation is an important task.
  - There is an important effort in order to improve surface modelling:
    - Lamberian reflexion.
    - Footprint operator.
- Working on improvement the use of the existing satellite data.
  - Better cloud detection for Infrared sensors like IASI and CrIS.
- Continue working on All Sky Radiances for microwave sensors in cycle 46 and 49.
- New missions and satellites are already providing observations and others are going to be launched in the near future.
  - MTGI-1 => FCI.
  - AWS.
  - MTGS-1 => IRS.

Thank you very much
Köszönöm szépen