Preparation of MTG era: developing of imager and sounder nowcasting products and services for pre-convection phase.

Miguel-Angel MARTINEZ

AEMET

mmartinezr@aemet.es

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- ✓ Test of MTG-FCI VIS0.9 channel for TPW
- ✓ Test of MTG-FCI NIR1.3 channel for HL

Preparation of sSHAI for MTG-IRS era:

qIRS:

- ✓ synthetic IASI spectra for a period

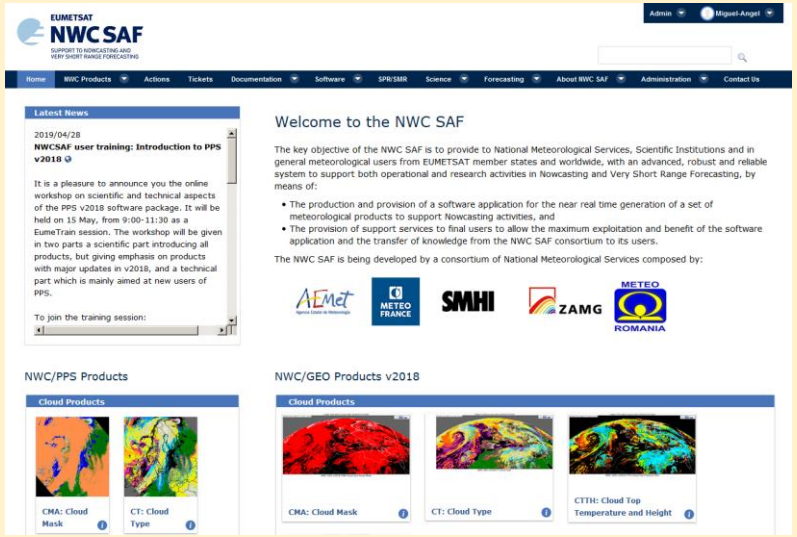
sSHAI_ES

- ✓ reprojection of IASI L2 product
- ✓ reprojection of Sentinel-5P product

Other

- ✓ 3D optional fields
- ✓ Optical flow

http://nwc-saf.eumetsat.int or http://www.nwcsaf.org/



....

NRT iSHAI outputs

Product and algorithm information

Copy of presentation in pptx format

References

http://www.nwcsaf.org/AemetWebContents/ReferenceSystem/GEO/HTMLContributions/iSHAI/references.html

iSHAI on NWC SAF framework

iSHAI (imager Satellite Humidity and Instability)

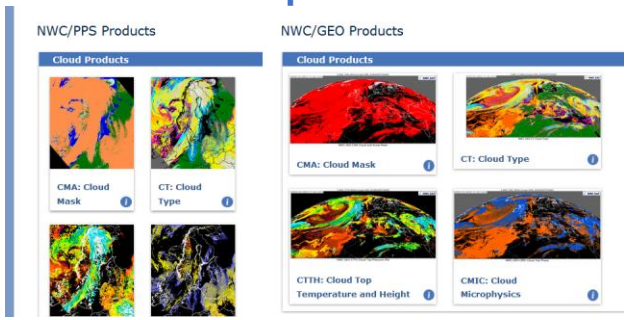
Former PGE13 SPhR(SEVIRI Physical Retrieval)

http://nwc-saf.eumetsat.int
http://www.nwcsaf.org/

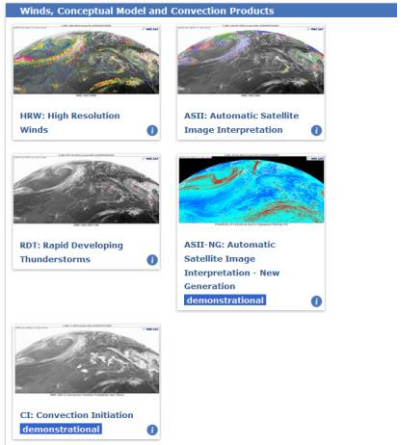
iSHAI

Satellite Humidity and Instability Products

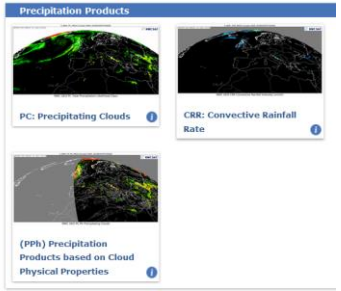
Cloud products



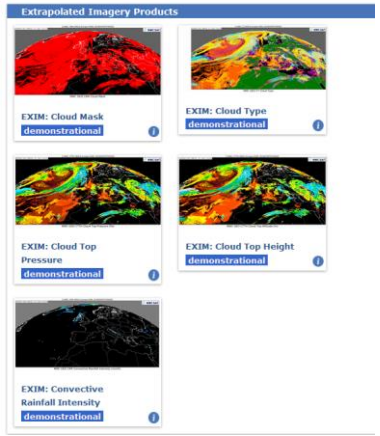
Satellite Winds, Conceptual Model and Convection Products



Precipitation Products



Extrapolated Imagery Products



iSHAI and PGE00 description

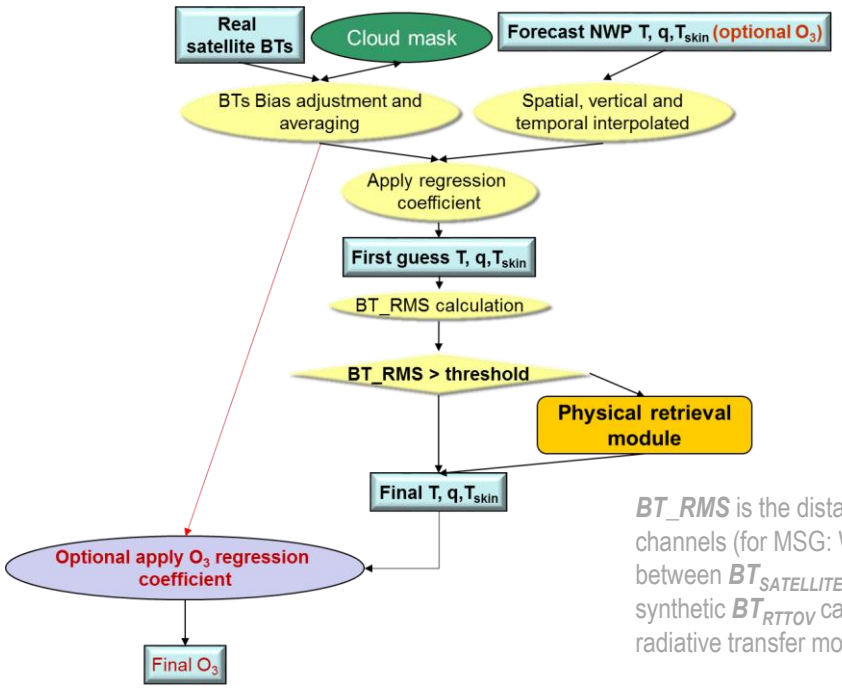
PGE00 is currently an AEMET internal tool
=> NWC SAF Extra tool

iSHAI algorithm is a combination of statistical and physical retrieval algorithms. Only on clear air pixels (or NxN boxes) it is made:

First step: uses a set of non linear regressions to built a First Guess profile from collocated background NWP temperature, humidity and ozone profiles and bias corrected satellite BTs.

Second step: physical retrieval with use of EOFs to reduce the dimension of matrix and reduce the computation time.

In MSG: 2 EOFs for T, 3 EOFs for q and 1 EOF for T_{skin}



BT_RMS is the distance in absorption channels (for MSG: WV6.2, WV7.3 y IR13.4) between $BT_{SATELLITE}$ (bias corrected) and synthetic BT_{RTTOV} calculated with the radiative transfer model RTTOV

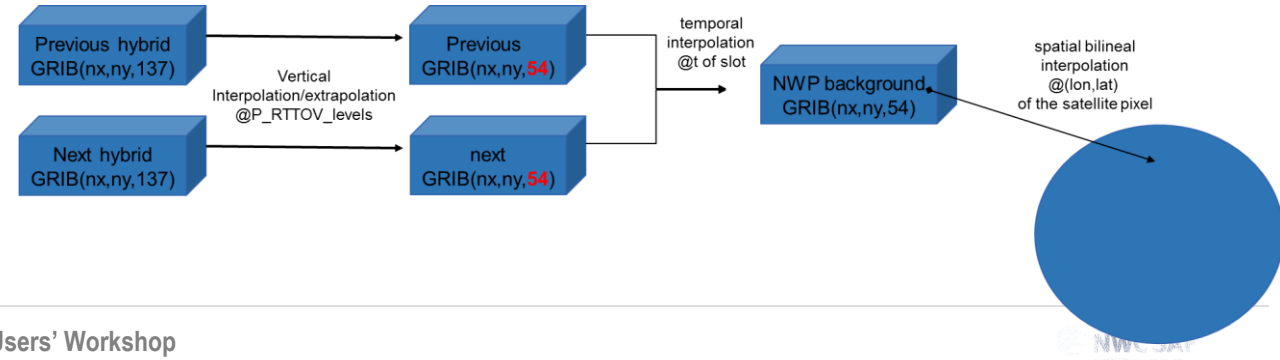
PGE00 is a simplified version of the NWP interpolation and RTTOV management of iSHAI. It is can be used as:

- NWP 4D *(presure, time, longitude, latitude)* interpolator of NWP GRIB files to satellite positions
- RTTOV BTs simulator for bias BT correction, iSHAI validation and testing, etc

GEO-PGE00-VISIR uses RTTOV-12.1. It can be used to make **high quality simulation of clouds for both Visible and IR** channels:

- 4D interpolation of T, q, O3, **CC, CLWC, CIWC, u, v** profiles on hybrid levels of ECMWF GRIB files.
- Call to RTTOV direct using the **clouds** and solar options
- Emissivities and BRDF from RTTOV atlases.

It can be used ECMWF GRIB files in hybrid levels.



See the iSHAI Algorithm Theoretical Basis document (ATBD) available on the website of the NWCSAF. The algorithm is similar to that used by NOAA for the GOES-R. The base algorithm was provided by Dr. Jun Li of CIMSS-Wisconsin.

iSHAI inputs and outputs scheme on version 2018.1

ABI GOES-R: WV6.2, WV6.9, WV7.3, IR13.3, IR10.4, IR11.2, IR12.3, IR9.6

AHI Himawari: WV6.2, WV7.0, WV7.3, IR13.3, IR10.4, IR11.2, IR12.3, IR9.6

SEVIRI MSG: WV6.2, WV7.3, IR13.4, IR10.8, IR12.0, IR9.7

Real satellite BTs

NWP

Cloud Mask

GEO-iSHAI-v40
YYYY-MM-DDThh:mm:00Z region config_file

Coefficients files: Bias BT correction, regression FG, EOF, …
Ancillary fields: longitude, latitude, zenith angle, land-sea mask, …

netCDF

- **TPW**
- **BL (sfc-850)**
- **ML (850-500)**
- **HL (500-top)**

Precipitable water at several layers

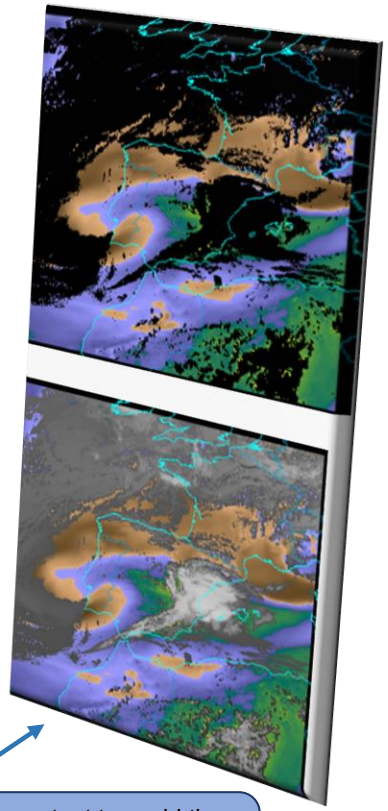
- **LI**
- **SHOWALTER**
- **K-INDEX**

Stability indices

- **TOZ**

Total Ozone

- **Tskin**
- \+ **Differences fields (iSHAI – NWP)**
- \+ **Quality Flags:** residual, status, conditions fields.
- \+ **Configurable IR BT degraded to 7 bits only in cloudy pixels.**



The IR image is important to avoid the "black holes" in the display of the fields. It helps to get the consistency in loops.

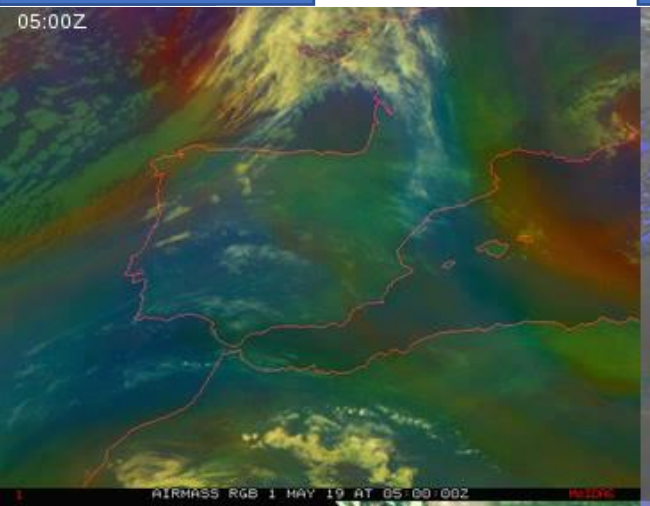
Optional output

(T, q, ozone) profiles and SKT in binary files.
✓ Arrays of structures.

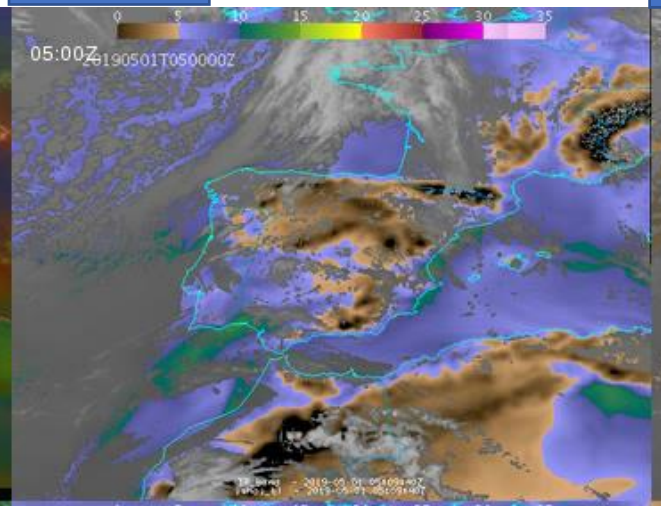
SAFNWC/MSG Task Manager synchronizes the execution of the products and the first product that is generated upon the arrival of a new image is the cloud mask.

Example of combined use of iSHAI, PGE00 and real RGB images: 1st May 2019

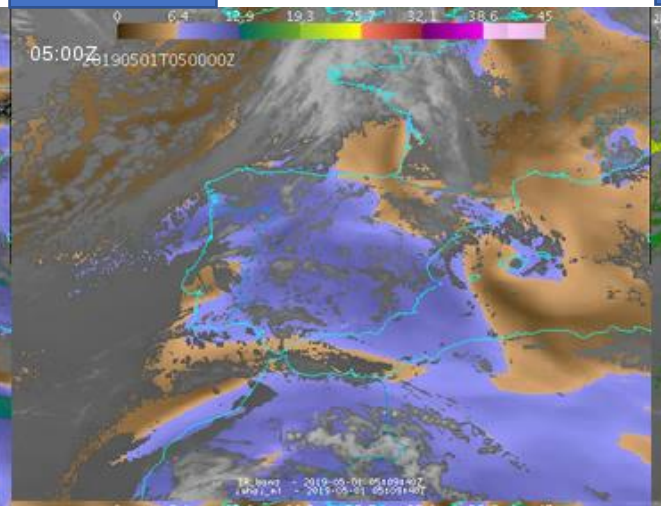
AIRMASS RGB



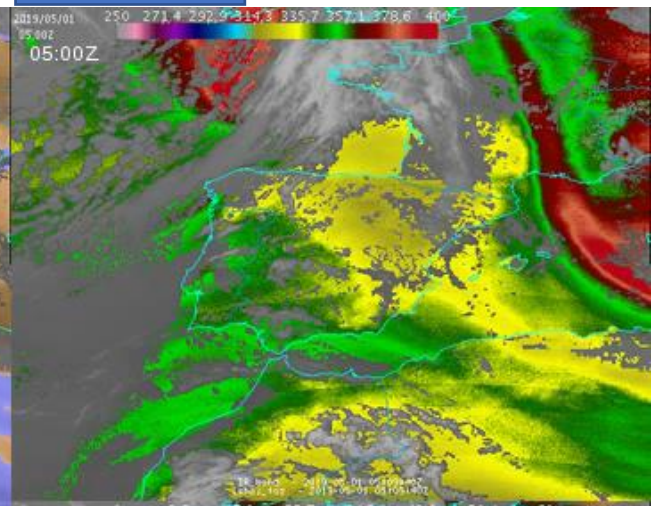
iSHAI BL

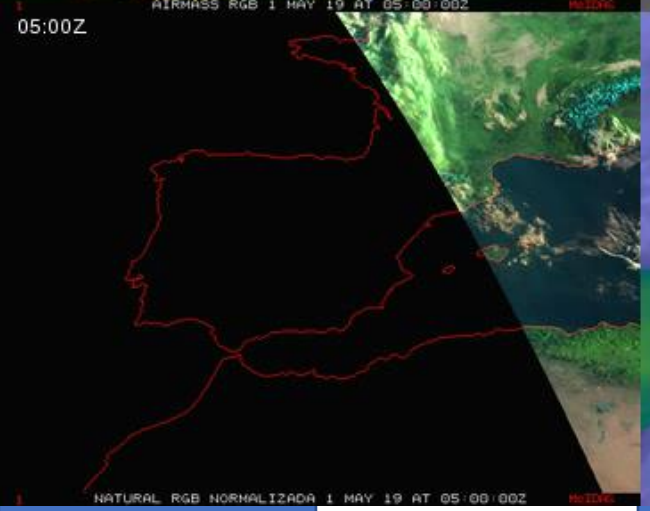


iSHAI ML

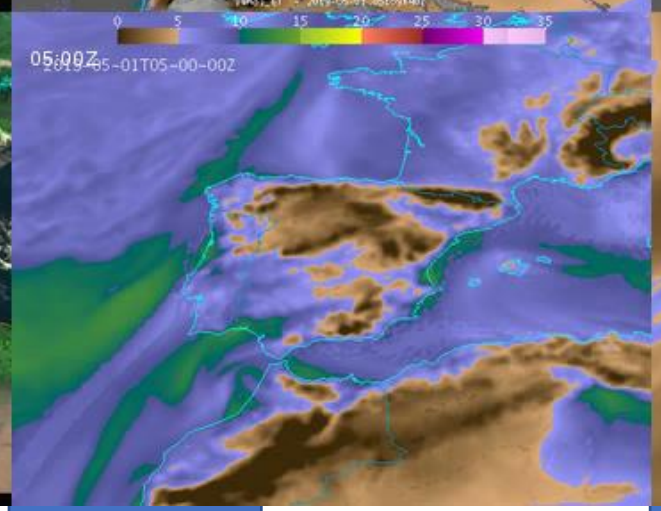


iSHAI TOZ

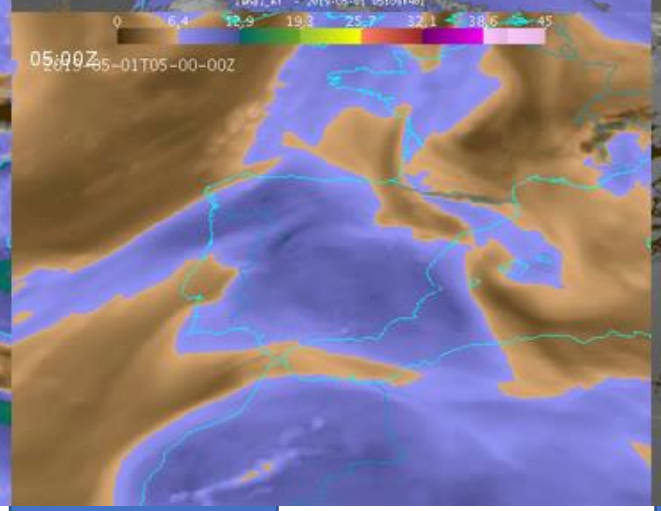




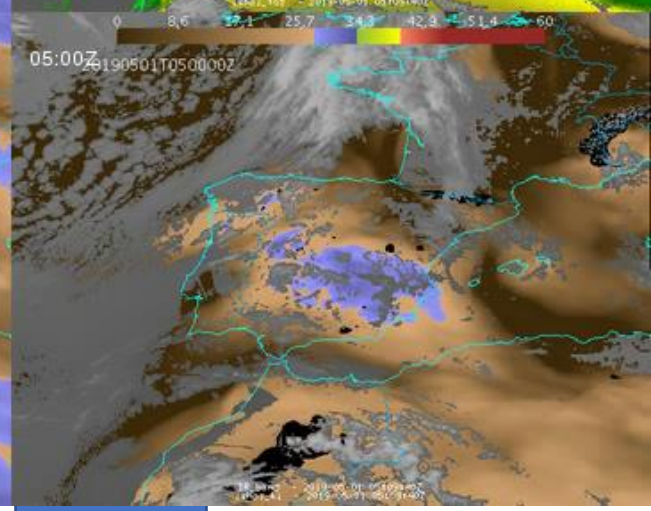
ECMWF BL



ECMWF ML



iSHAI KI



NATURAL RGB

Corrected to same sun zenith angle and hour

Loop available in an AVI file in this NWC SAF web page

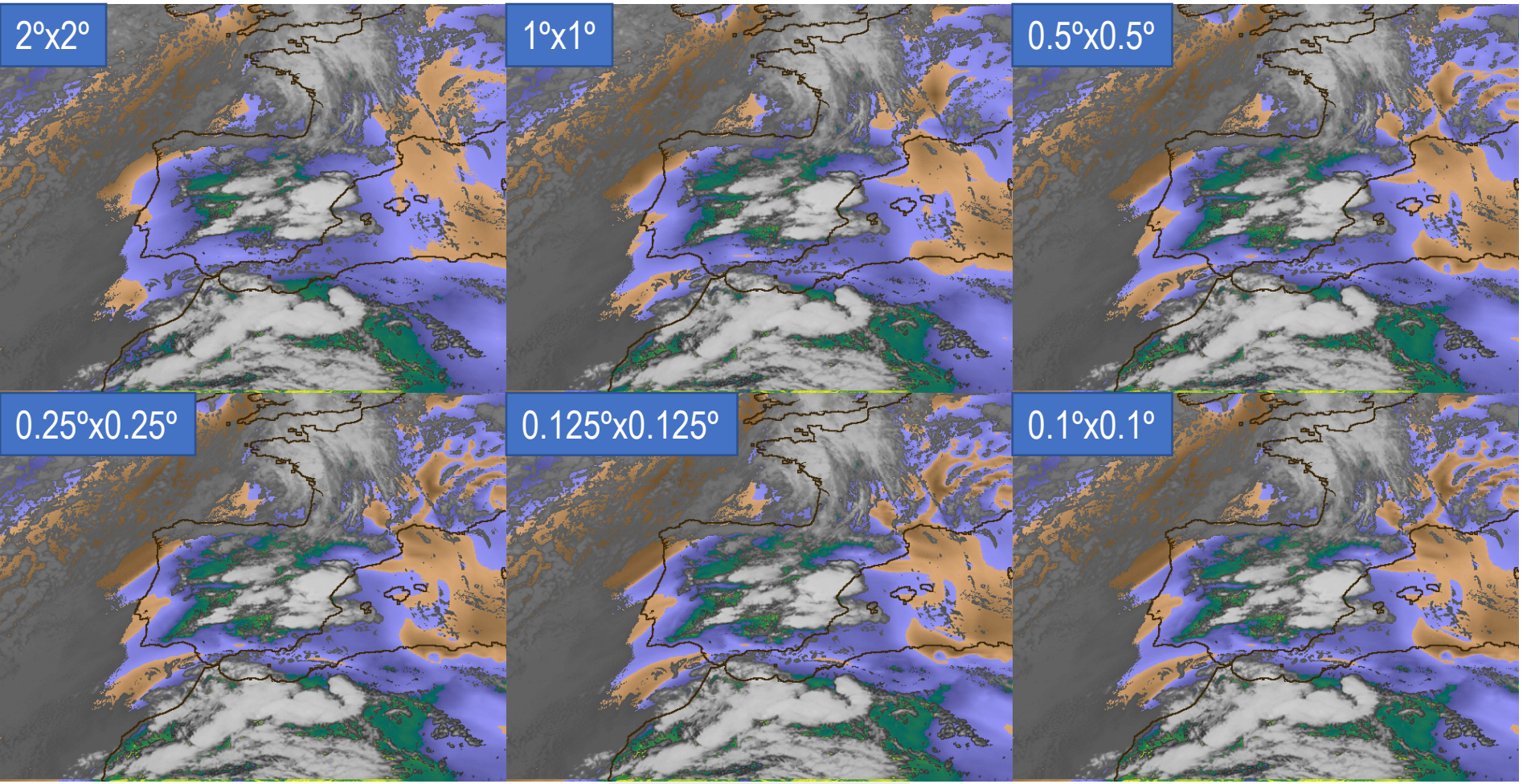
Test on the influence of NWP spatial and temporal resolution on iSHAI

It has used as background NWP input ECMWF GRIB file on hybrid levels to make tests with different:

- **spatial resolution [2ºx2º, 1ºx1º, 0.5ºx0.5º, 0.25ºx0.25º, 0.125ºx0.125º, 0.1ºx0.1º]**
- **with different temporal resolution: every 1 hour and every 6 hours.**

Same request to MARS with only different spatial resolution and steps.

NWP input influence: ML with NWP every 1 hour



ML
Precipitable Water
in Middle Layer
(850-500 hPa)

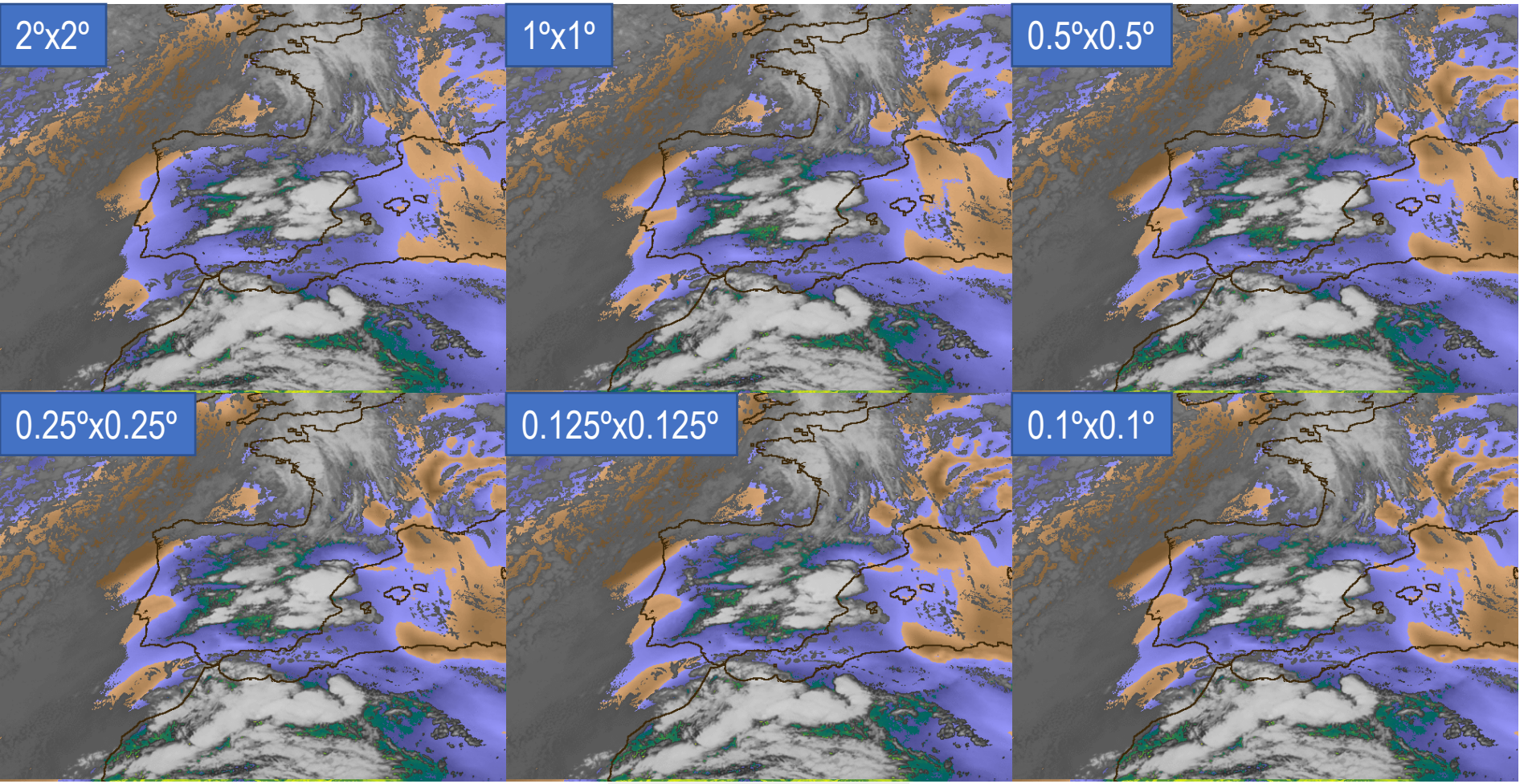
ML fields
15:30Z
1st May 2019

Using ECMWF GRIB files on hybrid level ***t+15*** and ***t+16*** forecast from 00Z run of 1st May 2019

Executed all with CMA null.

Transparent IR10.8 gray scale image on cloudy pixels has been overlapped

NWP input influence: ML with NWP every 6 hours



ML
Precipitable Water
in Middle Layer
(850-500 hPa)

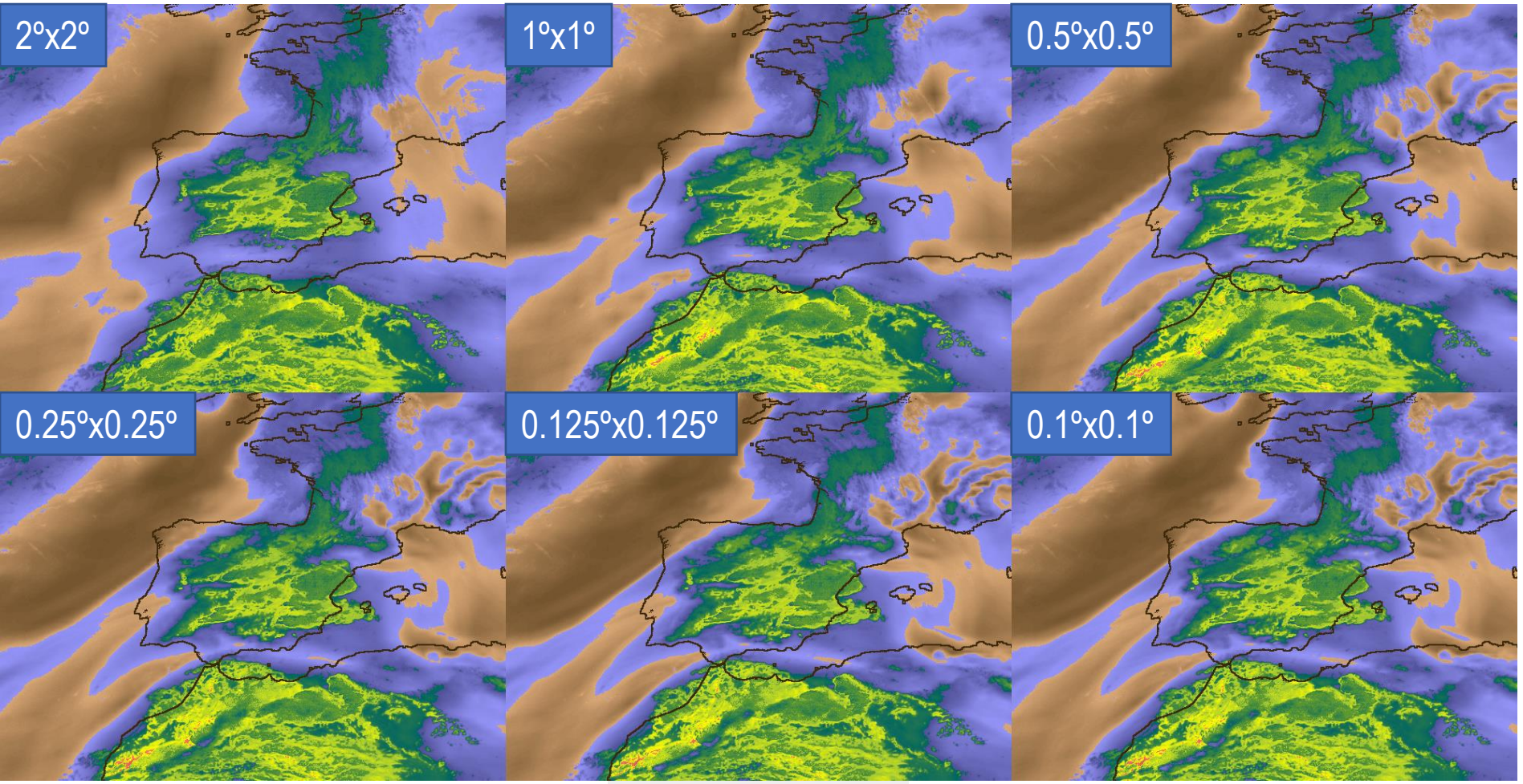
ML fields
15:30Z
1st May 2019

Using ECMWF GRIB files on hybrid level ***t+12*** and ***t+18*** forecast from 00Z run of 1st May 2019

Executed all with CMA null.

Transparent IR10.8 gray scale image on cloudy pixels has been overlapped

NWP input influence: ML with NWP every 1 hour



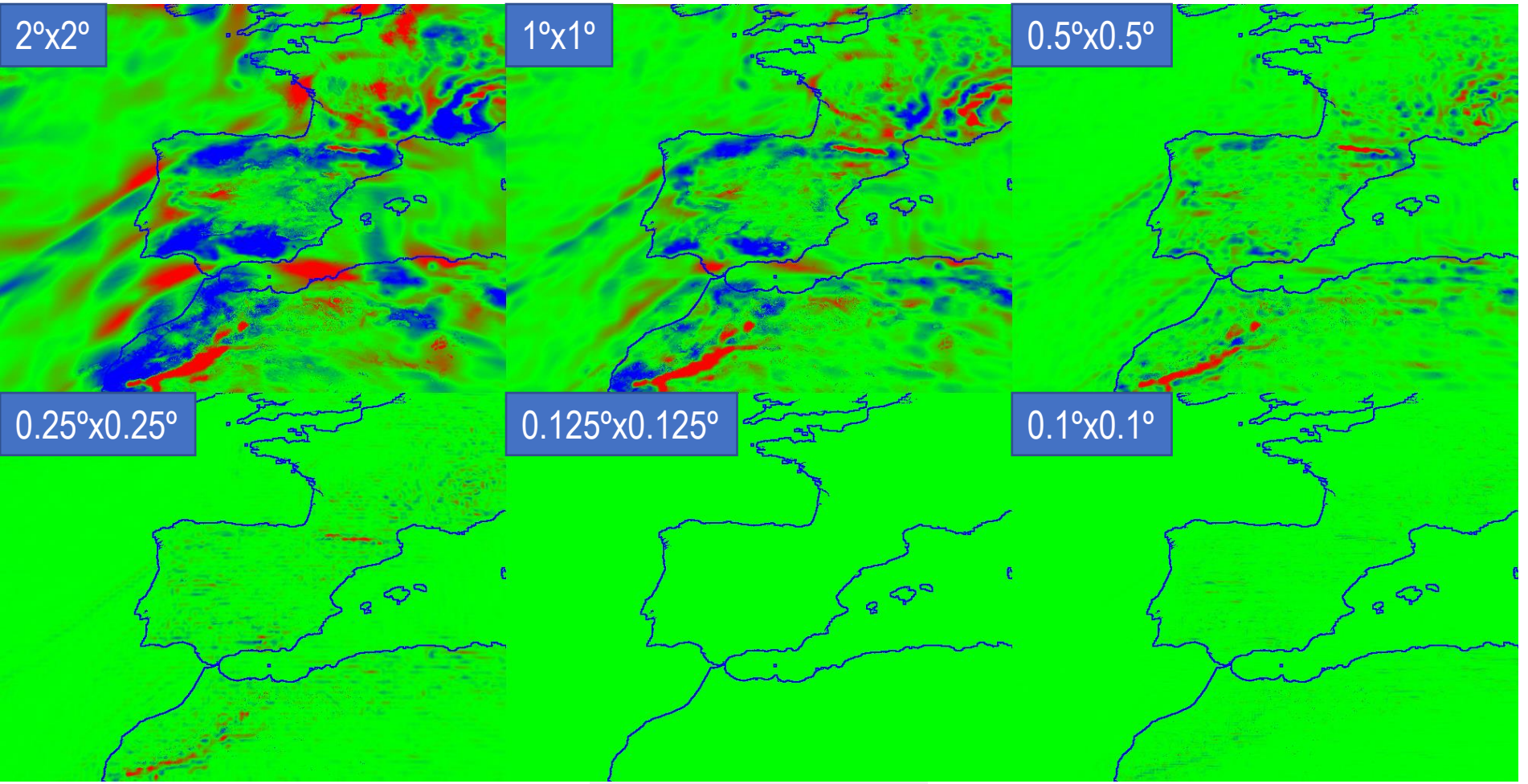
ML fields
15:30Z
1st May 2019

Using ECMWF GRIB files on hybrid level ***t+15*** and ***t+16*** forecast from 00Z run of 1st May 2019

Executed all with CMA null.

ML
Precipitable Water
in Middle Layer
(850-500 hPa)

NWP input influence: ML with NWP every 1 hour vs 0.125ºx0.125º



ML
Precipitable Water
in Middle Layer
(850-500 hPa)

Used as reference 0.125ºx0.125º resolution used in the previous loop

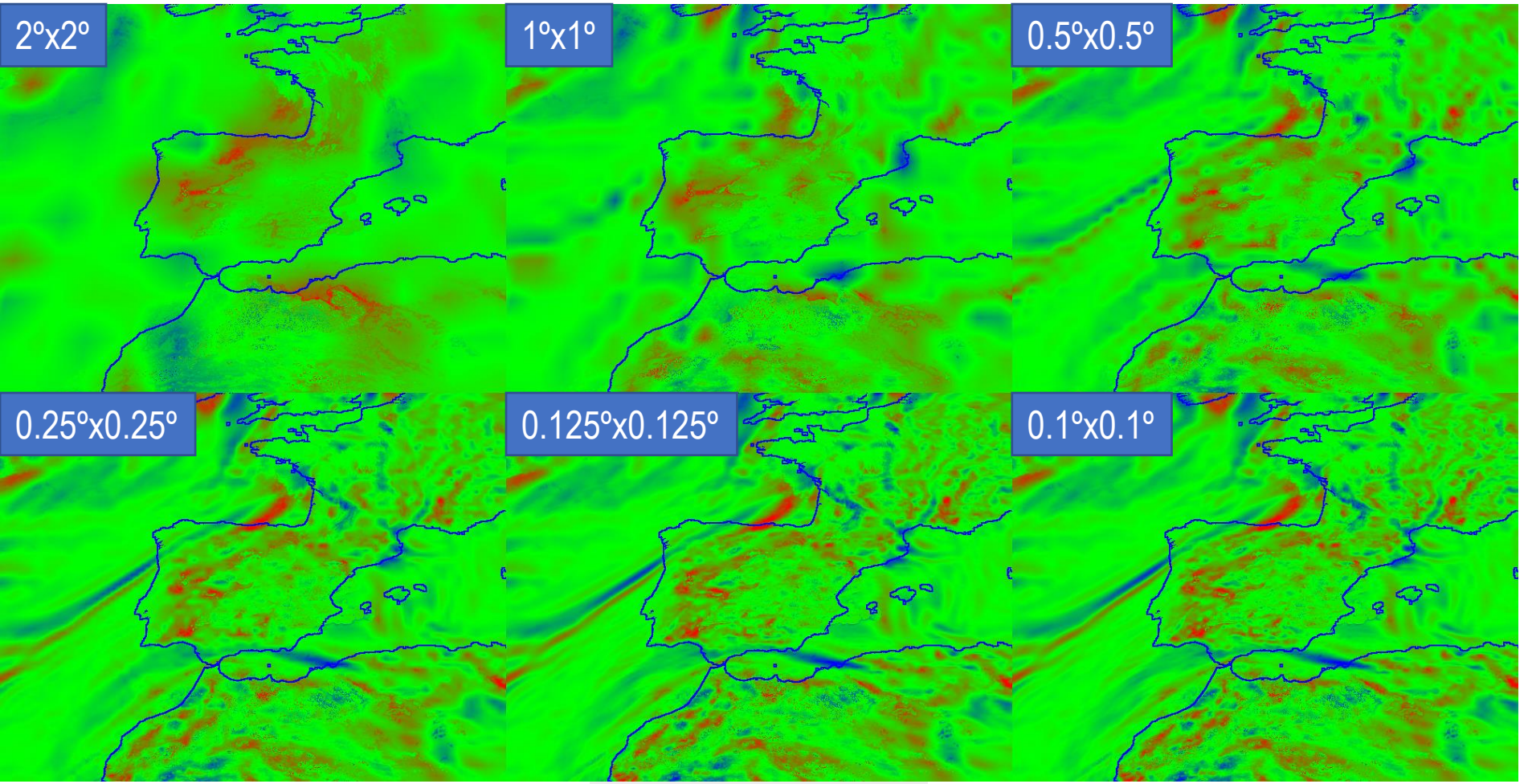
ML - $ML_{0.125ºx0.125º}$
15:30Z
1st May 2019

Subtracted ML from 0.125ºx0.125º

Using ECMWF GRIB files on hybrid level ***t+15*** and ***t+16*** forecast from 00Z run of 1st May 2019

Executed all with CMA null.

NWP input influence: ML with NWP every 1 hour vs every 6 hours

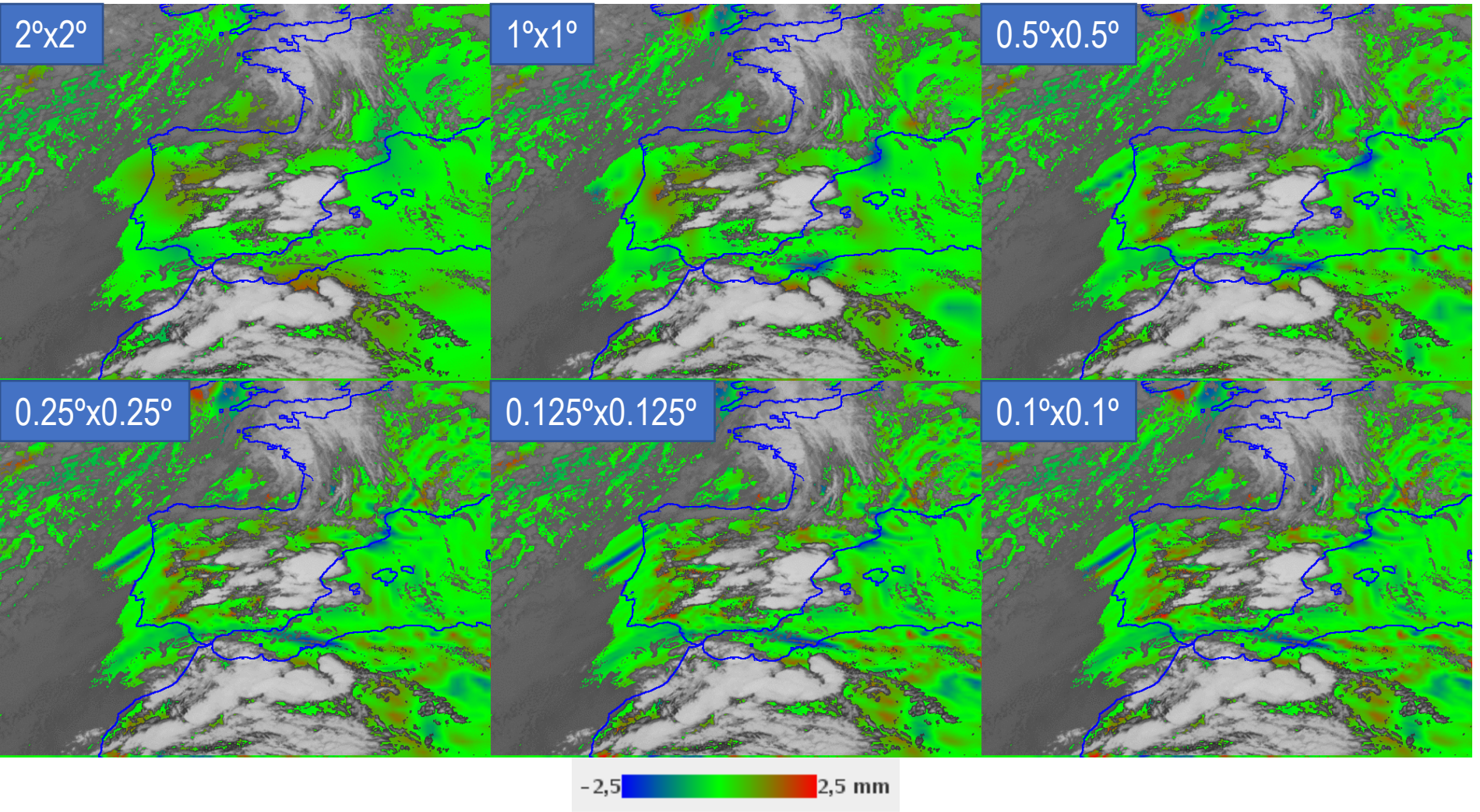


ML
Precipitable Water
in Middle Layer
(850-500 hPa)

$ML_{every6} - ML_{every1}$
15:30Z
1st May 2019

Executed all with CMA null.

NWP input influence: ML with NWP every 1 hour vs every 6 hours



$ML_{every6} - ML_{every1}$

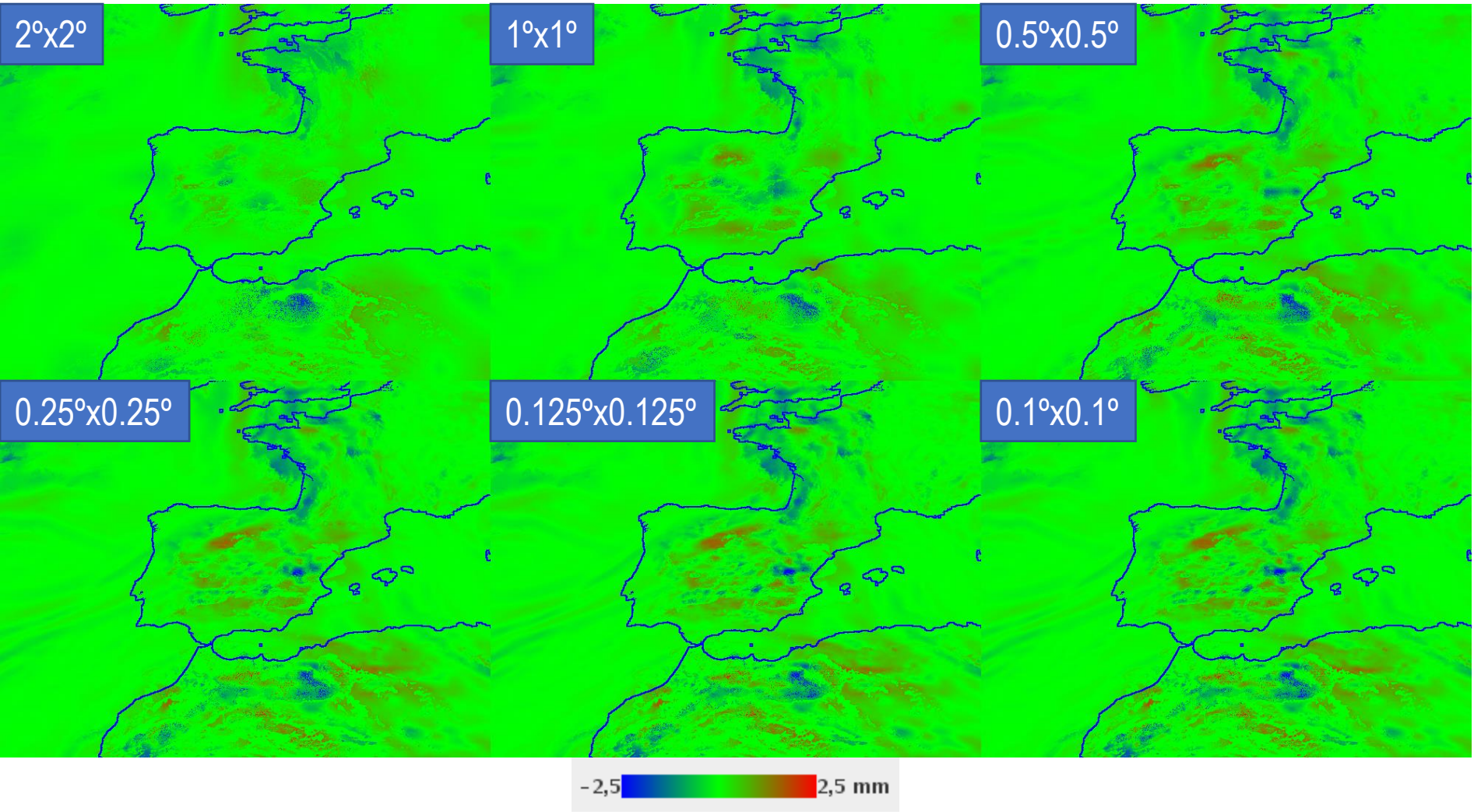
15:30Z

1st May 2019

Executed all with CMA null.

Transparent IR10.8 gray scale image on cloudy pixels has been overlapped

NWP input influence: diffML with NWP every 1 hour vs every 6 hours



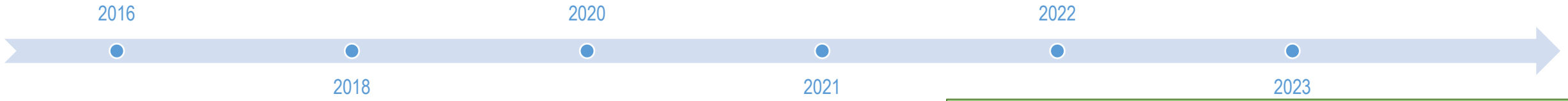
$diffML_{every6}$ - $diffML_{every1}$

15:30Z

1st May 2019

Executed all with CMA null.

iSHAI roadmap to MTG-FCI



iSHAI (imager **S**atellite **H**umidity **A**nd **I**nstability)

MTG

iSHAI FCI

PGE13

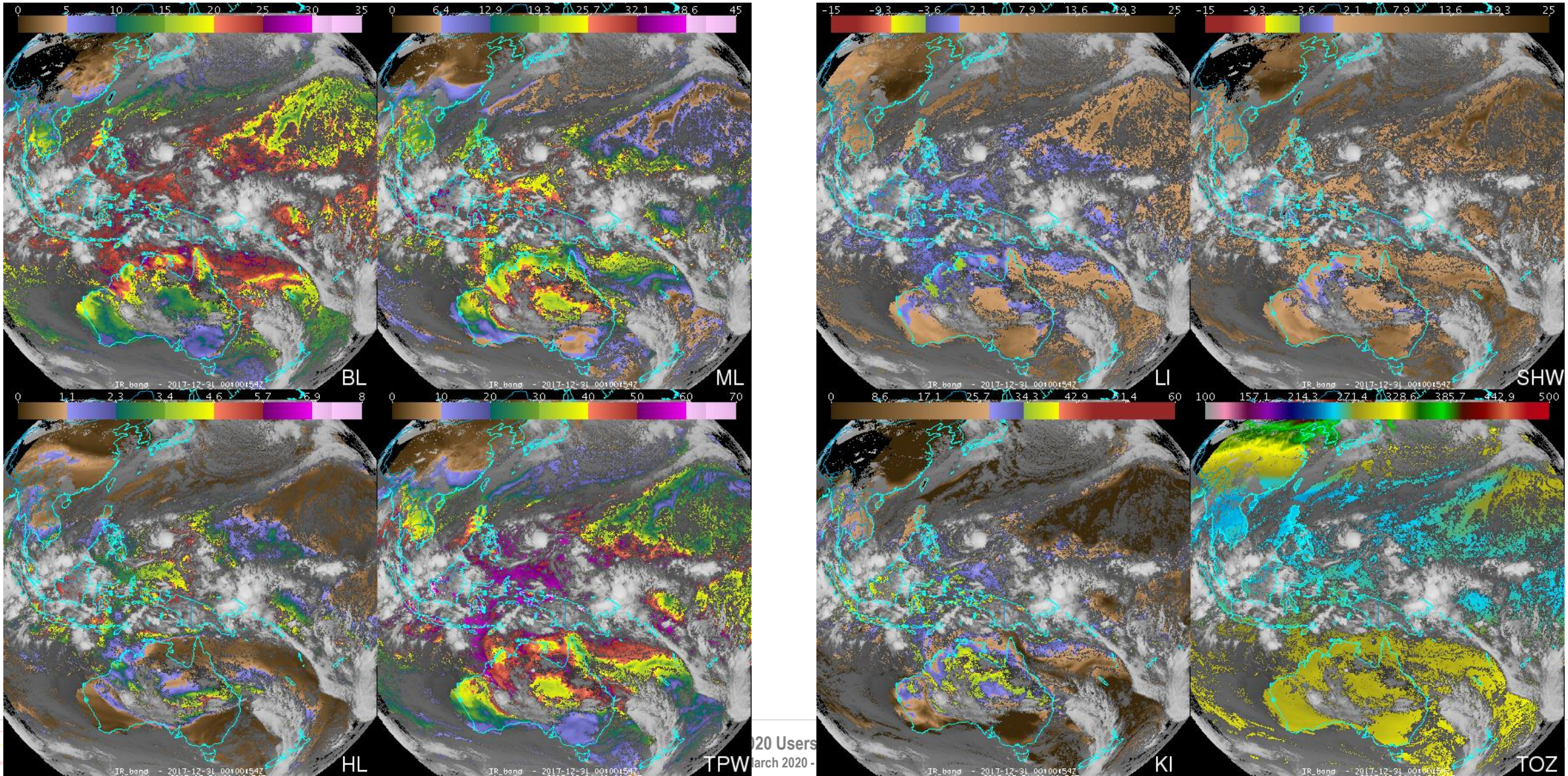
iSHAI MSG

iSHAI AHI

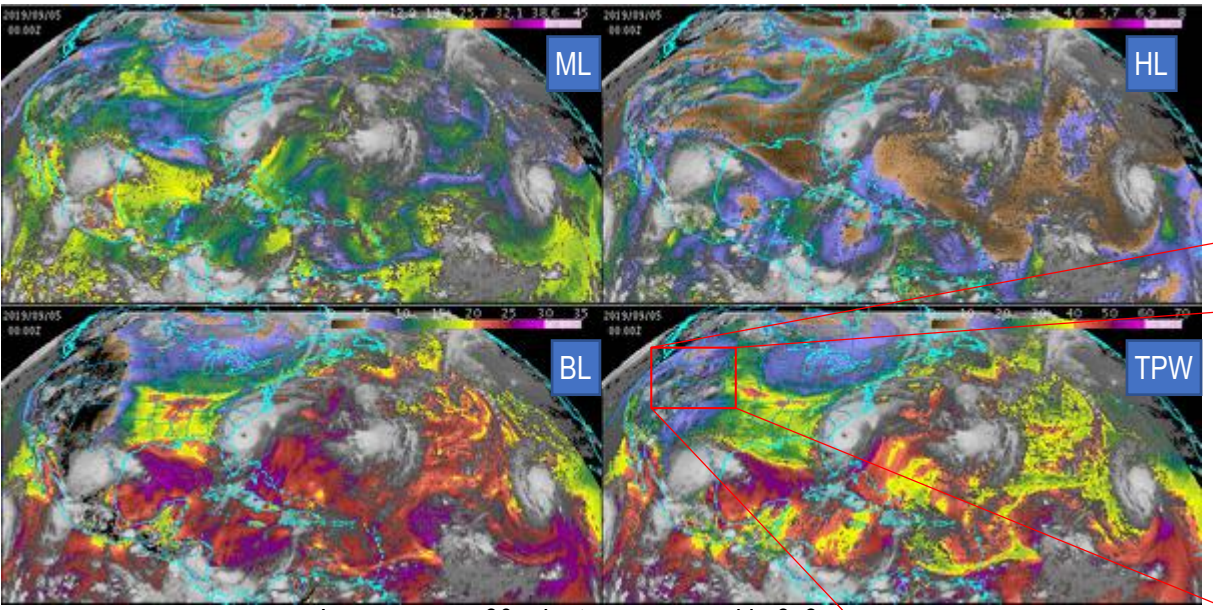
iSHAI ABI

Support of Himawari-AHI on version 2018

GEO-iSHAI AHI example on 2017-12-31 00Z



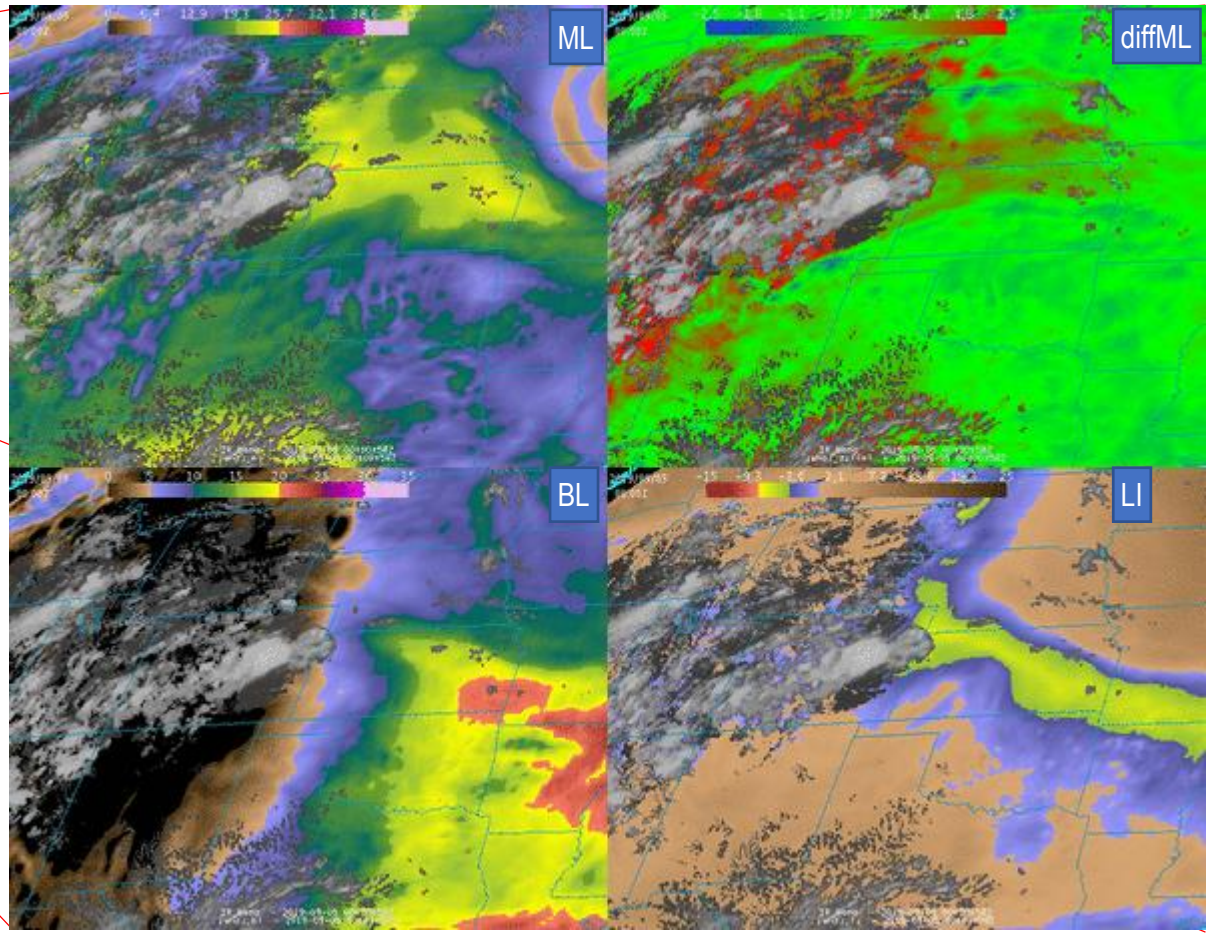
iSHAI from GOES-16 with version 2018.1: case 5th September 2019



Images every 30 minutes processed in 3x3

Hurricane Dorian off the East Coast and TS Gabrielle on the Atlantic can be seen.

Images every 10 minutes processed on 1x1



iSHAI obtains estimation of precipitable water (3 layers and total), instability indices, total ozone and skin temperature on clear air pixels; also the differences with the ones calculated from the background NWP are obtained.

BL:	Precipitable Water in Boundary Layer (P_{sfc}- 850hPa)
ML:	Precipitable Water in Middle Layer (850-500 hPa)
diffML:	($ML_{retrieved}$ –ML_{NWP})
HL:	Precipitable Water in High Layer (500-0.1 hPa)
TPW:	Total Precipitable Water in all Layers (P_{sfc}- 0.1 hPa)
LI:	Lifted Index

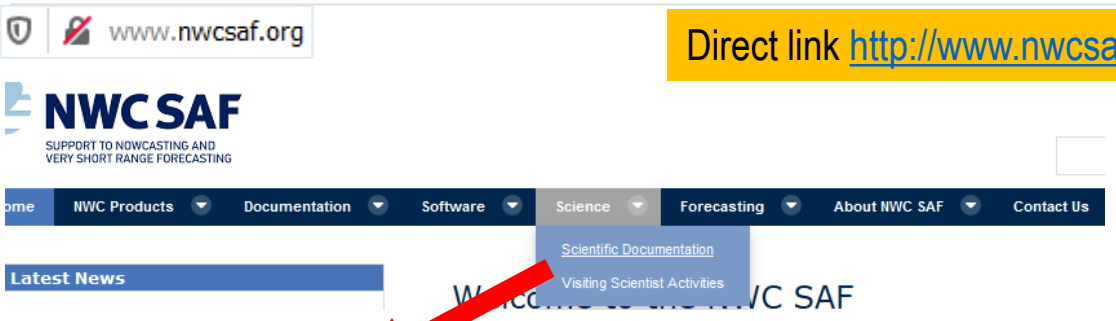
Background NWP: ECMWF GRIBs on hybrid levels from run 00Z every 1 hour spatial resolution 0.125 ˚ x 0.125˚

Loop available as animated GIFs in this NWC SAF web page

Bias BT correction
&
Training/Validation

Bias BT correction coefficients in NWC SAF web

Direct link http://www.nwcsaf.org/web/guest/bias-bt-correction-coefficients



Scientific Documentation

- NWCSAF/GEO Basic Documents
- NWCSAF/PPS Basic Documents
- NWCSAF/Auxiliary GEO Files

NWCSAF/Auxiliary GEO Files

- Bias BT correction coefficients
- HRW BUFR tables
- RDT BUFR tables

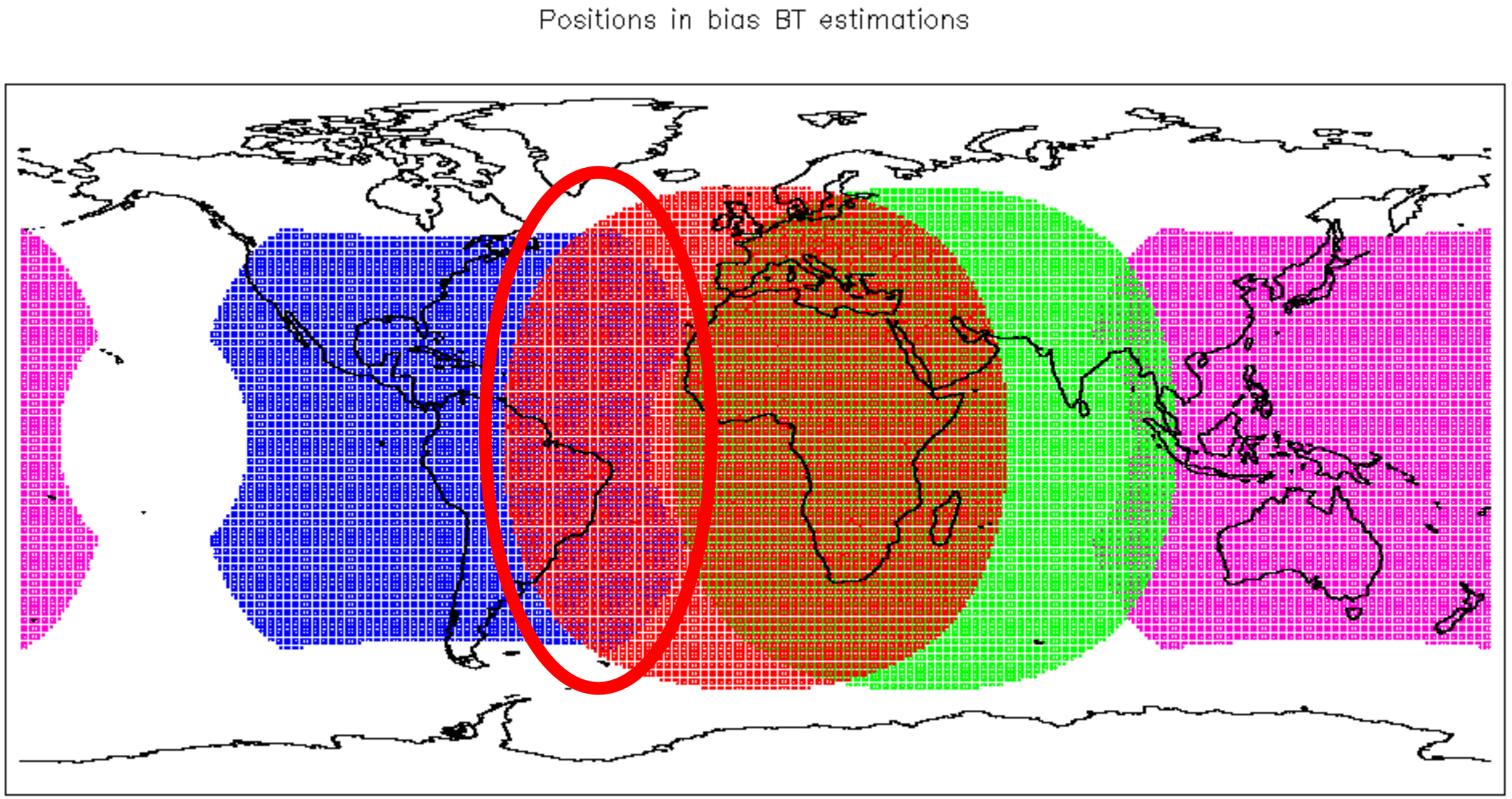
Bias BT correction coefficients for operational satellites

Description	Link
Bias BT correction coefficients for NWC SAF GEO package v2018-v2016	
Files for MSG-4 and ECMWF GRIBs in Pressure levels	biasBT PGE00P
Files for MSG-1 IODC and ECMWF GRIBs in Pressure levels	biasBT PGE00P
Files for Himawari-08 and ECMWF GRIBs in Pressure levels	biasBT PGE00P
Files for GOES-16 and ECMWF GRIBs in Pressure levels	biasBT PGE00P
Bias BT correction coefficients for PGE13 SPhR product v2013	
Files for MSG-4 and ECMWF GRIBs in Pressure levels	biasBT PGE13P
Files for MSG-4 and ECMWF GRIBs in Hybrid levels	biasBT PGE13Hyb

Bias BT correction coefficients for reprocessing

Description	Link
Bias BT correction coefficients for NWC SAF GEO package v2018-v2016	
Files for MSG-3 at 0º and ECMWF GRIBs in Pressure levels (until January 2018)	biasBT PGE00P
Bias BT correction coefficients for PGE13 SPhR product v2013	
Files for MSG-3 and ECMWF GRIBs in Pressure levels (until January 2018)	biasBT PGE13P
Files for MSG-3 and ECMWF GRIBs in Hybrid levels (until January 2018)	biasBT PGE13Hyb

Positions in bias BT correction datasets



Pending GOES-17 to close the ring.

Important the overlapping region of GOES-16 (GOES-R class) and MSG-4 for cross validation of iSHAI products with the equivalent from NOAA.

Possibility to check improvements of iSHAI and the performance of iSHAI from GOES-16 and from MSG.

Further there exist the possibility to create IR dual iSHAI products.

PGE00 and SHAI: training and validation dataset construction

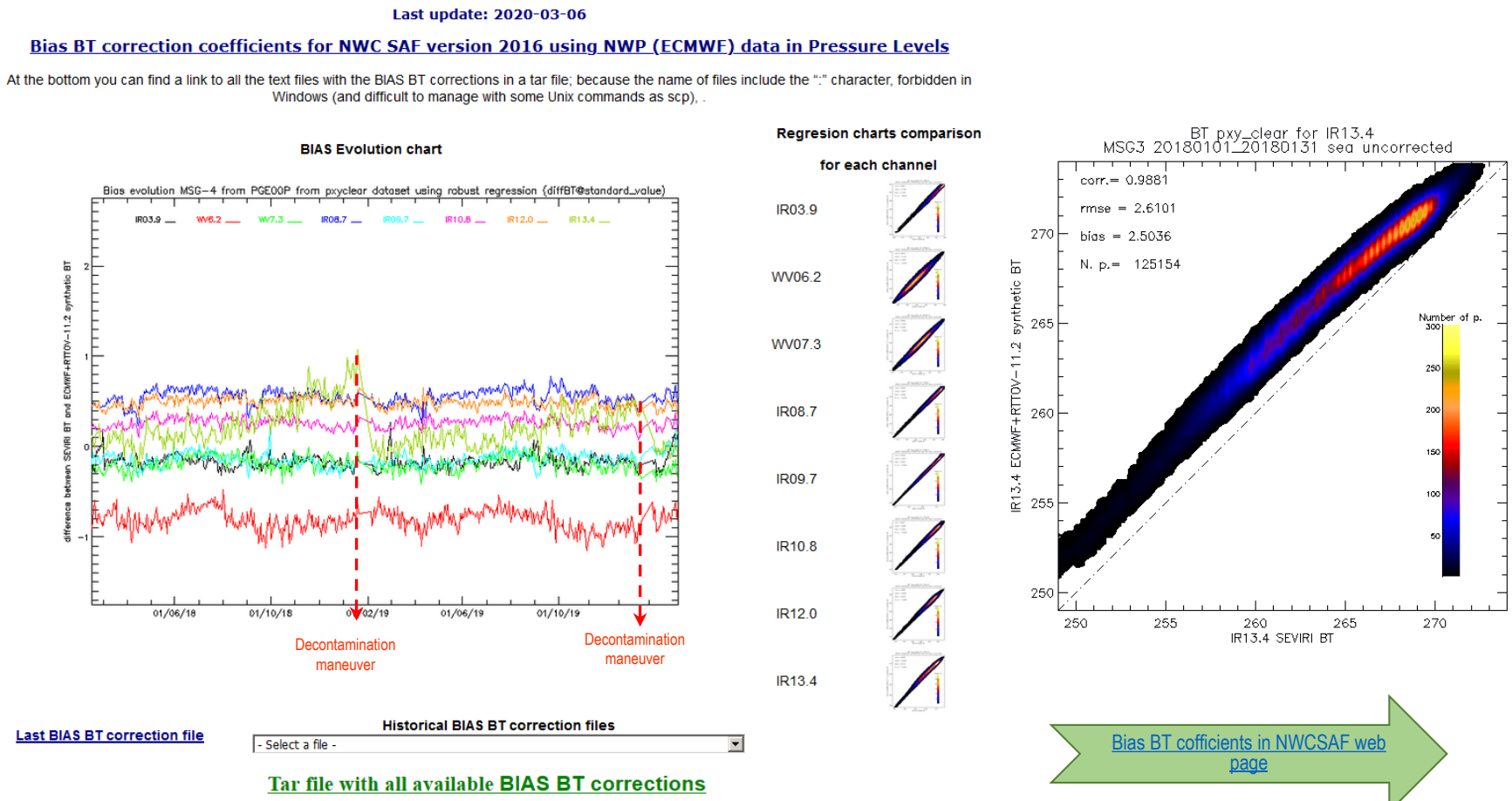
To build a training and validation dataset with real satellite data, ECMWF model is an important task.

This task is based in a continuous task of reprocessing at 00Z and 12Z of PGE00 or iSHAI only over a list of points *(RAOB positions and a grid of 1˚x1˚)* using *t+00* or *t+12* or *t+24* forecasts.

Binary files allows to create a dataset of (T, q, O_3, ..) profiles collocated with real radiances, etc.

Writing of validation reports, calculation of bias BT correction coefficients and training of new tuned physical retrieval coefficients are the main uses.

Evolution of the **bias correction between real BTs and synthetic BT_RTTOV** over sea pixels. Differences between a mean value before and after the bias correction calculated for a "moving average" window. **The full set of IR channels of every imager are monitored**.

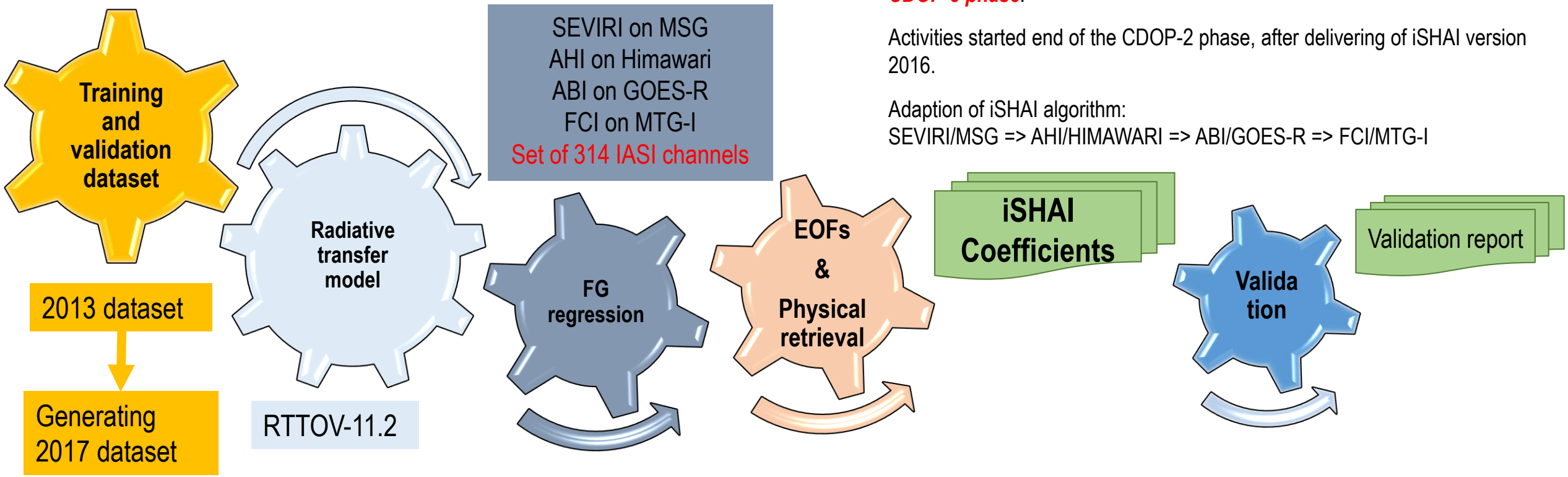


Training and validation activities on v2018

When the CDOP-3 proposal was written it was foreseen to have an early GEO/NWCSAF software for testing just before the ***MTG-I launch on end CDOP-3 phase***.

Activities started end of the CDOP-2 phase, after delivering of iSHAI version 2016.

Adaption of iSHAI algorithm:
SEVIRI/MSG => AHI/HIMAWARI => ABI/GOES-R => FCI/MTG-I

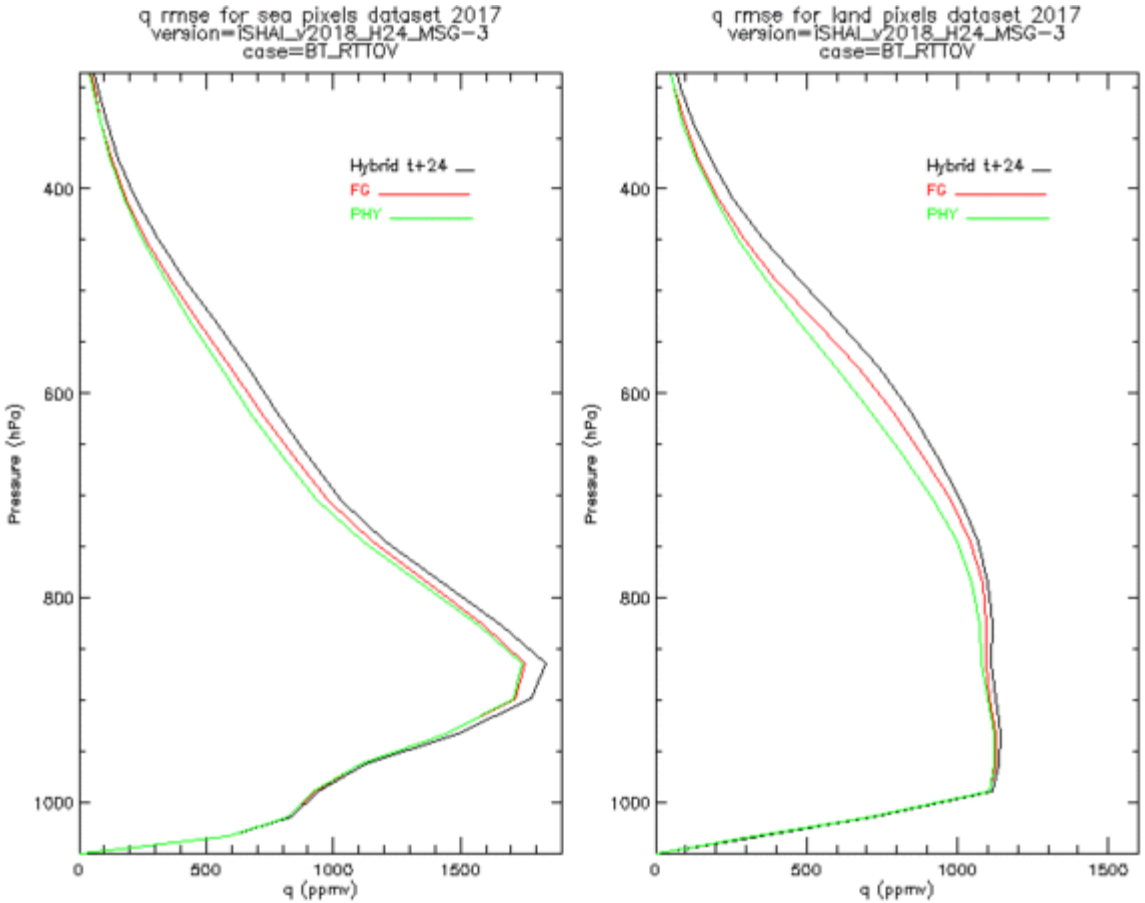


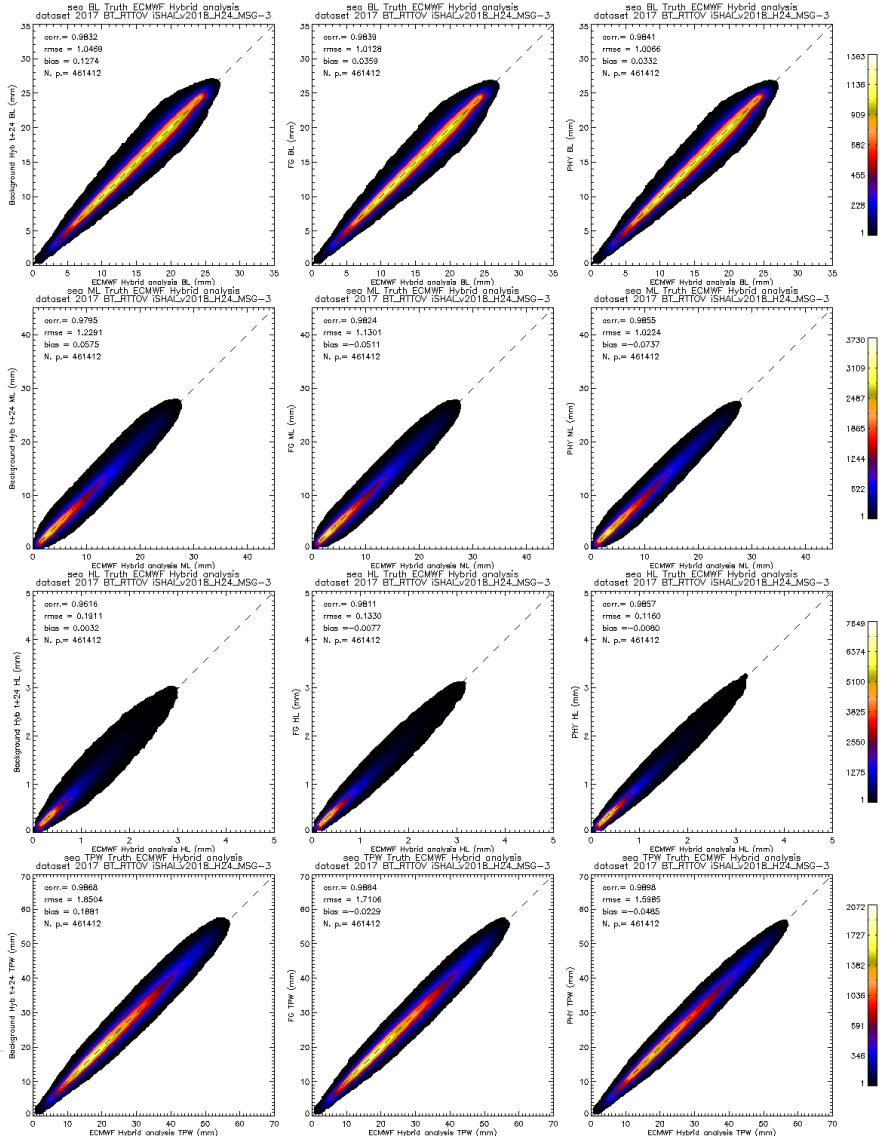
Comparative channels in SEVIRI/AHI/ABI/FCI

SEVIRI	12 channels	3x3km in IR	15 minutes temporal resolution.	**8 IR channels** (2 WV channels) (2 in split window).
AHI and ABI	16 channels	2x2 km in IR	10 minutes temporal resolution.	**10 IR channels** (3 WV channels) (3 in split window).
FCI will have	16 channels	2x2 km in IR	10 minutes temporal resolution.	**8 IR channels** (2 WV channels) (2 in split window).

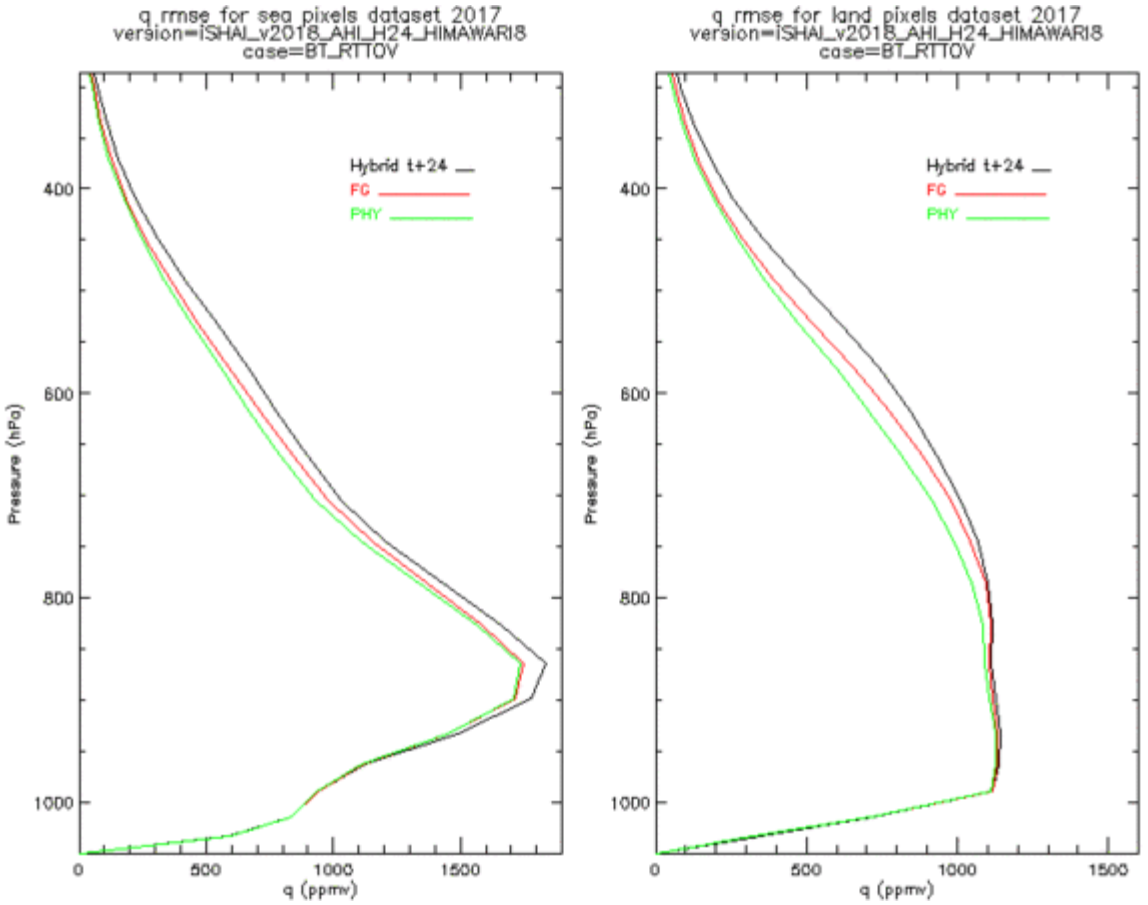
IRS will complement FCI

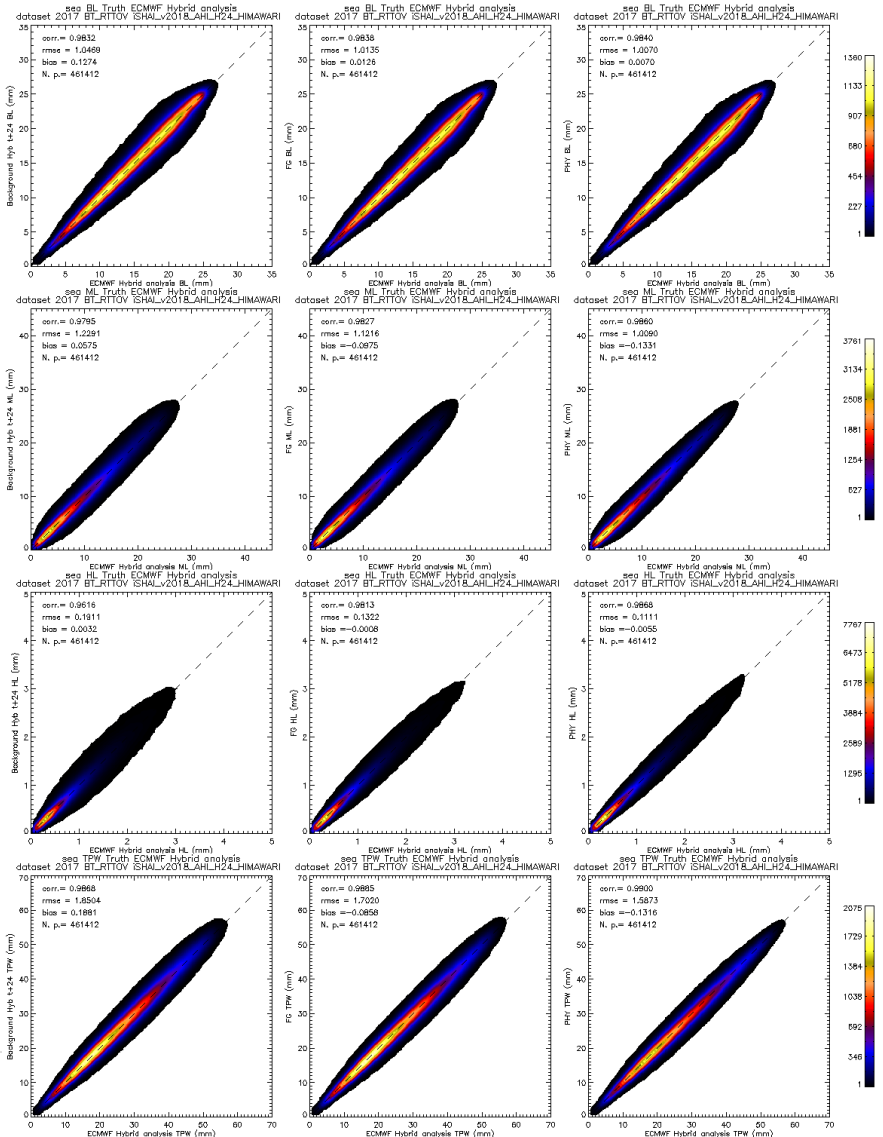
Developing and validation of iSHAI SEVIRI on MSG



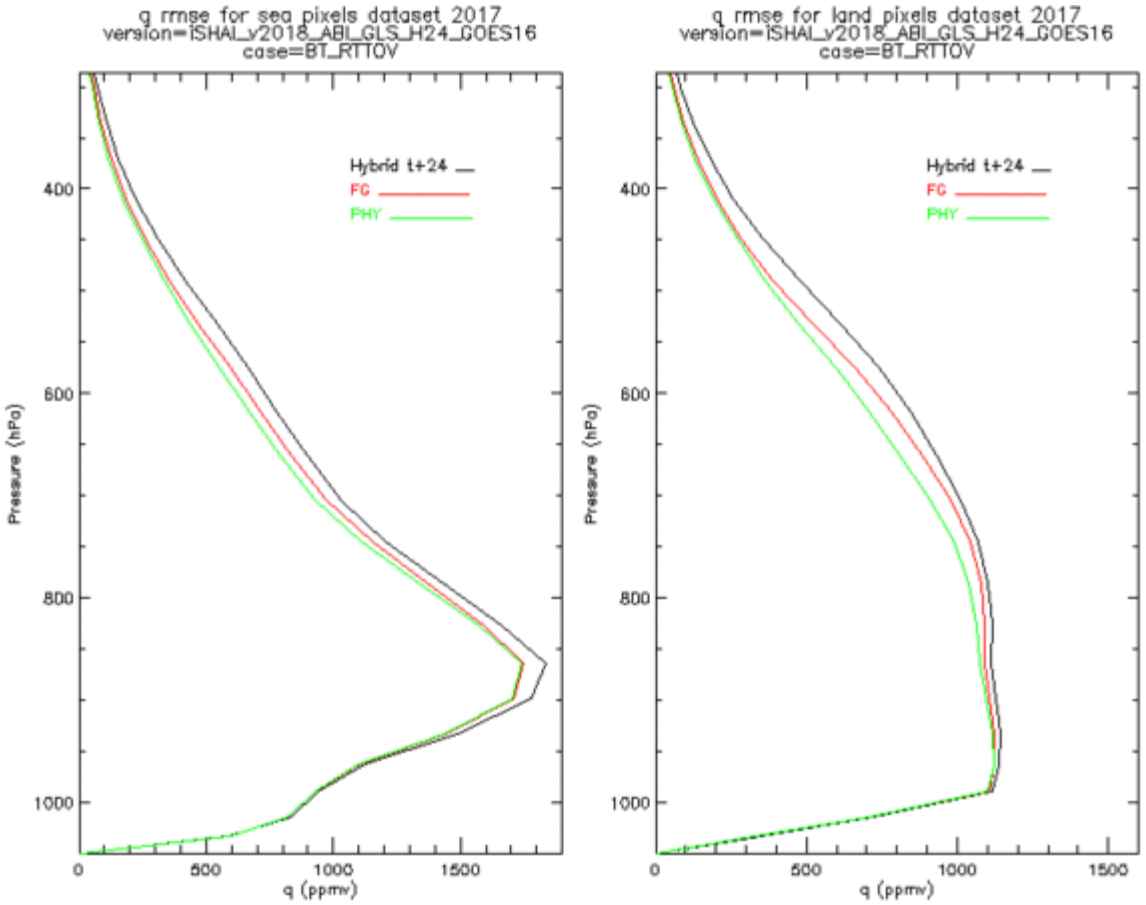


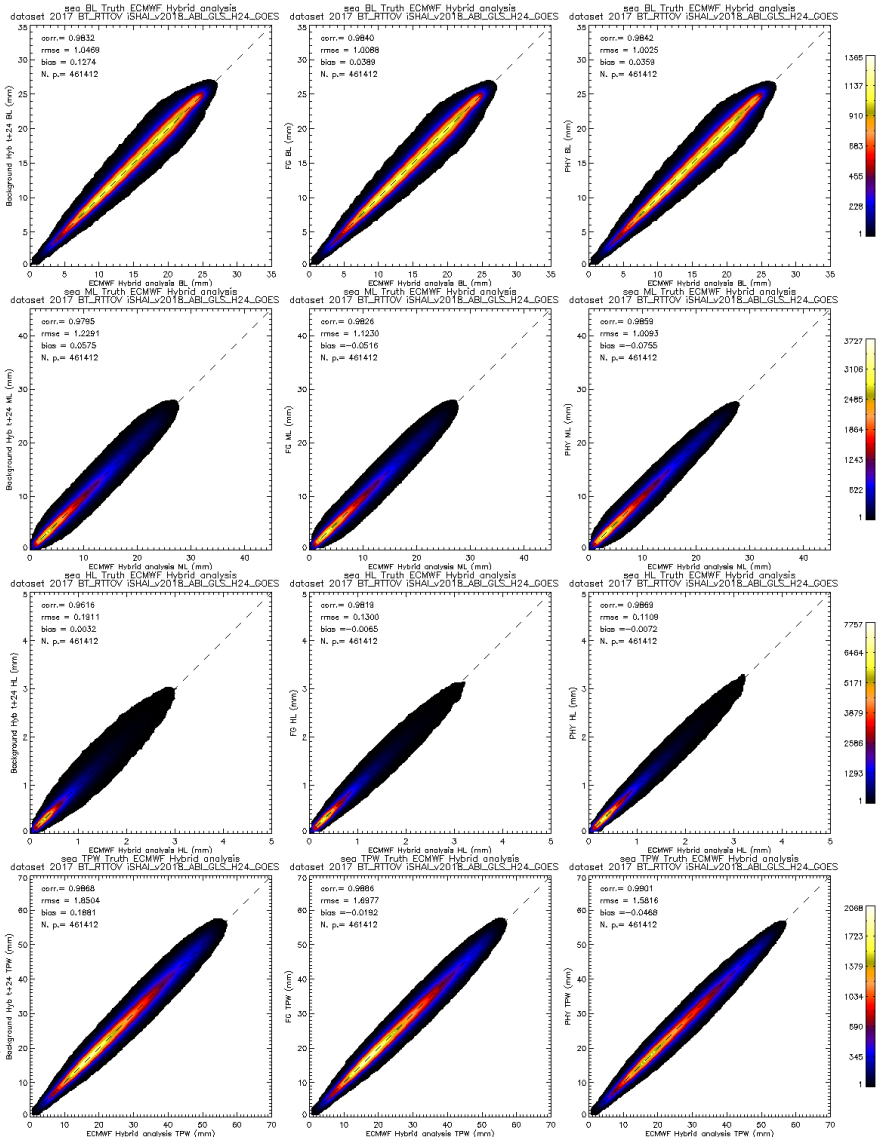
Developing and validation of iSHAI AHI on Himawari





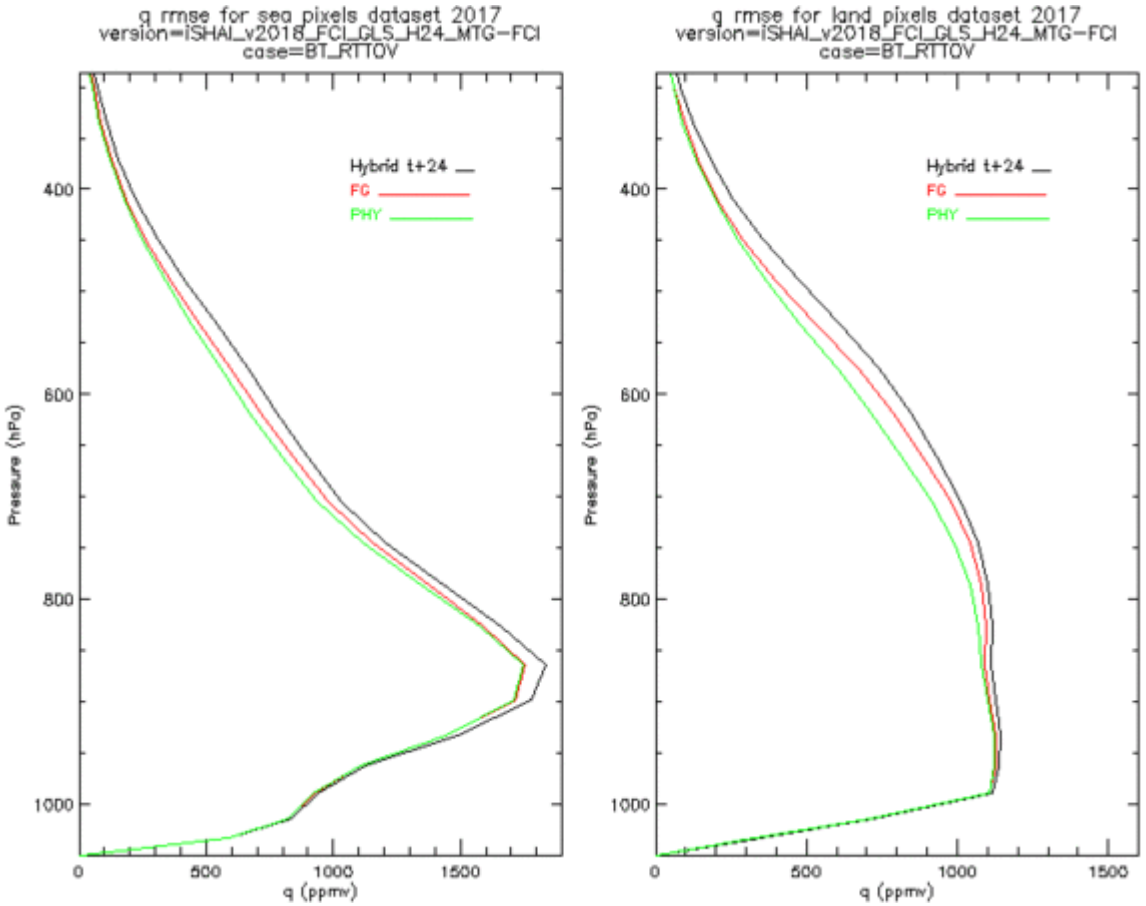
Developing and validation of iSHAI ABI on GOES-R





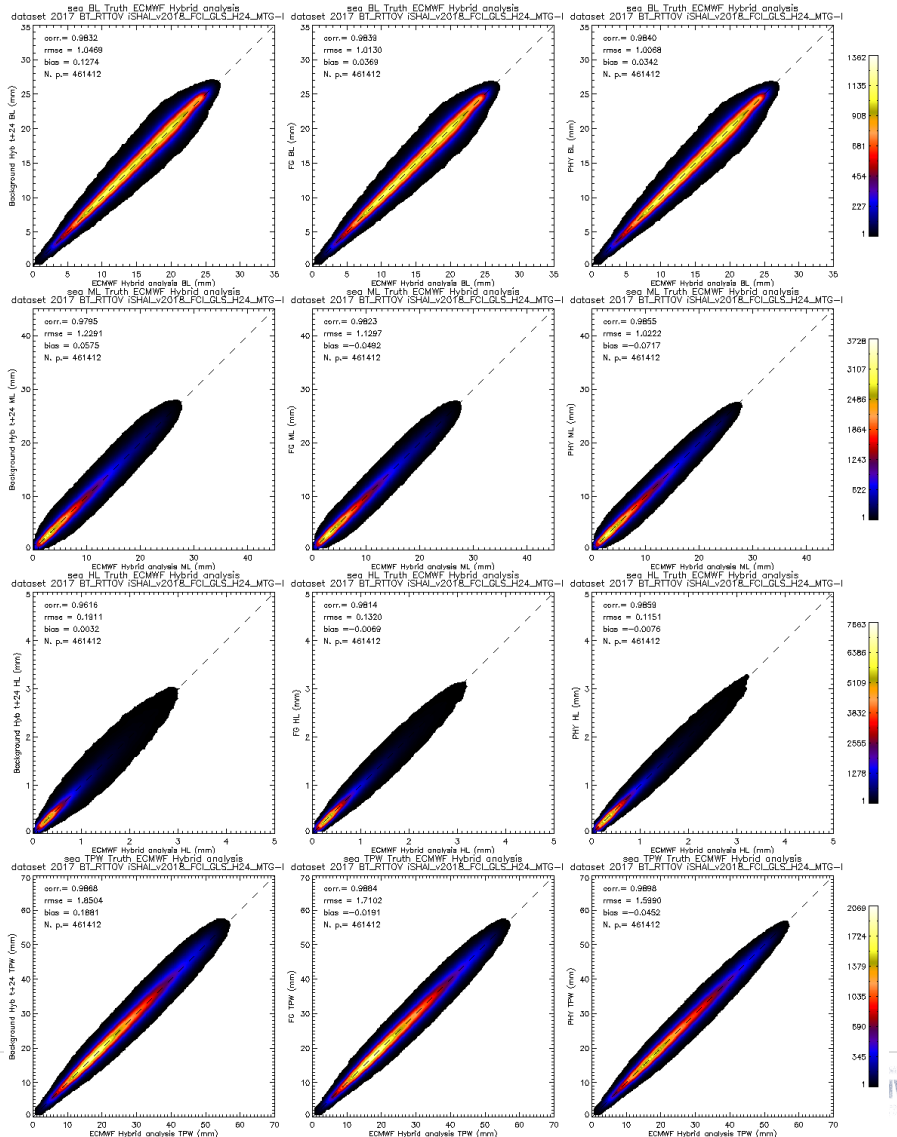
It is better ABI vs AHI because it has been same noise in every zenith angle

Developing and validation of iSHAI FCI on MTG-I



It is the basis to develop the future NWC SAF iSHAI MTG-FCI Day-1 MTG-I day1 algorithm will be tuned with first set of MTG/FCI data

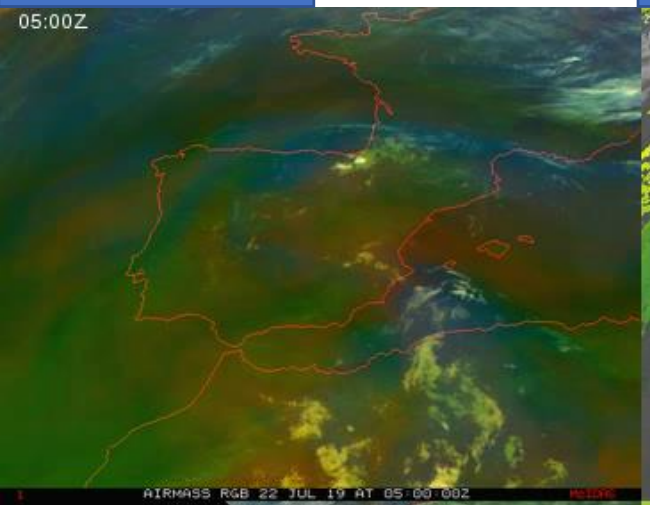
The performance of MTG-FCI is similar to the MSG-SEVIRI one. Taking into account that MTG-FCI will have better spatial and temporal resolution than MSG-SEVIRI, the MTG-FCI performance with real data will be better.



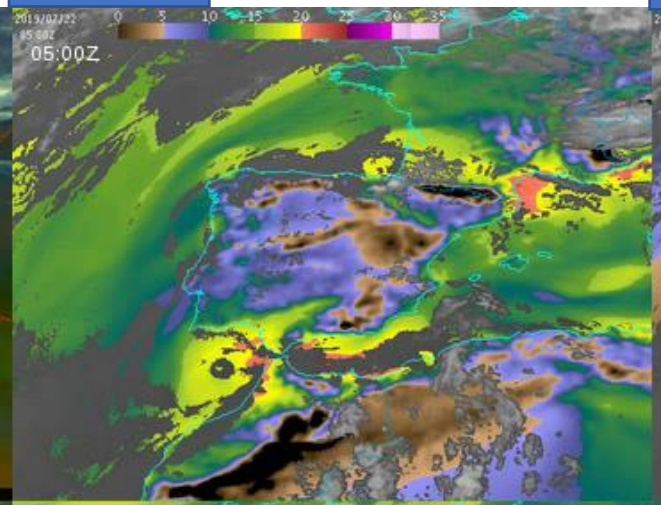
It is better FCI vs MSG because it has been same noise in every zenith angle

Example of combined use of iSHAI, PGE00 and real RGB images: 22th July 2019

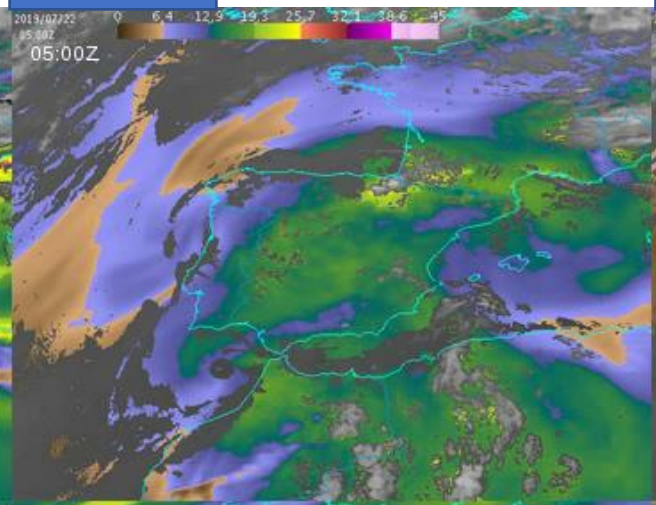
AIRMASS RGB



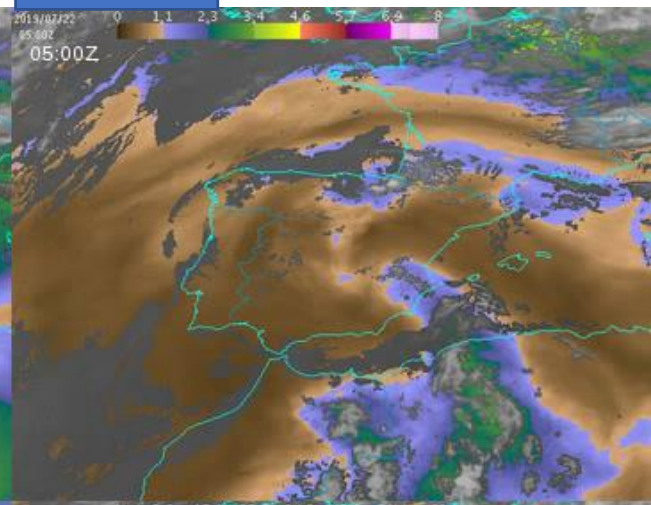
iSHAI BL

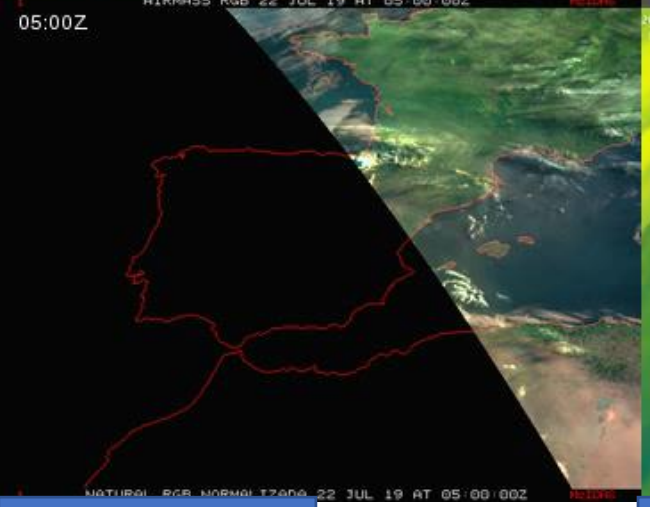


iSHAI ML

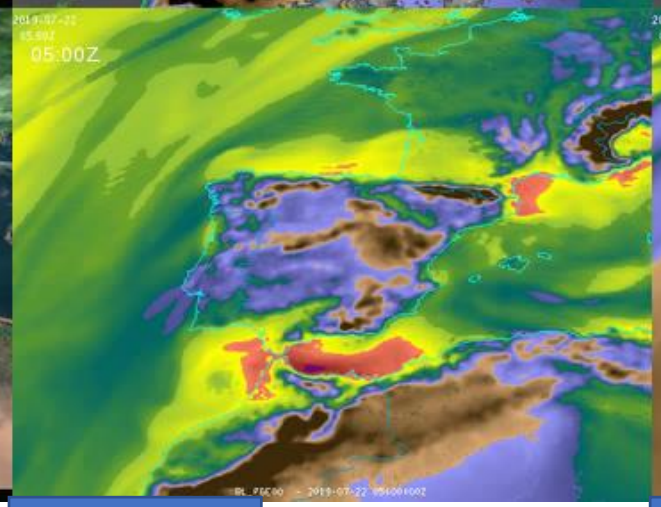


iSHAI HL

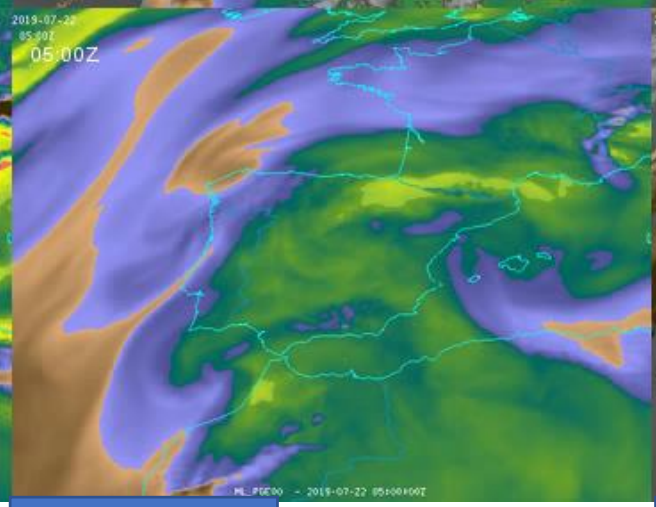




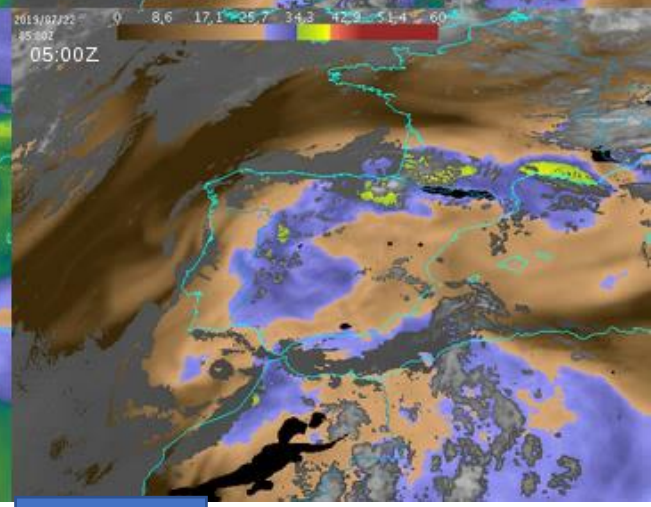
NATURAL RGB



ECMWF BL



ECMWF ML



iSHAI KI

Corrected to same sun position and hour

BL
Precipitable Water in Boundary Layer
(P_{sfc}- 850hPa)

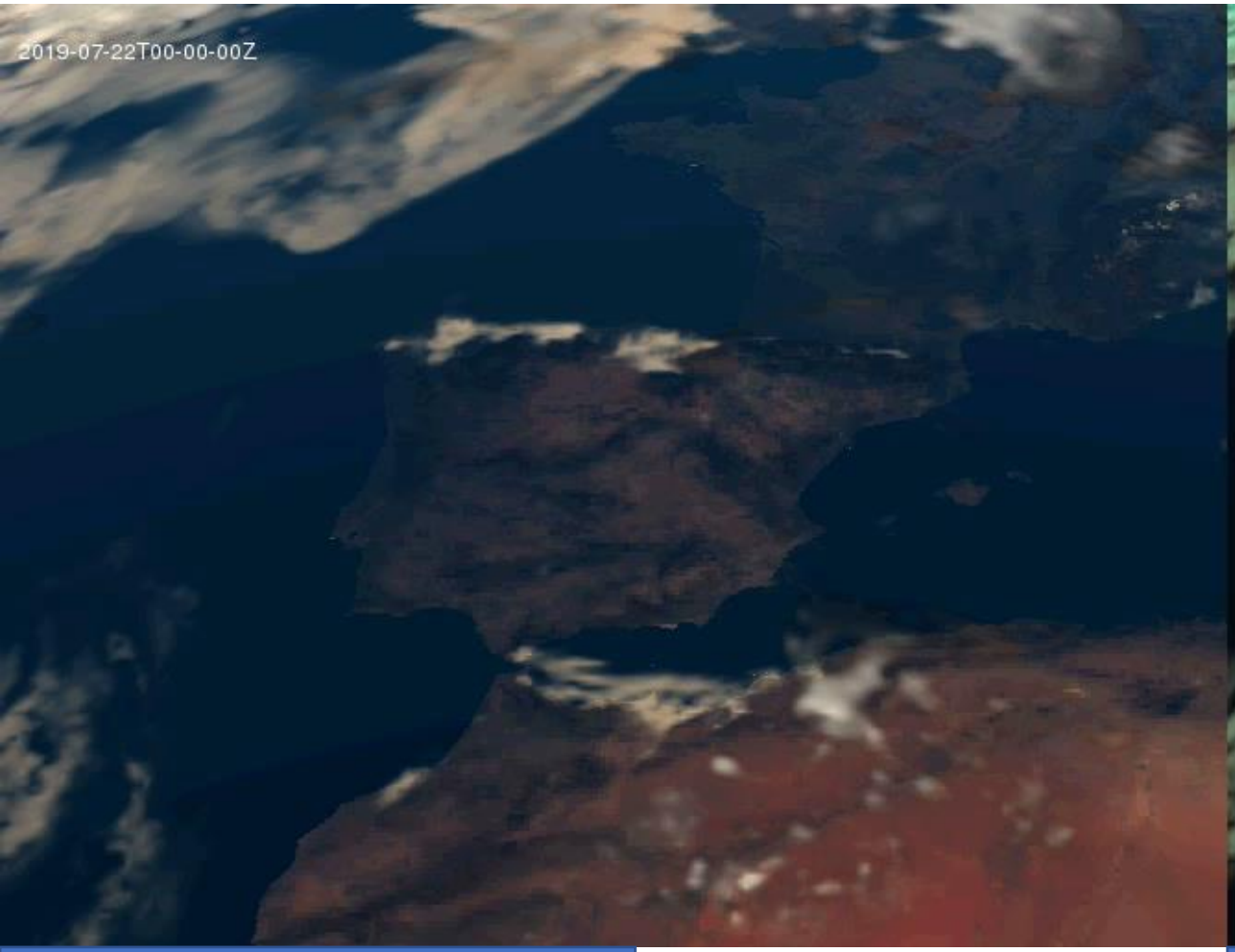
ML
Precipitable Water in Middle Layer
(850-500 hPa)

HL
Precipitable Water in High Layer
(500-0.1 hPa)

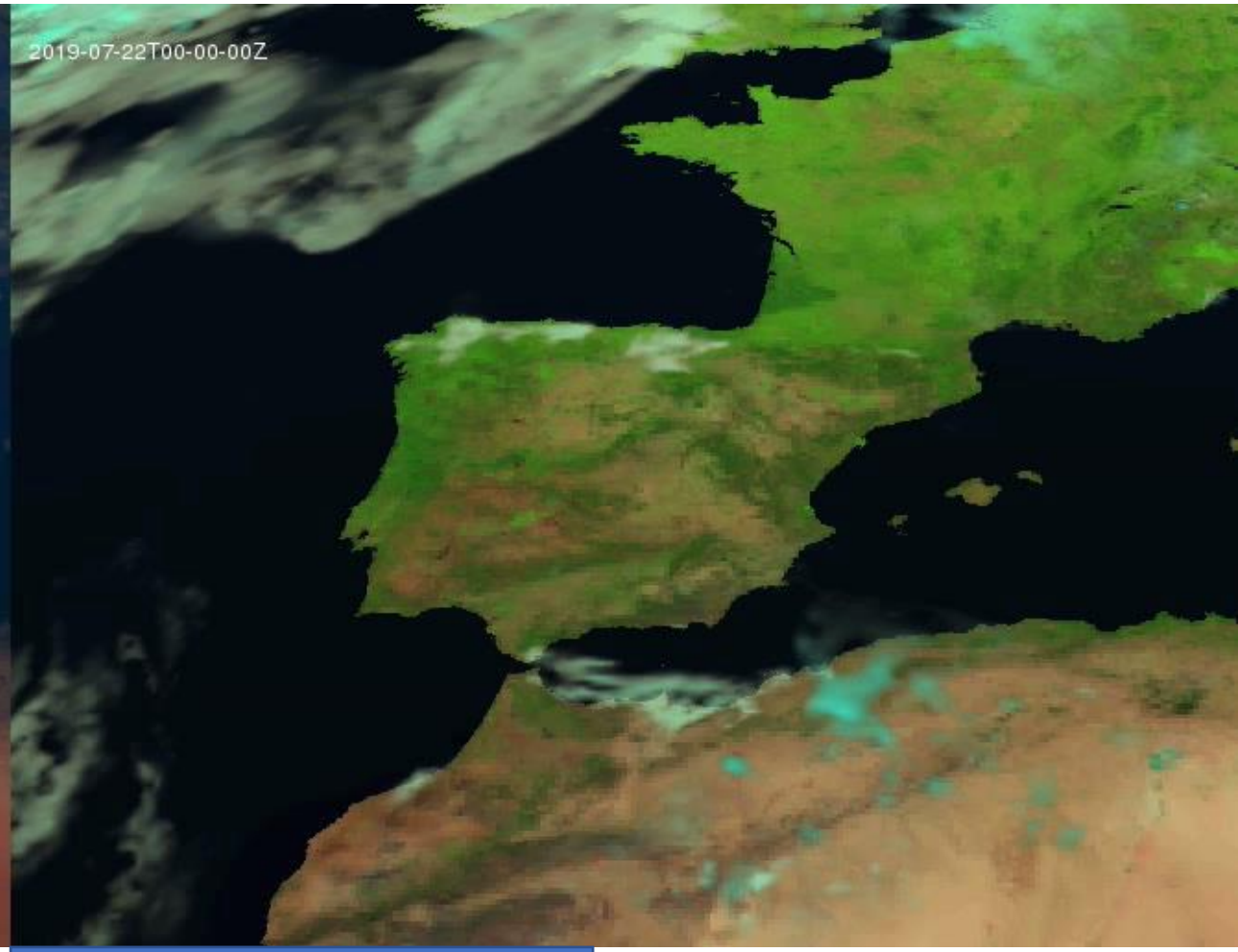
Loop available in an AVI file in this NWC SAF web page

MTG-I FCI synthetic data: example 22th July 2019

PGE00 with RTTOV-12.1 simulation with high quality in IR and VIS clear or with clouds



Synthetic MTG/FCI True color RGB



Synthetic MTG/FCI natural RGB

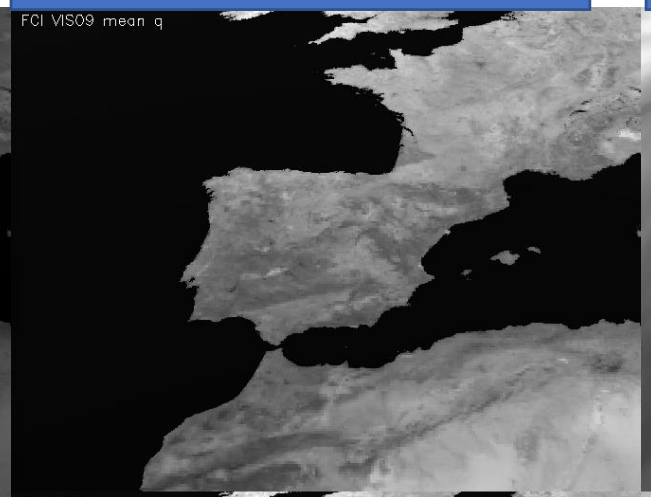
NWC SAF software package could be used to made the reflectance atmospheric correction to get high quality true color RGB images.

Loop available in an AVI file in this NWC SAF web page

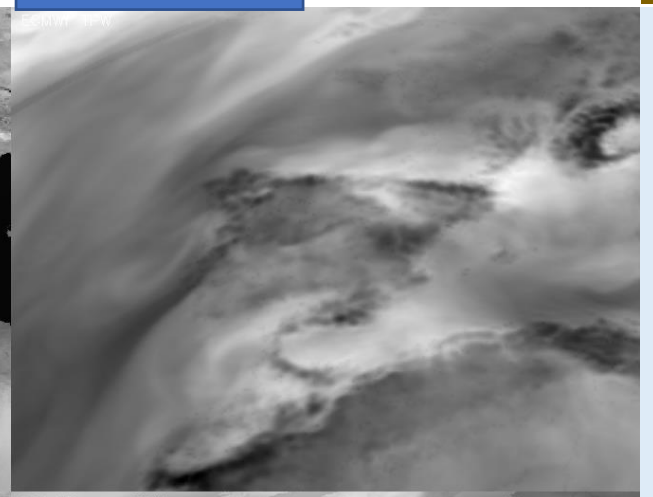
TPW with blended technique from MTG-FCI VIS0.9

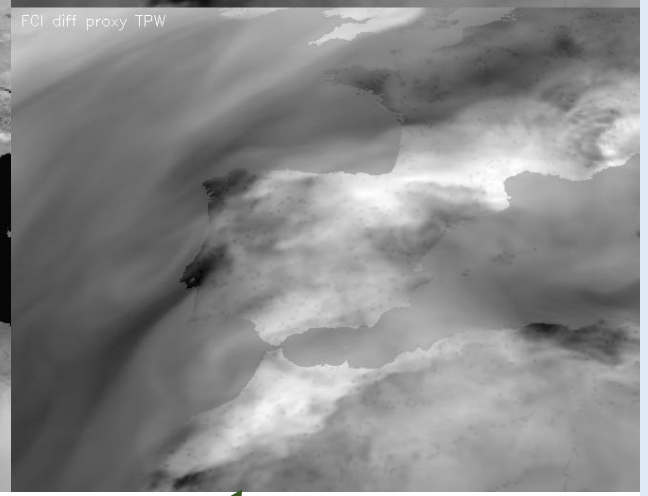
FCI VIS0.9

FCI VIS0.9 with mean q profile



ECMWF TPW





FCI VIS0.8

FCI VIS0.8 with mean q profile

Loop available as animated GIF in this NWC SAF web page

(Log(VIS0.9) -Log(VIS0.9mean_q)) - (Log(VIS0.8) -Log(VIS0.8mean_q))

22th July 2019

MTG-FCI VIS0.9 is a WV absorption channel in VIS range. Thus, it is of interest in convection

Developing of new RGBs or products with this channel will help to validate the iSHAI product.

Opportunity to test with Sentinel-3 products on cases studies and simulations; not shown here reprojection S3<==> NWCSAF.

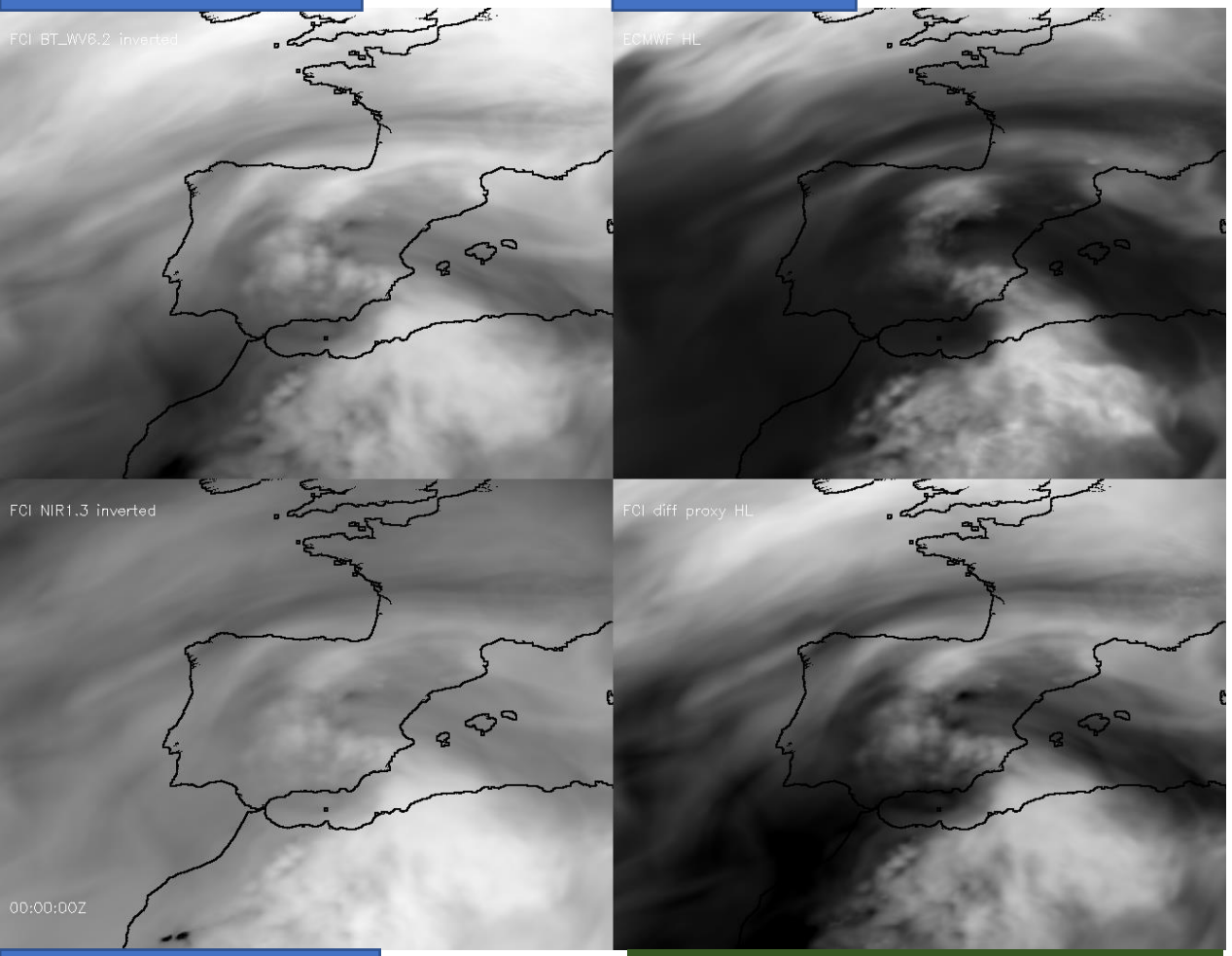
Opportunity target since PGE00 with RTTOV-12.1 developments allows simulation with high quality in IR and VIS. Not foreseen developments in CDOP-3 proposal.

Similar to case study presented on CWG 2018 on Ljubljana

HL proxy with blended technique from MTG-FCI NIR1.3

BT WV6.2 inverted

ECMWF HL



FCI NIR1.3 inverted

(Log(NIR1.3) -Log(NIR1.3mean_q))

22th July 2019

MTG-FCI NIR1.3 is a strong WV absorption channel in NIR range. Thus, it is of interest in convection

Developing of new RGBs or products with this channel will help to validate the iSHAI product.

Opportunity to test with GOES-R class satellite using NWCSAF/GEO v2018.1 with GOES-16 and PGE00 on cases studies and simulations.

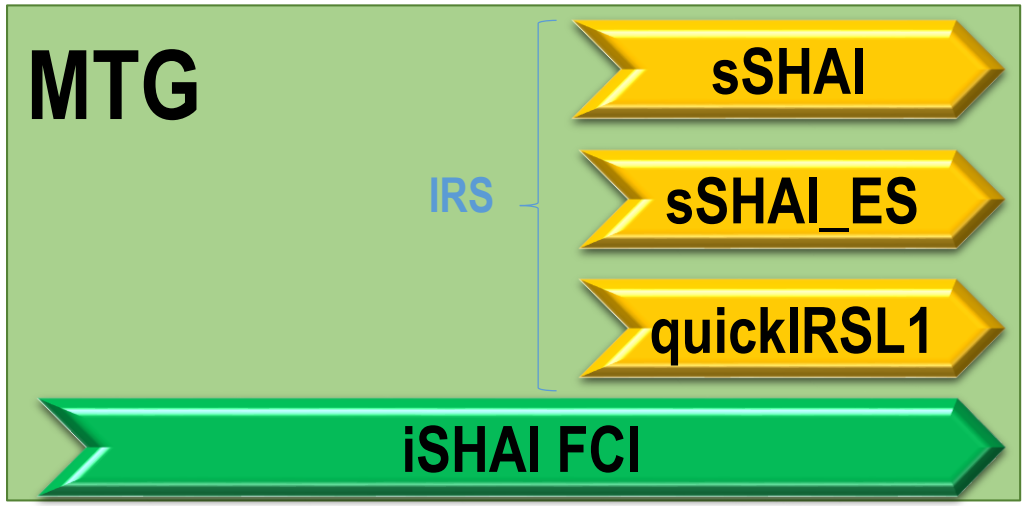
Opportunity target since PGE00 with RTTOV-12.1 developments allows simulation with high quality in IR and VIS

Loop available as animated GIF in this NWC SAF web page

SHAI roadmap for MTG-IRS

2016 2018 2020 2021 2022 2023

iSHAI (imager **S**atellite **H**umidity **A**nd **I**nstability)
sSHAI (sounder **S**atellite **H**umidity **A**nd **I**nstability)



PGE13
iSHAI MSG
iSHAI AHI
iSHAI ABI
PGE00
Synthetic MSG RGBs
Synthetic MTG FCI RGBs

NWC SAF products and services for MTG-IRS

NWC SAF provides software for use of satellite data in Nowcasting.

NWC-SAF products are generated locally by users => No bandwidth constraints on local generated products.

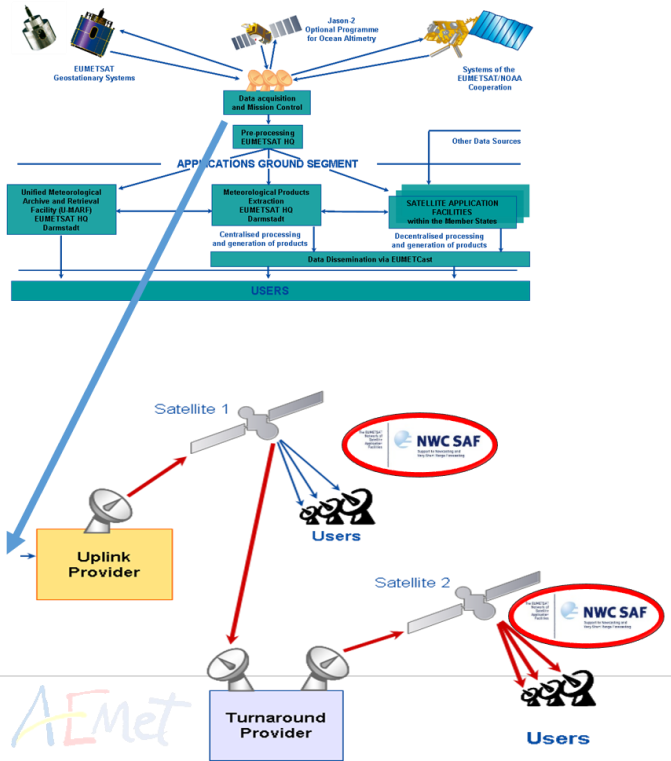
NWC-SAF is the SAF nearest to users. It works in the users side of the EUMETCast

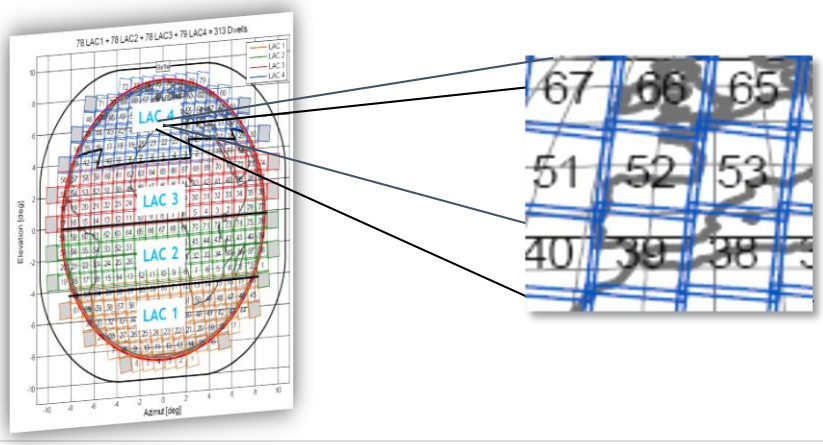
Plan for MTG: to offer a user friendly software to manage the FCI, LI and IRS L1 data and to generate L2 Nowcasting products. **The main objective is to explore the synergies and differences of MTG-FCI and MTG-IRS products and the background NWP.** They will be prepared during CDOP-3 and they will be available at Day-2.

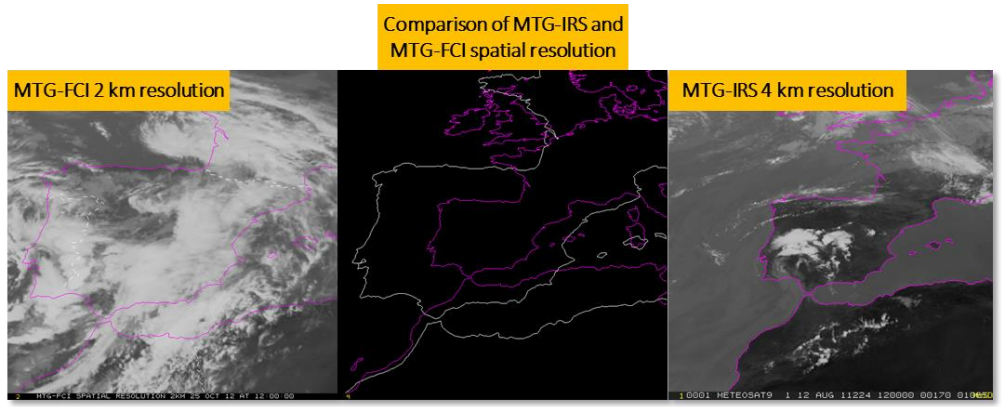
Key point: NWCSAF as integration and reprojection tool:

MTG-IRS will have the half of spatial resolution of MTG-FCI. MTG-IRS will explore in "dwells" of 160x160 pixels at 4x4 km **resolution with no reprojection on a common GEO grid.**

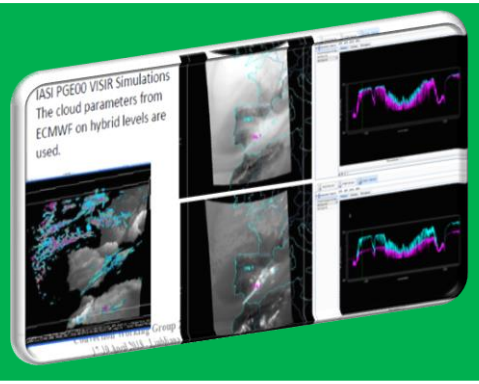
Thus, to cover a region ***it is needed of one re-projection and joining of dwell files tool to get one user interest region***. The default projection will be regions on MTG-FCI projection with FCI IR or half of FCI IR resolution.





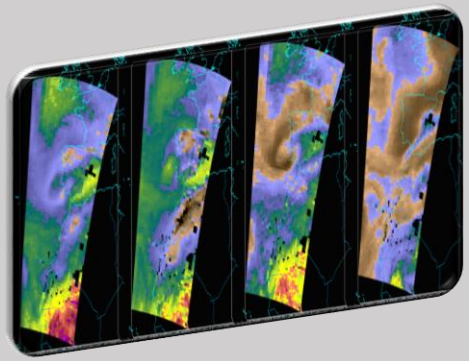


qIRS: Quick IRS product



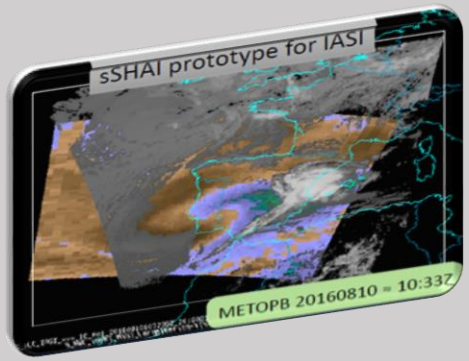
qIRS: Quick IRS product

- **Principal Components to BTs conversion and IRS L1 images generation on NWC SAF region:** PC to BTs at dwells, combination and reprojection of users selected MTG-S L1 BTs from dwells to user NWC SAF defined regions.
- Generation of IRS L1 imagery related products; as example RGB images.



sSHAI_ES: sounder Satellite Humidity And Instability from Eumetsat Secretariat

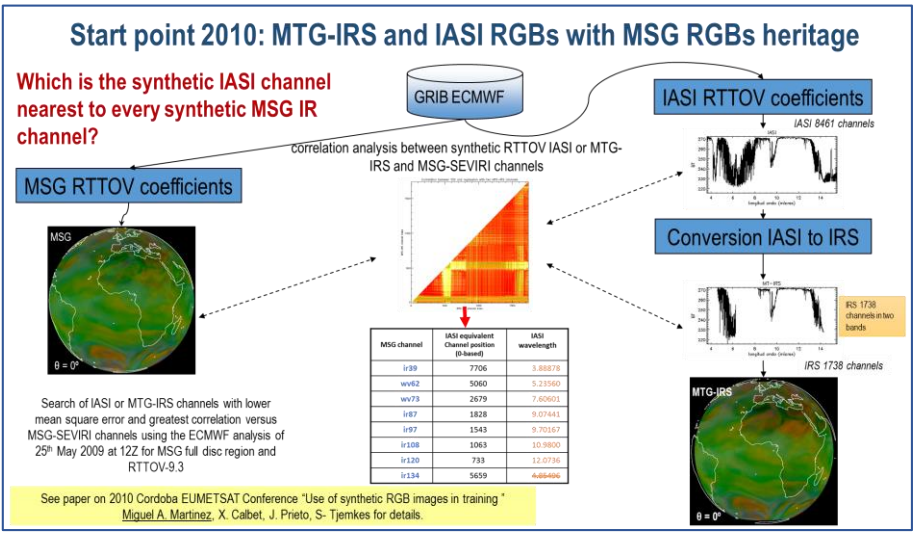
- **EUMETSAT Secretariat(ES) MTG-IRS L2 service:** combination and reprojection of 2D and 3D fields from dwells to user NWC SAF defined regions; calculation of nowcasting parameters (TPW, LPW and instability indices) at dwells. Add fields as IR images on cloudy pixels.



sSHAI: sounder Satellite Humidity And Instability from NWC SAF

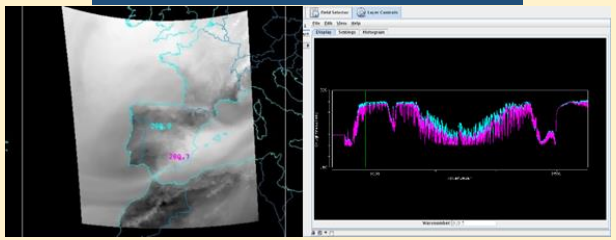
- Local NWCSAF MTG-IRS L2 product generation. Locally executed light CPU algorithms for retrieval of T, q profiles using as input local NWP models.
- Calculation of nowcasting parameters (TPW, LPW and Instability indices) at dwells. Combination and reprojection of dwells to user NWC SAF defined regions

qIRS: Quick IRS products (past activities)

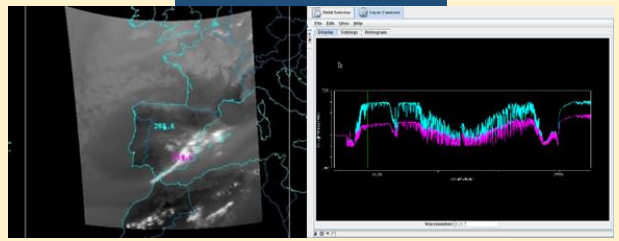


Examples with synthetic IASI images: using PGE00 to simulate IASI L1 spectra, convert to netCDF and display with McIDAS-V.

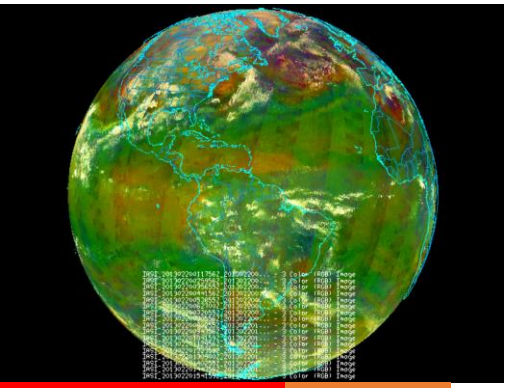
Clear air IASI simulations



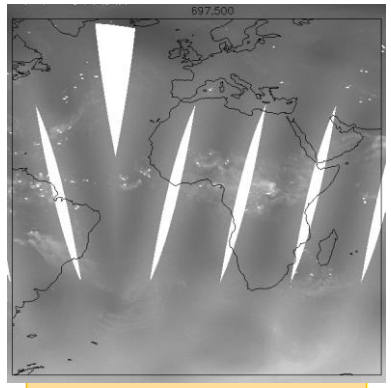
Cloudy air IASI



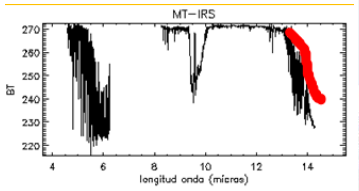
Early examples with real IASI images:
using converters from IASI L1 to netCDF



Real IASI airmass RGB 20-February-2013

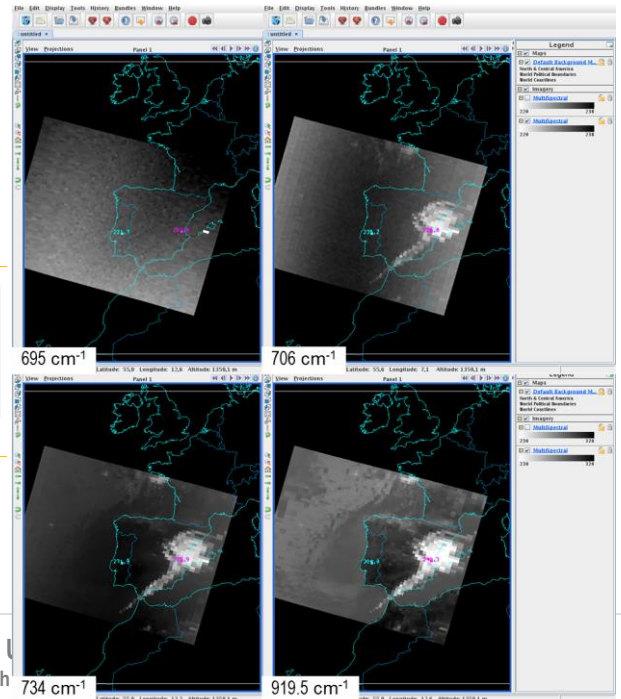


top to down quick looks

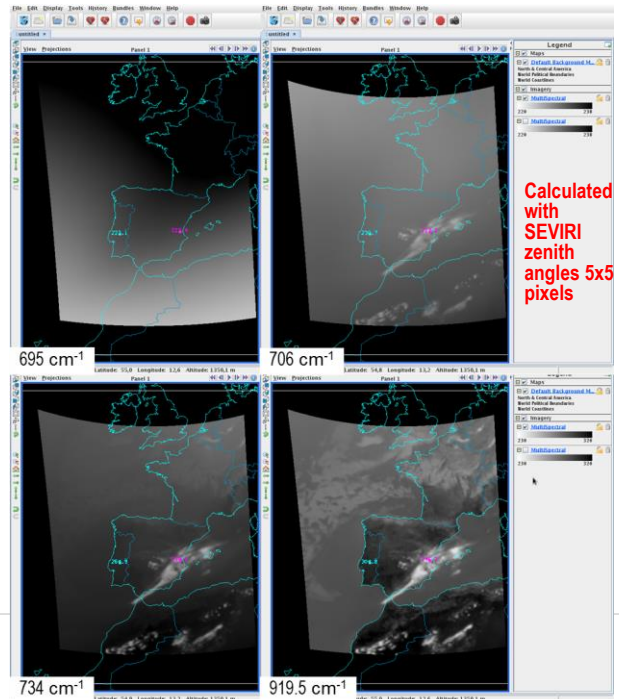


IR absortion peaks on [650 cm^{-1}, 824 cm^{-1}]

Real IASI METOP-B Image
2016-08-10T10:32:26Z



IASI Synthetic RTTOV-12.1
2016-08-10T12:00Z ECMWF *t+12*



Current activities

Loop available as animated GIF in this NWC SAF web page

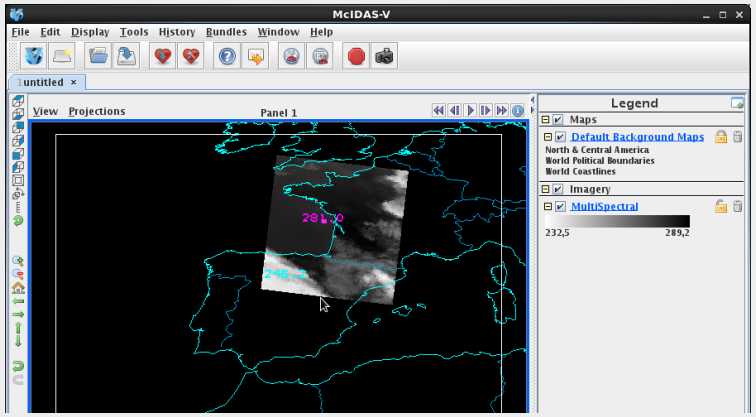
Improve of training database and software for quick-IRS L1:

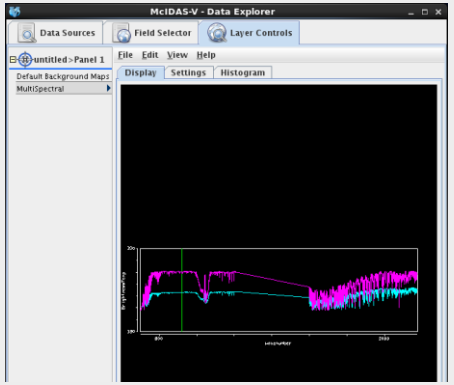
- ✓ IASI clear synthetic BTs spectra for a reduce dataset from 2017 training dataset with original profiles. Also IASI clear synthetic BTs spectra after perturbation of T, q and ozone profile.
- ✓ IASI PGE00 VISIR Simulations from several cases studies very 30 minutes on 1x1 pixels on region with size of one IR dwell. Using ECMWF GRIB files on hybrid levels every 1 hour at 0.1x0.1º resolution on request to MARS.The cloud parameters from ECMWF on hybrid levels are used.

They will be used for:

- other determination of channels for RGB images.
- conversion to MTG-IRS while not updated RTTOV MTG-IRS coefficient
- Look for changes IASI spectra in instability

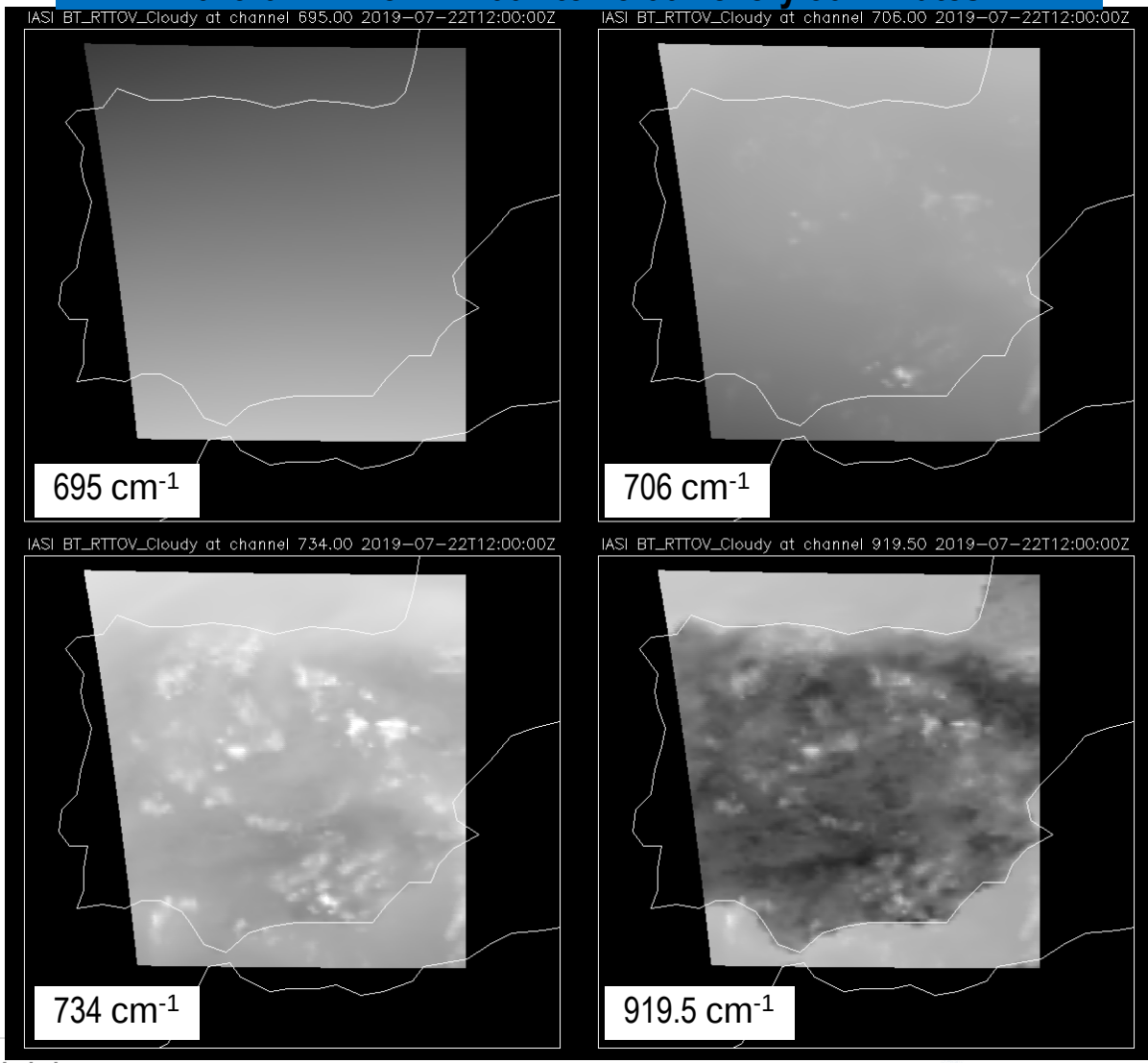
It has been made a reader for the test EUMETSAT IRS-L1 netCDF file and converted to a McIDAS-V compatible netCDF format





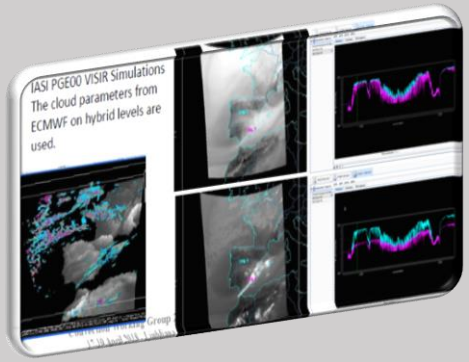
Loop of IASI synthetic RTTOV-12.1 BT

2019-07-22 from 12:00Z to 18:00Z every 30 minutes



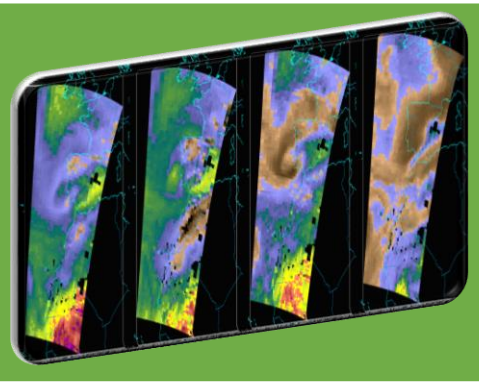
Calculated with SEVIRI zenith angles and resolution 1x1 pixels

NWC SAF services for MTG-S IRS



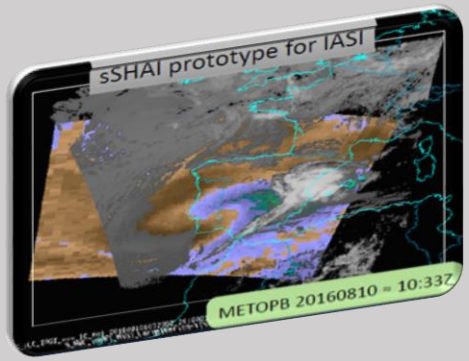
qIRS: Quick IRS product

- **Principal Components to BTs conversion and IRS L1 images generation on NWC SAF region:** PC to BTs at dwells, combination and reprojection of users selected MTG-S L1 BTs from dwells to user NWC SAF defined regions.
- Generation of IRS L1 imagery related products; as example RGB images.



sSHAI_ES: sounder Satellite Humidity And Instability from Eumetsat Secretariat

- **EUMETSAT Secretariat(ES) MTG-IRS L2 service:** combination and reprojection of 2D and 3D fields from dwells to user NWC SAF defined regions; calculation of nowcasting parameters (TPW, LPW and instability indices) at dwells. Add fields as IR images on cloudy pixels.



sSHAI: sounder Satellite Humidity And Instability from NWC SAF

- Local NWCSAF MTG-IRS L2 product generation. Locally executed light CPU algorithms for retrieval of T, q profiles using as input local NWP models.
- Calculation of nowcasting parameters (TPW, LPW and Instability indices) at dwells. Combination and reprojection of dwells to user NWC SAF defined regions

sSHAI_ES: sounder SHAI from Eumetsat Secretariat

Eumetsat Secretariat (ES) MTG-IRS L2 service:

- ❖ calculation of nowcasting parameters (TPW, LPW and Instability indices) at dwells if not disseminated (calculation of additional ones).
- ❖ Combination and reprojection of 2D and 3D variables from dwells to user defined regions

101 levels (or 137 hybrid levels) are hard to manages for the forecaster then the optimal is interpolate to users fixed pressure levels and to calculate precipitable water on several layer and instability indices.
Better to add a cloud image on non processed pixels.

Scheme on tasks in proxy ES IASI L2process used in next slides:

netCDF reader and converser

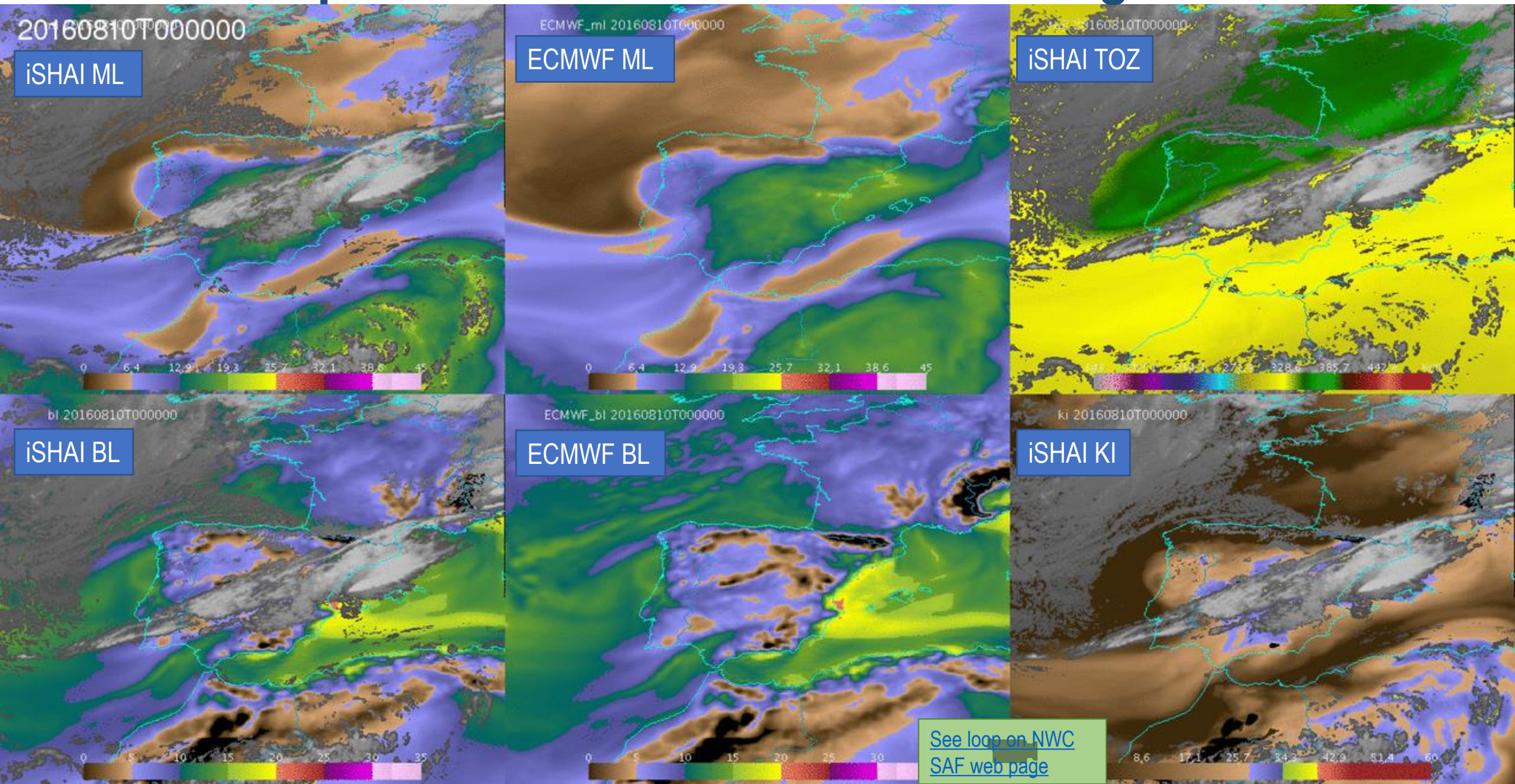
- Read netCDF *(using GDL and HDF-5 API)*
- Subsetting the interest region from the full orbit
- Reorder the IASI detectors
- Calculated relative humidity profile
- Calculated the same NWCSAF parameters (TPW, LPW and stability indices)
- Calculated sigma T and q profiles

Re-projection and writing on NWC SAF iSHAI netCDF on NWC SAF region

- Interpolation to 54 RTTOV pressure levels (used in iSHAI optional binary files as proxy of future users need)
- Subsetting the interest region
- Writing on McIDAS-V compatible netCDF files. 3D arrays in pressure levels in range [200, 1000 hPa]

- ✓ In the following slides the figures have been generated with IDL and GDL using as proxy IASI L2 v6.2 from UMARF
- ✓ IDL and GDL code was started during the collaboration with the Proxy MTG-IRS experiment (Stephen Tjemkes)
- ✓ It has been calculated the same layers than in in NWC SAF iSHAI.
- ✓ Used McIDAS-V as the foreseeable tool for interactive comparison and 3D use of proxy IRS-L2 and comparison with NWP.
- ✓ IASI L2 LPW and Instability indices with NWCSAF palette. Optimal to use same palettes.

Example of iSHAI and PGE00: 10th August 2016

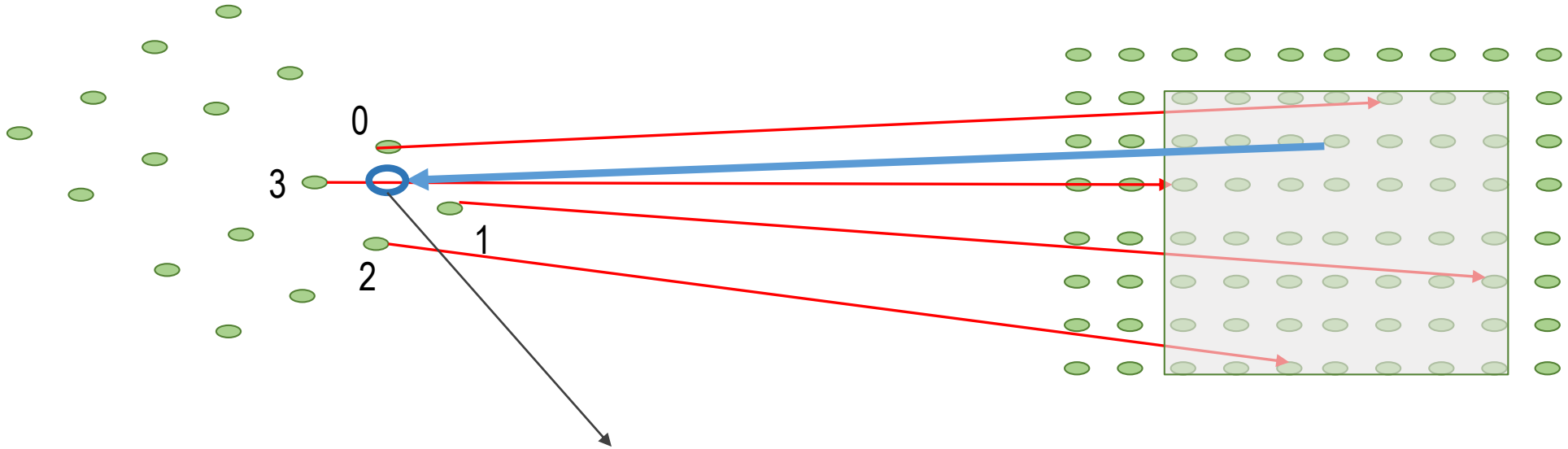


Early reprojection examples

NWC SAF as integration and reprojection tool. It has been started the study of optimal and fast reprojection algorithm from IASI pixels (as proxy of MTG-IRS) to NWC SAF regions (subsets of GEO reprojection grid).

The early prototype is written in IDL. It is based in:

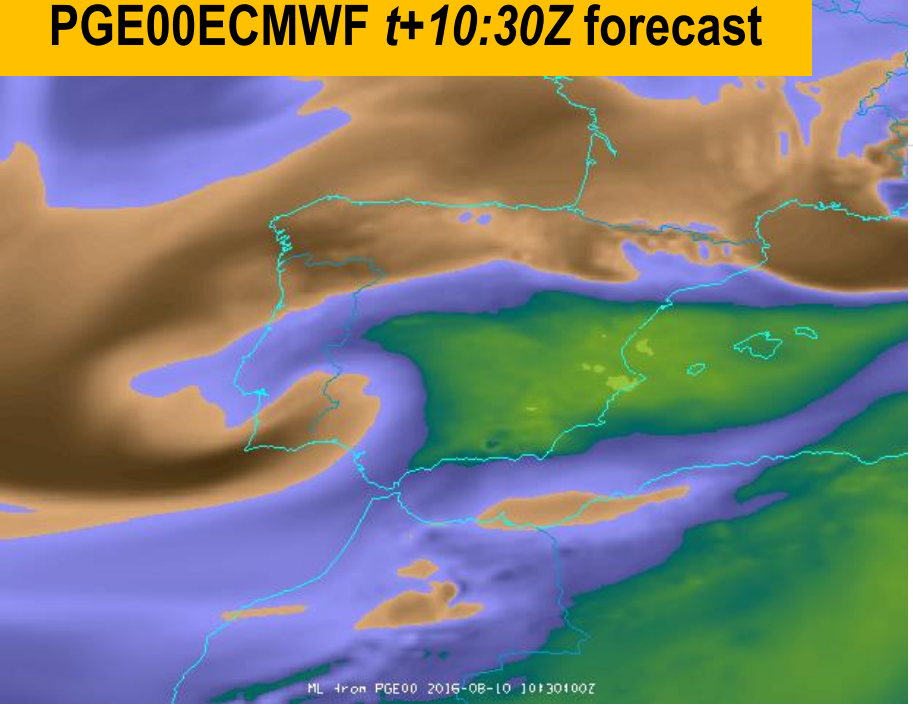
a) Search valid pixels in IASI array
b) For every valid IASI pixel use the (longitude, latitude) of the IASI pixels and a function (lon,lat) => (column, line) in MSG grid to calculate the (column, line) in the NWC SAF region for the 4 IASI corners.
c) For every GEO pixel between the corners, calculate the distances of the GEO pixel to the 4 IASI neighbors and calculate de value on GEO pixel as combination of the value in the 4 IASI neighbors weighted for the inverse of the square of the distances.



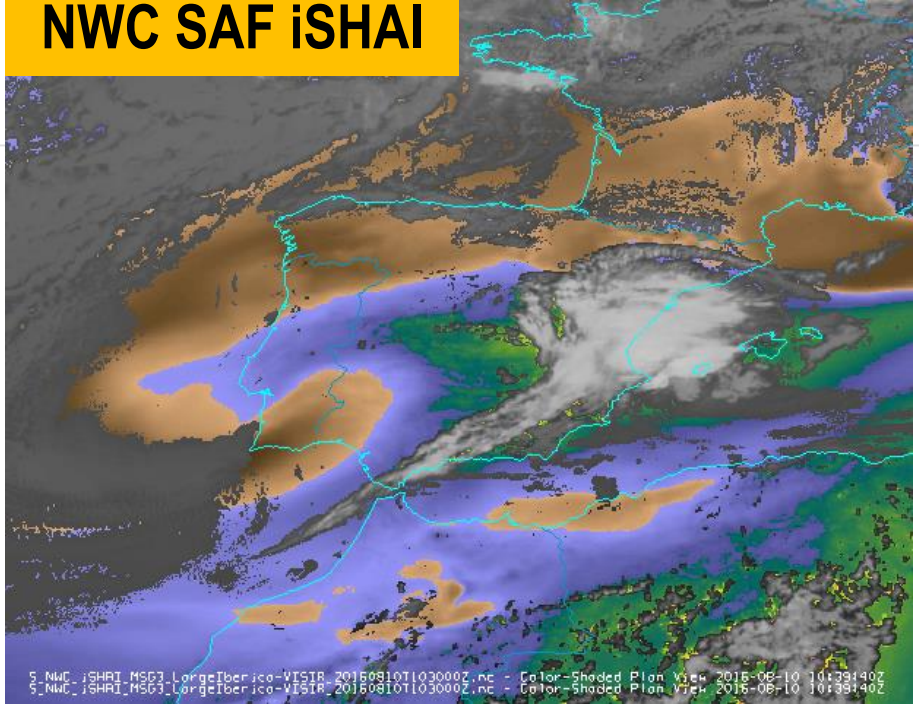
$$v= (v_0*f(d_0)+ v_1*f(d_1)+ v_2*f(d_2)+ v_3*f(d_3))/(f(d_0)+f(d_1)+f(d_2)+f(d_3))$$

ML
Precipitable Water in Middle Layer (850-500 hPa)

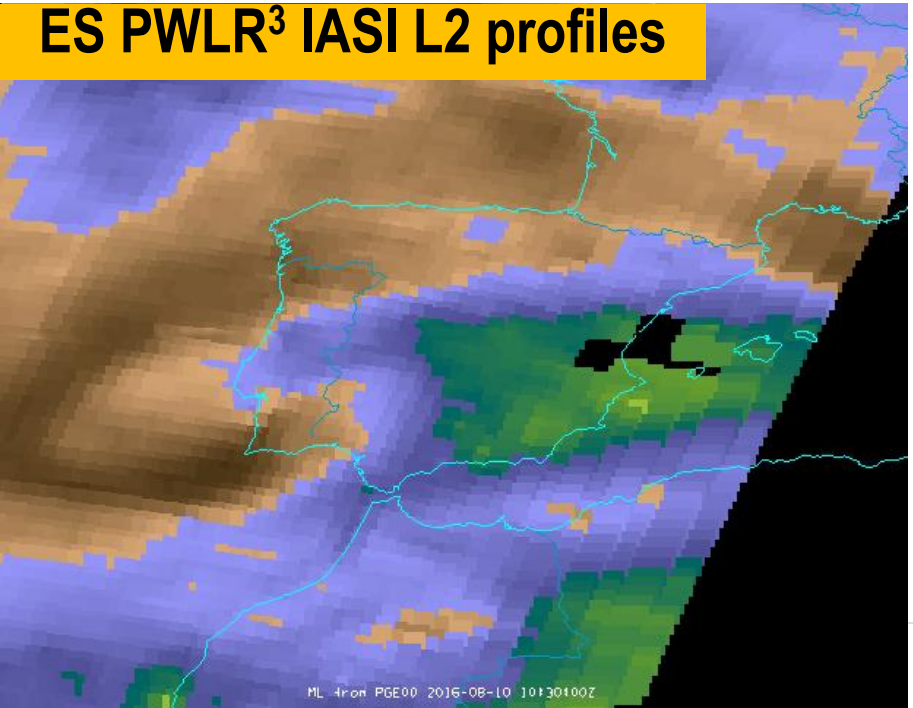
PGE00ECMWF *t+10:30Z* forecast



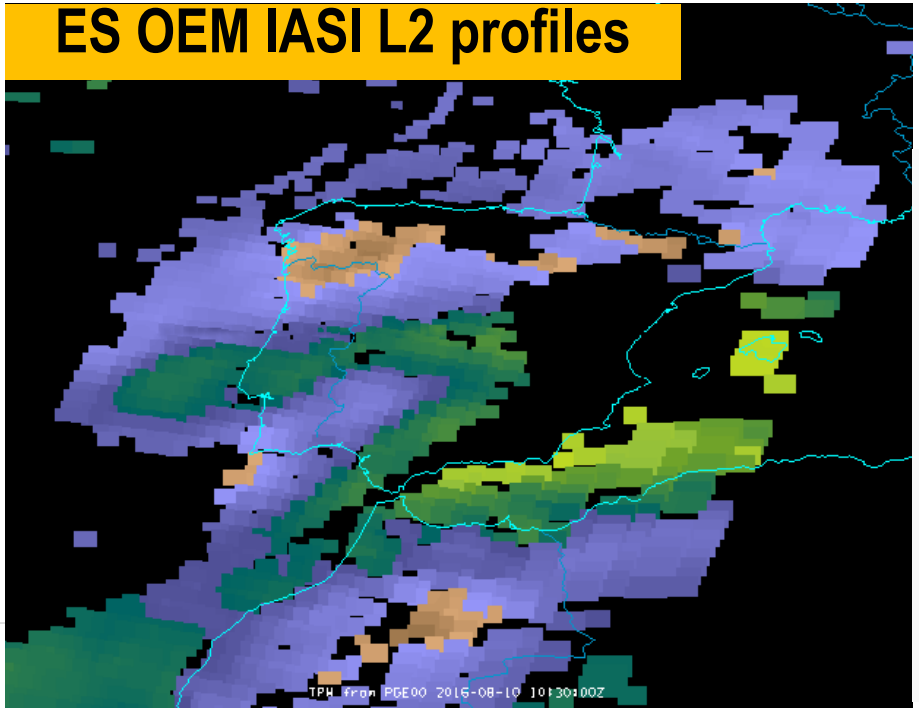
NWC SAF iSHAI

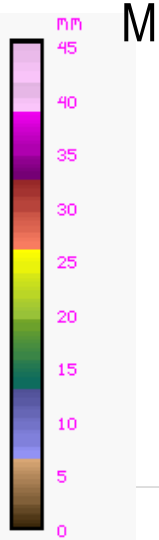


ES PWLR^3 IASI L2 profiles



ES OEM IASI L2 profiles





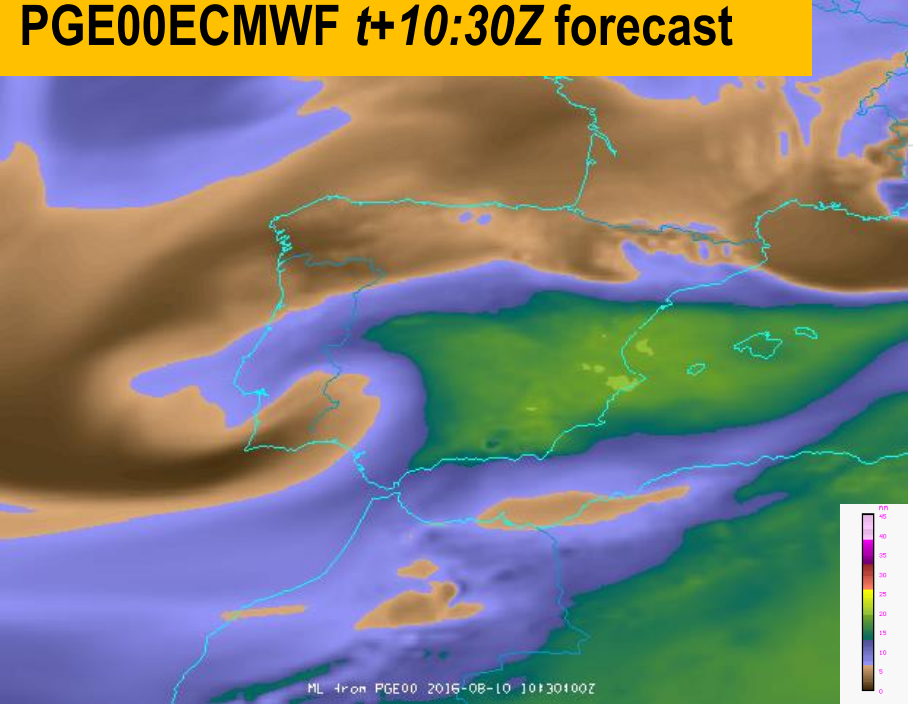
High humidity on low and medium levels is the “fuel” for the convection.

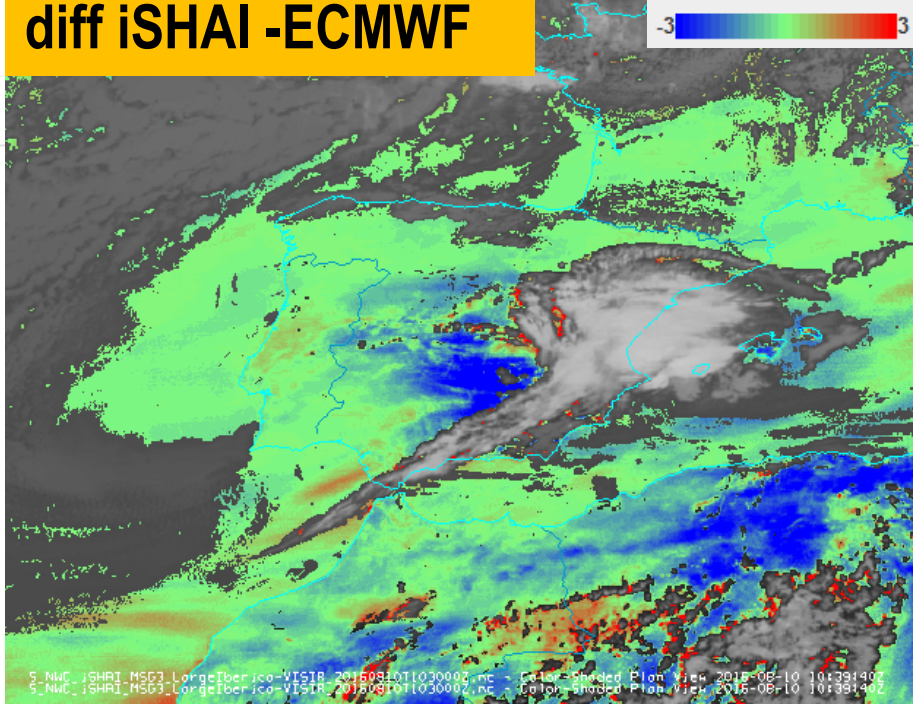
It is well represented on the IASI L2 and agrees with iSHAI ML

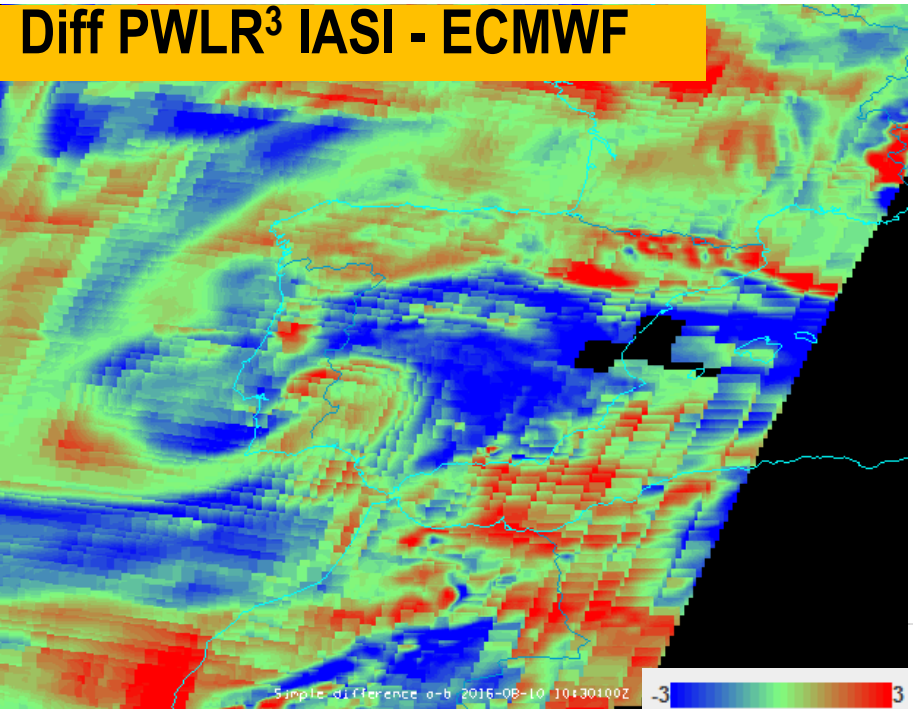
Difference ML with ECMWF

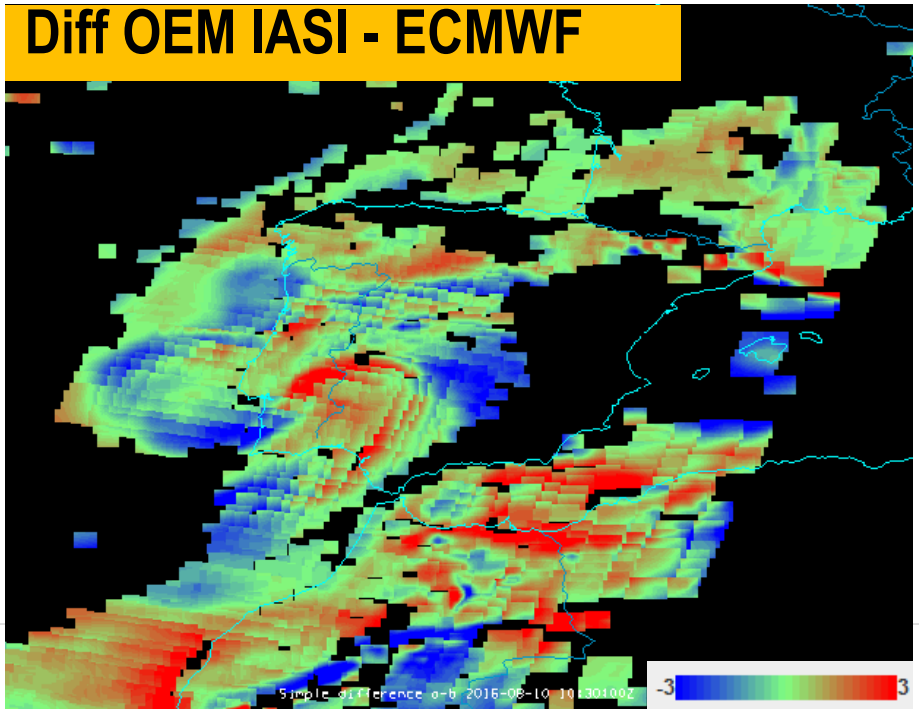
ML Precipitable Water in Middle Layer (850-500 hPa)

The difference ML fields agrees on overestimation on ML in the ECMWF in the region of interest of Betica region.





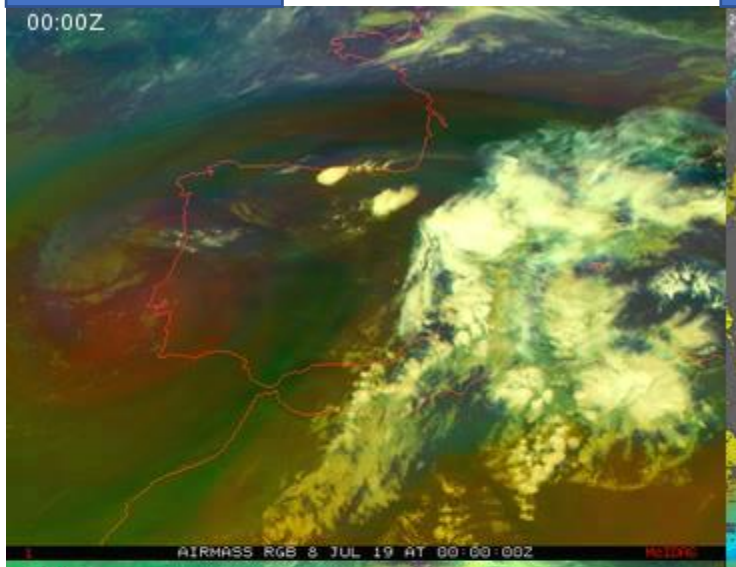




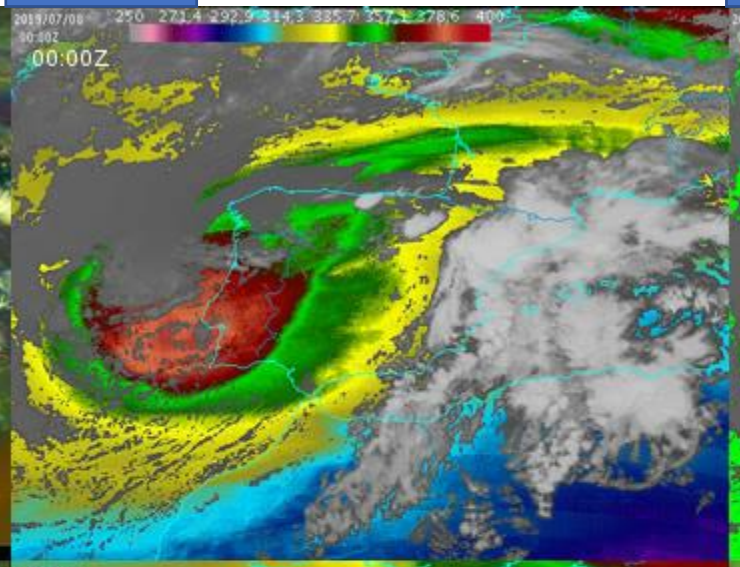
Combined use of iSHAI, PGE00 and real RGB images: 8th July 2019

Loop available in an AVI file in this NWC SAF web page

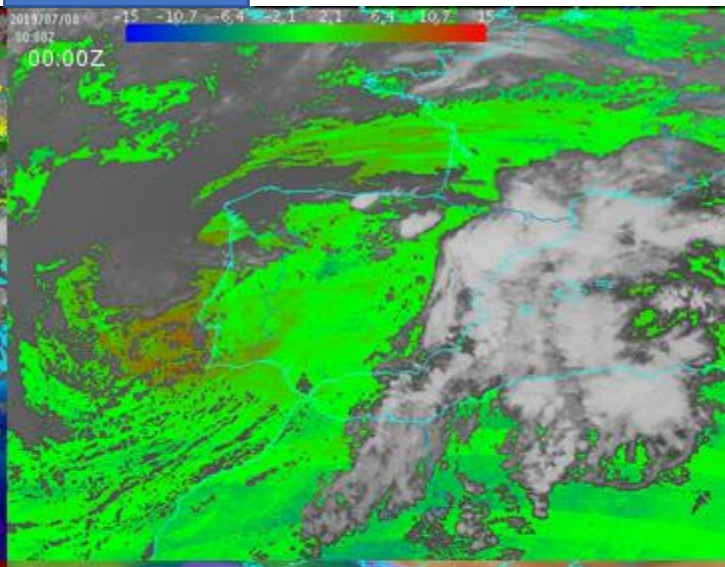
AIRMASS RGB



iSHAI TOZ



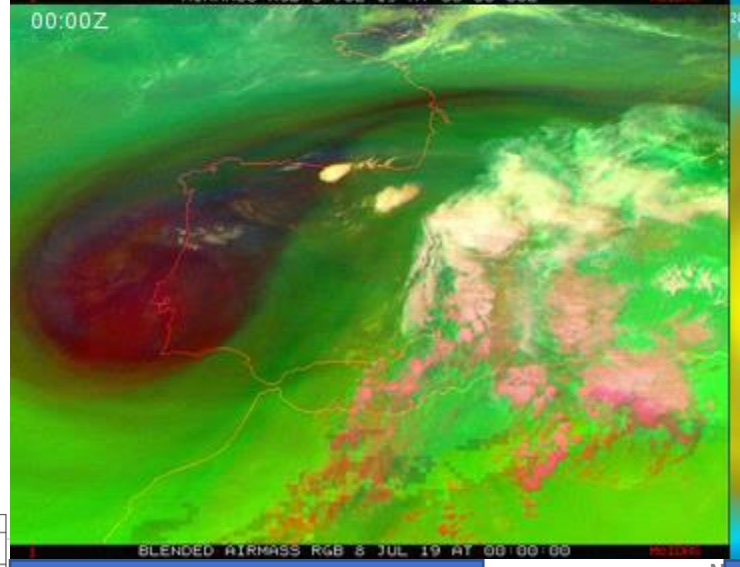
iSHAI diffTOZ



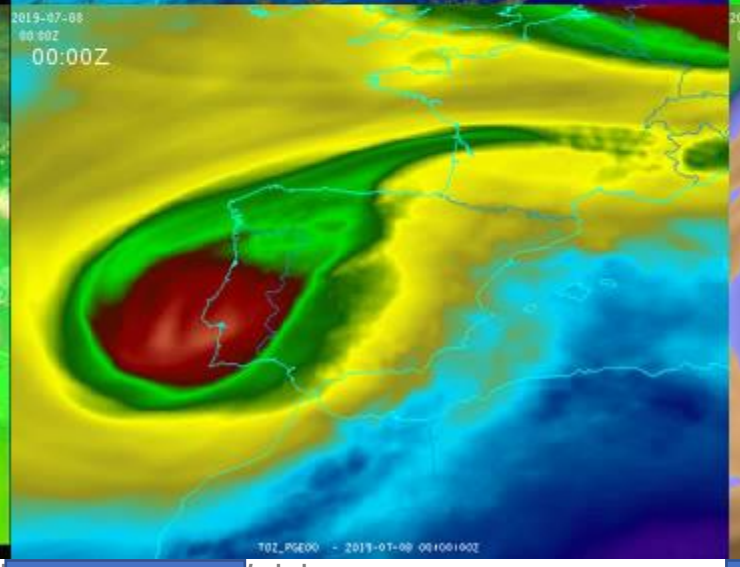
BLENDED AIRMASS RGB

blended (real&synthetic) air mass RGB.
In Green component is used formula with the difference between the BTs of RTTOV and real BTs in the IR9.7 and in the IR10.8 channel. See more information in link

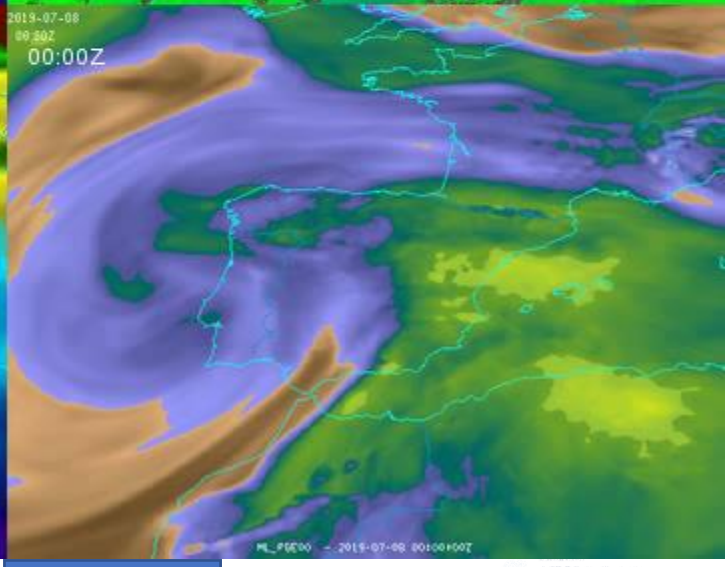
RED	WV6.2-WV7.3	[-25,0]
GREEN	(BTIR97- meanO3_clearIR97$_{RTTOV}$) -(0.54*(BTIR108 - meanO3_clearIR108$_{RTTOV}$) +0.18)	[-4,4]
BLUE	WV6.2	[243,208]



BLENDED AIRMASS RGB



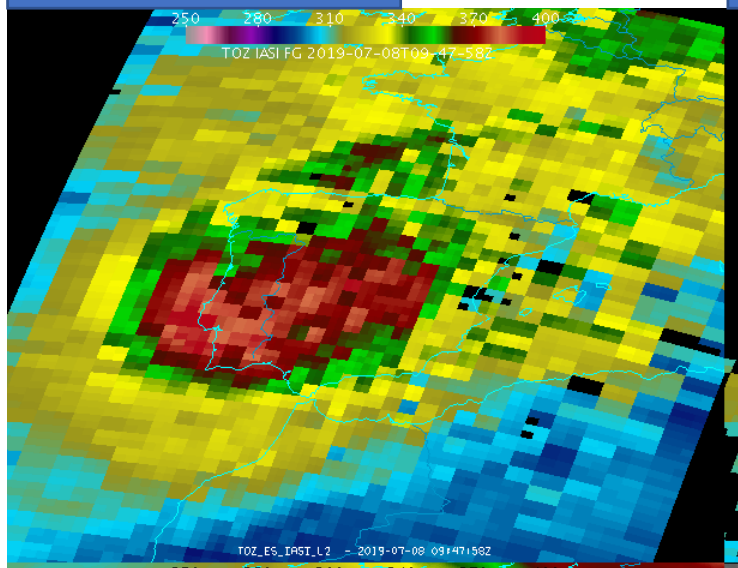
ECMWF TOZ



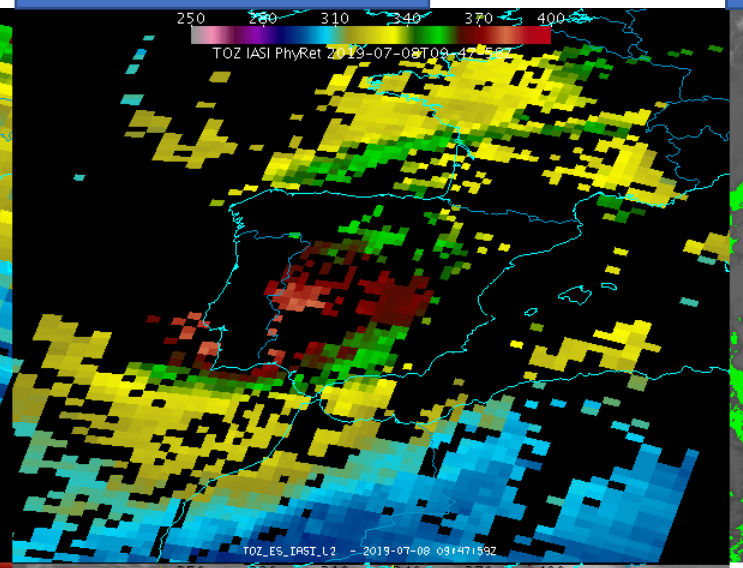
ECMWF ML

Comparison of IASI L2 Eumetsat, iSHAI, ECMWF: example TOZ 8th July 2019

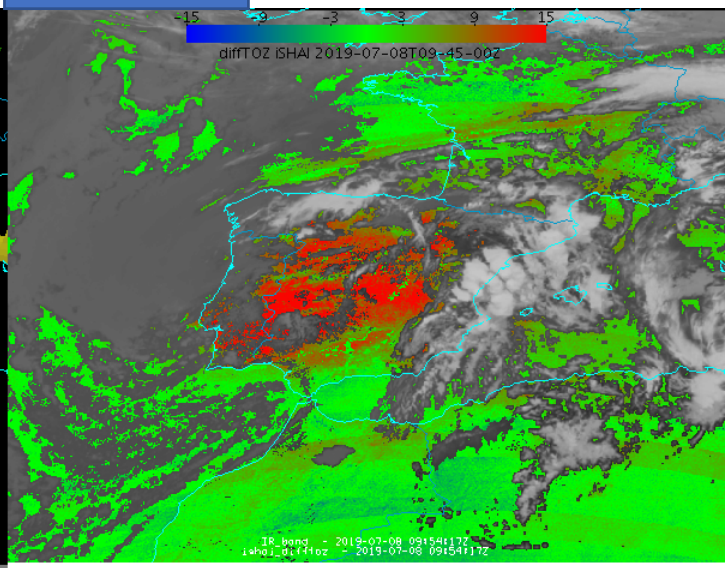
TOZ from IASI L2 FG

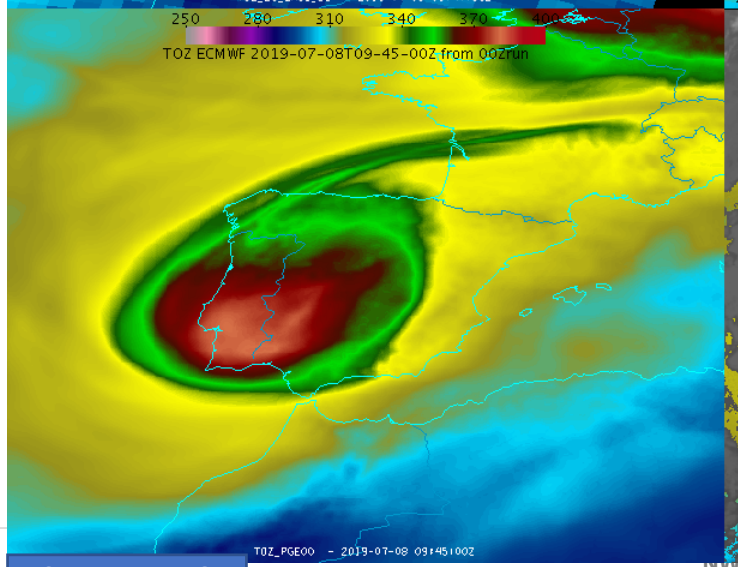


TOZ from IASI L2 OEM

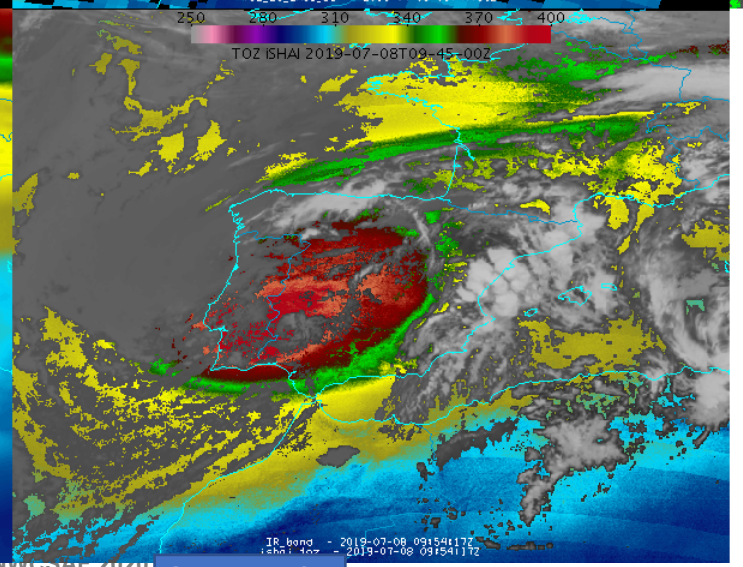


iSHAI diffTOZ





ECMWF TOZ

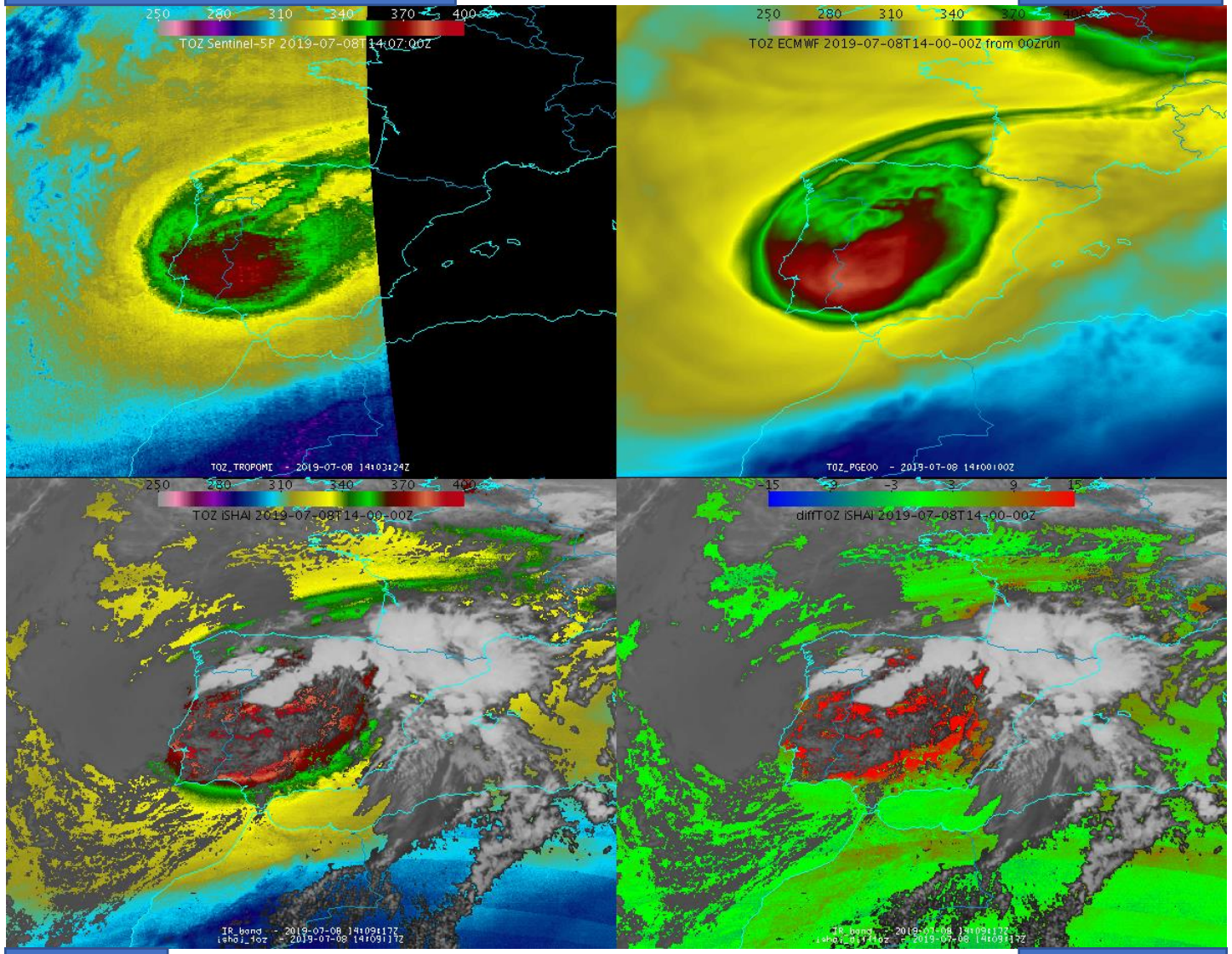


iSHAI TOZ

Comparison of Sentinel-5P, iSHAI, ECMWF: example TOZ 8th July 2019

TOZ Sentinel-5P TROPOMI

ECMWF TOZ



iSHAI TOZ

iSHAI diffTOZ

All the products are similar but different.

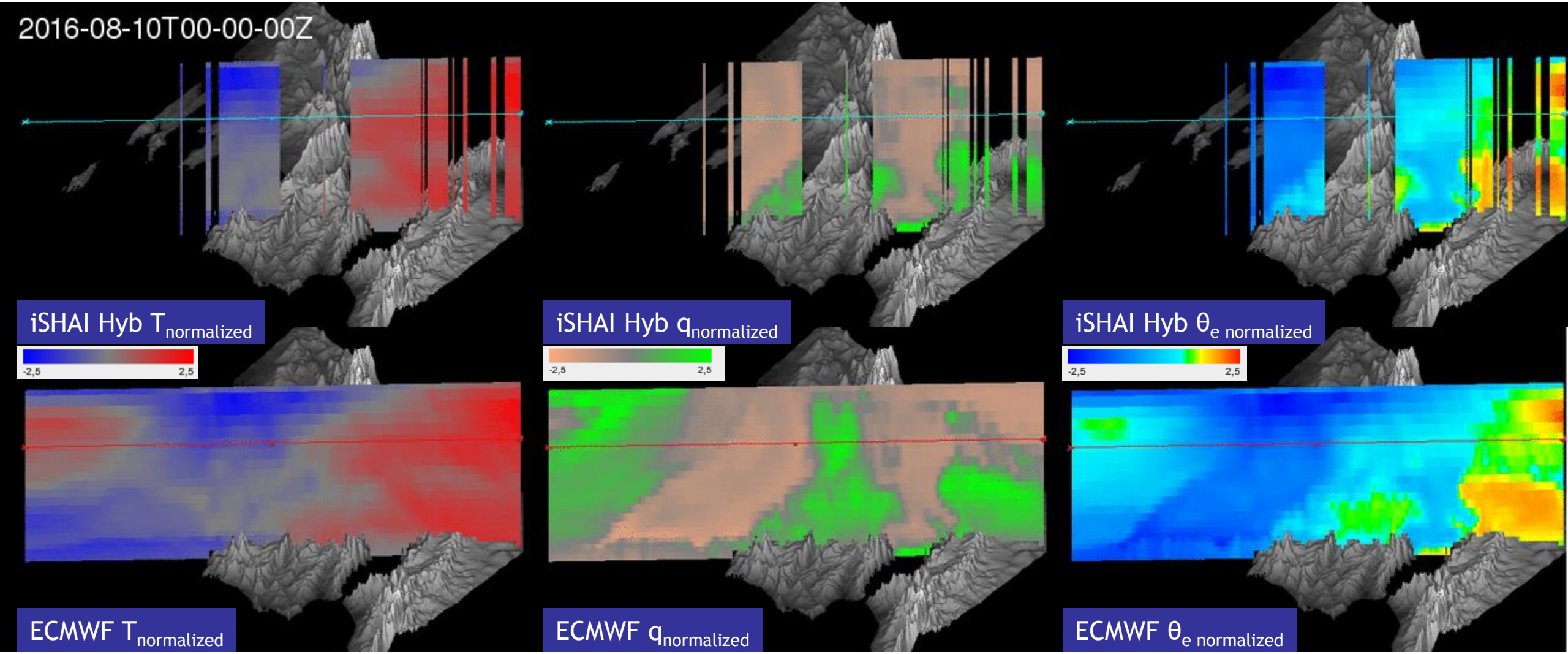
There is a great value add in the diversity.

It is needed look for tools for use the set of products for several tasks:

- ✓ Seamless production
- ✓ Maximize spatial and temporal resolution
- ✓ supervise with the high quality of hyperspectral and LEO products.

Similar problem to the use of ensembles and several global and local NWP models in forecast.

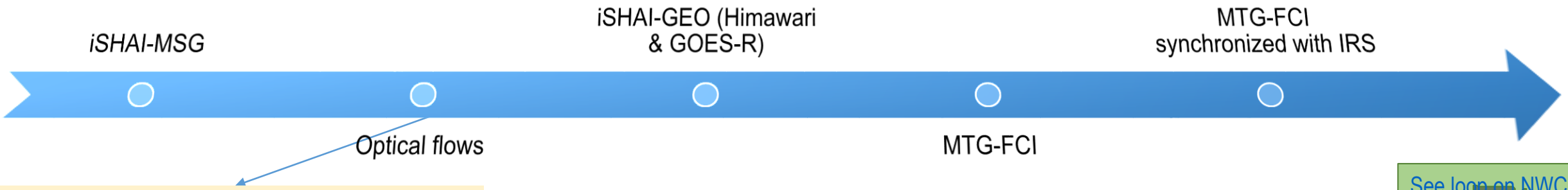
Normalized 3D vertical cross sections



Normalized 3D arrays after calculation the mean and standard deviation on the analysis at every layer and then create the normalized 3D cube subtracting the mean and dividing by the standard deviation at every layer.
As example in T 3D red => hotter than mean and blue => colder than mean at its layer.

See loop on NWC SAF web page

Use of iSHAI and PGE00 for optical flow



ISHAI and ECMWF collocated fields have a high spatial and temporal resolution.

Then, they are ideal to explore the use of gradients and trends between consecutive images in forecasting.

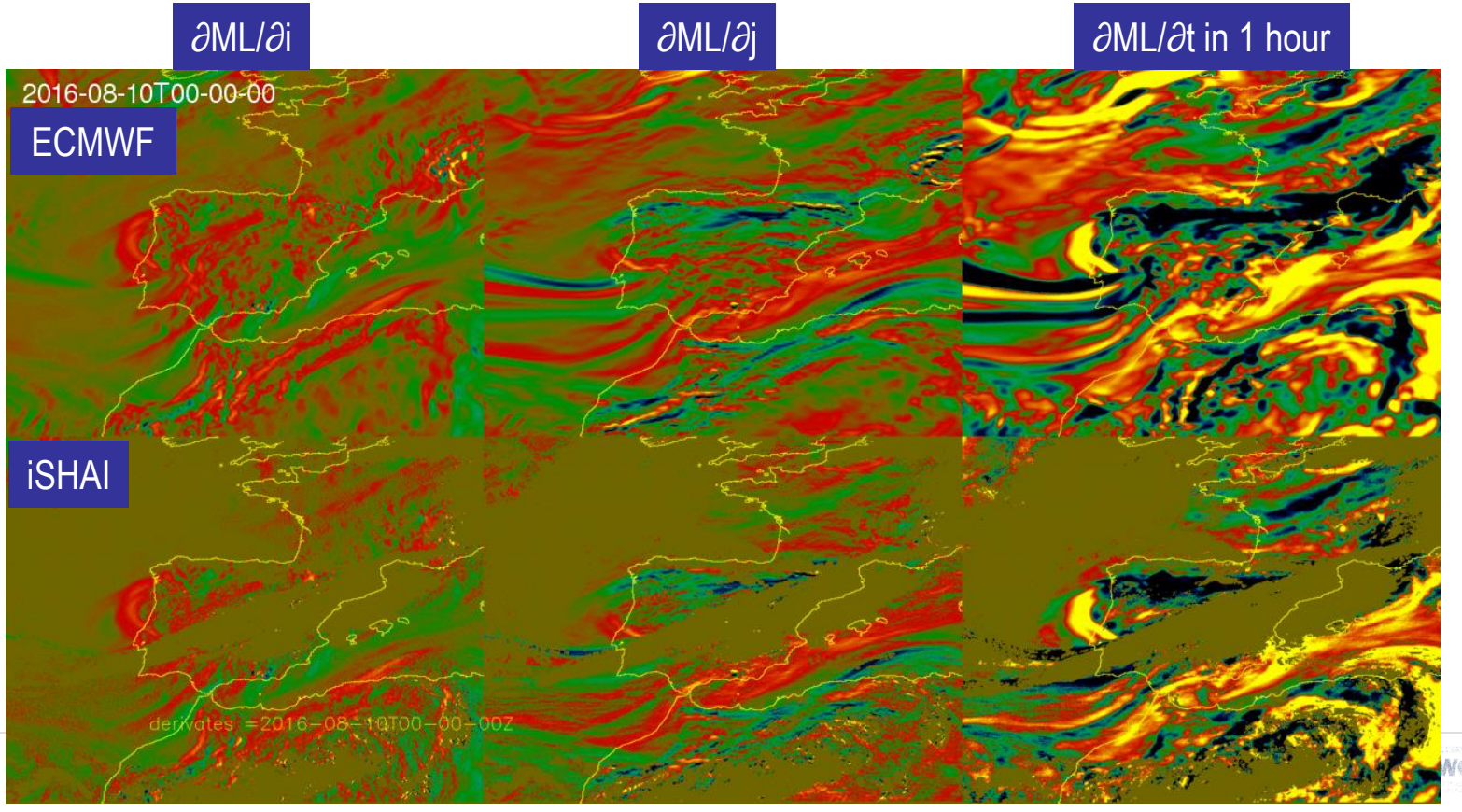
Another use it is to investigate the generation of optical flows.

$$\partial ML/\partial t + u*\partial ML/\partial i + v*\partial ML/\partial j \approx 0$$

PGE00-VISIR includes writing of NWP (u,v) wind components. McIDAS-V can use to display interactively hodograph and wind vertical cross-sections.

Foreseen activity use with GOES-R (real and synthetic) with standard optical flow software

See loop on NWC SAF web page



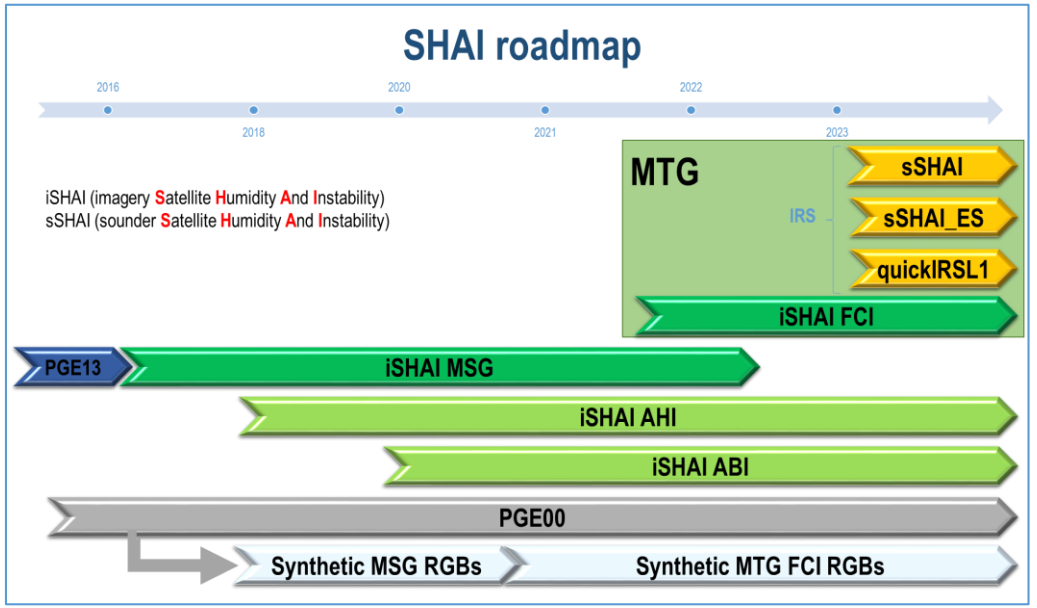
Summary & Conclusions

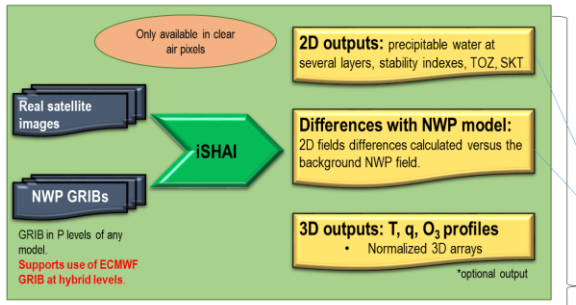
The combined use of iSHAI and PGE00 allows to improve the monitoring of key ingredients in pre-convective situations.

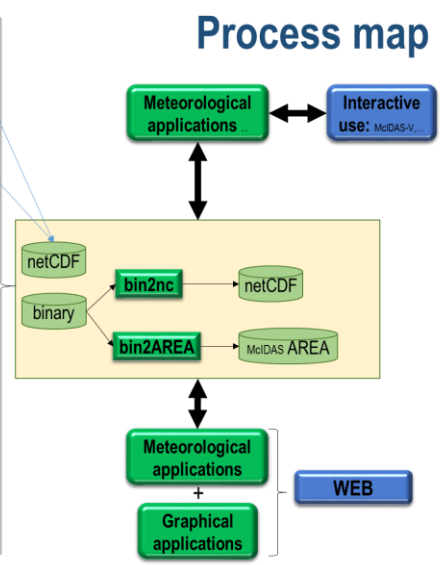
The evolution from iSHAI MSG to SHAI family will allow to exploit the synergy of MTG-FCI, MTG-IRS and NWP for the monitoring of key ingredients in pre-convective situations.

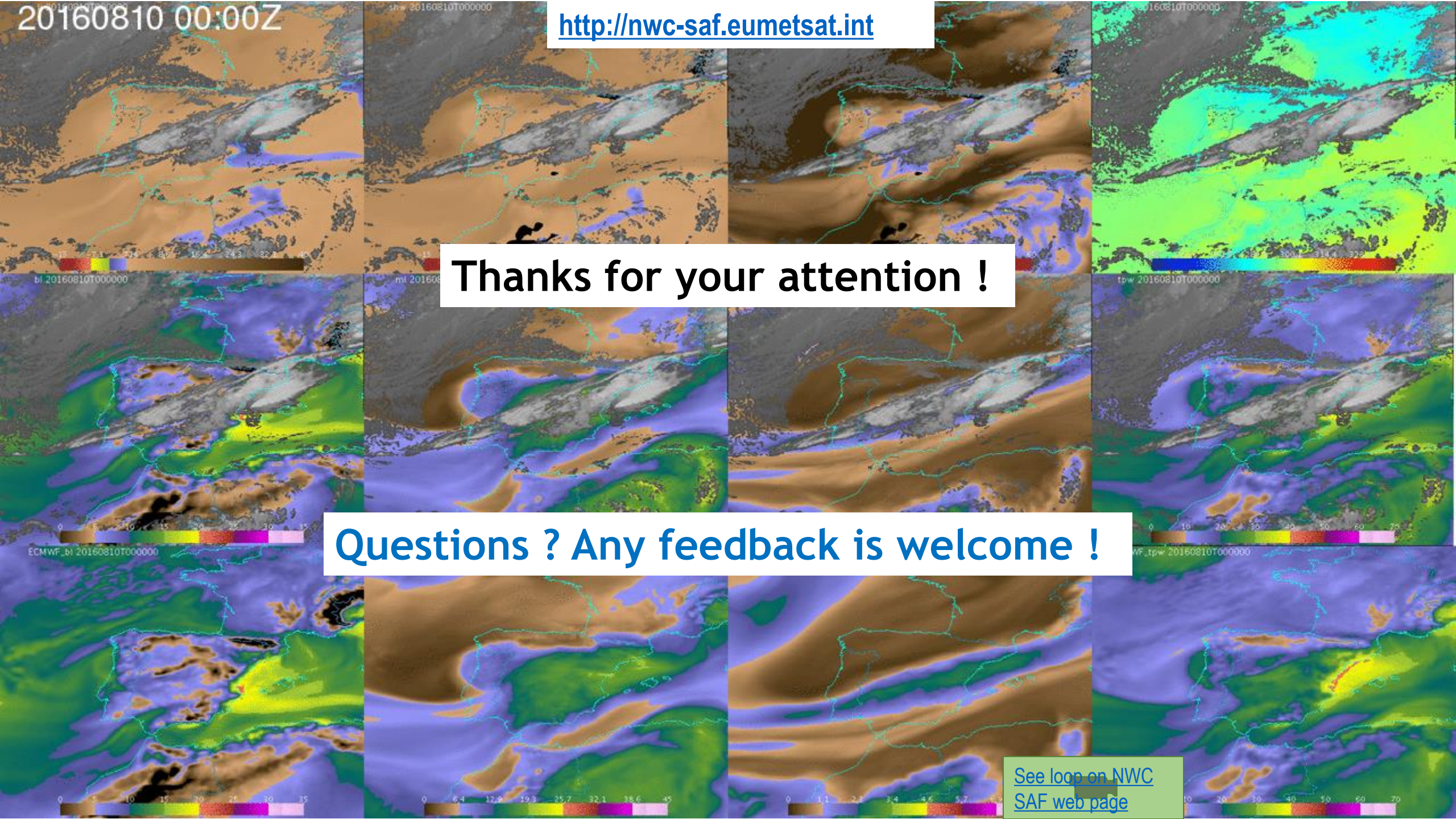
Research to operations (R2O) in MTG era:

- ✓ it is needed that software and processing chains must be available.
- ✓ R2O needs also that user's tools and automatic graphical processing should be able to use iSHAI and PGE00 files. Here it has been used McIDAS-V as demonstrator tool for interactive comparison and 3D use of proxy IRS-L2 and comparison with NWP.
- ✓ A lot of slight different products will be generated: it should be needed to develop some kind of integration tools using as artificial intelligence algorithms (Machine-Learning, Fuzzy-logic,…) for integration of L1 and L2 products.
- ✓ A high number of slight different products with different times generation allows be used for seamless nowcasting systems.








20160810 00:00Z
http://nwc-saf.eumetsat.int
Thanks for your attention !
Questions ? Any feedback is welcome !
See loop on NWC SAF web page