

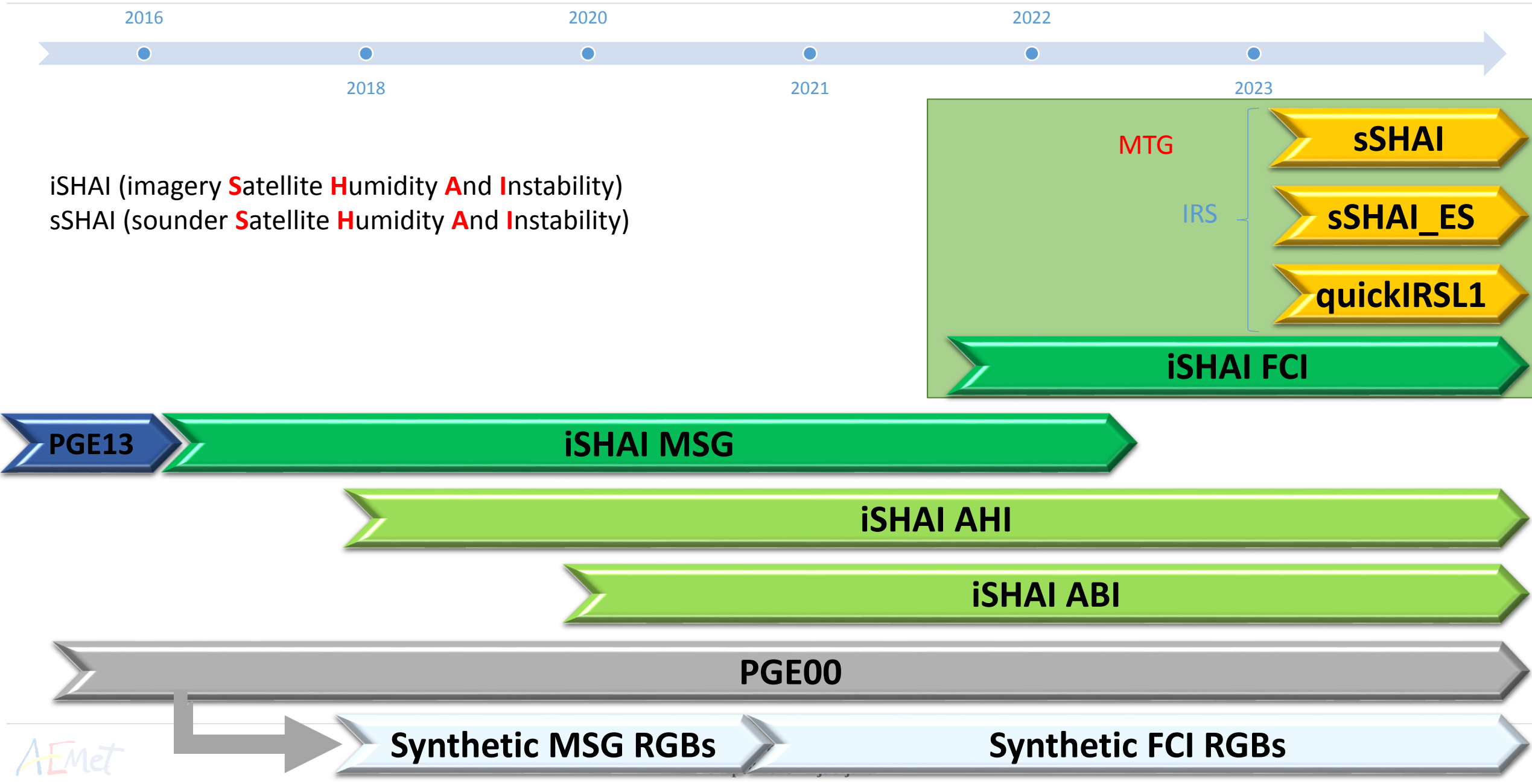
iSHAI and PGE00 as key tools in pre-convective

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AEMET

mmartinezr@aemet.es

SHAI roadmap



iSHAI and PGE00 description

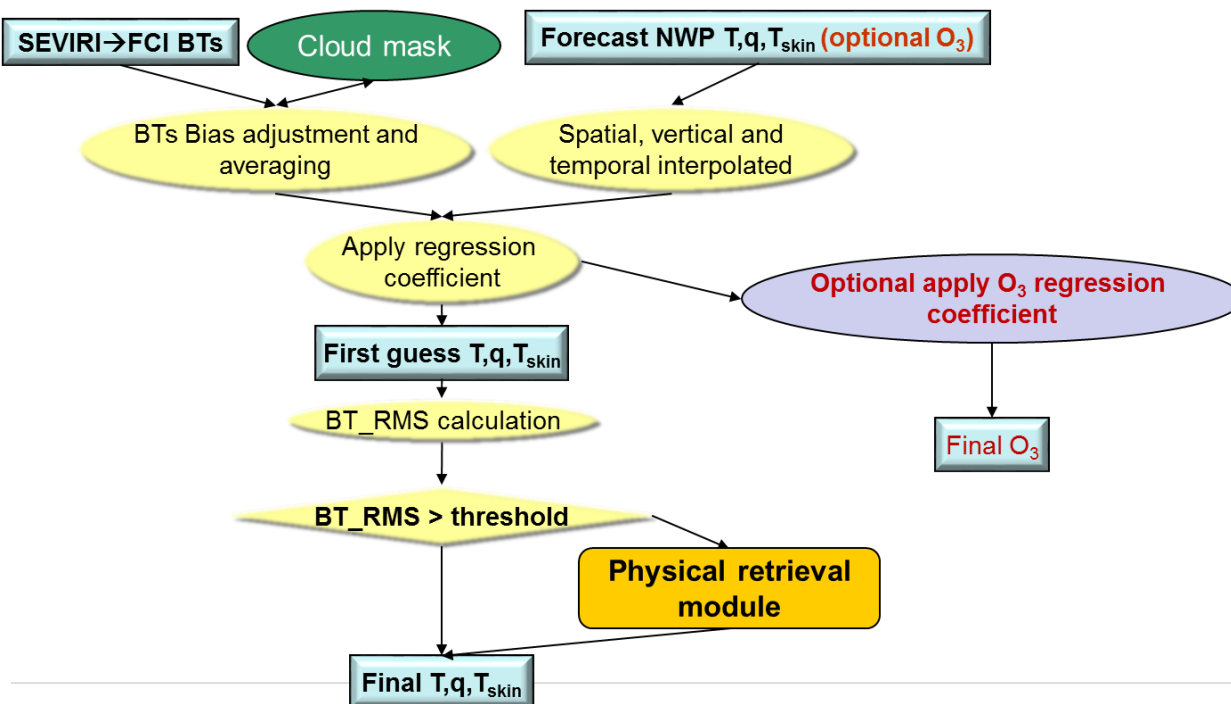
PGE00 is by now an
AEMET internal tool

iSHAI algorithm is a combination of statistical and physical retrieval algorithms:

First step: Uses a non linear regression 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}



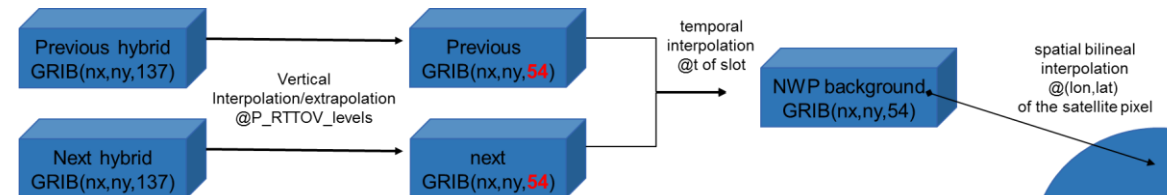
PGE00 is a simplified version of the NWP interpolation and RTTOV management of iSHAI. It can be used as:

- NWP 4D (*pressure, 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:

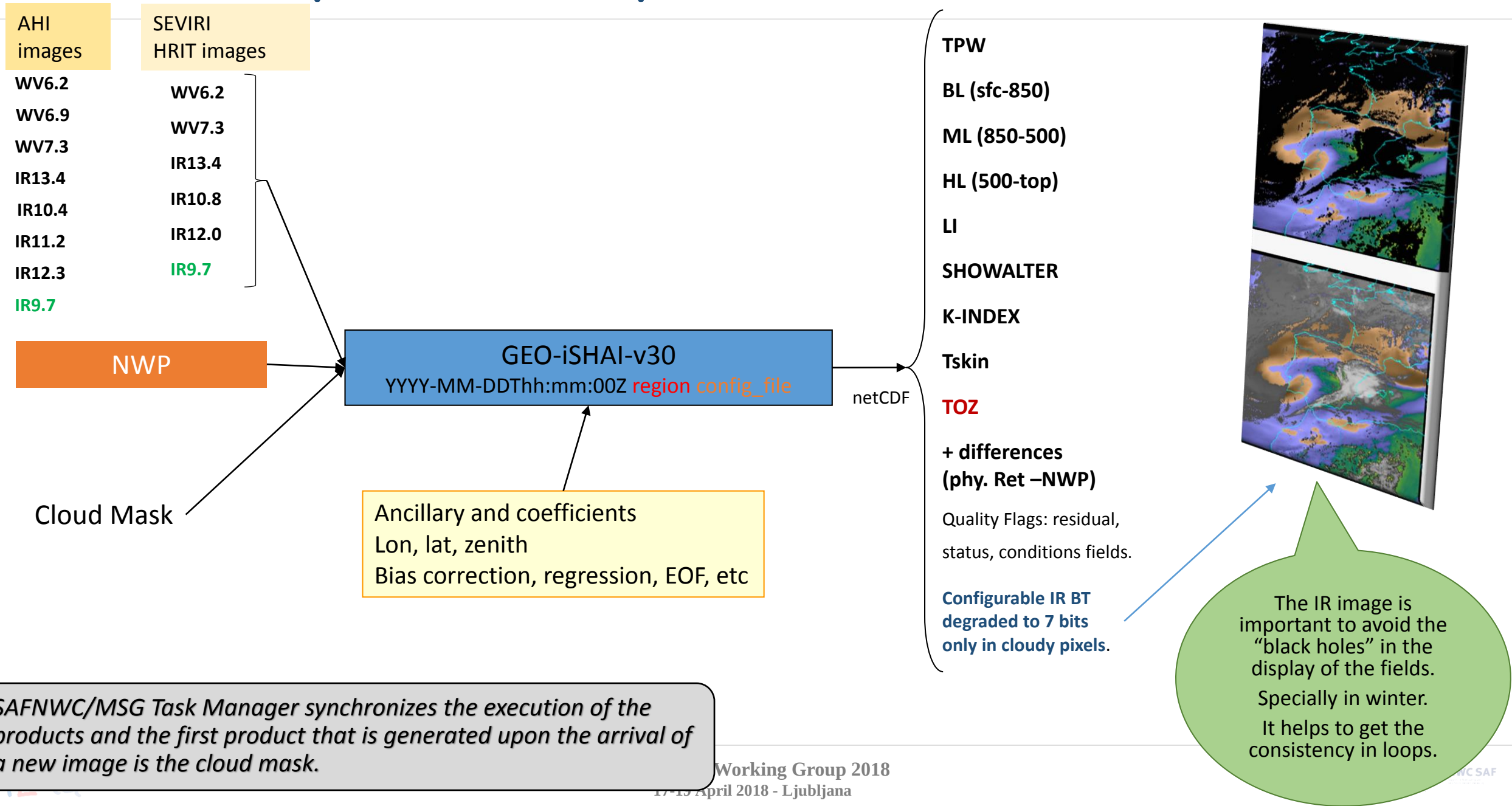
- 4D interpolation of T, q, O₃, **CC, CLWC, CIWC, u, v** profiles on hybrid levels of ECMWF GRIB files.
- Call to RTTOV direct using the **clouds** and solar options
- Emissivities and BRDF from RTTOV atlases.

For ECMWF it can be used GRIB files in hybrid levels.



New RTTOV-12.2 with faster VIS channels simulation will be tested soon.

iSHAI inputs and outputs scheme on version 2018



iSHAI outputs 10th August 2016

Precipitable water, instability indices, total ozone and Skin Temperature

BL

Precipitable Water
in Boundary Layer
($P_{\text{sfc}} - 850\text{hPa}$)

ML

Precipitable Water
in Middle Layer
(850-500 hPa)

HL

Precipitable Water
in High Layer
(500-0.1 hPa)

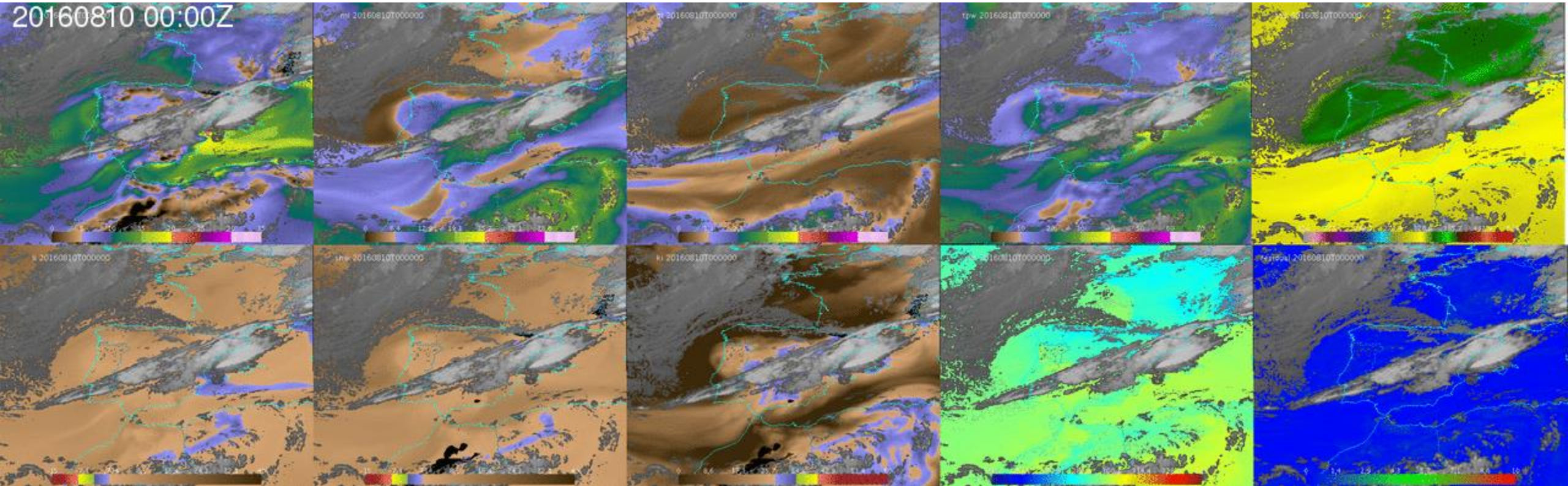
TPW

Total Precipitable
Water in all Layers
($P_{\text{sfc}} - 0.1\text{ hPa}$)

TOZ

Total Ozone
($P_{\text{sfc}} - 0.0\text{ hPa}$)

20160810 00:00Z



LI

Lifted Index

SHW

Showalter Index

KI

K-Index

SKT

Skin Temperature

Residual

Square root of sum
($BT_{\text{seviri}} - BT_{\text{rttov}}$)

The individuals images has been generated with McIDAS-V in batch mode after generation of bundle files and importing color palettes.

up 2018

17-19 April 2018 - Ljubljana

[See loop on NWC
SAF web page](#)

NWC SAF
www.nwc-saf.eu

Difference of iSHAI precipitable water, instability indices, total ozone and skin temperature with background NWP

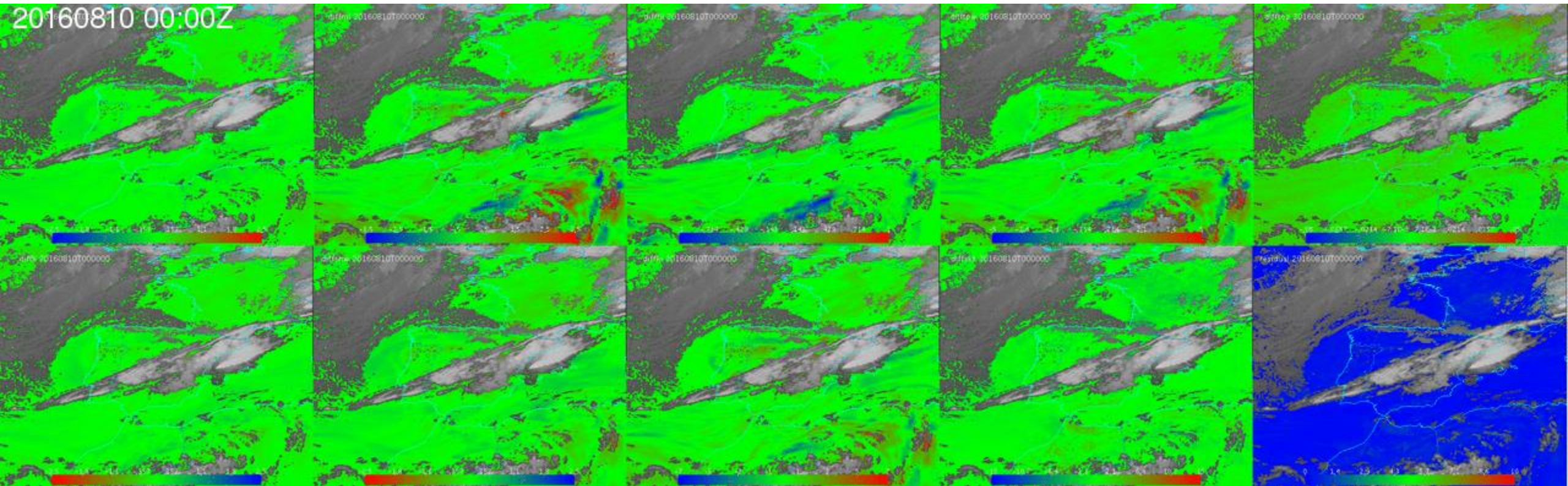
diffBL
Precipitable Water
in Boundary Layer
($P_{\text{sfc}} - 850\text{hPa}$)

diffML
Precipitable Water
in Middle Layer
($850 - 500\text{ hPa}$)

diffHL
Precipitable Water
in High Layer
($500 - 0.1\text{ hPa}$)

diffTPW
Total Precipitable
Water in Middle Layer
($P_{\text{sfc}} - 0.1\text{ hPa}$)

diffTOZ
Total Ozone
($P_{\text{sfc}} - 0.0\text{ hPa}$)



diffLI
Lifted Index

diffSHW
Showalter Index

diffKI
K-Index

diffSKT
Skin Temperature

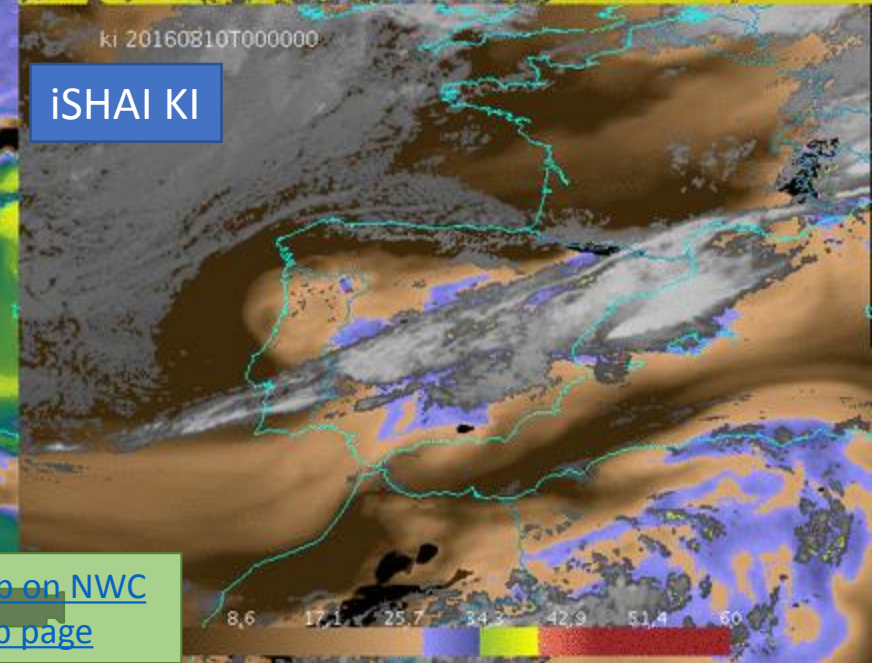
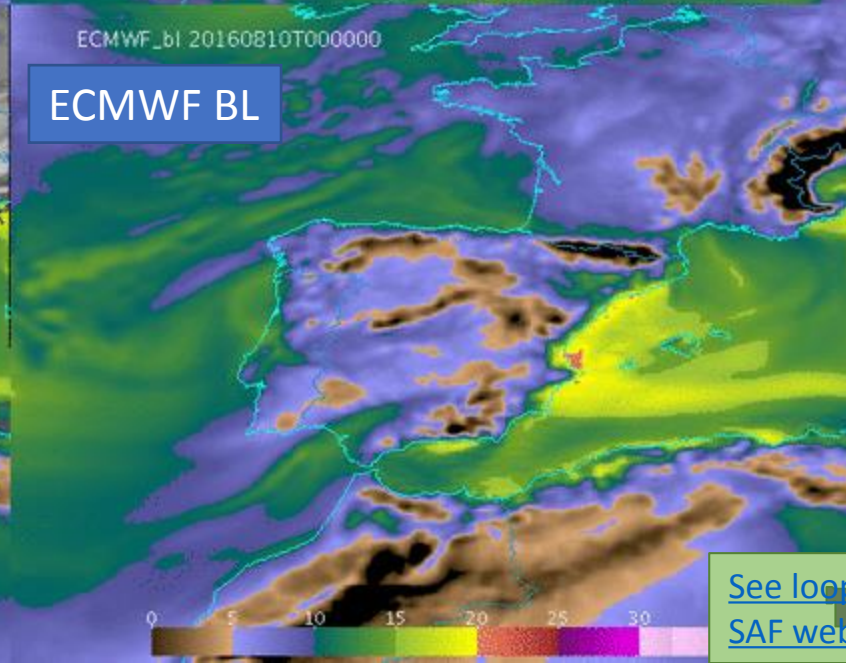
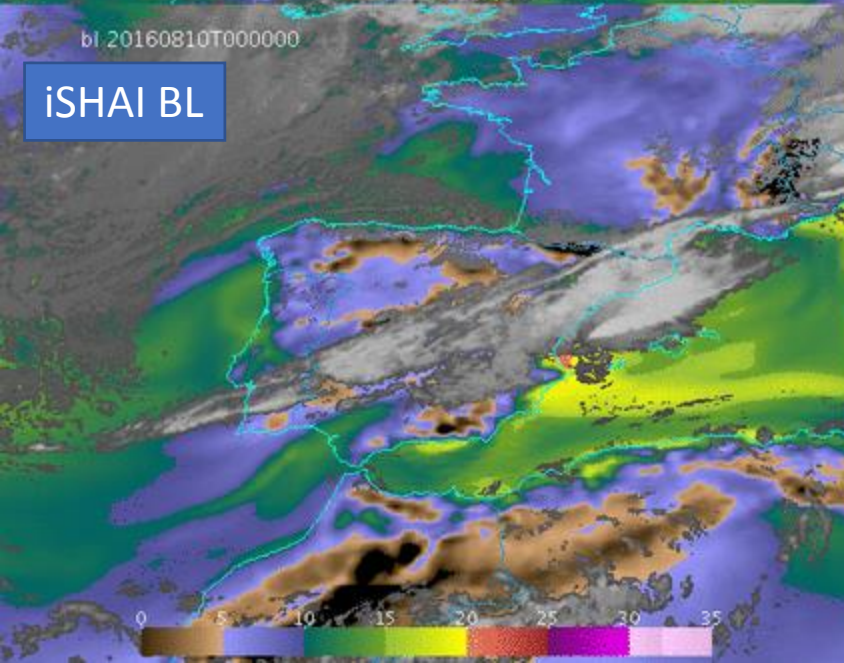
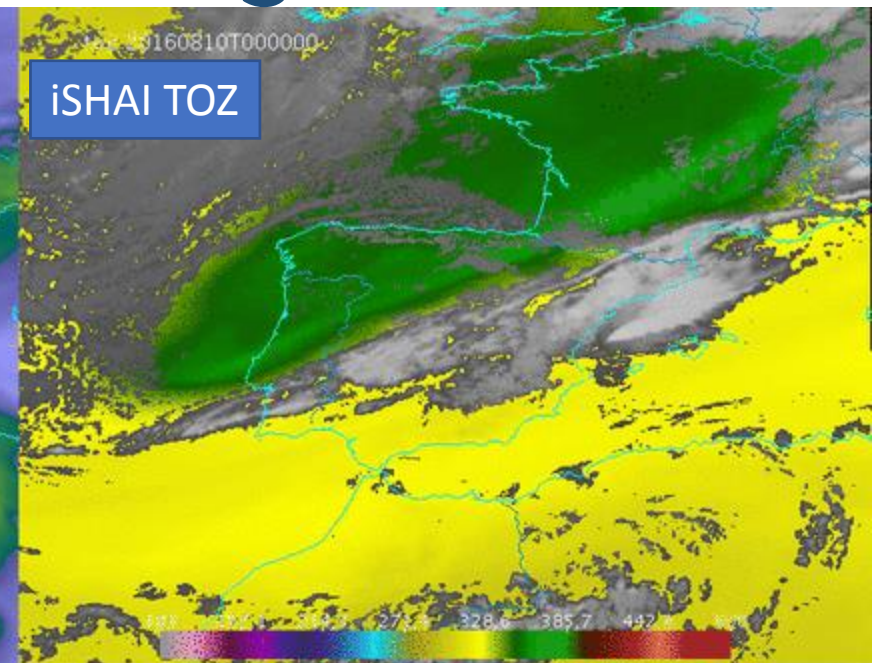
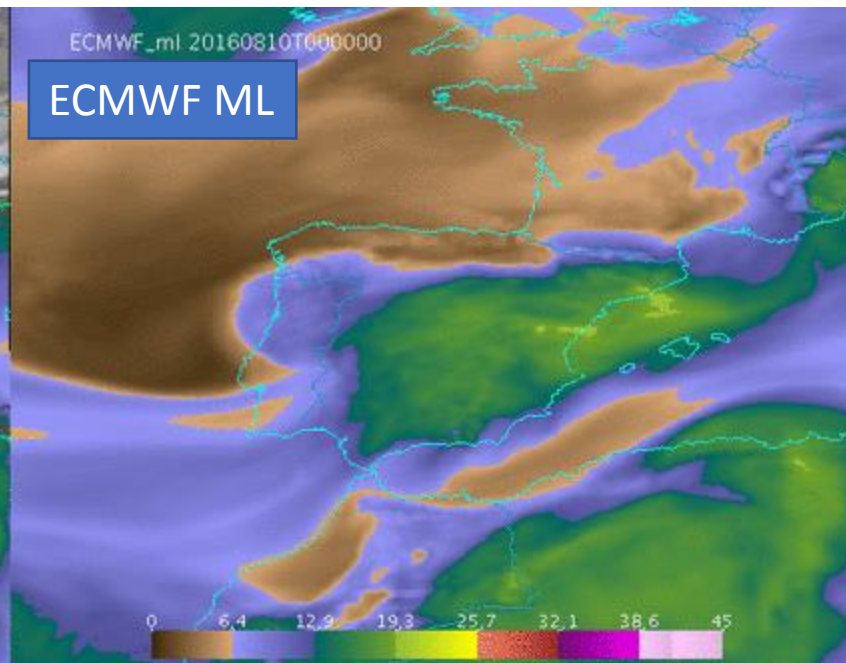
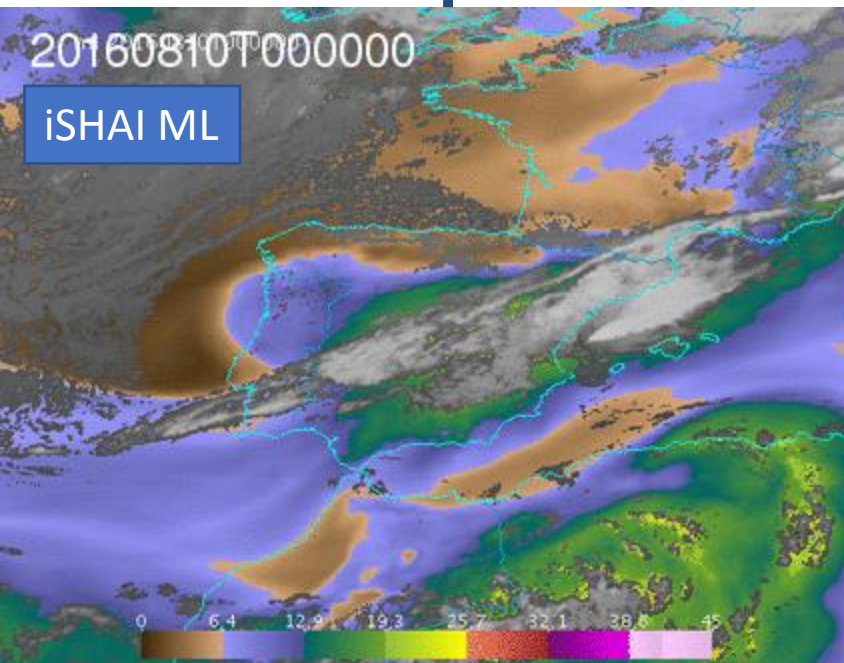
Residual
Square root of sum
($BT_{\text{seviri}} - BT_{\text{rttov}}$)

See example of detection of NWP disagreements in Martinez 2013.

http://www.eumetsat.int/website/wcm/idc/idcplg?IdcService=GET_FILE&dDocName=PDF_CONF_P_S3_04_MARTINEZ_V&RevisionSelectionMethod=LatestReleased&Rendition=Web

[See loop on NWC
SAF web page](#)

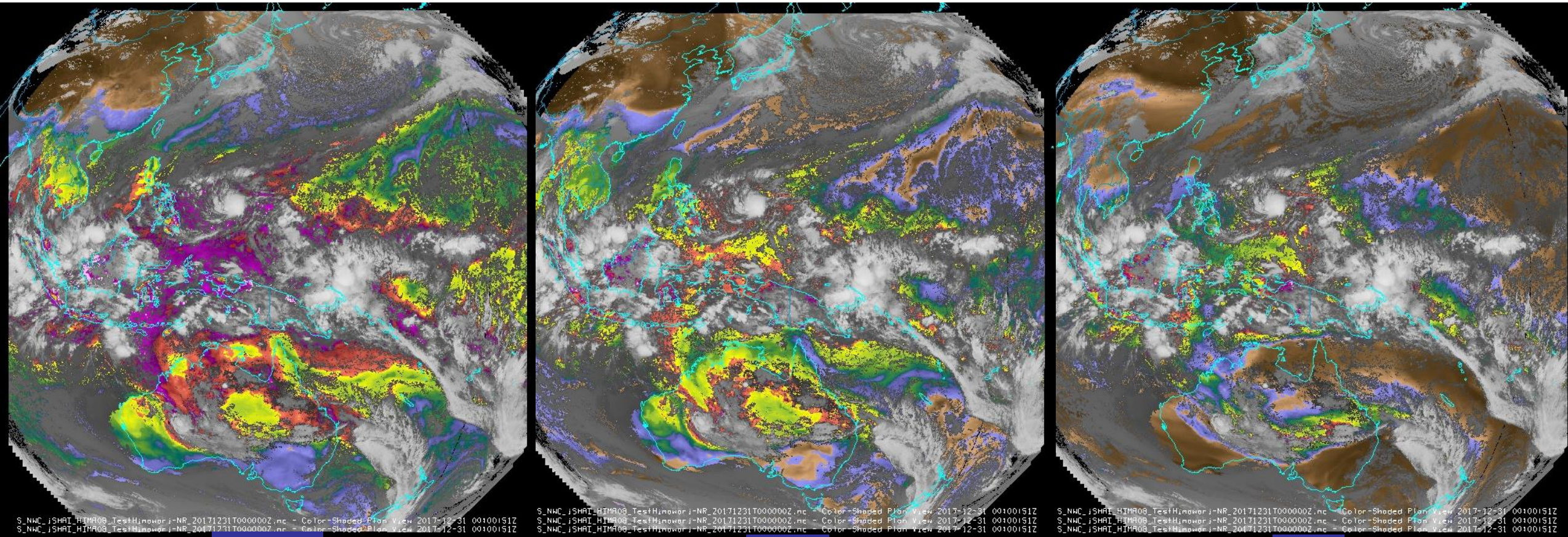
Example of iSHAI and PGE00: 10th August 2016



[See loop on NWC
SAF web page](#)

Support of Himawari-AHI on v2018

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



TPW

Total Precipitable
Water in all Layers
($P_{\text{sfc}} - 0.1 \text{ hPa}$)

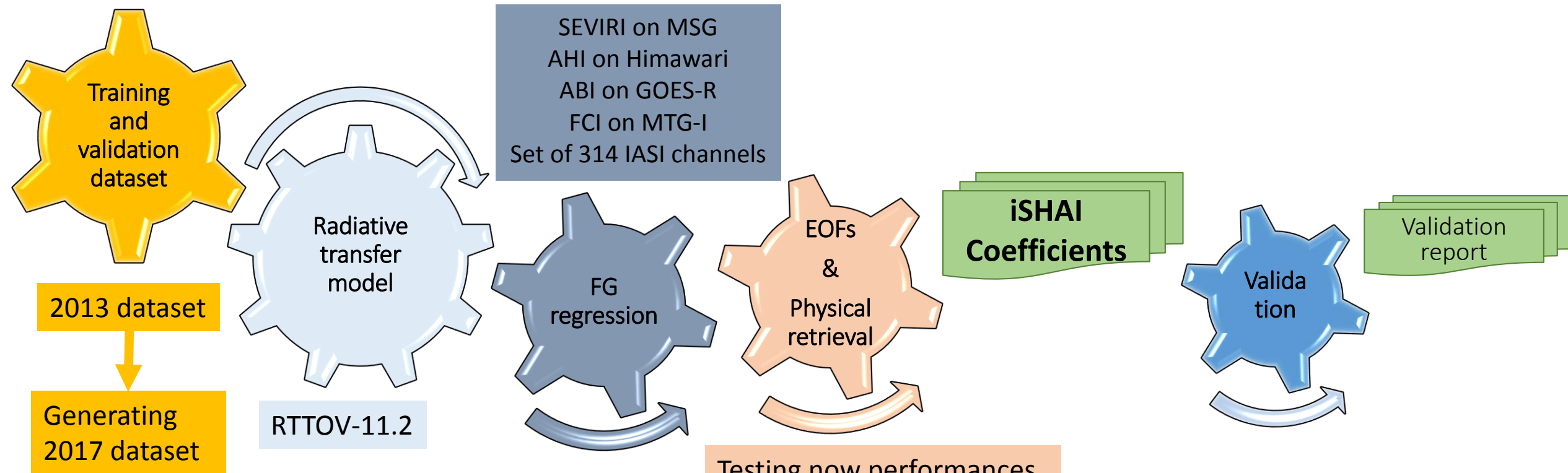
ML

Precipitable Water
in Middle Layer
(850-500 hPa)

HL

Precipitable Water
in High Layer
(500-0.1 hPa)

Training and validation activities on v2018



Testing now performances for MSG and AHI on the use EOF and in the use of $\log(q)$ or q profiles.

Better results of EOF and $\log(q)$ in v2016 tests

PGE00 and SHAI: training and validation dataset construction

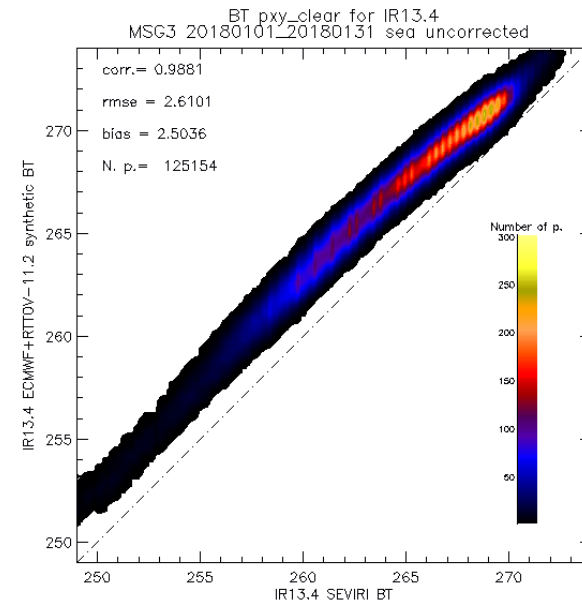
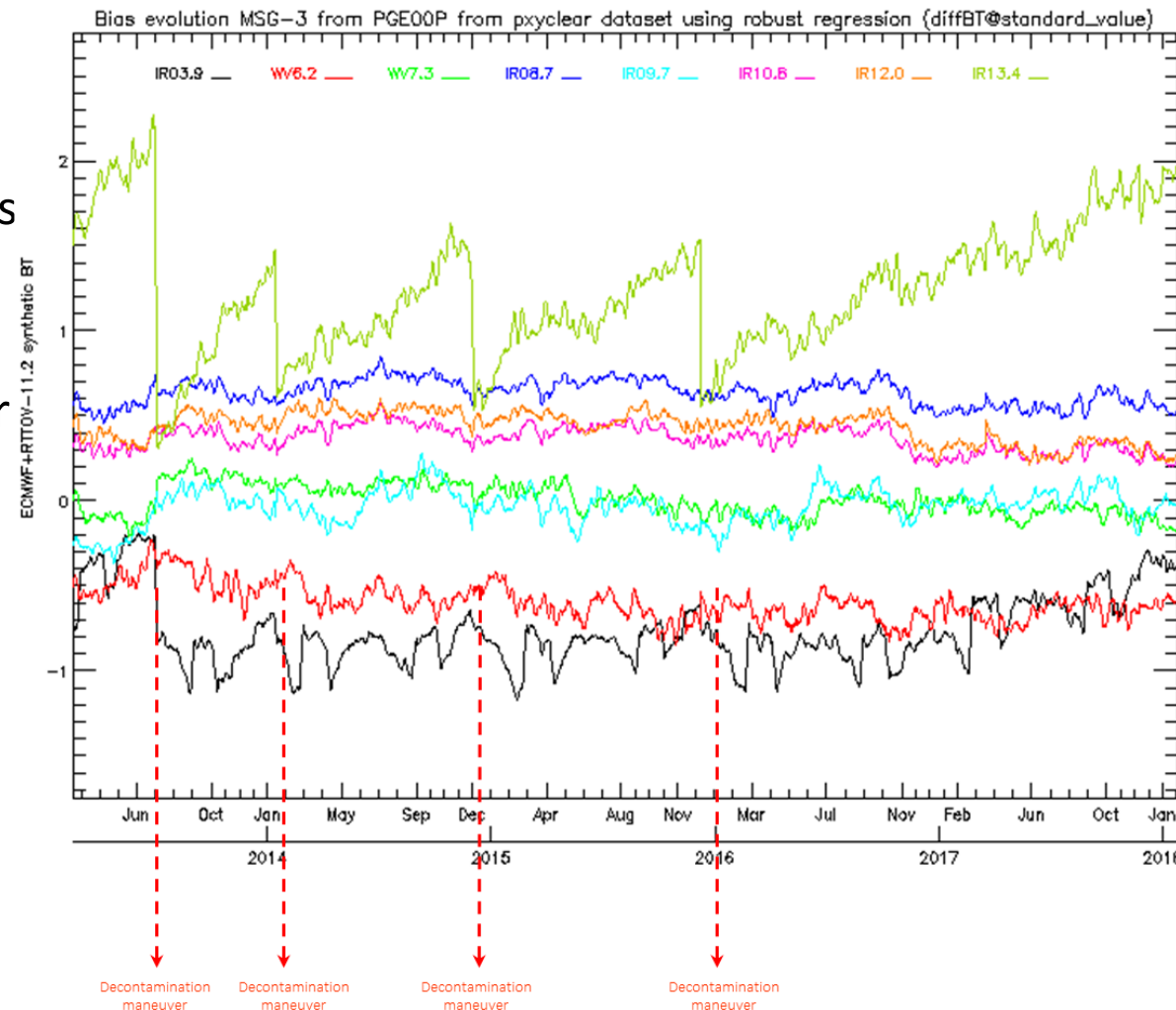
To build a training and validation dataset with real satellite data, ECMWF model and radiosounding profiles is an important task.

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 $1^\circ \times 1^\circ$*) using $t+00$ or $t+12$ or $t+24$ forecasts.

Binary files allows to create a dataset of (T, q, O₃, ..) 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 BT_SEVIRI 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 eight SEVIRI IR channels are monitored.



[Bias BT coefficients in NWCSAF web page](#)

MSG-1 IODC: bias BT correction with zenith angle calculated **without use of orbital parameters**

Some not explained artifacts appear in the two dimensional histograms of real versus synthetic brightness temperature in the process to calculate bias BTs correction in the case of MSG-1 IODC.

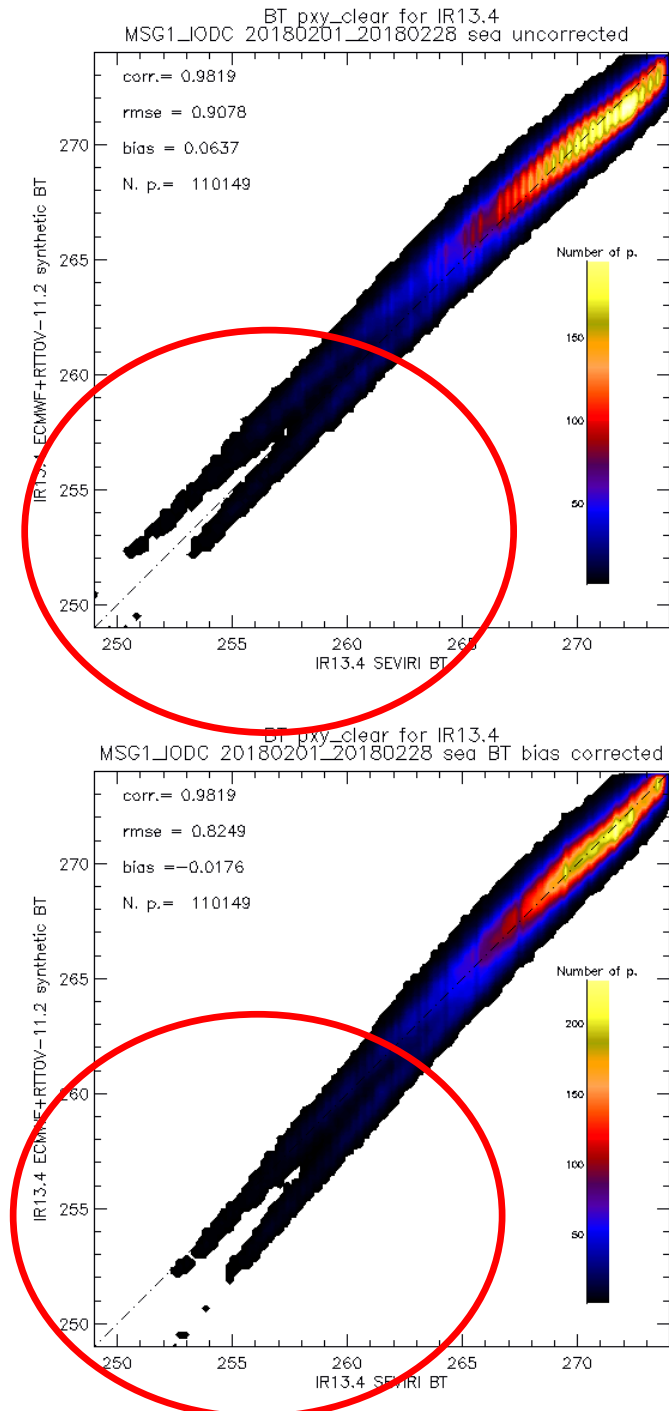
After some tests it was found that the issue could be related to the zenith angle calculation that uses the nominal coordinates calculated using the nominal subsatellite position.

Due to the high inclination of MSG-1 IODC it was tested the use of the parameterization of the satellite orbit in the calculation of the satellite zenith angle.

The parameterization of the orbit is available on the **HRIT *PRO*** files trough a set of Chebyshev polynomials. But the process is long and tricky

See PDF_TEN_05105_MSG_IMG_DATA-1.pdf

[See MSG-1 biasBT estimation web page](#)



MSG-1 IODC: bias BT correction using orbital parameters

Correction in MSG-1 IODC zenith angle calculation using parameterization of the orbit.
The parameterization of the orbit is available on the **HRIT *PRO*** file through a set of Chebyshev polynomials. The process is long and tricky:

- ❑ Read the set of polynomials Chebyshev from the HRIT *PRO* file.
- ❑ Read date and time image and convert to date in Julian format of the image.
- ❑ Using the date in Julian format of the image find the Chebyshev polynomial to use
- ❑ Normalize Julian time in the validity range of the polynomial range to $[-1,1]$
- ❑ Apply Chebyshev polynomial in normalized t to get the satellite $[X_{sat}, Y_{sat}, Z_{sat}]$ position.
- ❑ Zenith angle calculation using the satellite position instead of the nominal coordinates calculated using SSP position.
- ❑ Apply the RTTOV using the corrected satellite zenith angle.

- Open HRIT *PRO* file as binary file.
- Skip 90 bytes.
- Read the header structure
- Swap endian the structure.
- Get the set of Chebyshev polynomials as an array of doubles (8,96)

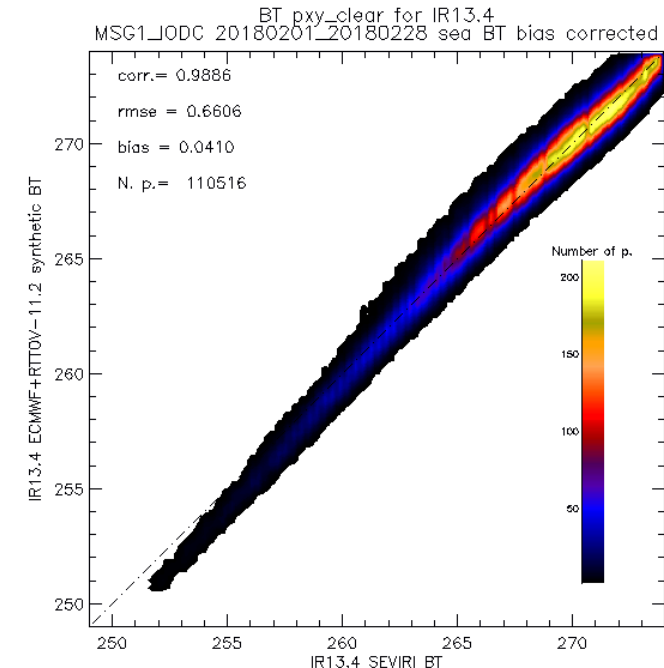
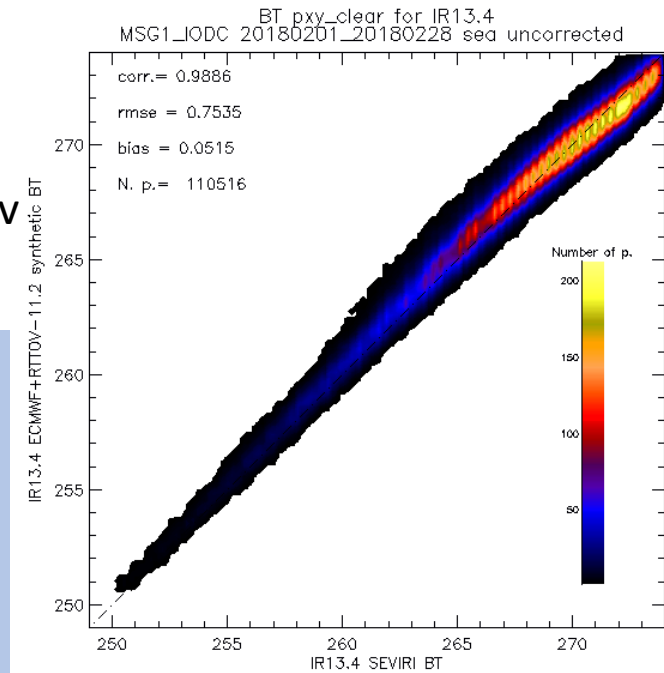
Notes:

Many of them are zero (normally 48)
Each polynomial has about 6 hours of validity

Start and end date from January 1, 1958

Non-standard Chebyshev polynomial the 0-coefficient 0 is $-\frac{1}{2}$ instead of -1

[See MSG-1 biasBT estimation web page](#)

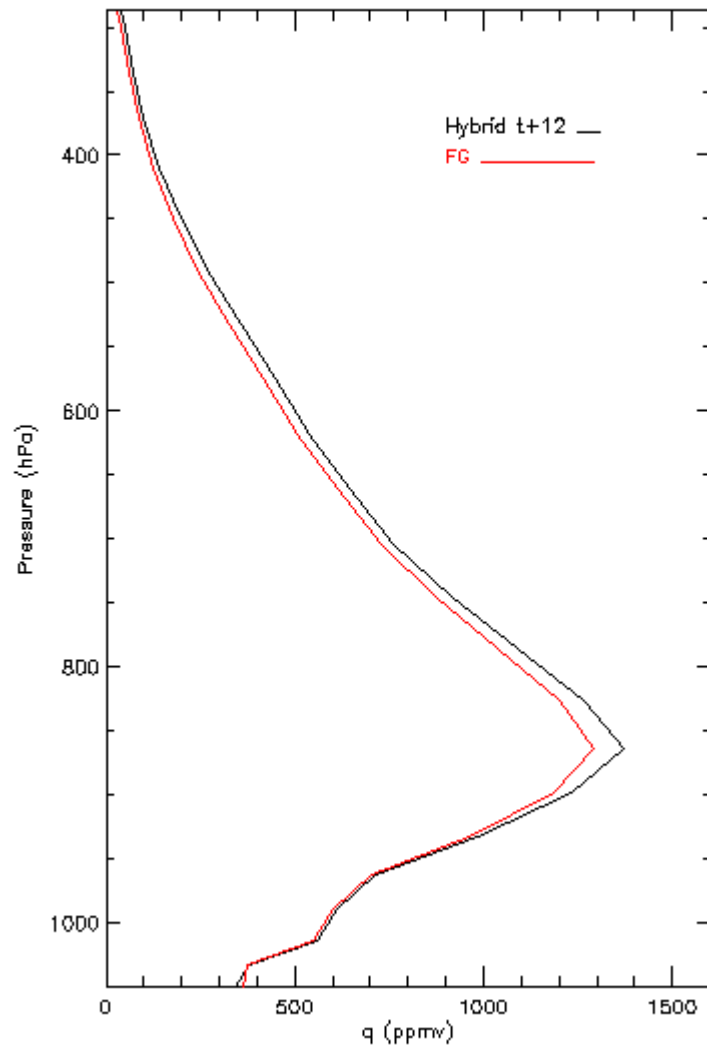


M. Lekouara(EUMETSAT) commented that in MTG-FCI format will be available directly the (lon,lat,z) of satellite.

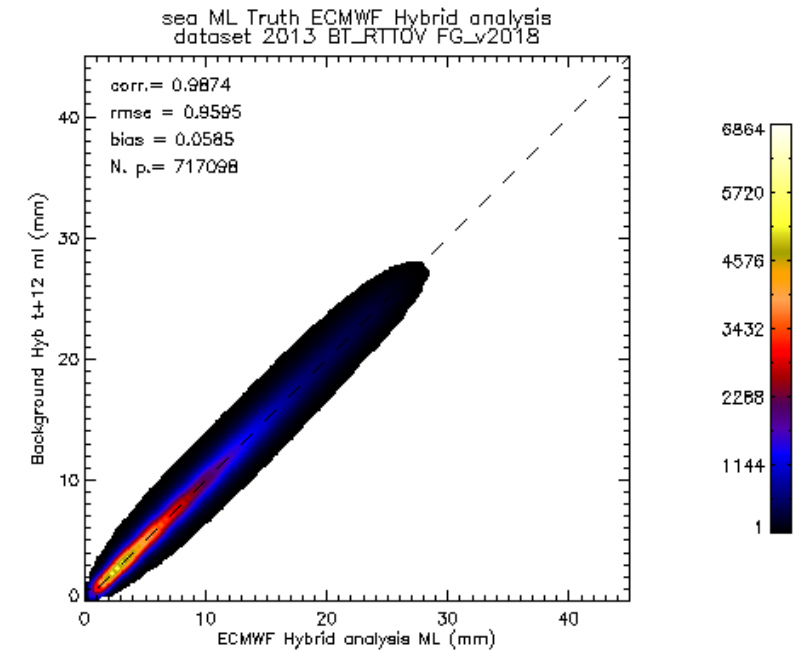
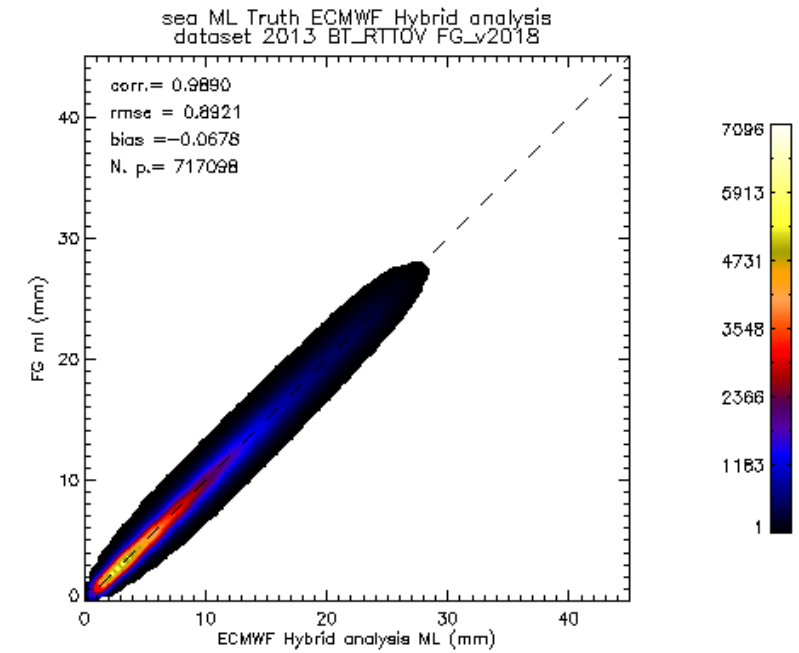
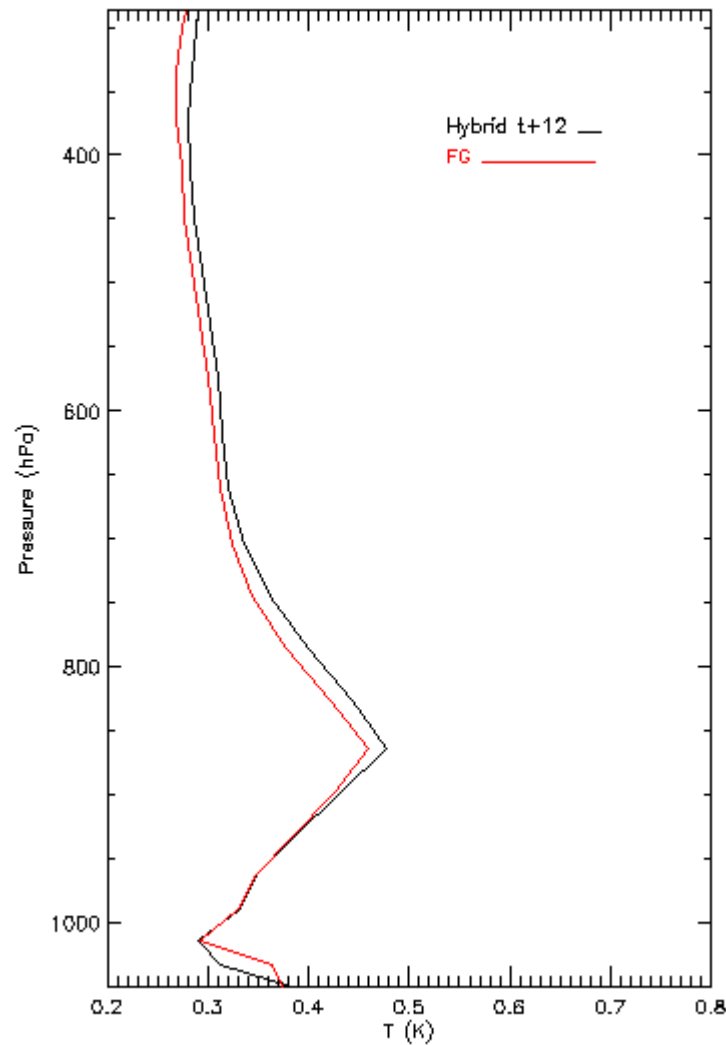
FG regression SEVIRI on MSGs

Draft statistics for v2018

q rmse for sea pixels dataset 2013
version=FG_v2018 case BT_RTTOV



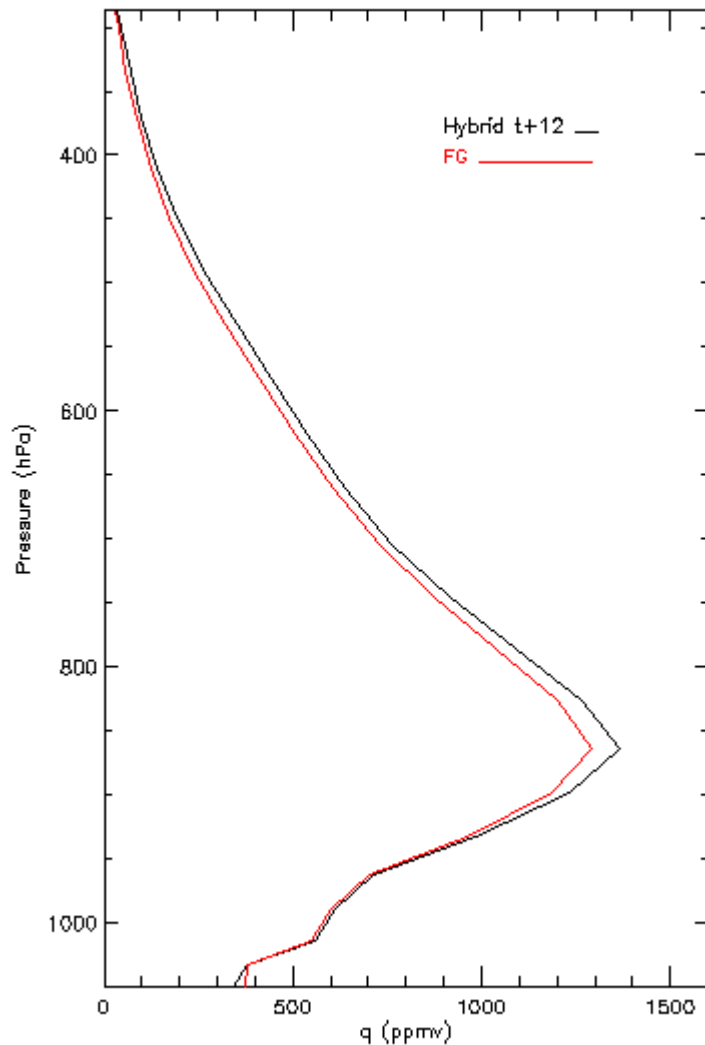
T rmse for sea pixels dataset 2013
version=FG_v2018 case BT_RTTOV



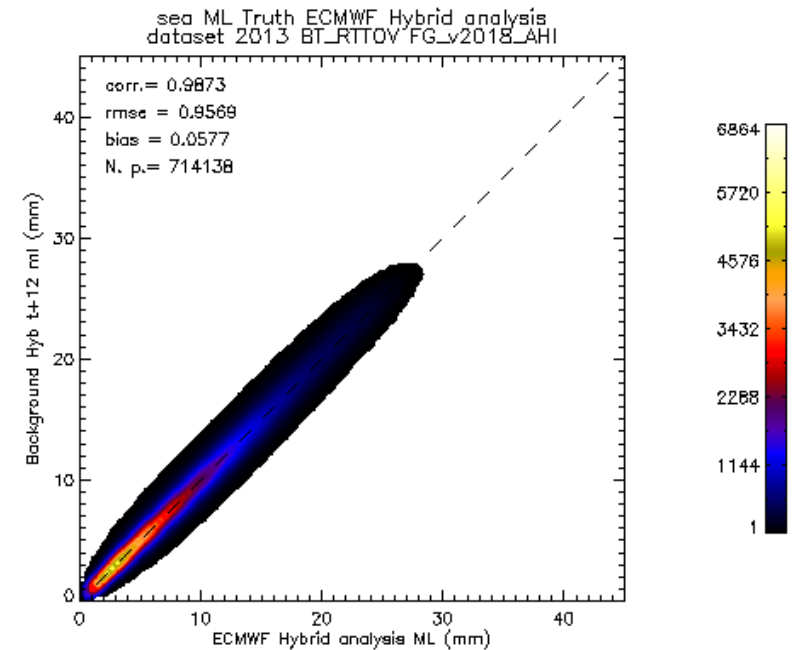
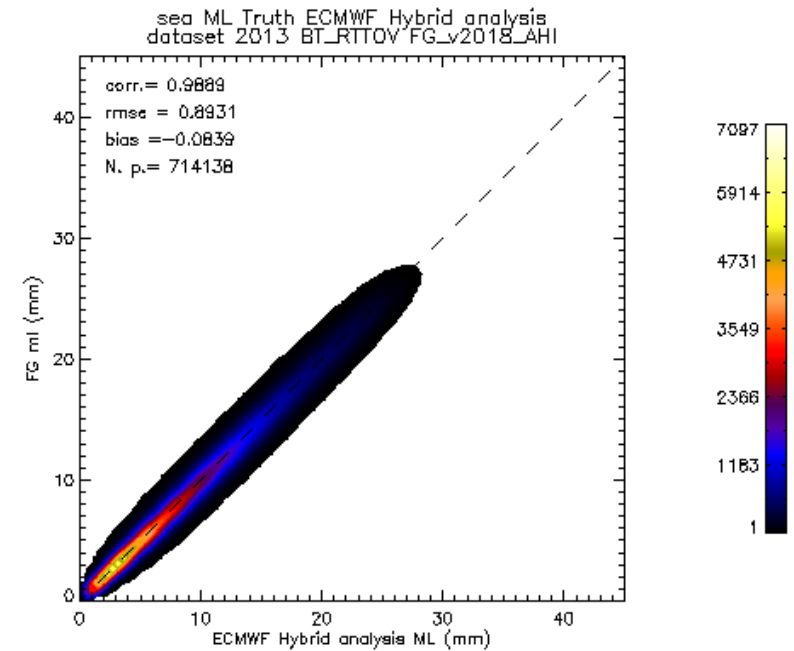
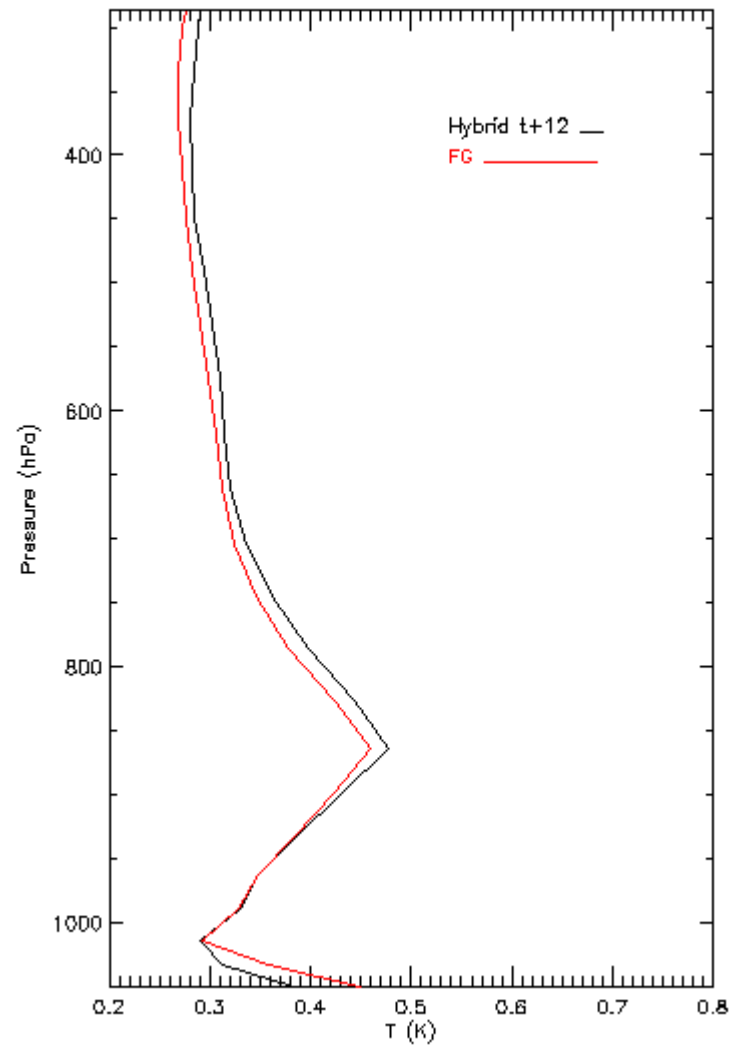
FG regression AHI on Himawari

Draft statistics for v2018

q rmse for sea pixels dataset 2013
version=FG_v2018_AHI case BT_RTTOV



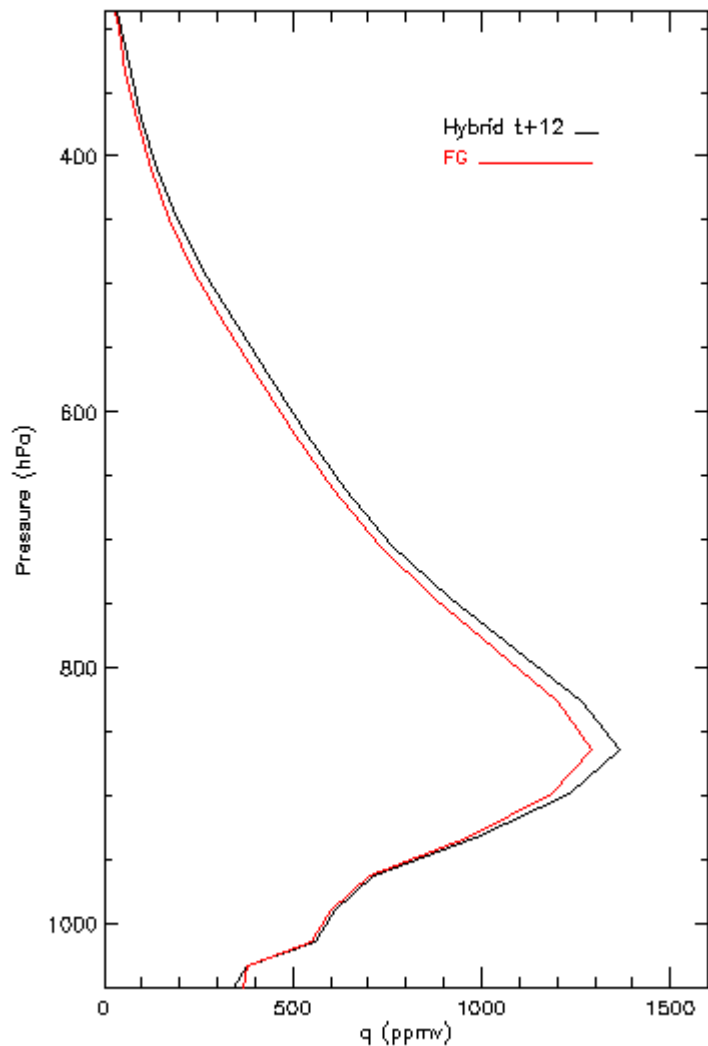
T rmse for sea pixels dataset 2013
version=FG_v2018_AHI case BT_RTTOV



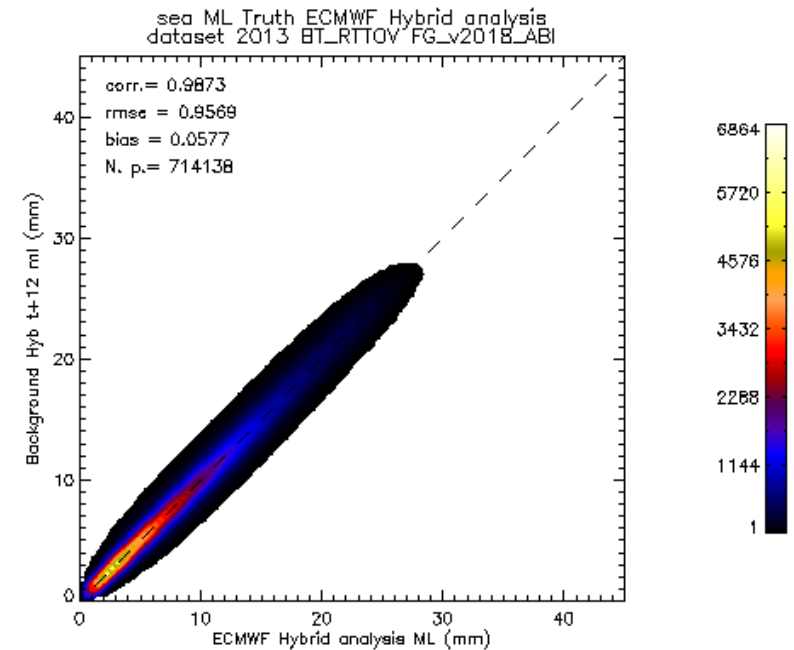
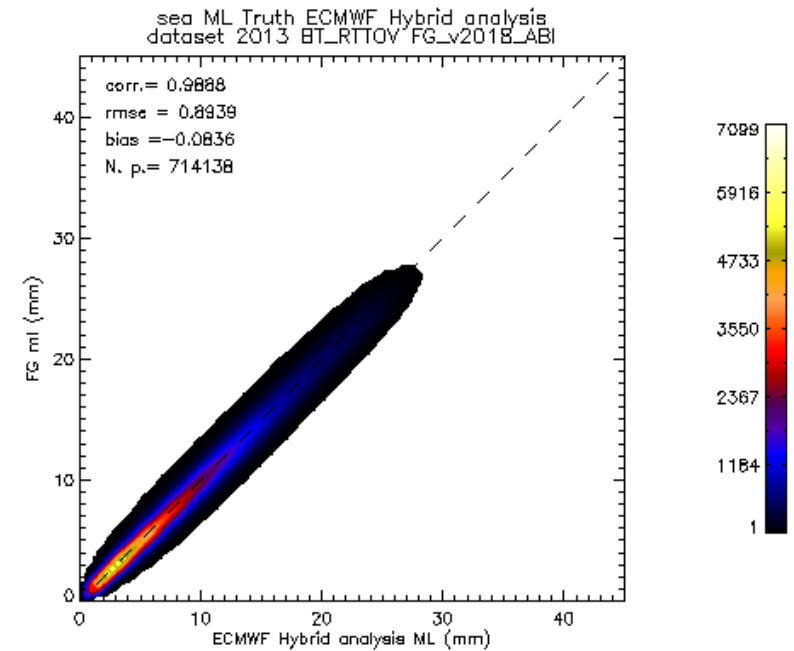
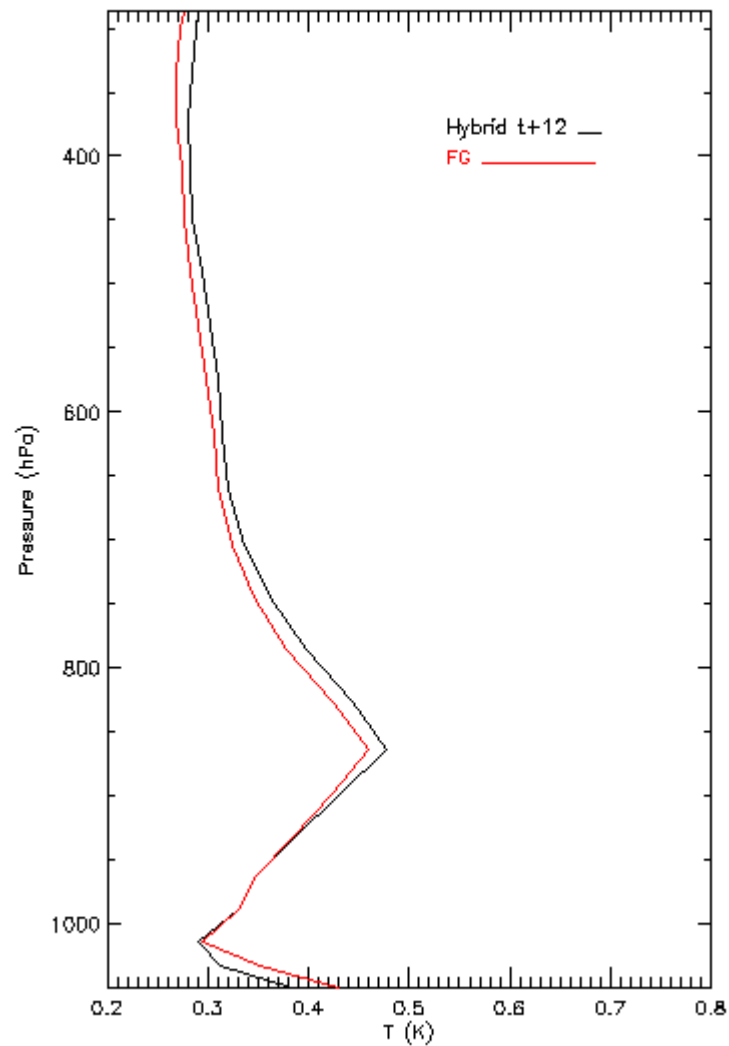
FG regression ABI on GOES-R

Draft statistics

q rmse for sea pixels dataset 2013
version=FG_v2018_ABI case BT_RTTOV



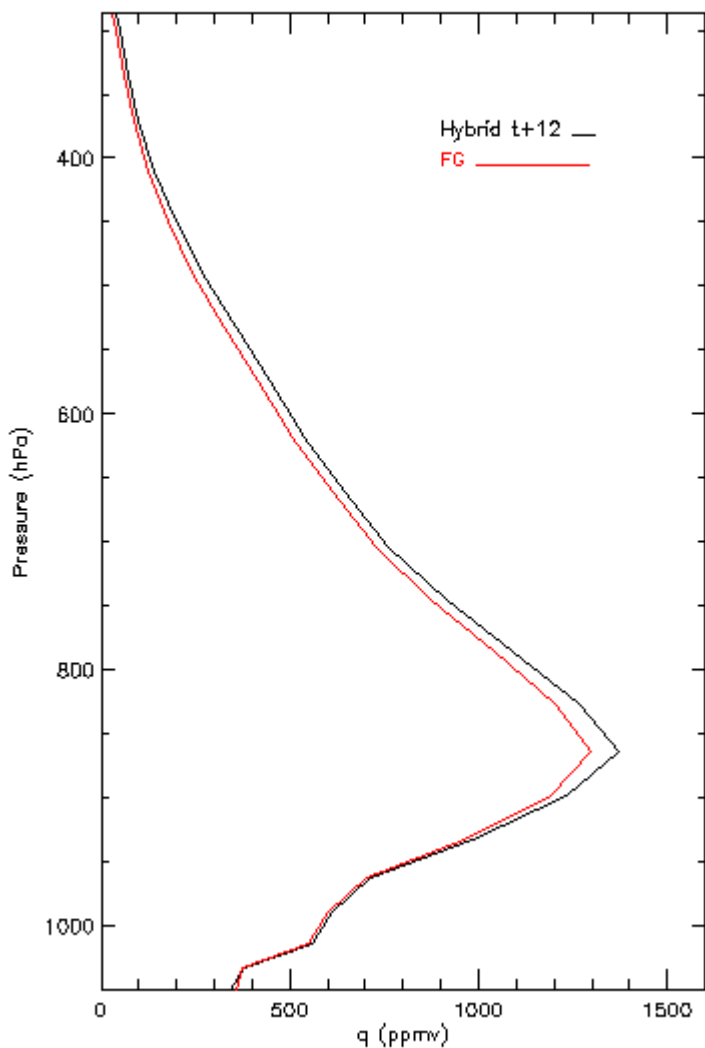
T rmse for sea pixels dataset 2013
version=FG_v2018_ABI case BT_RTTOV



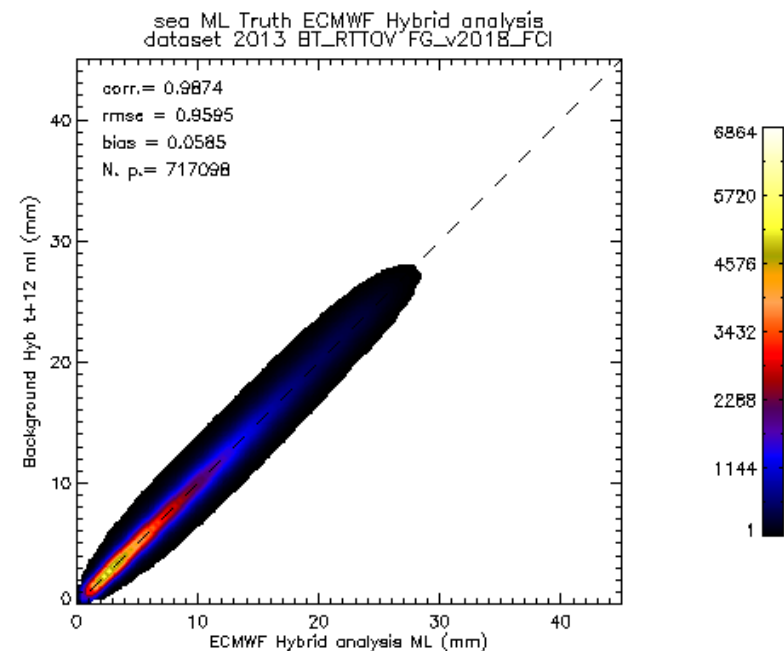
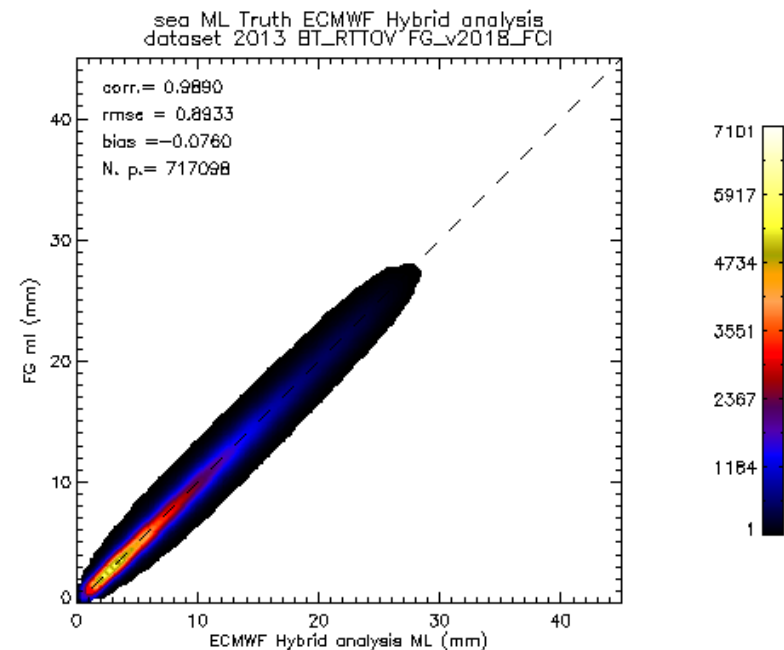
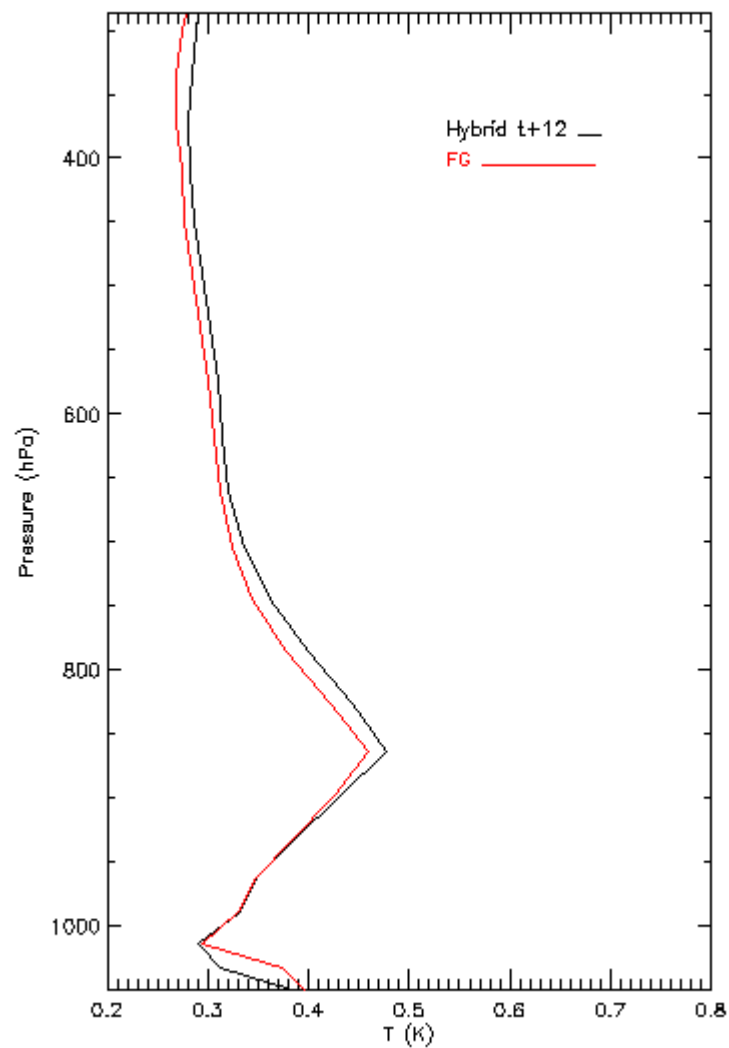
FG regression on MTG-FCI

Draft statistics

q rmse for sea pixels dataset 2013
version=FG_v2018_FCI case BT_RTT0V

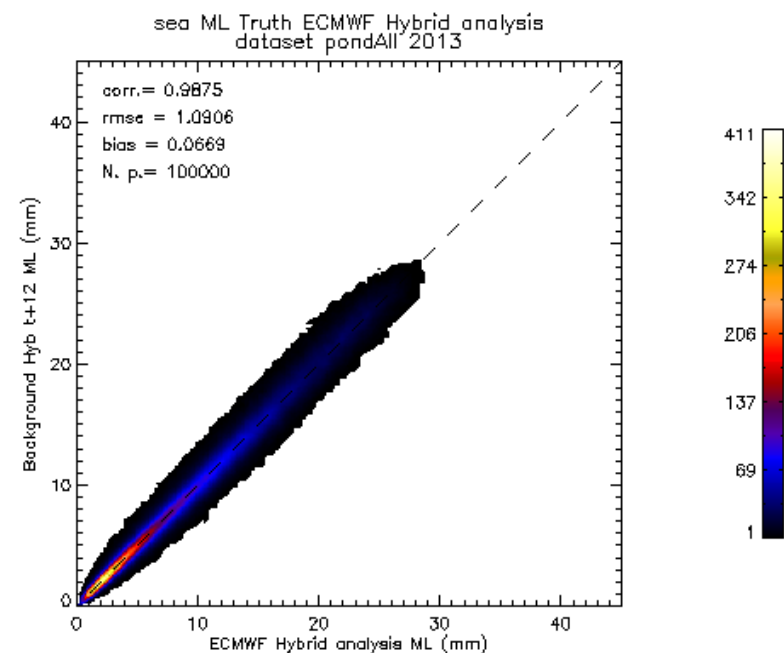
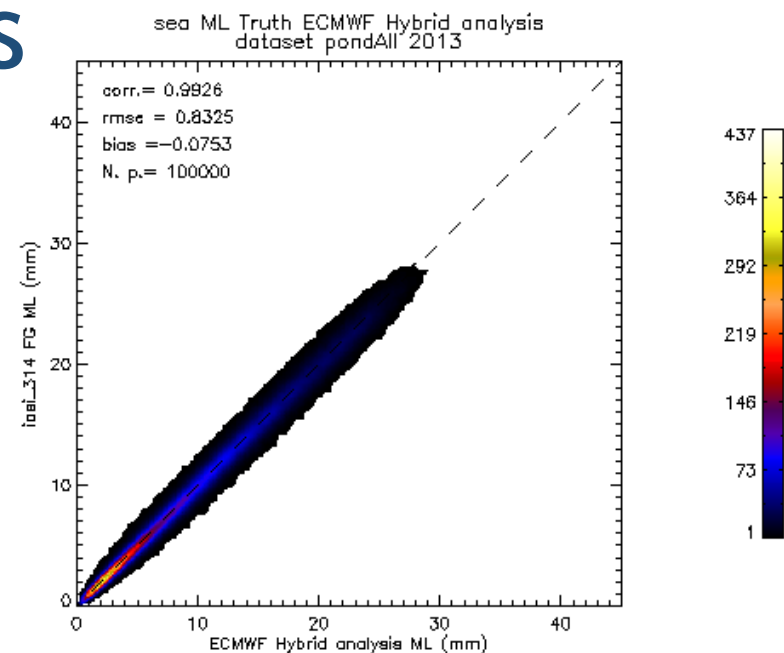
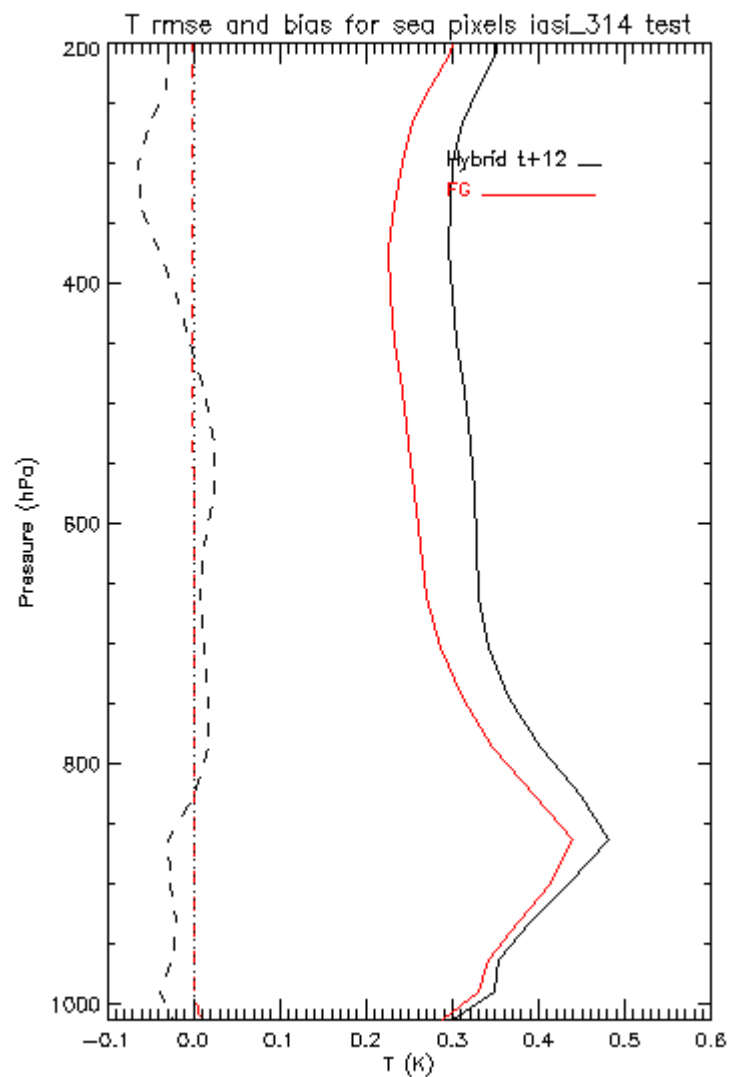
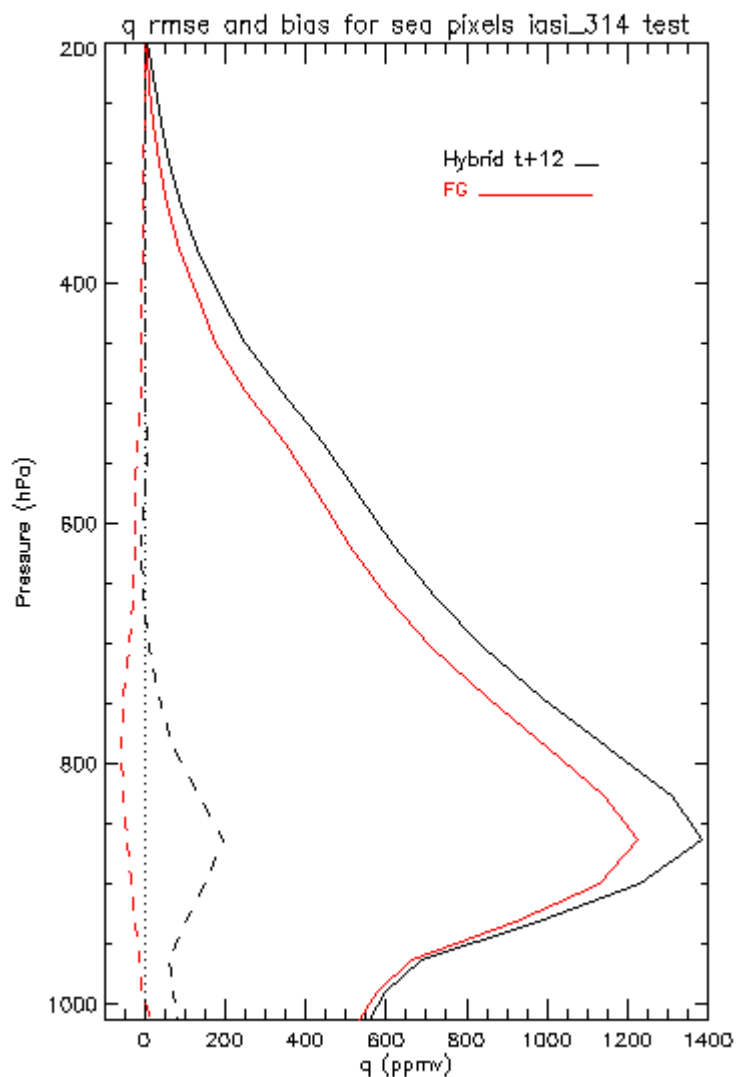


T rmse for sea pixels dataset 2013
version=FG_v2018_FCI case BT_RTT0V

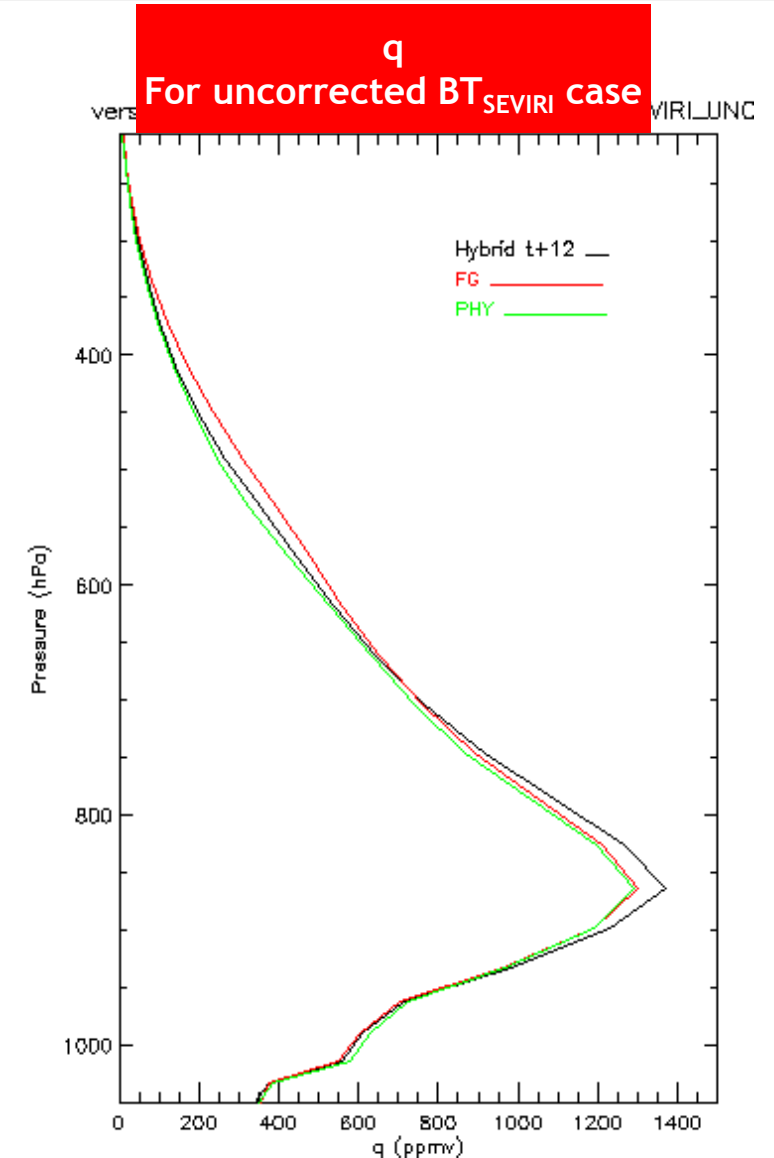
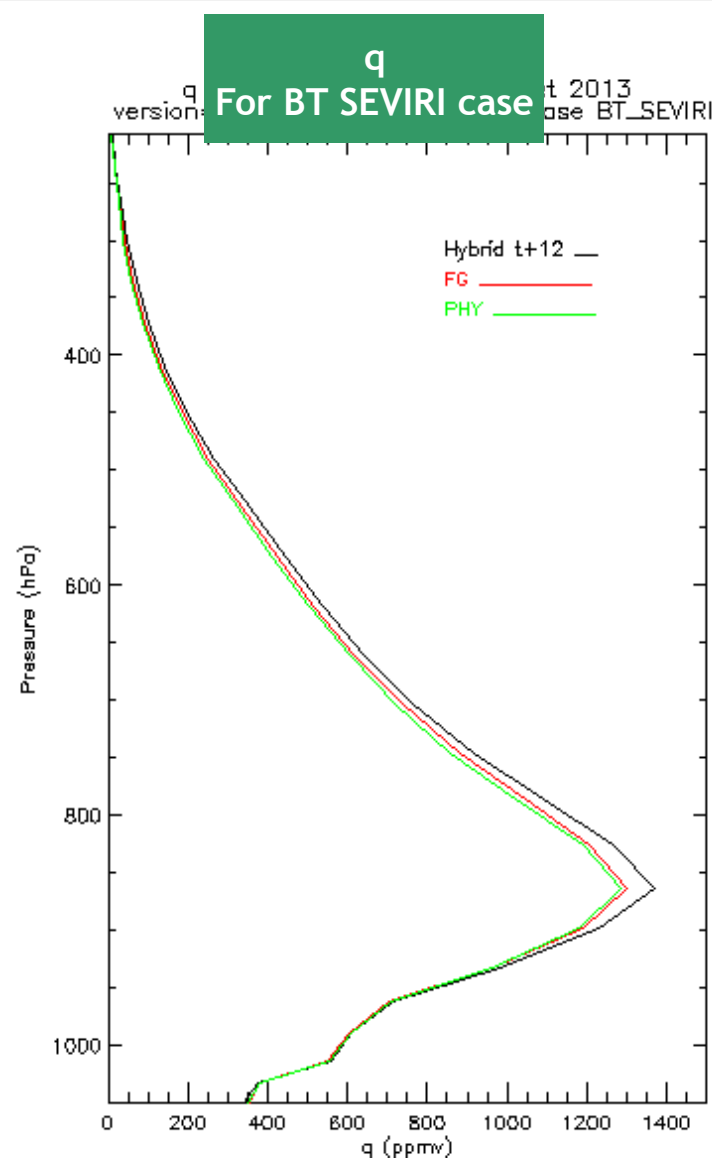
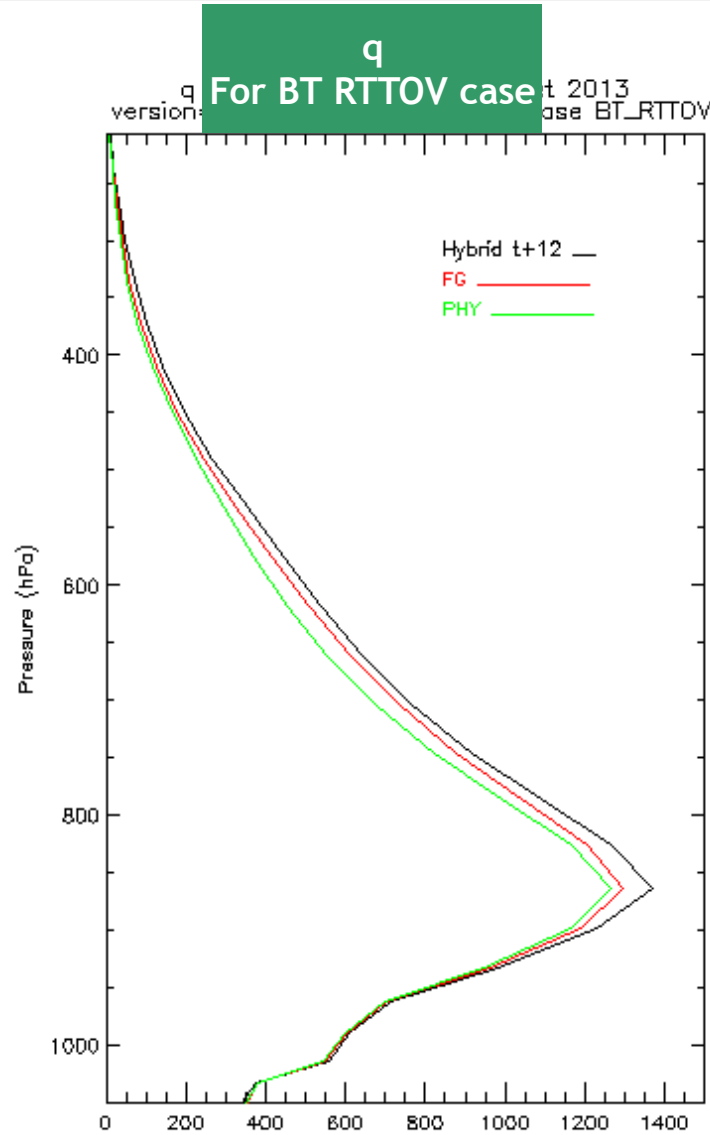


FG regression with 314 IASI channels

Note: Simplified training and test. Different validation dataset and some differences



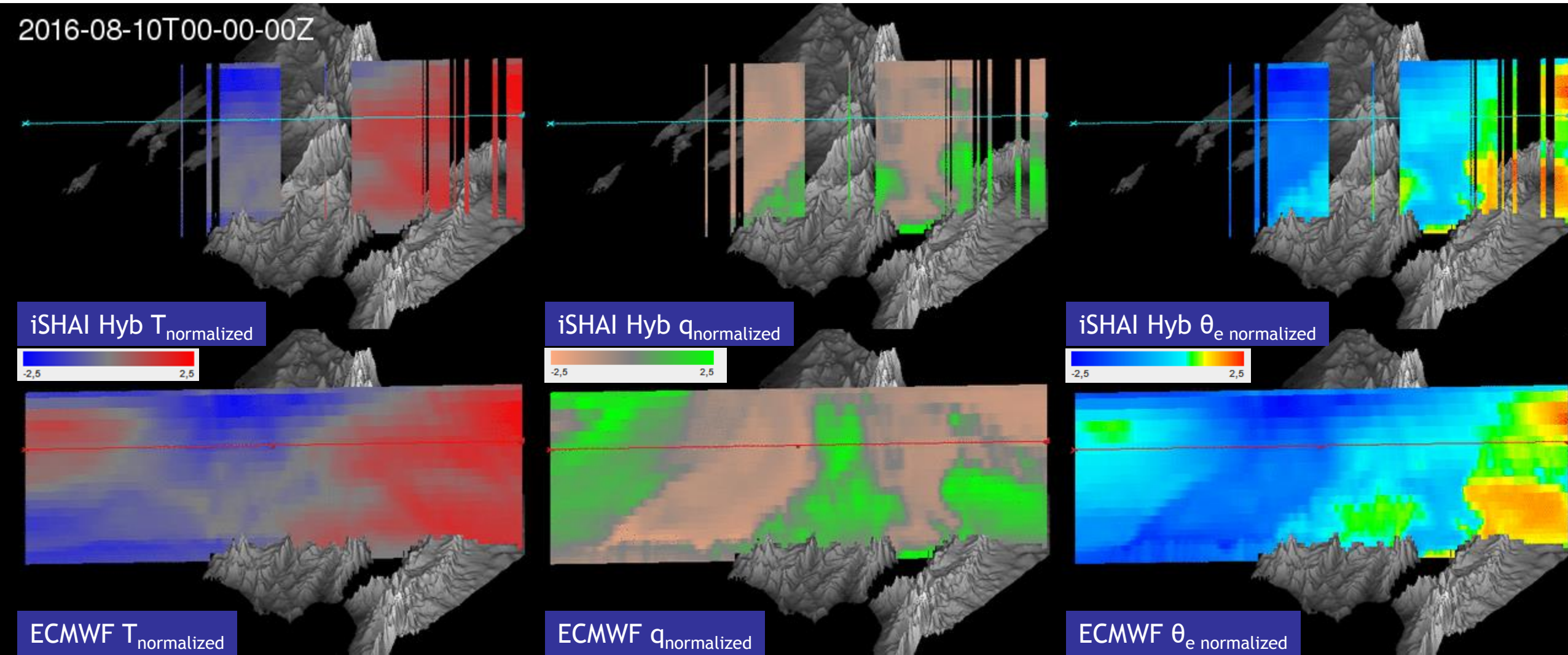
q rmse sea pixels: RTTOV-11.2 validation from version 2016



RMSE of q profiles at different steps compared with ECMWF analysis hybrid profiles over sea pixels in the Full Disk region after screening using synthetic RTTOV BTs

Background NWP model ECMWF at hybrid levels
After screening of 5% pixels with the largest distance between RTTOV_BT and SEVIRI BT on non-window channels

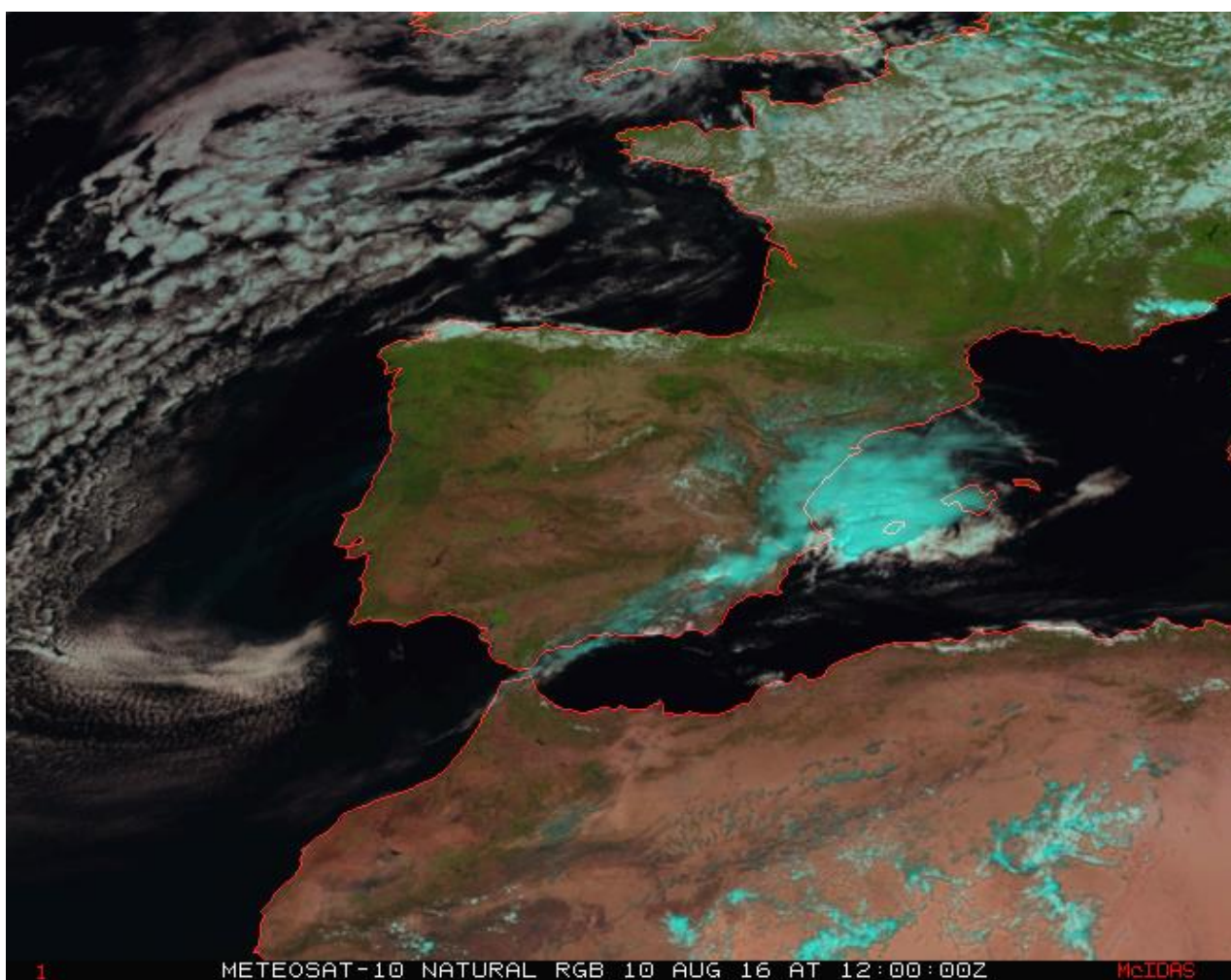
Normalized 3D vertical cross sections



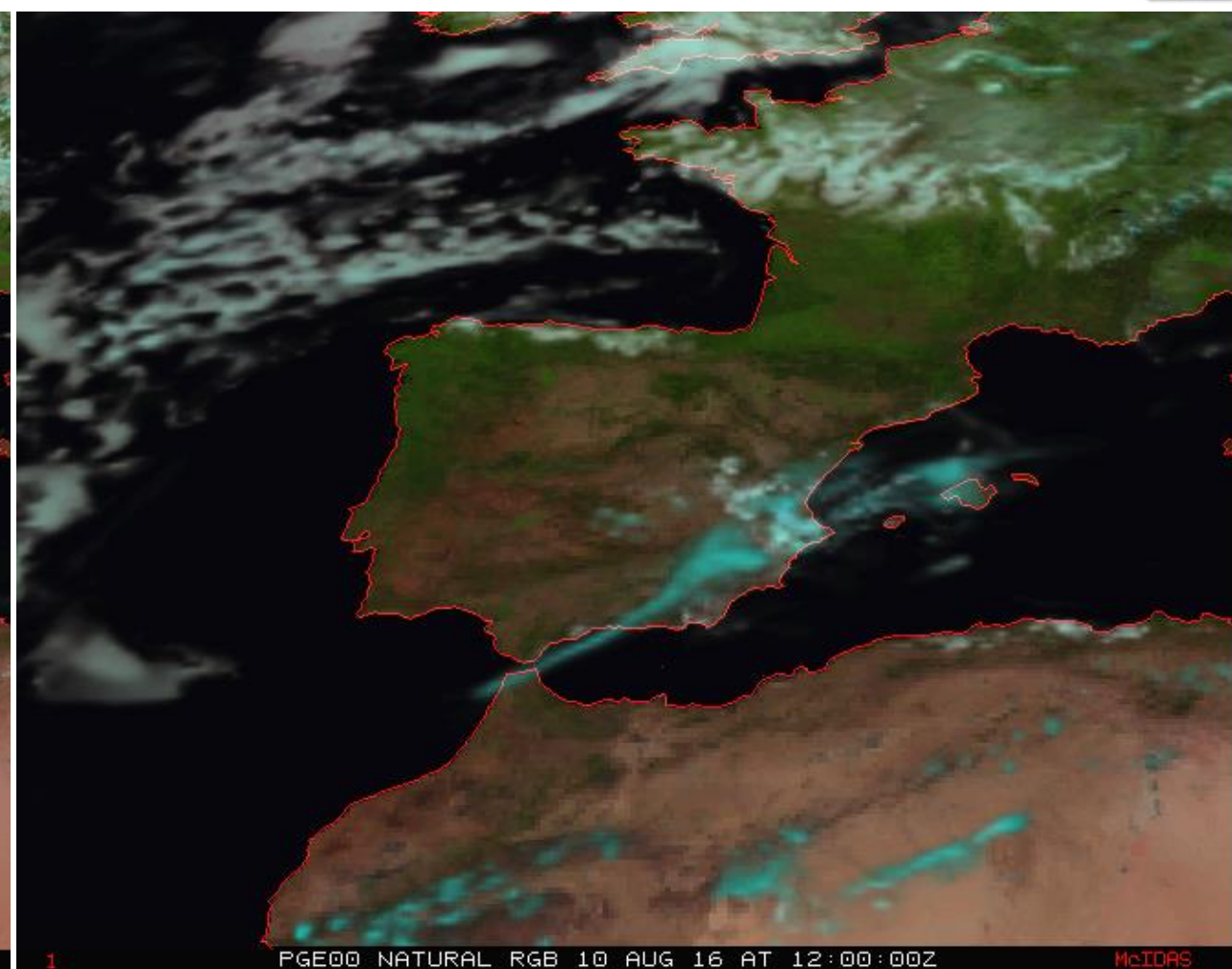
Normalized 3D arrays after calculation the mean and standard deviation on the analysis at every layer and then create the normalized 3D cube subtracting the mean and dividing by the standard deviation at every layer.
As example in T 3D red => hotter than mean and blue => colder than mean at its layer.

[See loop on NWC SAF web page](#)

Comparison of PGE00-VISIR synthetic and real RGBs from MSG



MSG real natural RGB



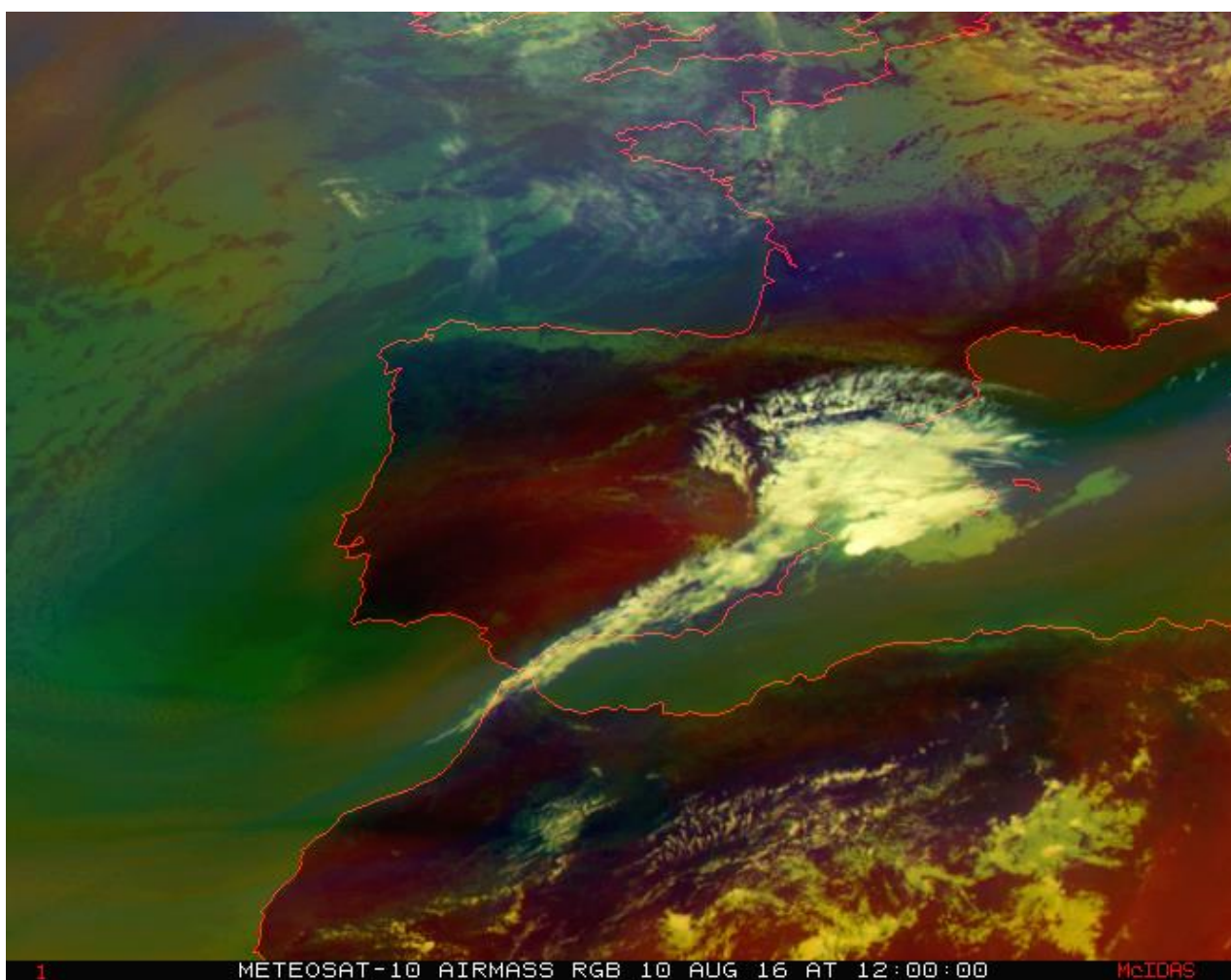
MSG synthetic PGE00-VISIR natural RGB

[See loop on NWC
SAF web page](#)

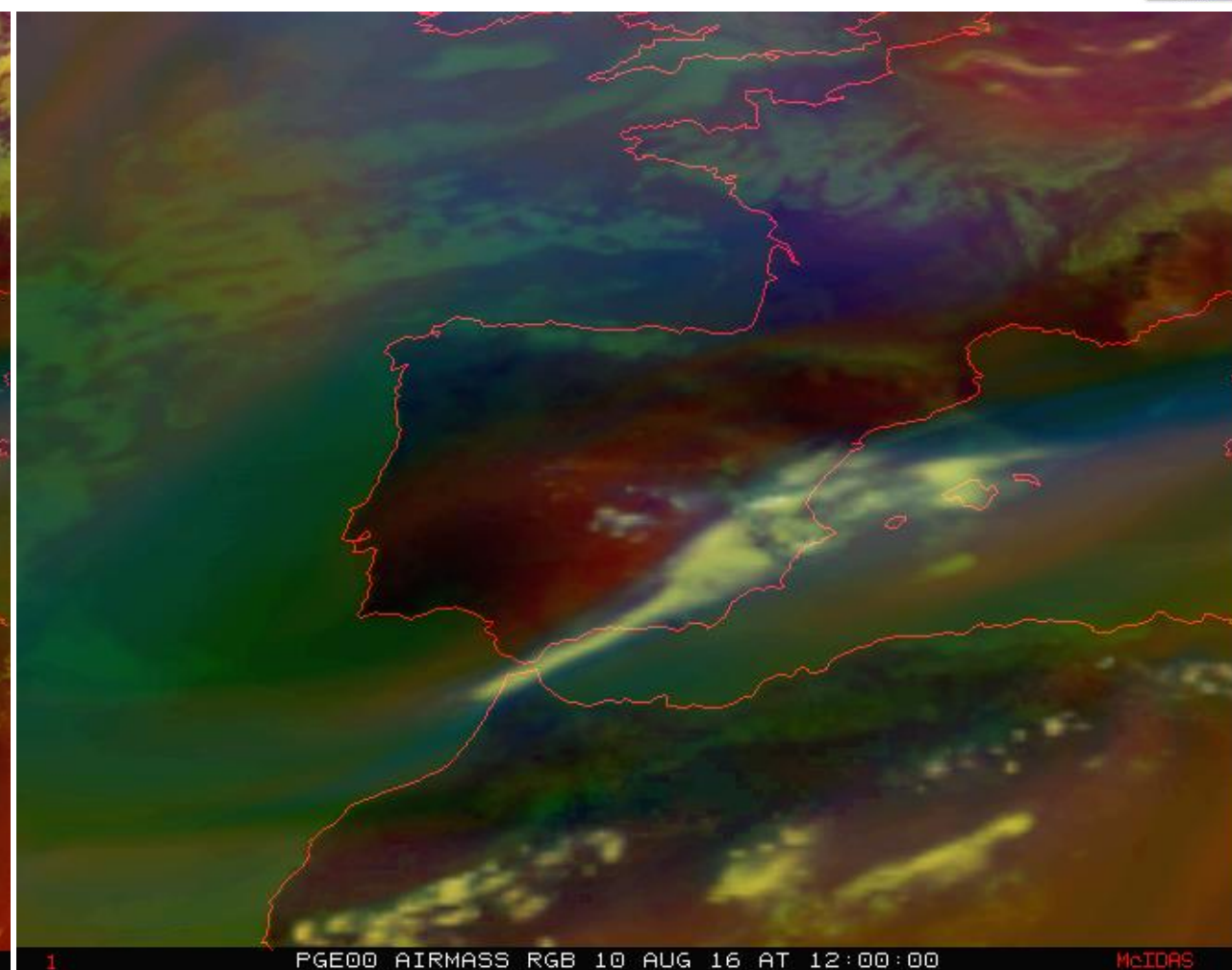
Convection Working Group 2018
17-19 April 2018 - Ljubljana

ECMWF 10th August 2016 12Z
t+12 from 10th August 2016 run 00Z

Comparison of PGE00-VISIR synthetic and real RGBs from MSG



MSG real airmass RGB



MSG synthetic PGE00 airmass RGB

ROJO	WV6.2-WV7.3	[-25,0]
VERDE	IR9.7-IR10.8	[-40,5]
AZUL	WV6.2	[243,208]

ECMWF 10th August 2016 12Z
t+12 from 10th August 2016 run 00Z

[See loop on NWC
SAF web page](#)

Blended NWP-real airmass RGB

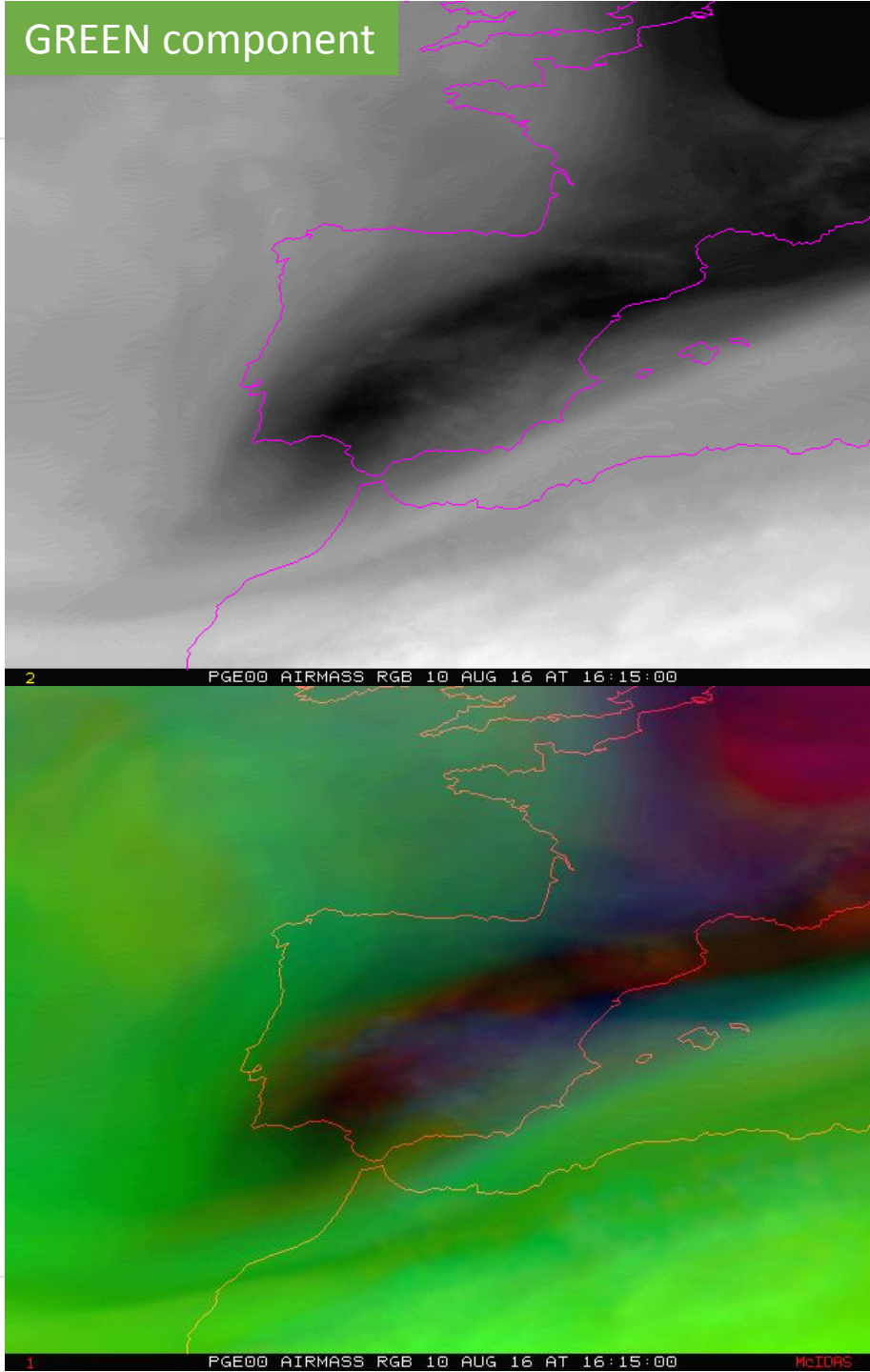
It was made a test using two simulations:

- a) **clearIR97_{RTTOV}** synthetic BTs on clear air using the ECMWF original profiles
- b) **meanO3_clearIR97_{RTTOV}** Calculation of synthetic BTs on clear air using the ECMWF original profiles for T and q but using as ozone profiles **for all the pixels the same mean of the ozone profile in every layer in the grid.**

(clearIR97_{RTTOV} - meanO3_clearIR97_{RTTOV})
on these clear air simulation shows clearly the influence of the ozone in IR9.7 channel.

If these difference is used in green component of airmass RGB it is shown in darker color the presence of the ozone intrusion.

ROJO	WV6.2-WV7.3	[-25,0]
VERDE	clearIR97 _{RTTOV} - meanO3_clearIR97 _{RTTOV}	[-4,4]
AZUL	WV6.2	[243,208]



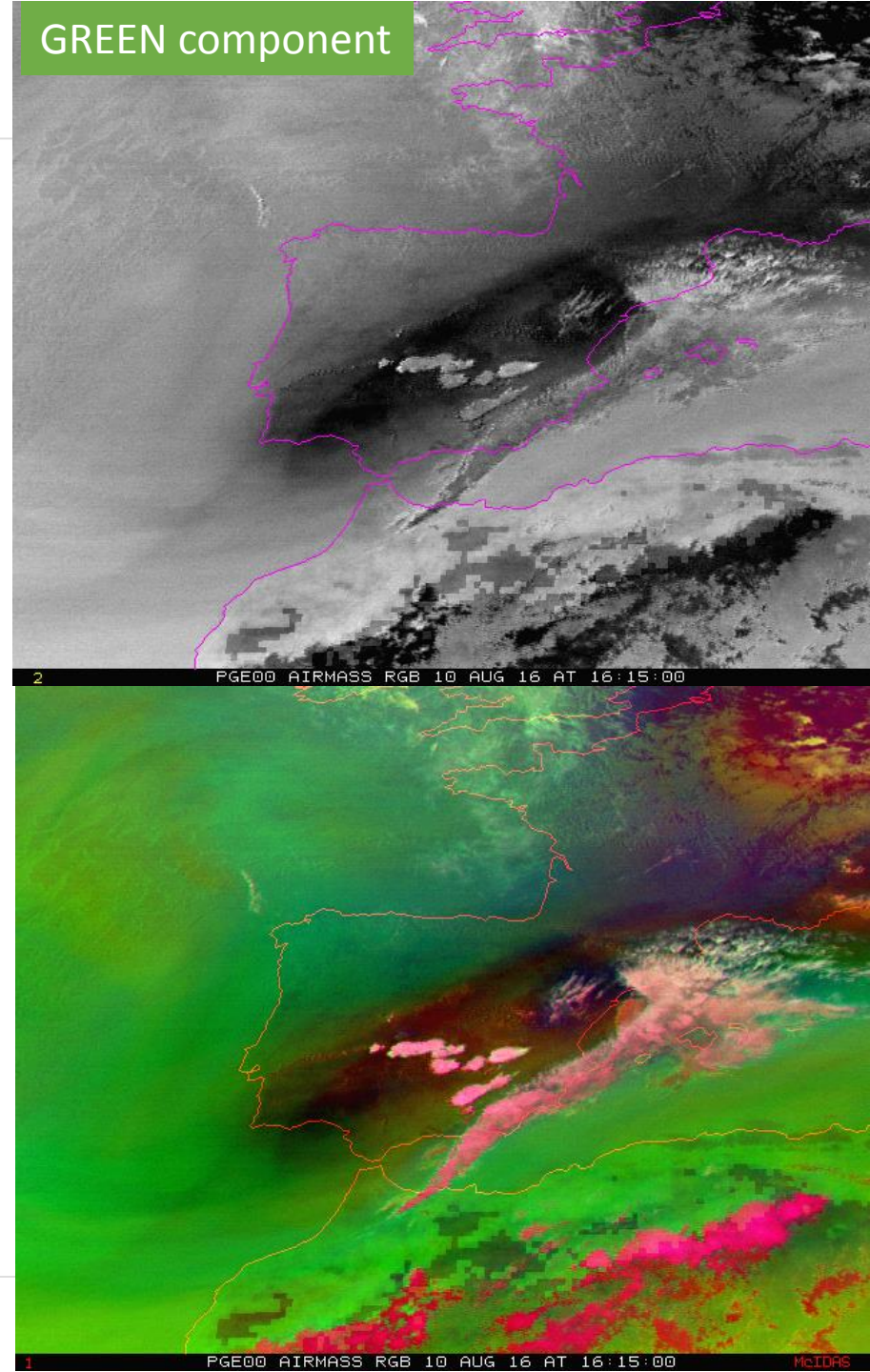
Blended NWP-real airmass RGB with real images

When using on real images it is needed to correct the difference between in RTTOV BTIR9.7 and real BTIR9.7

In the example the **GREEN component** has been made using **a regression** from the difference real and RTTOV in **IR10.8** and IR9.7.

$$(\text{BTIR97} - \text{meanO3_clearIR97}_{\text{RTTOV}}) - (0.54 * (\text{BTIR108} - \text{meanO3_clearIR108}_{\text{RTTOV}}) + 0.18)$$

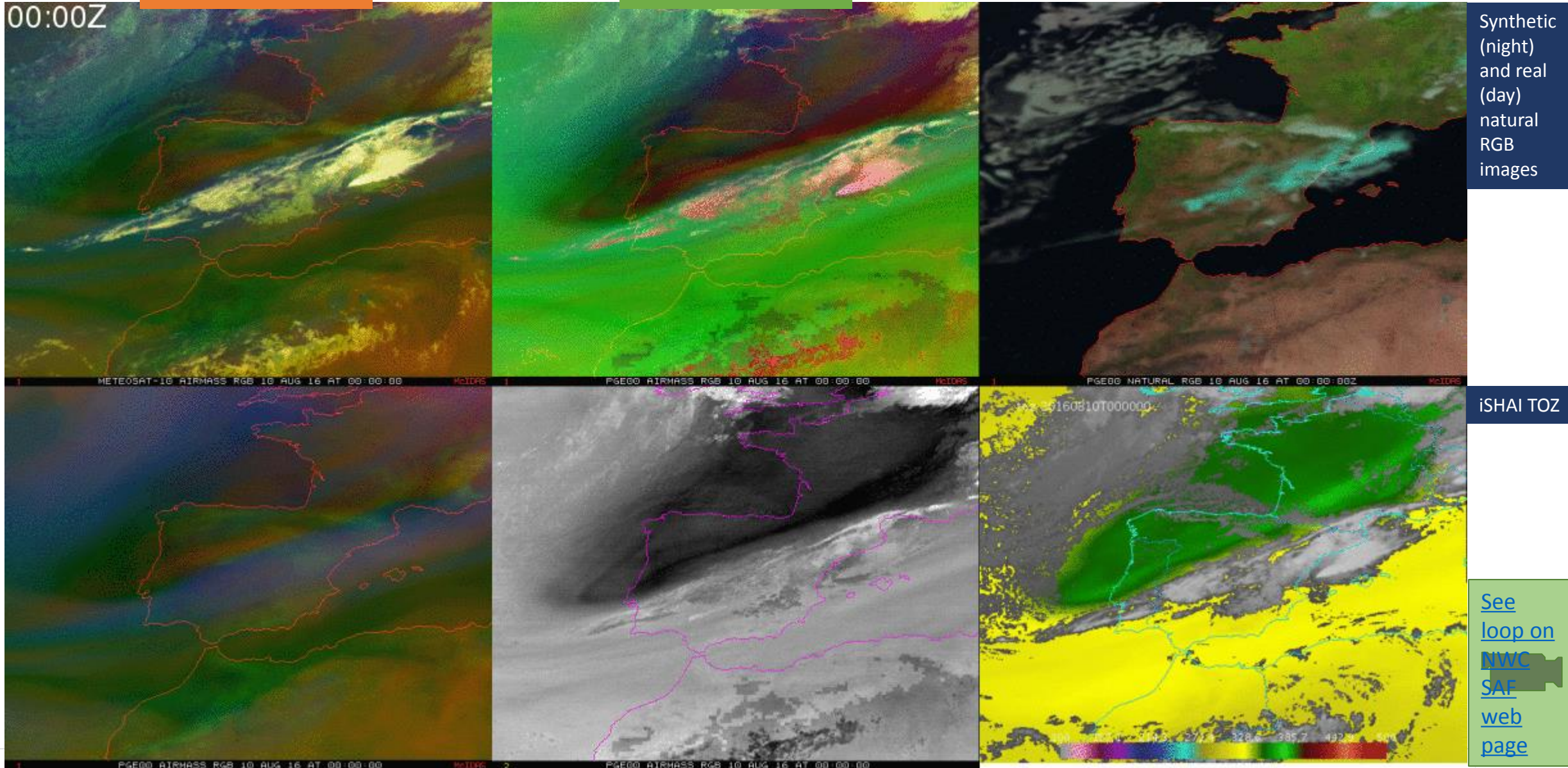
ROJO	WV6.2-WV7.3	[-25,0]
VERDE	$(\text{BTIR97} - \text{meanO3_clearIR97}_{\text{RTTOV}}) - (0.54 * (\text{BTIR108} - \text{meanO3_clearIR108}_{\text{RTTOV}}) + 0.18)$	[-4,4]
AZUL	WV6.2	[243,208]



Loop of Blended airmass RGB and others

real airmass RGB

blended airmass RGB



Clear synthetic airmass RGB

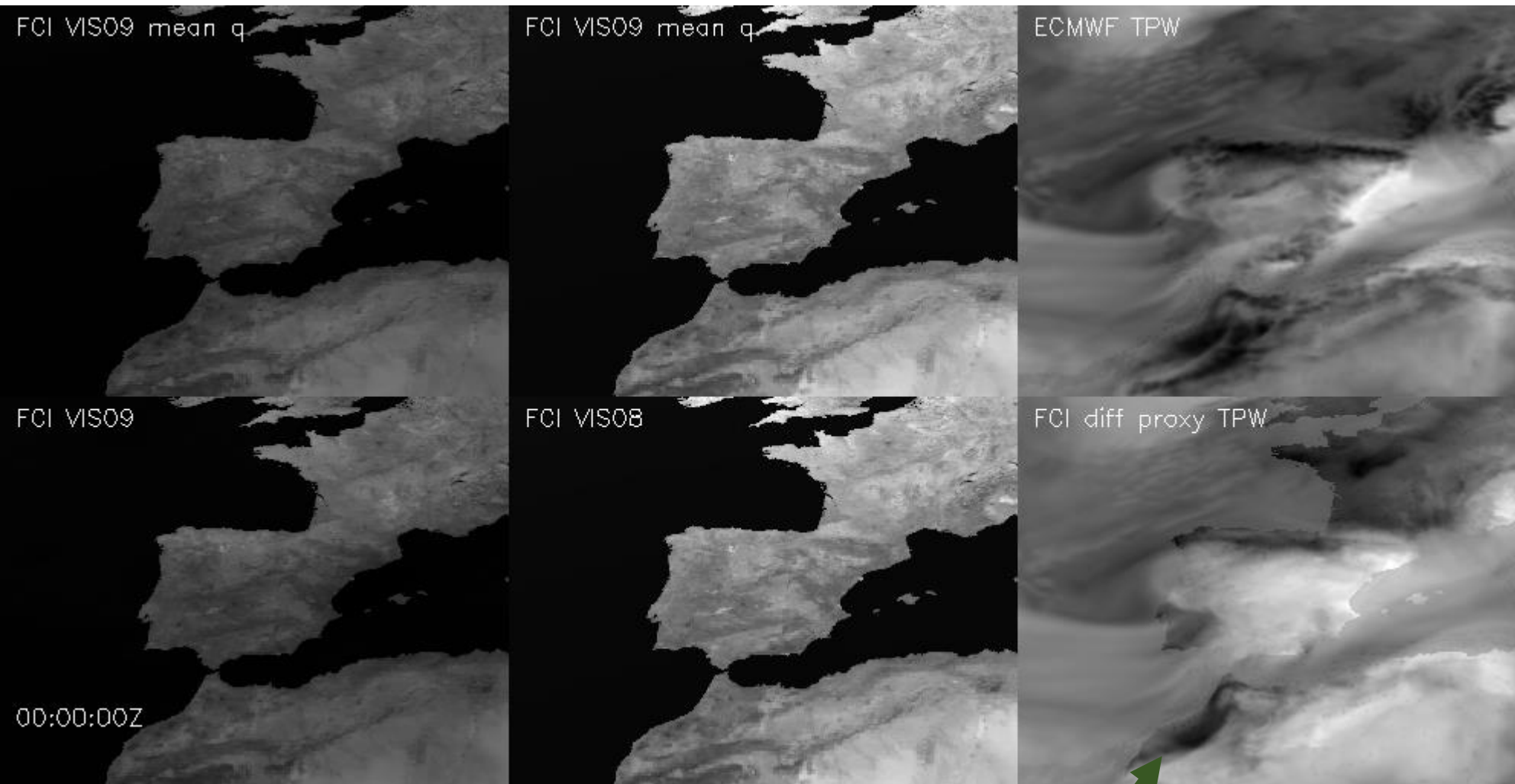
GREEN component blended airmass RGB

Synthetic
(night)
and real
(day)
natural
RGB
images

iSHAI TOZ

See
loop on
NWC
SAF
web
page

FCI VIS09 TPW with blended technique



MTG-FCI VIS0.9 is a WV absorption channel in VIS range.

Thus it is of interest in convection

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

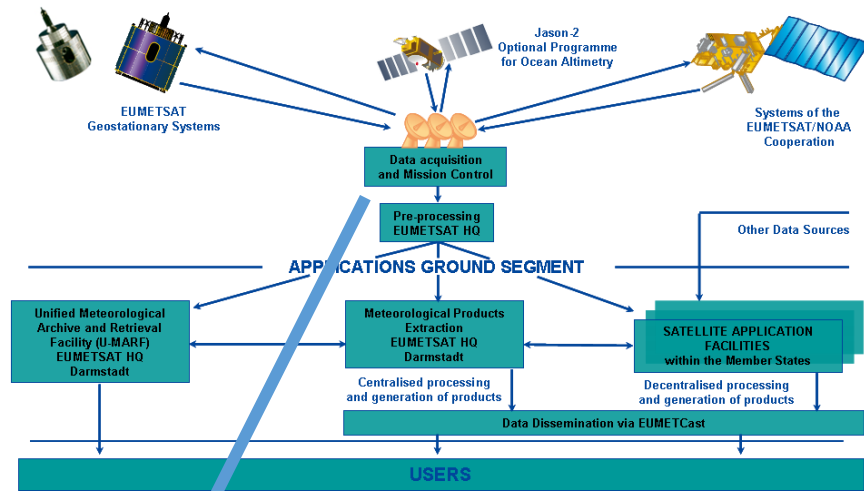
Not foreseen developments in CDOP-3 proposal.

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

$(\text{Log}(\text{VIS09}) - \text{Log}(\text{VIS09mean_q})) - (\text{Log}(\text{VIS08}) - \text{Log}(\text{VIS08mean_q}))$

[See loop on NWC SAF web page](#)

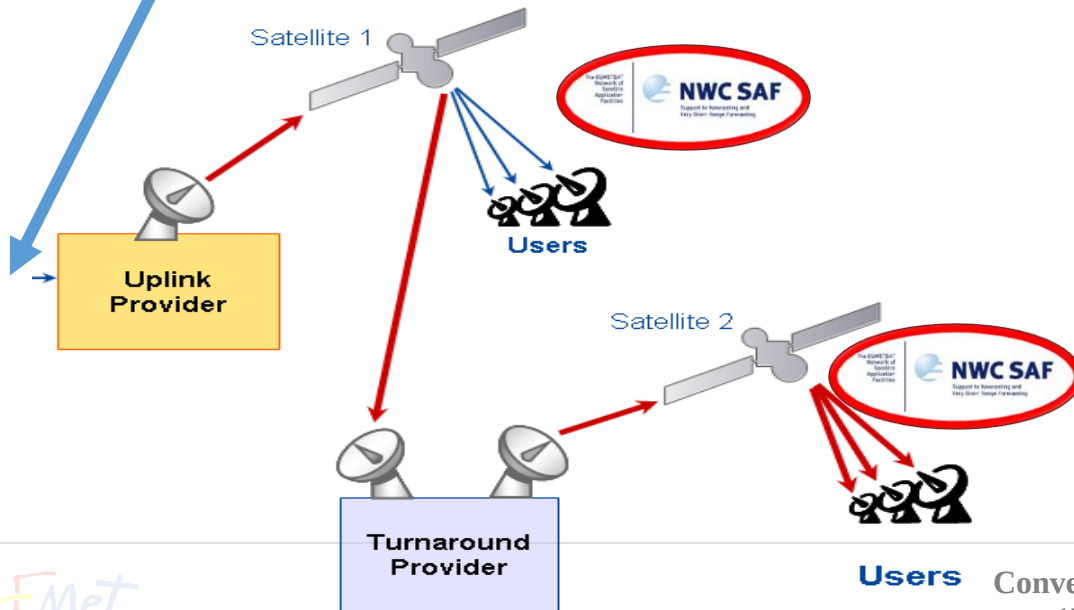
Future NWC SAF products for MTG-IRS



The general objective of the NWC SAF is to provide software to ensure the optimal use of meteorological satellite data in Nowcasting and Very Short Range Forecasting.

NWC-SAF is one special SAF because it develops software. 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**



Plans for MTG-S: To offer a user friendly software to manage the IRS L1 and L2 data and to generate Nowcasting products

qIRS: Quick IRS product

sSHAI_ES: sounder Satellite Humidity And Instability from Eumetsat Secretariat

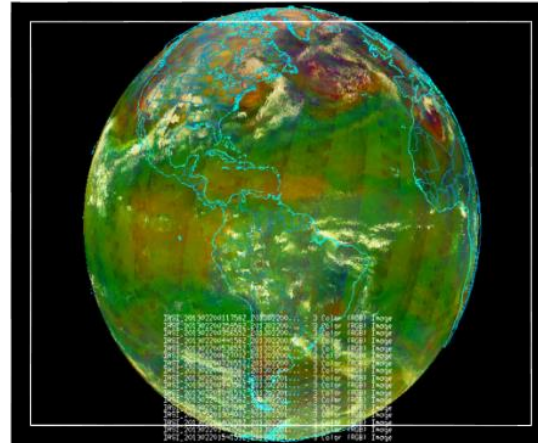
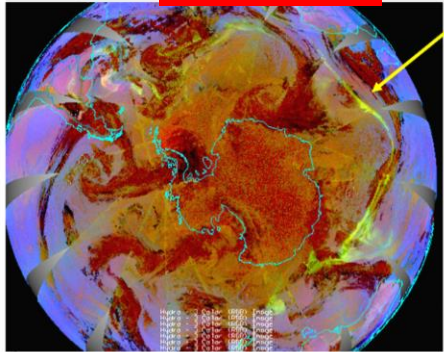
sSHAI: sounder Satellite Humidity And Instability from NWC SAF

qIRS: Quick IRS product

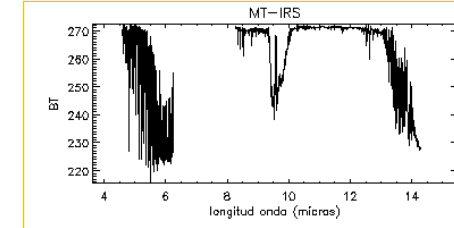
Dust RGB

Volcanic ash and SO₂

Eruption from the
Puyehue-Cordon
Volcano
9th June 2011
22:24Z



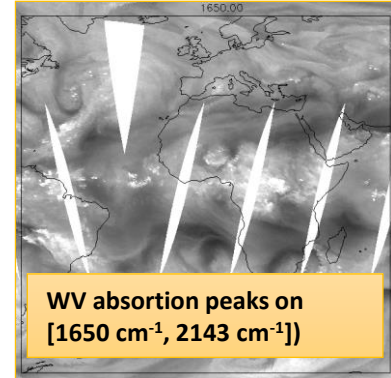
Airmass RGB



IRS 1738 channels in two bands

[See pps on NWC](#)
[SAF web page](#)

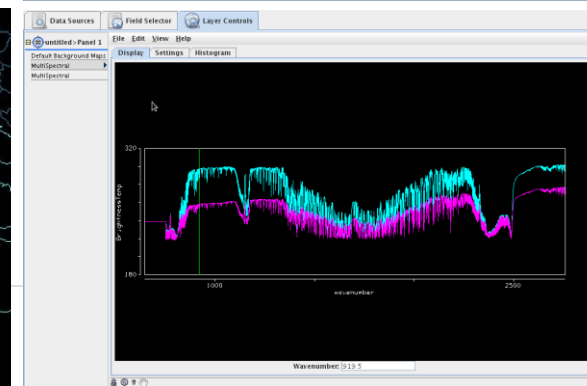
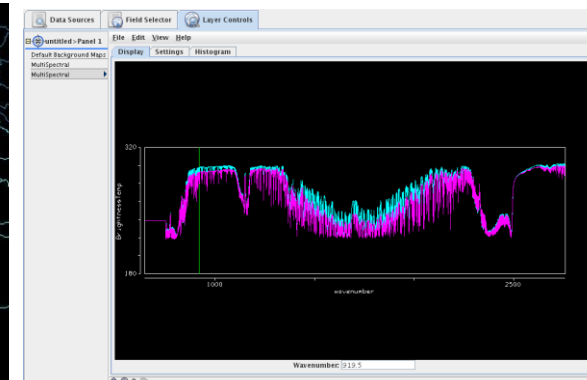
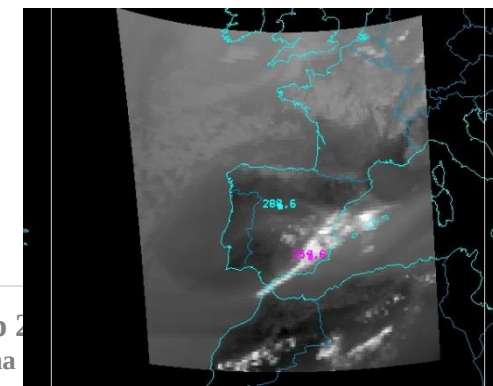
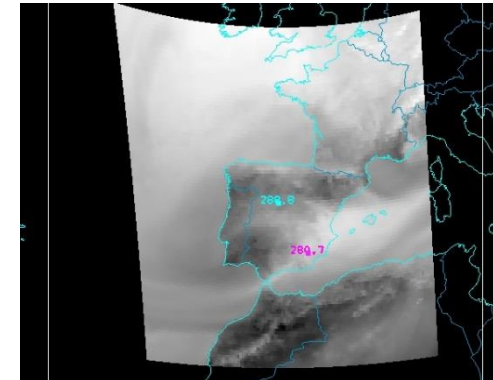
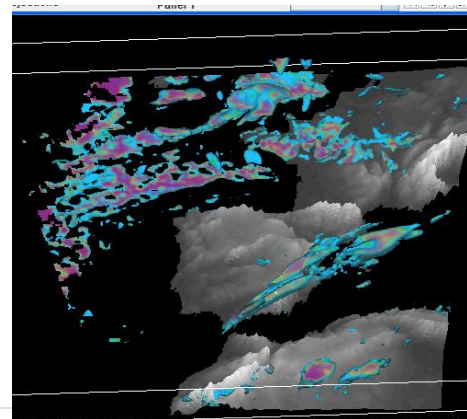
top to down quick looks



WV absorption peaks on
[1650 cm⁻¹, 2143 cm⁻¹]

Principal Components to BTs conversion
and IRS L1 images generation:
PC to BTs, generation of MTG-S L1 BTs
files for NWCSAF user defined regions.
Generation of L1 imagery as example RGB
images.

IASI PGE00 VISIR Simulations
The cloud parameters from
ECMWF on hybrid levels are
used.



Converters from IASI L1 to netCDF

They will be prepared during CDOP-3
and they will be available at Day-2.

Convection working Group 2
17-19 April 2018 - Ljubljana

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. Combination and reprojection of dwells to user defined regions

Converter prototype:

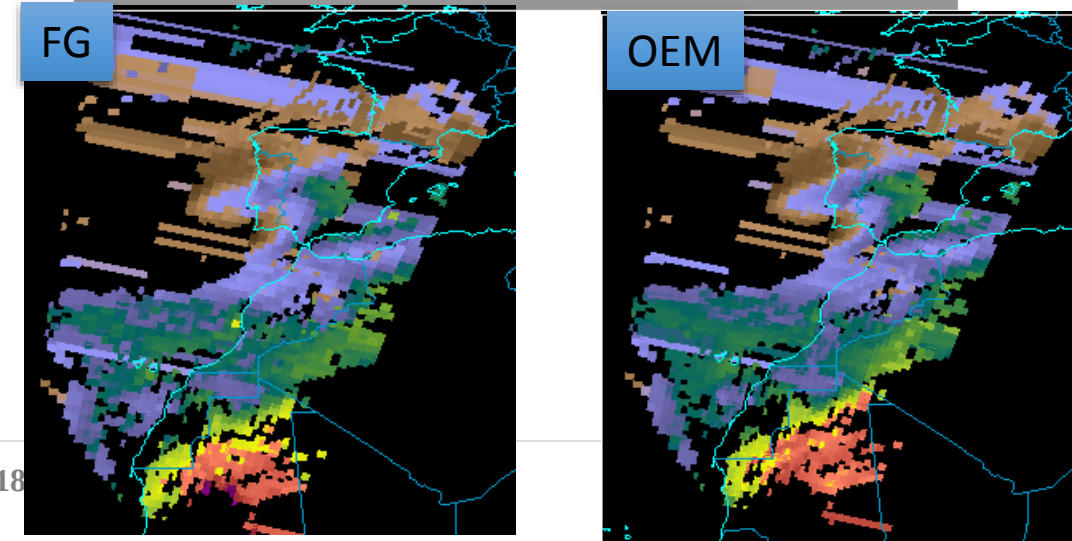
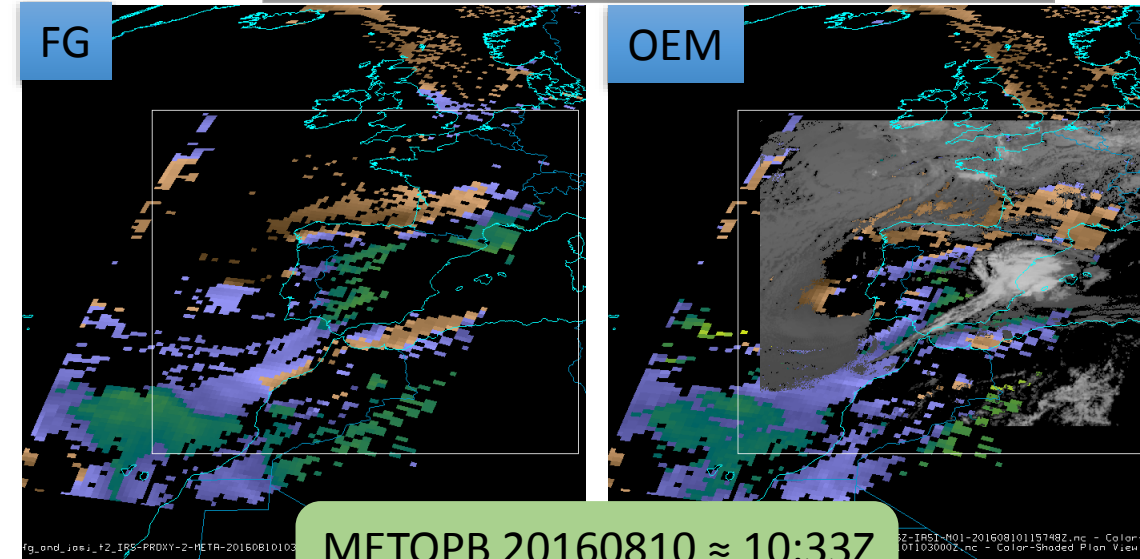
- Combined several individual dataset 5 minutes dataset in one orbit.
- **Reorder the IASI detectors**
- Calculated the same NWCSAF parameters (TPW, LPW and stability indices)

Converter prototype:

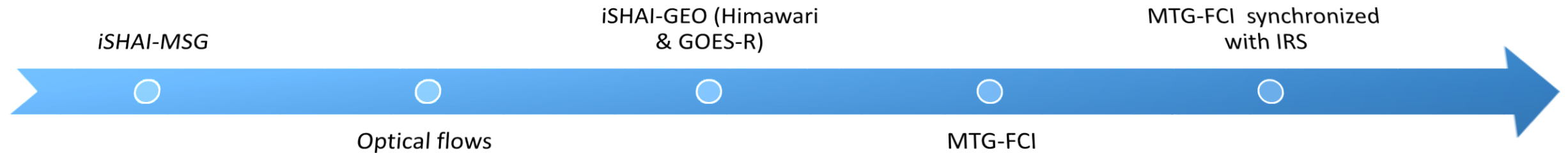
- Subsetting the interest region
- Reorder the IASI detectors
- Calculated relative humidity profile
- Calculated the same NWCSAF parameters (TPW, LPW and stability indices)

Used McIDAS-V as the foreseeable tool for interactive comparison and 3D use of proxy IRS-L2 and comparison with NWP.

Proxy MTG-IRS experiment



Use of iSHAI and PGE00 for optical flow



[See loop on NWC SAF web page](#)

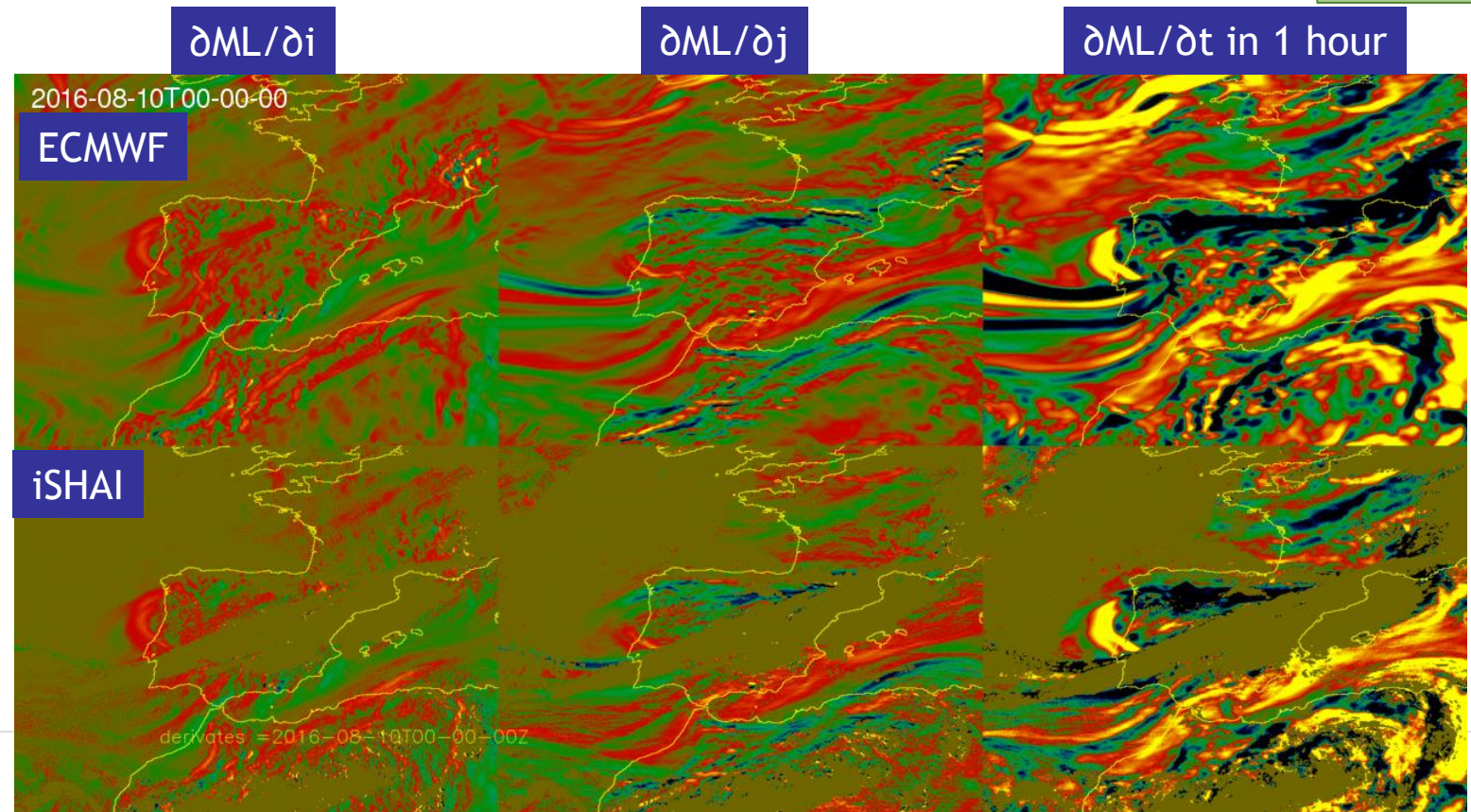
ISHAI and ECMWF collocated fields have a high spatial and temporal resolution.

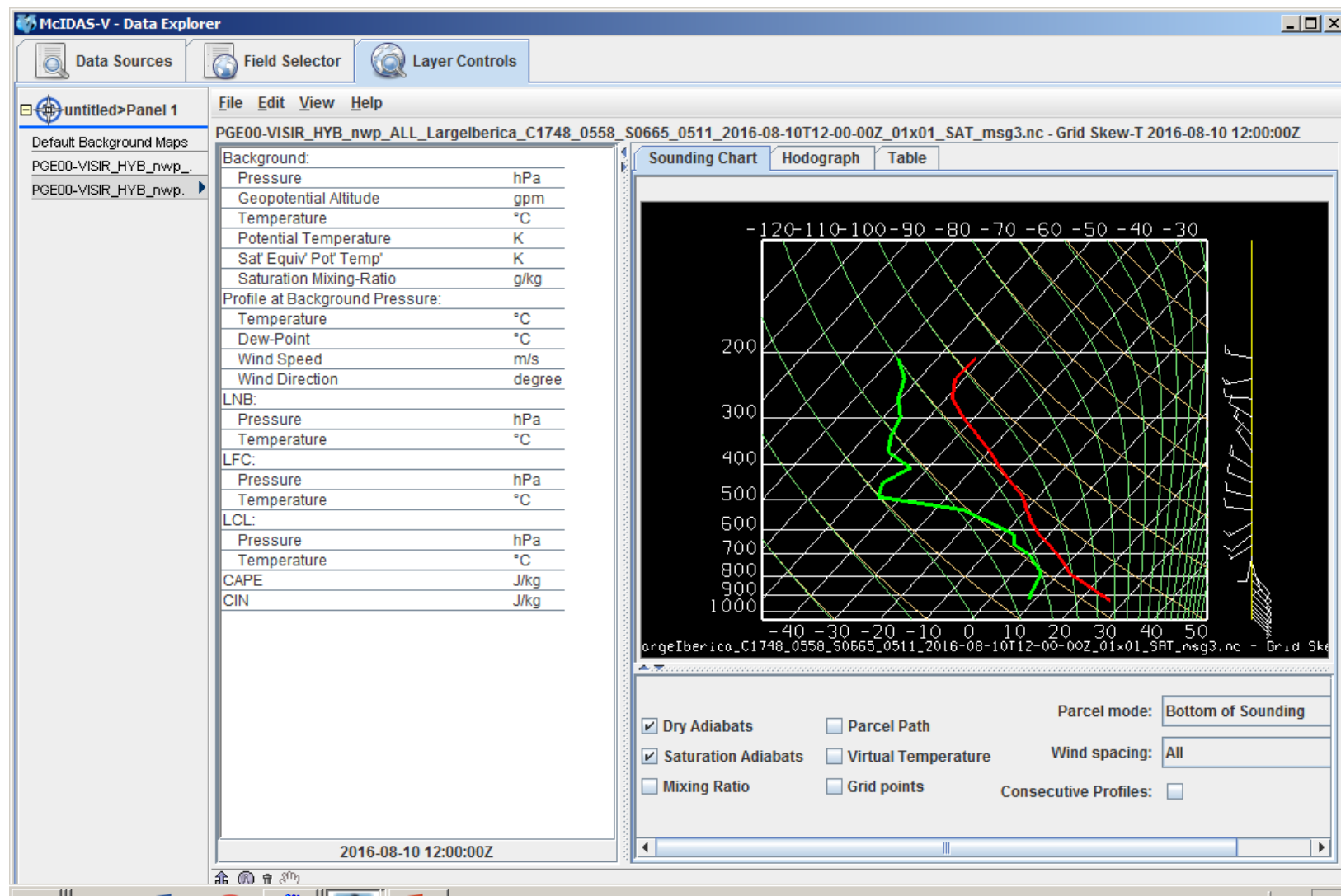
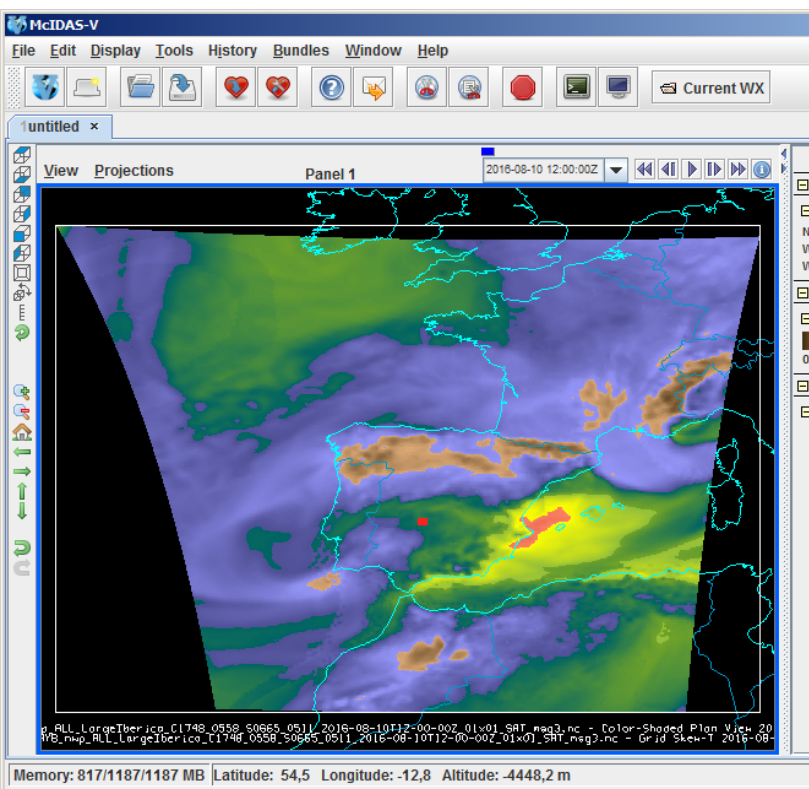
Then, they are ideal to explore the use of gradients and trends between consecutive images in forecasting.

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

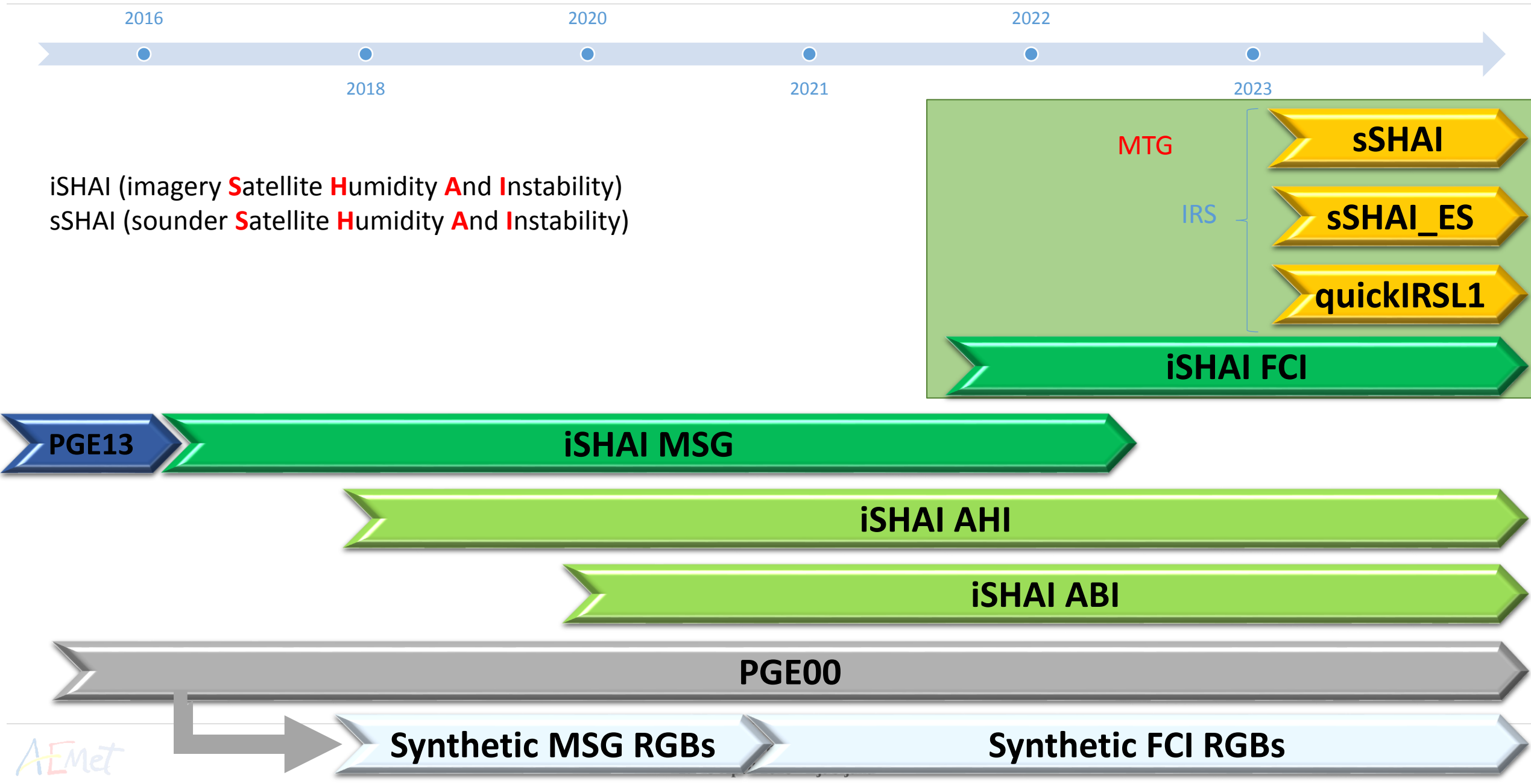
$$\partial ML / \partial t + u * \partial ML / \partial i + v * \partial ML / \partial j \approx 0$$

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





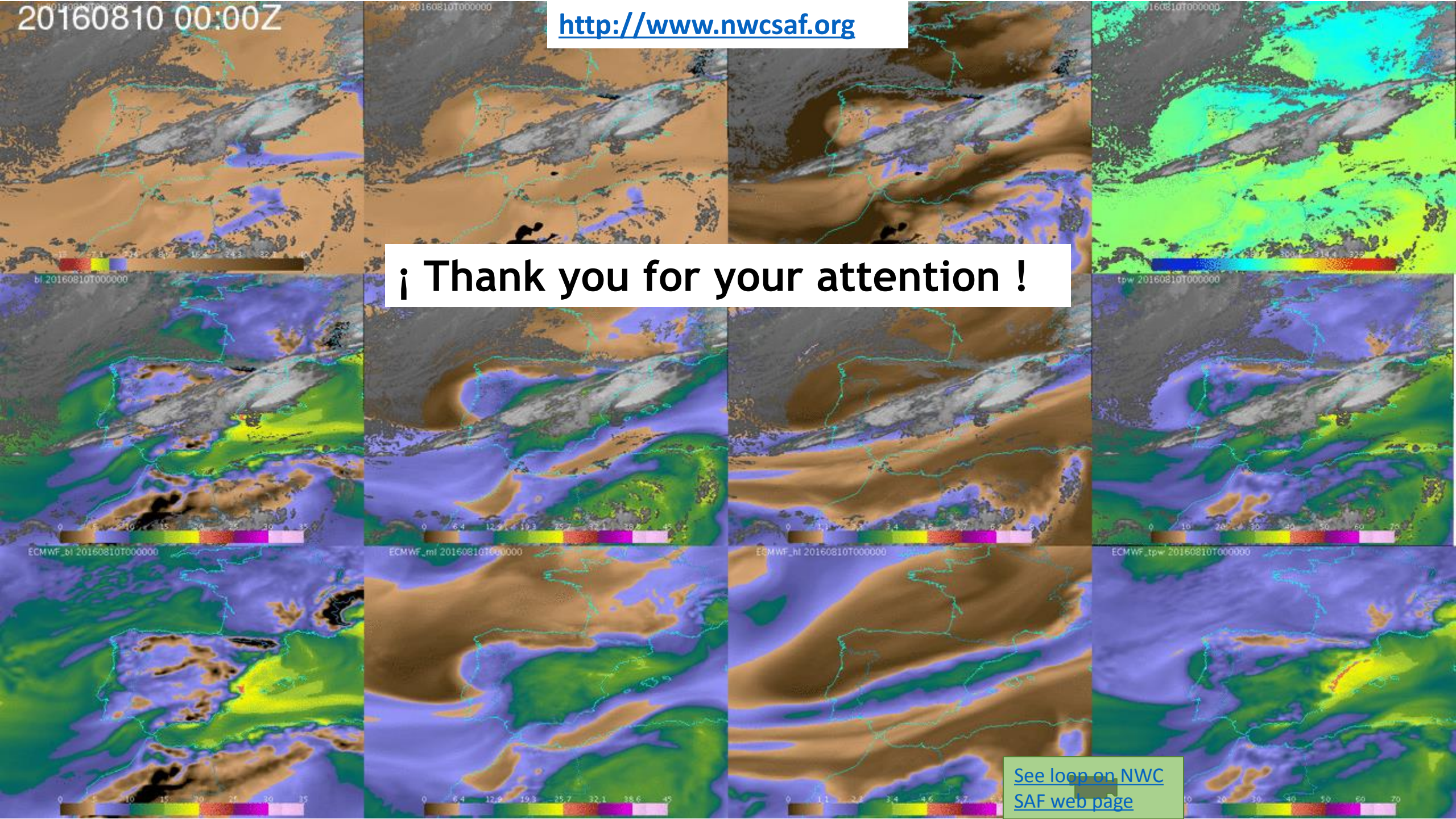
SHAI roadmap



20160810 00:00Z

<http://www.nwcsaf.org>

! Thank you for your attention !



See loop on NWC
SAF web page