



Preparation of MTG era.

qIRS service: NWCSAF approach for optimization of use of IRS spectra and images



Miguel-Angel MARTINEZ

AEMET







Index of presentation.

- $\checkmark\,$ Introduction to IRS.
- ✓ qIRS need. Dwell Principal Components (PCs) dissemination.
- $\checkmark\,$ qIRS IRS spectra reconstruction and remapping
- ✓ Examples of hyperspectral L1 data for nowcasting interest image generation:
 - ✓ First 2010 IASI RGBs synthetic example
 - ✓ First real IASI RGBs
 - ✓ Real IASI L1 image on gravity waves from Hunga Tonga case

✓ Synthetic IRS images.

- ✓ IANOS medicane images from DestinE model
- ✓ Transmissivity profiles and weighting functions for IRS

$\checkmark\,$ iSHAI v2025 training and validation dataset for IRS and FCI new images generation

- $\checkmark\,$ Use of IRS for inversions detections
- ✓ Conclusions





Introduction

- ✓ NWC SAF provides software.
- NWC-SAF products generated locally by users => No bandwidth constraints.
- NWC-SAF is the SAF nearest to users. It works in the users side of the EUMETCast

Full MTG support: friendly software to manage FCI, LI and IRS L1 data and to generate L2 Nowcasting products on user's side.

- Main objective is to explore the synergies and differences of MTG-I/FCI and MTG-S/IRS products and the background NWP.
- ✓ Full functionality be available at Day-2.

Key point: NWCSAF as integration and reprojection tool:

- MTG-S/IRS will have the half of spatial resolution of MTG-I/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 reprojection and joining of dwell files tool to get one user interest region.
- The default projection will be regions on MTG-I/FCI projection with FCI IR or half of FCI IR resolution 4x4 km (2x2 boxes of FCI@2x2 km).



1960 channels in two bands [4.44 μ m, 14.7 μ m] at \approx 0.600 cm⁻¹

- MTG-IRS L1 data will be disseminated compressed as 300 Principal Components (EOFs) instead of 1960 channels (lossy compression).
- Spatial resolution of 4 km
- Segmented in one file in NetCDF format for each "dwell" without a fixed grid.







NWCSAF MTG-I/FCI and MTG-S/IRS reader of EUMETCast files and conversion from multiple MTG files to a netCDF file for later extraction into NWCSAF region on MTG-I/FCI grid

MTG-I/FCI

NWCSAF GEO package: sdi2sat

- Read and JLS decompression of disseminated JLS FCI files files
- Conversion from radiances to reflectances or BTs.
- Writing on a FSD global netCDF dataset
- Extraction into NWC SAF regions:
 - Execution of NWCSAF PGEs.
 - Generation of netCDF FCI L1 imagery (L1SD). Use for example for RGB images generation.

MTG-S/IRS

qIRS: Quick IRS product

- Read Principal Components (PC) dwell files
- PC => BTs at dwells.

BT => P(

Disseminatio

EUMETCas

- IRS L1 images generation on NWC SAF regions:
 - Combination and reprojection of configurable MTG-S/IRS L1 BTs from dwells to user NWC SAF defined regions. Writing on netCDF on NWCSAF region.
 - Generation of IRS L1 imagery related products; as example RGB images.





Updated prototype with IRS PC files to latest EUMETSAT Secretariat test IRS dataset (MTGTD-443 December 2023)

qIRS prototype: testing PC=>BT conversion and reprojection from multiple MTG-S/IRS dwell EUMETSAT Secretariat IRS testdata files to an NWCSAF region on MTG-I/FCI grid

Updated prototype with IRS PC files from EUMETSAT Secretariat test IRS dataset v3.1 (TD-417 November 2022)







NWC SAF User's Workshop 2025 AEMET HQ, Madrid, 25-27 February 2025

Start point 2010: MTG-IRS and IASI RGBs with MSG RGBs heritage



2013: IASI AIRMASS RGB over Polar regions

20th February 2013 01:17Z to 15:41Z

on_haruna_2013/IASL.xxx_1C_M02_201302201599567_201302201599557_N_0_1

South Pole view



North Pole view





Case study: Cyclone Haruna near Madagascar 20th February 2013 The images are indeed the blending of several transparent PNG individual files created using IDL. The process can be make automatically after choosing the region, writing on 4byte transparent images and fixing full

transparent to white pixels.



) With METOP-A + METOP-B IASI data the COVERAGE IS COMPLETE

	Airmass RGB	IASI	Range	γ
	RED	IASI _{5.23560} -IASI _{7.6060}	-25+0K	1.0
lon	GREEN	IASI _{9.70167} -IASI _{10.9800}	-40+5K	1.0
uary	BLUE	IASI _{5.23560}	+243208K	1.0

Airmass RGB



NWC SAF User's Workshop AEMET HQ, Madrid, 25-27 Februar

Opportunity case study: Hunga Tonga-Hunga Ha'apai



15th January 2022

NWC SAF User's Workshop 2025 AEMET HQ, Madrid, 25-27 February 2025

AIRS on 4.3 microns spectral region

Opportunity case study: Hunga Tonga-Hunga Ha'apai



2013: 2nd brain storm idea: top to down quick looks

- One start point is to display images in certain regions of the spectrum (as the that allows to observe from very high levels in the stratosphere to the surface (on clear air pixels). It is performed interactively it seems go traveling through the atmosphere and clouds are appearing at different levels. The problem is that the oscillation due to the absorption bands creates a roller coaster effect.
- To avoid it an idea is instead of displaying all the channels to show only the channels with lower absorption (ie display only the channels that BT is a relative maximum).





Images on peaks at WV absorption band [1650 cm⁻¹, 2143 cm⁻¹])





NWC SAF User's Workshop 2025 AEMET HQ, Madrid, 25-27 February 2025

Note: It can be also be made on BT relative minimum.



DestinE ECMWF

synthetic MTG-S/IRS 2020-09-17 00Z run t+00 to t+24 forecast every **30** minutes

Grid 0.04° x 0.04°

NWC SAF

Thanks to DestineE team to provide GRIBs for IANOS case study

Transmissivity profiles and weighting functions for IRS

Special RTTOV PGE00s program for MTG-S IRS version

Same previous with pptional writing also of

- ✓ Total transmittances coefficients every pixels on binary files
- ✓ Profiles of transmittances coefficients on hybrid levels on binary files

Developed MTG-I/FCI version of PGE00* that allows to generate together with synthetic radiance and interpolated profiles to a configurable set of pressure levels the transmissivity profiles and weighting functions for FCI channels.

Replicated same developing and created MTG-S/IRS version of PGE00* to generate transmissivity profiles and weighting functions for IRS channels. To generate for IRS same netCDF files that for FCI it is difficult due to huge size of output files. But for a pixels NxN width boxes or summary of profiles could be possible.

It could be interesting in training of users to provide a guide of the layers were most part of information came for one IRS channel.

Total transmissivity coefficient from ground







wn= 706.240 cm⁻

NWC SAF User's Workshop 2025 AEMET HQ, Madrid, 25-27 February 2025





T and q 3D arrays has been normalized using:

X

X

- ✓ Calculated mean and standard deviation profiles for every pressure level
- ✓ Mean and standard deviation profiles have been smoothed
- ✓ Using smoothed mean and standard deviation profiles, it is subtracted the mean and divided by the standard deviation on every level



NWC SAF

Combination of FCI and IRS dataset for IRS RGB





PGE00_1d: use of iSHAI training and validation dataset



MTG-IRS and IASI RGBs with MSG RGBs heritage



Will be possible to develop future optimal RGB from MTG-IRS data?



2013: IASI Dust RGB





IASI Dust RGB on dust storm 8th March 2013

Λ	-M	
1		

Airmass RGB	IASI	Range	γ
RED	IASI ₁₂₀₇₃₆ - IASI _{10,9800}	-4+2K	1.0
GREEN	IASI _{10,9800} -IASI _{9,07441}	0+15K	2.5
BLUE	IASI _{10,9800}	+261289K	1.0

Dust RGB

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

Example of monitoring dust in IRS

In 2013 it was used a set of points labeled as "clear sea pixel" to calculate the mean BT spectra and find the positions of relative maxima and minima. The iterative process was repeated twice.

IASI 2012/03/08 10:11:59Z 11:50:55Z 🏼 🎉

In 2013 the set of points was created interactively.

FCI images could be used to make faster and better. As example using some field kind NDDI (NIR2.2-VIS0.4)/(NIR2.2+VIS0.4) or thresholds on RGBs or NWCSAF dust flag.

Use of synthetic images and interactive display to look for vertical dust distribution??

Lines of the local maxima (peaks) allows a better comparison for different pixel types regarding slopes, shape, etc.





- Red line are the local minima in the BT spectrum (after two search of local minima) and the green line is the moving average of the local minima with 9 size.
- The vertical representation is one attempt to provide the feeling a "spectral like sounding representation".







Simplified spectra representation for comparison of different types of pixels Example of peaks representation: use of local maxima



Comparison of spectra at pink, blue and green probes.

In the case of full spectra is more difficult.



NWC SAF User's Wo AEMET HQ, Madrid, 25-27





RGB for low level inversions detection using Paul Menzel communication about Justin Sieglaff idea to search for fingers up lines on probes in low level spectral region [780, 840] cm⁻¹

Case study on Finland 2013 January 17th







Line1 for Red (in: 798.5 cm⁻¹, off: 801 cm⁻¹)



There are several "fingers up" on low levels inversion.

Case study:

Finland 2013 January 17th



_ C SAF

Line1 for Red (in: 798.5 cm⁻¹, off: 801 cm⁻¹)



There are several "fingers up" on low levels inversion.

Case study:

Finland 2013 January 17th



Memory: 240/354/1189 MB Latitude: 72,0 Longitude: 12,4 Altitude: 2134,2 m

Line1 for Red (in: 798.5 cm⁻¹, off: 801 cm⁻¹)



NWC SAF

RGB for low levels inversion on Finland

Difference BT in Line1:





NWC SAF User's Workshop 2025 AEMET HQ, Madrid, 25-27 February 2025



qIRS images generation



Conclusions and outlooks

- Preparation of NWCSAF for IRS. NWCSAF will include qIRS service on IRS Day-2 support. It will start qIRS L1 files while maintaining the other GEO imager support.
- ✓ Synthetic cases clear and cloudy radiances with higher NWP resolution will be fundamental in further developments for version IRS and MTG Day-2. Several complementary tools has been developed (transmissivity and weighting function analysis). Likely change of the version of RTTOV to RTTOV-14
- ✓ A lot of synergies between FCI and IRS can be explored.
- ✓ Validation and datasets generation will be a continuous and important task.
- ✓ The formats of the files are important. They should be as closer to the user tools as possible. The optimal format be one that will allow the users just "click and play" files.

FCI will be one important eye on qIRS search of combinations





Exploration of synergies with IRS-L2. See sSHAI-ES presentation.





Thanks for your attention



