Agencia Estatal de Meteorología

EUMETSAT NWC SAF
SUPPORT TO NOWCASTING AND VERY SHORT RANGE FORECASTING

Preparation of MTG era.

sSHAI_ES *"Sounder Satellite Humidity And Instability (sSHAI) based on EUMETSAT Secretariat (ES) retrievals"* Service and Remapping tool to FCI grid.

NWCSAF approach for optimization of the use of IRS L2 (EUMETSAT and sSHAI) products

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Index and framework of presentation.

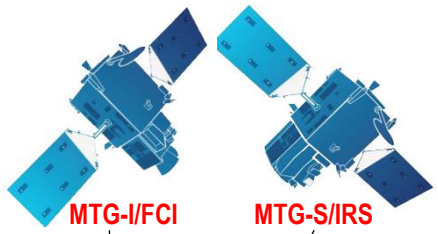
- ✓ **Introduction to IRS L2 managing issue. Dwell IRS L2 dissemination.**
- ✓ **IRS L2 need of remapping**
- ✓ **sSHAI_ES prototype.** *Test with IRS L2 test dataset "MTG_IRS_L2_LAC4-6h-20210624_TD-449_Sep2024"*
- ✓ **Example of CalVal on MTG era including IRS L2 proxies**
- ✓ **Other events:**
  - ✓ **NWCSAF Workshop**
  - ✓ **EUMTrain NWCSAF GEO-S event**
- ✓ **Conclusions**

NWCSAF contribution to IRS. NWCSAF GEO-S software package:

- ✓ **Quick IRS Service (qIRS)**
- ✓ **Sounder Satellite Humidity And Instability (sSHAI)**
- ✓ **Sounder Satellite Humidity And Instability based on EUMETSAT Secretariat retrievals Service (sSHAI_ES)**
  - ✓ **Remapping from IRS dwell to FCI grid**

NWC SAF products and services for MTG

- ✓ 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



L1 processing → L2 processing

EUMETSAT headquarters

MTG L1

MTG L2

EUMETCast

EWC

European Weather Cloud

IRS L2 → sSHAI_ES service → ES IRS L2

IRS L1 PC → qIRS service → IRS L1 BT

IRS L1 PC → sSHAI → NWCSAF IRS L2

FCI L1

LI

NWC SAF GEO → NWC SAF MTG-I L2

NWP

Obs(radar, synop)

User tools

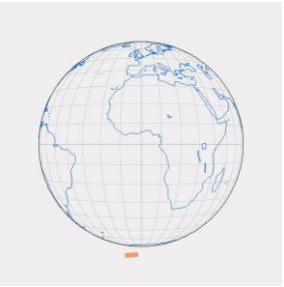
User 4D Weather data cube in NWC SAF region of interest

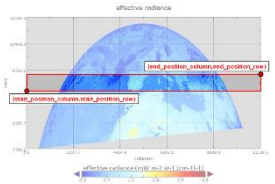
NWCSAF MTG-I/FCI and MTG-S/IRS readers of EUMETCast files and conversion from multiple MTG files to a netCDF file for later extraction into NWCSAF region on MTG-I/FCI grid

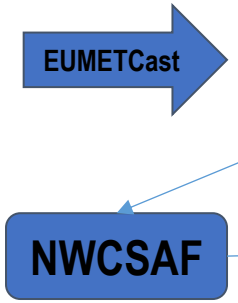
MTG-I/FCI

NWCSAF GEO package: *sdi2sat*

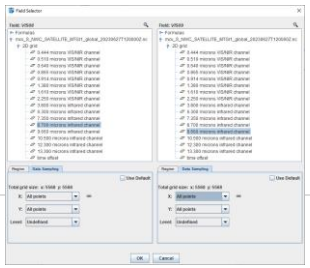
- ✓ Read and JLS decompression of disseminated JLS FCI files files
- ✓ Conversion from radiances to reflectances or BTs.
- ✓ Writing on a FSD global netCDF dataset
- ✓ Extraction into NWC SAF regions:
  - Execution of NWCSAF PGEs.
  - Generation of netCDF FCI L1 imagery (L1SD). Use for example for RGB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

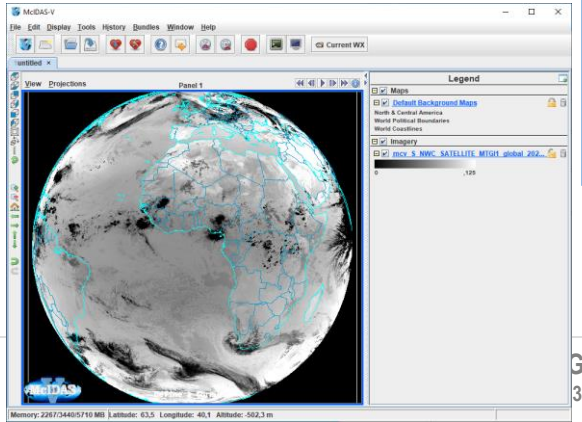






sdi2FSD has been modified and FSD global netCDF dataset are now compatible with McIDAS-V

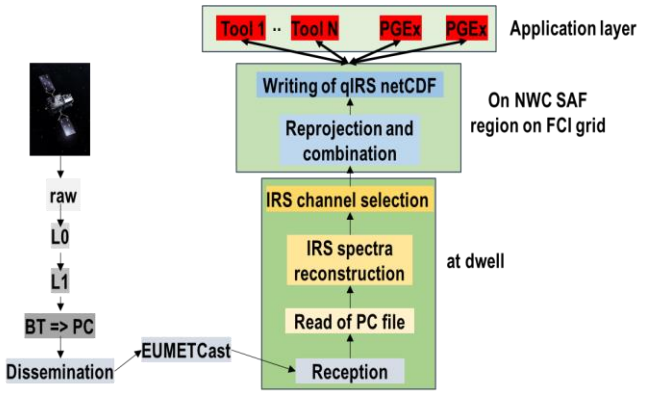


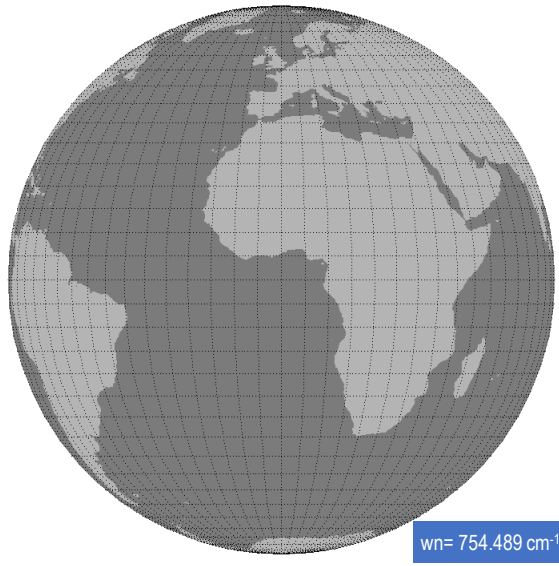


MTG-S/IRS

qIRS: *Quick IRS product*

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

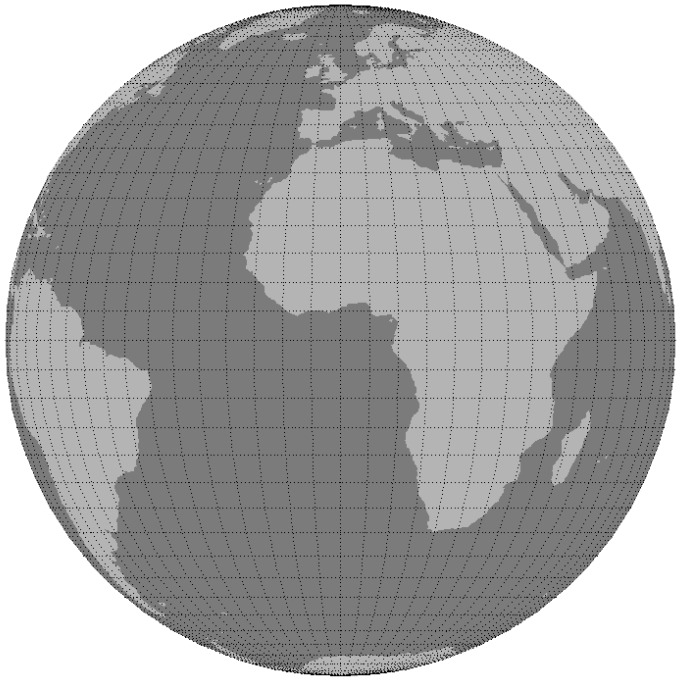




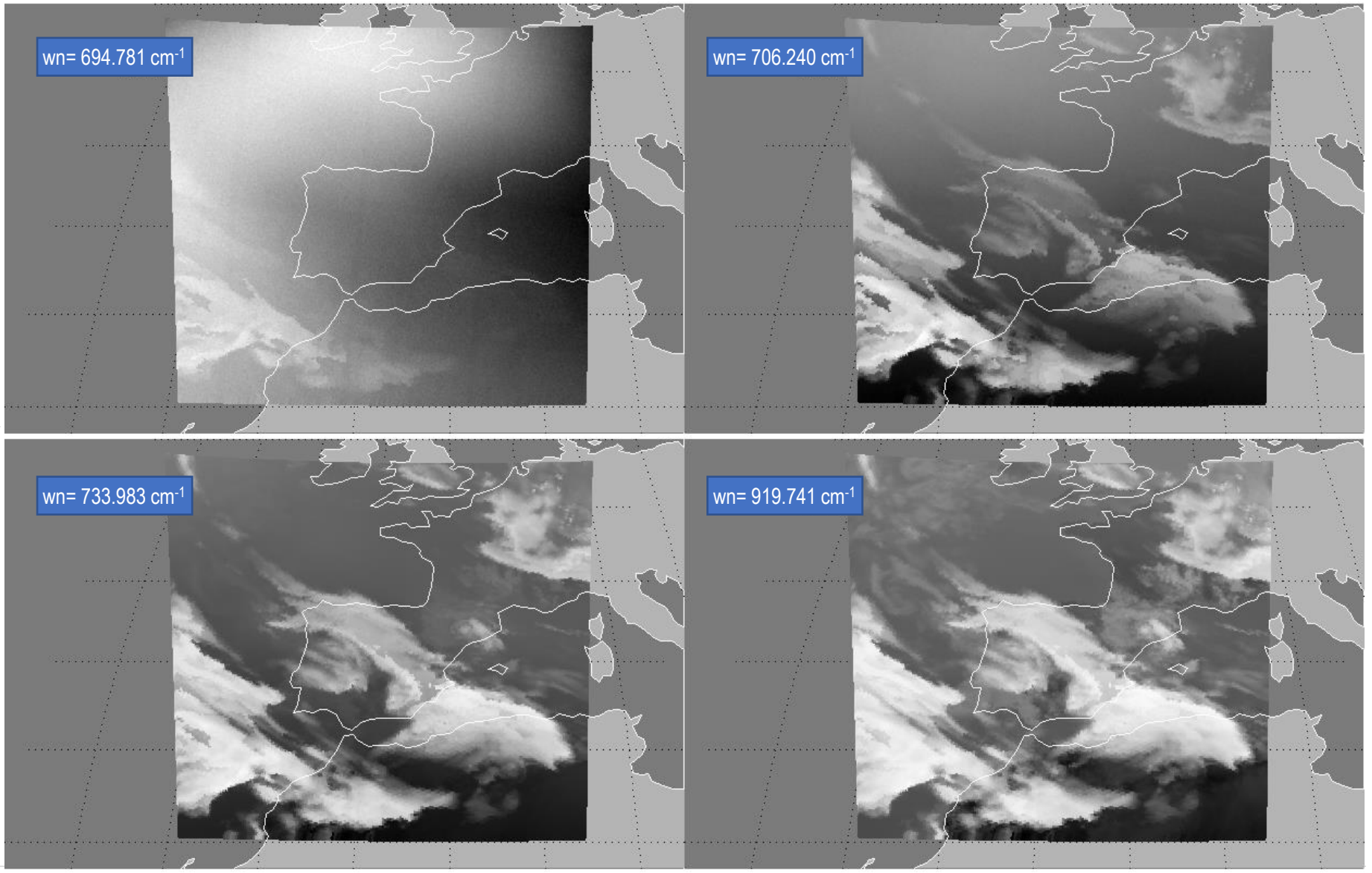
Updated prototype with IRS PC files to latest EUMETSAT Secretariat test IRS dataset (MTGTD-443 December 2023)

remapping prototype: 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)



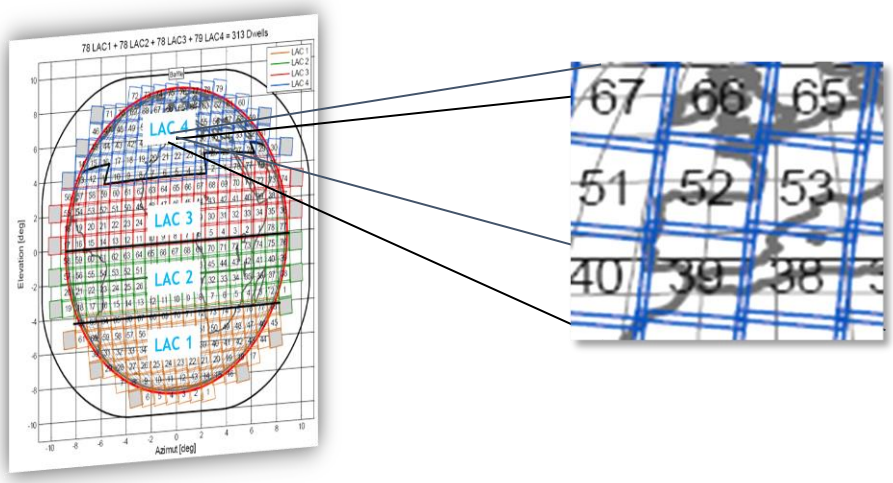
Usually IRS L1 will arrive before.
It will be calculated the dwell to nwcsaf region remapping transformation parameters
Optional save on temporal directory



Introduction to IRS L2 issue

EUMETSAT disseminates by EUMETCast the IRS L2 products on netCDF file by dwells but user likely will use on regions.

- **IRS L2 profiles will be disseminated on hybrid levels (101 or 137 levels) or in 101 RTTOV pressure levels.**
- **Spatial resolution of 4 km**
- Segmented in one file in NetCDF format for each “dwell” **without** a fixed grid.
- Better for nowcasting users if it is made an interpolation to one configurable set of pressure levels.
  - Extrapolation below surface pressure should be optionally applied.
- Needed later a remapping and concatenation of several dwells to cover one NWCSAF user’s region of interest.
- The output should be written in netCDF CF compliant files.



EUMETSAT IRS L2 dissemination on dwell netCDF files

Example using IRS L2 test dataset "MTG_IRS_L2_LAC4-6h-20210624_TD-449_Sep2024"

netCDF files on IRS L2 test dataset TD-449_Sep2024 have several issues:

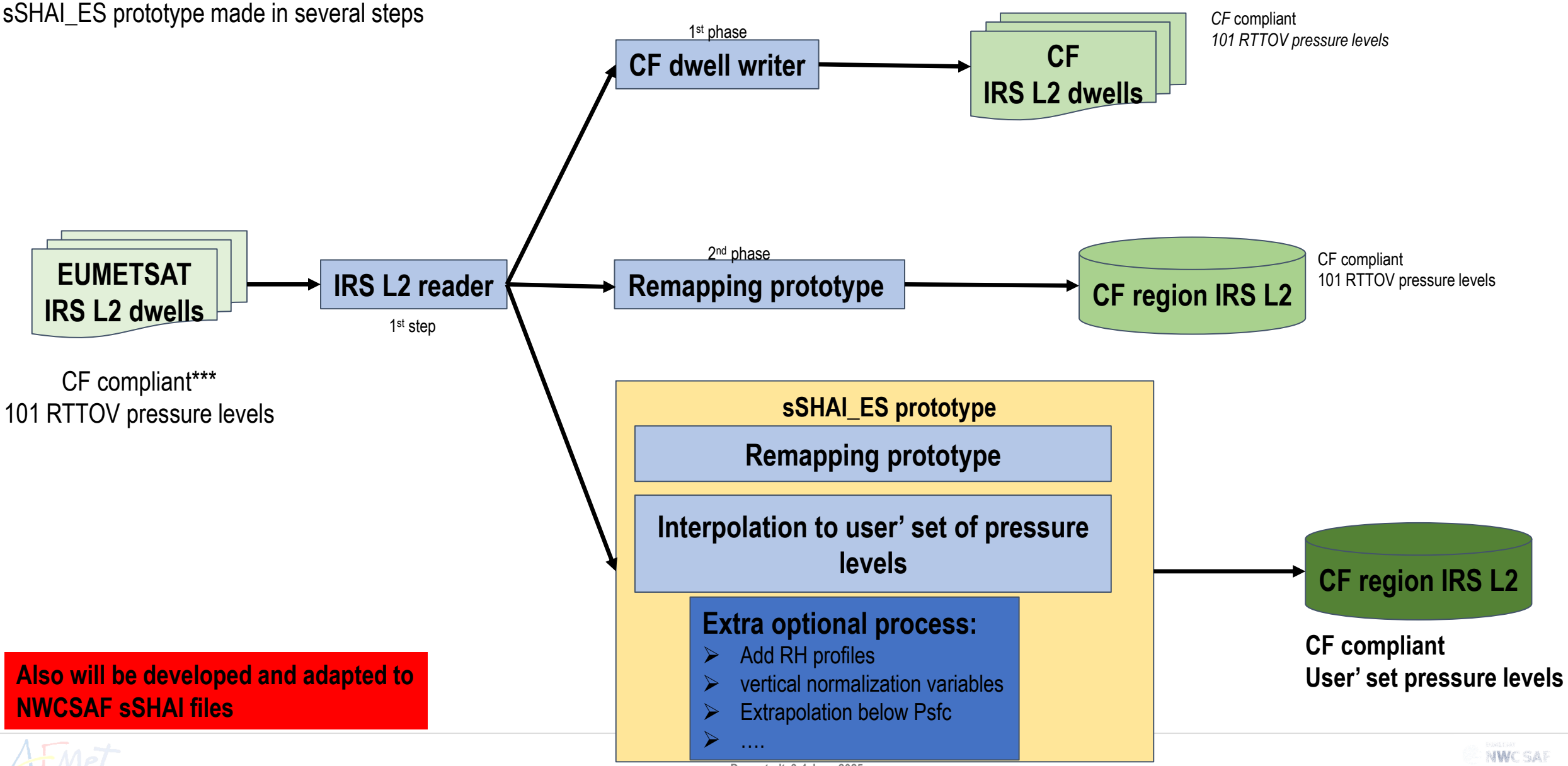
- ✓ **Although profiles are not on hybrid levels and they are on 101 pressure levels.** The 101 pressure levels are from RTTOV set and the pressure levels has not conventional levels (500, 700, ..).
- ✓ **netCDF files are CF*** compliant**
- ✓ **Several dwell files needed to cover an user's region of interest**

That implies need additional software by users if they want to use.

To fill this gap it was proposed the sSHAI_ES service was proposed in CDOP-4 NWCSAF proposal (2021) in order NWCSAF users could get simplified and configurable access to IRS L2 products.

sSHAI_ES prototype with netCDF files on IRS L2 test dataset TD-449_Sep2024

sSHAI_ES prototype made in several steps

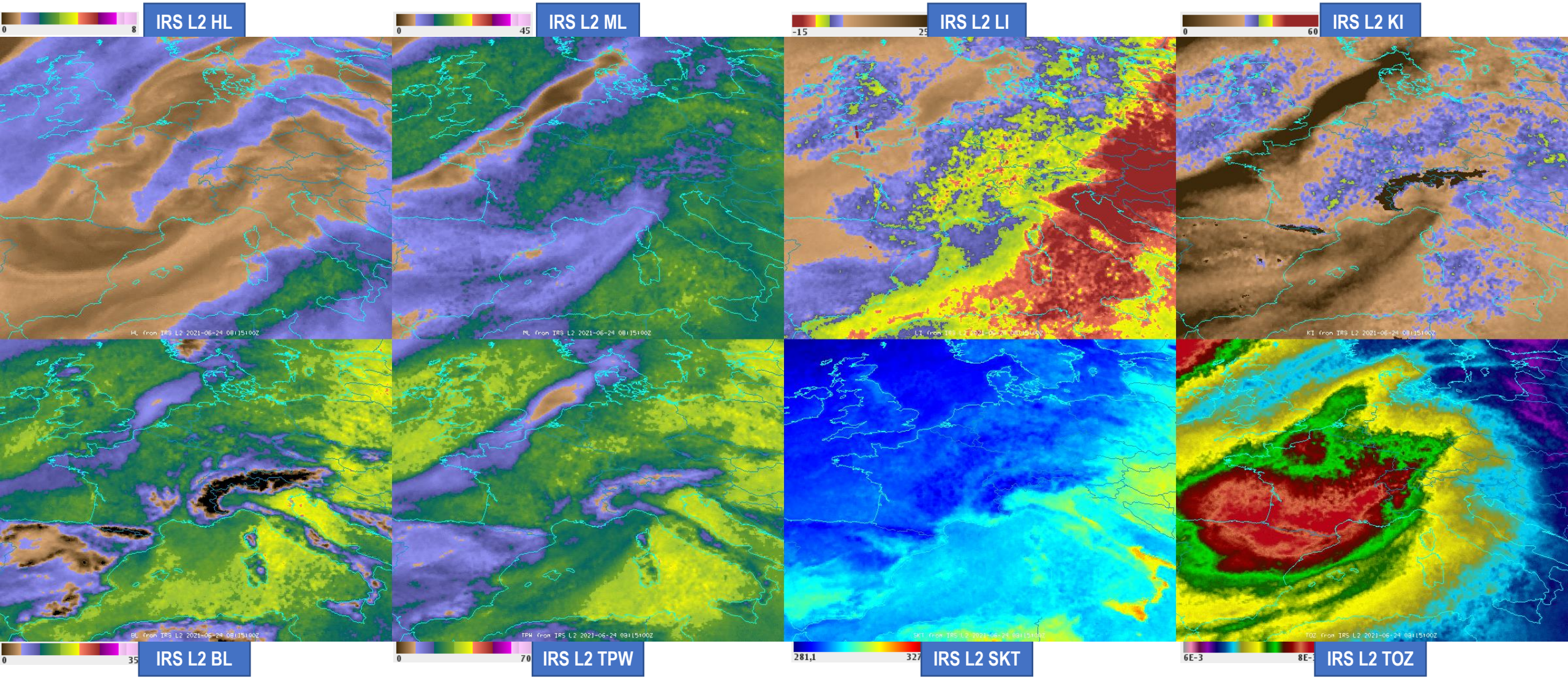


Also will be developed and adapted to NWCSAF sSHAI files

Use of sSHAI_ES netCDF file with McIDAS-V as example of user's tools

IRS L2 test dataset TD-449_Sep2024

2021-06-24 08:45Z to 13:45Z every 30 minutes



Example of IRS L2 fields also present in NWCSAF FCI iSHAI

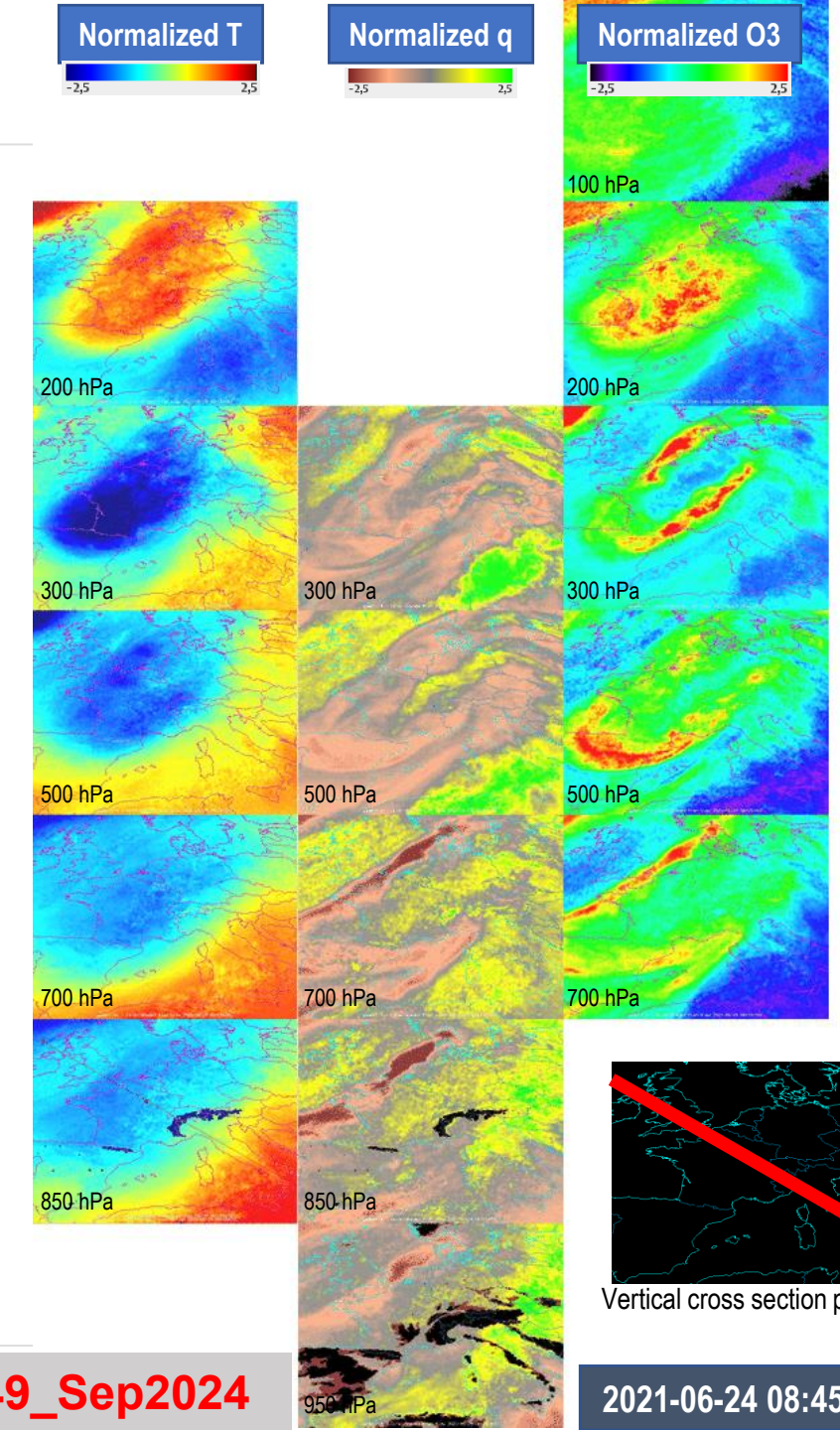
Use of sSHAI_ES netCDF file with McIDAS-V as example of user's tools

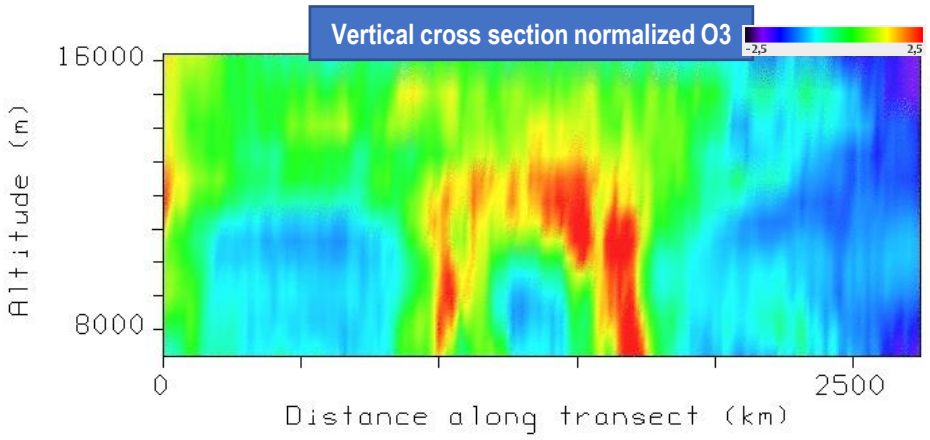
To check the 4D IRS L2 arrays and as example of further 4D use of sSHAI_ES are shown several animation of normalized vertical profiles.

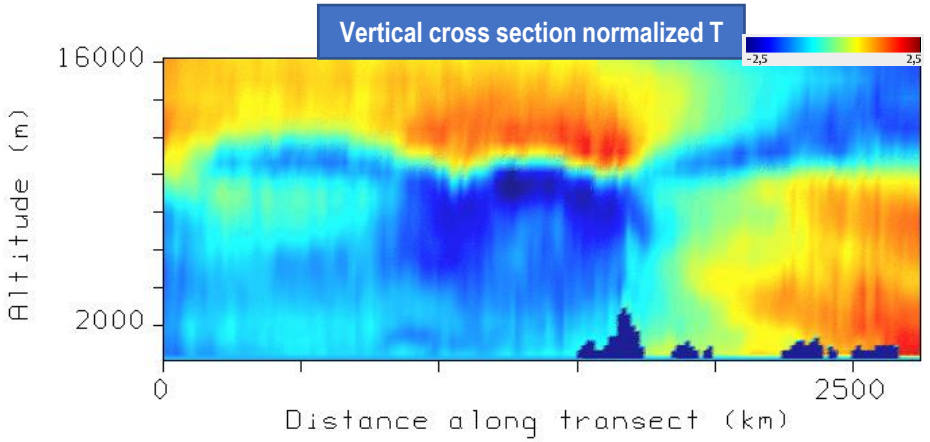
Normalized vertical profiles has been generated calculated the mean and standard deviation on every user' set of pressure levels for 12Z IRS L2 slot. The mean and standard deviation has been smoothed.

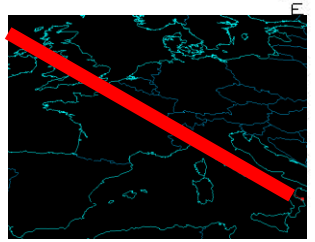
Then the normalized 3D array is calculated subtracting the mean and dividing by the standard deviation.

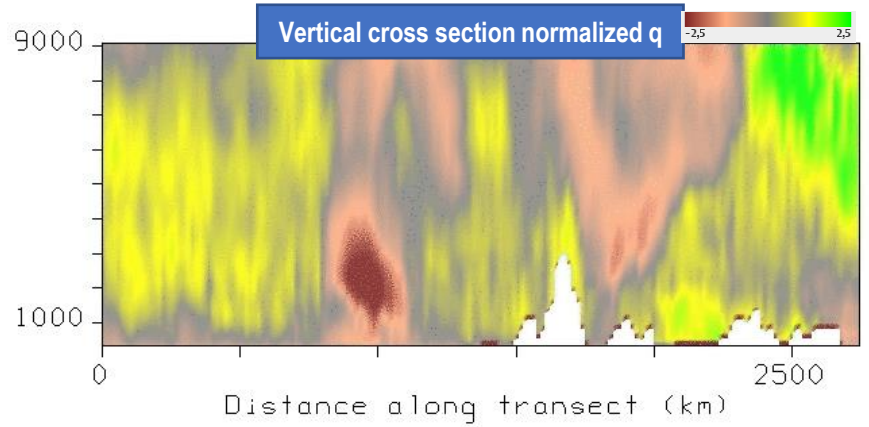
It will be used for 4D comparison with NWP, iSHAI vertical profiles, etc








Vertical cross section position



IRS L2 test dataset TD-449_Sep2024

2021-06-24 08:45Z to 13:45Z every 30 minutes

Comments and feedback on testdataset IRS L2

Definition of a variable on testdataset IRS L2 files

Recent Files --CHK-BODY---NC4E_C_EUMT_20240821152657_L2PF_DEV_20210624084540_20210624084550_N__T_0036_0005.n

- plev_QW
- pwlr_2m_temp
- pwlr_2m_wv
- pwlr_O3_column
- pwlr_O3_profile
- pwlr_O3_profile_error
- pwlr_emissivity
- pwlr_emissivity_error
- pwlr_mlev
- pwlr_obs_minus_calc
- pwlr_surf_pressure
- pwlr_surf_pressure_error
- pwlr_surf_temp
- pwlr_surf_temp_error
- pwlr_temp_profile

pwlr_surf_temp (48883, 2)
16-bit integer, 160 x 160
Number of attributes = 9
DIMENSION_LIST = 1-9482,1-9836
_Netcdf4Coordinates = 0,1
_Unsigned = true
coordinates = latitude longitude
long_name = PWLR surface skin temperature
scale_factor = 0.01
standard_name = surface_temperature
units = K
valid_range = 15000,35000

time_coverage_duration = 10s
time_coverage_end = 20210624084550
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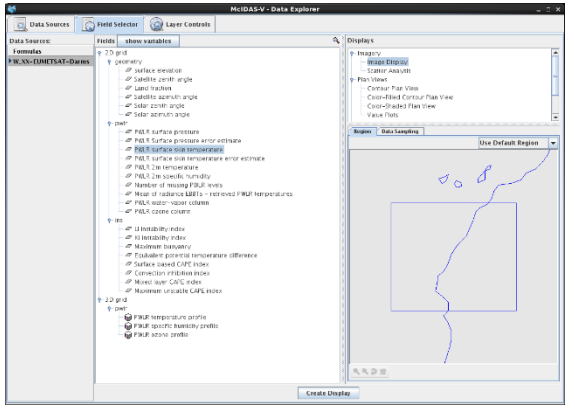
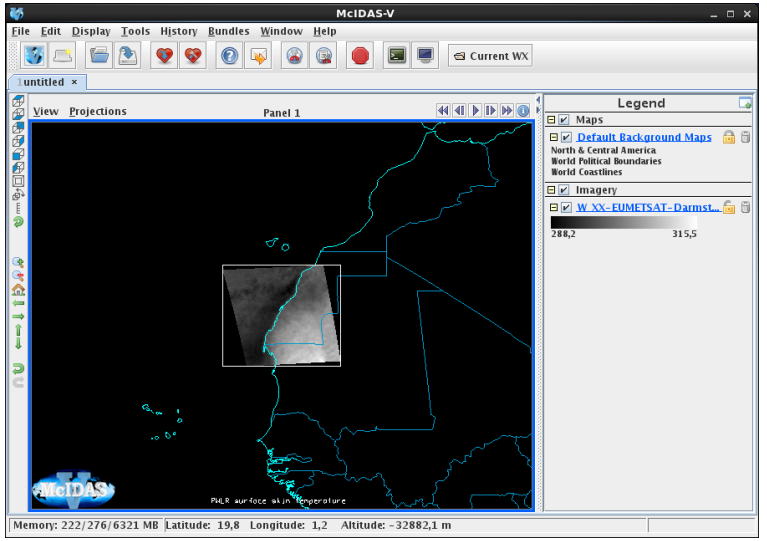
time_position = 084500

No time dimension

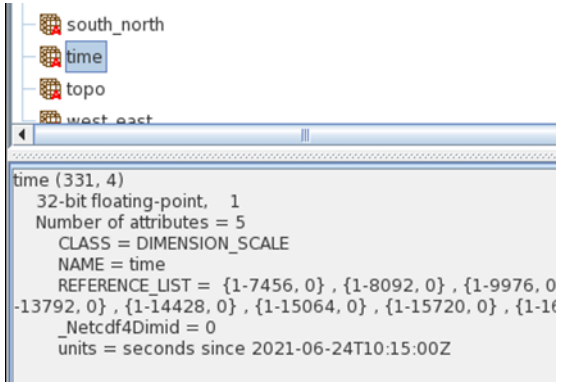


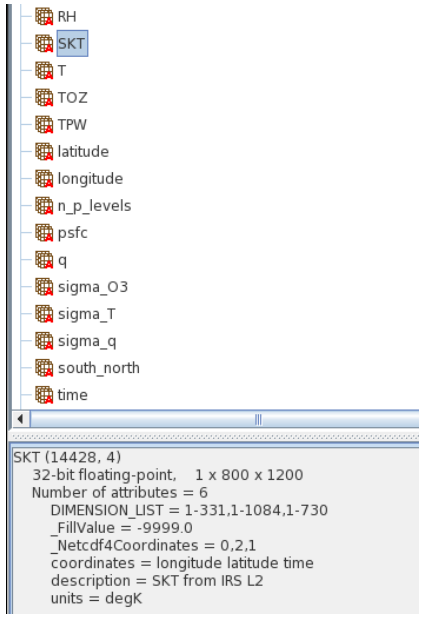


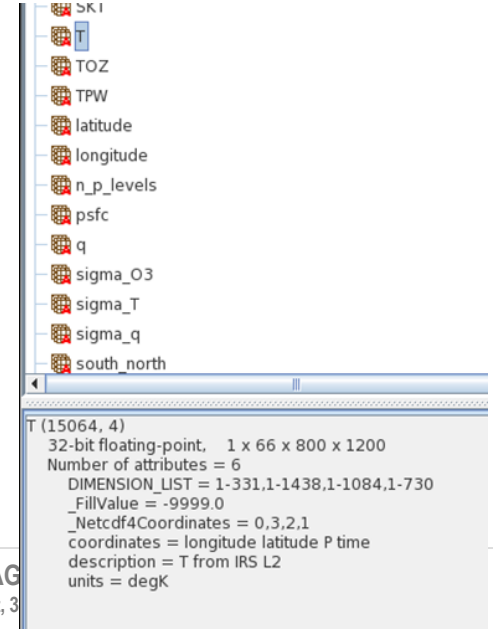
Differences with netCDF on sSHAI_ES

Definition of a variable on netCDF file from sSHAI_ES prototype

Time dimension

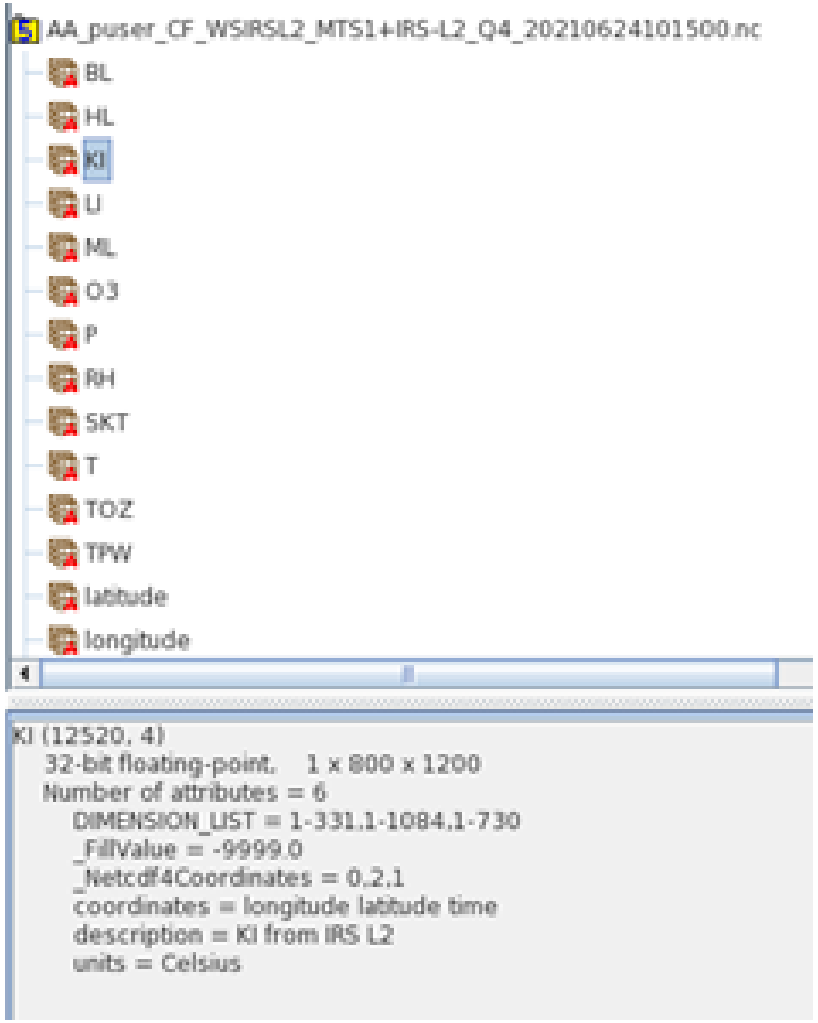






Comments and feedback on testdataset IRS L2

Definition of a variable on testdataset IRS L1 files



Early reprojection examples

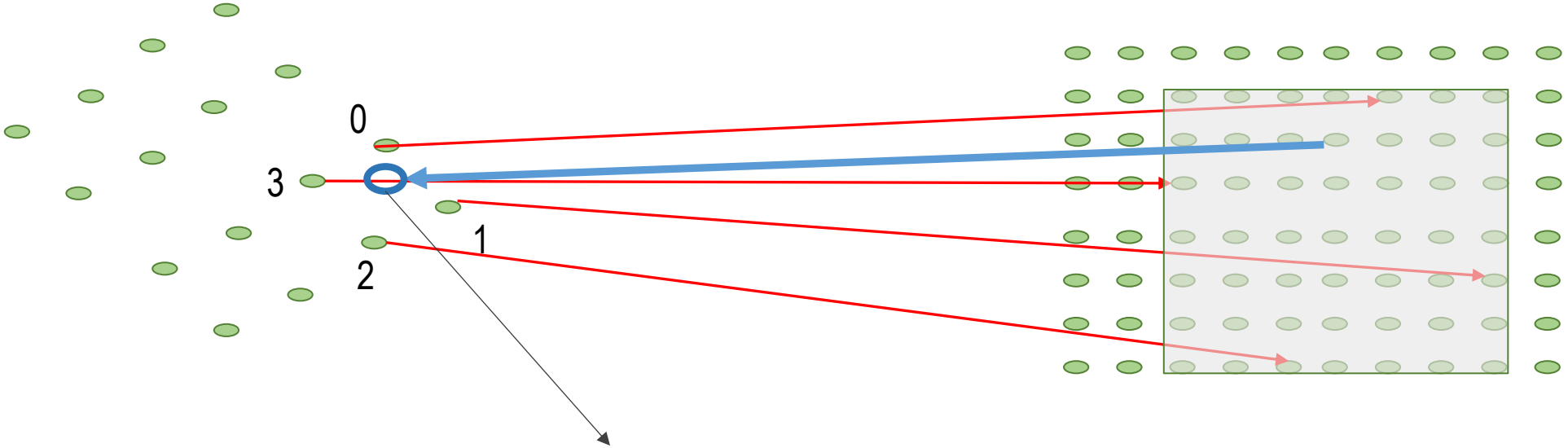
NWC SAF as integration and reprojection tool. It has been started the study of optimal and fast reprojection algorithm from IASI pixels (as proxy of MTG-IRS) to NWC SAF regions (subsets of GEO reprojection grid).

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

a) Search valid pixels in IRS (IASI) array

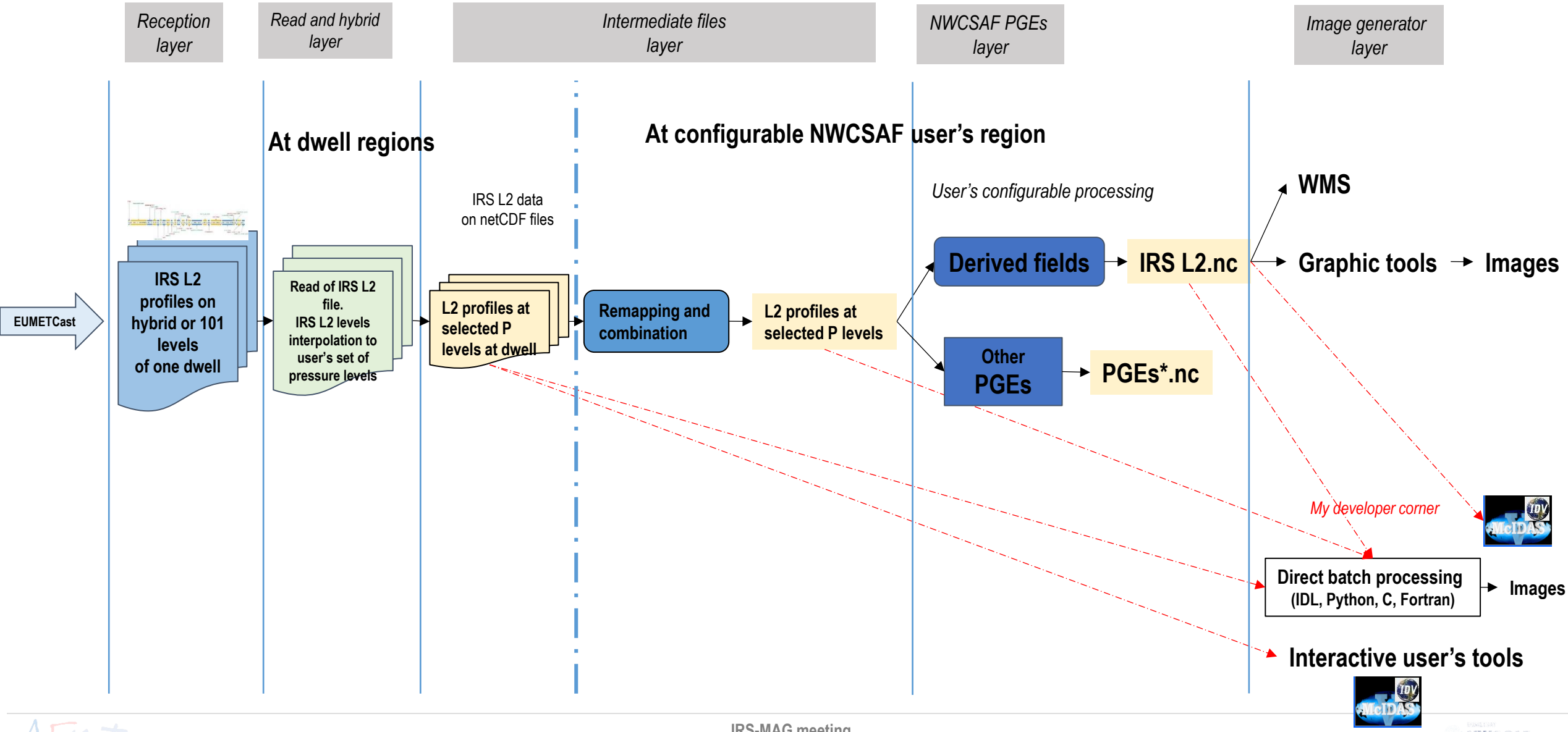
b) For every valid IRS (IASI) pixel use the (longitude, latitude) of the (IRS) IASI pixels and a function (lon,lat) => (column, line) in GEO grid to calculate the (column, line) in the NWC SAF region for the 4 (IRS) IASI corners.

c) For every GEO pixel between the corners, calculate the distances of the GEO pixel to the 4 IRS (IASI) neighbors and calculate de value on GEO pixel as combination of the value in the 4 IRS (IASI) neighbors weighted for the inverse of the square of the distances. Optional use of nearest neighbor.

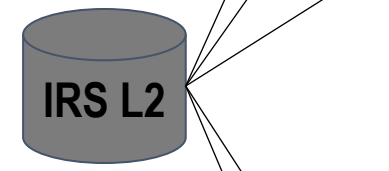


$$v= (v_0*f(d_0)+ v_1*f(d_1)+ v_2*f(d_2)+ v_3*f(d_3))/(f(d_0)+f(d_1)+f(d_2)+f(d_3))$$

sSHAI* processing diagram



What to do later with IRS L2 sSHAI_ES files



sSHAI_ES netcdf

Direct use by the users

Example the McIDAS-V tool. But any CF reader tool should be able to use them or provide the guide for code modification to make it compatible

Use on NWP

netCDF for region could be used for NWP. Also provide the guide for code modification to adapt it

Use on NWC SAF new products

Explore the generation of blended FCI, LI and IRS L1+L2 PGEs.

iSHAI interesting fields:

1. *Continuous update of emissivity atlas*
2. *SKT field*
3. *T, q, ozone profile*
4. *..*

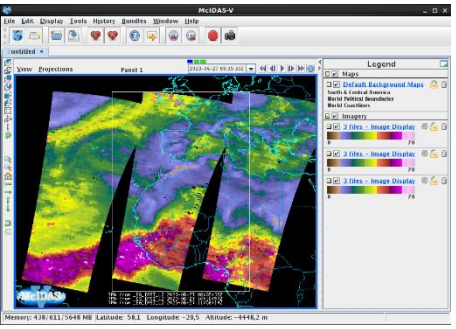
Cal/VAl

Generation of training and validation datasets. Example for Machine learning

Preparation of MTG era: TPW CAL/VAL example

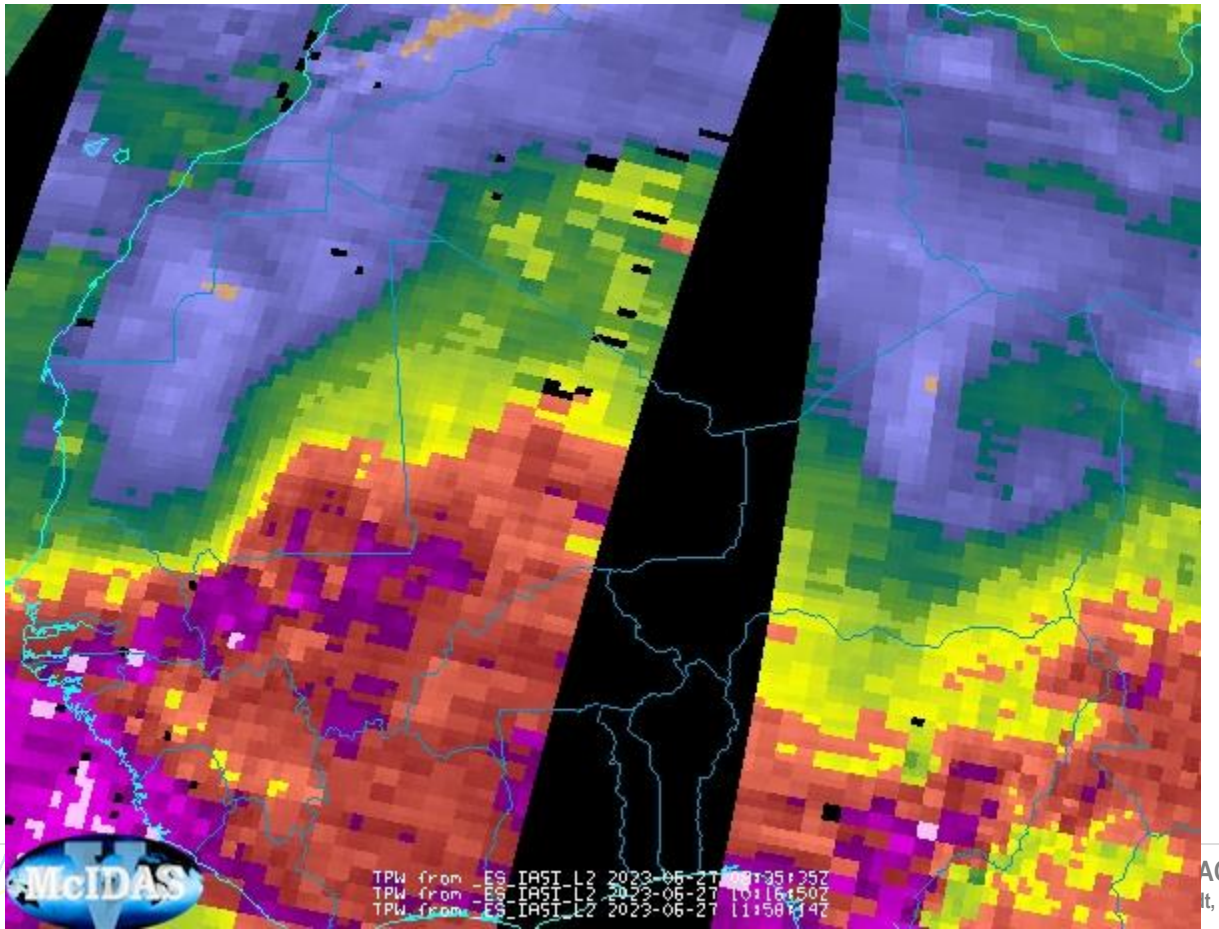
***first* comparison MTG-I/FCI 0.9 microns TPW and IASI L2 (as proxy of MTG-S/IRS) using also synthetic data generated with RTTOV-13.0**

First-guess (PWLR^3) TPW IASI L2 METOP-C



First-guess IASI L2 (PWLR^3) profiles are available in all pixels.

- The METOP-C IASI L2 has been download from EUMETSAT Data Store and Data Tailor.
- It has been used own IDL software to reorder data, interpolate to a set of pressure levels and written on netCDF files.
- This ECMWF netCDF files has been used on McIDAS-V to display optimal estimation TPW IASI L2 with same colour palette and projection.



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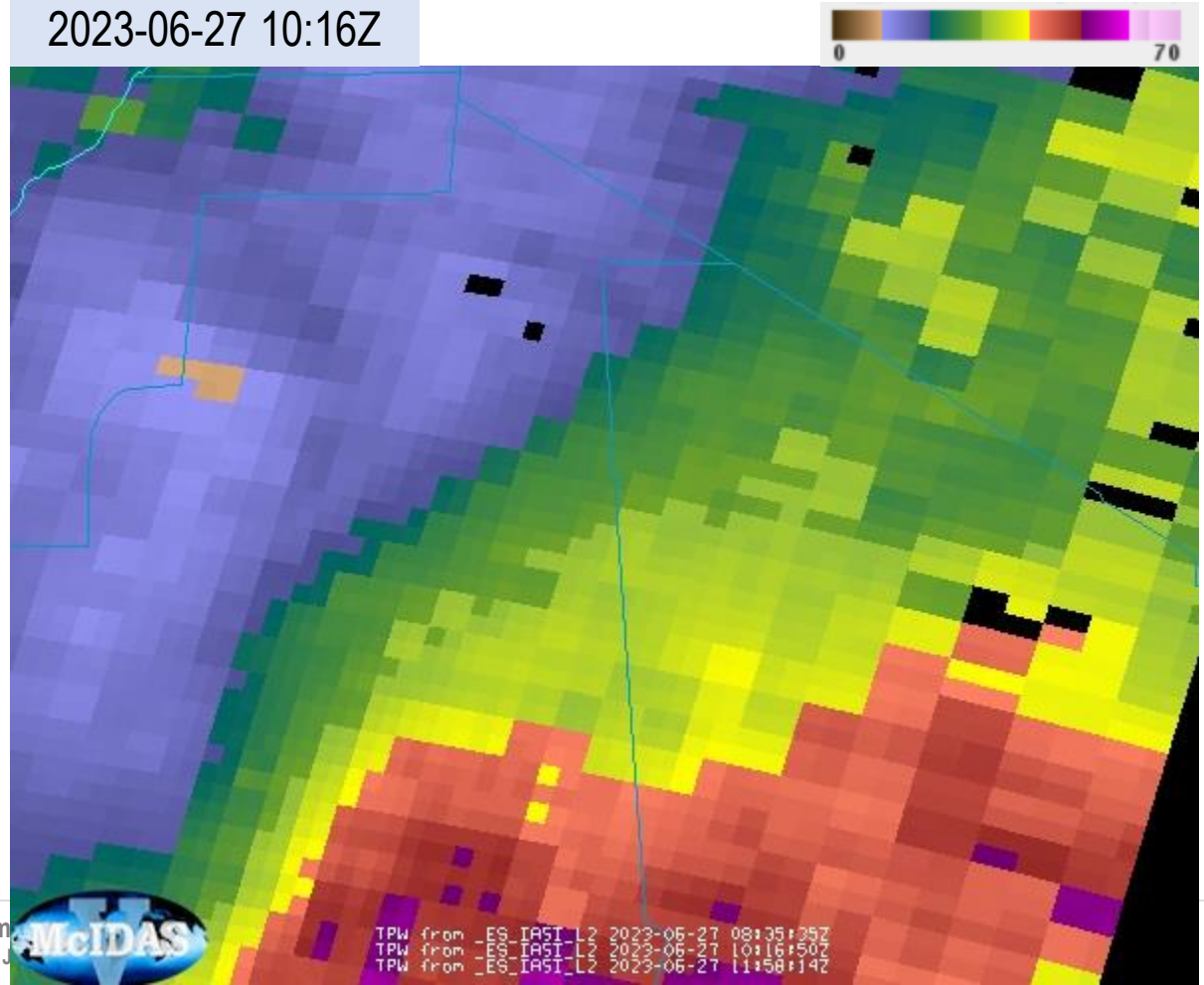


TPW iSHAI version MTG using real FCI data

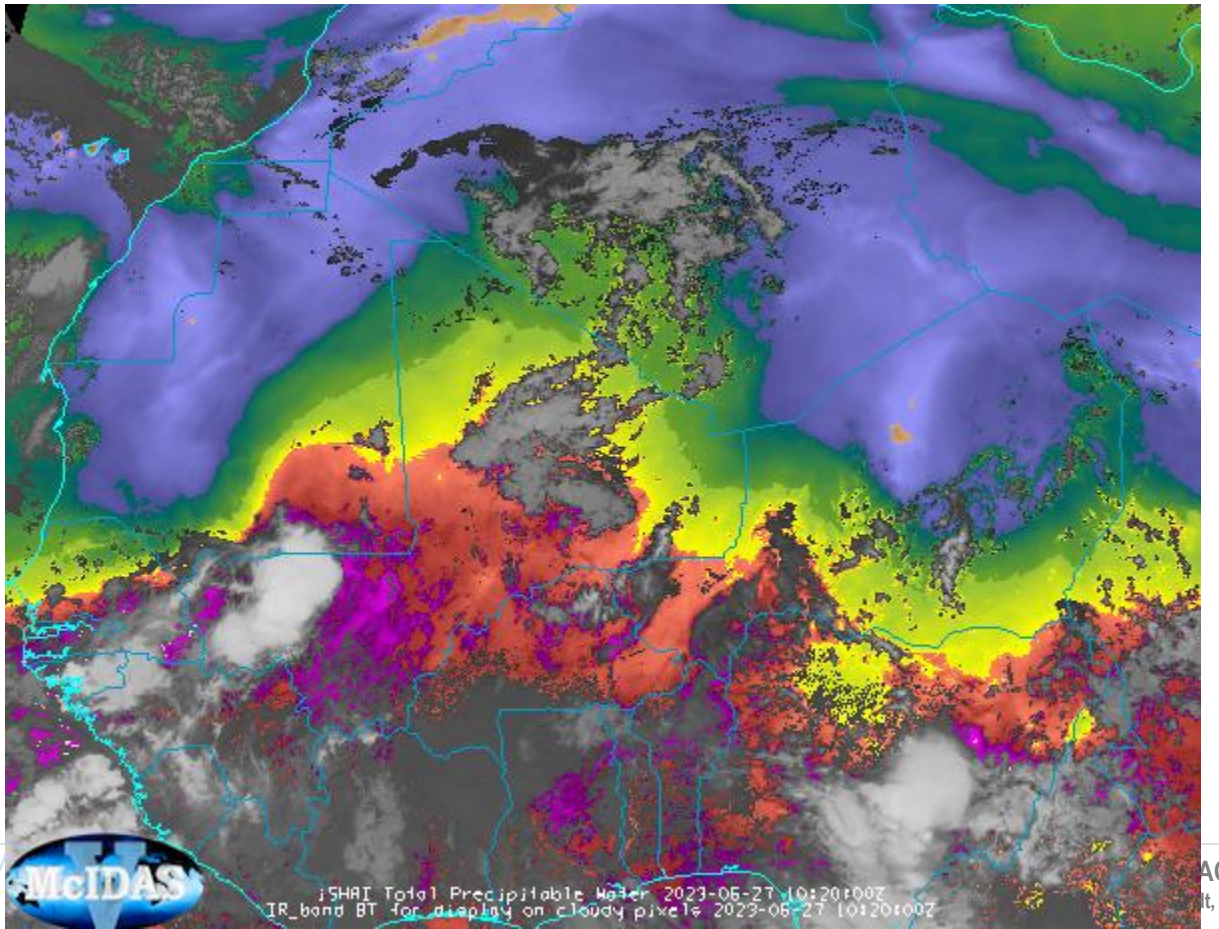
It has been used iSHAI PGE version MTG prototype with **real** MTG-I1/FCI data.
It has been used as background NWP the ECMWF model. Spatial resolution is FCI IR resolution (2x2 km on nadir)

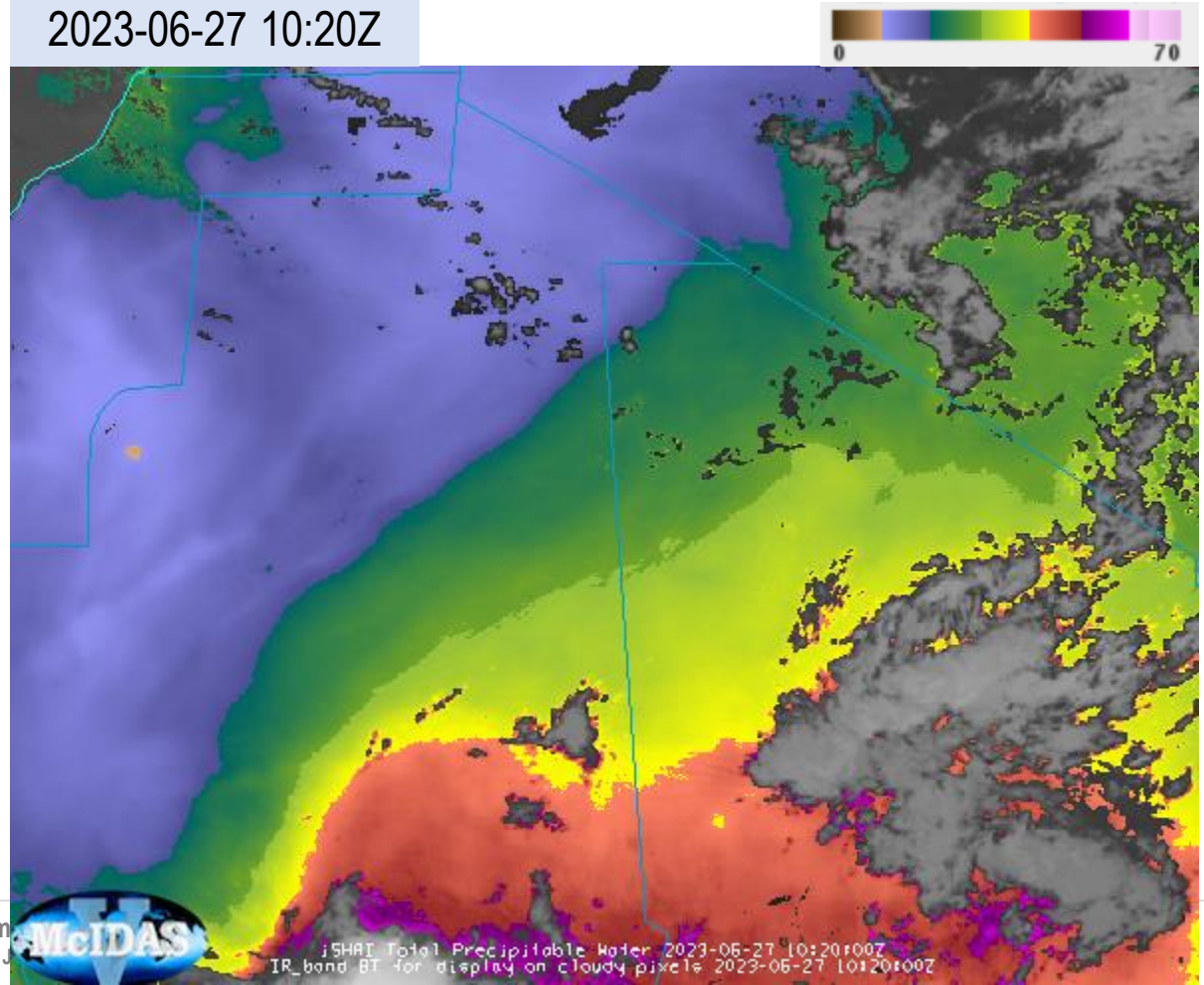
It has been used NWCSAF Cloud Mask to screen cloudy pixels. iSHAI is only executed on clear-air pixels.

- ✓ TPW iSHAI on coloured pixels.
- ✓ Grey pixels indicates cloudy pixels on NWC SAF Cloud Mask and it is displayed scaled IR10.5 BTs.

iSHAI algorithm is a combination of statistical and physical retrieval algorithms.
Only on clear air pixels (or NxN boxes)
iSHAI is based in Jun Li's algorithm similar to GOES-R one.

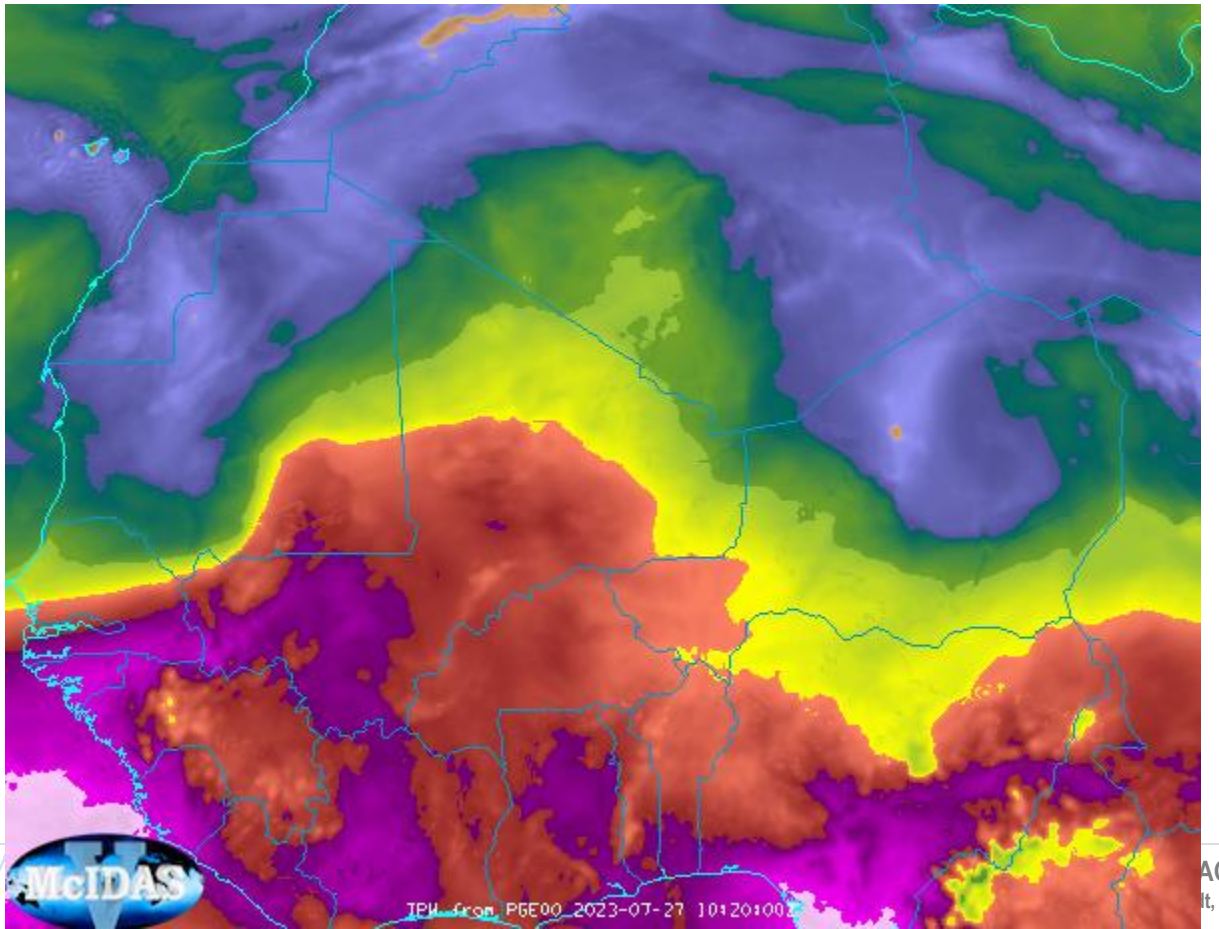
2023-06-27 10:20Z





TPW ECMWF interpolated using PGE00 tool

It has been used PGE00 tool with ECMWF GRIB files on hybrid levels (0.1x0.1º). t+10 and t+11 forecast GRIB files has been vertical, temporal and spatially interpolated to IR MTG-I/FCI projection. Then, it has been calculated TPW ECMWF and written on netCDF files. This ECMWF netCDF files has been used on McIDAS-V with same colour palette and projection.



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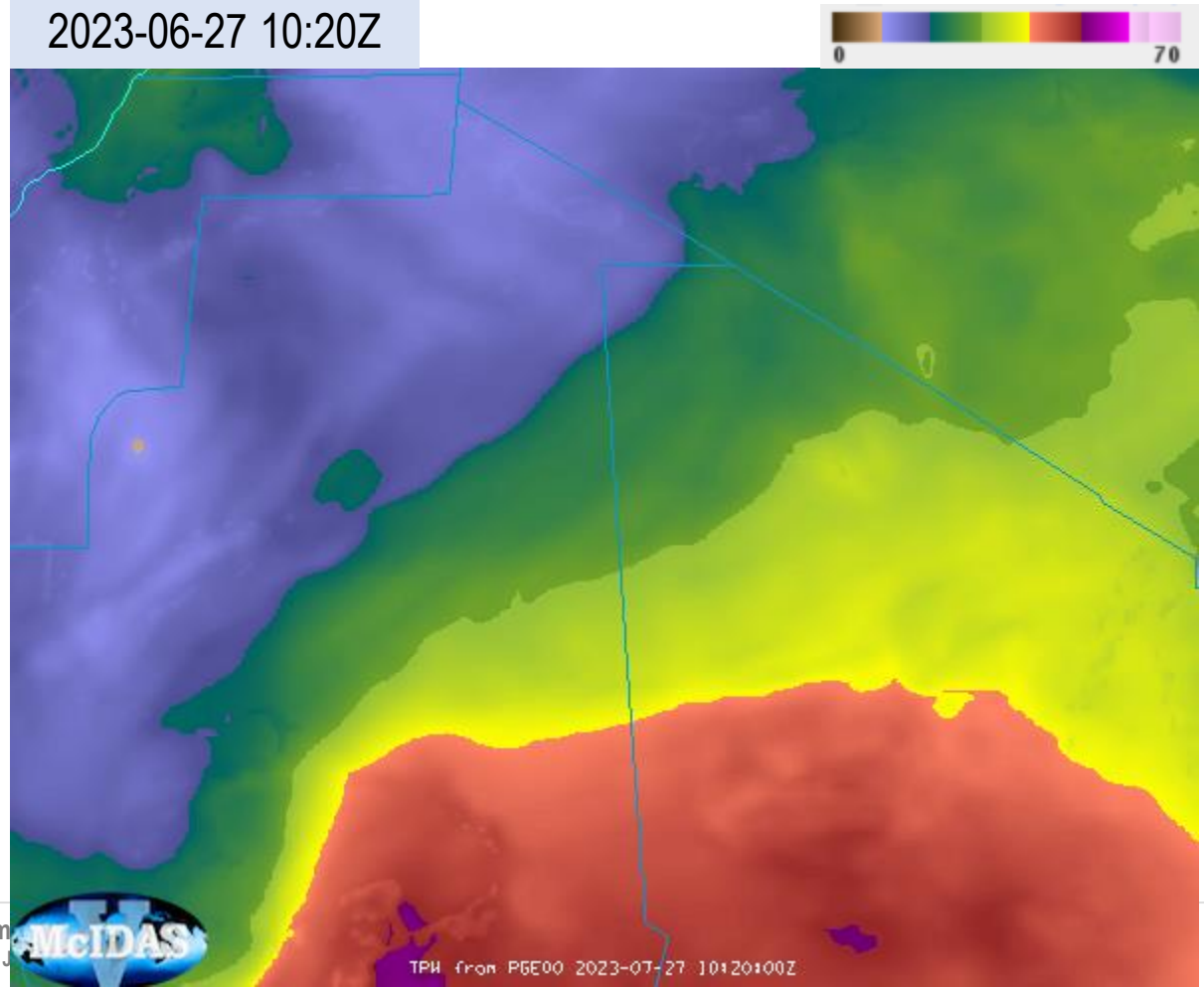
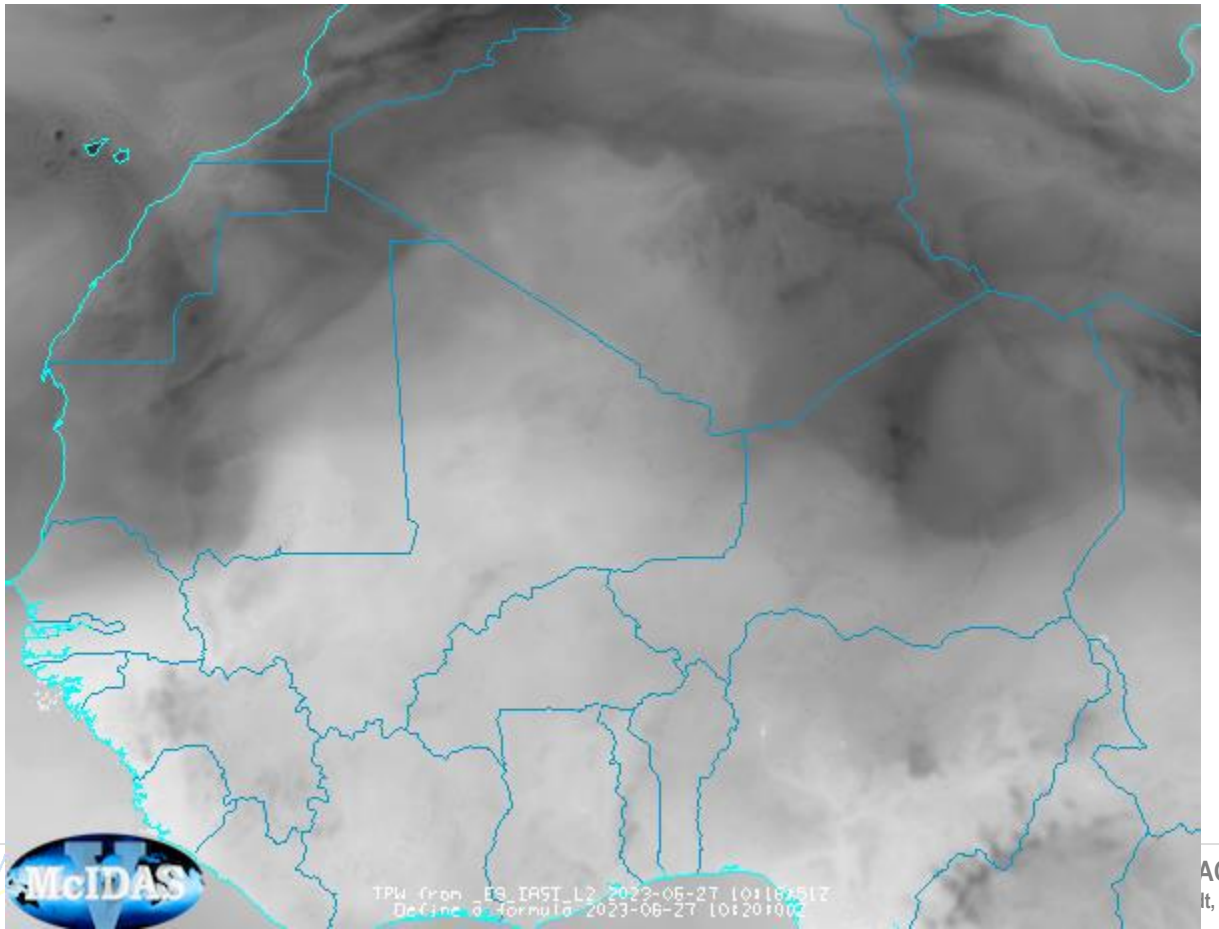
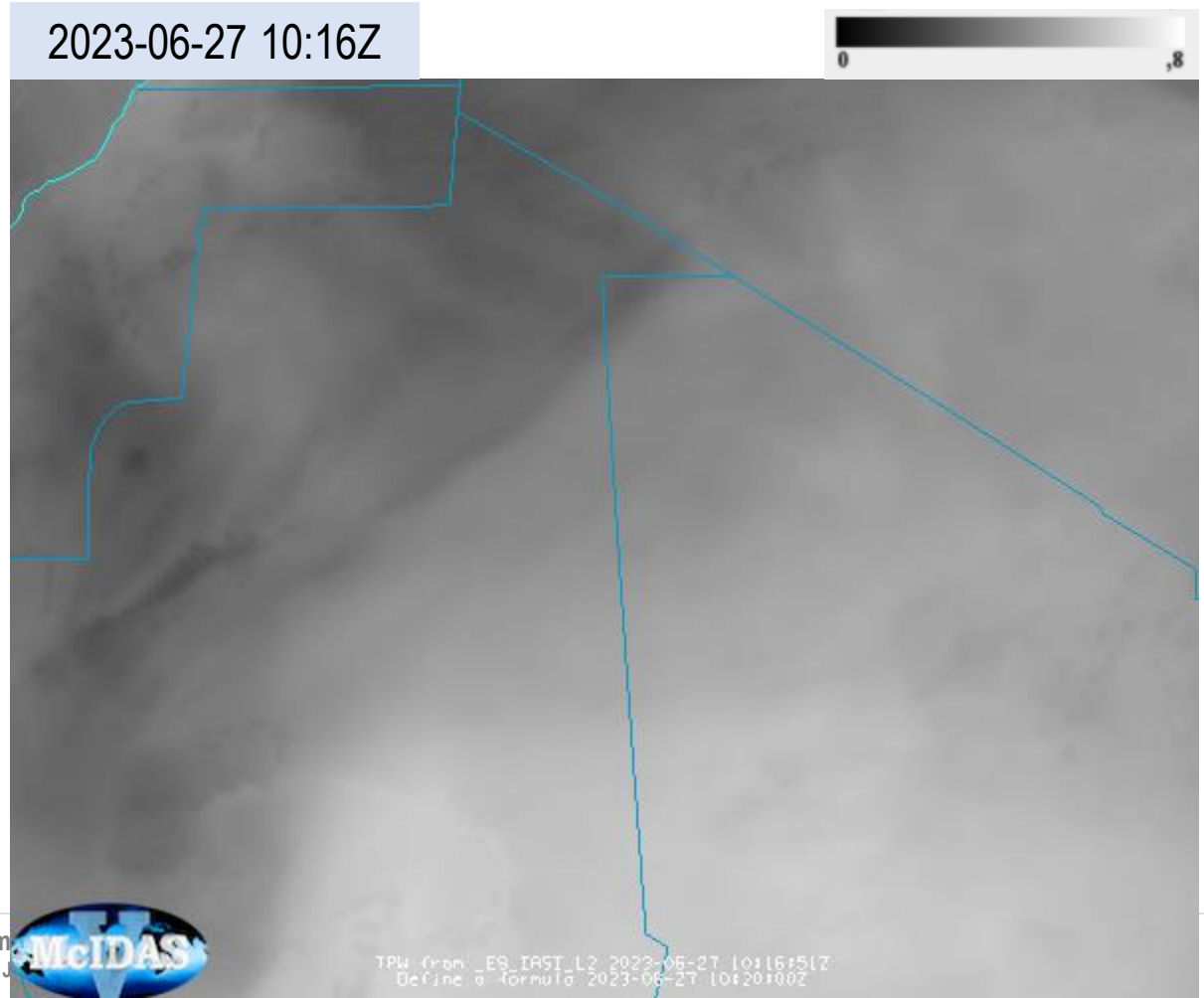


TPW proxy using synthetic VIS0.9 and VIS0.8 FCI from ECMWF and RTTOV 13.0

It has been used RTTOV-13.0 with ECMWF GRIB files on hybrid levels ($0.1x0.1^{0}$) to calculate synthetic FCI data (on clear and cloudy conditions).
t+10 and t+11 forecast GRIB files has been vertical, temporal and spatially interpolated to IR MTG-I/FCI projection at 10:20Z and calculated the **FCI synthetic data**. Then, it has been calculated proxy TPW ECMWF using the ***(log(VIS0.8)-log(VIS0.9))*** and written on netCDF files. This ECMWF netCDF files has been used on McIDAS-V with same grey palette, range and projection that **in next slide with real FCI data**.



2023-06-27 10:16Z

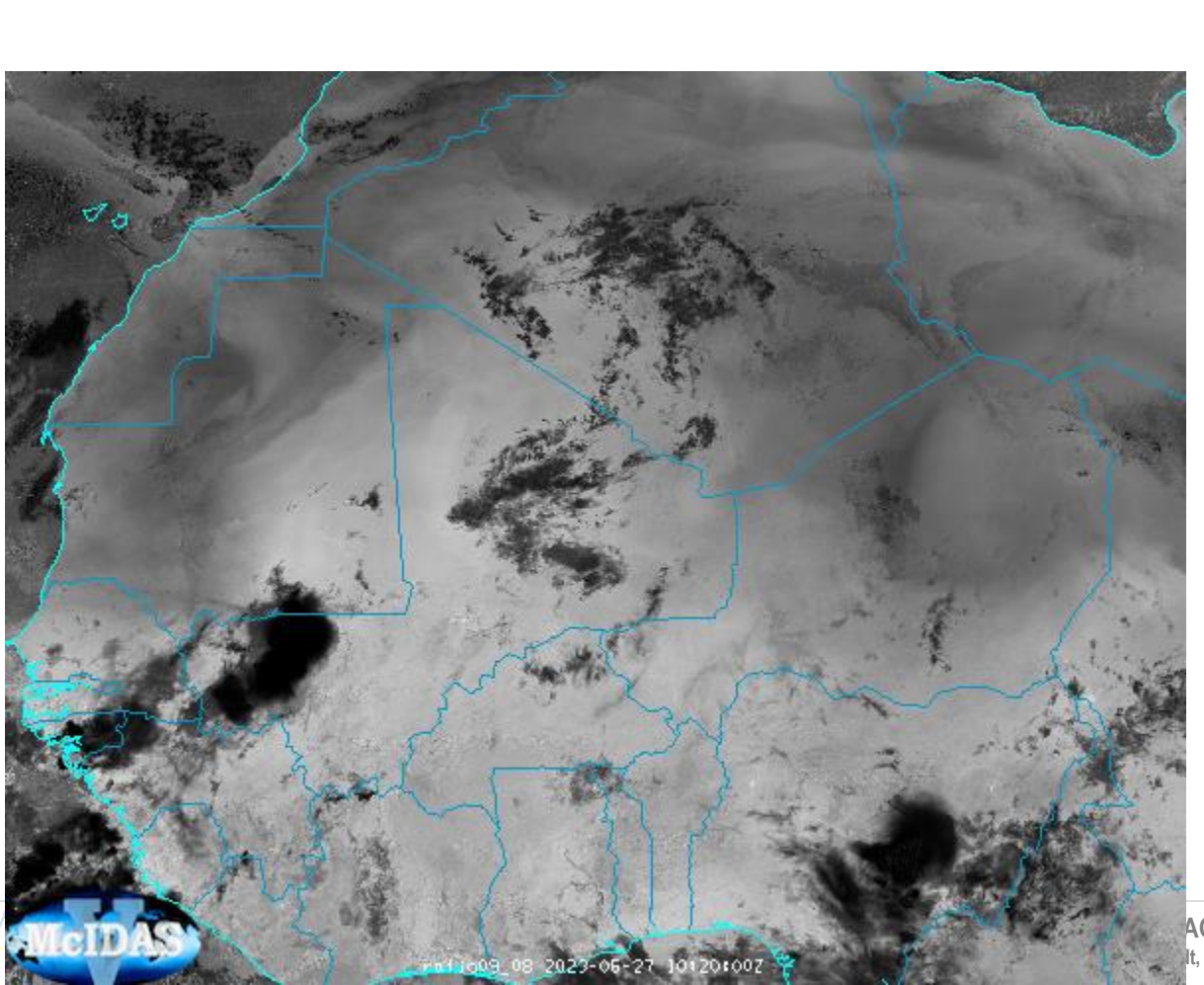


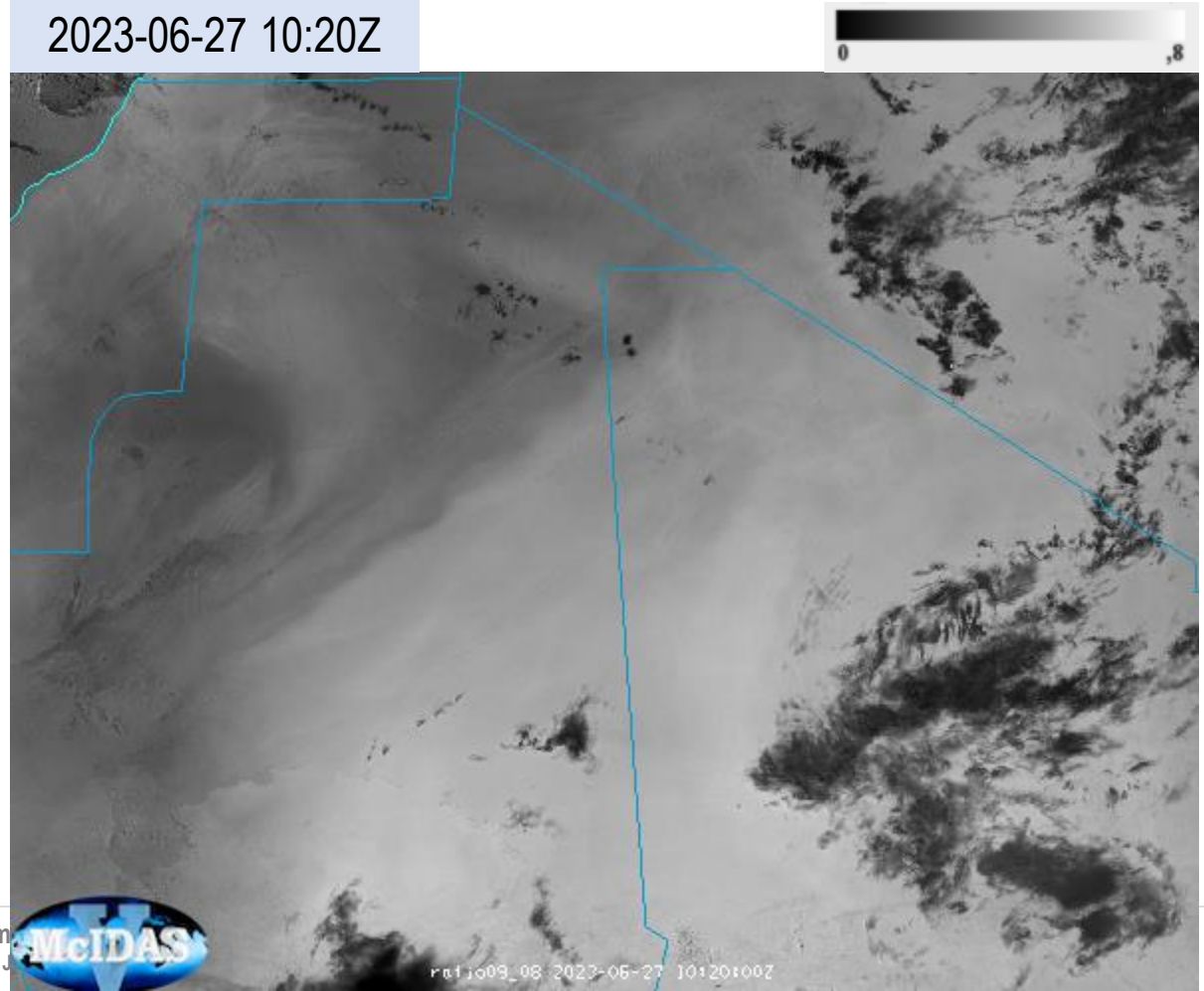
TPW proxy calculated using real VIS0.9 and VIS0.8 FCI

It has been calculated proxy TPW ECMWF using the ***(log(VIS0.8)-log(VIS0.9))*** with real MTG-I1/FCI and written on netCDF files. This netCDF files has been used on McIDAS-V with same grey palette, range and projection.
Spatial resolution is FCI VIS resolution (***1x1 km on nadir***). ***It is clear the high spatial resolution of this FCI qualitative TPW estimation.***
***The temporal resolution is also very high 10 minutes (see next slide) but* only available during day (visible channels).**

There is in the NWCSAF foreseen another 0.9 TPW field using optimal estimation (FUB algorithm).

2023-06-27 10:20Z



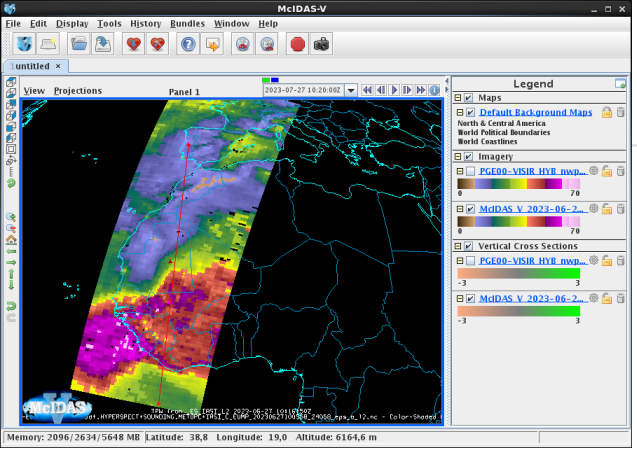


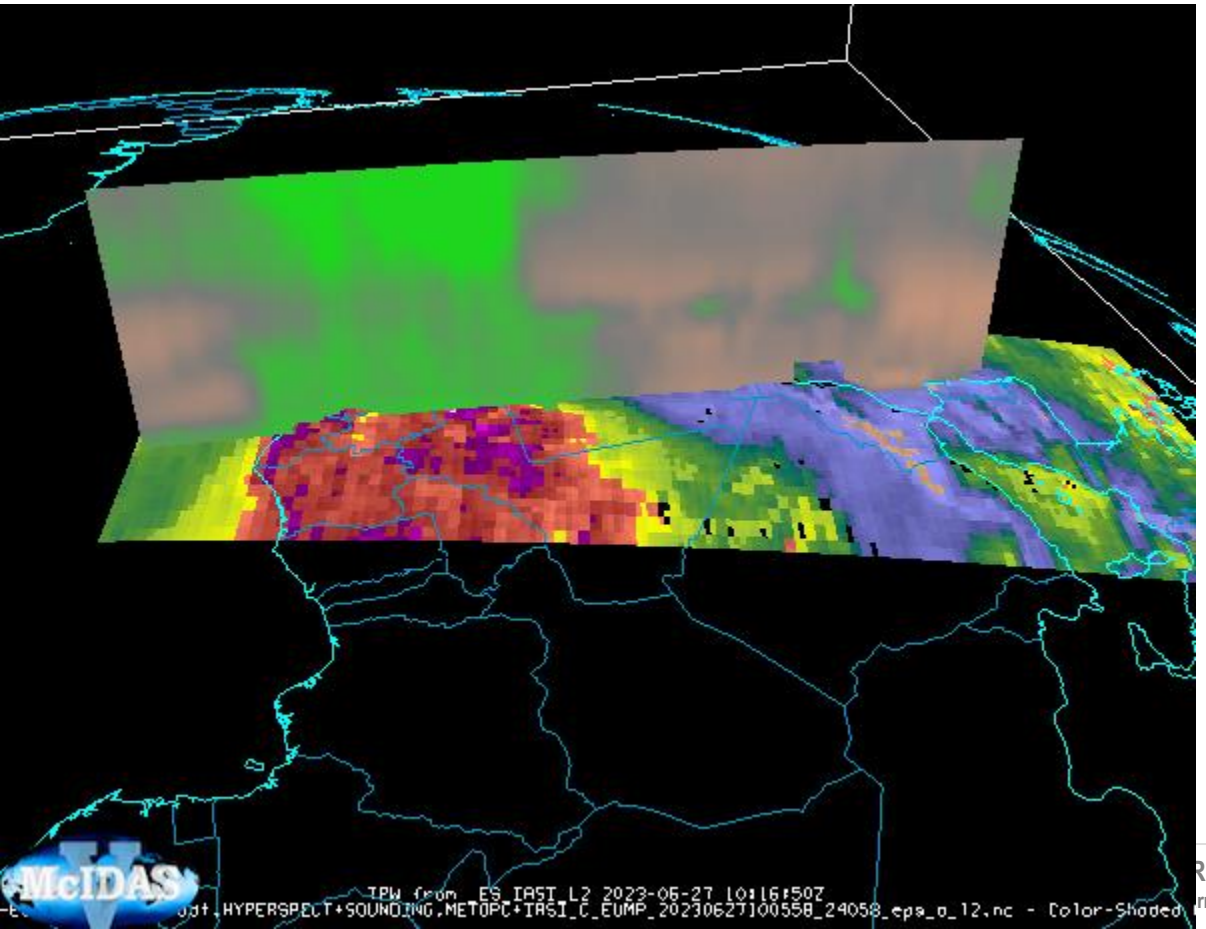
First-guess TPW IASI L2 METOP-C

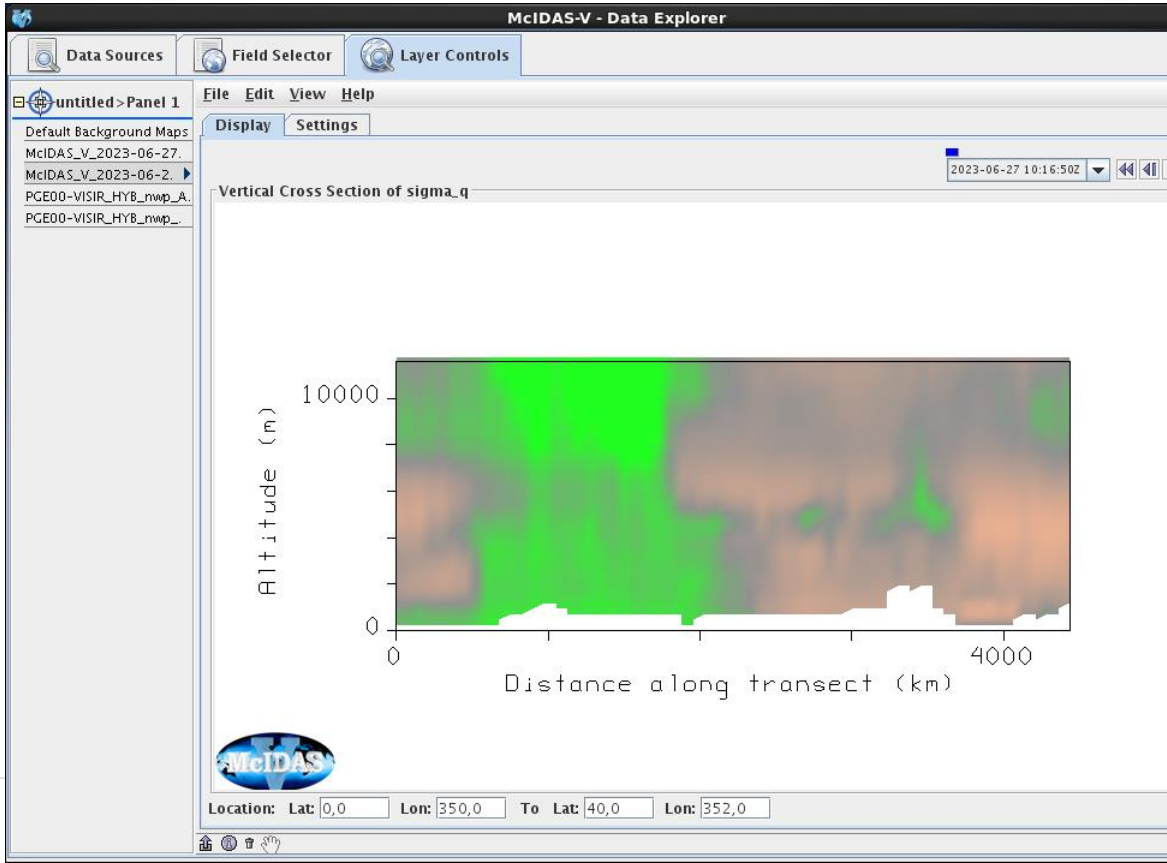
3D display example of normalized q of first-guess TPW IASI L2 METOP-C

q profile are normalized using mean and standard deviation on every level.
Common mean and standard deviation values are used.

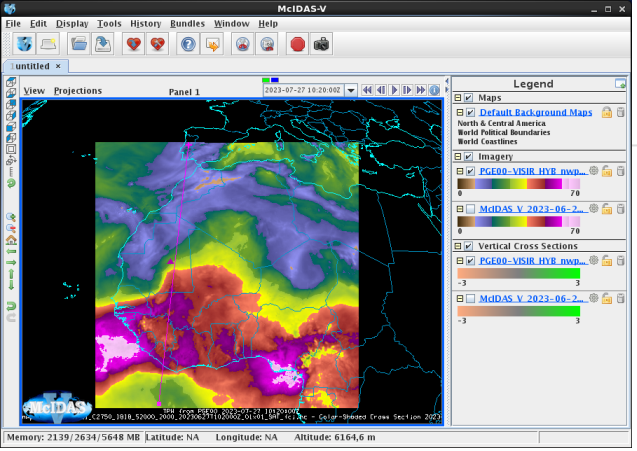
2023-06-27 10:16Z







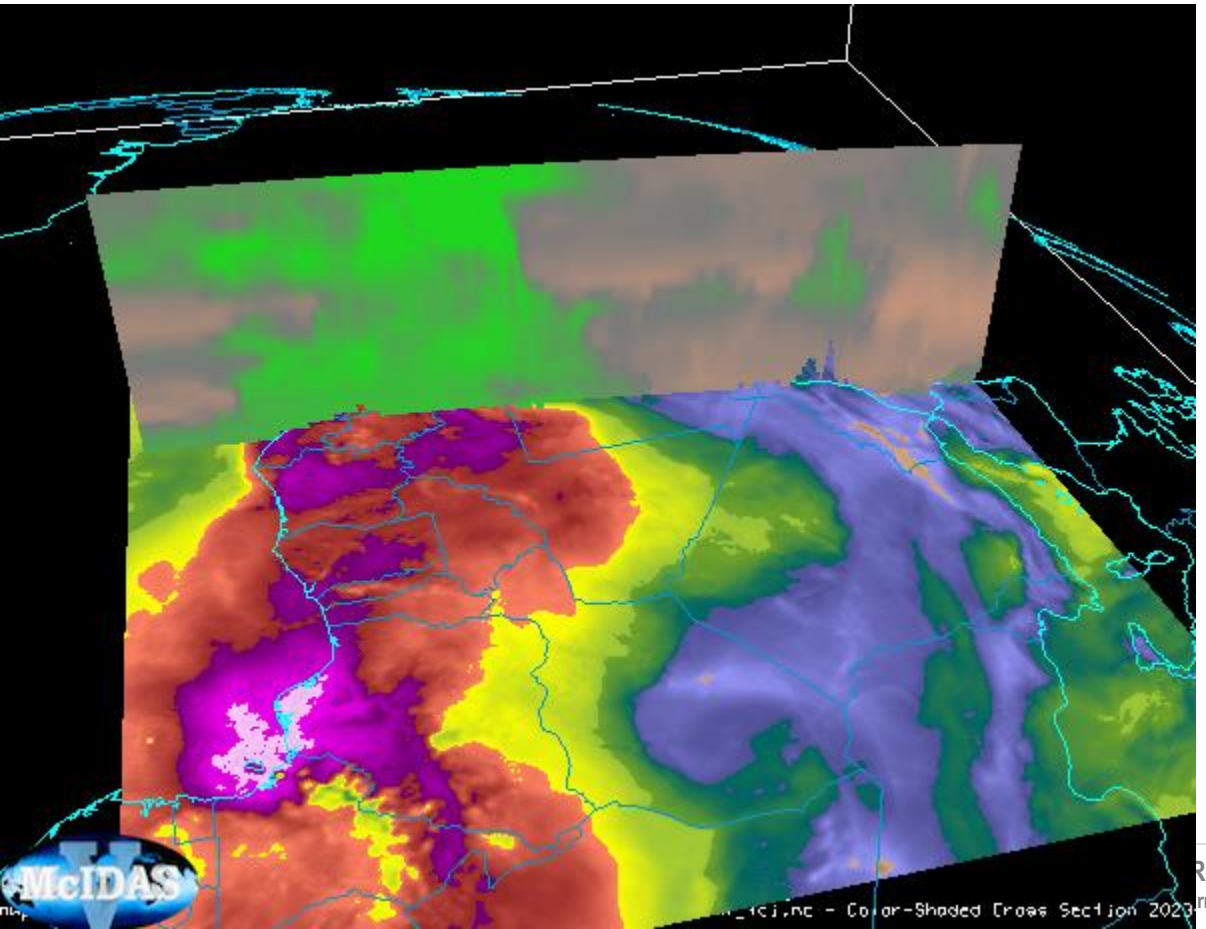
TPW ECMWF

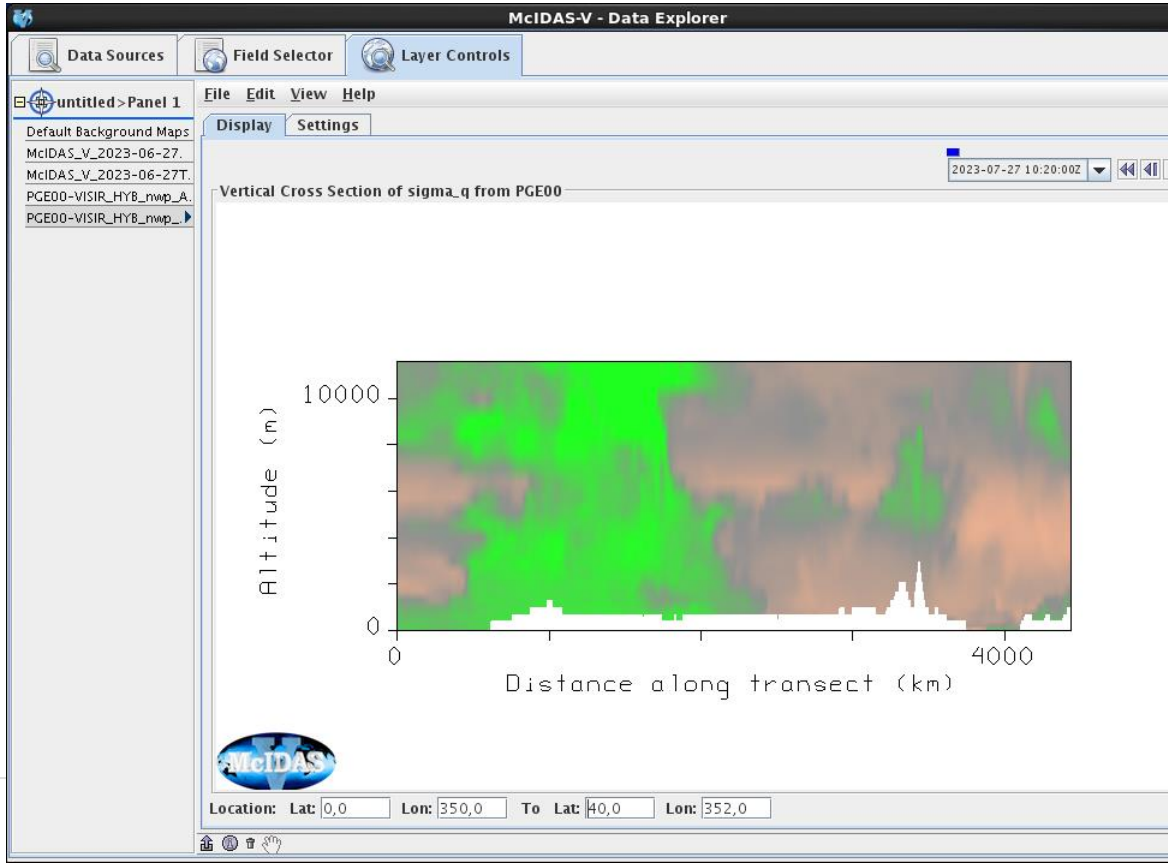


3D display example of normalized q of TPW ECMWF

q profile are normalized using mean and standard deviation on every level.
Common mean and standard deviation values are used.

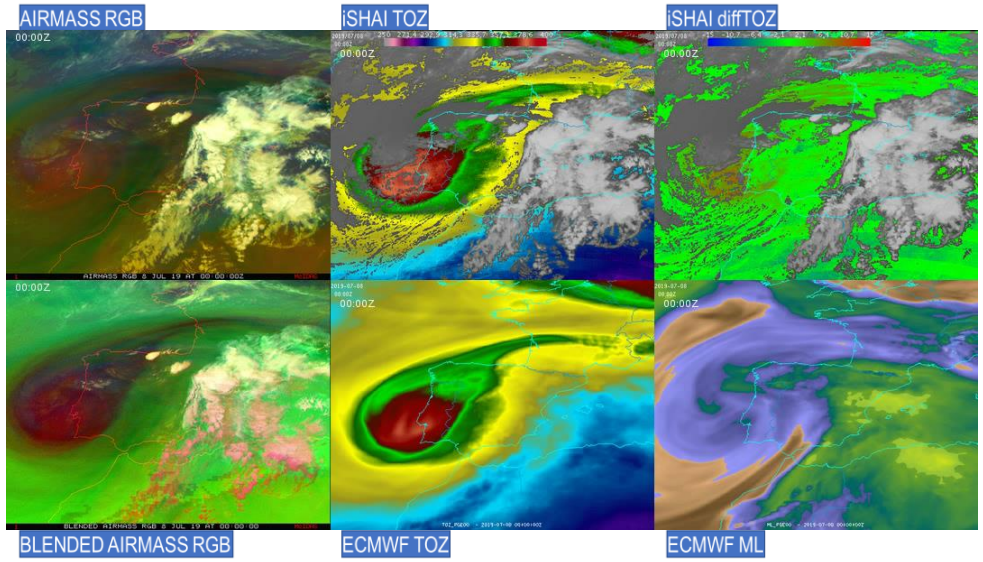
2023-06-27 10:20Z

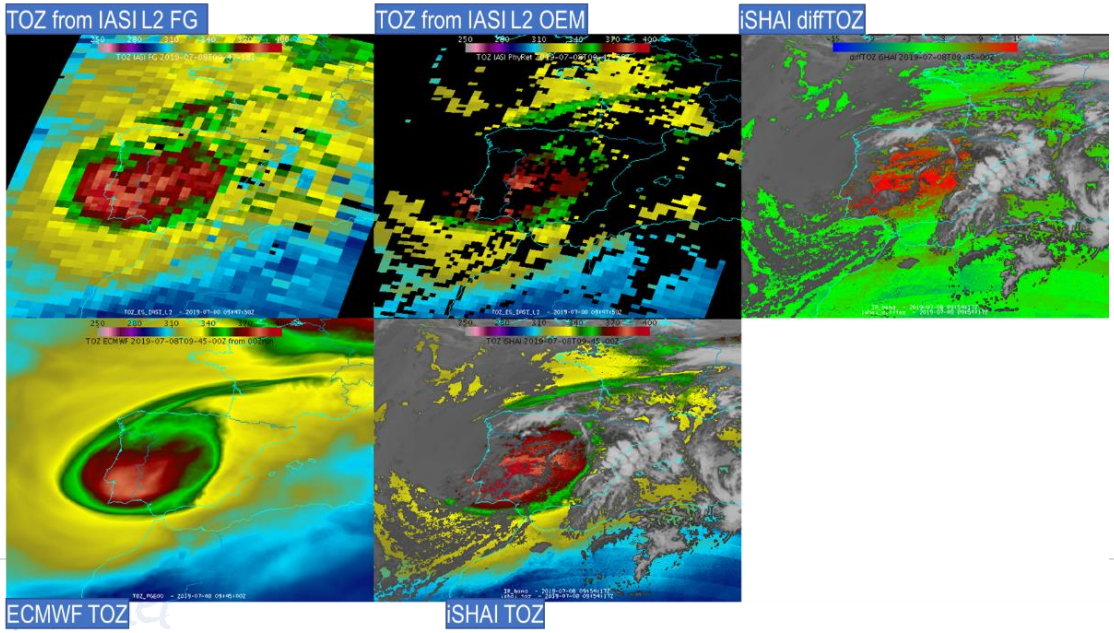


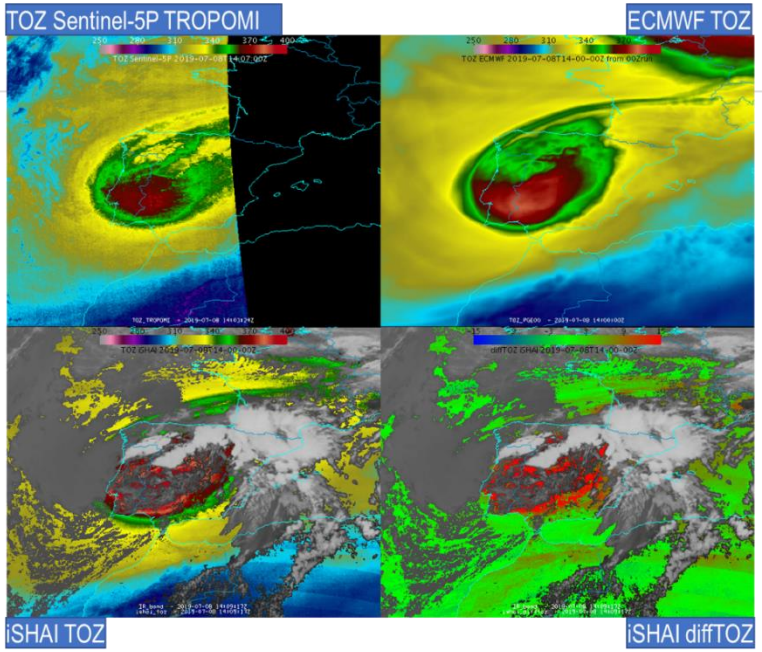


sSHAI_ES and Sentinel-4

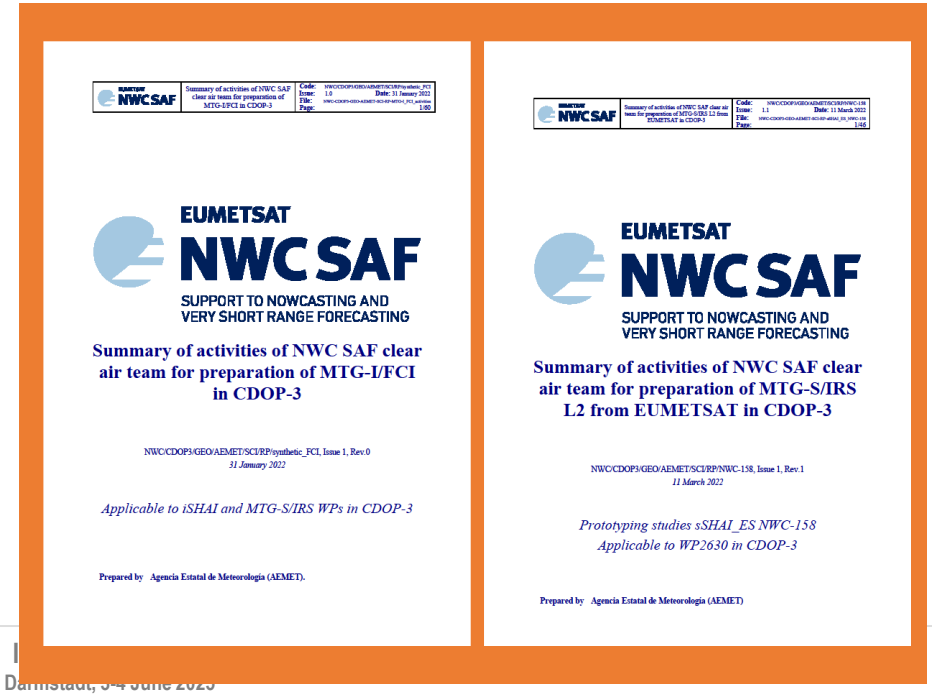
Case study 8th July 2019







It will be needed to develop further "glue" software for Sentinel4 L1 and L2 reader and integration.



EUMETSAT NWC SAF
SUPPORT TO NOWCASTING AND VERY SHORT RANGE FORECASTING

Summary of activities of NWC SAF clear air team for preparation of MTG-I/FCI in CDOP-3

NWC/CDOP3/GEO/AEMET/SCI/RP/synthetic_FCI, Issue 1, Rev.0
31 January 2022

Applicable to iSHAI and MTG-S/IRS WPs in CDOP-3

Prepared by Agencia Estatal de Meteorología (AEMET).

EUMETSAT NWC SAF
SUPPORT TO NOWCASTING AND VERY SHORT RANGE FORECASTING

Summary of activities of NWC SAF clear air team for preparation of MTG-S/IRS L2 from EUMETSAT in CDOP-3

NWC/CDOP3/GEO/AEMET/SCI/RP/NWC-158, Issue 1, Rev.1
11 March 2022

Prototyping studies sSHAI_ES NWC-158
Applicable to WP2630 in CDOP-3

Prepared by Agencia Estatal de Meteorología (AEMET)

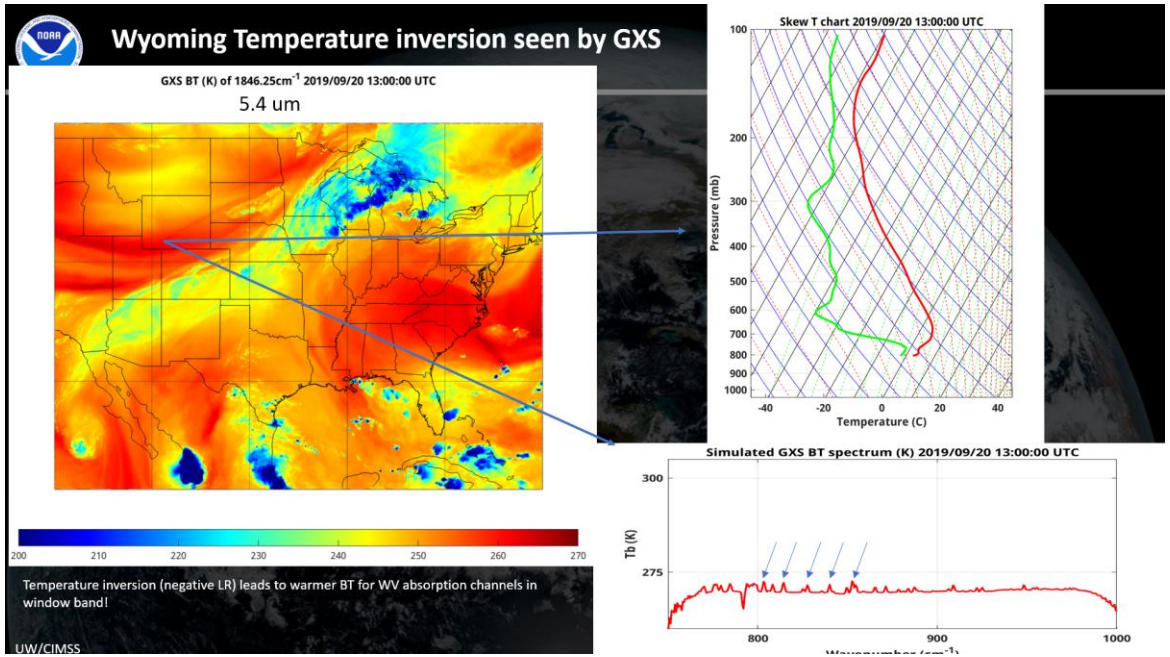
sSHAI_ES
Contribution of IRS L2 EUMESAT Secretariat to user's local 4D datacubes generation.

CDOP4
Explore more uses of the 4D datacubes. Comparison of profiles, vertical cross sections, etc

Example: IASI L2 profiles (CAF and SAF) versus ECMWF profiles

Low level inversions on hyperspectral L1

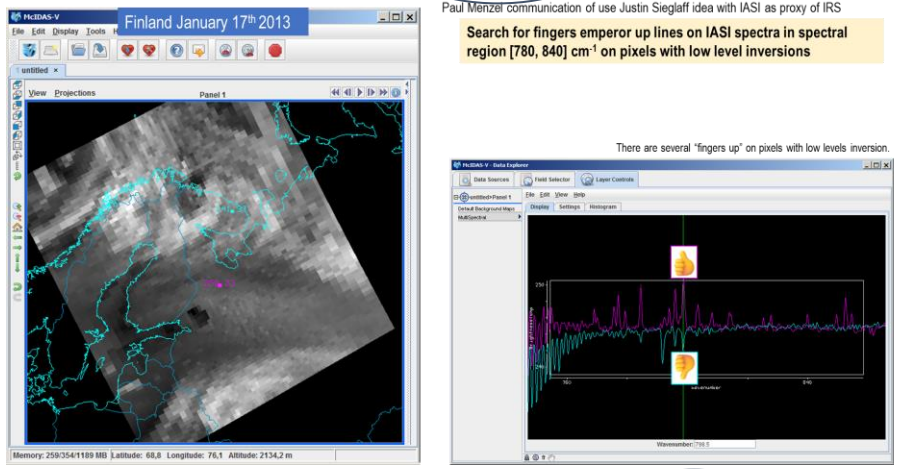
GXS synthetic image



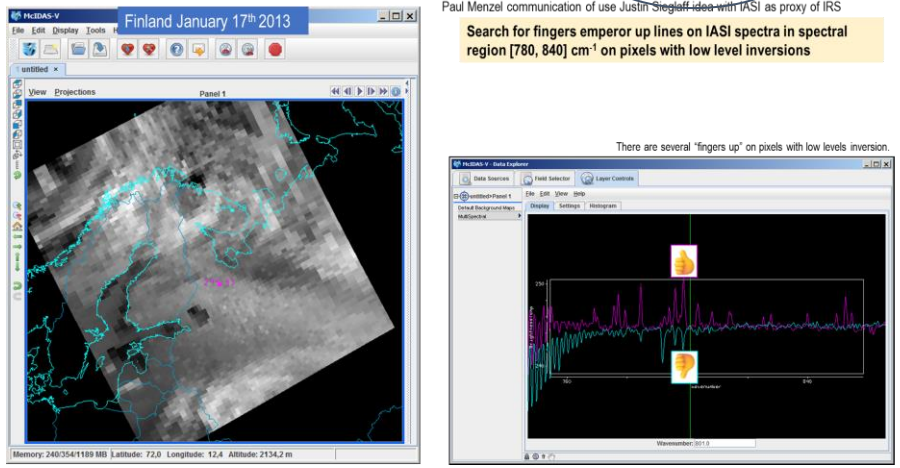
Taken from Bill line presentation on "ESSL-EUMETSAT Expert Workshop on Use of MTG-IRS L2 Products for Nowcasting"
Available on EUMETSAT sftp MTG-UP

Real IASI data

Line1 for Red (in: 798.5 cm^{-1}, off: 801 cm^{-1})



Line1 for Red (in: 798.5 cm^{-1}, off: 801 cm^{-1})

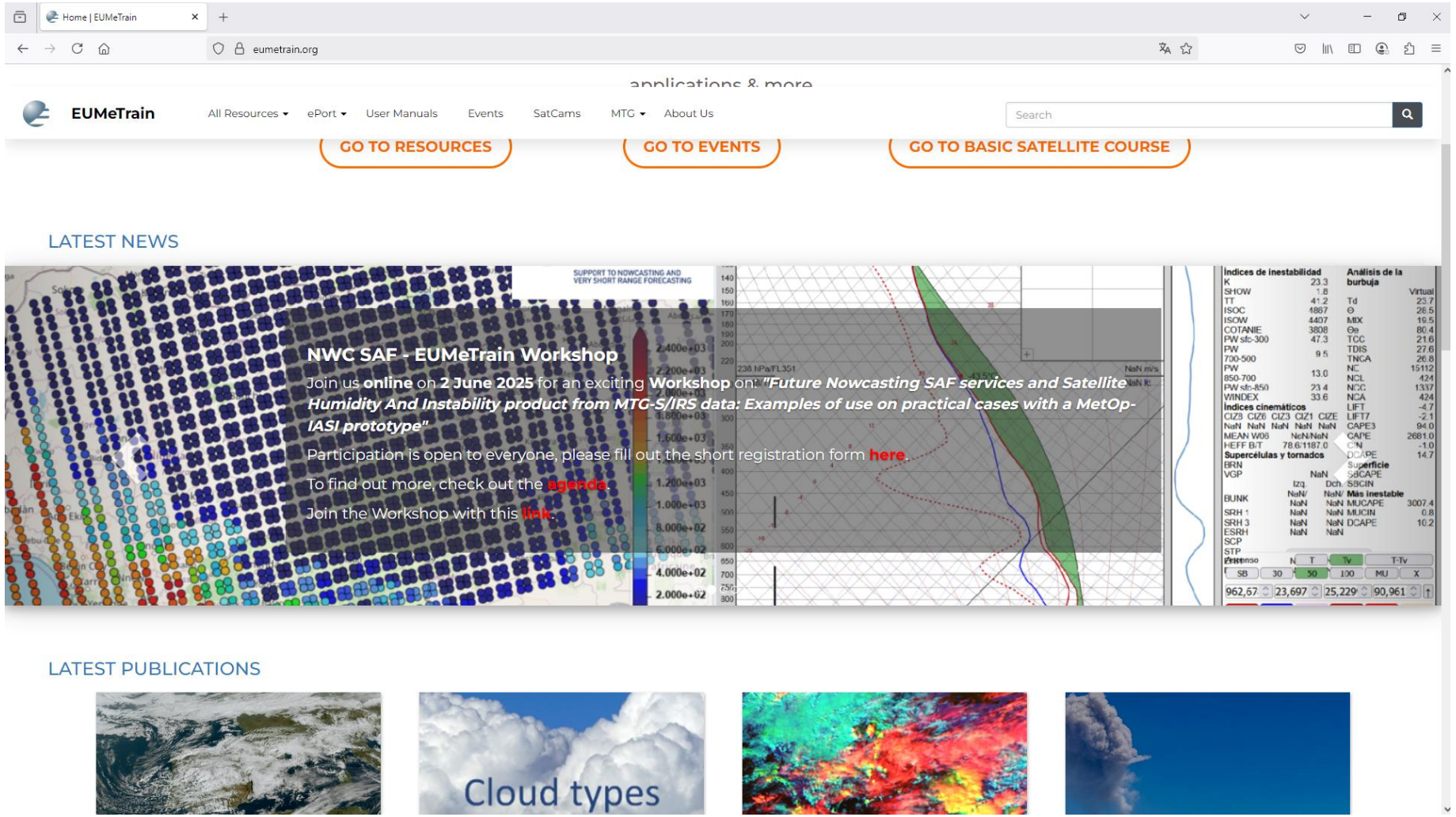


NWCSAF Workshop 2025

Presentations are available on: https://www.nwcsaf.org/web/guest/2025_users_ws

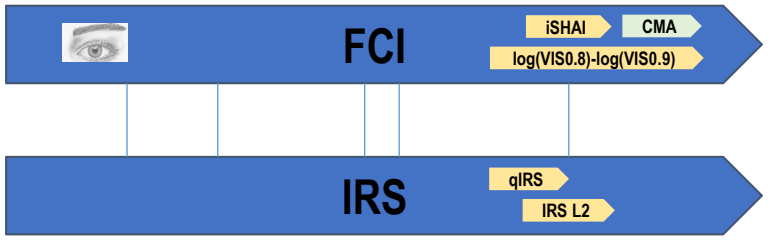
Session VI: MTG-S PRODUCTS		
Author	**Title**	**Link**
M.A. Martínez (AEMET)	qIRS: NWCSAF approach for optimization of use of IRS spectra and images.**(See below)	
N. Peinado-Galán (AEMET)	Severe convection events analyse using the new sSHAI product from METOP/IASI as a Proxy for MTG/IRS.	
M.A. Martínez (AEMET)	Remapping IRS and sSHAI_Es: NWCSAF approach for optimization of the use of IRS L2 (EUMETSAT and sSHAI) products.**(See below)	

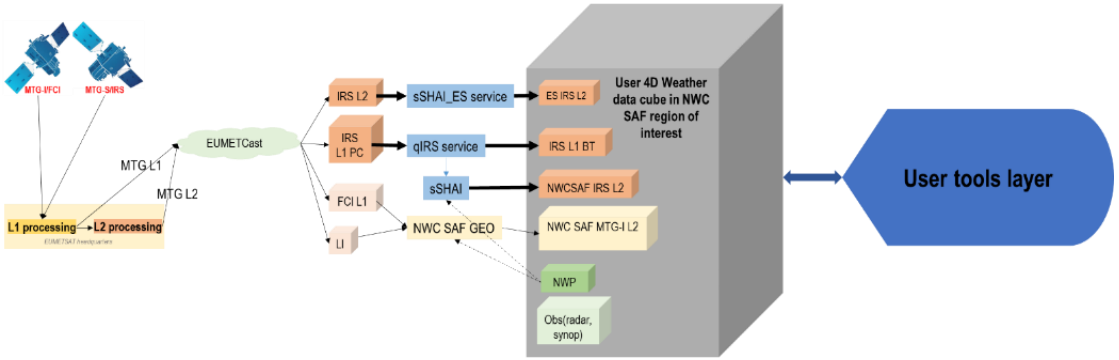
EUMETrain NWCSAF GEO-S Event 2 June 2025



Conclusions

- ✓ sSHAI_ES service ends the local 4D data cube generation and exploitation on the user's side of EUMETCast. **It is a small service but it is the *nearest to the user*.**
- ✓ It fills the gap between EUMETSAT formats and the used for users' tools. 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.
- ✓ sSSHAI_ES completes the integration of IRS on NWCSAF on GEO-S package. Once sSHAI_ES prototype is updated with IRS L2 testdataset it could be started the migration from IDL to other languages. *It will be used iSHAI (C and Fortran) and PGE00 code as basis. They are using the SAFNWC library and environment.*
- ✓ Similar to iSHAI difference fields, IRS L2 could be used to detect disagreement with NWP models on nowcasting.
- ✓ New milestones in next phase CDOP-5:
  - ❑ Generation of collocated and combined datasets with FCI, IRS and NWP (synthetic) should be a priority task for a full cross validation and calibration. Also could be used on machine learning.
  - ✓ A lot of slight different products will be generated: it should be needed to develop some kind of integration tools 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. Similar to high number of medical tests in one hospital; it is needed to study when and why use them on a seamless way.





See NWC SAF iSHAI product References page for more details

Thanks for your attention