# Continuity of Mid-Morning Polar Observations through EUMETSAT Metop-SG Satellites


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# Metop-SG Background

- EUMETSAT Polar System (EPS) programme Second Generation (EPS-SG) or Metop-SG (Second Generation) is the next generation follow on to the current Metop-A, B and C of satellites in the morning orbit
  - Provide continuity of mid-morning observations to NOAA Operations
  - Enhance current midmorning polar satellite products to be compatible with the new generation midafternoon JPSS products for consistency between AM and PM observations
- As part of the NOAA-EUMETAT Joint Polar Satellite (JPS) agreement, NOAA flies the afternoon satellites (JPSS) and EUMETSAT will fly the morning constellation (Metop-SG)

# The Two Polar-orbits

## -mid morning vs. afternoon

Successful collaboration between NOAA and EUMETSAT for the Joint Polar System

# Two Satellite Configuration

- **Metop-SG-A**
  - IASI-NG (IASI, AIRS)
  - METimage (AVHRR, MODIS)
  - MWS (AMSU-A, MHS)
  - 3MI (POLDER)
  - Sentinel-5 (GOME-2, SCIAMICHY, OMI)
  - RO (GRAS, COSMIC)

- **Metop-SG-B**
  - SCA (ASCAT, QUICKSCAT)
  - MWI (SSMI, AMSR-E)
  - ICI (AURA-MLS, Odin-SMR)
  - RO (GRAS, COSMIC)
  - ARGOS-4

*Heritage*

# Notional Launch Schedule (According to EUMETSAT web page 10/18/2019)

| SATELLITE | PLANNED LAUNCH DATE | START OF ROUTINE OPERATIONS | DETAILS |
|---|---|---|---|
| Metop-SG A1 | Q4 2022 | Q2 2023 | 823–848 km, METimage, IASI-NG, MWS, Sentinel-5, 3MI, RO |
| Metop-SG B1 | Q4 2023 | Q2 2024 | 823–848 km, SCA, MWI, ICI, RO, ADCS-4 |
| Metop-SG A2 | Q4 2029 | | 823–848 km, METimage, IASI-NG, MWS, Sentinel-5, 3MI, RO |
| Metop-SG B2 | Q4 2030 | | 823–848 km, SCA, MWI, ICI, RO, ADCS-4 |
| Metop-SG A3 | Q4 2036 | | 823–848 km, METimage, IASI-NG, MWS, Sentinel-5, 3MI, RO |
| Metop-SG B3 | Q4 2037 | | 817 km, SCA, MWI, ICI, RO, ADCS-4 |

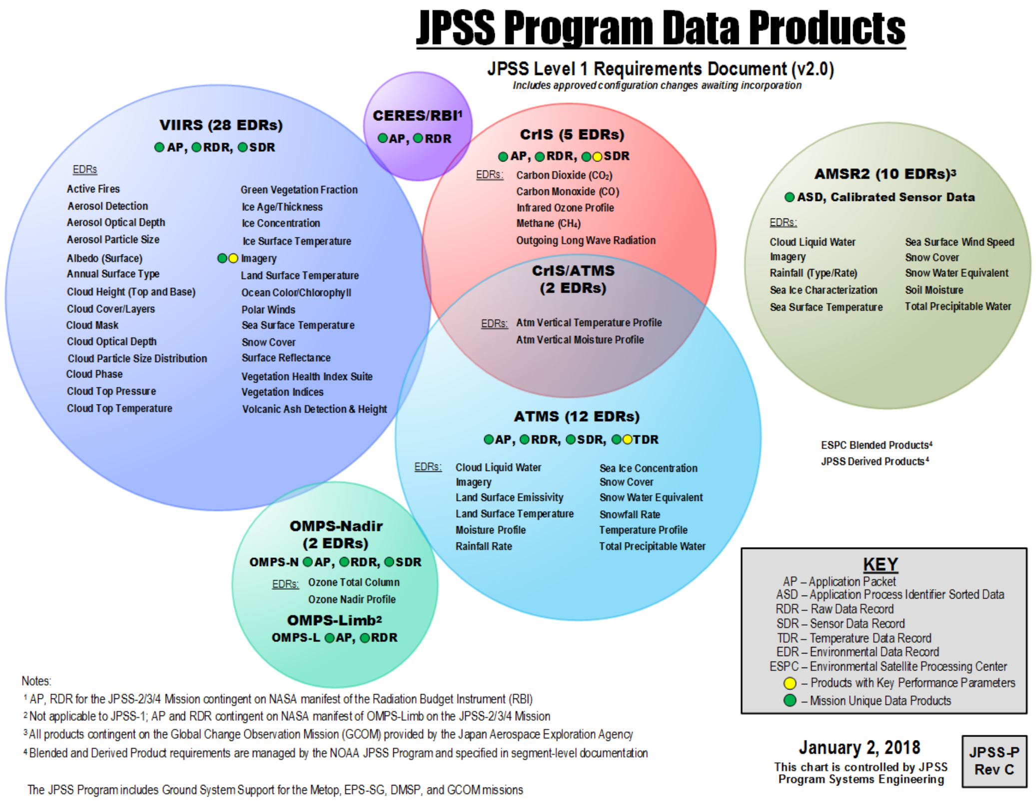
# Mapping of Metop-SG NOAA Instruments

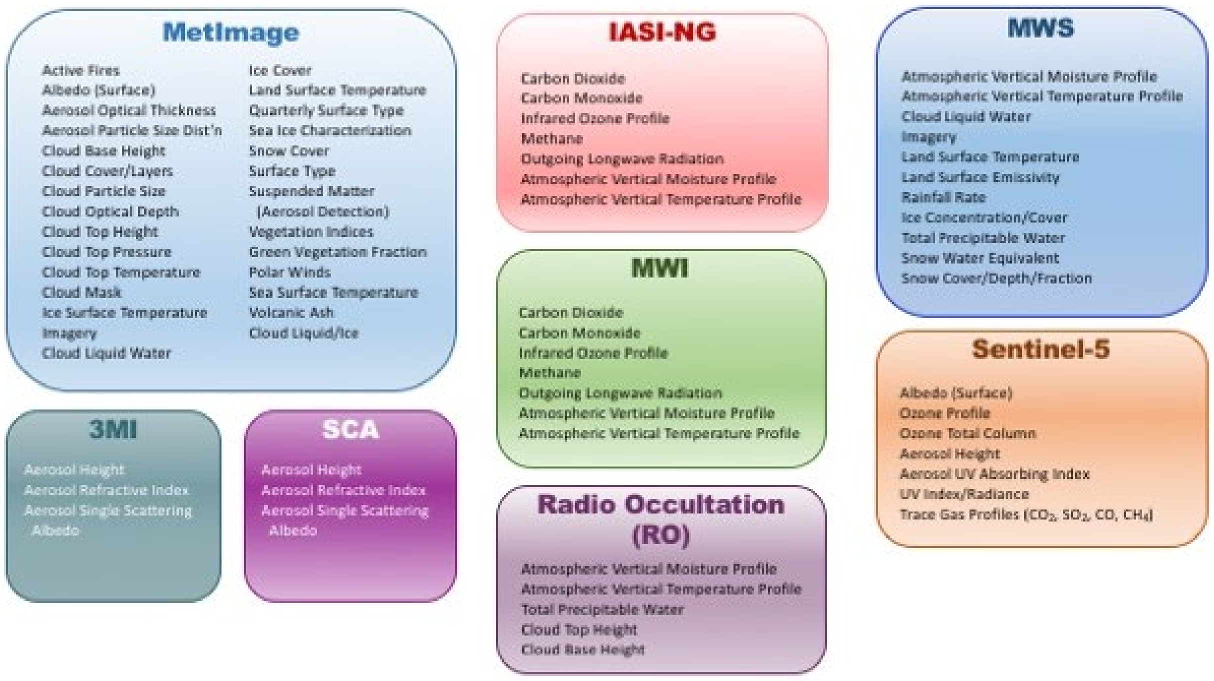
| Mission | EPS-SG Instrument | JPSS Instrument | Applications Benefitting |
|---|---|---|---|
| Hyper-spectral Infrared Sounding | IASI-NG | CrIS | NWP, NWC, Air Quality, CM |
| Visible/Infrared Imaging | METimage | VIIRS | NWC, NWP, CM, Hydrology, Oceanography |
| Microwave Sounding | MWS | ATMS | NWP, NWC, CM |
| Radio Occultation Sounding | RO | - | NWP, CM |
| Nadir viewing UV/VIS/NIR/SWIR Sounding | Sentinel-5 | OMPS | Ozone-UV, Air Quality, CM, Composition-Climate interactions |
| Multi-viewing, -channel, -polarisation Imaging | 3MI | - | Air Quality, CM, NWC |
| Scatterometry | SCA | - | NWP, NWC, Oceanography, Hydrology |
| Microwave Imaging | SSMIS | AMSR | NWP, NWC, Hydrology, CM, Oceanography |
| Ice Cloud Imaging | ICI | - | NWP, NWC, Hydrology, CM |

# STAR Roles and Responsibilities

- Provide the enterprise algorithm development, test and validation of EPS-SG data to generate high quality environmental products required by the user community
- Establish science collaboration teams with EUMETSAT and other science colleagues to consider improvements to existing products
- Provide science maintenance of all products generated by the Metop SG PPA Project
- Deliver long term science maintenance to help troubleshoot on-orbit anomalies that impact product quality

# Mapping JPSS Products and MetOp-SG Continuity



# METImage

*Contributions from Cao, Hillger, Miller*

# METImage-VIIRS Comparison

Highlighted bands are unique to each instrument.

**22 Bands**

| VIIRS Band | Central Wavelength (µm) | |
|---|---|---|
| M-1 | 0.412 | "violet blue" |
| M-2 | 0.445 | |
| M-3 | 0.488 | "true color blue" |
| M-4 | 0.551 | |
| I-1 | 0.64 | 375 m visible band |
| M-5 | 0.672 | |
| M-6 | 0.746 | |
| M-7/I-2 | 0.865 | |
| M-8 | 1.24 | |
| M-9 | 1.38 | |
| M-10/I-3 | 1.61 | |
| M-11 | 2.25 | |
| M-12/I-4 | 3.74 | |
| M-13 | 4.05 | |
| M-14 | 8.55 | |
| M-15 | 10.76 | |
| I-5 | 11.45 | 375 m IR window |
| M-16 | 12.01 | |
| DNB | 0.5-0.9 | Low-light visible |

VIIRS has **5** high resolution Imagery channels (I-**bands**), **16** moderate resolution channels (**M-bands**) and **a** Day/Night Band (DNB)

| METImage Band | Central Wavelength (µm) | |
|---|---|---|
| VII-4 | 0.443 | |
| VII-8 | 0.555 | |
| VII-12 | 0.67 | |
| VII-15 | 0.752 | Dual bands at similar wavelength to M6, but not prone to saturation |
| VII-16 | 0.763 | |
| VII-17 | 0.865 | |
| VII-20 | 0.914 | VNIR band with some water vapor absorption |
| VII-22 | 1.24 | |
| VII-23 | 1.38 | |
| VII-24 | 1.63 | |
| VII-25 | 2.25 | |
| VII-26 | 3.74 | |
| VII-28 | 3.96 | |
| VII-30 | 4.04 | |
| VII-33 | 6.72 | Upper- and Lower-level IR water vapor bands |
| VII-34 | 7.33 | |
| VII-35 | 8.54 | |
| VII-37 | 10.69 | |
| VII-39 | 12.02 | |
| VII-40 | 13.35 | "$CO_2$ band" |

**20** VIR/IR channels all at 500m spatial resolution

# VIIRS and METIMage Data

## Data volume estimates

**VIIRS ~ 1.7 TB/day**

1012 granules/day (86 seconds of data collection)

SDR Imagery:

5 I-bands (**6400x1536** pixels/granule) +
I-band Ellipsoid + Terrain-corrected Geolocation
16 M-bands (**3200x768** pixels/granule) +
M-band Ellipsoid + Terrain-corrected Geolocation
DNB (**4064x768** pixels/granule)

EDR Imagery:

5 I-bands (**8241x1531** pixels/granule) + Geolocation
6 M-bands (**4121x771** pixels/granule) + Geolocation
NCC (**4121x771** pixels/granule) + Geolocation

**METImage ~250 GB/day**

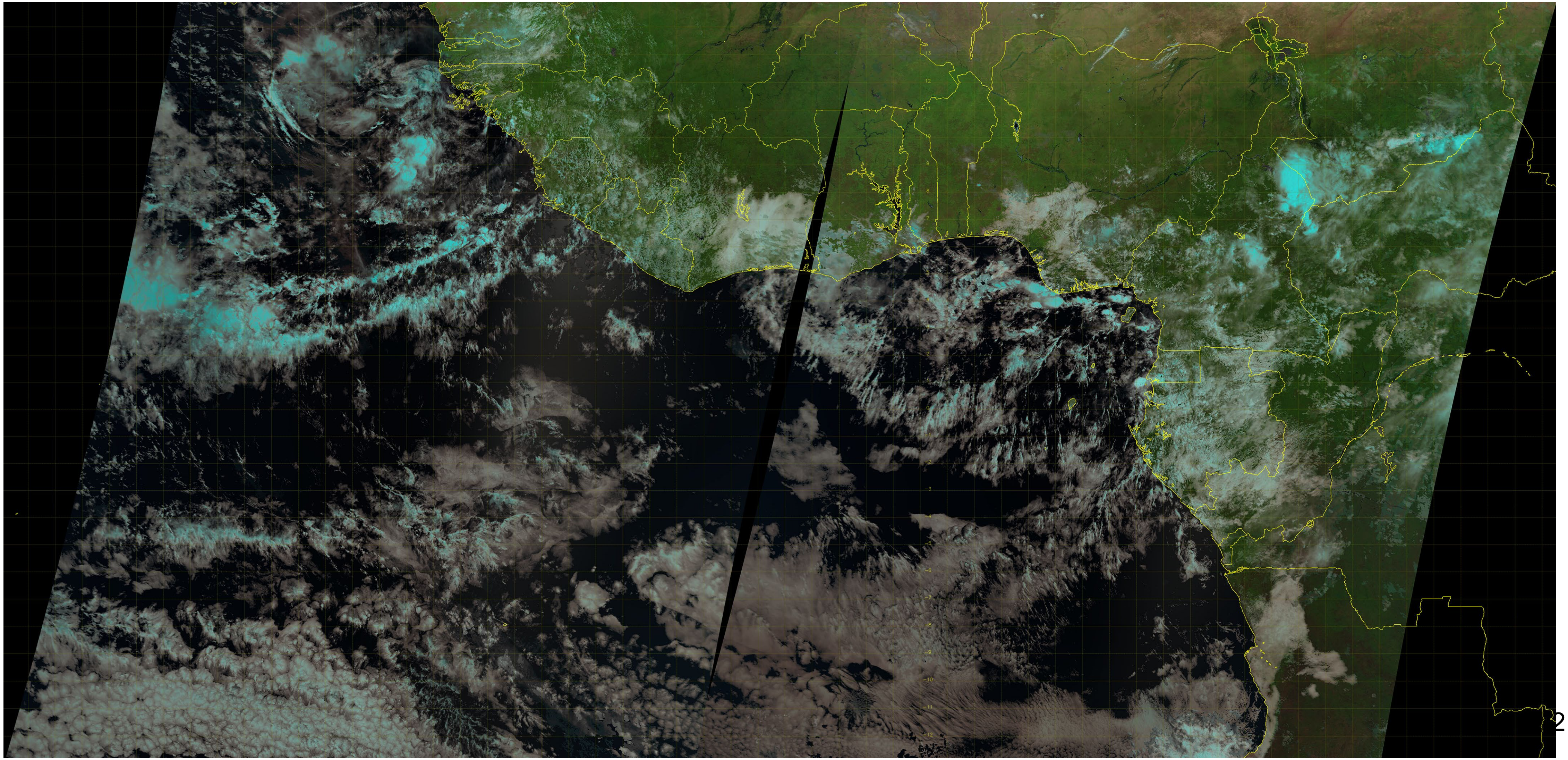
286 granules/day (5 min. 2 sec. of data collection)

20 bands (**4200x3144** pixels/granule) +
Ellipsoid + Terrain-corrected Geolocation

*From MetImage Proxy Data Review*

# METImage Proxy Data Review (2)

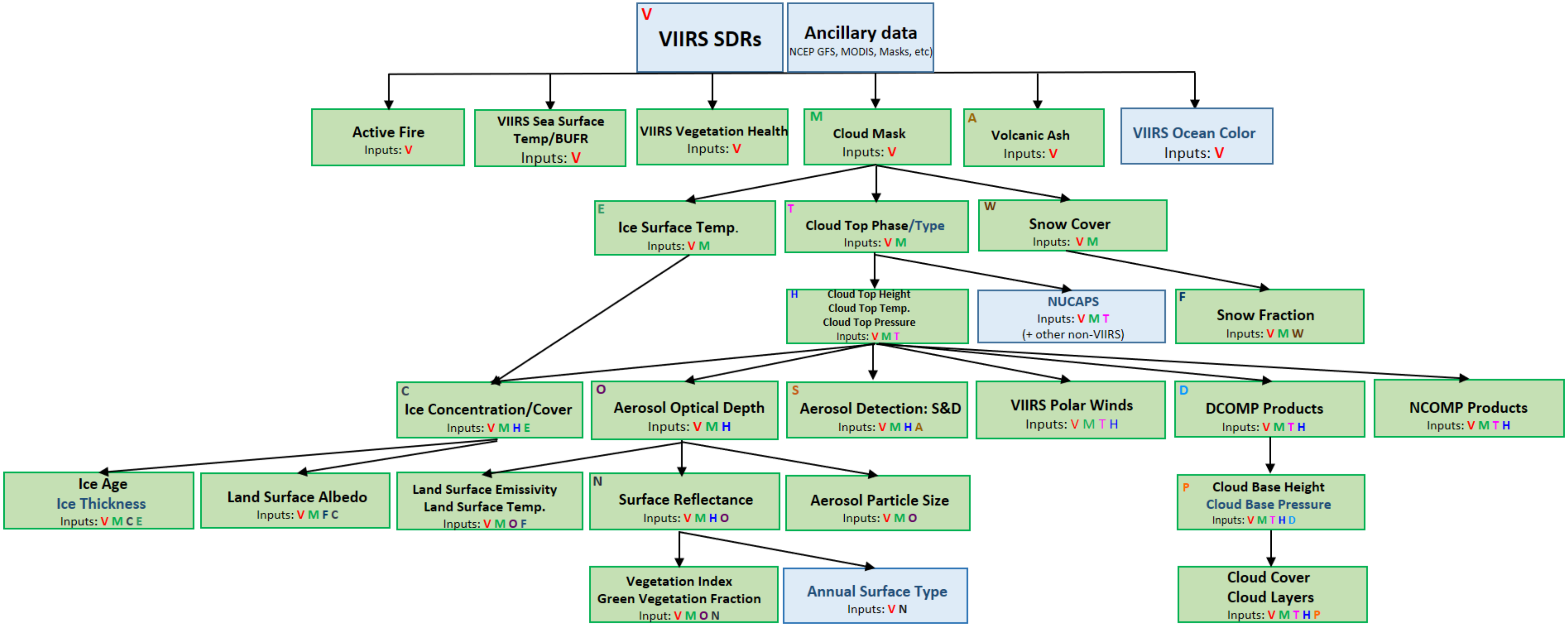
METImage simulated data (2007/09/12) shows that data gaps will exist near the Equator



# JPSS/Metop-SG Project

# VIIRS family tree

*Updated 7/5/2019*




***Legend:***

- *Top-left* lettering represents the corresponding data box (e.g. V = VIIRS SDRs)
- **Green shading** = Matches Metop-SG requirements list
- **Blue font** = Specific product not listed at Metop-SG requirements

# Microwave Sounder (MWS)

*Contributions from Liu and Grassotti*

# MWS Inter-comparison with Legacy Sensors

| AMSU / MHS | | | ATMS | | | MWS | | |
|---|---|---|---|---|---|---|---|---|
| Ch. | GHz | Pol. | Ch. | GHz | Pol. | Ch. | GHz | Pol. |
| 1 | 23.8 | QV | 1 | 23.8 | QV | 1 | 23.8 | QV |
| 2 | 31.4 | QV | 2 | 31.4 | QV | 2 | 31.4 | QV |
| 3 | 50.3 | QV | 3 | 50.3 | QH | 3 | 50.3 | QV |
| | | | 4 | 51.76 | QH | | | |
| 4 | 52.8 | QV | 5 | 52.8 | QH | 4 | 52.8 | QV |
| | | | | | | 5 | 53.246 ± 0.08 | QH |
| 5 | 53.595±0.115 | QH | 6 | 53.596±0.115 | QH | 6 | 53.596±0.115 | QH |
| | | | | | | 7 | 53.948 ± 0.081 | QH |
| 6 | 54.4 | QH | 7 | 54.4 | QH | 8 | 54.4 | QH |
| 7 | 54.94 | QV | 8 | 54.94 | QH | 9 | 54.94 | QV |
| 8 | 55.50 | QH | 9 | 55.50 | QH | 10 | 55.50 | QH |
| 9 | 57.290344 | QH | 10 | 57.290344 | QH | 11 | 57.290344 | QH |
| 10 | 57.290344±0.217 | QH | 11 | 57.290344±0.217 | QH | 12 | 57.290344±0.217 | QH |
| 11 | 57.290344 ±0.3222±0.048 | QH | 12 | 57.290344 ±0.3222±0.048 | QH | 13 | 57.290344 ±0.3222±0.048 | QH |
| 12 | 57.290344±0.3222±0.022 | QH | 13 | 57.290344±0.3222±0.022 | QH | 14 | 57.290344±0.3222±0.022 | QH |
| 13 | 57.290344±0.3222±0.010 | QH | 14 | 57.290344±0.3222±0.010 | QH | 15 | 57.290344±0.3222±0.010 | QH |
| 14 | 57.290344±0.3222±0.0045 | QH | 15 | 57.290344±0.3222±0.0045 | QH | 16 | 57.290344±0.3222±0.0045 | QH |
| 15 | 89.0 | QV | | | | | | |
| 16 | 89.0 | QV | 16 | 88.2 | QV | 17 | 89.0 | QV |
| 17 | 157.0 | QV | 17 | 165.5 | QH | 18 | 164-167 | QV |
| 18 | 183.311±1.0 | QH | 22 | 183.311±1.0 | QH | 23 | 183.311±1.0 | QV |
| | | | 21 | 183.31 ± 1.8 | QH | 22 | 183.311±1.8 | QV |
| 19 | 183.311±3.0 | QH | 20 | 183.311±3.0 | QH | 21 | 183.311±3.0 | QV |
| | | | 19 | 183.311±4.5 | QH | 20 | 183.311±4.5 | QV |
| 20 | 191.31 | QV | 18 | 183.311±7.0 | QH | 19 | 183.311±7.0 | QV |
| | | | | | | 24 | 229 | QV |

**22 Channels** (ATMS)

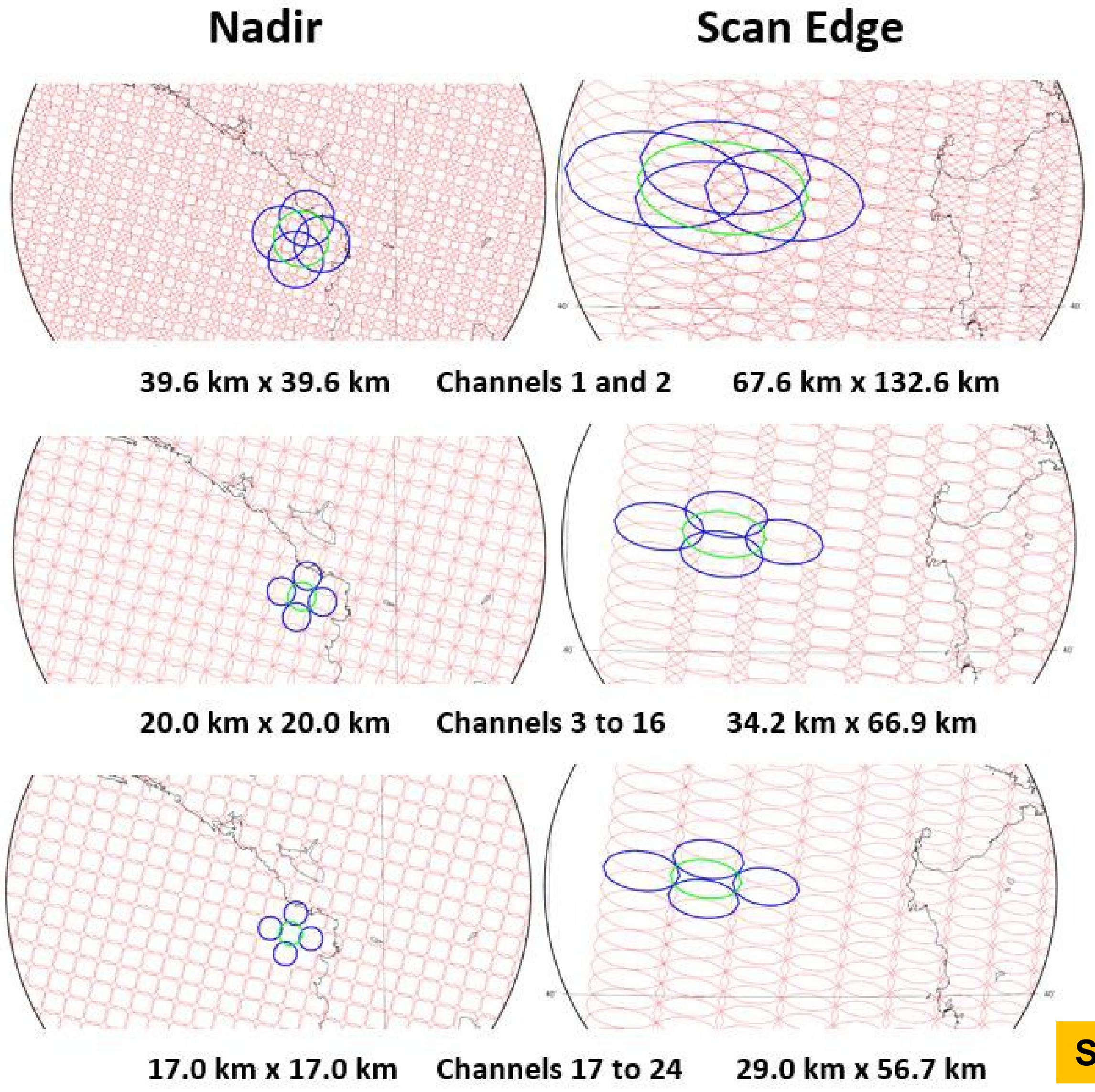
**24 Channels** (MWS)

ATMS ch. 4: 51.76 GHz

- Exact match to AMSU/MHS
- Only Polarization different
- Unique Passband
- Unique Passband, and Pol. different from closest AMSU/MHS channels

*From Christophe Accadia et al. EUMETSAT*
*8th IPWG and 5th IWSSM Joint Workshop, 3-7 October, 2016*

# JPSS/MetOp-SG sensor inter-comparison (ATMS vs. MWS): Scan Geometry




- Both MWS and ATMS are cross-track scanning
- Scan positions: MWS=95, ATMS=96
- Scan angle range: MWS = ±49.31, ATMS = ±52.73
- MWS channels 1 and 2 FOVs are significantly smaller than ATMS; this may preclude the need for resampling/footprint matching

| Channels (MWS) | Nadir resolution (km) | | Edge of scan resolution (km) | |
|---|---|---|---|---|
| | MWS | ATMS | MWS | ATMS |
| 1-2 | 39.6 x 39.6 | 74.8 x 74.8 | 67.6 x132.6 | 141.8 x 323.1 |
| 3-16 | 20.0 x 20.0 | 31.6 x 31.6 | 34.2 x 66.9 | 60.0 x 136.7 |
| 17-24 | 17.0 x 17.0 | 15.8 x 15.8 | 29.0 x 56.7 | 30.0 x 68.4 |

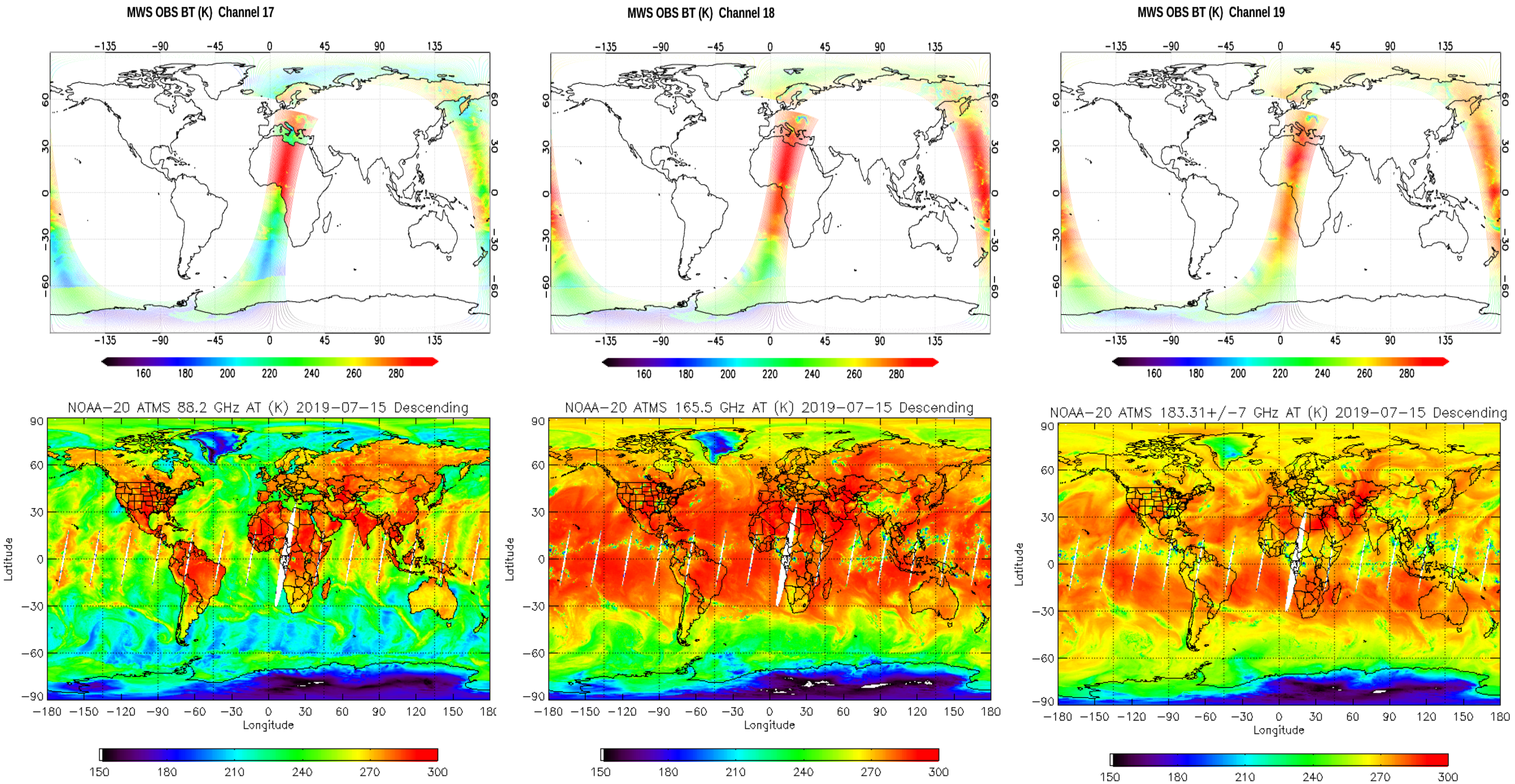
**Source: MWS L1B ATBD**

# MWS Proxy Data review

- Examined the proxy data created by M. Liu from the original EUMETSAT proxy data; new data have the correct channels, polarizations and scan configuration
- MWS TBs are similar to ATMS at corresponding channels

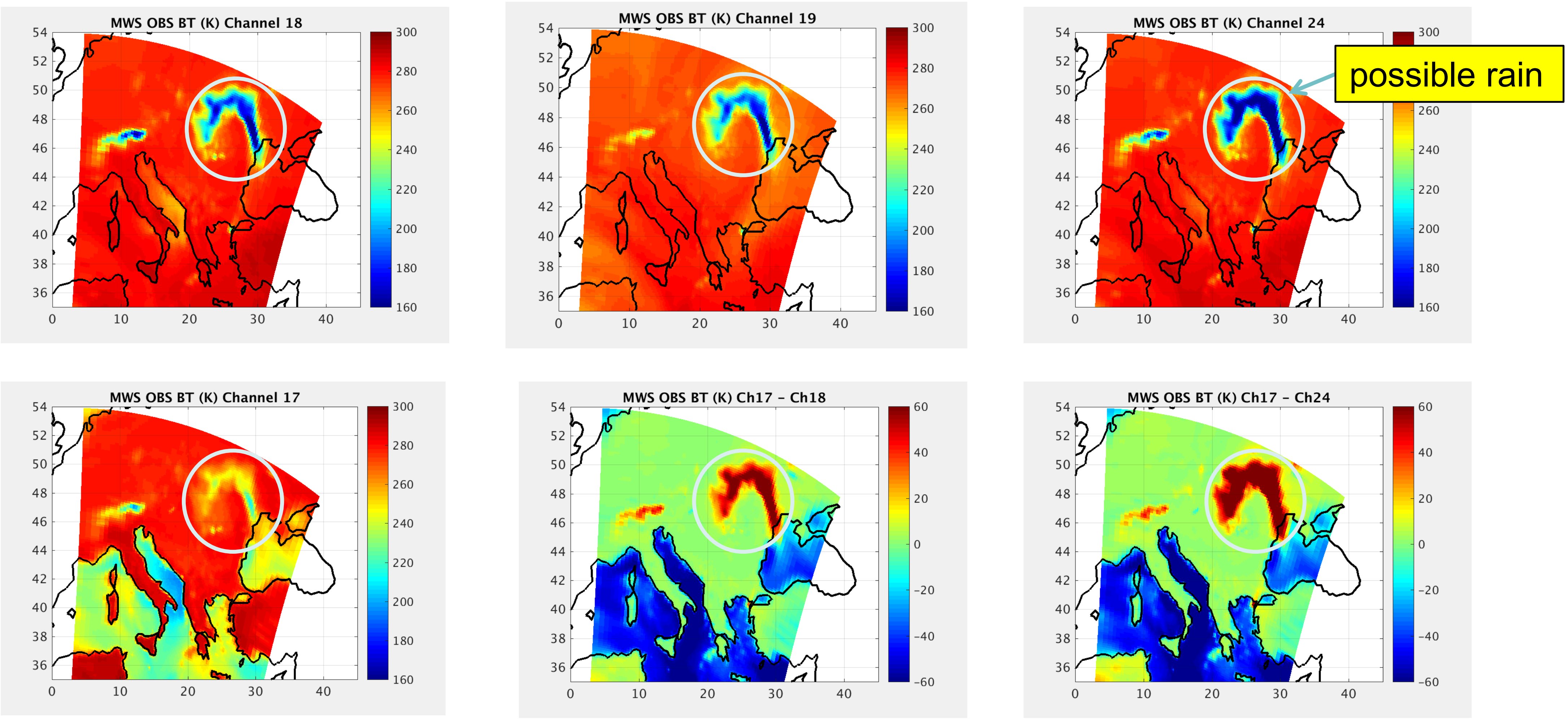
MWS

ATMS



# Proxy Data review – Explore the new 229 GHz channel

- The 229 GHz frequency (channel 24) is sensitive to cloud ice and precipitation
- It appears to have stronger signal than other precipitation-sensitive channels



# NOAA Microwave Integrated Retrieval System (MIRS)

MiRS produces 11 official operational products. Products derived from ATMS are validated according to JPSS requirements (JERD, JPSS-REQ-1004). Based on assessment of ATBD and other documentation, similarity of MWS with ATMS (see following slides) and other legacy sensors should allow MiRS MWS retrieval performance to meet JPSS requirements.

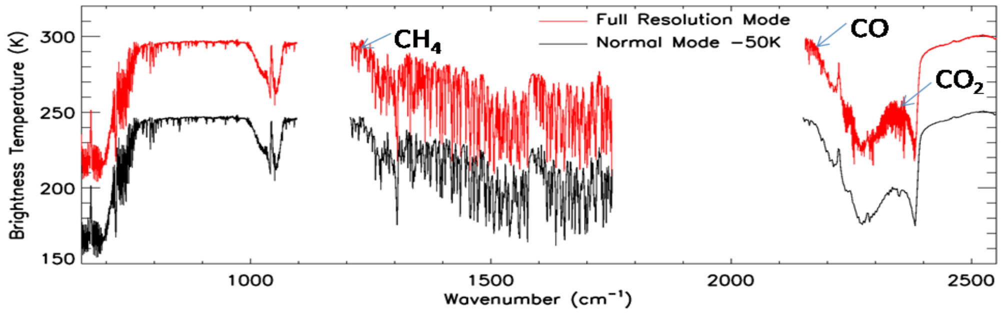
| Observational Parameter | Imagery Product | Sounding Product | Core or Derived Product |
|---|---|---|---|
| Atmospheric Temperature profile (T) | | X | Core |
| Atmospheric Water Vapor profile (Q) | | X | Core |
| Total Precipitable Water (TPW) | X | | Derived from retrieved profile |
| Land Surface Temperature (LST) | X | | Core |
| Surface Emissivity Spectrum (Em) | X | | Core |
| Sea-ice Concentration (SIC) | X | | Derived from emissivity |
| Snow Cover Extent (SCE) | X | | Derived from emissivity |
| Snow-Water Equivalent (SWE) | X | | Derived from emissivity |
| Integrated Cloud Liquid Water (CLW) | X | | Derived from retrieved cloud profile |
| Rainfall Rate (RR) | X | | Derived from CLW, IWP, RWP |
| Snowfall Rate (SFR) | X | | External algorithm |

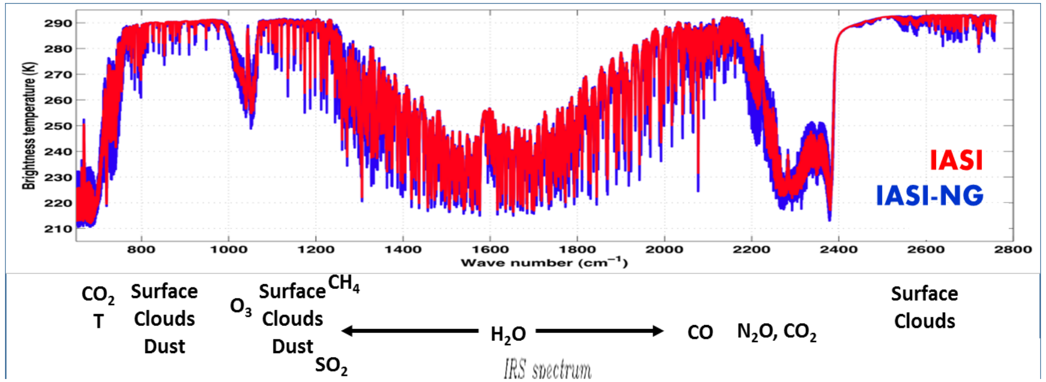
# Infrared Atmospheric Sounding Interferometer-Next Generation (IASI-NG)

*Contributions from Iturbide-Sanchez, Divakarla*

# JPSS/MetOp-SG sensor Inter-comparison

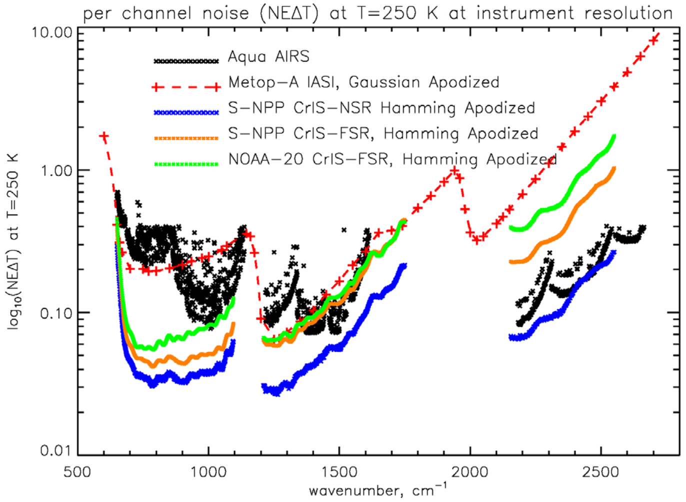
## IASI-NG vs. IASI and CrIS

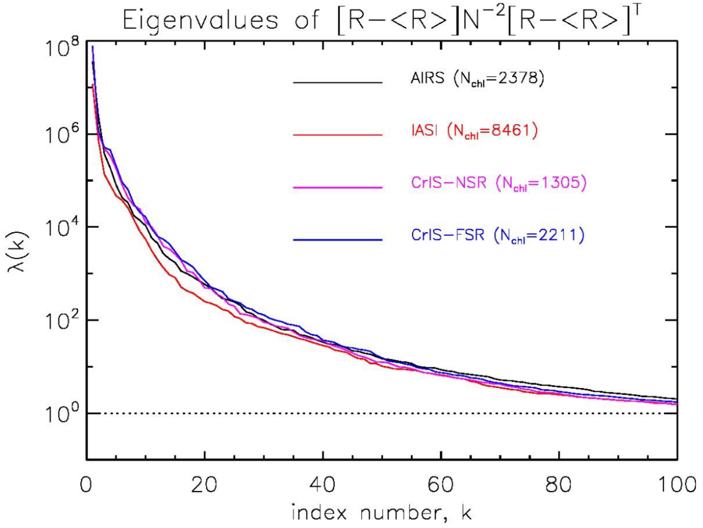



| | CrIS | IASI | IASI-NG |
|---|---|---|---|
| Spectral Range And Spectral Resolution | 650-1095, 1210-1750, 2155-2550 cm-1 0.625 cm-1 | 645-2760 cm-1 0.625 cm-1 | 645-2760 cm-1 0.125 cm-1 |
| **FOV Footprint** | **14 Km at Nadir** | **12 Km at Nadir** | **12 Km at Nadir** |
| Number of FOVS for Field of Regard (FOR) Retrieval | 3 x 3 | 2 x 2 | 4 x 4 |
| **Number of Channels** | **2211** | **8461** | **16,821** |

- With the increase in spectral resolution combined with reduced radiometric noise at least by a factor of 2 compared to IASI
- IASI-NG should be able to retrieve some additional trace gas products, and with a slightly improved accuracy than CrIS/IASI
- At a minimum, IASI-NG would produce products at least with comparable accuracy to CrIS and IASI.




The 1st 100 significant Eigen v actors from the operational NUCAPS regression training.

# The NOAA Unique Combined Atmospheric Processing System (NUCAPS)

**The NOAA Unique Combined Atmospheric Processing System (NUCAPS)** is the NOAA operational hyper-spectral sounding product system to derive hyper-spectral radiance products, vertical profiles of temperature, water vapor, ozone, and six trace gas products (CO, CH4, CO2, Volcanic SO2, HNO3 and N2O). The algorithm has the heritage from the AIRS Science Team algorithm.

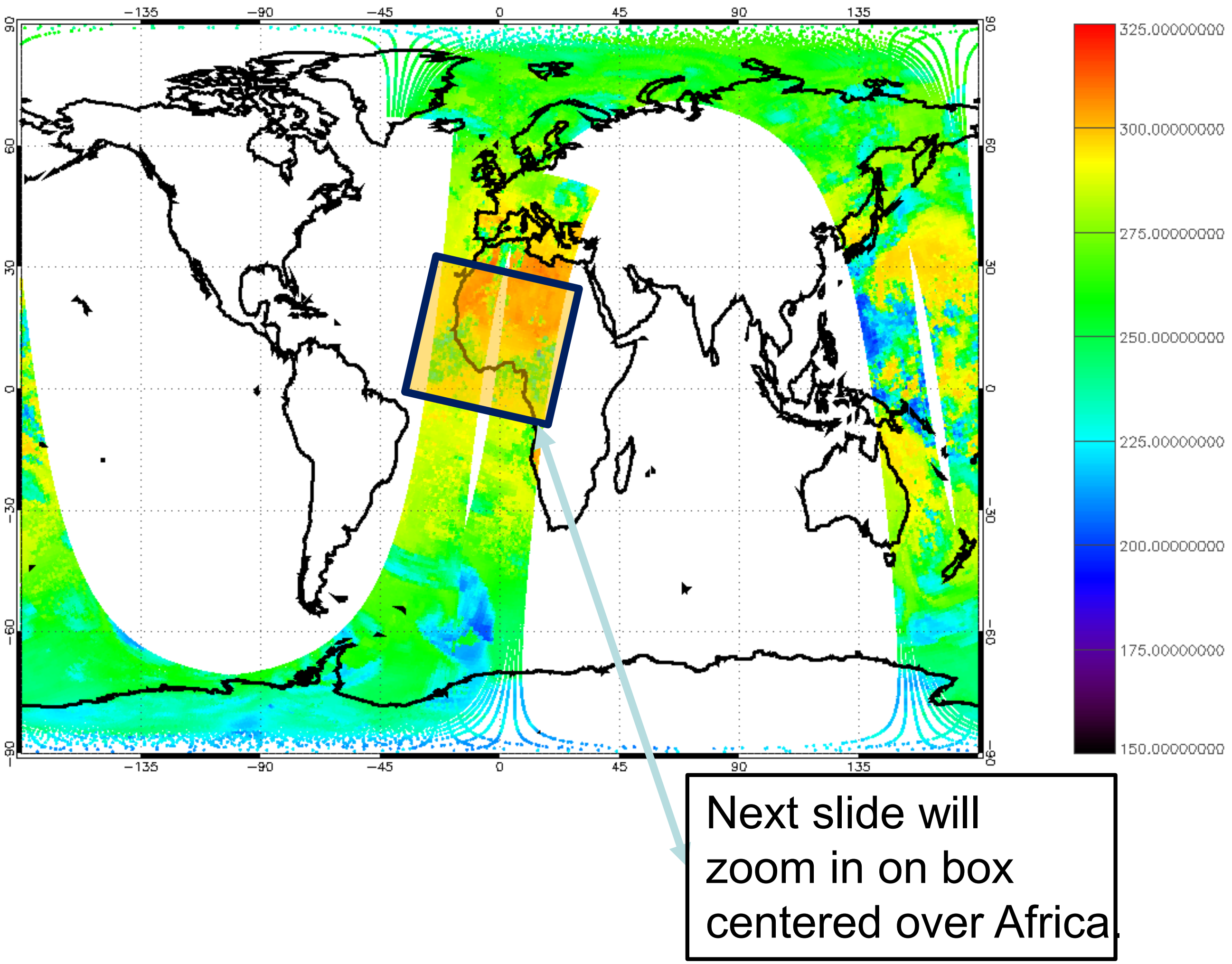
- NUCAPS runs within the Hyper-Spectral Enterprise Algorithm Package (HEAP) to operationally generate retrieval products from hyperspectral infrared instruments. Microwave sounder data are used to produce initial guess for the hyper-spectral IR sounding retrievals.
- NOAA/NESDIS/STAR has been operationally running NUCAPS since 2009 and distributing NUCAPS products in near real time to the science community through CLASS.
- NUCAPS has been operationally running on the CSPP/Direct Broadcast (DB) network producing near real time products for many regional applications.

# IASI-NG Usage at NOAA

- We will use NOAA Unique Combined Atmospheric Processing System (NUCAPS) to generate NOAA products
  - NUCAPS retrievals are sent to forecast offices on NWS systems

# Proxy Data Evaluation

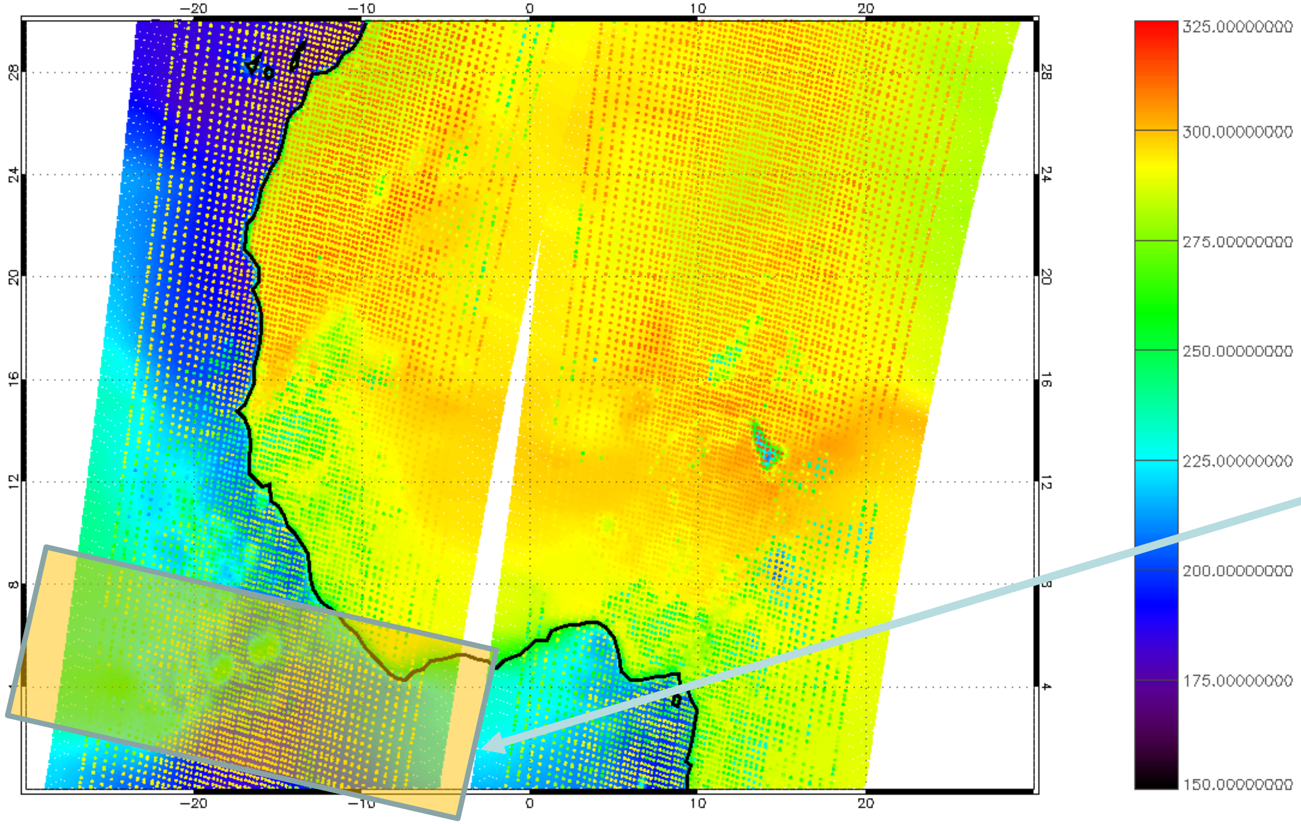
## EUMETSAT - IASI Simulated Orbits




- Each granule contains 16921 wave numbers, incrementing at a rate of 0.125 m-1.
- IASI data is provided in 4x4 clusters (16 FOVs) for each FOR.
- There are 14 clusters per row, and up to 10 rows per granule.
- There are approximately 35-40 granules per orbit.
- The distance across near the equator is approximately 2100 km. This leads to an average resolution of 37.5 km, but it is unevenly spaced.

# Proxy Data Evaluation

## EUMETSAT – IASI/MWS Overlay




- Zoom-in on two orbits: MWS with IASI overlay
- MWS CH #1/IR 900 cm-1
- September 12, 2007
- Dots are individual IASI simulated retrievals
- Next slide will focus on this area.

# Microwave Imager (MWI)

*Contributions from Ferraro*

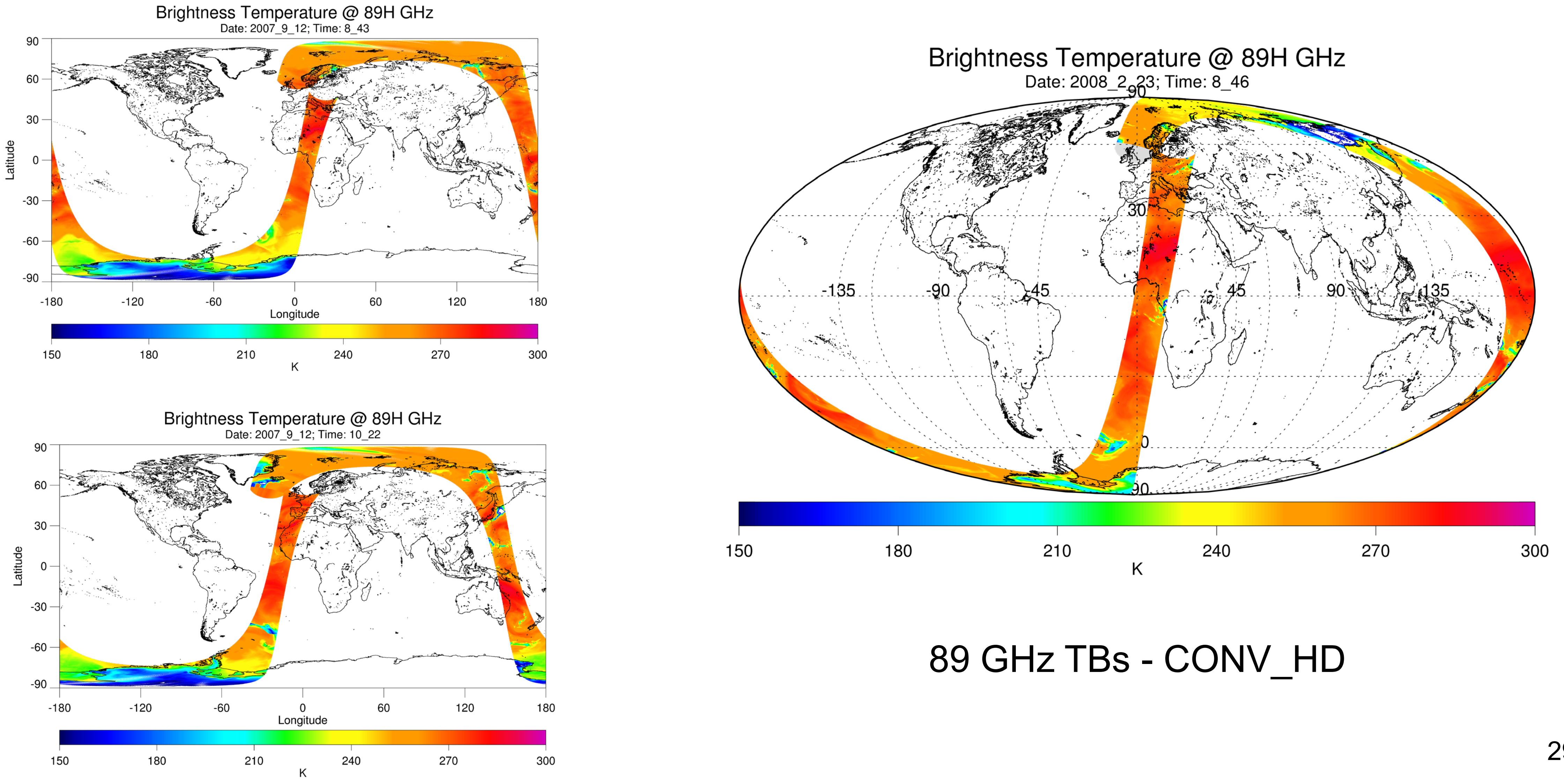
# AMSR-2 and MWI sensor inter-comparison – Geometry

| Property | AMSR2 | EPS-SG |
|---|---|---|
| Swath width [km] | 1450 km | 1650 km |
| # of pixels per scan | 486 @ high-freq. | 630 |
| Altitude | ~705 km | ~835 km |
| Sampling | Along track: ~ 10 km<br>Along scan: ~ 5 – 10 km | Along track: ~ 8.5 km<br>Along scan: ~ 3.3 km |
| FOV size [km] | 5 – 60 km | 10 – 50 km |
| Antenna size [cm] | 200 cm | 75 cm |
| Active portion of the scan | +/-61 deg | +/-65 deg |
| Observation Zenith Angle | 55 deg | 53 +/-2 deg |
| # of channels and freq. | 14 (7 – 89 GHz) | 26 (18 – 183 GHz) |
| Antenna rotation rate | 40 rpm | 45 rpm |
| Inclination | 98 deg | Similar |
| Local obs time | 1:30 am/pm | 9:30 am/pm |

# MWI sensor Channels

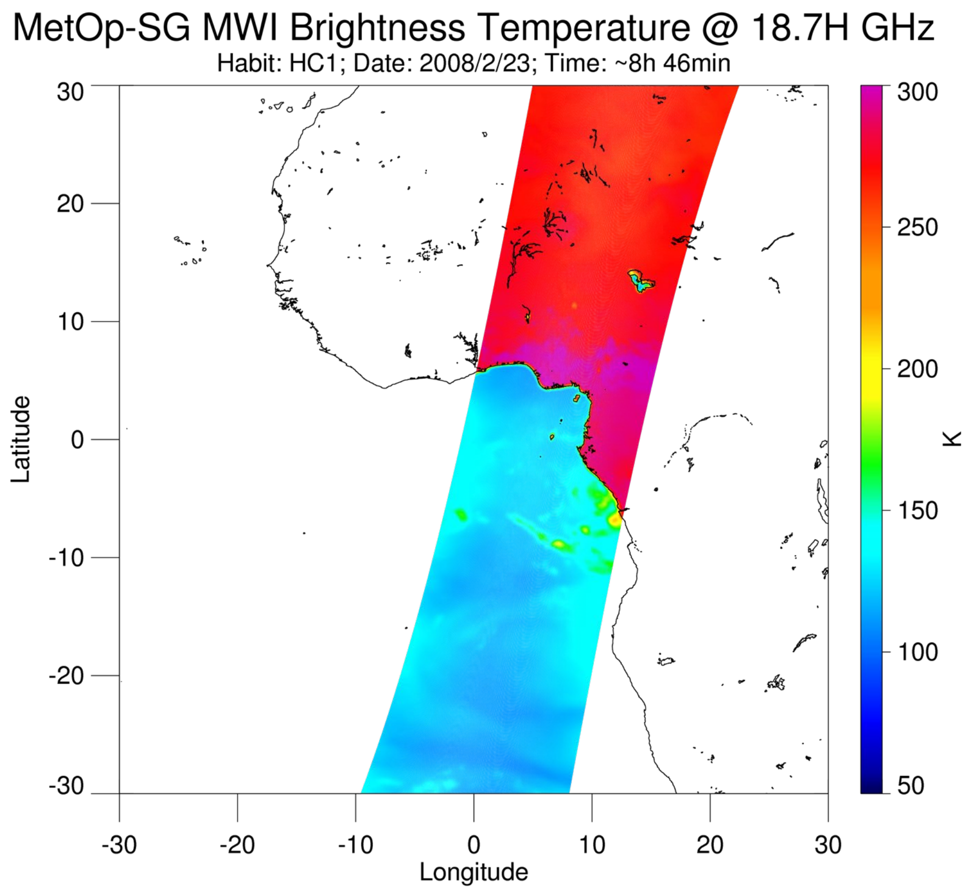
| Channel No | Frequency (GHz) | Bandwidth (MHz) | Utilization | NEΔT (K) | Footprint (km) |
|---|---|---|---|---|---|
| MWI-1 | 18.7 | 200 | Precipitation over sea | 0.8 | 50 |
| MWI-2 | 23.8 | 400 | Total column water vapor over sea | 0.7 | |
| MWI-3 | 31.4 | 200 | Precipitation over sea and (marginally) land | 0.9 | |
| MWI-4 | 50.3 | 400 | Precipitation over sea and land including drizzle, snowfall, height and depth of the melting layer | 1.1 | |
| MWI-5 | 52.61 | 400 | | | 30 |
| MWI-6 | 53.24 | 400 | | | |
| MWI-7 | 53.75 | 400 | | | |
| MWI-8 | 89 | 4000 | Precipitation (sea & land) & snowfall | 1.1 | |
| MWI-9* | 118.7503±3.2 | 2 x 500 | Precipitation over sea and land including light precipitation and snowfall, height and depth of the melting layer | 1.3 | |
| MWI-10* | 118.7503±2.1 | 2 x 400 | | | |
| MWI-11* | 118.7503±1.4 | 2 x 400 | | | |
| MWI-12* | 118.7503±1.2 | 2 x 400 | | | |
| MWI-13* | 165.5±0.725 | 2 x 1350 | Quasi-window, water-vapor profile, precipitation over land, snowfall | 1.2 | 10 |
| MWI-14* | 183.31±8.4 | 2 x 2000 | | 1.3 | |
| MWI-15* | 183.31±6.1 | 2 x 1500 | | 1.2 | |
| MWI-16* | 183.31±4.9 | 2 x 1500 | Water vapor profile and snowfall | 1.2 | |
| MWI-17* | 183.31±3.4 | 2 x 1500 | | 1.2 | |
| MWI-18* | 183.31±2.0 | 2 x 1500 | | 1.3 | |

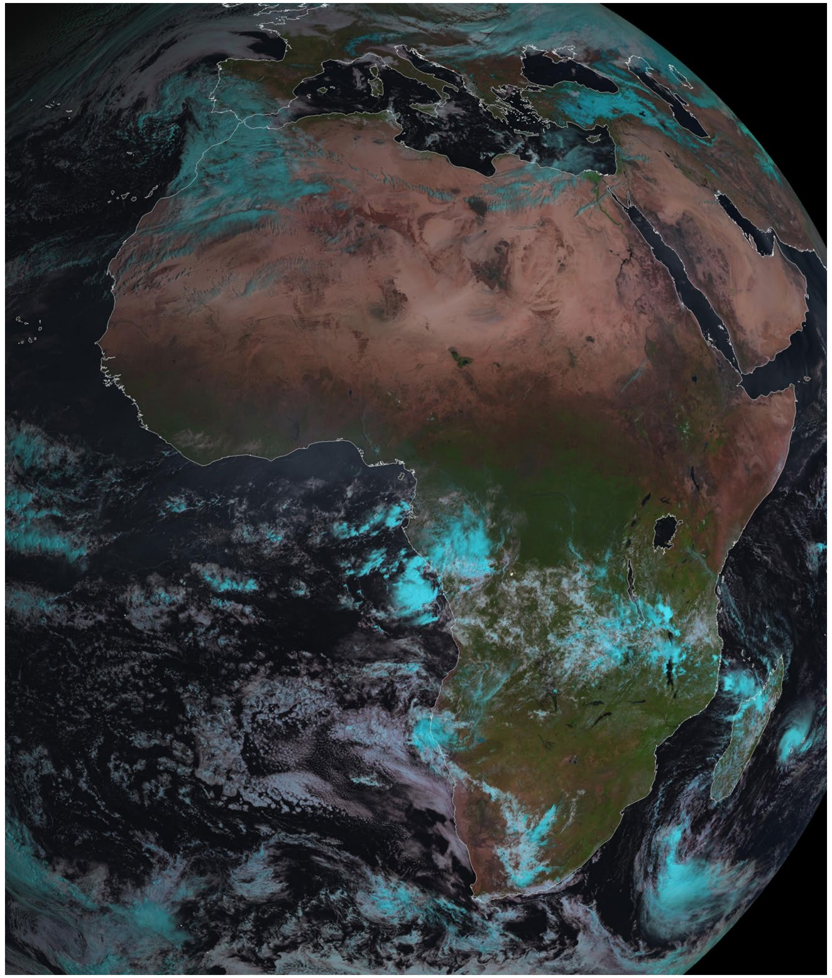
# Proxy Data review – three orbits TBs at 89 GHz




89 GHz TBs - CONV_HD

# Proxy Data review – 18 GHz H-pol and MSG2-SEVIRI



# MWI Product Development at STAR

- Most of the legacy enterprise algorithms (currently used for AMRS2 instrument) can be reused for MetOp-SG.
- Sampling will need to be addressed in order to meet JPSS products accuracy.
  - Level-1R may be required
- Some sensor-specific technical modifications will be required (e.g., creating new database for Precipitation Retrieval).
- AMSR2 channels at 6, 7, and 10 GHz (both V and H) are not present at EPS-SG MWI.
  - These channels are primarily used for Wind Speed, Soil Moisture and SST products but also contribute to sea ice concentration, wind speed, and rainfall retrievals.
  - While precipitation products should be able to compensate the lack of information content by relying on the available channels (18 GHz through 89 GHz), SST retrieval may see some challenges, and retrievals of Sea Surface Wind Speed and Soil Moisture are likely to be jeopardized.

# Sentinel 5/UVNS

*Contributions from Kondragunta*

# Sentinel 5 UVNS Sensor Characteristics

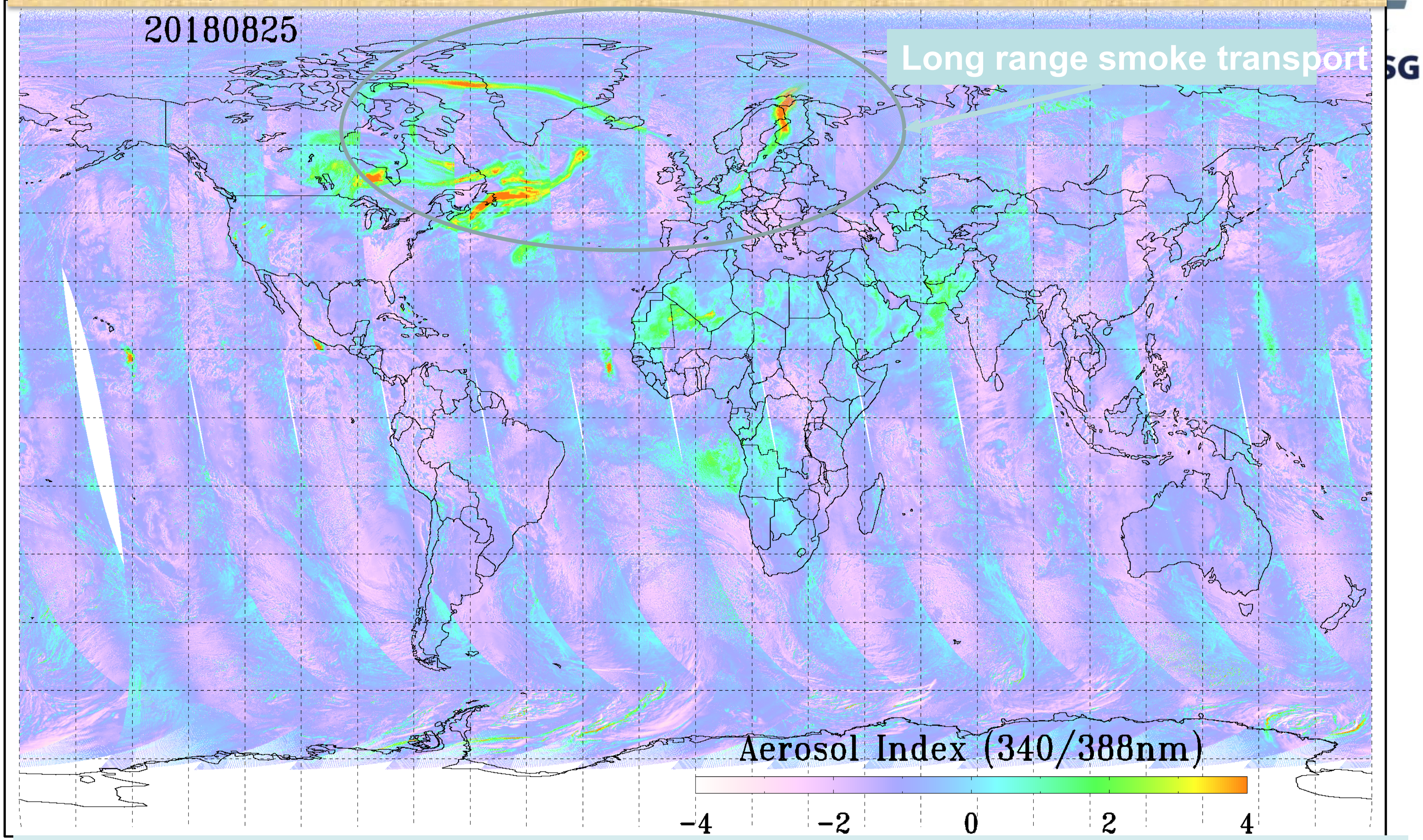
- Configuration: Push broom staring (non-scanning) in nadir viewing
- Swath width: 2 670 km
- Spatial sampling: 50x50 $km^2$(UV1), 7.5x7.5 $km^2$ (all other channels),
- Spectral: 5 spectrometers (1 in UV1, 1 in UV2VIS, 1 in NIR, 2 in SWIR)

- Sentinel 5P (Precursor) – TROPOMI currently flying in the same orbit as SNPP
- STAR routinely receives TROPOMI products and use them for air quality monitoring

# Reusability of JPSS (or legacy) enterprise algorithms for MetOp-SG

- Several S5/UVNS products such as Ozone can be readily used by NESDIS
  - Aerosol Detection algorithm has been already applied to S5P TROPOMI (*See Ciren, Kondragunta, Loyola presentation at the JSC meeting in Boston*). This can be transitioned to TROPOMI. There is no official product from EUMETSAT or ESA. DLR has expressed interest in running our algorithm
  - Aerosol Index is derived as part of Aerosol Detection algorithm
  - New products from EUMETSAT that NOAA can use
    - CO (no heritage; CrIS is IR sounder)
    - Formaldehyde (no heritage; OMPS has some minimal capability)
    - Sulfur dioxide (no heritage; OMPS has some minimal capability)
    - Aerosol Layer Height (no heritage)

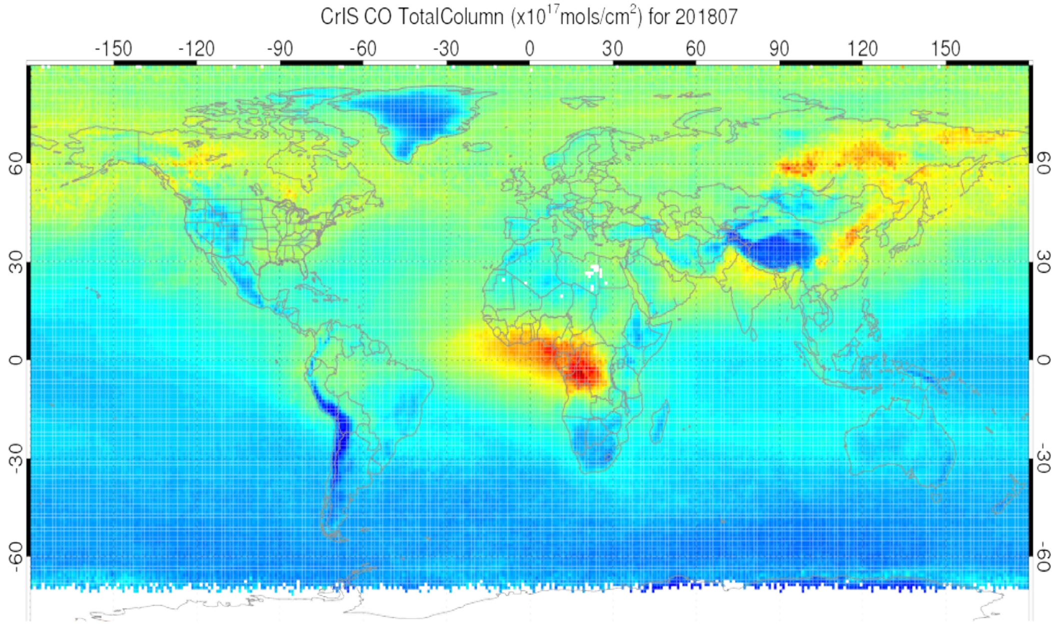
# Operational TROPOMI UV Aerosol Index



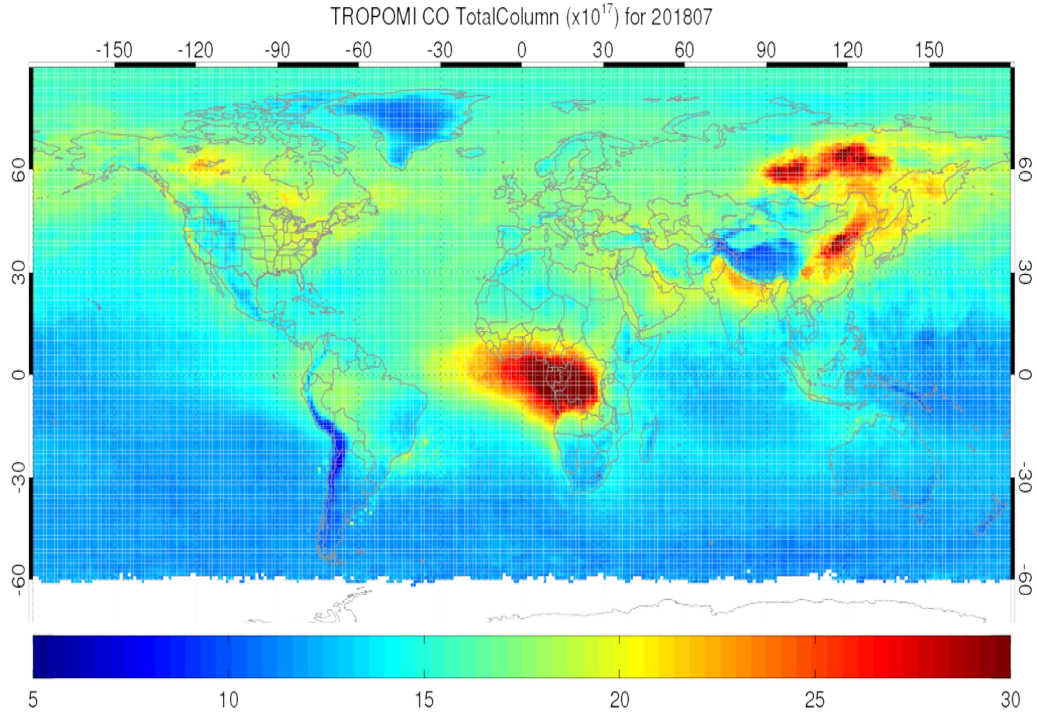

- High value of TOPOMI UV Aerosol Index is associated with the presence of absorbing aerosol
- It works over bright surface, such as snow/ice and clouds, however, it is not able to differentiate between Smoke and dust.

# TROPOMI Examples

SNPP NUCAPS CO COLUMN




TROPOMI CO COLUMN




STAR has gained tremendous experience in exploiting and using TROPOMI.

We will be using several EUMETSAT/ESA S5P products from day 1 after MetOP-SG launch

# 3MI: Multi-viewing, Multi-channel, Multi-polarization Imager

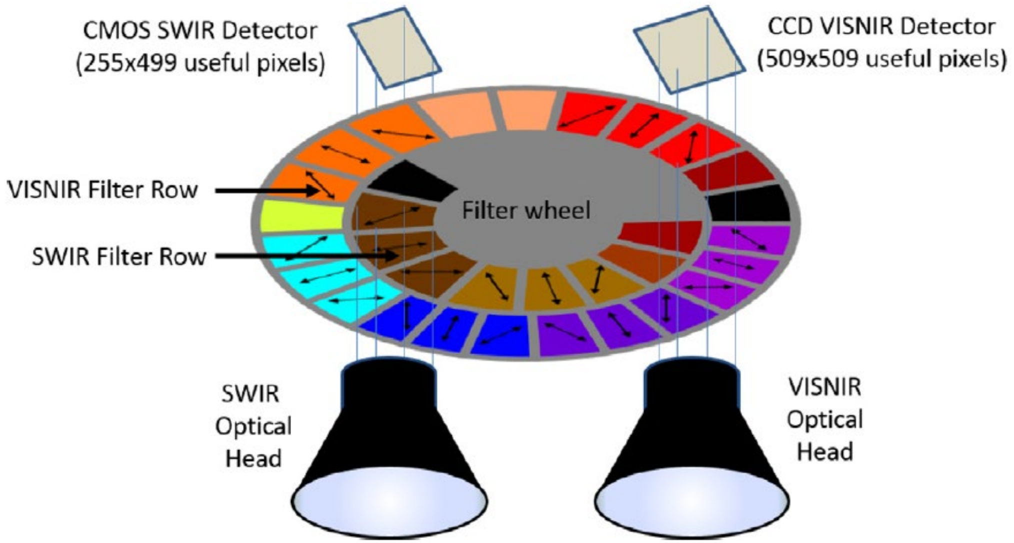
Credit: ESA

*Contributions from Laszlo*

# 3MI: Multi-viewing, Multi-channel, Multi-polarization Imager

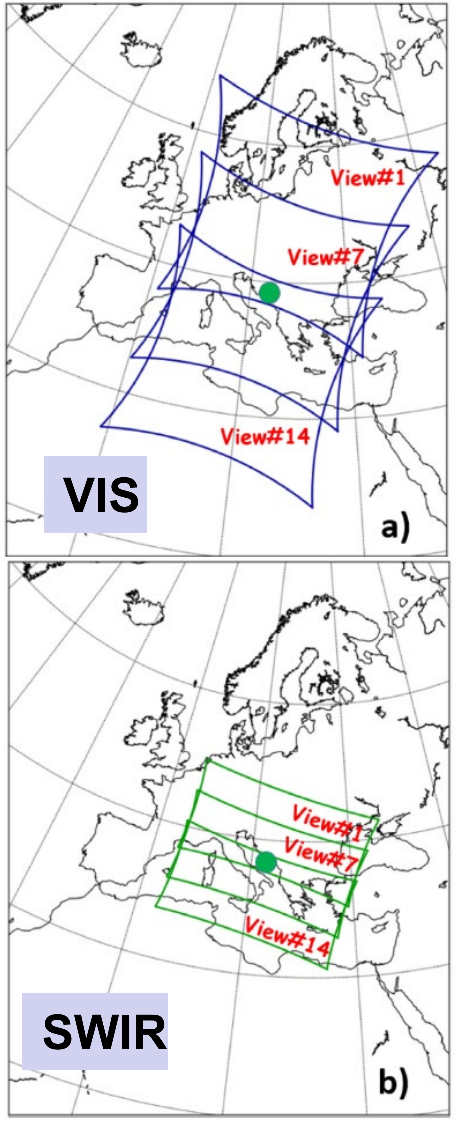
- Wide instantaneous field of view (IFOV)
  - VNIR: 2200 ×2200 km² across-track (ACT) x along-track (ALT)
  - SWIR: 2200 ×1100 km² ACTxALT
- Spatial resolution: 4 km
  - Grows to 5.5 km at the border and 9 km at the corner of the VNIR footprint.
- Data acquisition per band: every 22 s (VNIR), 11 s (SWIR).
- Number of angles: 14 (VNIR), 28 (SWIR)
  - Separation angle 9° (VNIR), 4.5° (SWIR)
- Heritage - POLDER

Multi Channel



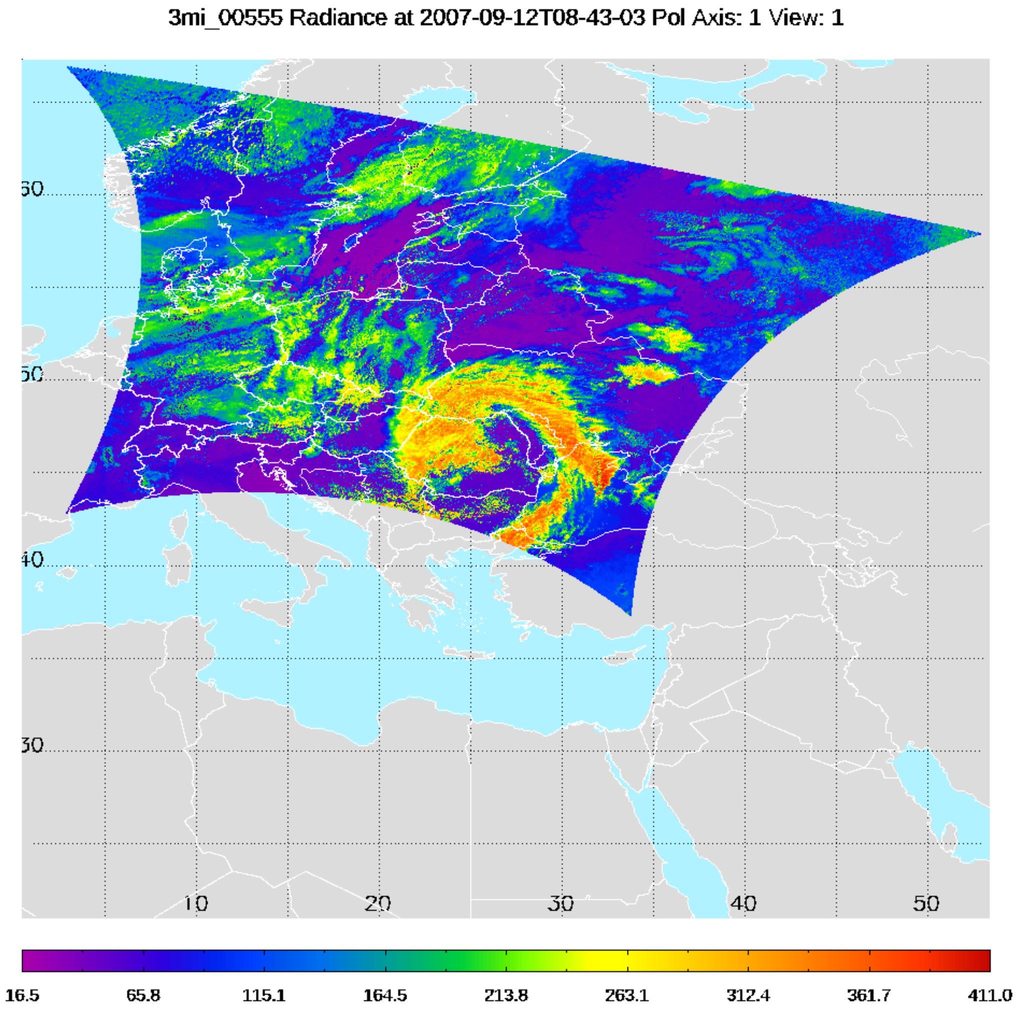

Multi Polarization: 3 polarizers at -60°, 0° + 60°
Multi-spectral (from 410 to 2130 nm)
Multi-angular (14 views)

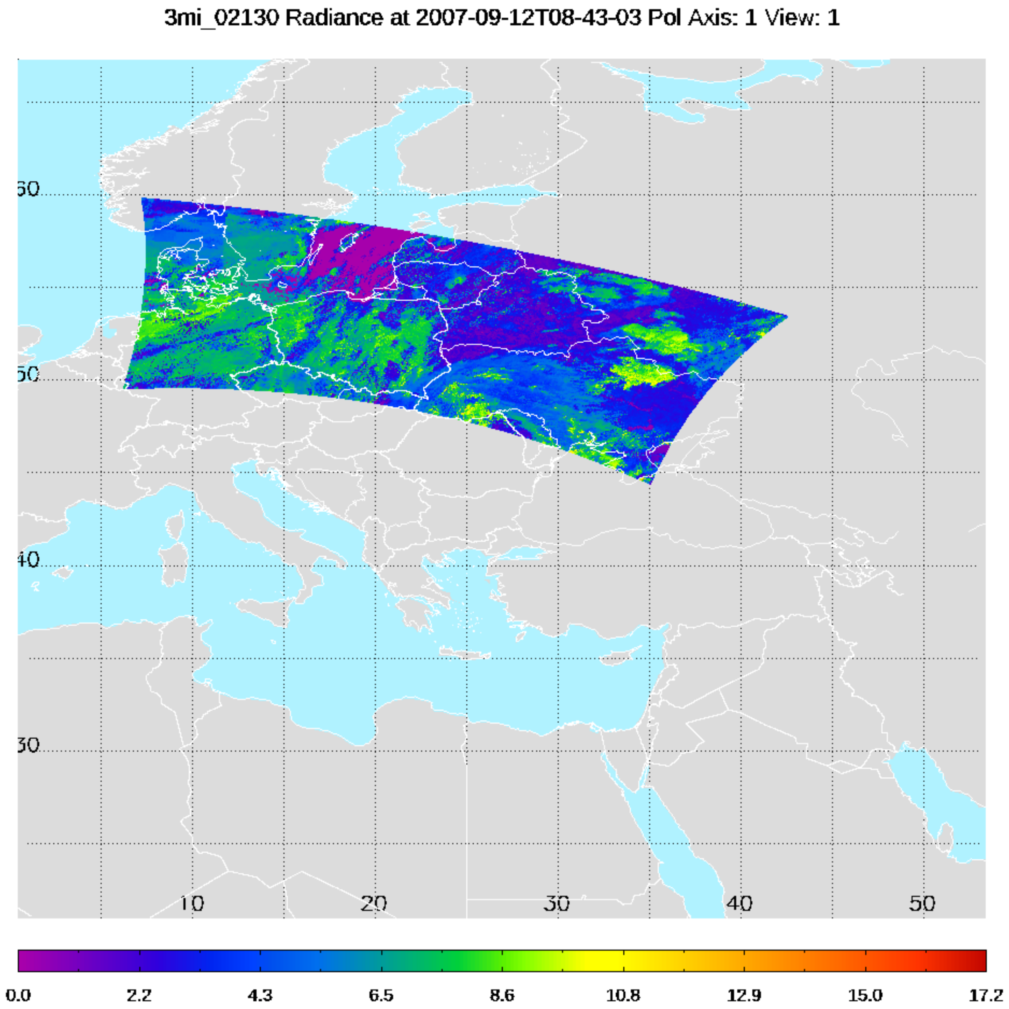
Multi Viewing



# Proxy Data review – 3MI - Example

555-nm VISNIR (left) and 2130-nm SWIR (right) radiance (W $m^{-2}$ $sr^{-1}$ $\mu m^{-1}$) in Polarization Axis 1 (*I*)

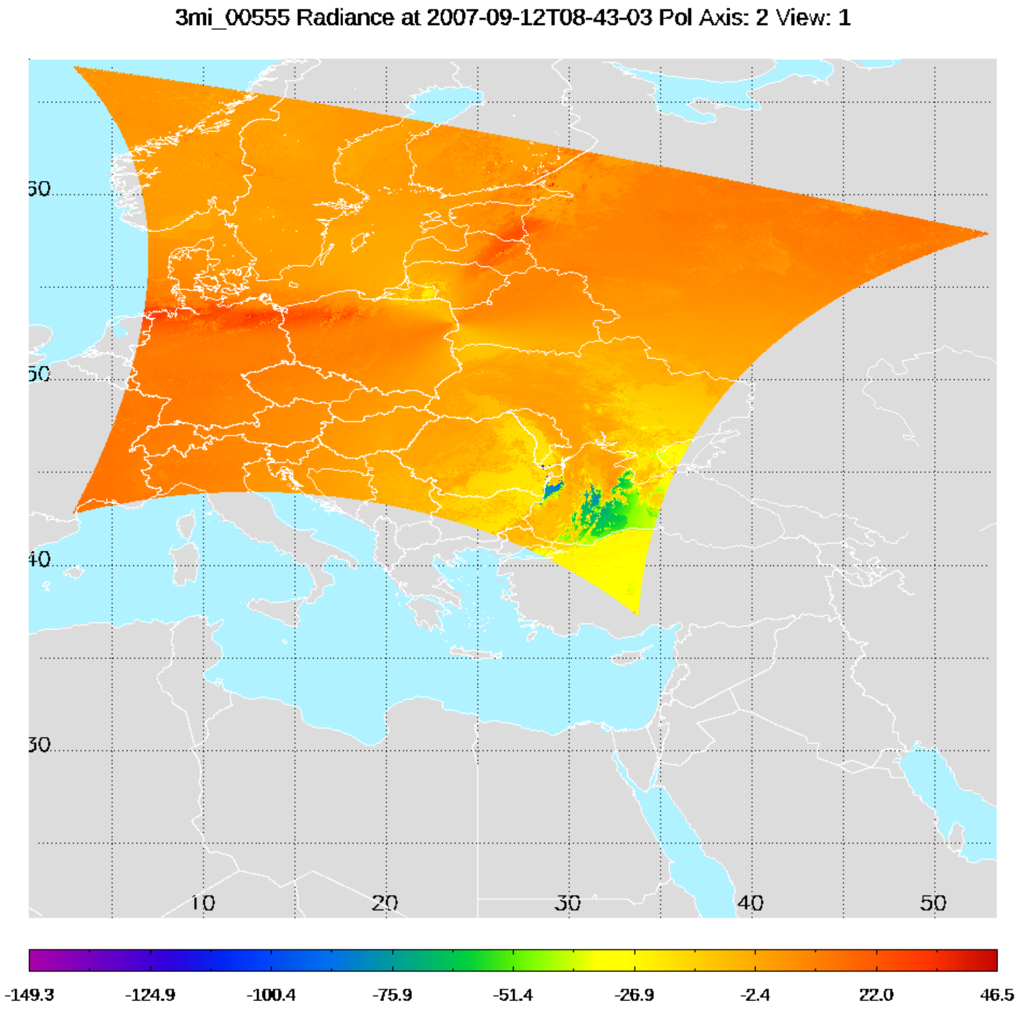


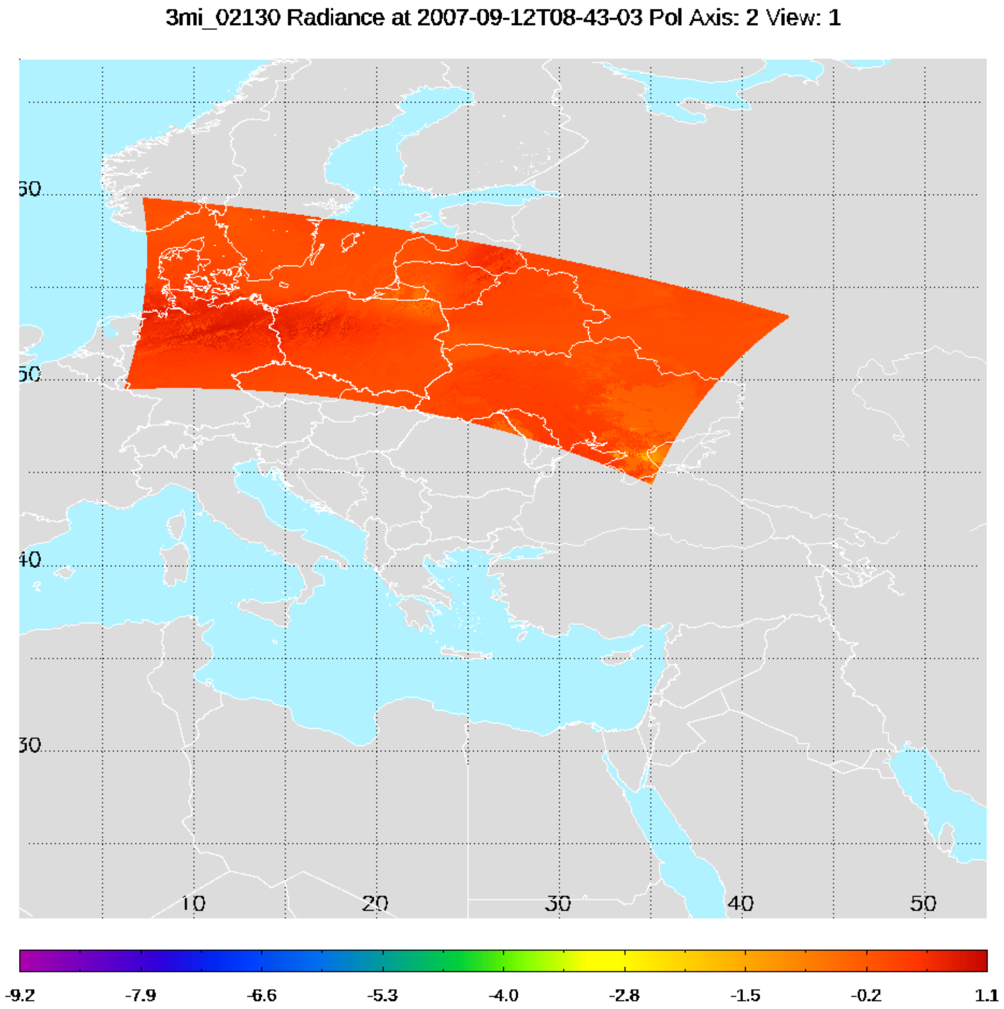




Plot by H. Liu

# Proxy Data review – 3MI - Example

555-nm VISNIR (left) and 2130-nm SWIR (right) radiance (W $m^{-2}$ $sr^{-1}$ $\mu m^{-1}$) in Polarization Axis 2 (Q)

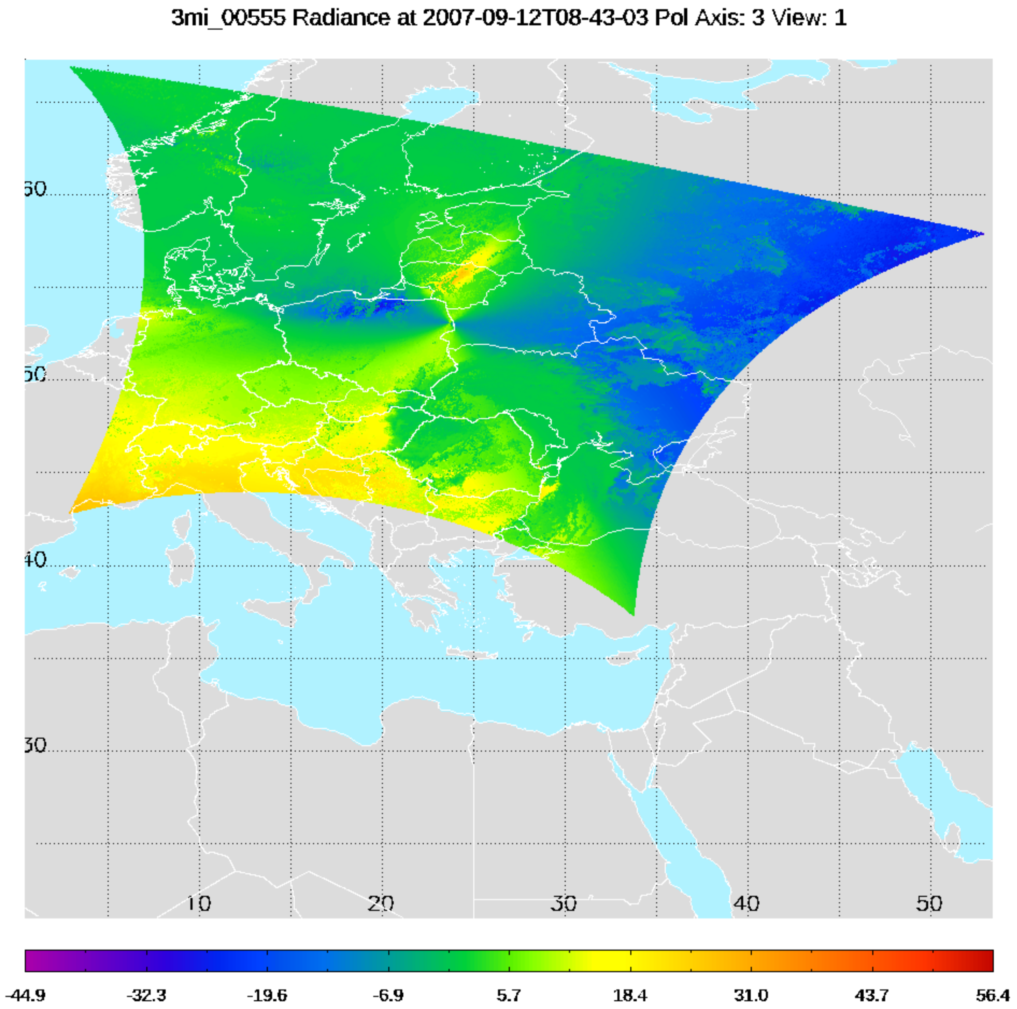


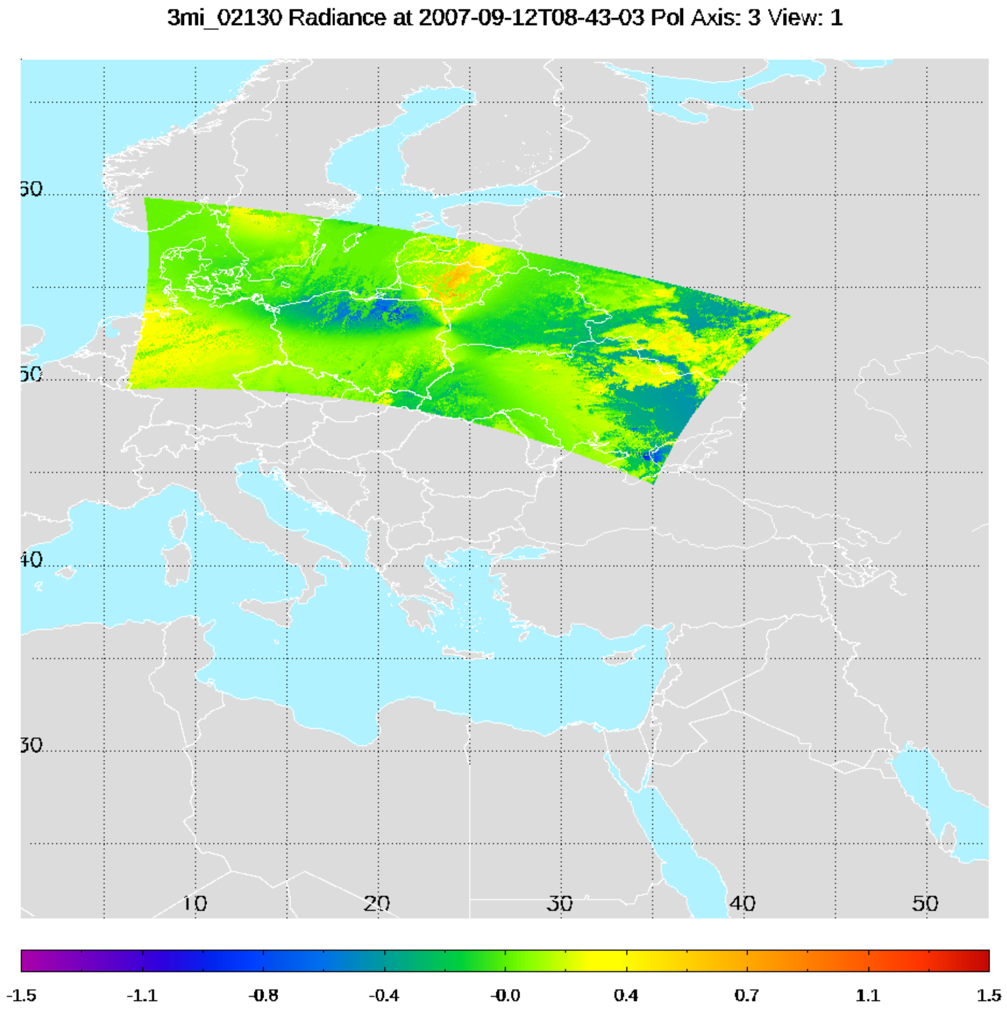




Plot by H. Liu

# Proxy Data review – 3MI - Example

555-nm VISNIR (left) and 2130-nm SWIR (right) radiance (W m$^{-2}$ sr$^{-1}$ μm$^{-1}$) in Polarization Axis 3 (*U*)




Plot by H. Liu

# 3MI Products from ESA

- Aerosol optical depths for accumulation, coarse and total modes at high horizontal resolution.
- Aerosol particle size for accumulation, coarse and total modes.
- Aerosol type through Ångström exponent, refractive index, non-sphericity index.
- Aerosol height index.
- Aerosol absorption
- Products from EUMETSAT can be readily used by NOAA by N42

# Questions/Discussion