Introducing METImage: EUMETSAT's next generation polar imager on METOP-SG

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Outline

- Background
- METImage Instrument characteristics
- Expected METImage performance
  - Radiometric
  - Spectral
  - Geospatial
- Simulated METImage data
- Q&A

Background-1

- Metop will end in the 2020 time frame, followed by the Metop-SG in the mid-morning orbit.
- NOAA and EUMETSAT agreed to establish the Joint Polar System to provide long-term continuity of observations from polar orbit supporting operational meteorology, oceanography, atmospheric chemistry, and climate monitoring including additional environmental services to support meteorology, hydrology, and land surface processes.
- The Metop SG is a cooperation between EUMETSAT and the European Space Agency (ESA). EUMETSAT will be responsible for the development and operation of the related Metop-SG ground segment to control and monitor the satellite and its data and to process data up to level 1. The operational processing of level 1 data to higher levels will be done either at the Metop SG ground segment or in the SAFs.
- The Metop-SG satellites will carry payloads primarily dedicated to operational meteorology and climate monitoring. Secondary goal includes operational oceanography and environmental services. In addition, Metop SG will contribute to research, including global change, atmospheric chemistry and physics, hydrology, oceanic research, and the study of the cryosphere.

Background-2

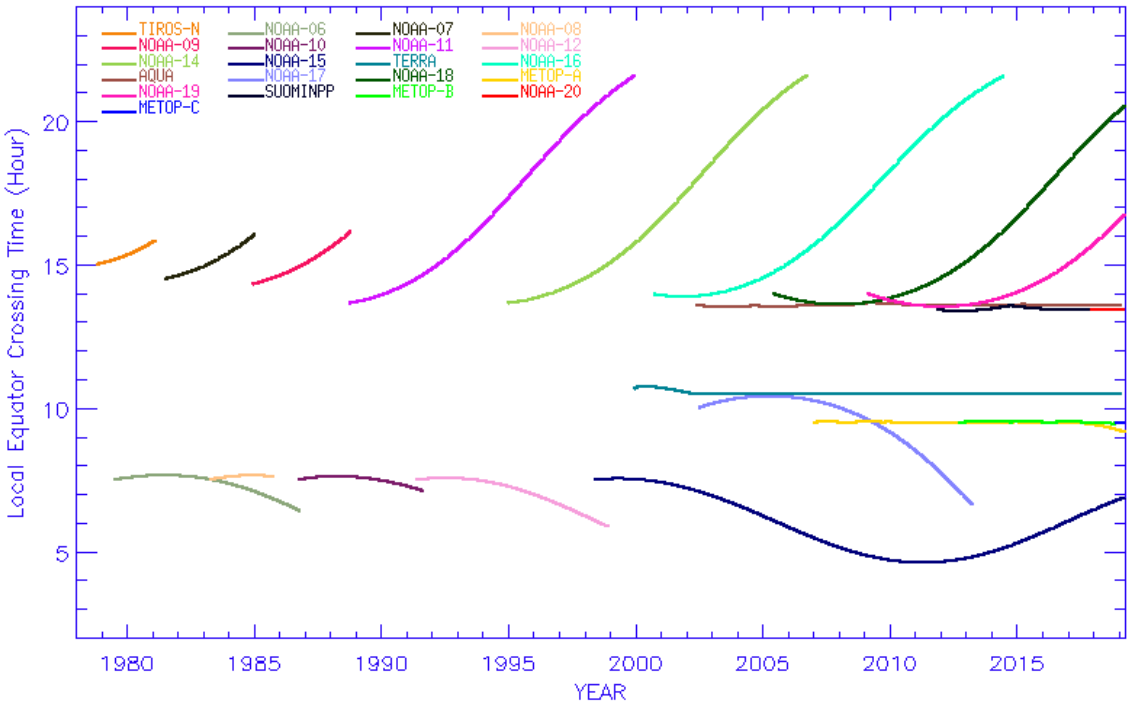
- ESA will develop new instruments
  - Radio Occultation (RO),
  - Scatterometry (SCA),
  - Microwave Sounding (MWS),
  - Microwave Imaging (MWI),
  - Multi-viewing, Multi-channel, Multi-polarisation (3MI)
  - Ice-Cloud Imaging (ICI) missions.
- The EU/ESA GMES Sentinel 5 will be on the Metop-SG satellites in support of the nadir-looking UV/VIS/NIR/SWIR (UVNS) sounding mission.
- Infrared atmospheric sounding (IAS) mission by CNES.
- DLR for METimage instrument implementing the Visible Infra-red Imaging (VII) mission.
- Argos-4 data collection and location system.

Metop-SG Satellites

	MetOp-SG-A	MetOp-SG-B
Launch	~2021?	~2022?
Orbit, altitude	SSO, 830 km	SSO, 830 km
S/C mass	~4,017 kg	~3,818 kg
Design Life	8.5 years	8.5 years
Sensor Payloads		
	METimage (DLR)	MWI (Microwave Imaging Radiometer), (ESA)
	MWS (Microwave Sounder), (ESA)	ICI (Ice Cloud Imager), (ESA)
	IASI-NG, (CNES)	SCA (Scatterometer), (ESA)
	RO (Radio Occultation), (ESA)	RO (Radio Occultation), (ESA)
	3MI (Multi-view Multi-channel Multi-polarization Imager), (ESA)	Argos-4 (Data Collection Service) (NOAA/CNES)?
	Sentinel-5/UVNS (ESA/Copernicus)	Search and Rescue (COSPAS-SARSAT)?

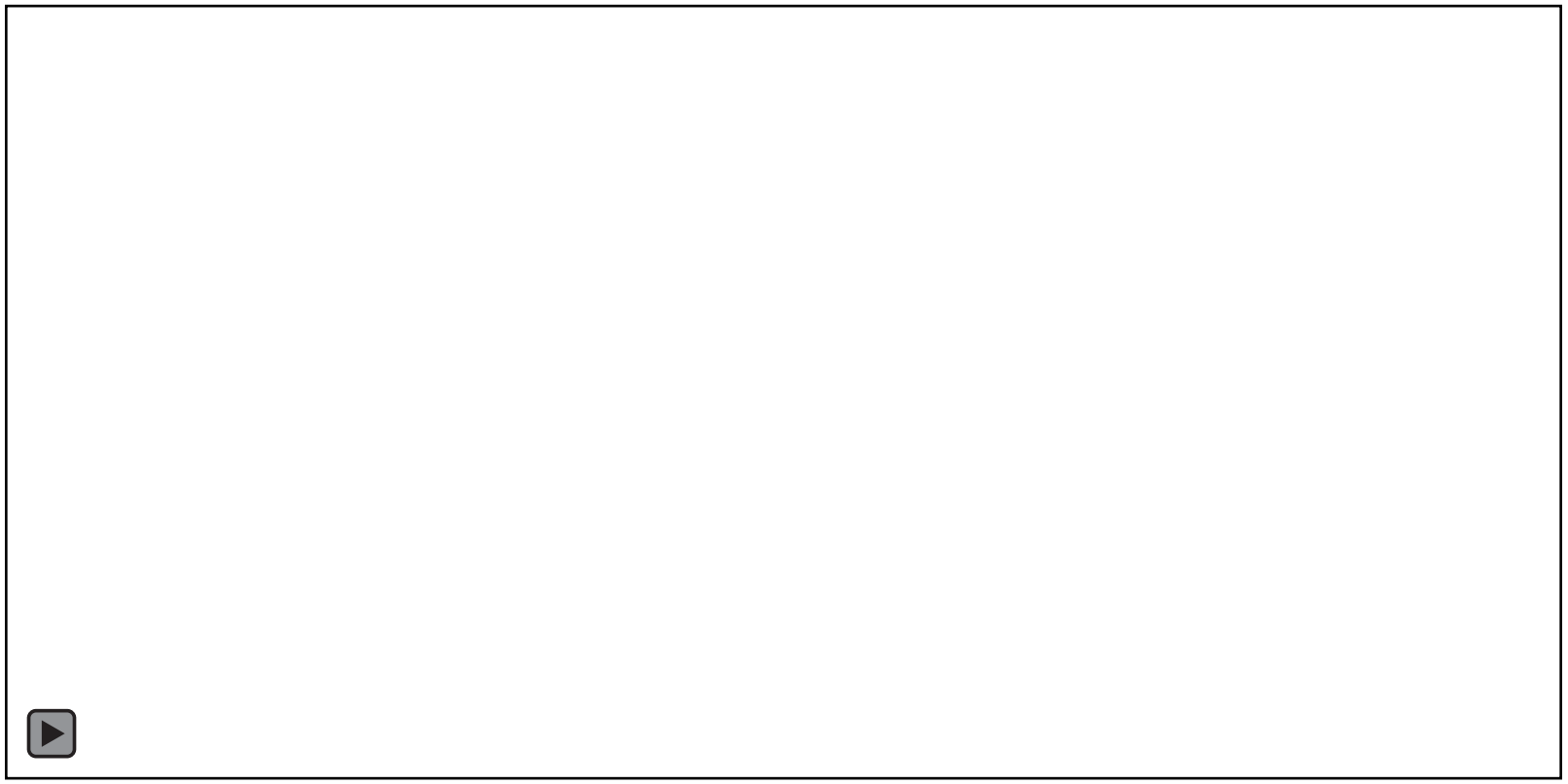
Operational Polar-orbiting Satellite Orbits

- NOAA initially maintained two orbits: early morning and afternoon.
- The early morning orbit was changed to mid morning orbit since NOAA-17, and evolved into MetOp which also fixed the orbital drift problem since then
- NOAA currently maintains the afternoon orbit, with NOAA-19 being the last satellite with AVHRR onboard, succeeded by VIIRS on Suomi NPP and NOAA-20
- Satellite mission life has extended significantly over the last four decades. Earlier satellites had a typical life span about two years, while modern satellites have a design life of 7 years.



Polar-orbiting Operational Environmental Satellite
Orbital Local Equator Crossing Time

The Two Polar-orbits: AM vs. PM



What METImage is

- METimage (also called Visible Infrared Imager or VII) is an advanced multispectral imaging radiometer for meteorological applications, to be integrated in the EUMETSAT Polar System –Second Generation (EPS-SG) or Metop SG, which is planned to be operational by ~2022.
- From an orbital altitude of 830 kilometers, the METImage swath width is about 2800 kilometers, with a Ground Sampling Distance of 500 Meters, 20 spectral channels from 443 nanometers to 13.345 micrometers. METimage orbits the earth 14 times daily and generates 140 gigabytes of data.
- METimage is a follow-on to AVHRR on Metop in the mid morning orbit. Compared to VIIRS on JPSS, the METImage has several water vapor channels that VIIRS does not. On the other hand, it doesn't have low light imaging capabilities as in the VIIRS/DNB. Many other differences can also be found.

METImage Objectives: high quality imagery

- High horizontal resolution cloud products including micro-physical analysis
- Aerosol products
- Atmospheric water-vapour gross profiles at high horizontal resolution
- Polar atmospheric motion vectors
- Vegetation
- Snow coverage
- Fire detection
- Sea and ice surface temperature, sea ice coverage

o Other mission objectives include:

- Land surface temperature
- Atmospheric temperature gross profiles at high horizontal resolution

o Support the EPS-SG sounders, particularly:

- Geolocation
- Cloud characterisation
- Scene inhomogeneity
- quantification for correction of the spectral response.

o To provide continuity of other key imager channels in support of long-term climate records.

METImage (VII) products

Primary products

- Cloud (mask, imagery, cover profile, optical depth, top temperature, top height, type, Cloud drop (liquid) or particle (solid) effective radius at the cloud top)
- Polar Atmospheric Motion Vectors (AMVs)
- Water-vapour imagery
- Aerosol optical depth (total columnar amount and gross profile)
- Earth surface albedo,
- SW Earth's surface bi-directional reflection
- SW cloud reflectance
- Vegetation: (Leaf area index (LAI), Vegetation type, Fraction of vegetated land, Fraction absorbed photosynthetically active radiation (FAPAR), Photosynthetically active radiation (PAR), Normalised Differential Vegetation Index (NDVI)
- Snow and land ice: (Snow detection, Snow cover, Snow surface temperature, Snow albedo)
- Fire: (Fire detection, Fire fractional cover)
- Sea surface temperature
- Sea ice: (Imagery, Sea ice coverage, Sea ice drift)

"Further products"

- Land surface temperature
- Aerosol
  - type (total columnar amount and gross profile)
  - effective radius (total columnar amount and gross profile)
  - Total aerosol single scattering albedo,
- Down-welling SW radiation at the Earth's surface
- Glacier cover
- Frozen soil and permafrost
- Fire
  - smoke detection
  - temperature
  - radiative power
- Sea ice melt-pond fraction
- Lake surface water temperature

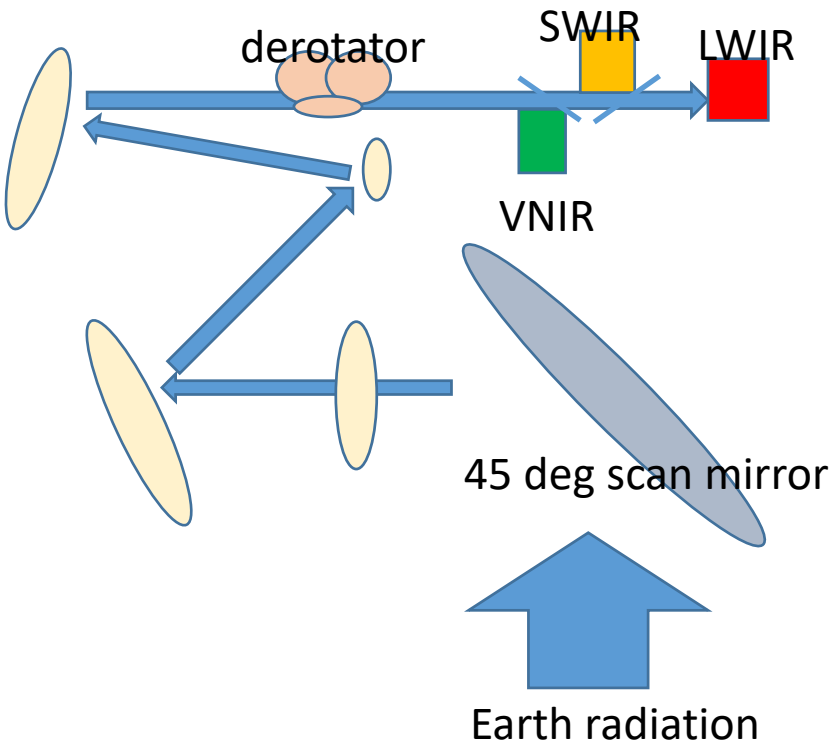
EUMETSAT Responsible Products

Product description as per [RD-5]	Responsibility	EUMETSAT product ID	Parameter to be validated
Cloud detection /Cloud mask	EUMETSAT NWC SAF	VII-02-CLD	Clear/cloudy flag
		VII-02-ICM	Clear/cloudy flag. Validation of first guess cloud phase, COT and CTH is optional.
Cloud top temperature/pressure	EUMETSAT NWC SAF	VII-02-OCA VII-02-CTP	CTP and CTT

Cloud-top phase	EUMETSAT NWC SAF	VII-02-OCA	Cloud phase
Cloud optical thickness (by-product)	EUMETSAT NWC SAF	VII-02-OCA VII-02-CTP	COT (optional)
Cloud particle effective radius at cloud top (by-product)	EUMETSAT NWC SAF	VII-02-OCA	CRE (optional)
Cloud liquid/ice water path (by-product)	EUMETSAT NWC SAF	VII-02-OCA	LWP and IWP (optional)
Volcanic ash	EUMETSAT	VII-02-OCA	Ash flag
Water-vapour total column	EUMETSAT	VII-02-WVV VII-02-WVI	TPW
Polar atmospheric motion vectors	EUMETSAT	VII-02-AMV	AMV direction, speed, pressure and temperature

METimage Instrument Design

- Whisk-broom scanner,
- Each scan has 24 lines (detectors)
- 1.729 sec per scan rotation with constant scan angle
- IFOV: 0.6 mrad
- The scan mirror covers an extended Earth view of 108° per revolution in addition to view of on-board calibration sources.
- A **derotator** assembly, which is half-speed synchronised with the scanner, is inserted in the optical beam after the telescope
  - derotator rotates at half of the scanner frequency
  - derotator compensates the image rotation in the focal plane.
  - derotator optical arrangement is a five mirror concept that minimises the polarisation sensitivity.
  - derotator design is constrained by optical performance, mass and compactness
- A set of dichroic beam splitters separates the beam into 3 spectral bands and folding mirrors direct the beams towards the VNIR and the IR detectors.
- Calibration with a psedo full aperture solar diffuser, second solar diffuser, space view, and a blackbody with floating temperature
- Calibration accuracy requirements: 5% for solar bands, 0.5K for thermal emissive bands.



after: Renotte et al. (2018), Wallner et al. (2016)

12

METImage Performance Specifications

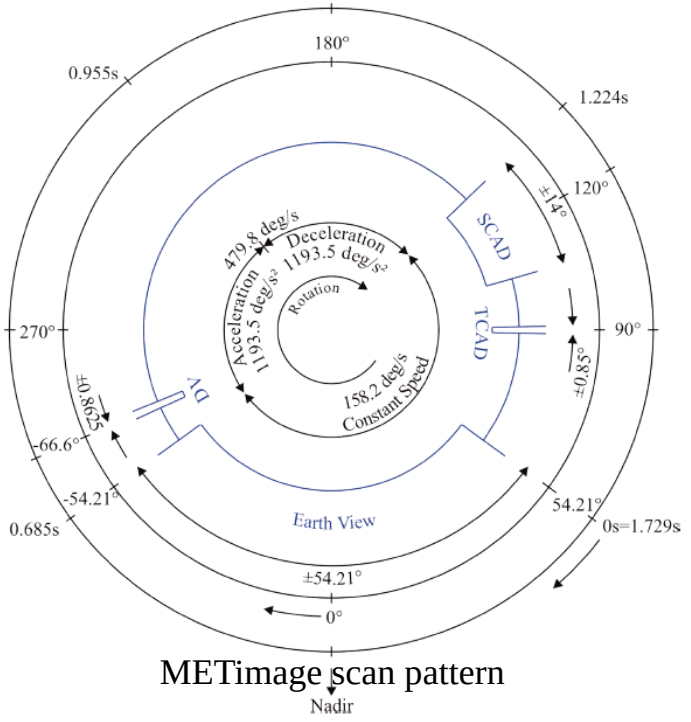
Tab. 1 Key instrument parameters.

Orbit parameters				
	• Orbit	Sun synchronous, polar		
	• Orbit height	830km (average)		
Observational parameters				
	• Scan range	±53deg		
	• GSD	500m (at 830km, nadir)		
	• Swath	12km ALT x 2670km ACT		
Spectral bands				
solar bands	VNIR channels	CWL [nm]	FWHM [nm]	add. TDI stages
	• VII-4	443	30	
	• VII-8	555	20	
	• VII-12	670	20	
	• VII-15	752	10	1
	• VII-16	763	10	1
	• VII-17	865	20	
	• VII-20	914	20	1
	SMWIR channels	CWL [nm]	FWHM [nm]	TDI stages
	• VII-22	1240	20	
	• VII-23	1375	40	
	• VII-24	1630	20	
	• VII-25	2250	50	
thermal bands	• VII-26	3740	180	1
	• VII-28	3959	60	1
	• VII-30	4050	60	1
	LVWIR channels	CWL [nm]	FWHM [nm]	TDI stages
	• VII-33	6725	370	
	• VII-34	7325	290	
	• VII-35	8540	290	
	• VII-37	10690	500	
	• VII-39	12020	500	1
	• VII-40	13345	310	1
Telescope parameters				
	• Input aperture	170mm, circular		
	• Focal length	1660mm		
	• FoV	1.6deg, circular		
Detector parameters				
	• VNIR	CMOS, 250µm x 250µm read-out pixel size 96 x 4 read-out pixels per channel (ALTxACT) ambient operational temperature		
	• SMWIR/ LVWIR	MCT, 90µm x 90µm read-out pixel size 51 x 6 read-out pixels per channel (ALTxACT) 60K operational temperature		
External interfaces				
	• Mass	296kg		
	• Power	465W	nominal operations mode	
		287W	survival & LEOP mode	
	• Data rate	18 Mbps	day	
		9 Mbps	eclipse (VNIR channels off)	
	• Data volume	82 Gbit	over 1 orbit	

Source: Wallner et al. (2016)

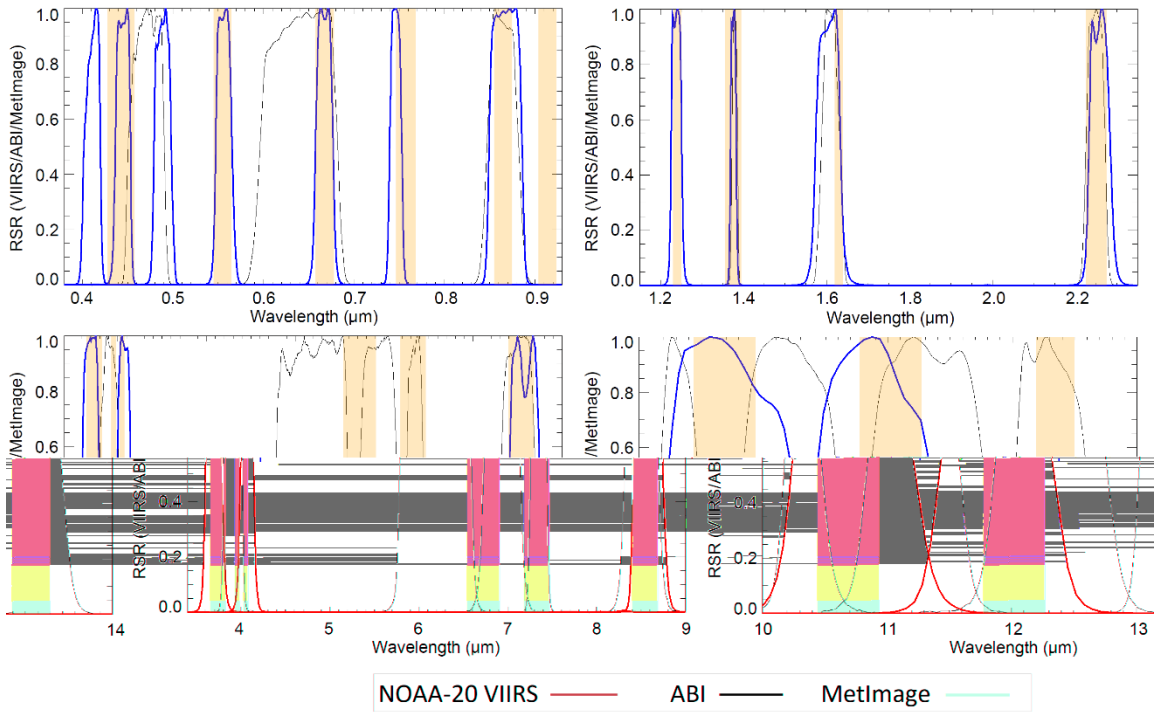
Parameter	Solar channels (VII-4…25)	Thermal channels (VII-26…40)
• Inter-channel co-registration	< 0.2 spatial samples	
• Polarization sensitivity	< 5%	< 11%
• Radiometric noise	SNR up to 400	NedT up to 0.05K
• Radiometric accuracies		
○ Bias	< 5%	< 0.5 K
○ Inter-channel	< 1%	< 0.1 K
○ Inter-spatial	< 1%	< 0.1 K

Performance summary



METImage scan pattern

METImage(VII) and VIIRS Channel comparisons



MetImage-SG			VIIRS		
Channel No	Center Wavelength (μm)	Bandwidth (FWHM in μm)	Band	Center Wavelength (μm)	Eq. Width (μm)
VII-4	0.443	0.03	M2	0.444	0.0198
VII-8	0.555	0.02	M4	0.551	0.0209
VII-12	0.668	0.02	M5	0.672	0.02
VII-16	0.763	0.01	M6	0.745	0.0146
VII-17	0.865	0.02	M7	0.862	0.0394
VII-22	1.24	0.02	M8	1.238	0.0271
VII-23	1.375	0.04	M9	1.375	0.015
VII-24	1.63	0.02	M10	1.602	0.0587
VII-25	2.25	0.05	M11	2.257	0.0467
VII-26	3.74	0.18	M12	3.697	0.192
VII-30	4.05	0.06	M13	4.067	0.165
VII-35	8.54	0.29	M14	8.578	0.324
VII-37	10.69	0.5	M15	10.729	0.99
VII-39	12.02	0.5	M16	11.845	0.866

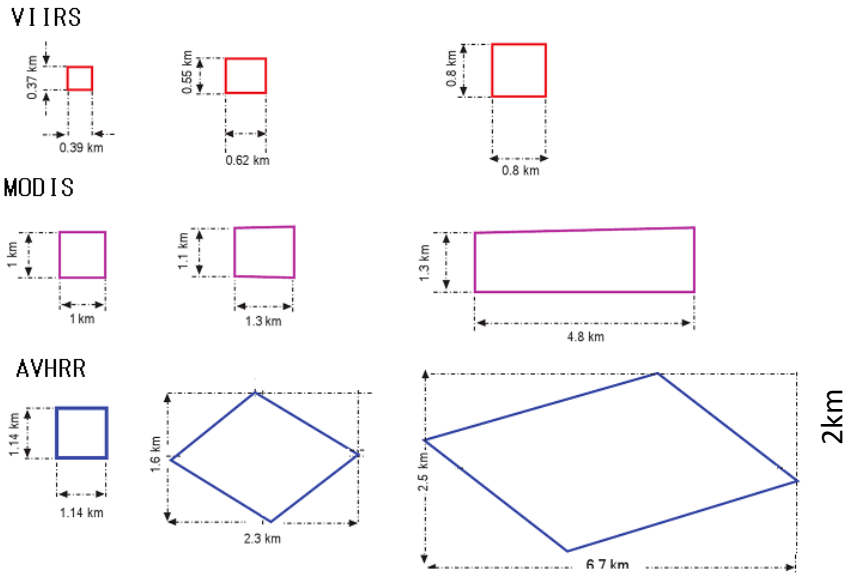
Dynamic range and SNR requirements

Channel	Central Wavelength (μm)	$L_{typical}$ (W m^{-2} sr^{-1} μm^{-1})	L_{high} (W m^{-2} sr^{-1} μm^{-1})	L_{low} (W m^{-2} sr^{-1} μm^{-1})	SNR at $L_{typical}$
VII-4	0.443	42	704	7.8	221
VII-8	0.555	22	678	5.7	215
VII-12	0.670	9.5	673	2.9	66
VII-16	0.752	28	434	1.7	500
VII-15	0.763	20	370	0.36	500
VII-17	0.865	6.04	379	0.8	60
VII-20	0.914	15	294	6.1	250
VII-22	1.24	5.4	150	5.4	90
VII-23	1.375	6	81	2	300
VII-24	1.63	7.3	72	0.4	300
VII-25	2.25	1	32	0.12	110
Channel	Central Wavelength (μm)	$T_{typical}$ (K)	T_{high} (K)	T_{low} (K)	NEDT at Tt_{ypical} (K)
VII-26	3.74	300	350	186	0.050
VII-28	3.959	300	345	185	0.074
VII-30	4.04	300	344	185	0.074
VII-33	6.725	238	271	186	0.215
VII-34	7.325	250	282	186	0.200
VII-35	8.54	300	330	185	0.050
VII-37	10.69	300	345	185	0.050
VII-39	12.02	300	345	185	0.050
VII-40	13.345	260	290	185	0.1

SNR Comparison for VIIRS and METImage

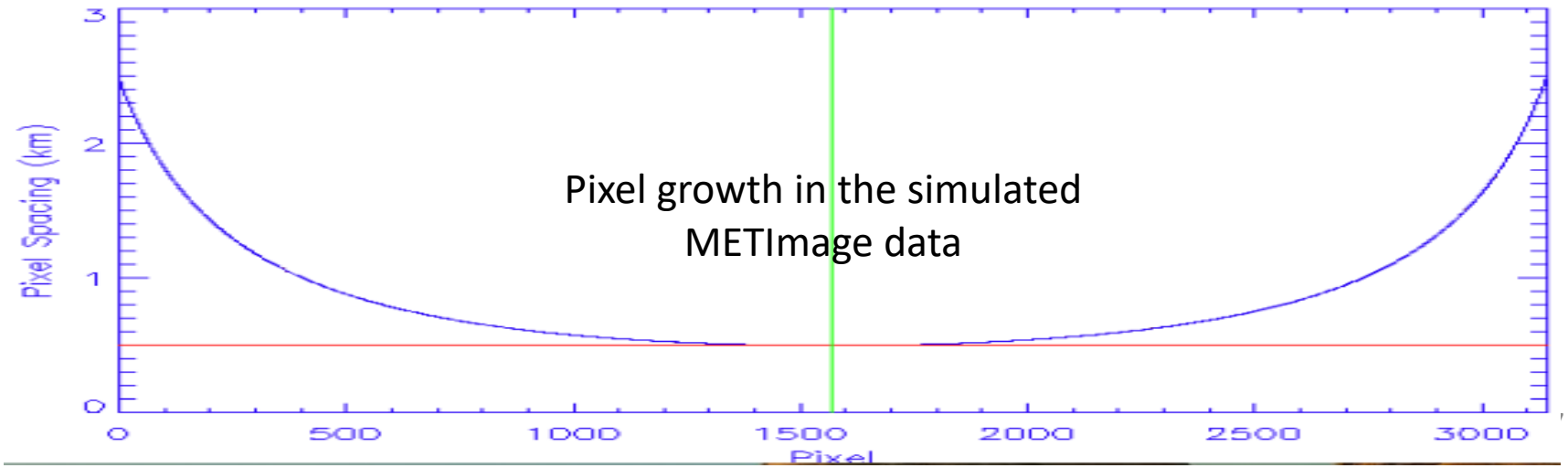
METimage				VIIRS			
Band	Center Wavelength (μm)	Ltyp [W m-2 sr-1 μm-1] or BTtyp (K)	SNR at Ltyp or NEDT (K) at BTtyp	Band	Center Wavelength (μm)	Ltyp [W m-2 sr-1 μm-1] or BTtyp (K)	SNR at Ltyp or NEDT (K) at BTtyp
	380	VII-4	0.443	42	221	M2	0.444	40
	409							146
	362	VII-8	0.555	22	215	M4	0.551	21
	315							90
	242	VII-12	0.668	9.5	66	M5	0.672	10
	360							68
	199	VII-16	0.763	20	400	M6	0.745	9.6
	215	VII-17	0.865	6	60	M7	0.862	6.4
4	340							33.4
	74	VII-22	1.24	5.4	90	M8	1.238	5.4
	83	VII-23	1.375	6	300	M9	1.375	6
	342	VII-24	1.63	7.3	300	M10	1.602	7.3
2	10	VII-25	2.25	1	110	M11	2.257	0.12
)	0.396	VII-26	3.74	300	0.05	M12	3.697	270
)	0.107	VII-30	4.05	300	0.074	M13	4.067	300
)	0.423							380
)	0.091	VII-35	8.54	300	0.05	M14	8.578	270
)	0.07	VII-37	10.69	300	0.05	M15	10.729	300
)	0.072	VII-39	12.02	300	0.05	M16	11.845	300

Scan Geometry Comparison



- VIIRS preserves the shape and has the smallest pixel growth from nadir to end of scan
- AVHRR has the largest pixel growth with image rotation
- MODIS has large pixel growth in the scan direction

Pixel shape for METImage with derotator ?



Pixel growth in the simulated METImage data

Simulated METImage Data

EUMETSAT has kindly provided sample simulated METImage data and provided to use, which are available on STAR linux system at:

/data/data444/metop_sg/NOAA/VII

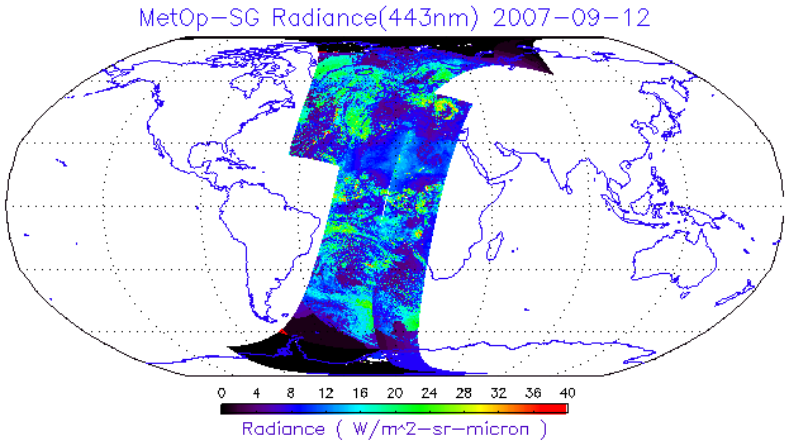
There are three orbits of simulated data, and the files are in netCDF format.

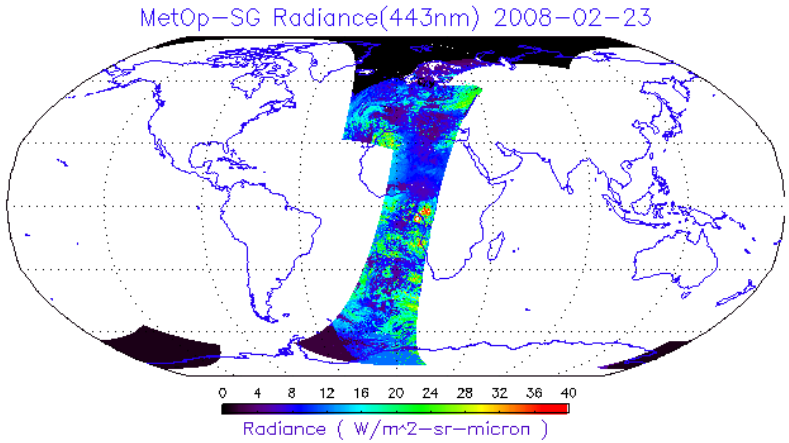
- 1st orbit: 2007/09/12 at 08:43 to 10:23
- 2nd orbit: 2007/09/12 at 10:23 to 12:05
- 3rd orbit: 2008/02/23 at 08:46:02.784Z to 10:29

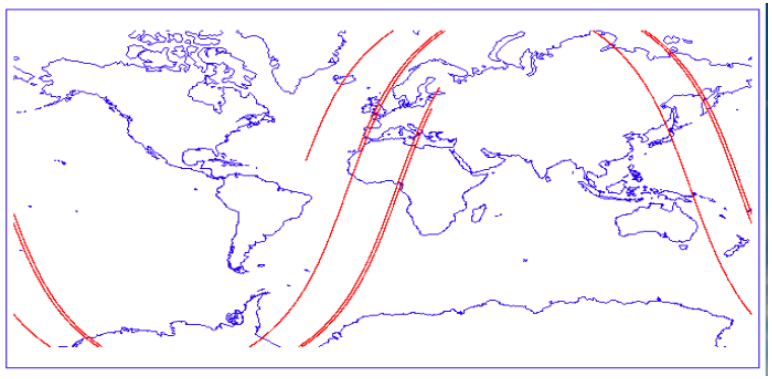
A typical METImage has 3144 samples across scan, centered at 1572, Pixel#1 is defined as the furthest point from nadir observed on the left side with respect to spacecraft motion.

- Definition:
  - OZA: Observation zenith angle (view zenith)
  - OAA: Observation azimuth angle (view azimuth)

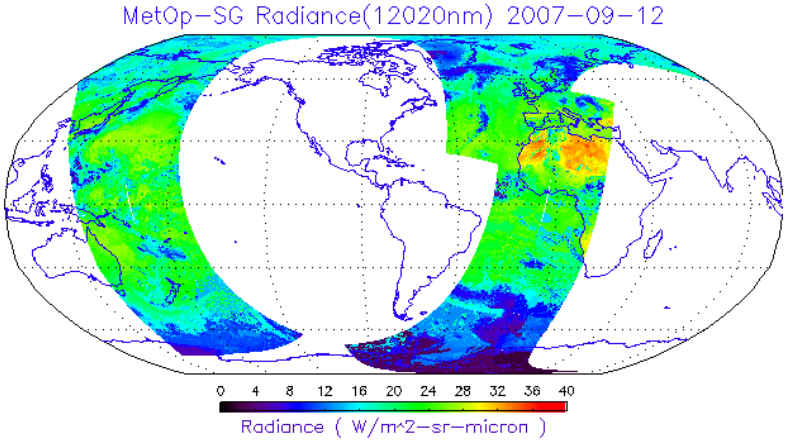
METImage sample plots
RSB Band 1 Radiance

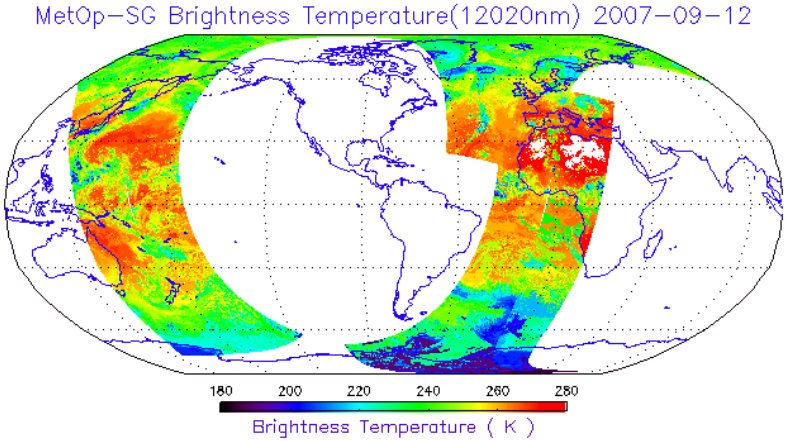


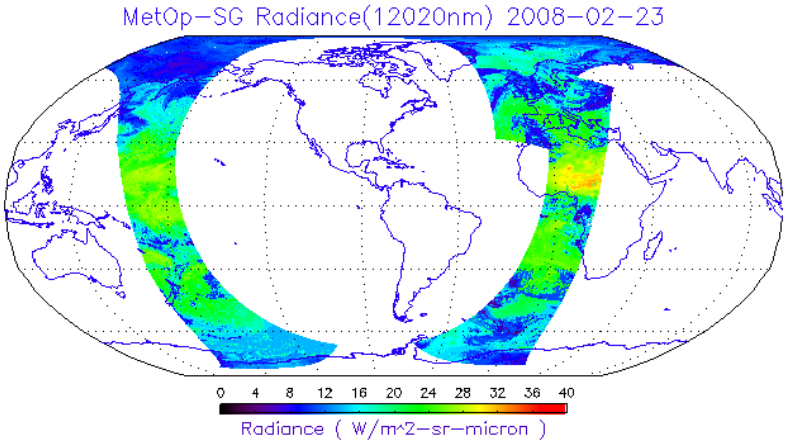


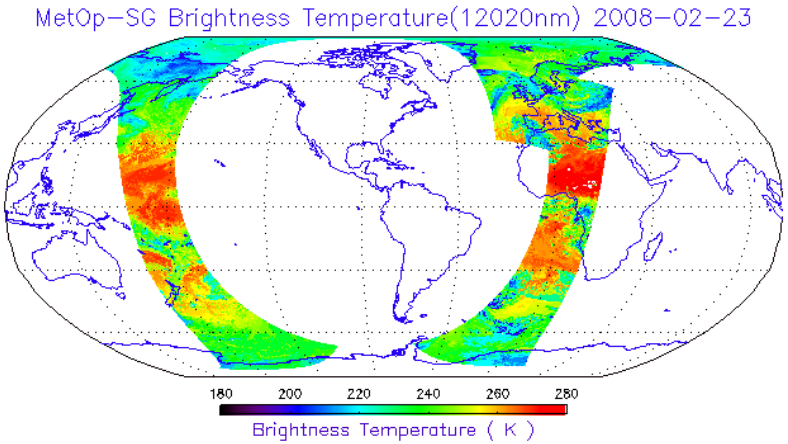


METImage Thermal Band 19 Radiance and Brightness Temperature









How are the Simulated METImage data generated

- The simulated METImage data are based on:
  - AVHRR product for clouds
  - MACC (Monitoring Atmospheric Composition and Climate) reanalysis for aerosols,
  - ECMWF reanalysis for atmospheric state,
  - MODIS albedo climatology
- Simulated TOA radiances generated at Level 1b, equivalent to the calibrated and geolocated measurements by the instrument.
- RTM Simulation model used ARTDECO (Laboratoire d'Optique Atmosphérique at the Université de Lille-1)
- Datafiles: NETCDF4/5 (5 minute Granules)
- Geolocation, sampling geometry, ancillary input etc in separate files.

- Ancillary data:
  http://www.icare.univ-lille1.fr/dev_ftp/4MSDS/VII/DELIVERY_V3.0/
  http://www.icare.univ-lille1.fr/dev/4MSDS/

More about the simulated data

- Terrain corrected geolocation
- Validation of the simulated data:
  - Compared with AVHRR, MODIS
- Each file consists of 302.5 seconds of data, corresponding to 175 scans (one granule)
- Naming convention:
  - **EPS-SG_VII_GEOLOC_**YYYY-MM-DD**T**HH-mm-ss**_V**p.p**.nc**
  - **Example:**
    - ***EPS-SG_VII_GEOLOC_2007-09-12T08-43-03_V3.0.nc***

METImage data structure

- Data Structure
  - ANCILIARY
    - EPS-SG_VII_ANCILLARY_2007-09-12T08-43-03_V4.0.nc
    - Mean Size: 363M~104GB/Day
    - Variables: Cloud_mask, Albedo etc.
  - GEOLOC
    - EPS-SG_VII_GEOLOC_2007-09-12T08-43-03_V4.0.nc
    - Mean Size: 110M~32GB/Day
    - Variables: lon/lat; (Sensor/Sat)Azimuth/Zenith etc
  - GEOLO_DEM
    - EPS-SG_VII_GEOLOC_DEM_2007-09-12T08-43-03_V4.0.nc
    - Mean Size: 150MB~43GB/Day
    - Variables: lon/lat; (Sensor/Sat)Azimuth/Zenith etc
  - RADIANCES
    - EPS-SG_VII_RAD_2007-09-12T08-43-03_V4.0.nc
    - Mean Size: 601MB ~ 173GB/day
    - Variables: Radiance (20 CHs), size: 4200*3144

METImage NetCDF-4 Files

```
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 group      /    group      /VII_SWATH_Type_L1B
 group      /VII_SWATH_Type_L1B/Data_Fields      dataset    /VII_SWATH_Type_L1B/Data_Fields/flag_metim_00443
 dataset    /VII_SWATH_Type_L1B/Data_Fields/flag_metim_00555     dataset    /VII_SWATH_Type_L1B/Data_Fields/flag_metim_00670
 dataset    /VII_SWATH_Type_L1B/Data_Fields/flag_metim_00752     dataset    /VII_SWATH_Type_L1B/Data_Fields/flag_metim_00763
 dataset    /VII_SWATH_Type_L1B/Data_Fields/flag_metim_00865     dataset    /VII_SWATH_Type_L1B/Data_Fields/flag_metim_00914
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 dataset    /VII_SWATH_Type_L1B/Data_Fields/flag_metim_07325     dataset    /VII_SWATH_Type_L1B/Data_Fields/flag_metim_08540
 dataset    /VII_SWATH_Type_L1B/Data_Fields/flag_metim_10690     dataset    /VII_SWATH_Type_L1B/Data_Fields/flag_metim_12020
 dataset    /VII_SWATH_Type_L1B/Data_Fields/flag_metim_13345     dataset    /VII_SWATH_Type_L1B/Data_Fields/metim_00443
 dataset    /VII_SWATH_Type_L1B/Data_Fields/metim_00555  dataset    /VII_SWATH_Type_L1B/Data_Fields/metim_00670
 dataset    /VII_SWATH_Type_L1B/Data_Fields/metim_00752  dataset    /VII_SWATH_Type_L1B/Data_Fields/metim_00763
 dataset    /VII_SWATH_Type_L1B/Data_Fields/metim_00865  dataset    /VII_SWATH_Type_L1B/Data_Fields/metim_00914
 dataset    /VII_SWATH_Type_L1B/Data_Fields/metim_01240  dataset    /VII_SWATH_Type_L1B/Data_Fields/metim_01375
 dataset    /VII_SWATH_Type_L1B/Data_Fields/metim_01630  dataset    /VII_SWATH_Type_L1B/Data_Fields/metim_02250
 dataset    /VII_SWATH_Type_L1B/Data_Fields/metim_03740  dataset    /VII_SWATH_Type_L1B/Data_Fields/metim_03959
 dataset    /VII_SWATH_Type_L1B/Data_Fields/metim_04050  dataset    /VII_SWATH_Type_L1B/Data_Fields/metim_06725
 dataset    /VII_SWATH_Type_L1B/Data_Fields/metim_07325  dataset    /VII_SWATH_Type_L1B/Data_Fields/metim_08540
 dataset    /VII_SWATH_Type_L1B/Data_Fields/metim_10690  dataset    /VII_SWATH_Type_L1B/Data_Fields/metim_12020
 dataset    /VII_SWATH_Type_L1B/Data_Fields/metim_13345  group      /VII_SWATH_Type_L1B/Geolocation_Fields
 dataset    /VII_SWATH_Type_L1B/Geolocation_Fields/Latitude      dataset    /VII_SWATH_Type_L1B/Geolocation_Fields/Longitude
 dataset    /column      dataset    /ligne
 }      }
```

METImage Level 1b file content

Dataset name	Description and units	Dimension
Geolocation Fields		
Latitude	Latitude of the pixel in degrees (non DEM corrected)	2-D (4200x3144)(1) array
Longitude	Longitude of the pixel in degrees (non DEM corrected)	2-D (4200x3144)(1) array
Data Fields		
Solar_Zenith	Solar zenith angle in the pixel at the observation time (in degrees)	2-D (4200x3144)(1) vector
Solar_Azimuth	Solar azimuth angle in the pixel at the observation time (in degrees)	2-D (4200x3144)(1) vector
Sensor_Azimuth	Observation azimuth angle of the pixel by the sensor (in degrees)	2-D (4200x3144)(1) vector
Sensor_Zenith	Observation zenith angle of the pixel by the sensor (in degrees)	2-D (4200x3144)(1) vector
Scattering_Angle	Scattering Angle in degrees	2-D (4200x3144)(1) vector
TAI_Time	International Atomic Time in s of the pixel observation (since the 1st January 1993 0:00 UTC)	2-D (4200x3144)(1) array
Day_Night_Flag	Flag (0 = Day, 1 = Night) describing the day/night situation of the pixel at the observation time (no unit)	2-D (4200x3144)(1) vector
DEM corrected fields	**Only of DEM corrected files**	
Latitude_DEM_corrected	Latitude corrected for DEM elevation	2-D (4200x3144)(1) vector
Longitude_DEM_corrected	Longitude corrected for DEM elevation	2-D (4200x3144)(1) vector
DEM Height (1)	Altitude of the pixel in m, from the DEM ACE2 dataset	2-D (4200x3144)(1) vector

METImage Data Fields

Dataset name	Description and units	Dimension
VII_SWATH_Type_L1B/Geolocation Fields		
Latitude	Geodetic Latitude	2-D (4200x3144)(1) array
Longitude	Geodetic Longitude	2-D (4200x3144)(1) array
VII_SWATH_Type_L1B/Data Fields		
metim_00443	Spectral radiance for the 443 nm channel (in W m-2 sr-1 microns-1)	2-D (4200x3144)(1) array
metim_00555	Spectral radiance for the 555 nm channel (in W m-2 sr-1 microns-1)	2-D (4200x3144)(1) array
metim_00670	Spectral radiance for the 670 nm channel (in W m-2 sr-1 microns-1)	2-D (4200x3144)(1) array
metim_00752	Spectral radiance for the 752 nm channel (in W m-2 sr-1 microns-1)	2-D (4200x3144)(1) array
metim_00763	Spectral radiance for the 763 nm channel (in W m-2 sr-1 microns-1)	2-D (4200x3144)(1) array
metim_00865	Spectral radiance for the 865 nm channel (in W m-2 sr-1 microns-1)	2-D (4200x3144)(1) array
metim_00914	Spectral radiance for the 914 nm channel (in W m-2 sr-1 microns-1)	2-D (4200x3144)(1) array
metim_01240	Spectral radiance for the 1240 nm channel (in W m-2 sr-1 microns-1)	2-D (4200x3144)(1) array
metim_01375	Spectral radiance for the 1375 nm channel (in W m-2 sr-1 microns-1)	2-D (4200x3144)(1) array
metim_01630	Spectral radiance for the 1630 nm channel (in W m-2 sr-1 microns-1)	2-D (4200x3144)(1) array
metim_02250	Spectral radiance for the 2250 nm channel (in W m-2 sr-1 microns-1)	2-D (4200x3144)(1) array
metim_03740	Spectral radiance for the 3740 nm channel (in W m-2 sr-1 microns-1)	2-D (4200x3144)(1) array
metim_03959	Spectral radiance for the 3959 nm channel (in W m-2 sr-1 microns-1)	2-D (4200x3144)(1) array
metim_04050	Spectral radiance for the 4050 nm channel (in W m-2 sr-1 microns-1)	2-D (4200x3144)(1) array
metim_06725	Spectral radiance for the 6725 nm channel (in W m-2 sr-1 microns-1)	2-D (4200x3144)(1) array
metim_07325	Spectral radiance for the 7325 nm channel (in W m-2 sr-1 microns-1)	2-D (4200x3144)(1) array
metim_08540	Spectral radiance for the 8540 nm channel (in W m-2 sr-1 microns-1)	2-D (4200x3144)(1) array
metim_10690	Spectral radiance for the 10690 nm channel (in W m-2 sr-1 microns-1)	2-D (4200x3144)(1) array
metim_12020	Spectral radiance for the 12020 nm channel (in W m-2 sr-1 microns-1)	2-D (4200x3144)(1) array
metim_13345	Spectral radiance for the 13345 nm channel (in W m-2 sr-1 microns-1)	2-D (4200x3144)(1) array

References

- **Renotte, E.**, Bastin, C., Bernard, F., Bernat, A., Boitrel, J. M., Bougoin, M., ... & Laffitte, G. (2019, July). Full-SiC derotator optics for METimage: preliminary design and verification approach. In *International Conference on Space Optics—ICSO 2018* (Vol. 11180, p. 111808G). International Society for Optics and Photonics.
- **Wallner, O.**, Reinert, T., & Straif, C. (2017, September). METIMAGE: a spectro-radiometer for the VII mission onboard METOP-SG. In *International Conference on Space Optics—ICSO 2016* (Vol. 10562, p. 105620E). International Society for Optics and Photonics.
- **Phillips, P.**, Bonsignori, R., Just, D., Schlüssel, P., Schmülling, F., & Zerfowski, I. (2018, September). Calibration and validation of Level 1B radiances of the EUMETSAT polar system-second generation (EPS-SG) visible/infrared imager METimage. In *Sensors, Systems, and Next-Generation Satellites XXII* (Vol. 10785, p. 1078512). International Society for Optics and Photonics.

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Q&A

MetImage(VII) and VIIRS Specification

MetImage

Channel No	Center Wavelength (μm)	Bandwidth (FWHM in μm)	Spatial Resolution (km)	Ltyp [W m-2 sr-1 μm-1] or BTtyp (K)	SNR at Ltyp or NEDT (K) at BTtyp
VII-4	0.443	0.03	0.5km for all bands	42.0	221.0
VII-8	0.555	0.02		22.0	215.0
VII-12	0.668	0.02		9.5	66.0
VII-15	0.752	0.01		28.0	400.0
VII-16	0.763	0.01		20.0	400.0
VII-17	0.865	0.02		6.0	60.0
VII-20	0.914	0.02		15.0	250.0
VII-22	1.24	0.02		5.4	90.0
VII-23	1.375	0.04		6.0	300.0
VII-24	1.63	0.02		7.3	300.0
VII-25	2.25	0.05		1.0	110.0
VII-26	3.74	0.18		300	0.050
VII-28	3.959	0.06		300	0.074
VII-30	4.05	0.06		300	0.074
VII-33	6.725	0.37		238	0.215
VII-34	7.325	0.29		250	0.200
VII-35	8.54	0.29		300	0.050
VII-37	10.69	0.5		300	0.050
VII-39	12.02	0.5		300	0.050
VII-40	13.345	0.31		260	0.200

VIIRS

Bands	Center Wavelength (μm)	Equivalent Width (μm)	Spatial Resolution (km)	Band Gain	Ltyp [W m-2 sr-1 μm-1] or BTtyp (K)	SNR at Ltyp or NEDT (K) at BTtyp
M1	0.411	0.0198	0.75	H	44.9	352
				L	155	316
M2	0.444	0.0143	0.75	H	40	380
				L	146	409
M3	0.486	0.019	0.75	H	32	416
				L	123	414
M4	0.551	0.0209	0.75	H	21	362
				L	90	315
I1	0.639	0.0775	0.375	S	22	119
M5	0.672	0.02	0.75	H	10	242
				L	68	360
M6	0.745	0.0146	0.75	S	9.6	199
I2	0.862	0.0394	0.375	S	25	150
M7	0.862	0.0387	0.75	H	6.4	215
				L	33.4	340
M8	1.238	0.0271	0.75	S	5.4	74
M9	1.375	0.015	0.75	S	6	83
I3	1.602	0.0572	0.375	S	7.3	6
M10	1.602	0.0587	0.75	S	7.3	342
M11	2.257	0.0467	0.75	S	0.12	10
I4	3.753	0.036	0.375	S	270	2.5
M12	3.697	0.192	0.75	S	270	0.396
M13	4.067	0.165	0.75	H	300	0.107
				L	380	0.423
M14	8.578	0.324	0.75	S	270	0.091
M15	10.729	0.99	0.75	S	300	0.07
I5	11.469	1.75	0.375	S	210	1.5
M16	11.845	0.866	0.75	S	300	0.072