Instrumentation planned for MetOp-SG

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Satellite Radiance Assimilation Group

Met Office

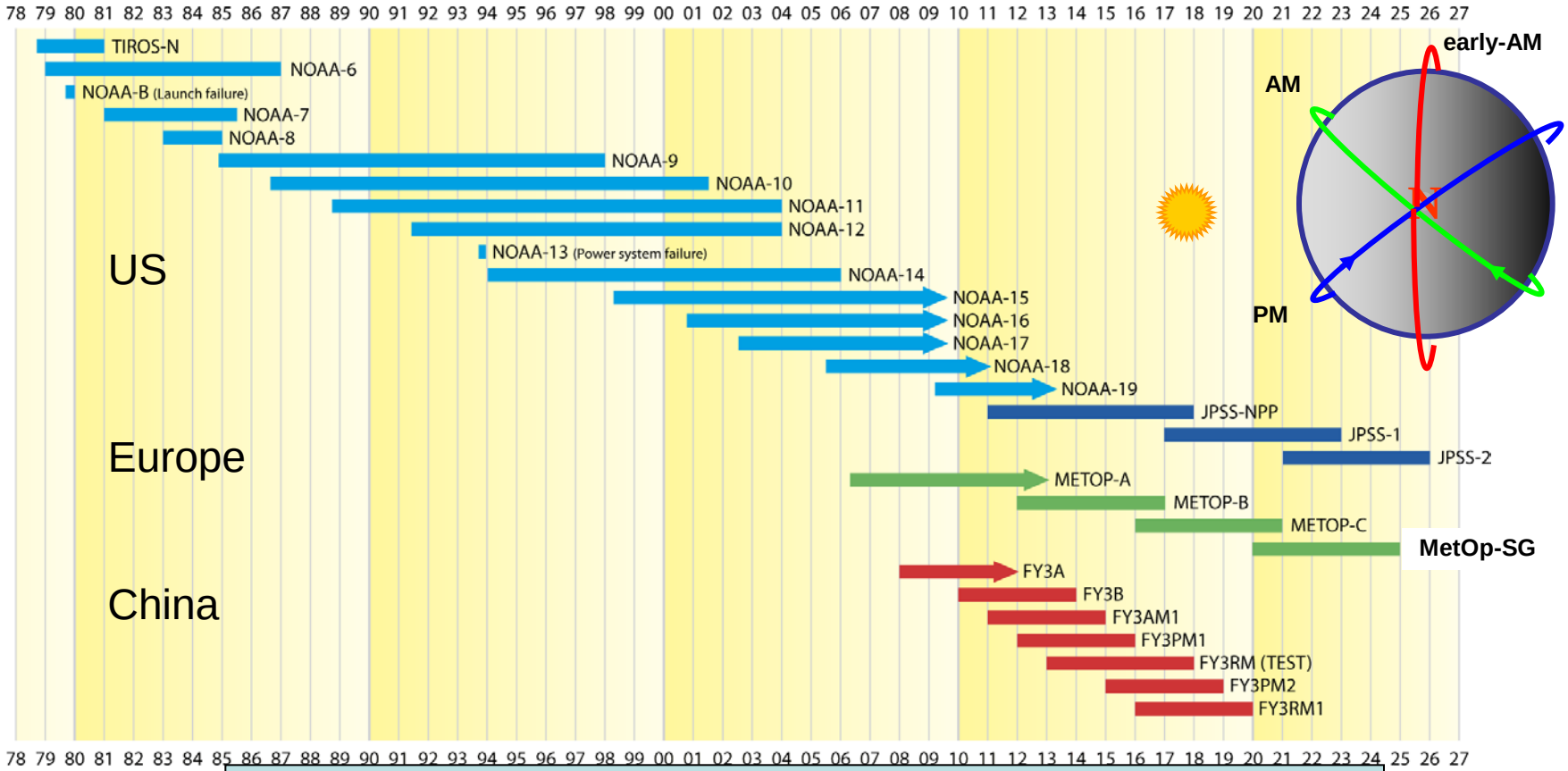
Outline

- Background - the MetOp-SG programme
- The MetOp-SG instruments
- Summary

Acknowledgements:

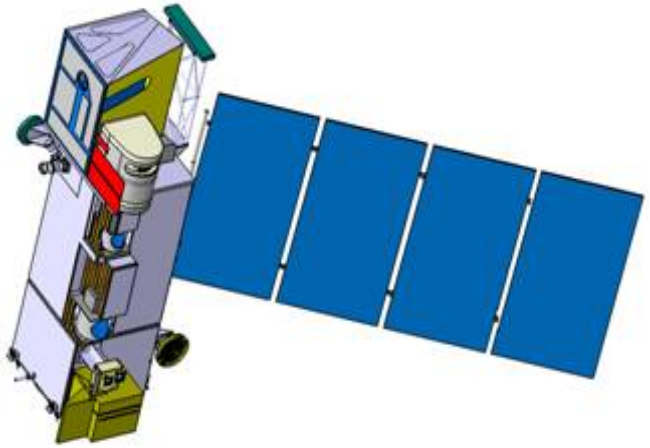
John Eyre, Joerg Ackermann, Christophe Accadia, Stefan Buehler

Background
Operational Sounding Satellites: 1978 - 2020



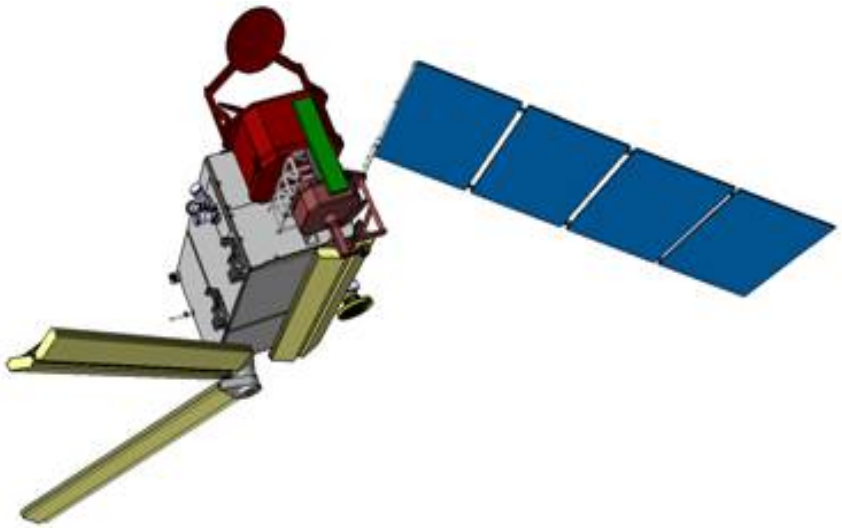
- EUMETSAT's MetOp-SG continues MetOp observations from 2020 (until ~2040)
- Serves user community spanning : numerical weather prediction (NWP) ; climate and atmospheric composition
- In Metop-SG era - aim is for US, China and Europe to populate three complementary orbit planes

Metop-SG Satellite A



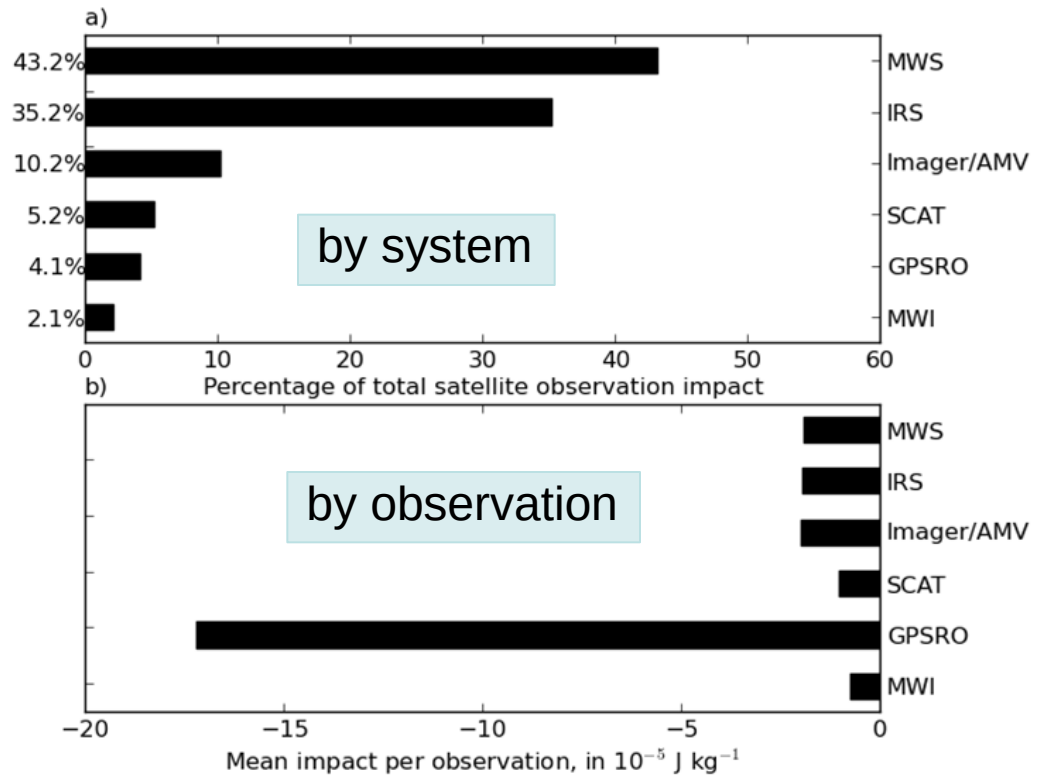
Satellite-A Payload	Infrared Atmospheric Sounder Interferometer-Next Generation IASI-NG Microwave Sounder MWS Meteorological Imager METimage Multi-view Multi-channel Multi-polarization Imager 3MI Ultra-Violet /Visible/Near Infrared/Short Wave Infrared Spectrometer UVNS (Sentinel-5) Radio Occultation Sounder RO

Metop-SG Satellite B



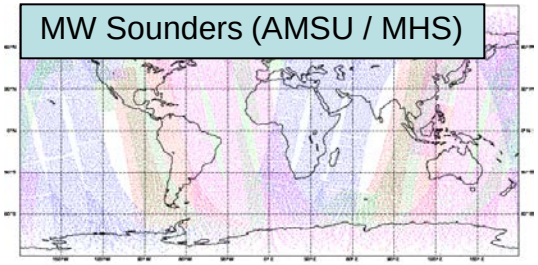
Satellite-B Payload	Scatterometer SCA Microwave Imager MWI Ice Cloud Imager ICI Radio Occultation Sounder RO Data Collection System DCS (Argos-4)

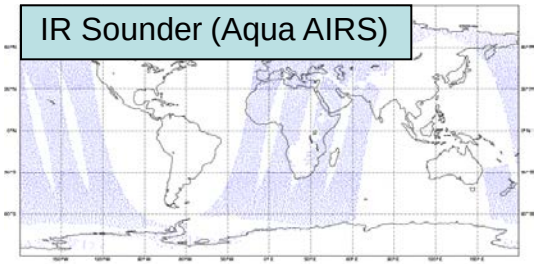
Forecast impact per system & per observation

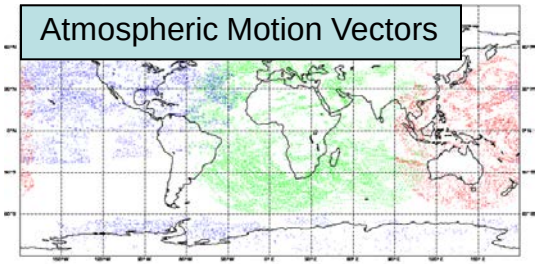


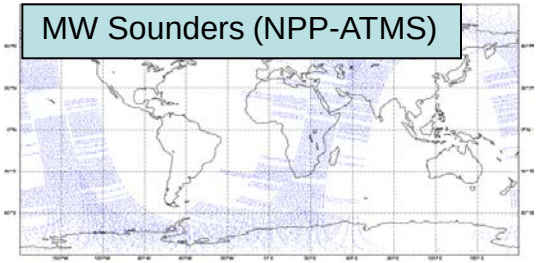
Results from Joo, Eyre and Marriott (Monthly Weather Review, 2013) based on '*Forecast Sensitivity to Observations*' – an adjoint based technique for assessing the relative contribution of observing systems to forecast accuracy

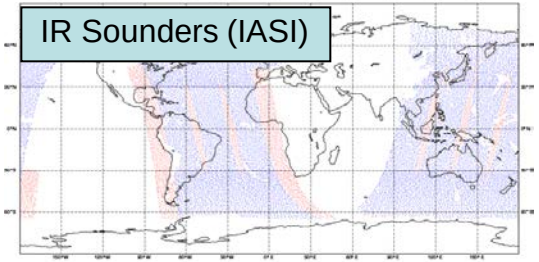
Satellite data coverage in a 6-hour assimilation cycle

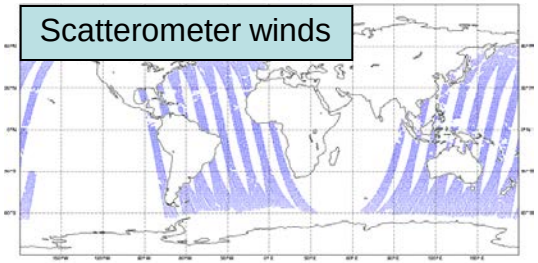


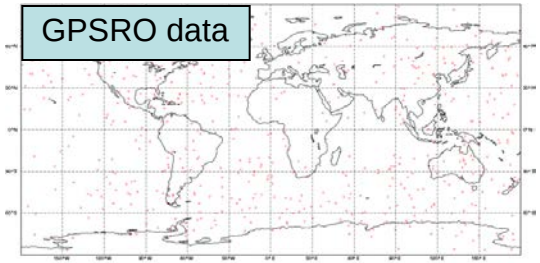


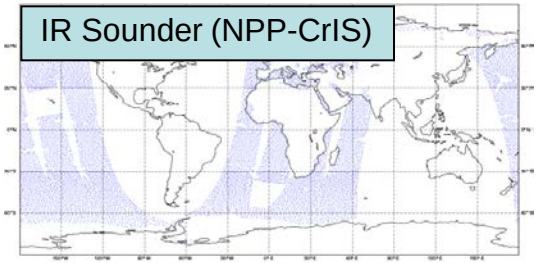


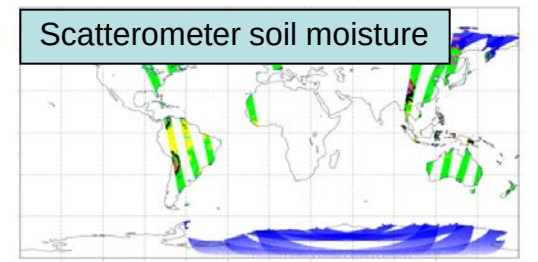




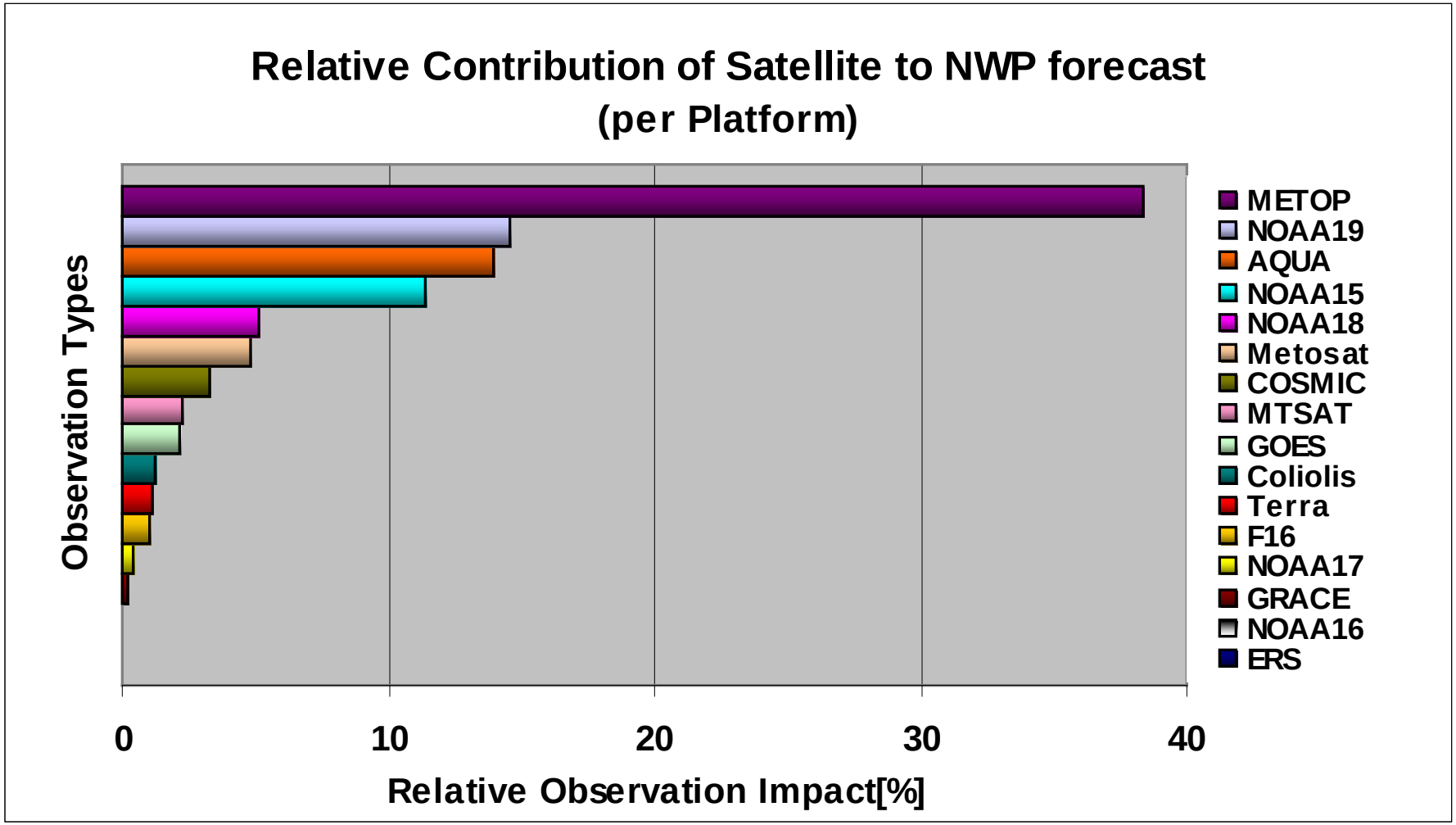








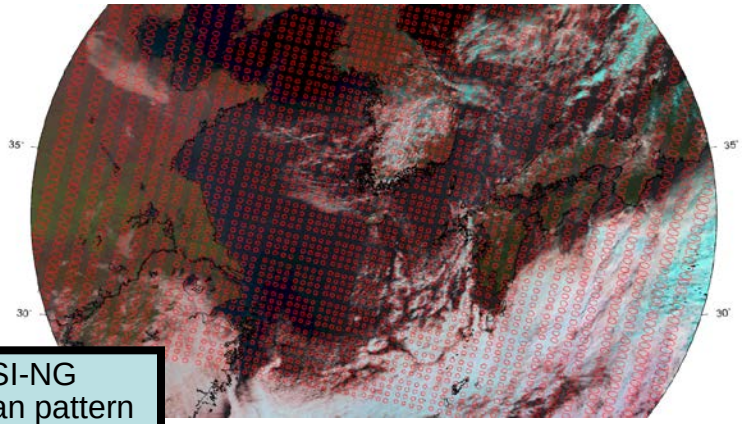
Satellite observation impact per platform



Metop-SG: instruments

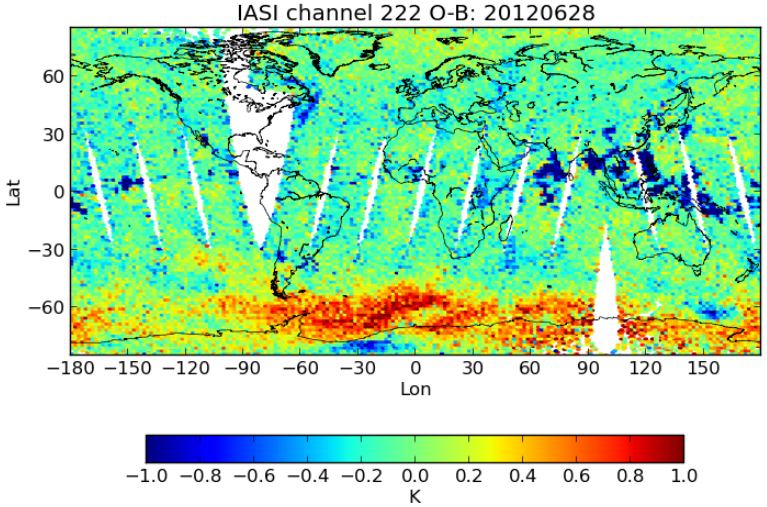
High-resolution infra-red sounding IASI → IASI-NG (CNES)

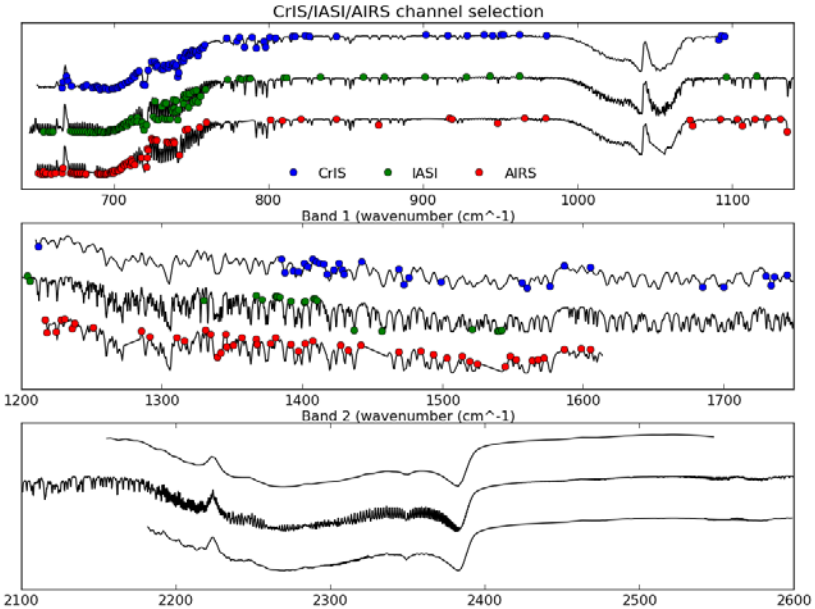
- Heritage: IASI (Metop)
- Objectives:
- temperature/humidity profiles at high vertical resolution
- sea/land/ice surface temperature
- clouds, minor/trace gases



IASI-NG scan pattern

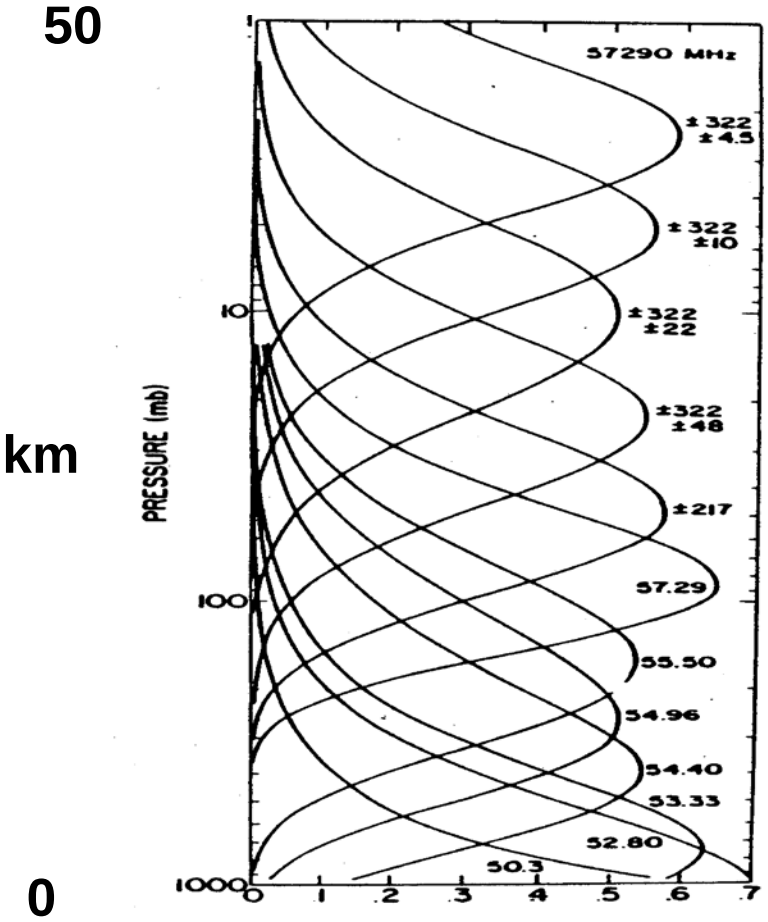
obs – model differences (T_B / K)
from short range (T+6h) forecast fields
T-sounding channel, peaking at 14km

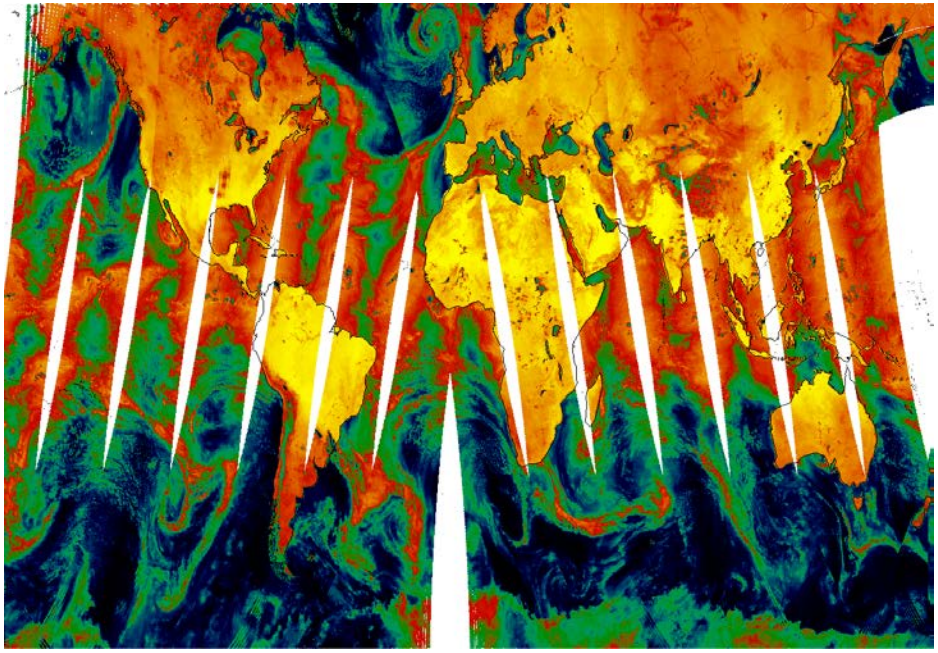




IASI-NG will provide (×2) improvements in:
spectral resolution; horizontal resolution & noise performance

Microwave sounding
MWS → ATMS → MWS



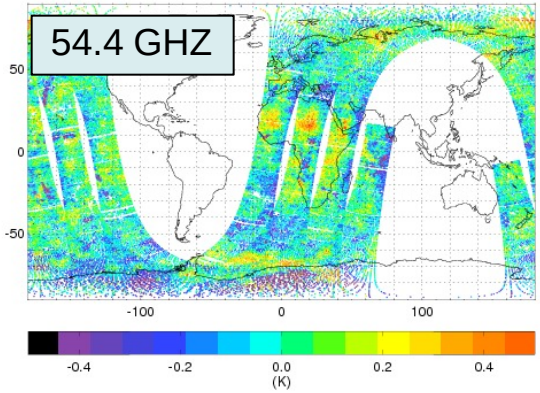


- Heritage: AMSU/MHS (NOAA, Metop)
- Objectives:
- temperature/humidity profiles in clear and cloudy air
- cloud liquid water total column
- imagery: precipitation and cloud liquid

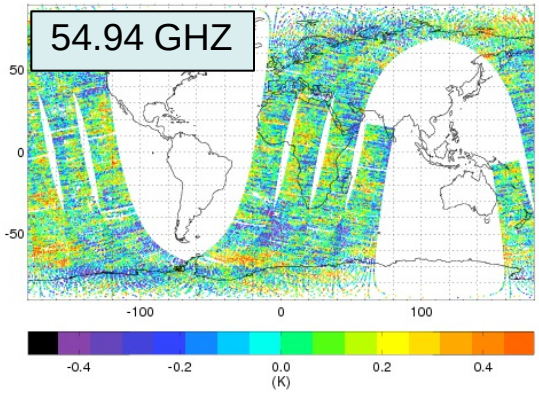
• 24 channels in the range 23 – 229 GHz
• Key channels are 50-60 GHz (T) and 183 GHz (humidity)

MWS
Radiometric performance & scan pattern

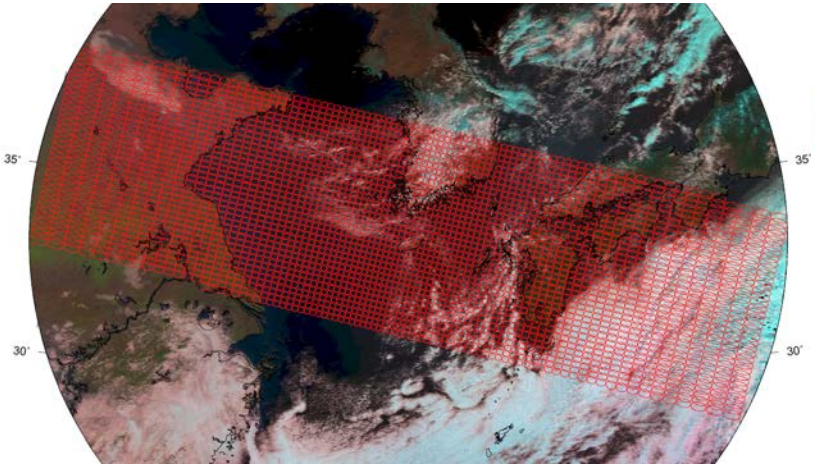
NOAA19 ch6, C-B, 08/11 QU00

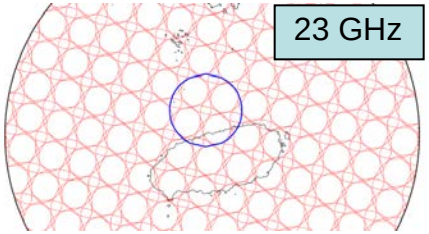


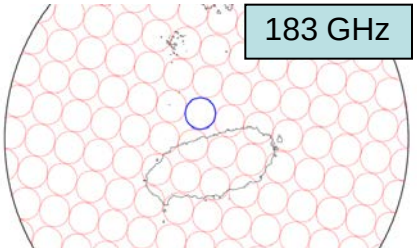
NOAA19 ch7, C-B, 08/11 QU00

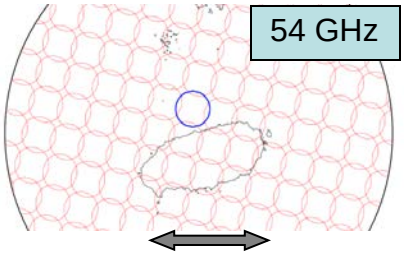


- geophysical signals small : ~ 50-100 mK (stdev)
- NEΔT ~ 100 - 200 mK
- Radiometric performance specifications are demanding - for temperature sounders







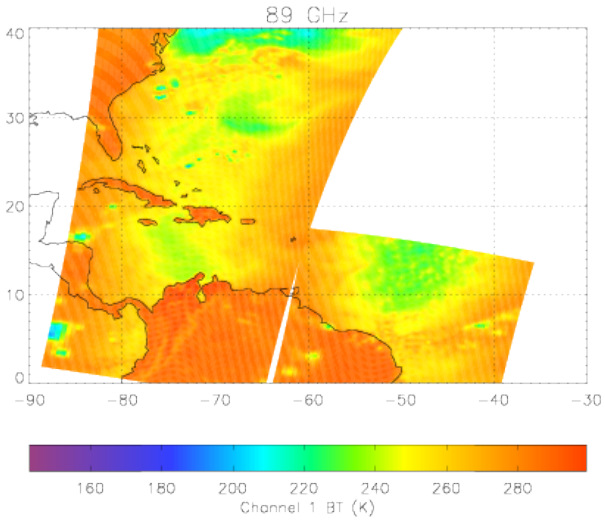


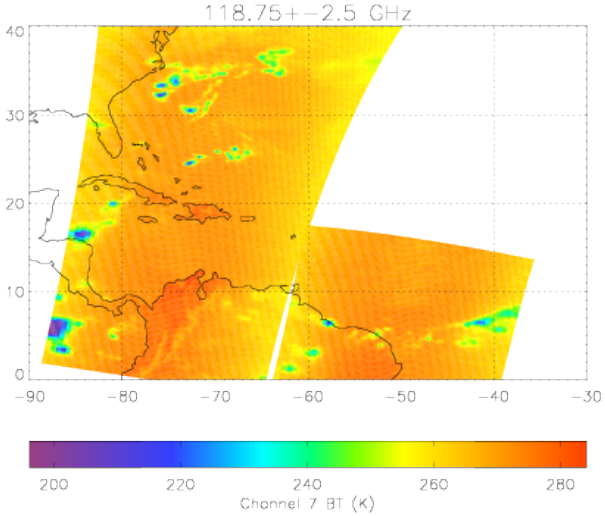
60km

Microwave Imaging - precipitation focus
MWI (ESA)

- Heritage: SSMI, SSMIS, AMSR
- (frequencies: 18-183 GHz)

- Objectives
- cloud and precipitation
  - part of Global Precip. Mission (GPM)
- total column water vapour (ocean)
- sea-ice
- sea surface wind speed
- snow water equivalent





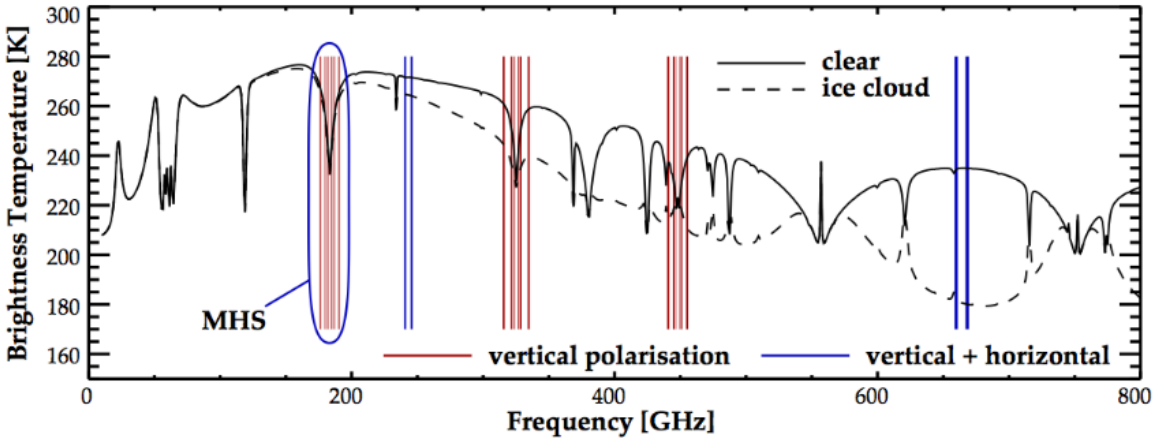
Data from CMA FY-3C MWHS-2 (a sounder – but illustrating potential of 118 GHz channels for cloud and precipitation)

Microwave Imaging – ice cloud focus
ICI (ESA)

- Heritage: none (some ESA proposals)
- (frequencies: 183-664 GHz)

- Objectives
- cloud ice content (mainly total column)
- frozen precipitation
- water vapour profile

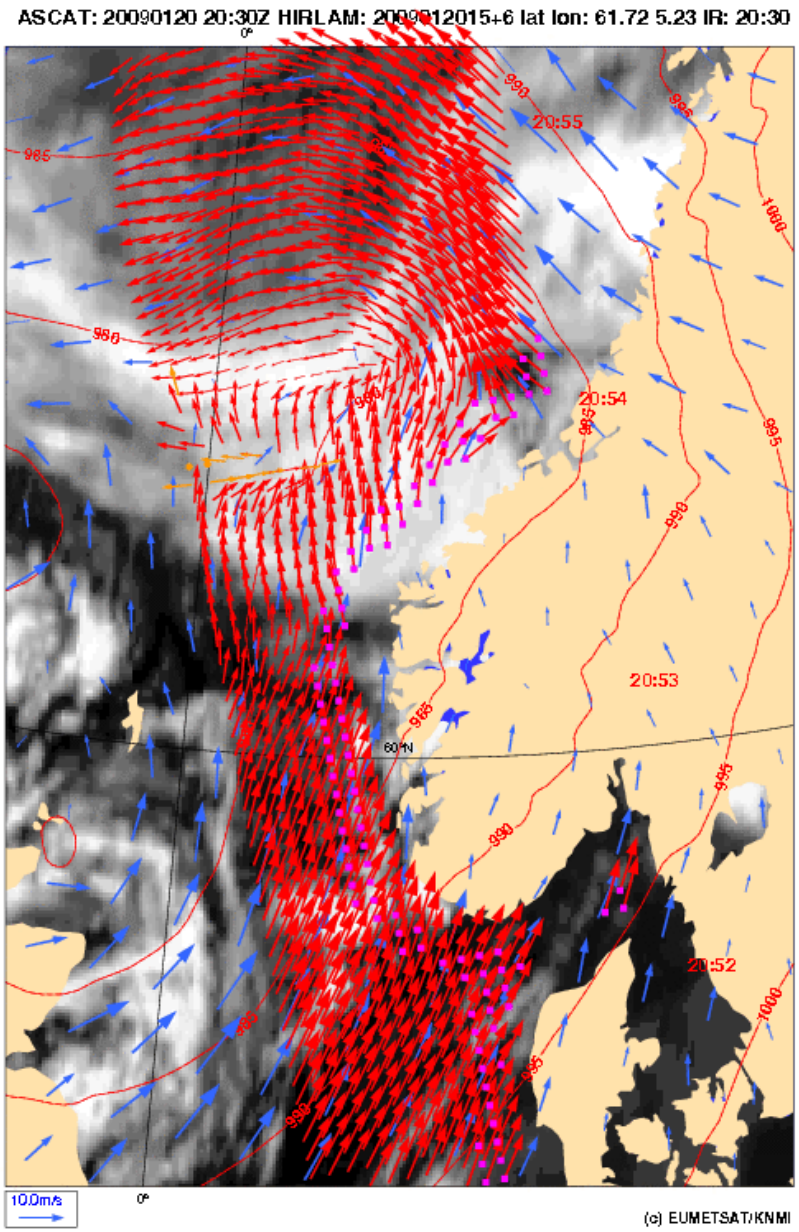
Channel	frequency [GHz]	polarisation
1	183.31 ± 7.00	45° / V
2	183.31 ± 3.40	45° / V
3	183.31 ± 2.00	45° / V
4	243.2 ± 2.5	45° / V,H
5	325.15 ± 9.50	45° / V
6	325.15 ± 3.50	45° / V
7	325.15 ± 1.50	45° / V
8	448.0 ± 7.2	45° / V
9	448.0 ± 3.0	45° / V
10	448.0 ± 1.4	45° / V
11	664.0 ± 4.2	45° / V,H



Scatterometry SCAT (ESA)

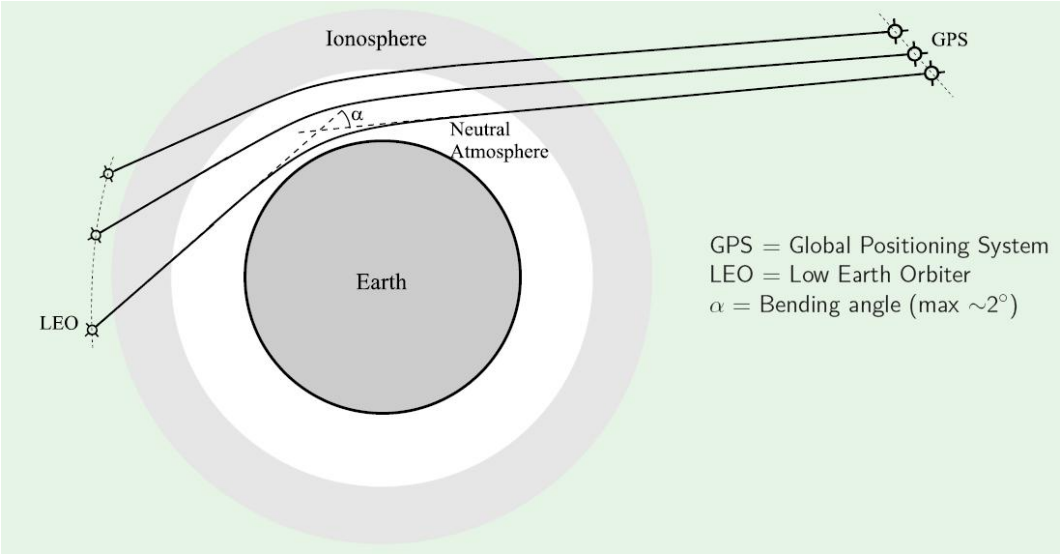
- Heritage: ASCAT (Metop)

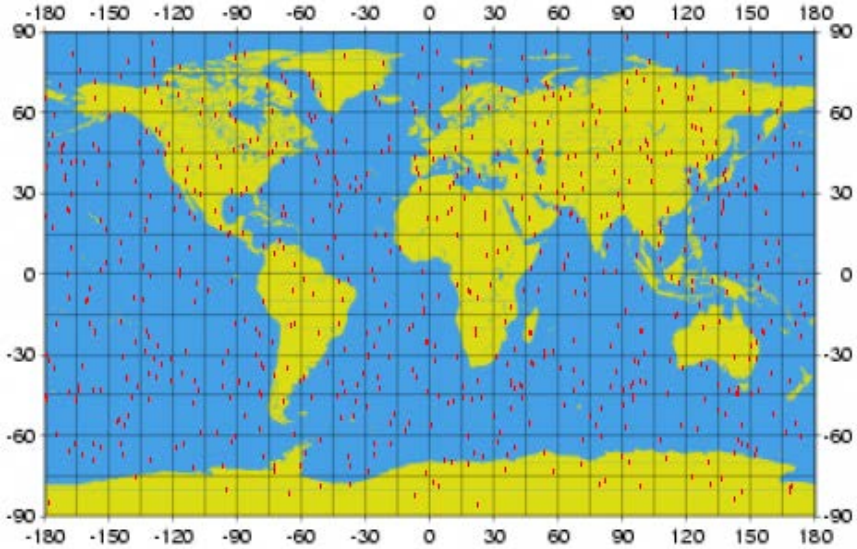
- Objectives
- ocean surface wind speed and direction
- soil moisture
- snow equivalent water
- sea-ice type

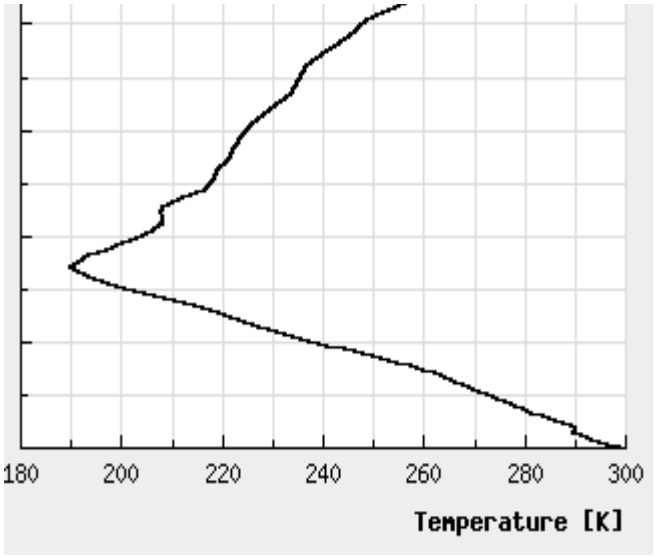


Radio occultation RO (ESA)

- Heritage: GRAS (Metop)
- Objectives:
- refractivity profiles at high vertical resolution
  - temperature / humidity profiles
- ionospheric electron content



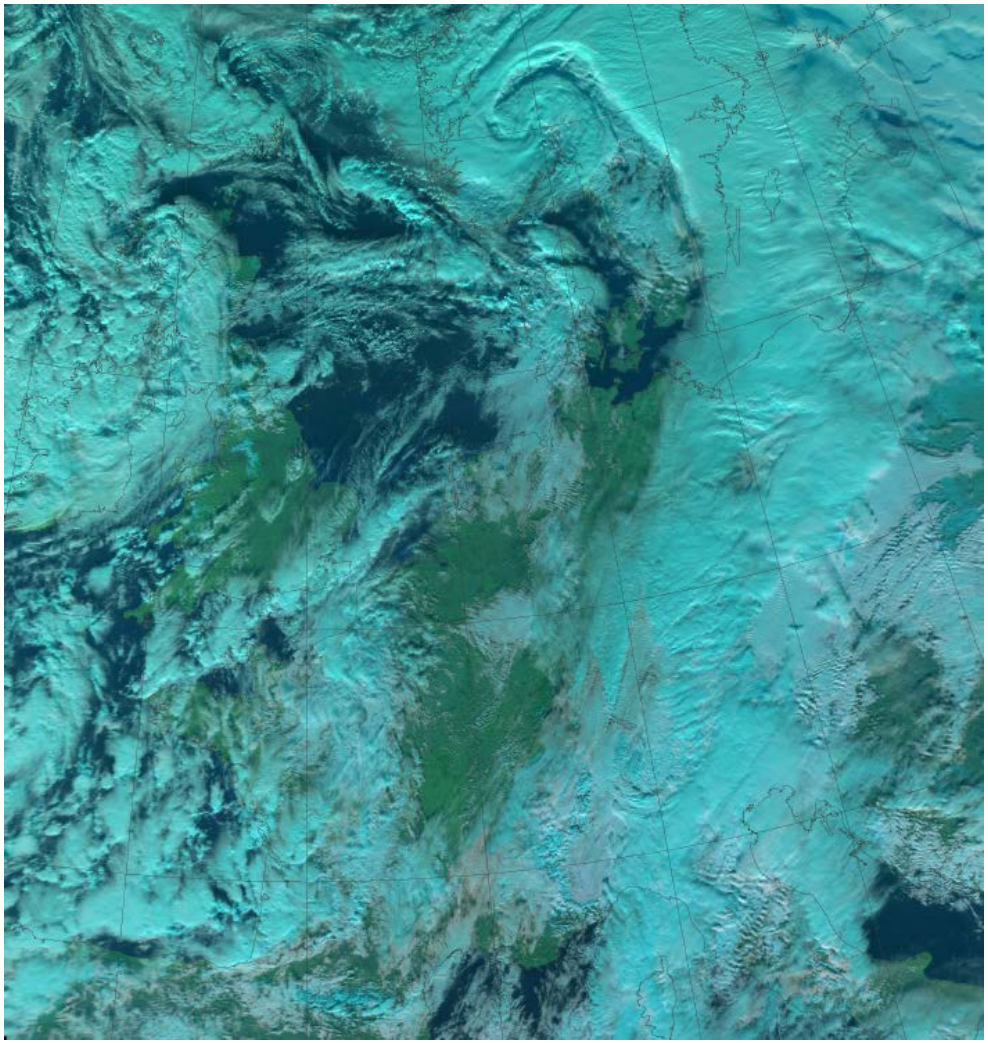




Visible / infra-red imaging: METimage (DLR)

- Heritage: AVHRR, MODIS, VIIRS

- Objectives:
- high-resolution cloud products, including cloud microphysics
- aerosols
  - incl. dust and volcanic ash
- winds at high latitude
- sea/ice/land surface temp
- vegetation, snow, fire
- support to sounding missions

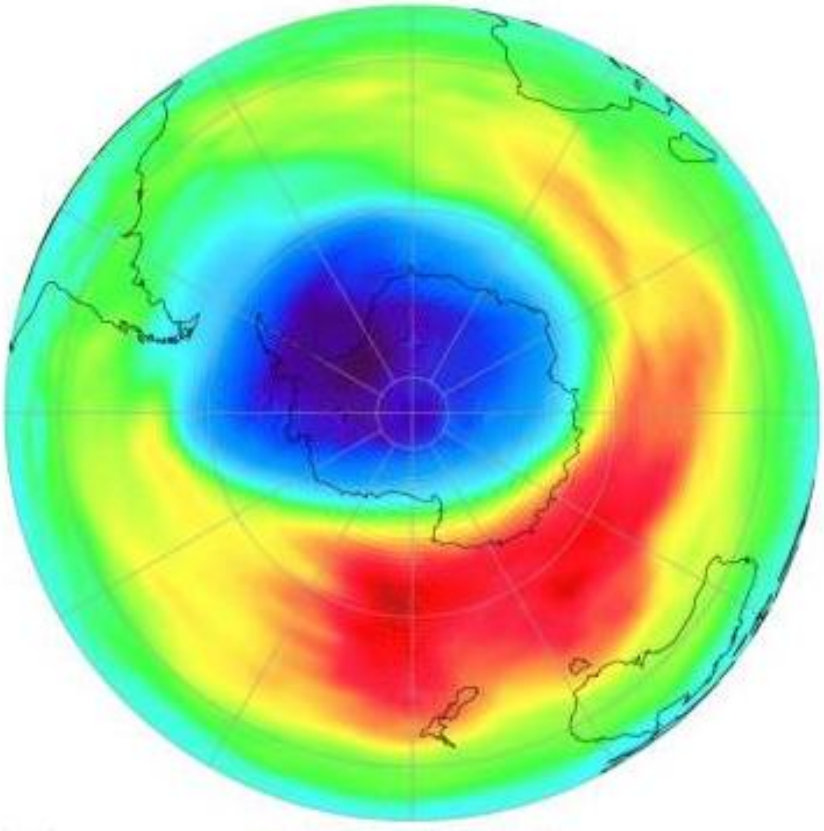


Nadir-viewing UV-SWIR spectrometry UVNS (Sentinel-5, ESA)

- Heritage: GOME-2 (Metop)

- Objectives
- ozone profile and column
- columns of SO_2, NO_2, H_2O, CO, CH_4
- aerosol optical depth
- columns of BrO, HCHO, OCHCHO
- column of CO_2

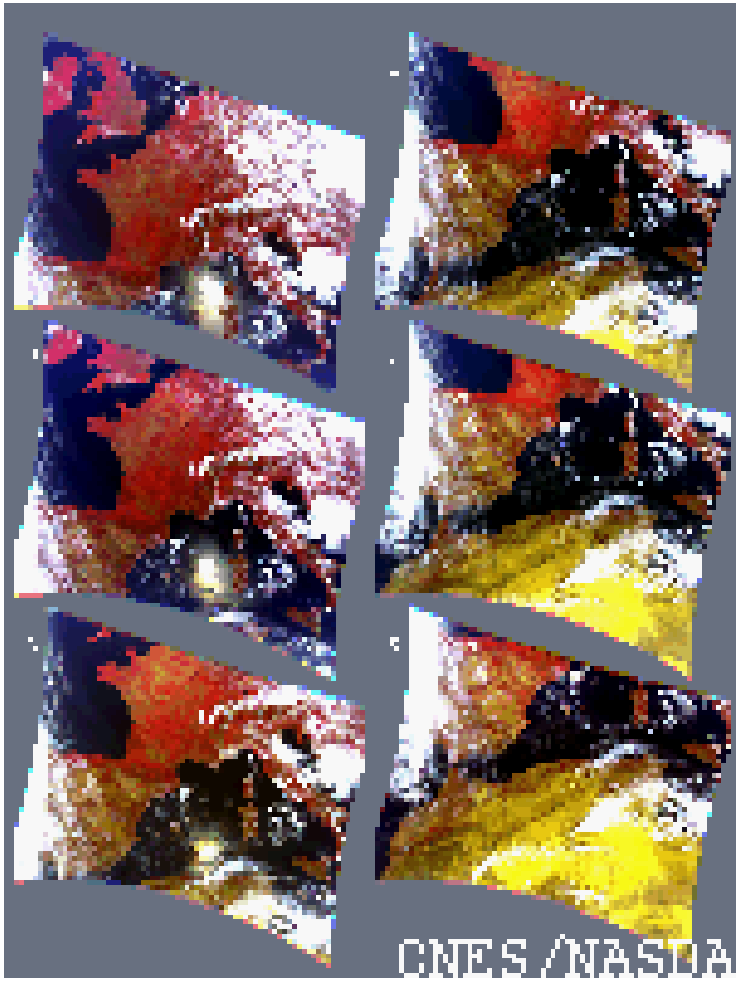
- Implementation:
- EU's GMES Sentinel-5



Multi-viewing multi-channel multi-polarisation imaging 3MI (ESA)

- Heritage: POLDER (ADEOS)

- Objectives
- aerosol – optical thickness, particle size, type, height, absorption
- cloud phase, height, optical depth
- surface albedo, ocean colour



Summary

- Metop-SG will provide long term continuity (2020 - 2040) for the MetOp series in the morning orbit plane, serving NWP, climate and composition applications
- Payload includes all key instruments for NWP (including MWS and IASI-NG)
- Most instruments provide performance improvements over current capability.
- MWS (UK's primary contribution) is critical for NWP, key aspects of the instrument performance are :
  - Radiometric sensitivity; and
  - Pre-launch characterisation