Meteosat Third Generation (MTG): Background and upcoming applications

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Weather (and climate) related Economic Risks

Among 30 global risks, extreme weather events & natural disasters are ranked as the top 2 global risks in terms of likelihood, and ranked 2 and 3 in terms of impact on economies;

Failure of climate change mitigation and adaption comes shortly after.

National & Regional Meteorological and Hydrological and Climate Services are key providers of information for reducing the major economic risks associated with extreme weather, natural disasters, and climate change.

Source: World Economic Forum, Global Risks Perception Survey, 2018

Meteosat Third Generation: Imaging mission (MTG-I)

- Imagery mission implemented by two MTG-I satellites
- Full disc imagery every 10 minutes in 16 bands
- Fast imagery of Europe every 2.5 minutes
- New Lightning Imager (LI)

- **Start of operations in 2022**
- **Operational exploitation: 2022-2042**

Meteosat Third Generation: Sounding mission (MTG-S)

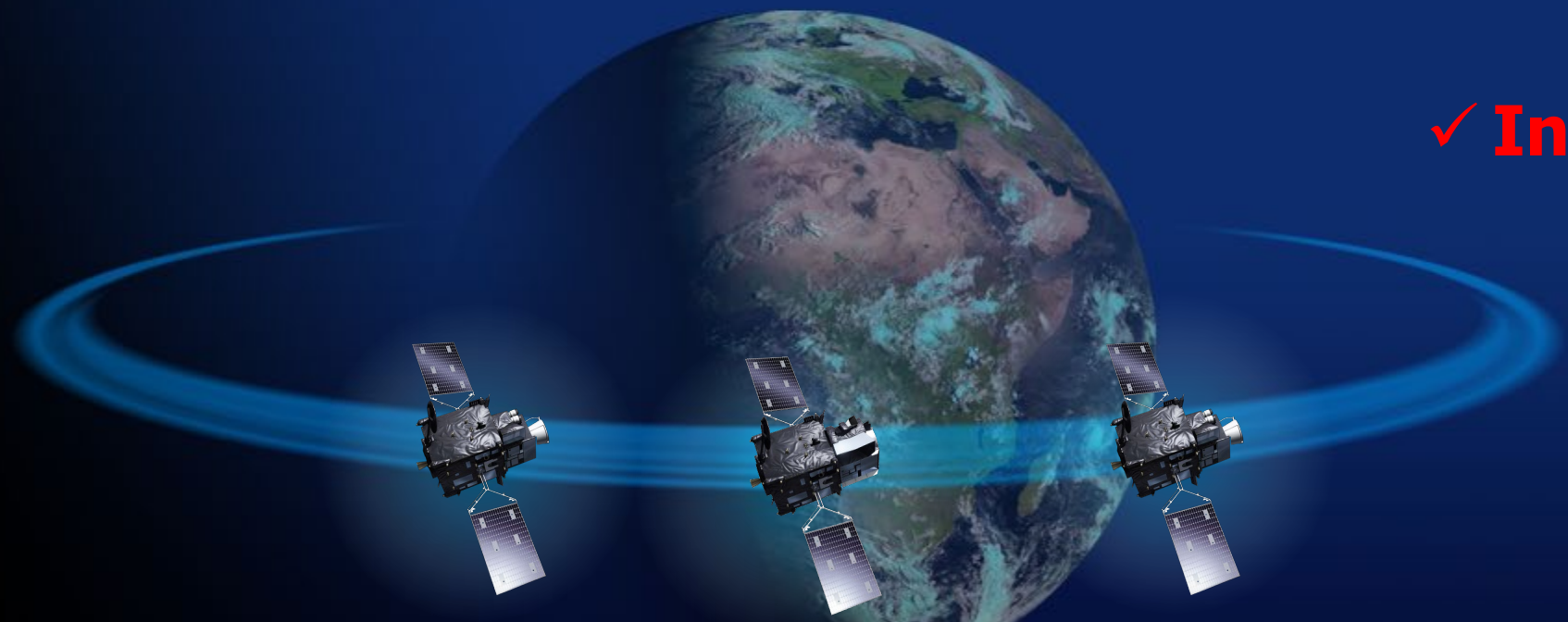
- Hyperspectral infrared sounding mission
- 3D weather cube: temperature, water vapour, O3, every 30 minutes over Europe
- Air quality monitoring and atmospheric chemistry in synergy with Copernicus Sentinel-4 instrument

- **Start of operations in 2024**
- **Operational exploitation: 2024-2043**

Meteosat Third Generation (MTG): Full operational configuration

✓ **Continuity**

✓ **Innovation**



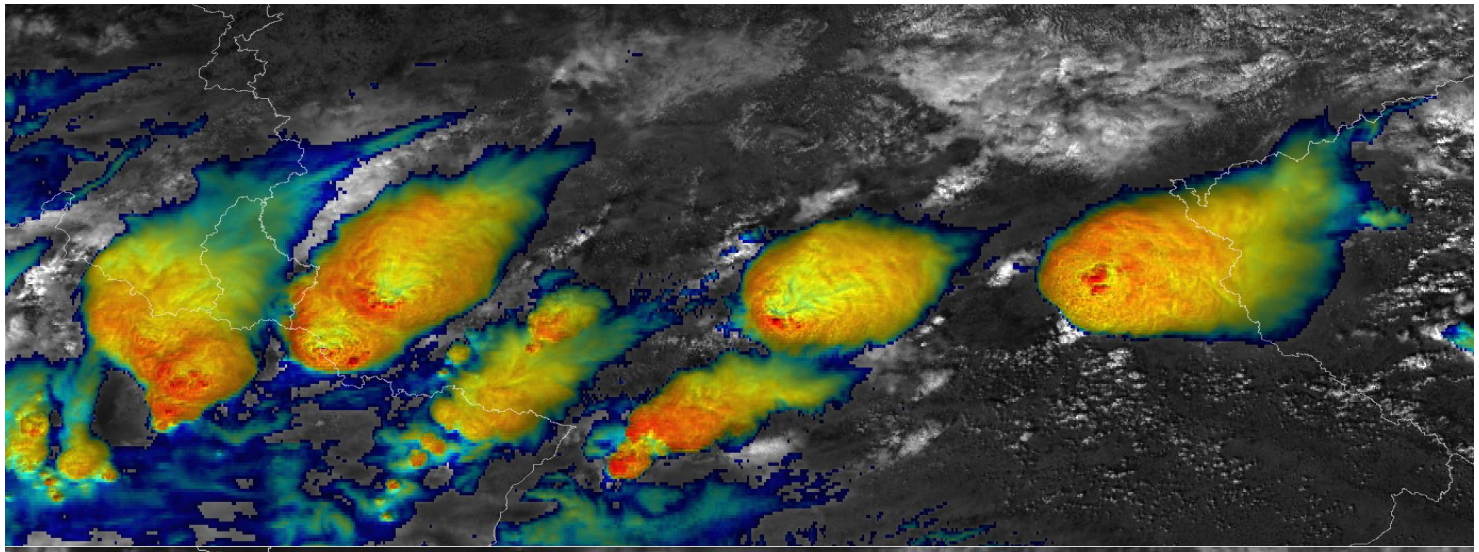
MTG-I
Rapid Scan Service

MTG-S
Sounding Service

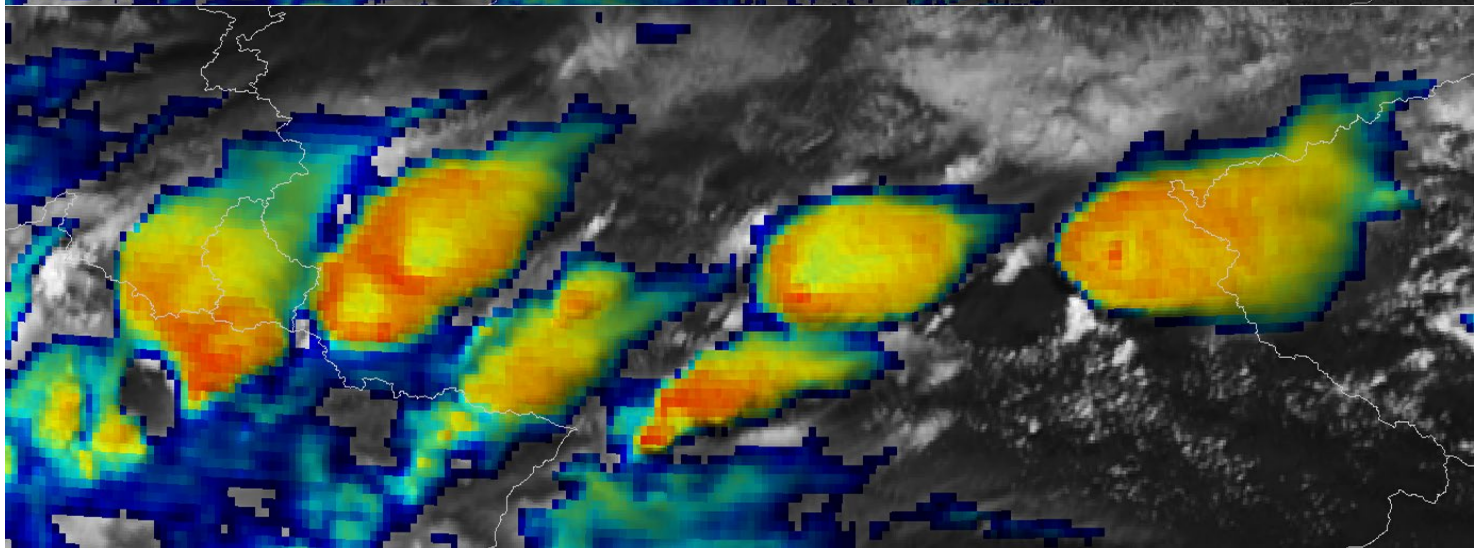
MTG-I
Full Scan Service

MTG Imager (FCI): Cloud top of convective storms through higher spatial and temporal resolution

Future



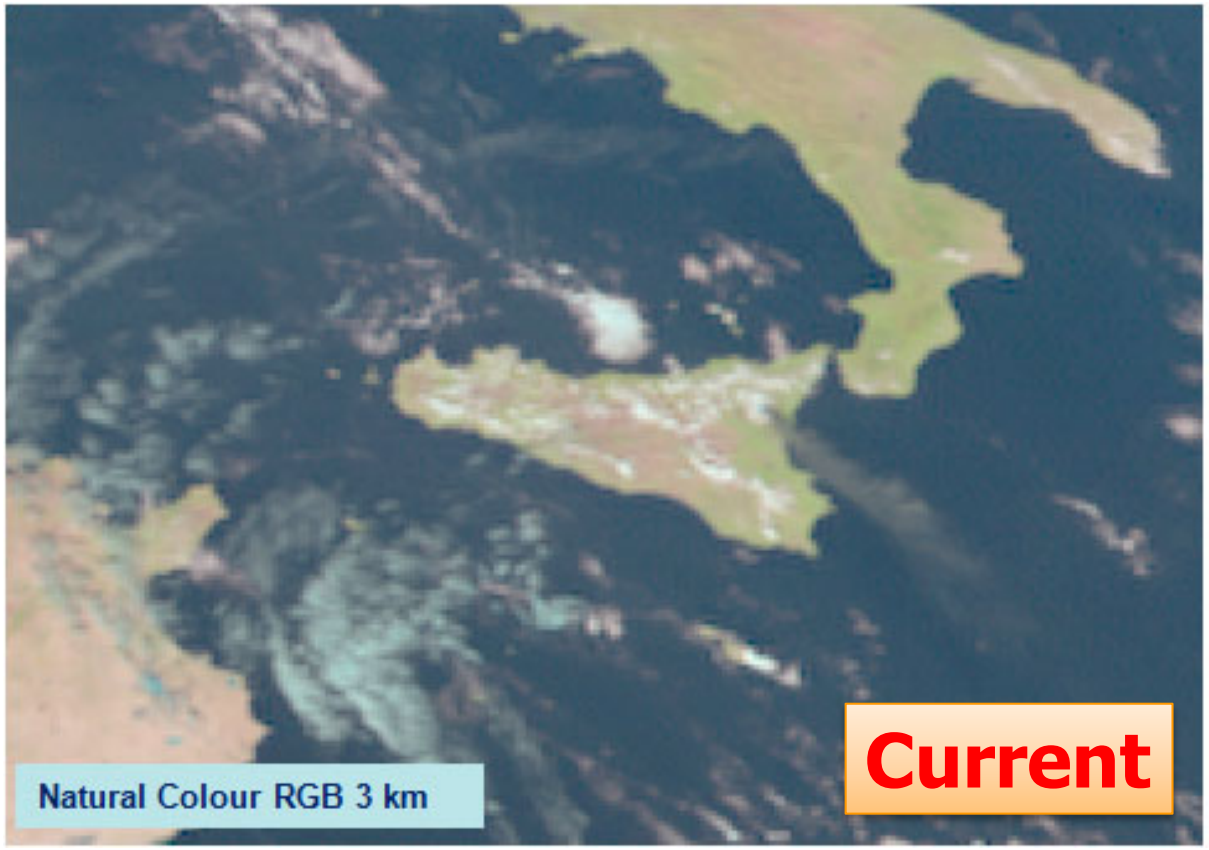
Current

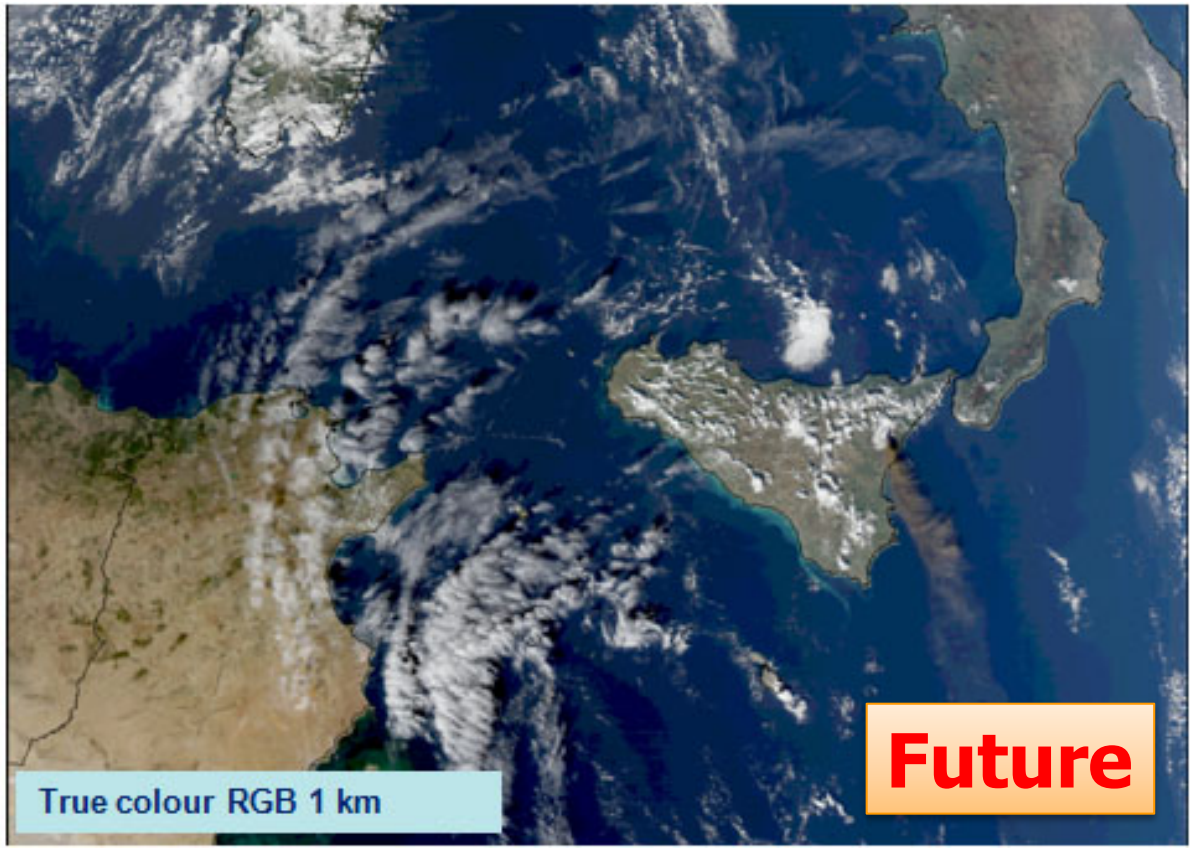


FCI imagery simulated over Central Europe based on data from the VIIRS instrument on the NOAA Suomi-NPP satellite; combining 0.865 µm imagery (background) and 11.45 µm (convective storms) to a 'sandwich' product

Courtesy M. Setvak

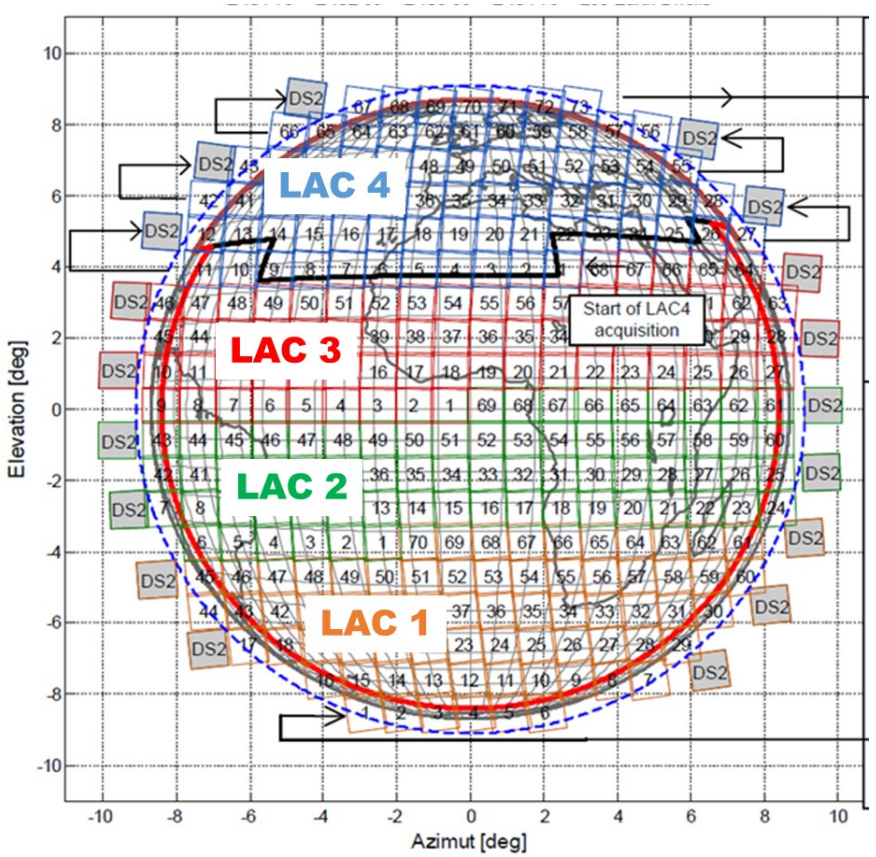
MTG Imager (FCI): higher spatial resolution imagery

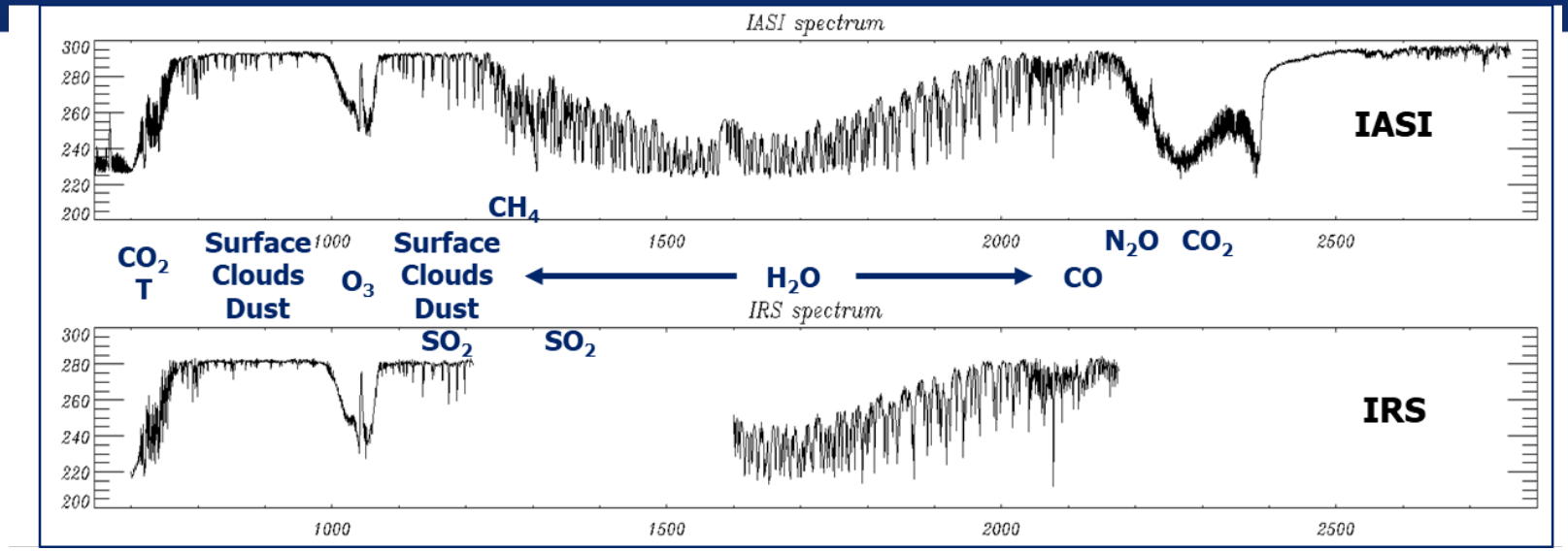




Example of ash detection, SEVIRI Natural Colour RGB, 12:15 UTC, 26 November 2006 (left), MODIS True Colour RGB, 12:20 UTC, 26 November 2006

MTG Infra-Red Sounder (IRS)

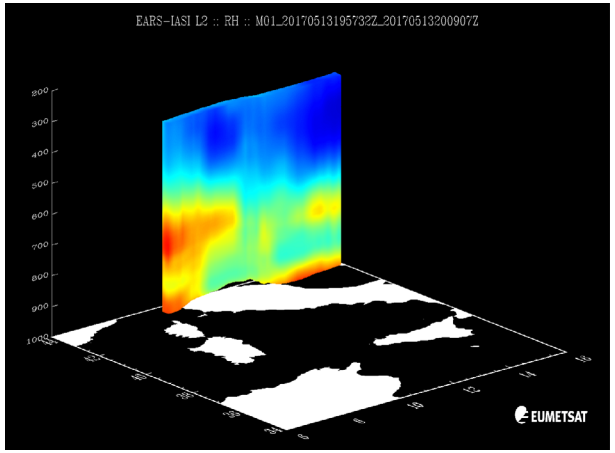




4 Local Area Coverage (LAC):

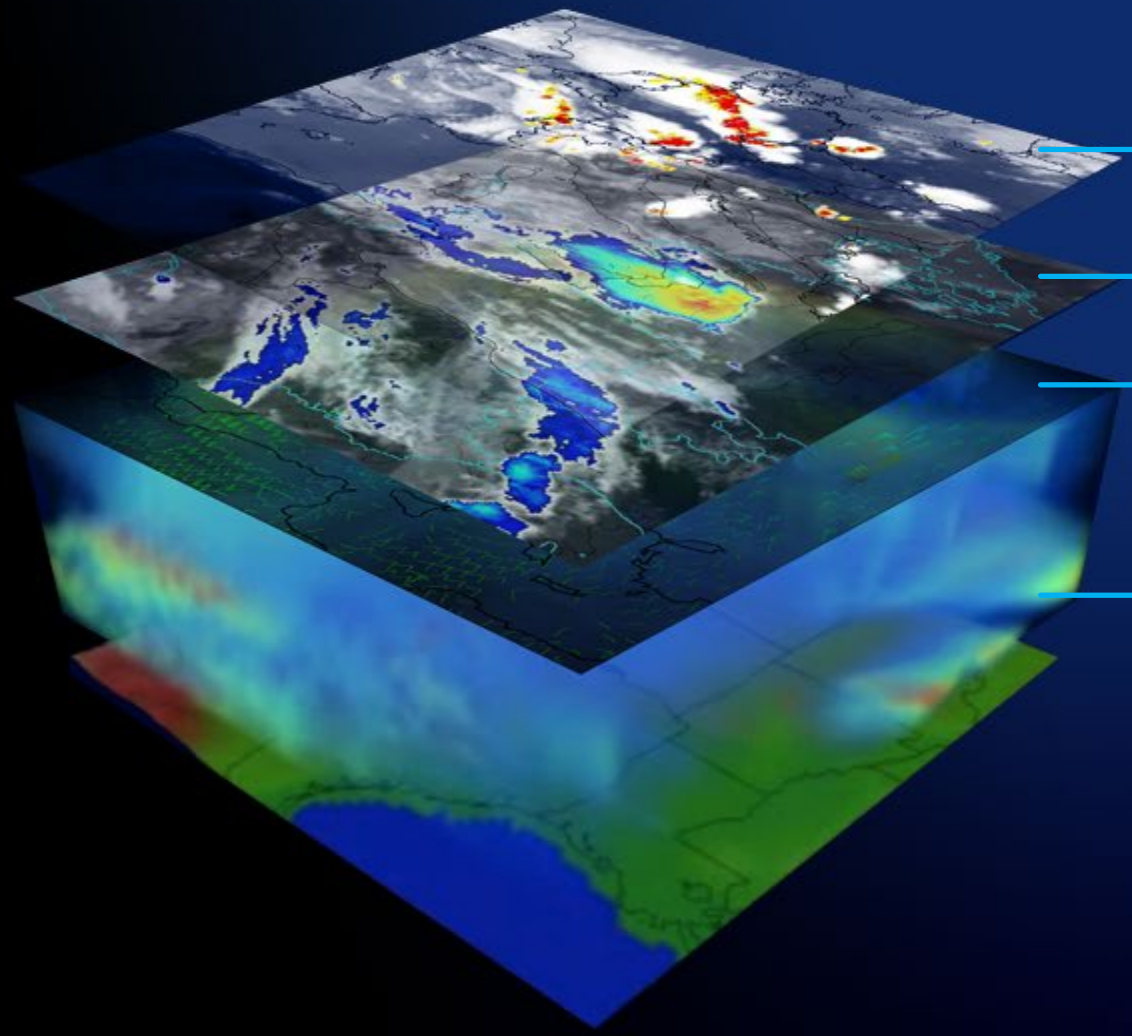
- One LAC acquired within 15'
- Overlapping step & stare dwells
- 160x160 pixels, ~4km at Nadir
- Europe (LAC 4) observed every 30'

Major innovation: Operational spectro-imagery at high spectral, spatial & temporal resolution



EUMETSAT

‘4D Weather Cube’: Probing the atmosphere to detect severe weather



Lightning

Convection

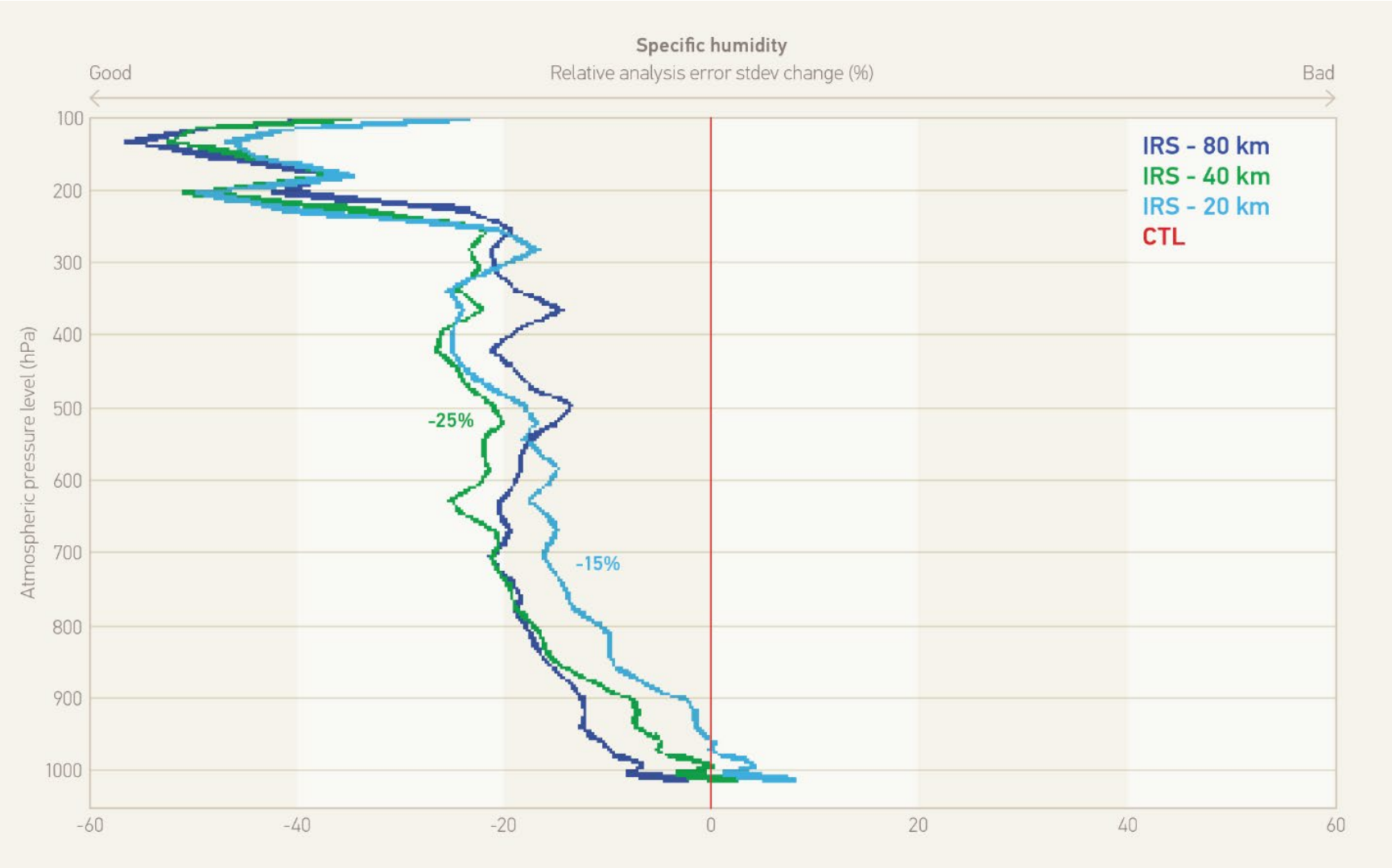
Winds

Atmosphere

Enabled by MTG

Every 30 min over Europe

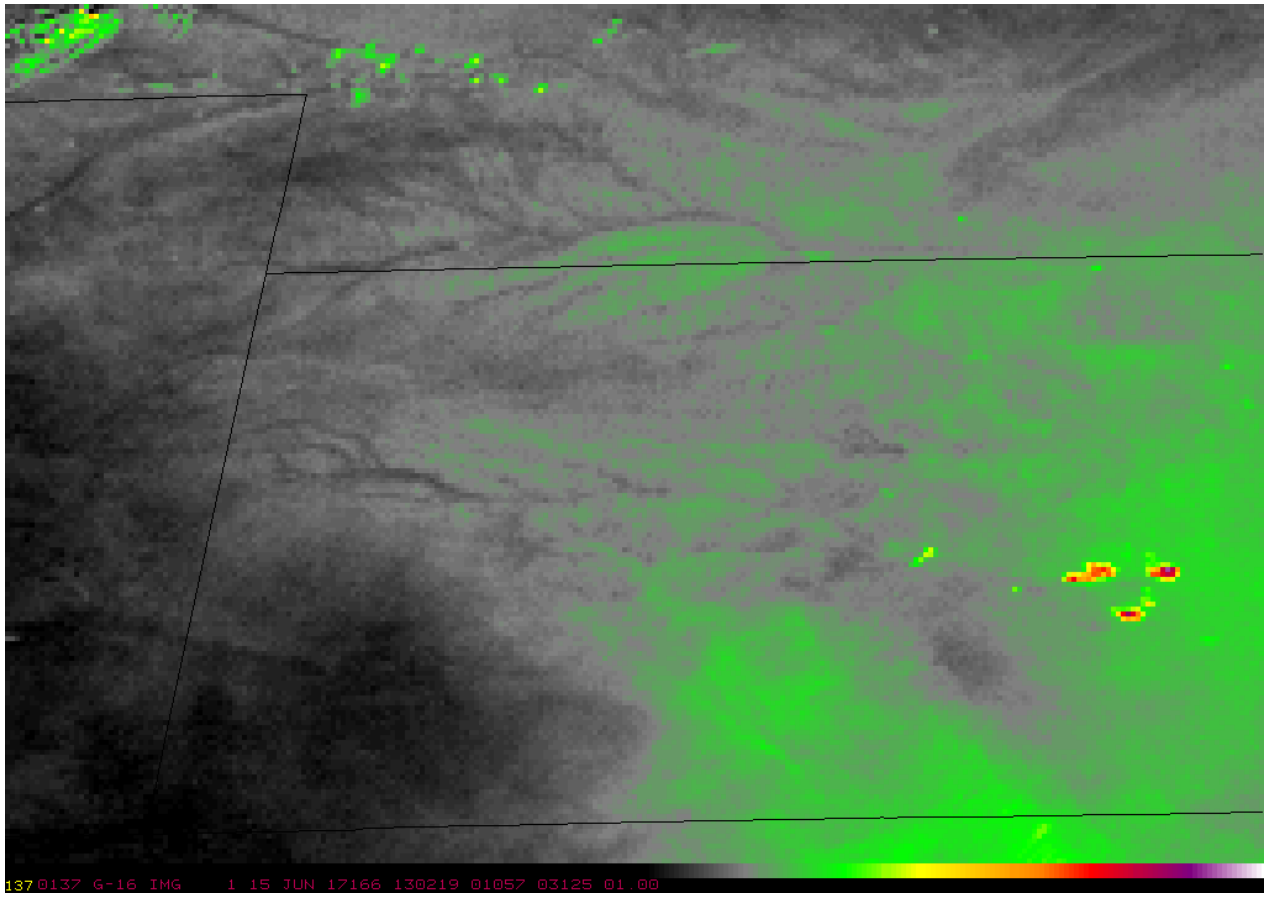
MTG InfraRed Sounder (IRS): Enhancing numerical weather prediction



Simulated MTG infrared sounding data have a demonstrated positive impact on regional weather modelling, by reducing the error of forecasting specific humidity and other meteorological parameters

Source: Guedj et al., 2014

MTG Imager and Sounder: Detecting convective initiation



Detection of low-level moisture over Kansas, USA, using the Split Window Difference (10.35 µm minus 12.3 µm) of NOAA GOES-16 ABI data (right panel, in orange-red colours), a precursor for potentially severe storms, while conventional imagery detect no signal (left panel)

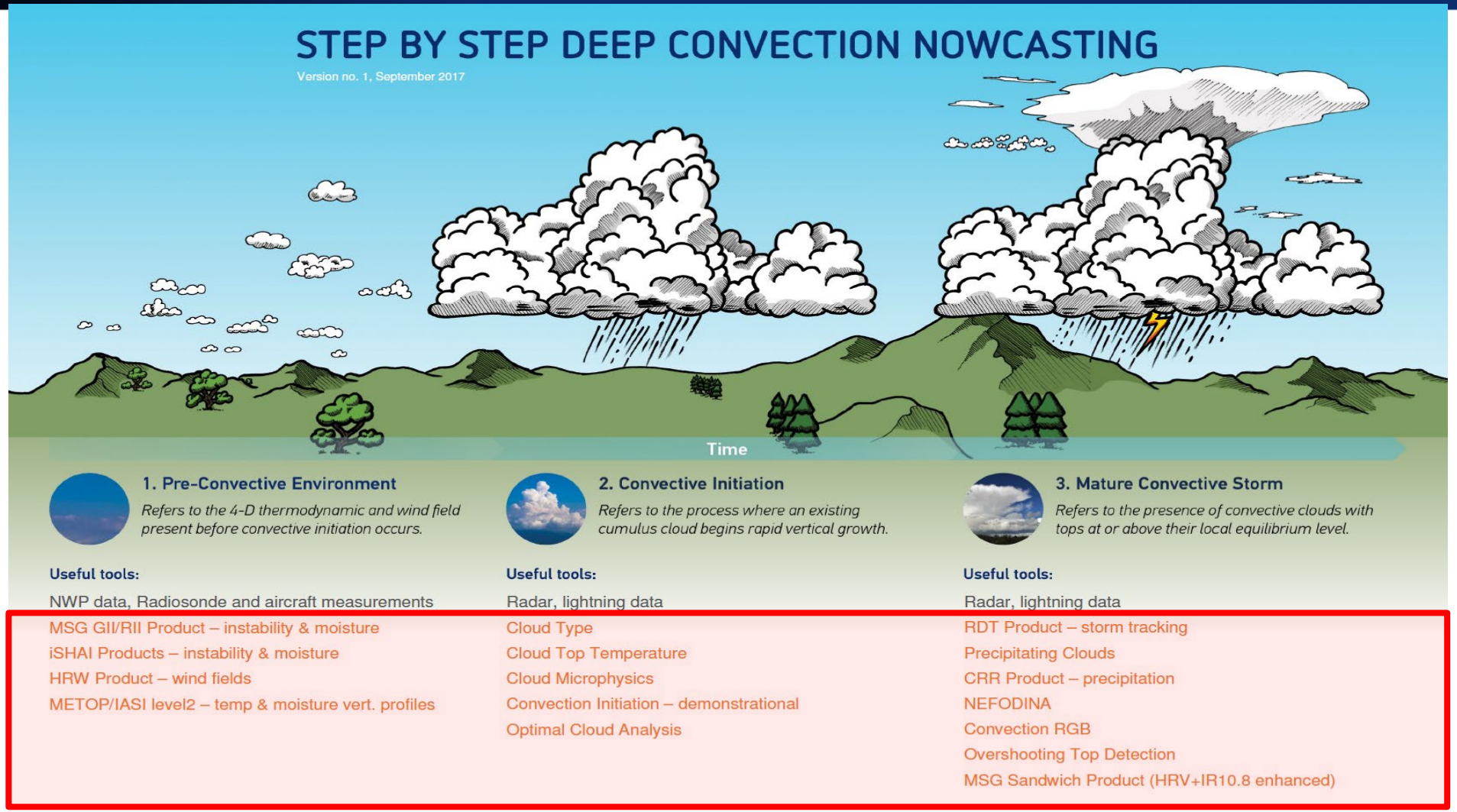
Courtesy: Dan Lindsey (NOAA), 15 June 2017

The low-level moisture boundary is evident about 2.5 h before clouds form.

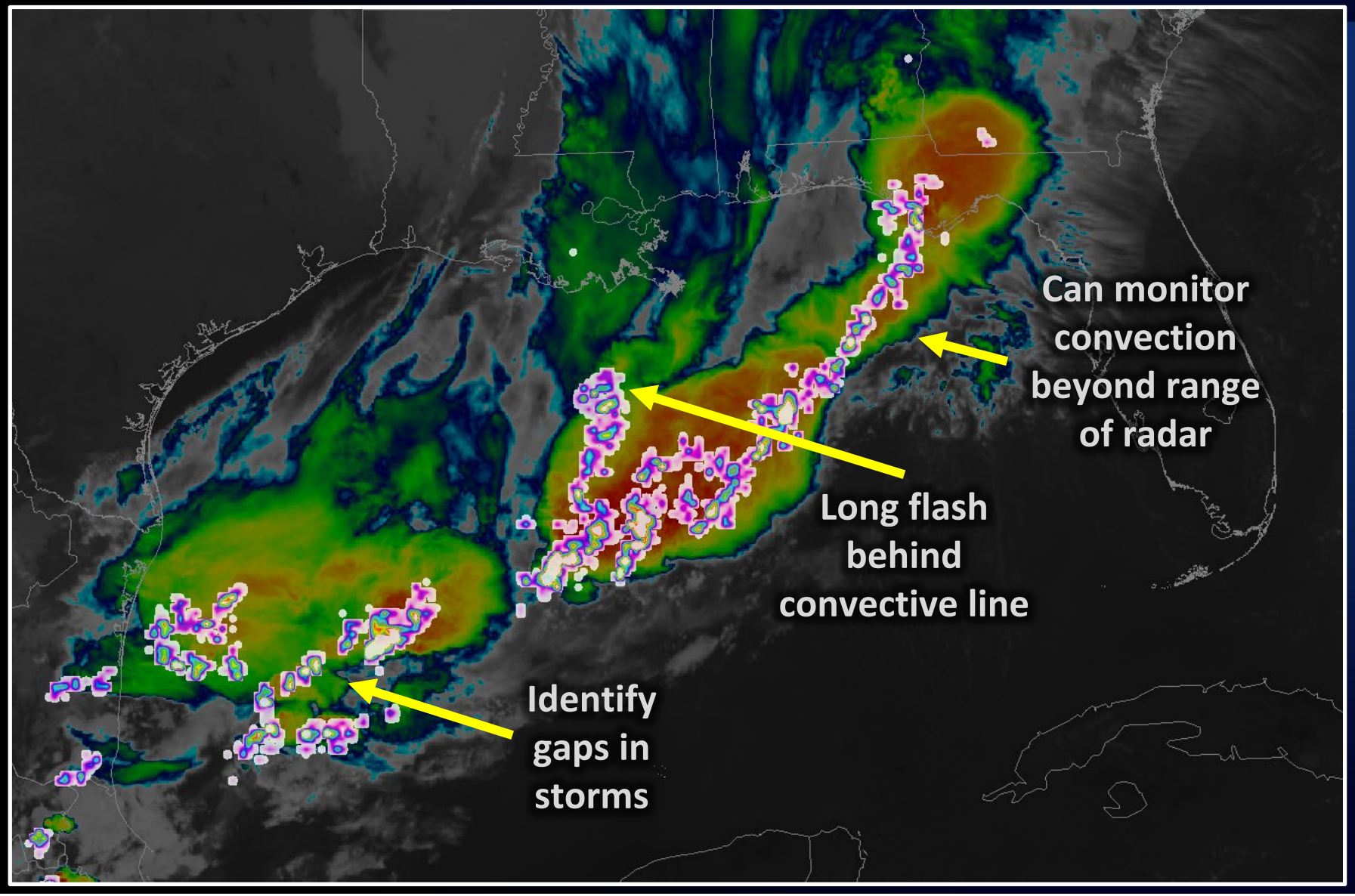
MTG Imager and Sounder: Tools for nowcasting convective storms

Existing satellite products

To be enhanced with MTG data



MTG Lightning Imager (LI): U.S. Proxy Data



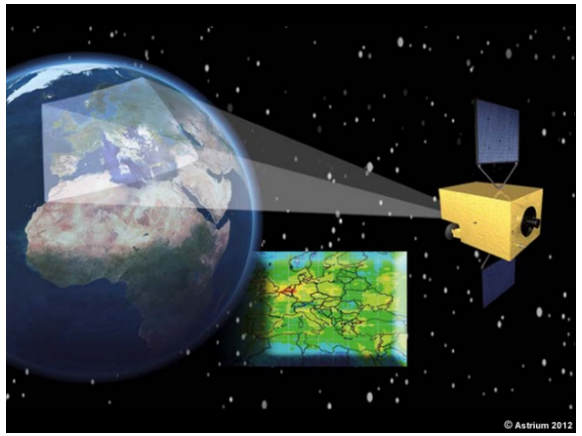
- Lightning activity monitored from space (white-blue-magenta in colours) along a convective storm line (yellow-orange-red shades in background infrared imagery) over the Gulf of Mexico.
- Weather forecasters have additional information to more precisely monitor convective development, especially in areas where detection efficiency of ground-based lightning detection networks is lower

Sentinel 4 on MTG-S Sounding Mission

The spatial resolution ~ 8 x 8 km
with hourly temporal resolution

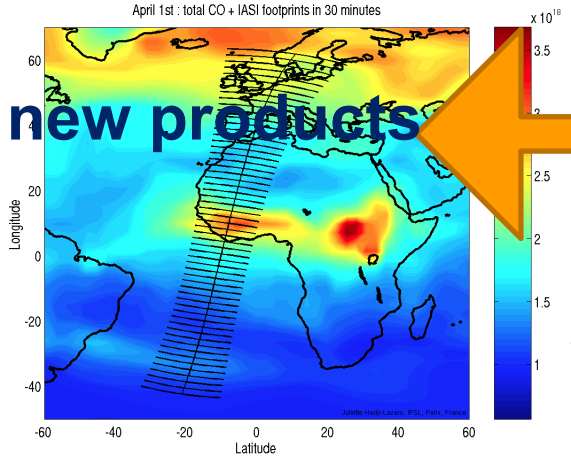
First Geostationary over EU

Focus on air quality with the main data products being O_3, NO_2, SO_2, HCHO, and aerosol optical depth.

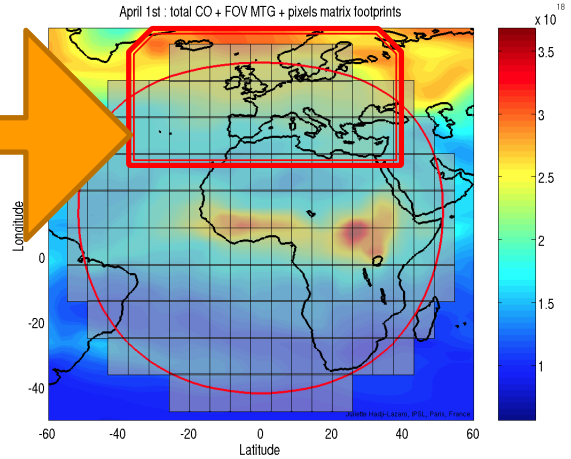


Synergy for new products

Sentinel 5 & 5P



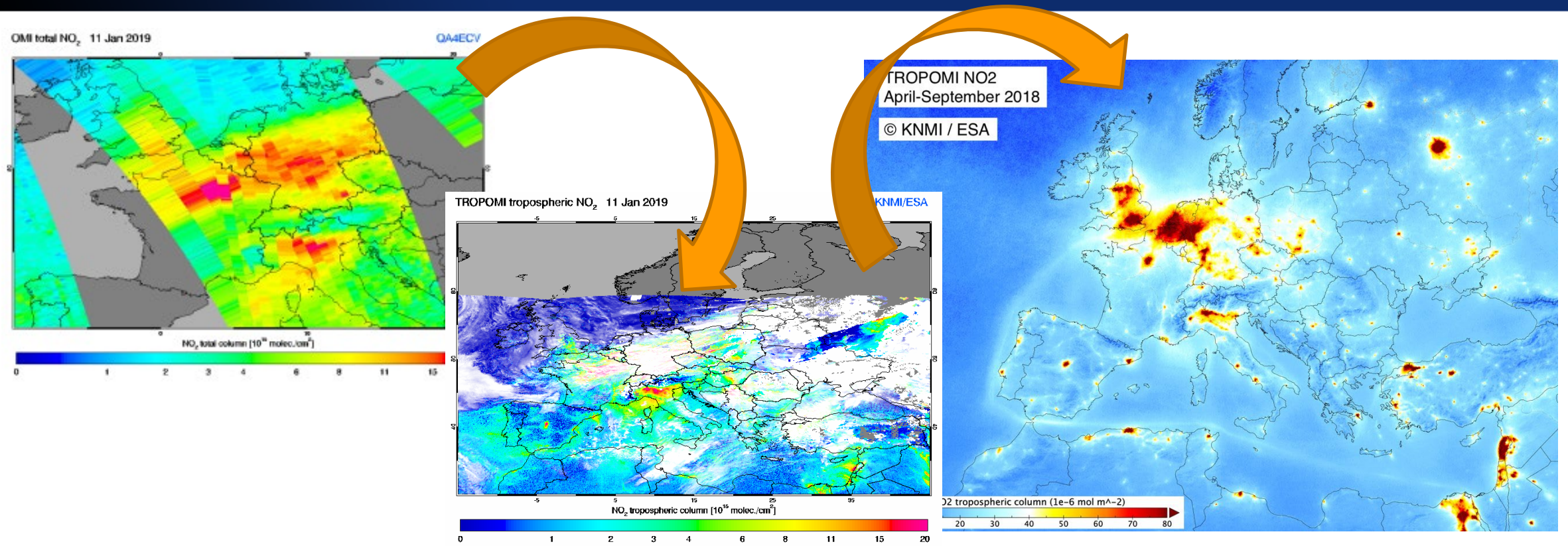
Sentinel 4



Start of operations: 2023

Operational : 2023-2042

NO_2 seen from satellite



Nitrogen dioxide is an important pollutant who act both as precursor and harmful gas, mainly as a result of human activity. Product of burning. Traces also from lightning (IPCC 2013).

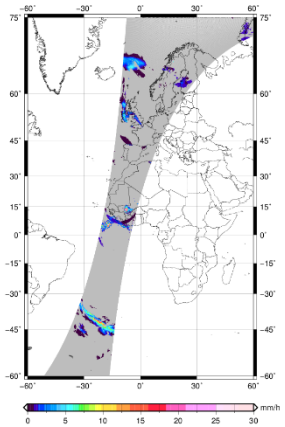
MTG data Application – improving H-SAF Rain estimation

H-SAF Objective: to provide satellite-derived products from existing and future satellites with sufficient time and space resolution to satisfy the needs of operational hydrology; identified products

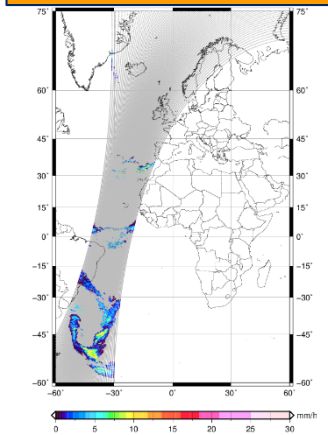
Current

MTG data Application (HSAF Rain estimation)

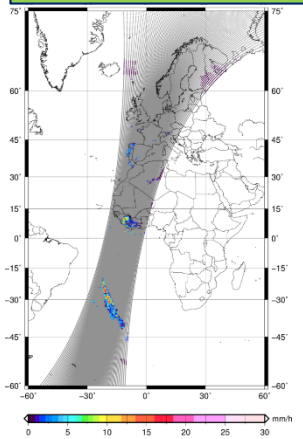
H01 – P-IN-SSMIS



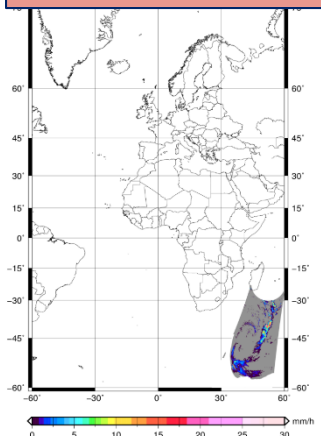
H02 – P-IN-MHS



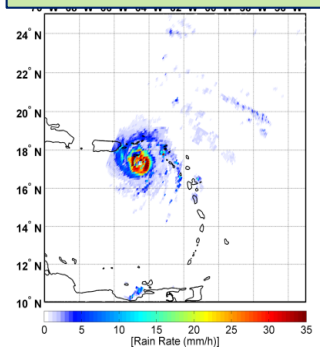
H18 – P-IN-ATMS



H-AUX-17 (AMSR2)

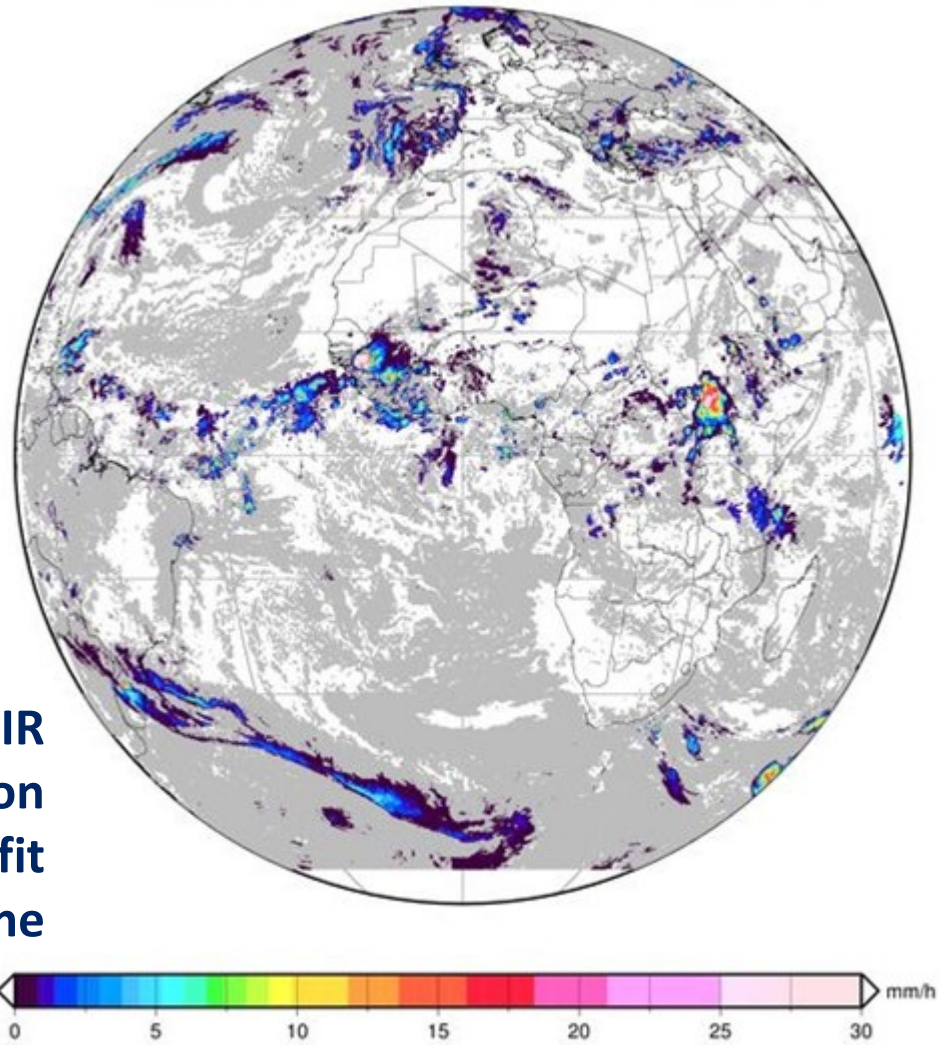


H-AUX-20 (GMI)



cross-track scanning) offering the most complete satellite based observations for precipitation monitoring and hydrological applications from physical and space/time resolution of IR.

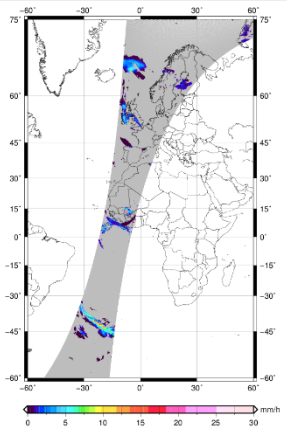
Combination of LEO MW estimates and GEOs IR observations due to the ability of MW radiation penetrate precipitating clouds and interact with liquid and ice hydrometeors



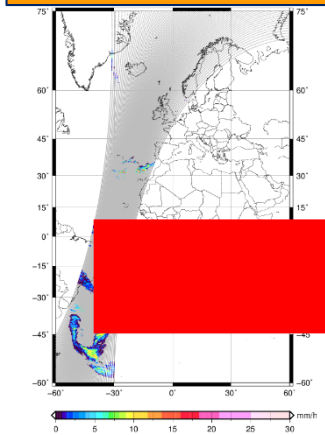
Current

MTG data Application (H-SAF Rain estimation)

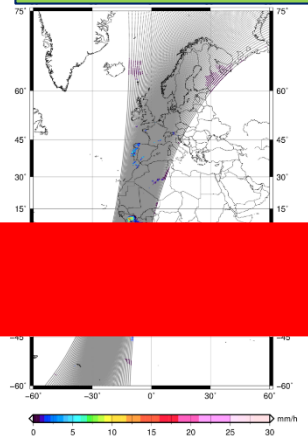
H01 – P-IN-SSMIS



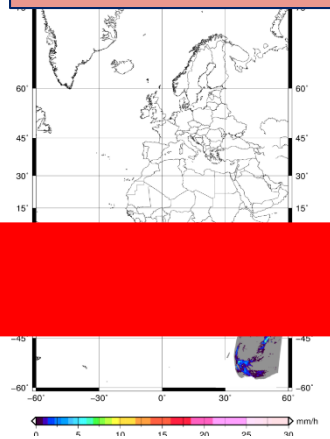
H02 – P-IN-MHS



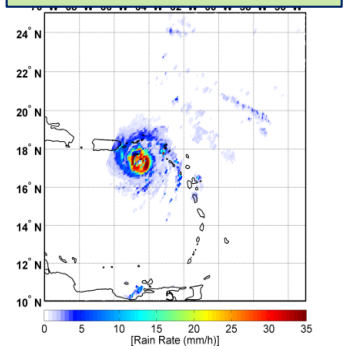
H18 – P-IN-ATMS



H-AUX-17 (AMSR2)

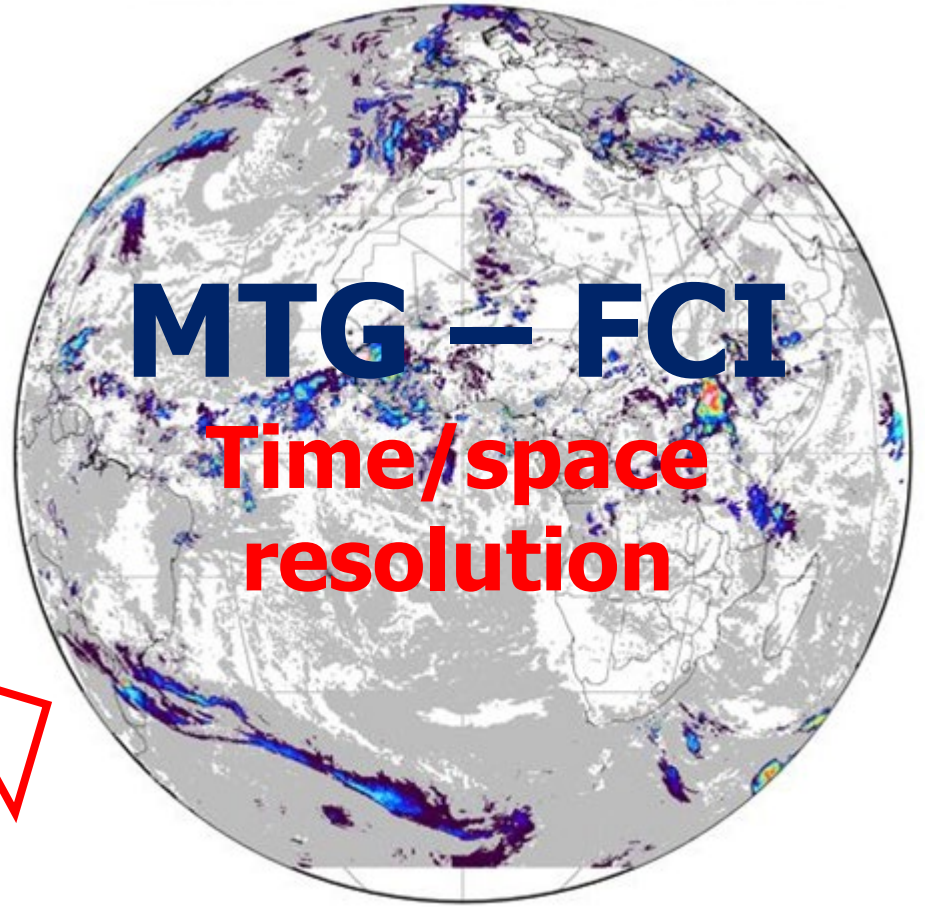


H-AUX-20 (GMI)



Microwave Imager (MWI)

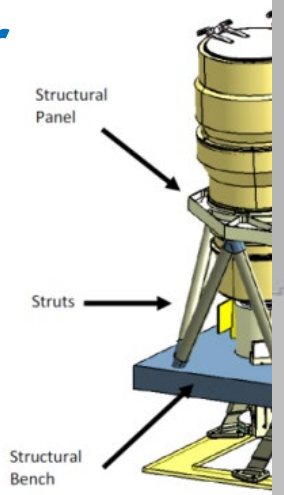
Microwave Sounder (MWS)



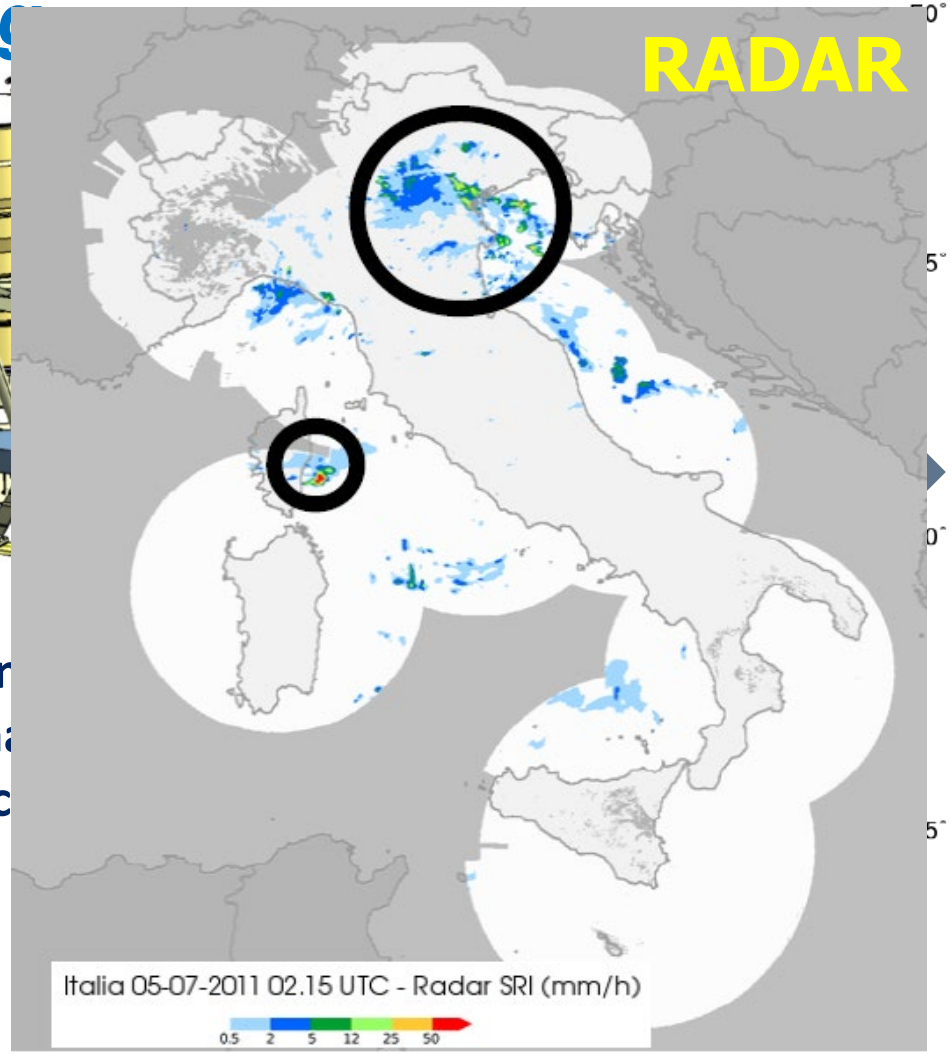
Future

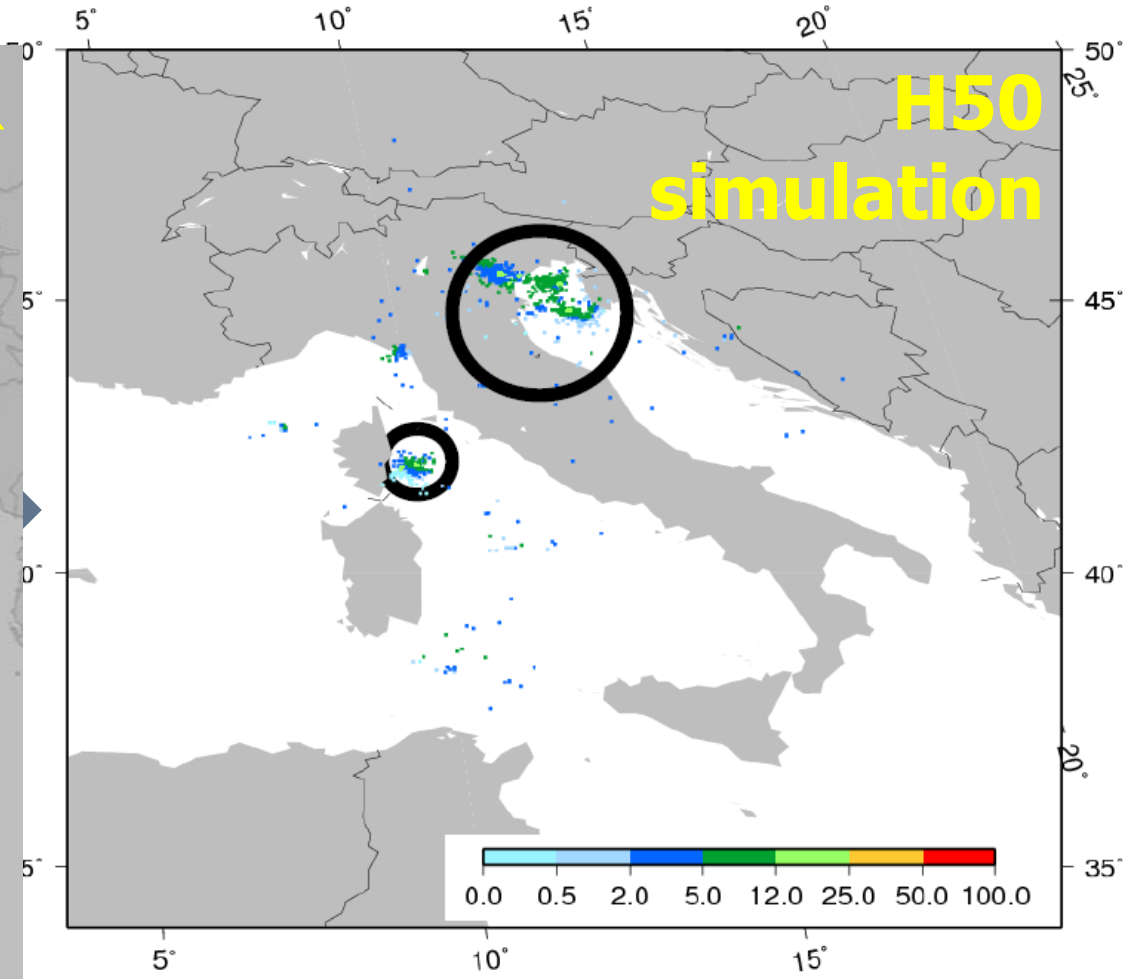
MTG data Application (HSAF Rain estimation)

MTG – Lightin… Imager



Lightning data contair… rainfall estimation, ma… where MW retrieval c…





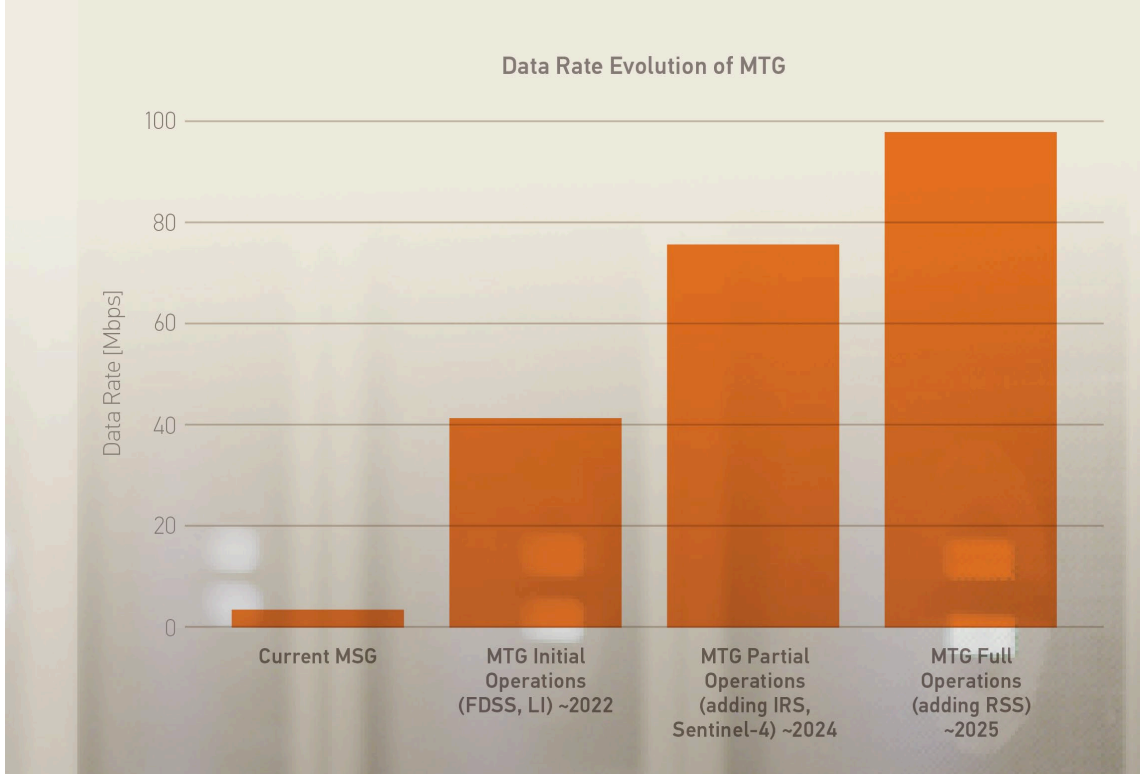
Future

Getting ready for MTG: A National Perspective

National technical infrastructure and resources are fit-for-purpose, in terms of :

increased data rates and volume and handling the novel data streams and their format in data processing and visualisation systems

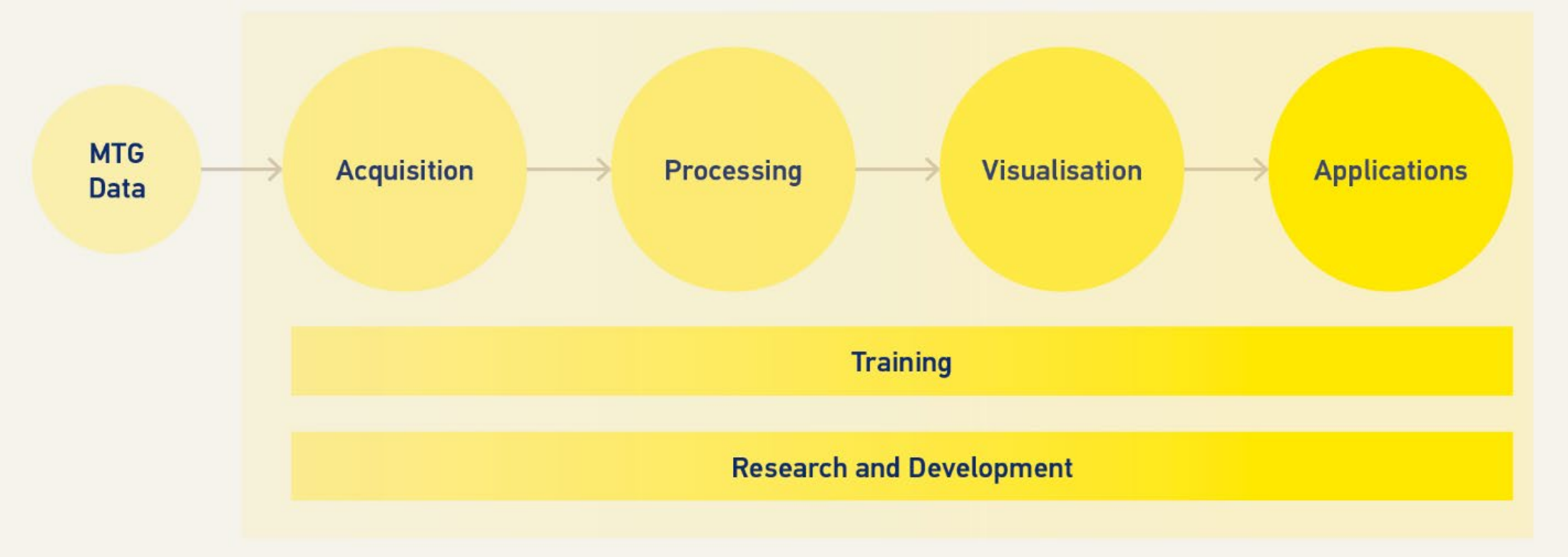
adapting local software, algorithms and products to MTG data & ingesting MTG data and products into applications



→ Several Member State NMHS have started user preparedness projects to address these issues.

User preparedness projects to (1) identify national priorities (2) define necessary scientific and technical developments (3) secure national resources (WMO, 2017).

Getting ready for MTG: A National Perspective

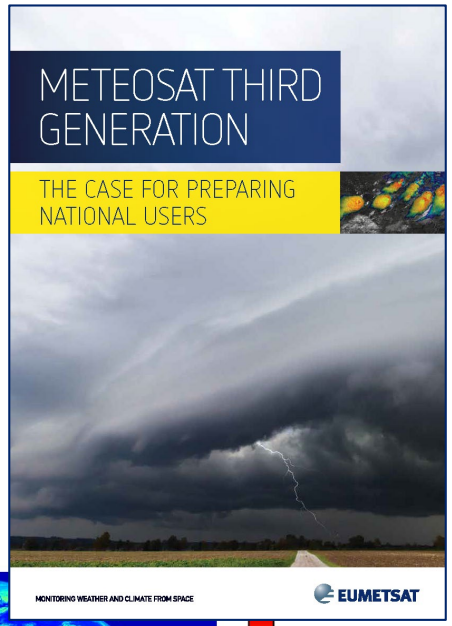


MTG-related data value chain, to guide the adequacy assessment of national infrastructure, and related investments.

How EUMETSAT can help

User Support
The EUMETSAT User Service Helpdesk can answer your questions regarding MTG. Contact our team at ops@eumetsat.int

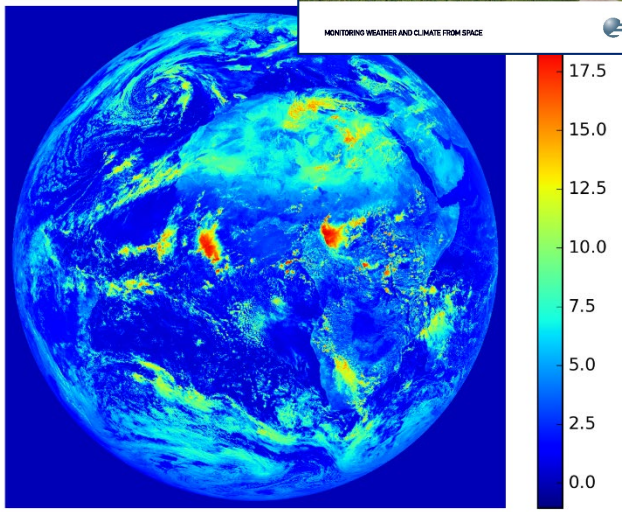
Training
Specific training programme based on consolidated experience
https://twitter.com/eumetsat_users or contact ops@eumetsat.int
Short term exchange program



MTG User Preparation Project (MTGUP)
Fostering cross-institutional exchange of experience and collaboration on science, information, data access, familiarisation

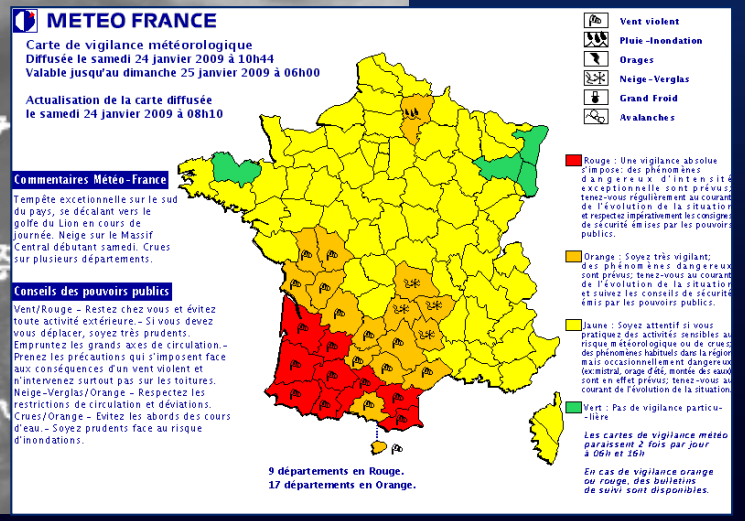
https://www.eumetsat.int/website/home/Satellites/FutureSatellites/MeteosatThirdGeneration/MTGResources/index.html

In 2019 simulated data by EUMETSAT:
FCI Level 1c data for format – Upcoming !
IRS Level 1b data for format familiarisation
LI Level 2 data for user familiarisation

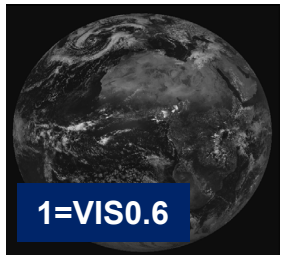


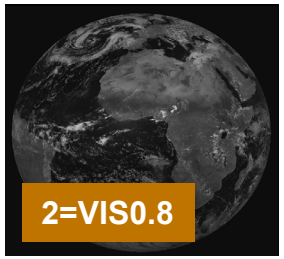
MTG enhances current capability for confirming forecasts

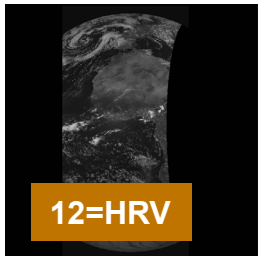
Winter storm "Klaus" 2009
MSG Water Vapour Imagery

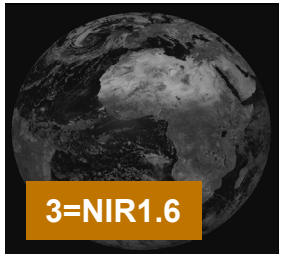


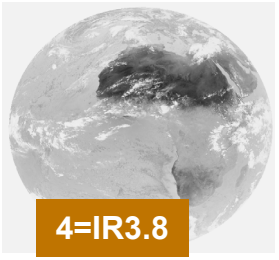
Current and future imagers channels: MSG SEVIRI and MTG FCI

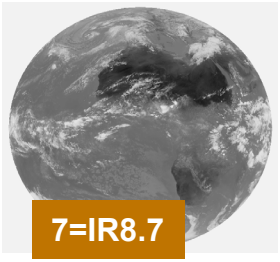


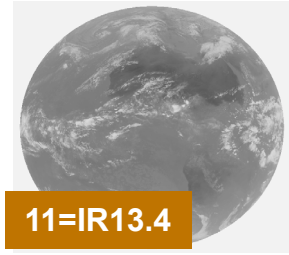








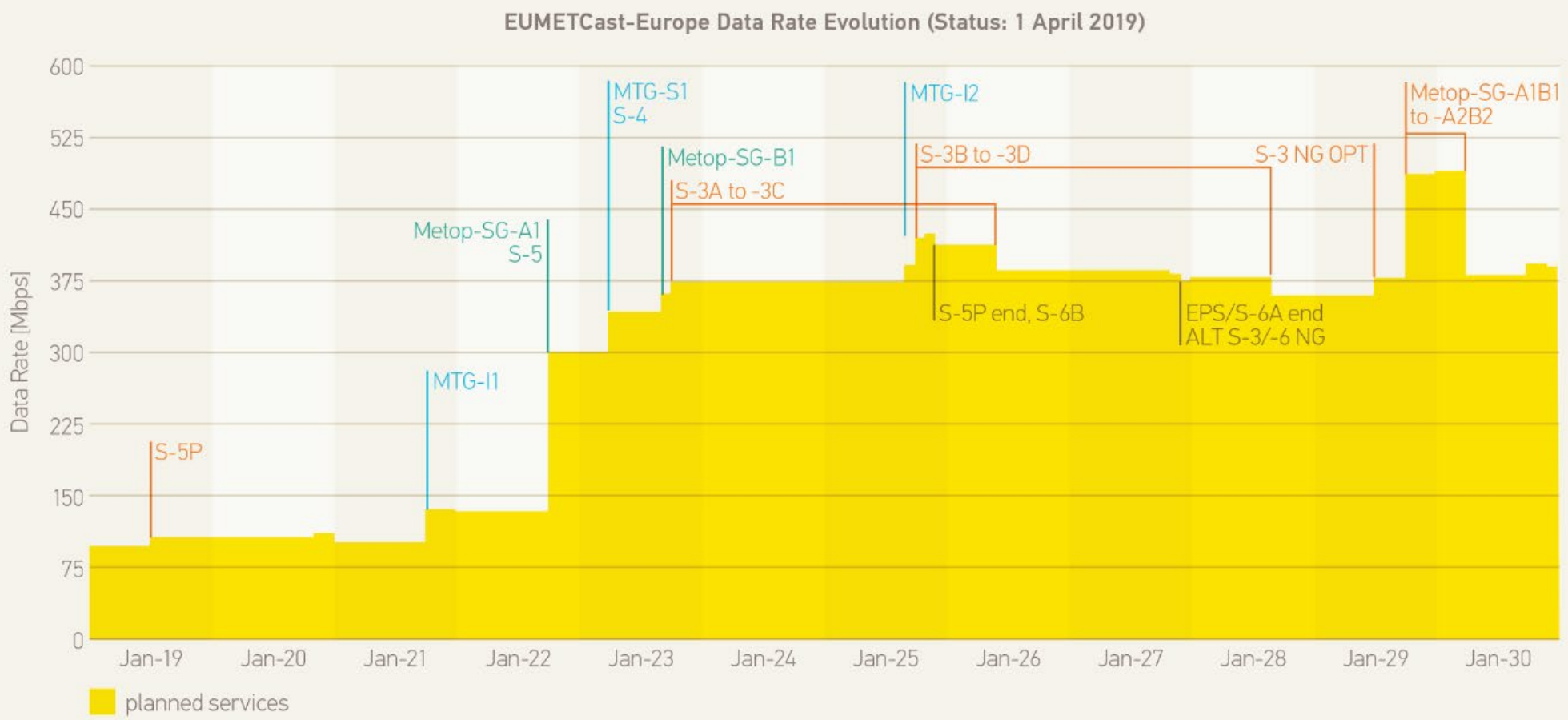




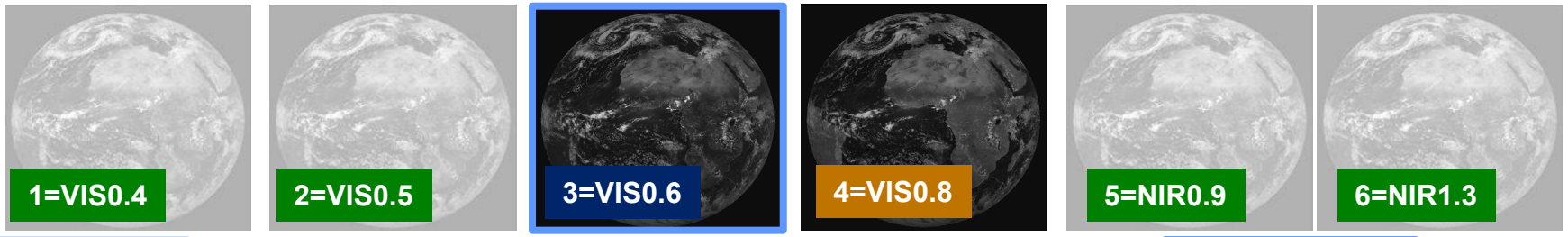
Current SEVIRI

MTG: Evolution of Data Access and Dissemination

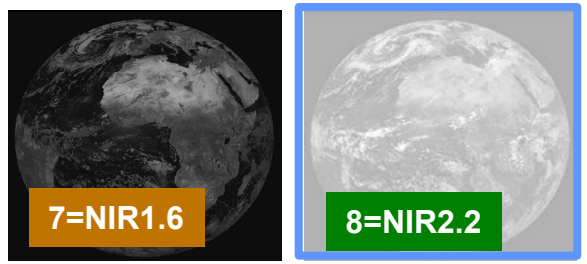
Figure 17: EUMETCast-Europe data rate evolution. The full operational MTG capability is planned to be reached by 2026.



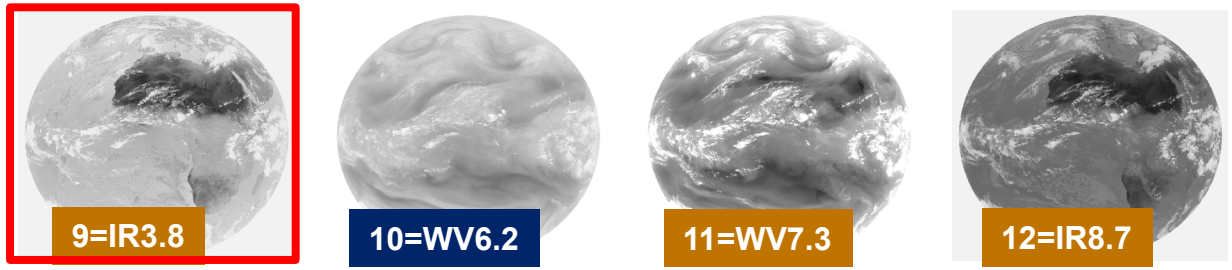
Current and future imagers channels: MSG SEVIRI and MTG FCI

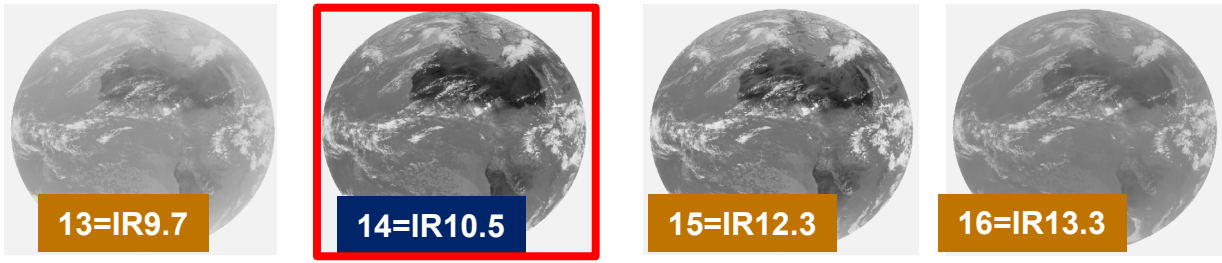


solar channels provided in 0.5 km / 1.0 km resolution



thermal channels provided in 1 km / 2 km resolution





✓ Continuity

✓ Innovation

Future FCI

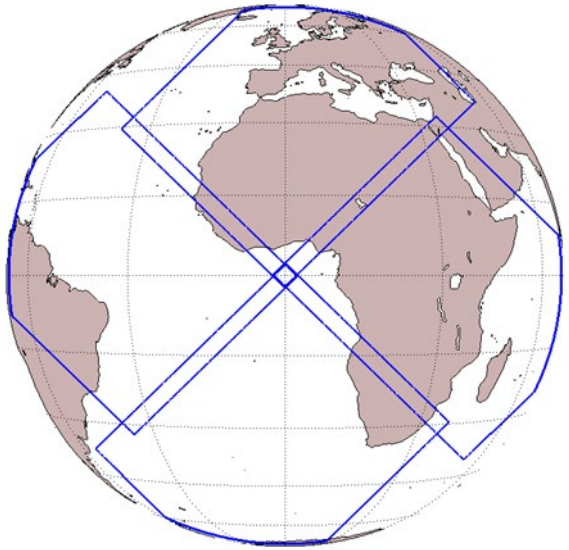
Benefits from the MTG Imager (FCI)

- New channels (0.444 µm and 0.51 µm) will support **true colour images** and permit surpassing current **aerosol retrievals** especially over land – also an important contribution to air quality monitoring.
- The 0.91 µm channel will provide during **daytime total column precipitable water** especially over land surfaces.
- The 1.375 µm channel will improve detection of **very thin cirrus clouds** not seen by the current system. If not detected, errors are introduced in all clear sky products.
- The 2.26 µm channel will provide the capability for an **improved retrieval of cloud microphysics.**
- The higher spatial resolution (1 km and 2 km) of the 3.8 µm channel will **improve fire detection** and, via its extended dynamical range (from 350 K to 450 K), the quality of products.
- To **improve the convection detection** through the shorter repeat cycle and better spatial resolution.

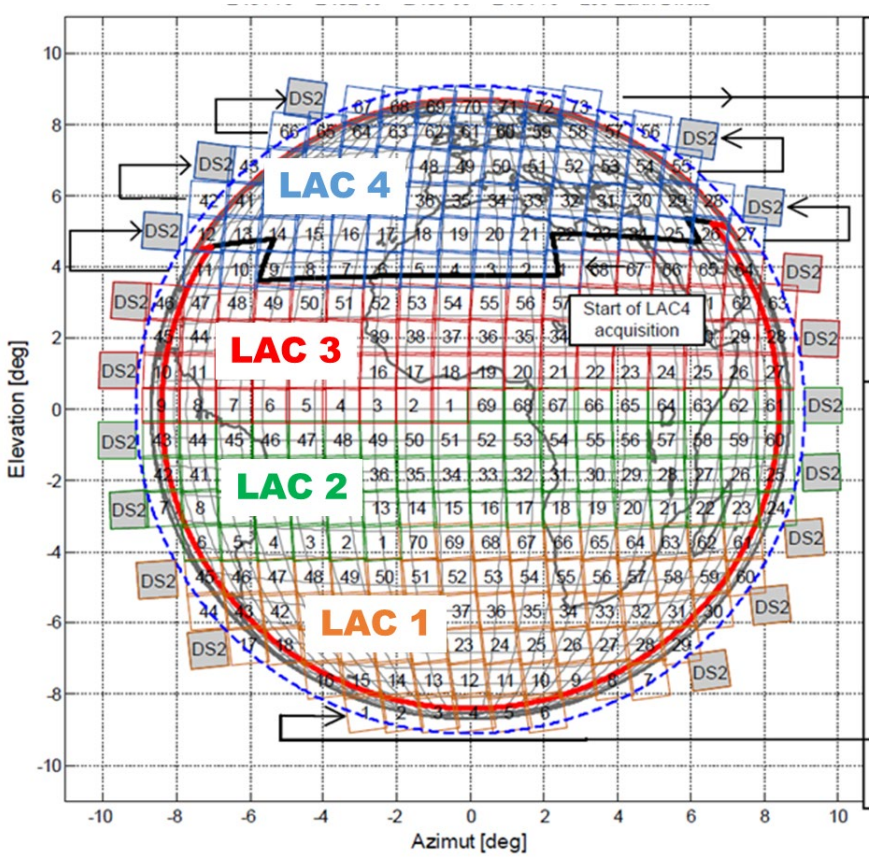
MTG lightning imager mission: *Why do we care?*

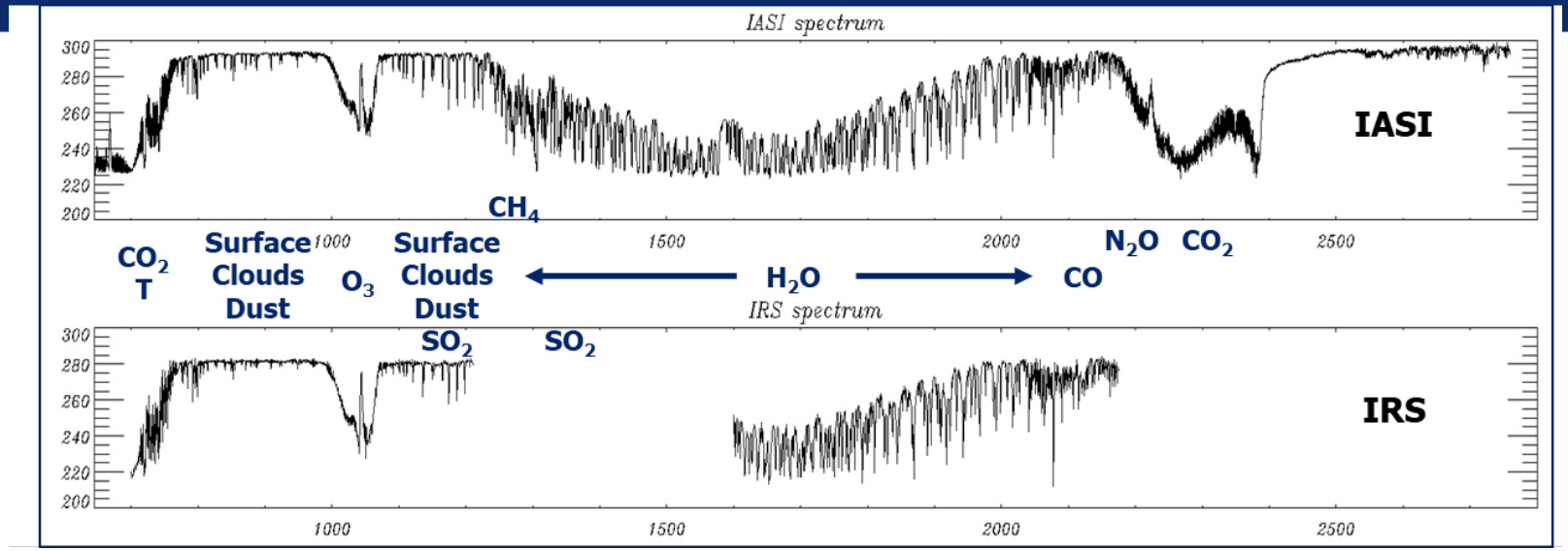
- Lightning is a precursor of severe weather, with a lead time of tens of minutes
- Most ground-based lightning location systems are mainly sensitive to cloud-to-ground lightning (CG)
- Often, no increase in CG due to "weather intensification" observable → Total lightning is the parameter of interest

Total lightning = cloud-to-ground + cloud-to-cloud lightning



MTG Infra-Red Sounder (IRS)

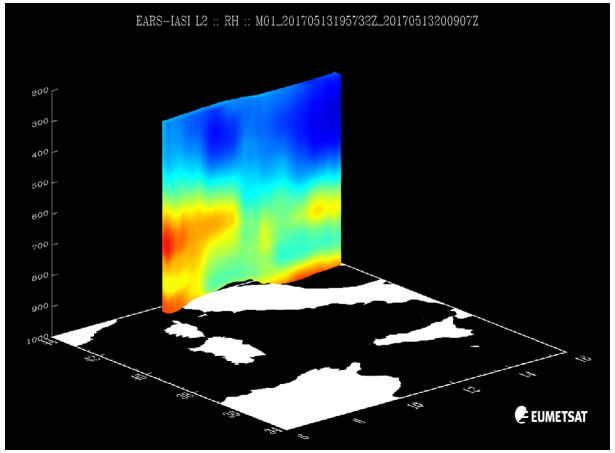




4 Local Area Coverage (LAC):

- One LAC acquired within 15'
- Overlapping step & stare dwells
- 160x160 pixels, ~4km at Nadir
- Europe (LAC 4) observed every 30'

Major innovation: Operational spectro-imagery at high spectral, spatial & temporal resolution



EUMETSAT

MTG-S: Monitoring atmospheric composition

- The second instrument aboard MTG-S: the Ultraviolet Visible Near-infrared (UVN) spectrometer – *Copernicus Sentinel-4*
- This mission covers the need for continuous monitoring of atmospheric composition / chemistry.
- **Focus on air quality with the main data products being O_3, NO_2, SO_2, HCHO, and aerosol optical depth**.
- Spatial sampling at 45° North: 8 x 8 km²
- Temporal resolution: 60 min.