Meteosat Third Generation (MTG)

An Innovative Approach to Advanced Observations from the Geostationary Orbit

S. Rota, L. Schwarz, C. Hartley, R. Stuhlmann
with support of the MTG Team

EUM/MTG/VWG/11/0639
7th GOES User's Conference
19-21 October 2011, Birmingham, AL

EUMETSAT

MTG to Secure Continuity and Evolution of EUMETSAT Services

1977 — 2002 — 2017 and 2019

MOP/MTP **MOP/MTP**

MSG **MSG**

MTG-I and MTG-S

Observation mission:
- MVIRI: 3 channels

Spinning satellite
Class 800 kg

Observation missions:
- SEVIRI: 12 channels
- GERB

Spinning satellite
Class 2-ton

Observation missions:
- Flex.Comb. Imager: 16 channels
- Infra-Red Sounder
- Lightning Imager
- UVN

3-axis stabilised satellites
Twin Sat configuration
Class 3-ton

Implementation of the EUMETSAT Mandate for the Geostationary Programme

Atmospheric Chemistry Mission (UVN-S4): via GMES Sentinel 4

MTG Space Segment Providing 5 Missions

MTG-I; 4 satellites

MTG-S; 2 satellites

Courtesy of

ThalesAlenia Space
A Thales / Finmeccanica Company

MTG Provides a Total of Five Missions Compliant to the User Needs

- Full Disk High Spectral resolution Imagery (FDHSI), global scales (Full Disk) over a BRC = 10 min, with 16 channels at spatial resolution of 1 km (8 solar channels) and 2 km (8 thermal channels)
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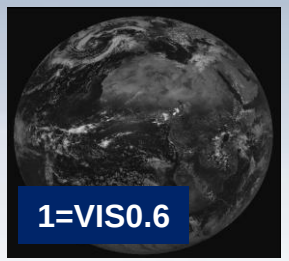
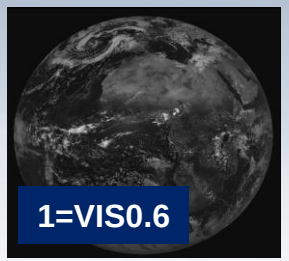
- UVN Sounding, implemented as GMES Sentinel 4 Instruments provided by ESA

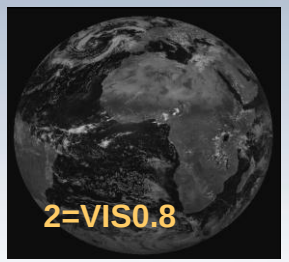
From MVIRI through SEVIRI to FCI on MTG

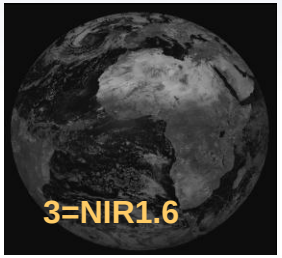


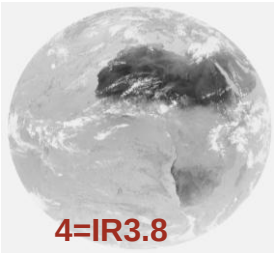
12=HRV

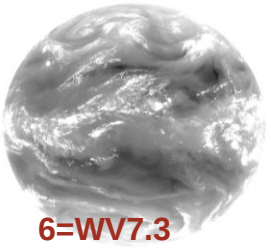
From MVIRI through SEVIRI to FCI on MTG

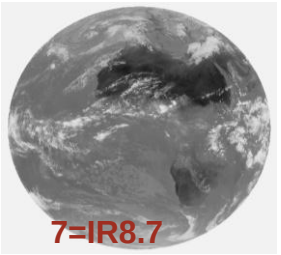


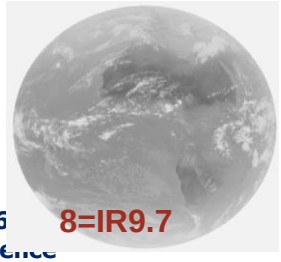


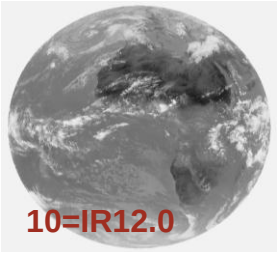


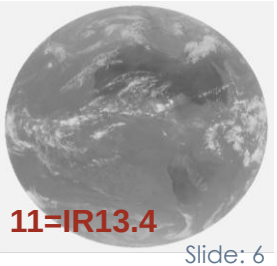




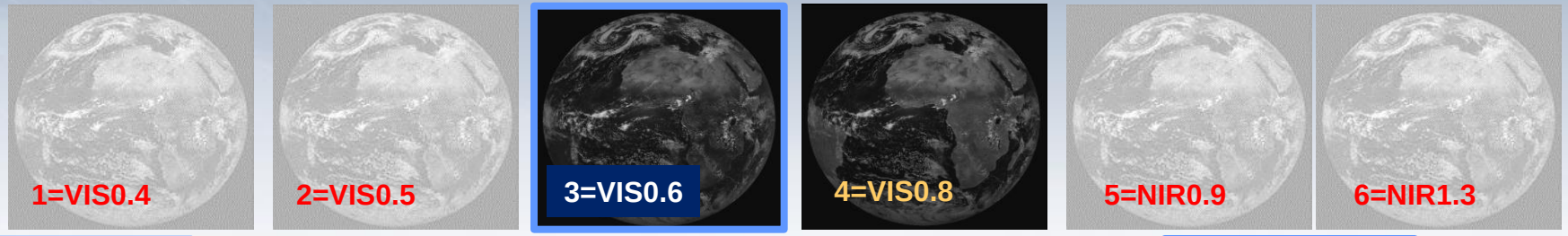




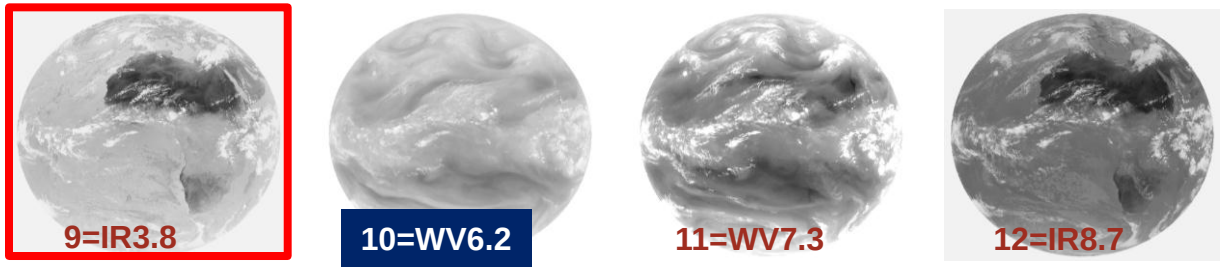




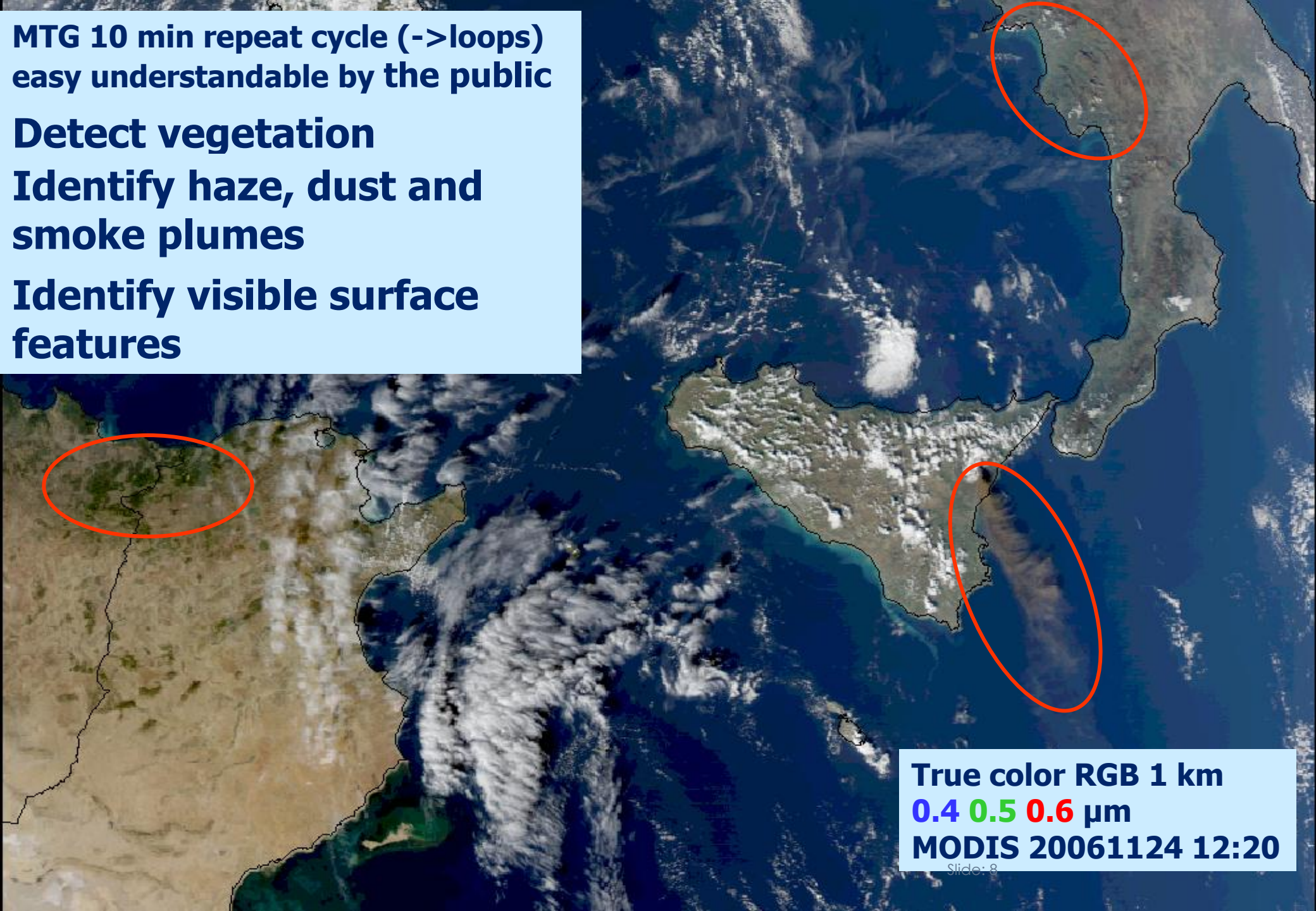
From MVIRI through SEVIRI to FCI on MTG



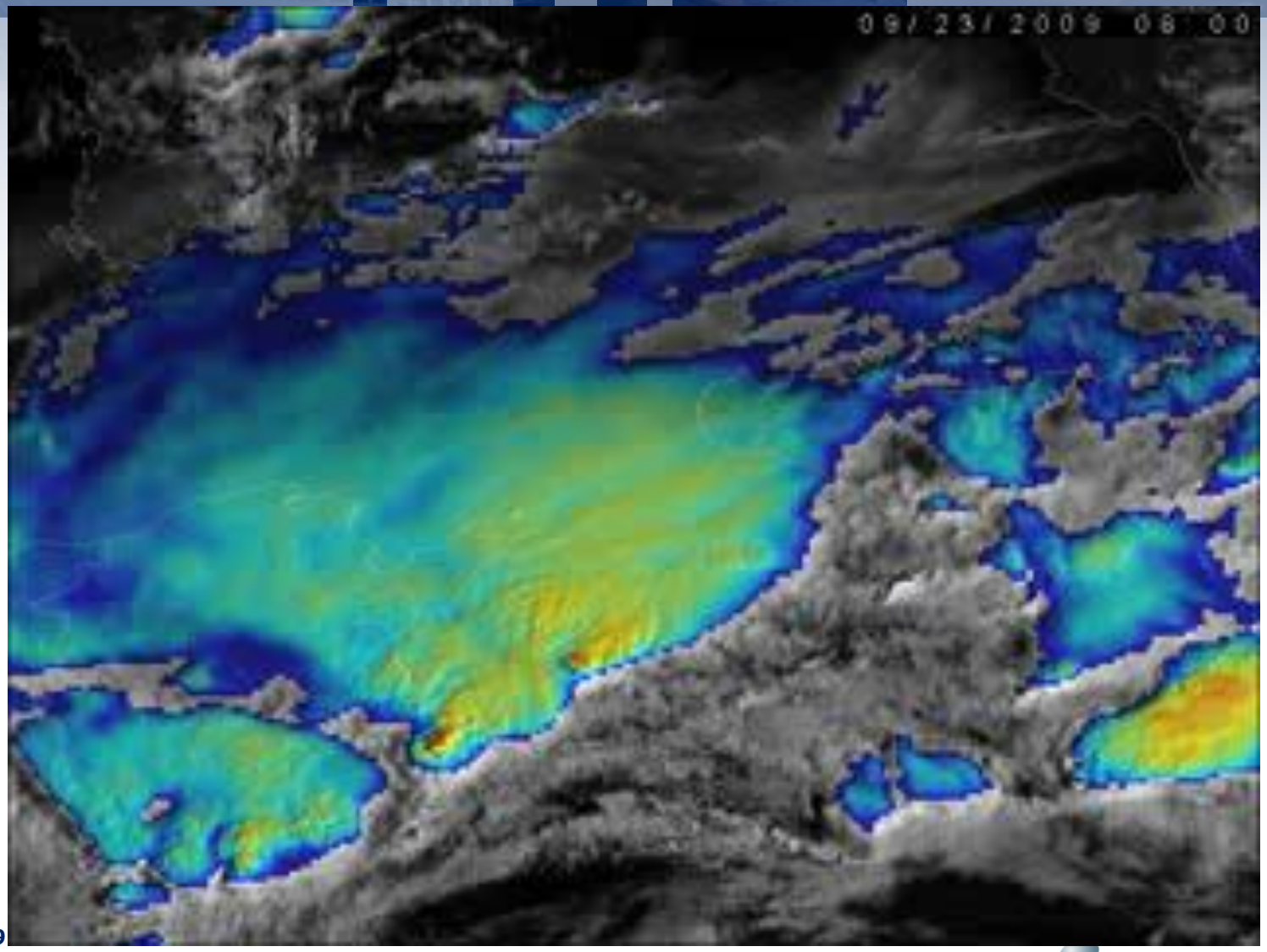
solar channels provided in 0.5 km / 1.0 km resolution



thermal channels provided in 1 km / 2 km resolution


MTG 10 min repeat cycle (->loops)
easy understandable by the public
Detect vegetation
Identify haze, dust and smoke plumes
Identify visible surface features
True color RGB 1 km
0.4 0.5 0.6 µm
MODIS 20061124 12:20

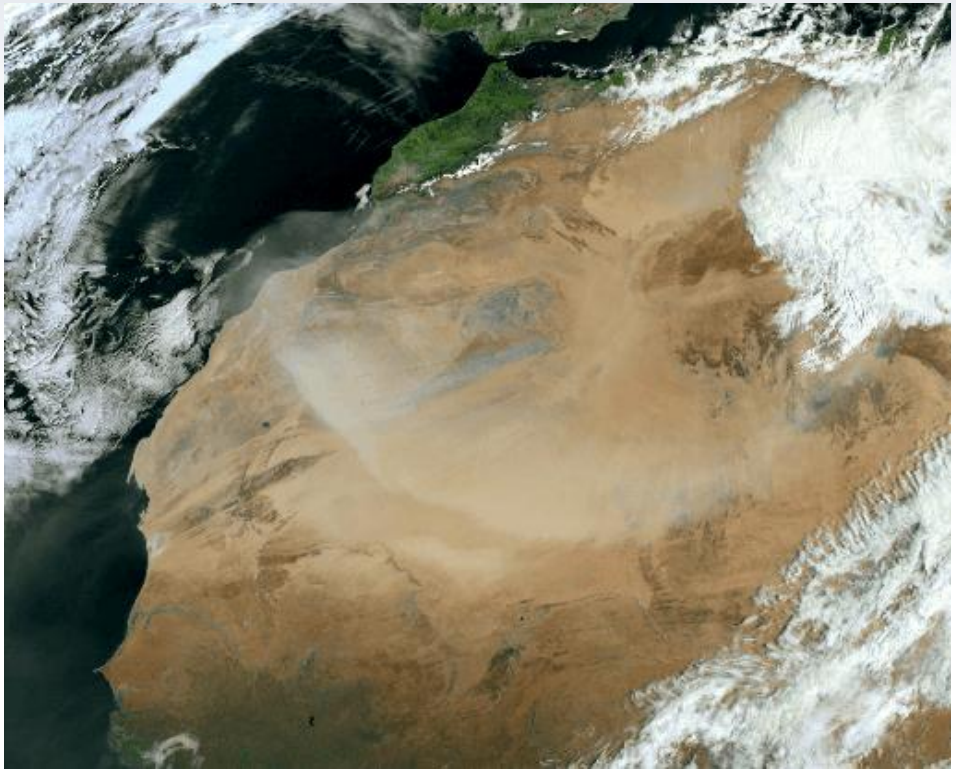
MSG 10.8 µm HVS Channels combined

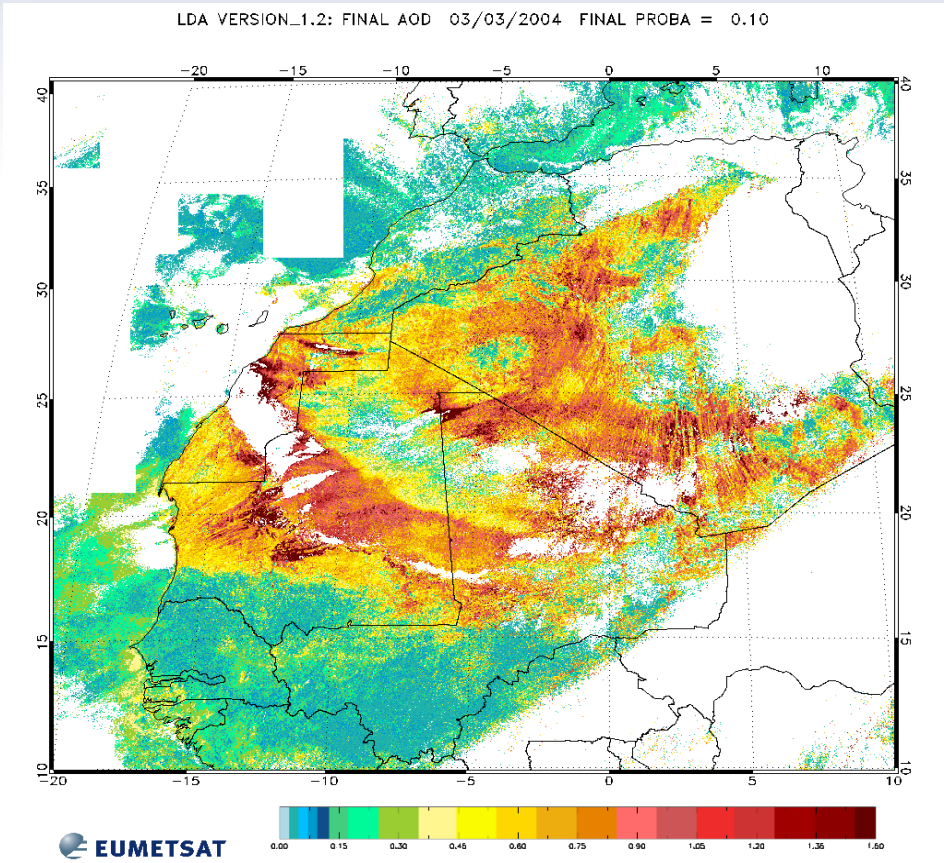


Land Daily Aerosol from SEVIRI

Quantitative retrieval of aerosol (suspended particle) concentration in the atmosphere

Example: Dust raised by a desert storm on 3 March 2004.





MTG Missions
FCI – Benefits Summary

- The 0.444 µm and the 0.51 µm channels will 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 introducing errors in all clear sky products.

- The 2.26 µm channel will provide the capability for an improved retrieval of cloud microphysics.

- The improved spatial resolution (1 km and 2 km) and the extended dynamical range (from 350 K to 450 K) of the 3.8 µm channel will firstly outperform the fire detection quality of MSG and secondly outbid the quality of products as Fire Radiative Energy (FRE) – a climate relevant product directly related to the CO_2 production of active fires.

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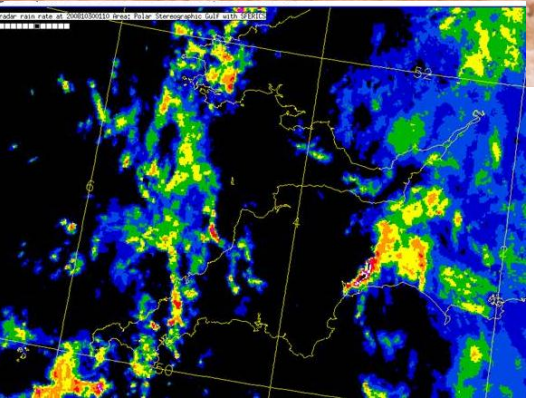
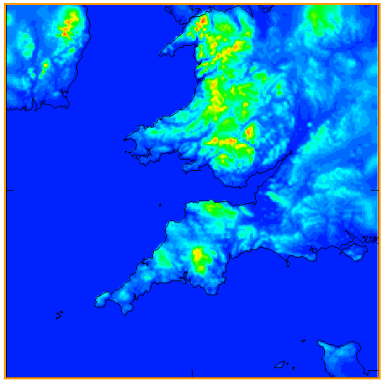
Devon Hailstorm 30 October 2008



Radar

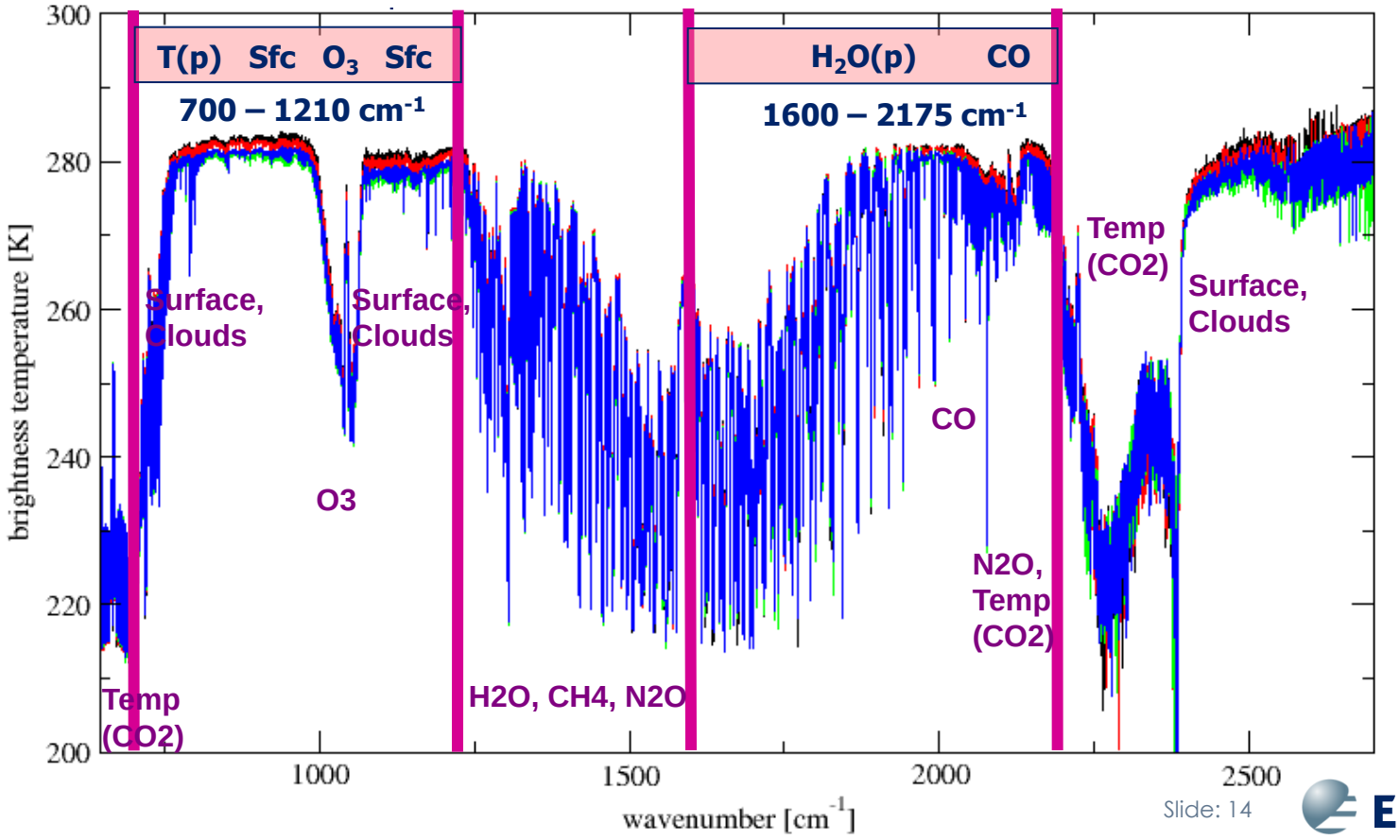


Met Office On Demand Model

Boscastle Storm in 2004

MTG-IRS Concept: High Spectral/Spatial sampling

MTG-IRS mission will deliver unprecedented information on horizontal and vertical gradients of moisture, wind and temperature between measurements of individual radiosondes and hyperspectral soundings from the polar orbiting satellites.

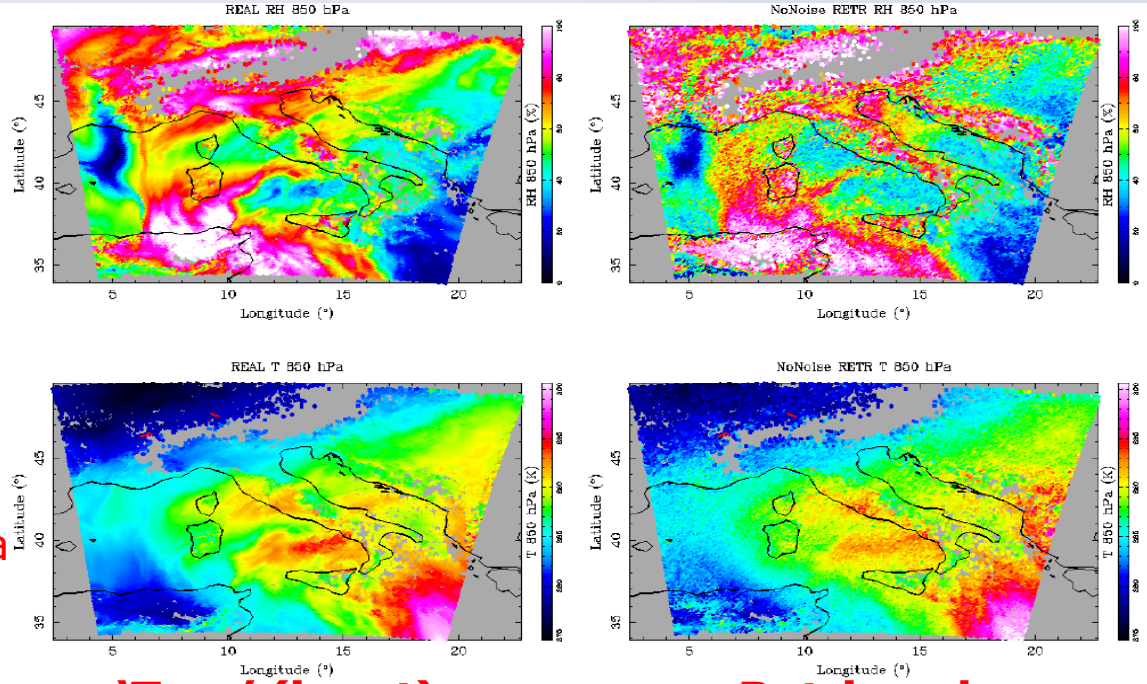


Optimal Estimation Retrieval:
Tested on MTG-IRS Synthetic Radiances from COSMO-IT model

Low level flow of moisture rivers.

RH @ 850 hPa

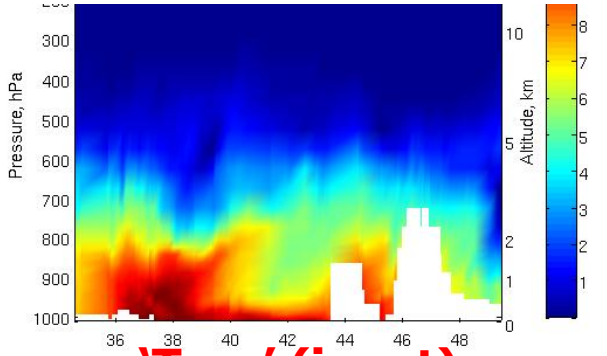
T @ 850 hPa



'True' (input)

Retrieved

© X.Clabet, EUMETSAT



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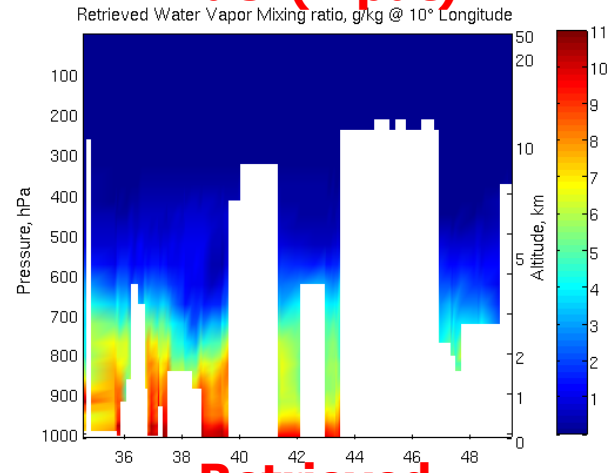
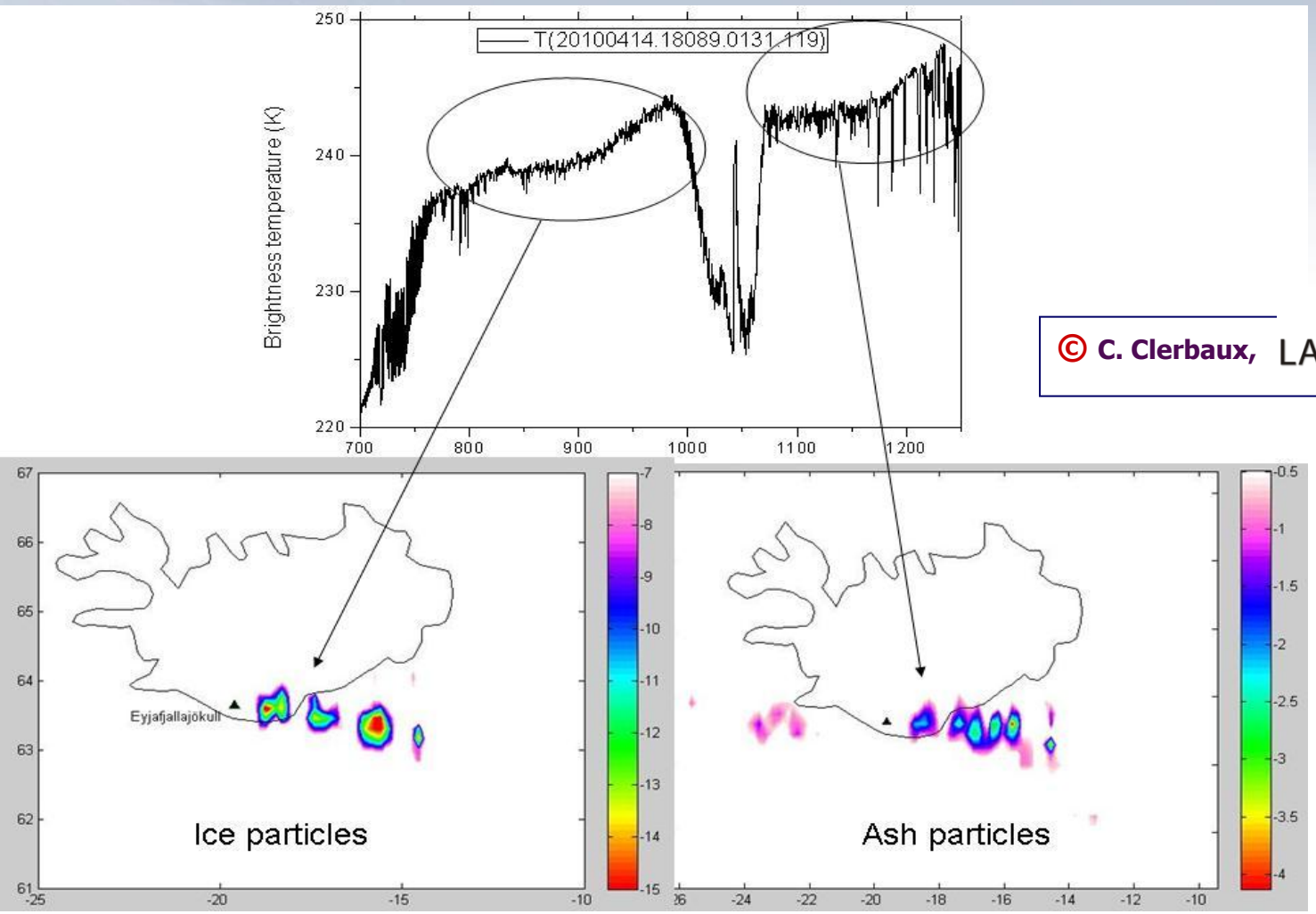


Retrieved

© C. Serio C., G. Masiello, G. Grieco, DIFA

MTG-IRS Potential to Detect High Pollution Events at Urban and Regional Scales



© C. Clerbaux, LATMOS

MTG Missions
IRS – Benefits Summary

- The IRS (30 min repeat cycle over Europe) will fill large spatial and temporal voids in the 12-hour time standard radiosonde observations and will allow time and space interpolation of moisture/temperature observations taken from the polar orbit.
- The IRS derived information on low tropospheric moisture and its changes in time is expected to lead to a better depiction of the hydrological cycle in models, potentially providing better precipitation forecast.
- The IRS will provide information on vertically resolved atmospheric motion vectors with improved height assignment, which in particular is beneficial for the tropical areas having only a weak coupling between the dynamic and thermodynamic atmospheric fields.
- The IRS will provide information to identify pre-convective situations supporting NWC applications to forecast convective initiation.
- IRS will support forecasting pollution and monitoring of atmospheric minor constituents through its capability to provide estimates of diurnal variations of tropospheric contributions of atmospheric trace gases as O_3 and CO.

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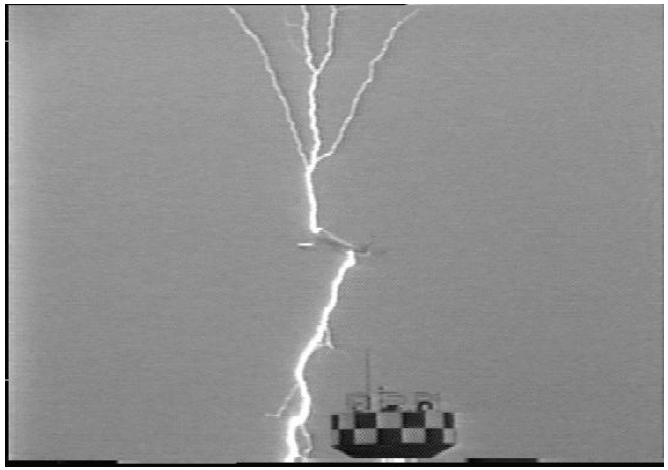
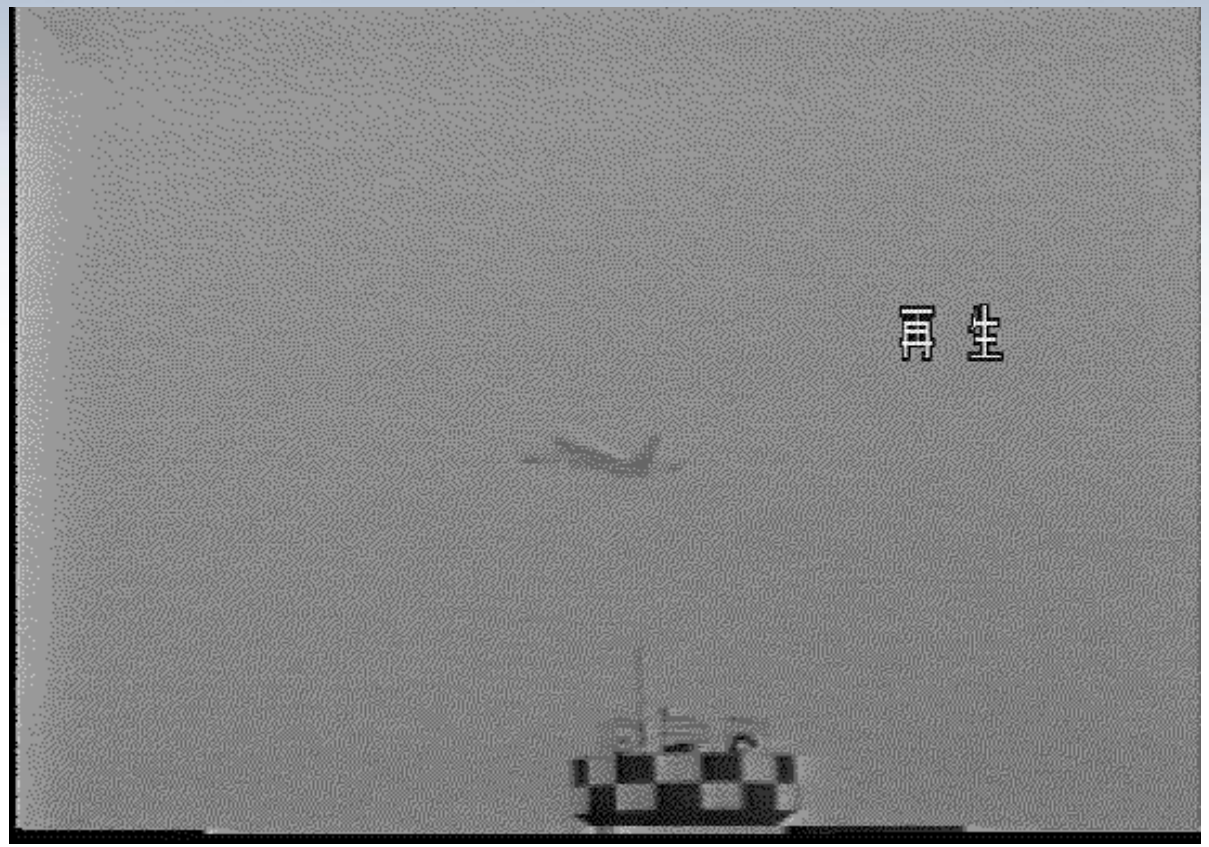
Total Lightning – Improved Guidance for Aviation

Improved knowledge of the state of electrification of thunderstorms (weak electrification within the extended anvils) will improve aviation guidance in the vicinity of airports and en route.





Source: Kawasaki, Univ. Osaka

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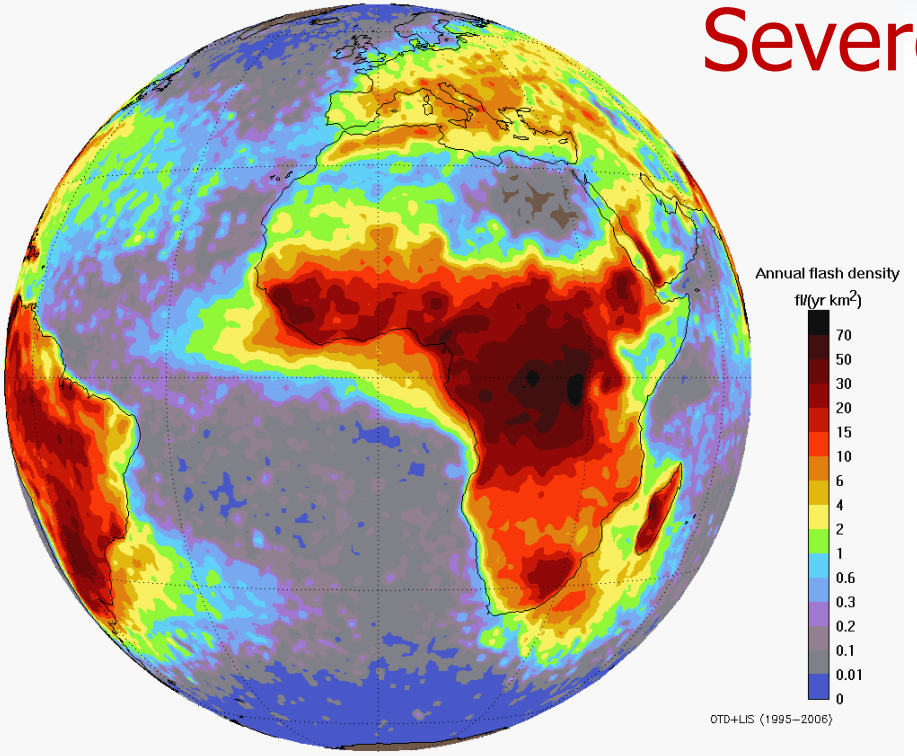
MTG Lightning Imager (LI)

The Lightning I on MTG measures/maps Total Lightning: Cloud-to-Cloud Lightning (IC) and Cloud-to-Ground Lightning (CG)

Detect, Monitor, Track and Extrapolate in Time Where/If Lightning Will Potentially Cause Severe Damages



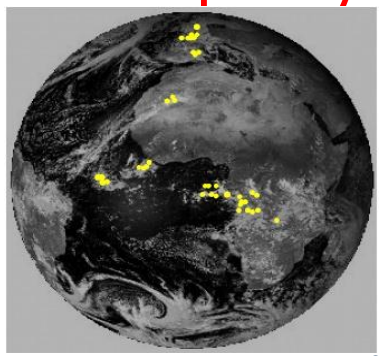
- Development (Intensity/Movement) of active convective areas
- Monitoring of Storm Lifecycle
- Validation of Convective Initiation Forecast
- Support to Climate and Air Chemistry

Continously and Simultaneously Information on Total Lightning over the Full Disk

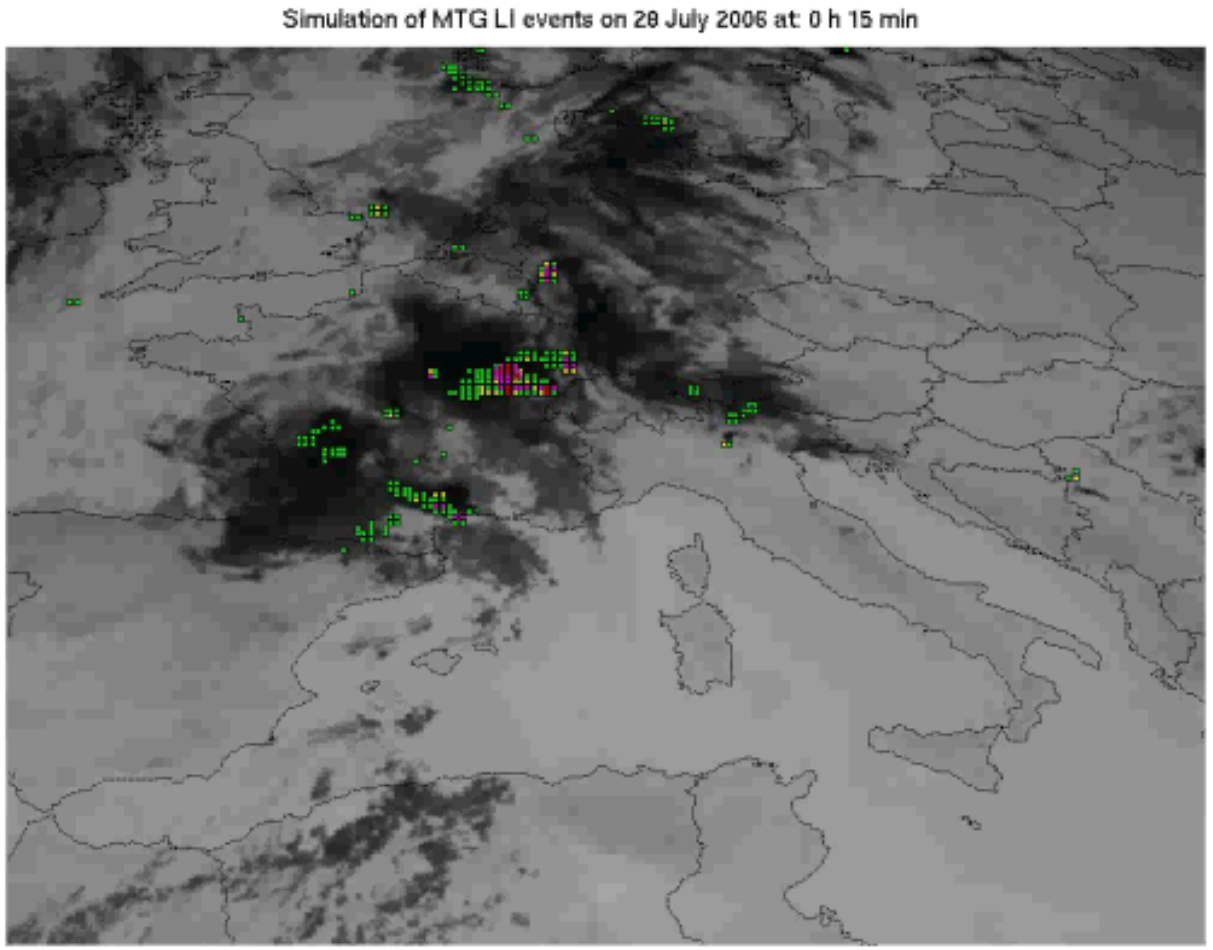
Lightning as seen from Space

MTG LI delivers information on total lightning (IC+CG) with high timeliness and homogeneous data quality over full disk

Typical LI budget:
Detector Array ~ 1500*1500
Integration Time ~1 ms
Mass: < 80 kg
Power: < 320 W
Data rate: < 30 Mbps
Navigation using Background images



Proxy data development – example



Based on LINET ground-based data over Europe

Colour code indicates the MTG-LI "event" density

MTG Missions
LI – Benefits Summary

- The MTG LI measurements of total lightning will complement global measurements of ground based systems (e.g. ATDnet) improving the quality of information essential for air traffic routing and safety
- MTG-LI/ATDnet IC+CG lightning information to assess impact of climate change on thunderstorm activity by monitoring and long-term analysing lightning characteristics (coordination with NOAA's GLM mission on GOES-R and GOES-S essential)
- IC+CG information on a global scale as prerequisite for studying and monitoring the physical and chemical processes in the atmosphere regarding NOx, playing a key role in the ozone conversion process and acid rain generation
- IC+CG information on a global scale with known error-characteristic a prerequisite for: assimilation in regional models to improve very short range forecasts of convective events verification/validation of algorithms to nowcast (time and location) convective initiation

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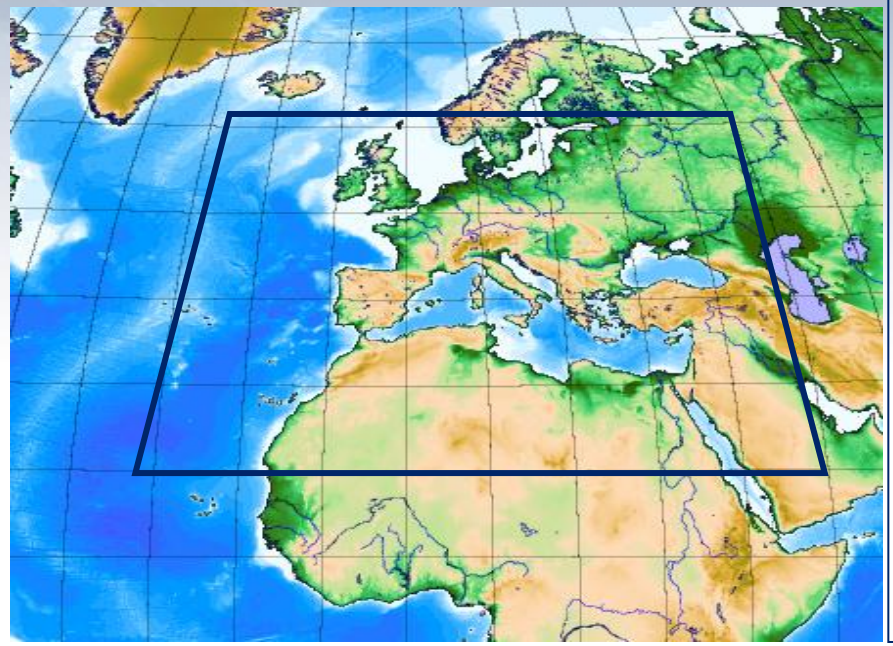
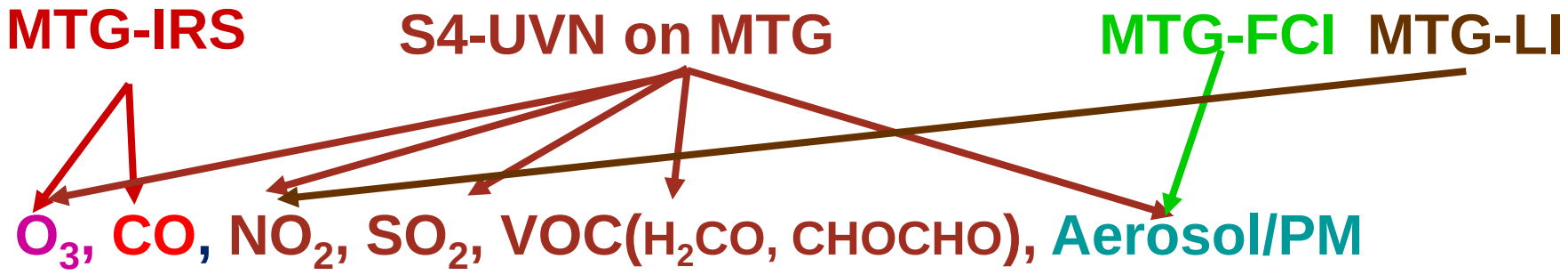
MTG-S will Accommodate GMES Sentinel 4 Ultraviolet Visible Nearinfrared (UVN)



The GMES Sentinel-4 sounding mission is achieved through the Ultraviolet, Visible & Near-infrared (UVN) Instrument accommodated on the MTG-S satellites

- covering Europe every hour
- taking measurements in three spectral bands (UV: 305 - 400 nm; VIS: 400 - 500 nm, NIR: 750 - 775 nm)
- with a resolution around 8km.

The primary data products are O3, NO2, SO2, HCHO and aerosol optical depth.



Summary User Priorities on MTG Missions

- MTG information on the 'fast' component of the hydrological cycle will improve warnings on the location and intensity of severe storm hazards,
- The MTG enhanced information on convective/non-convective events, critical weather situations (~ fog, sand/dust storms, icing,..), fires, volcanic ash eruptions will allow surpassing present capabilities to provide warnings to the community,
- MTG information on horizontally, vertically, and temporally (4-D) resolved gradients of moisture, wind, and temperature is expected to deliver a breakthrough regarding precipitation forecasts via assimilation into advanced non-hydrostatic regional models.
- MTG information on carbon monoxide and ozone in the troposphere (IRS and UVN) and nitrous oxides generated by lightning will be a significant contribution to atmospheric chemistry and air quality applications,
- MTG information on location and intensity of lightning will support warnings on lightning strikes for aviation and surface related business.

Conclusion on MTG Missions

MTG Missions will

- ensure continuation and improvement of existing services
- enable new services expected for 2018 – 2038

breakthrough expected in precipitation forecast exploiting MTG information for regional NWP and NWC

MTG – Overall system configuration overview

GSTF: Ground Station Facility (TTC-MDA);

MOF: Mission Operations Facility;

IDPF: Instr. Data Proc. Facility;

MME: Multi Mission Elements;

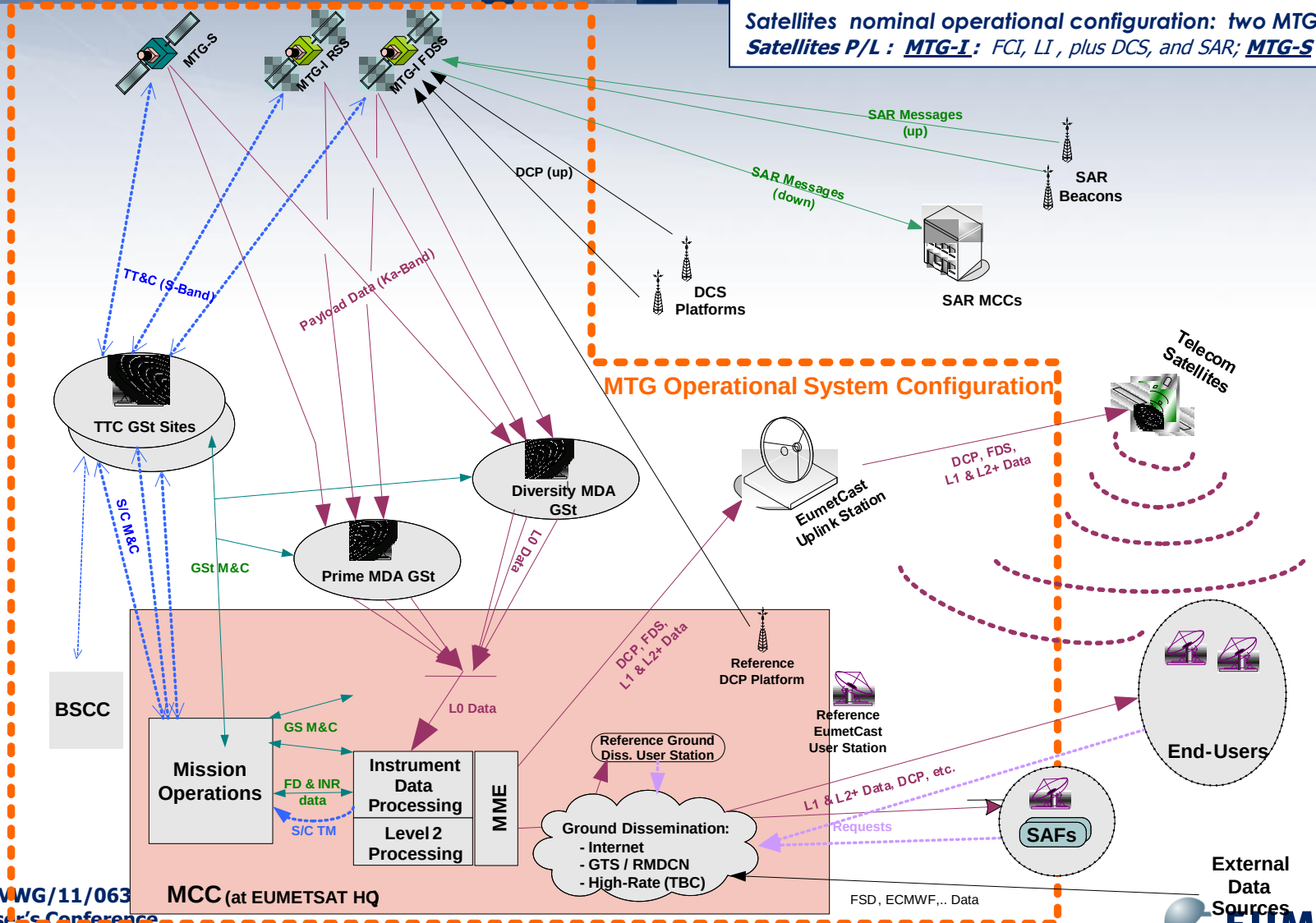
L2PF: Level 2 Proc. Facility;

SAFs: Satellite Application Facilities;

MCC: Mission Control Centre - the aggregate of the Ground Segment elements at the central site.

BSCC: Backup Spacecraft Control Centre

Satellites nominal operational configuration: two MTG-I, one MTG-S
*Satellites P/L : **MTG-I** : FCI, LI , plus DCS, and SAR; **MTG-S** : IRS , UVN*



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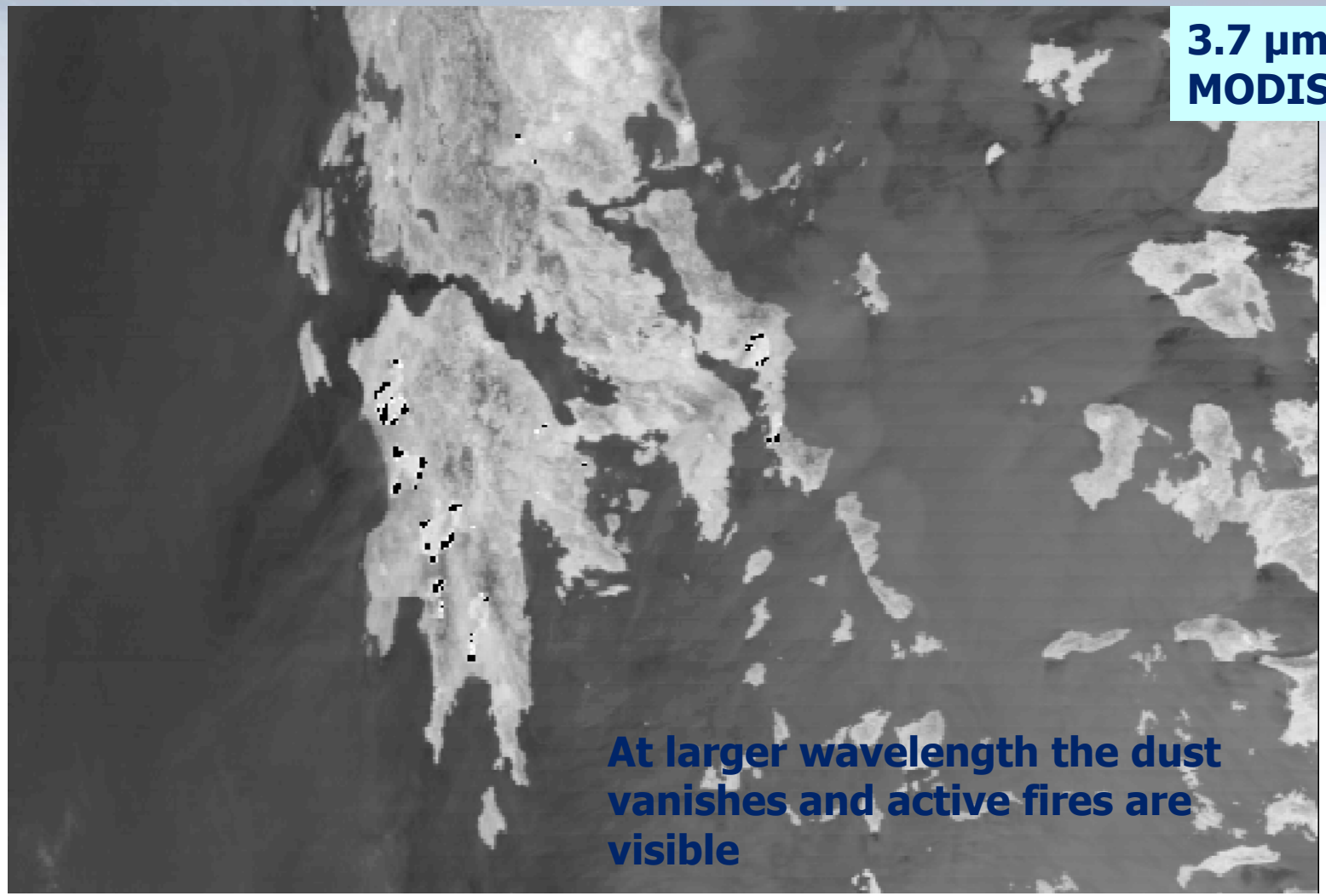
MTG System Concept: Space Segment

MTG Space Segment Configuration

- Twin Satellite Concept, based on 3-axis platforms
  - Imaging Satellites (MTG-I) (MTG-I1/I2/I3/I4 : 20 years of operational service)
  - Sounding Satellites (MTG-S) (MTG-S1/S2 : 15.5 years of operational service)
- The payload complement of the MTG-I satellite consists of
  - The Flexible Combined Imager (FCI)
  - The Lightning Imager (LI)
  - The Data Collection System (DCS) and Search and Rescue (GEOSAR)
- The payload complement of the MTG-S satellite consists of
  - The Infrared Sounder (IRS)
  - The Ultra-violet, Visible and Near Infrared Sounder (UVN).

    UVN is provided as GMES Sentinel 4 Instruments

MTG-FCI outbids MSG-SEVIRI Delivering Information on Fires and their Damages



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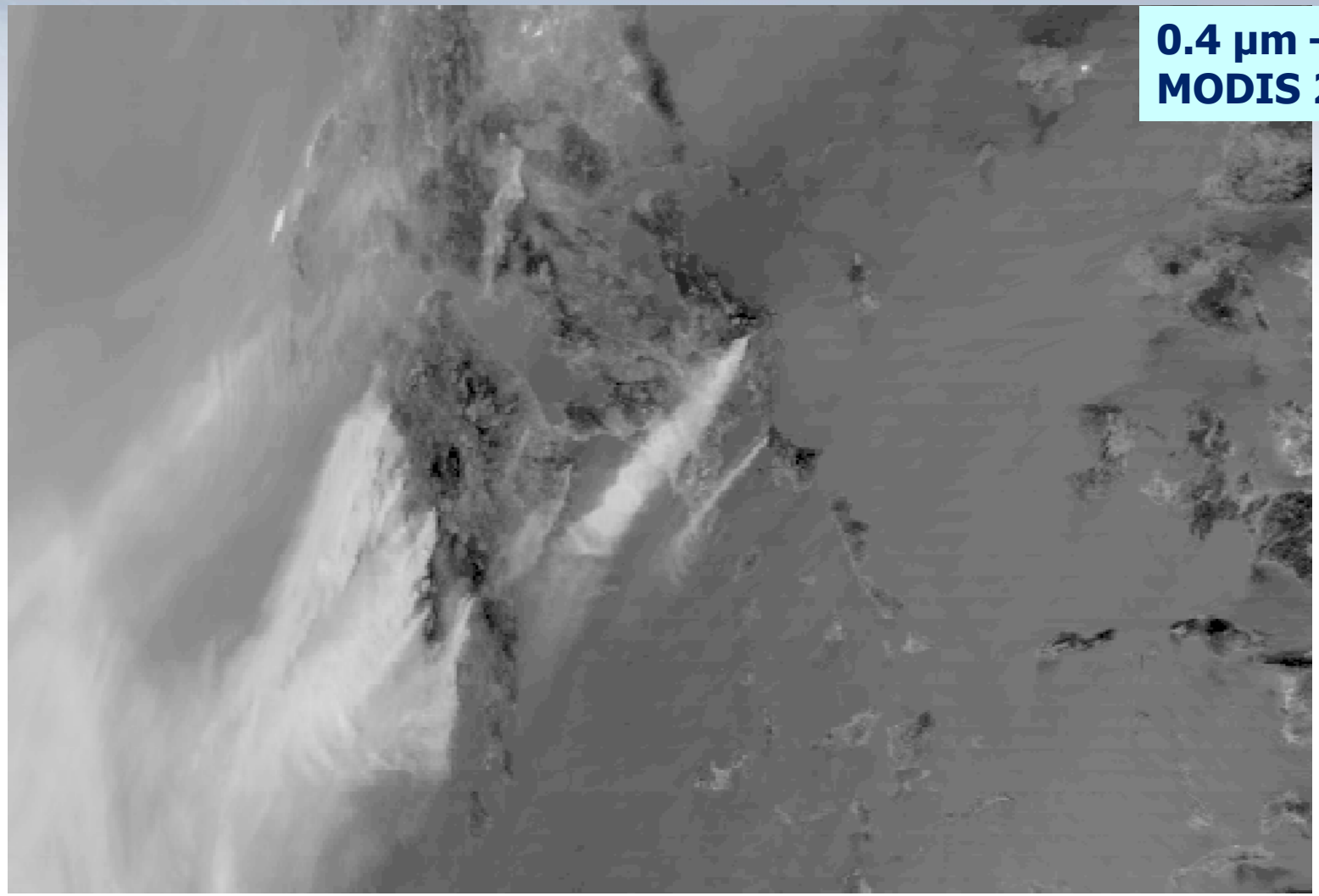
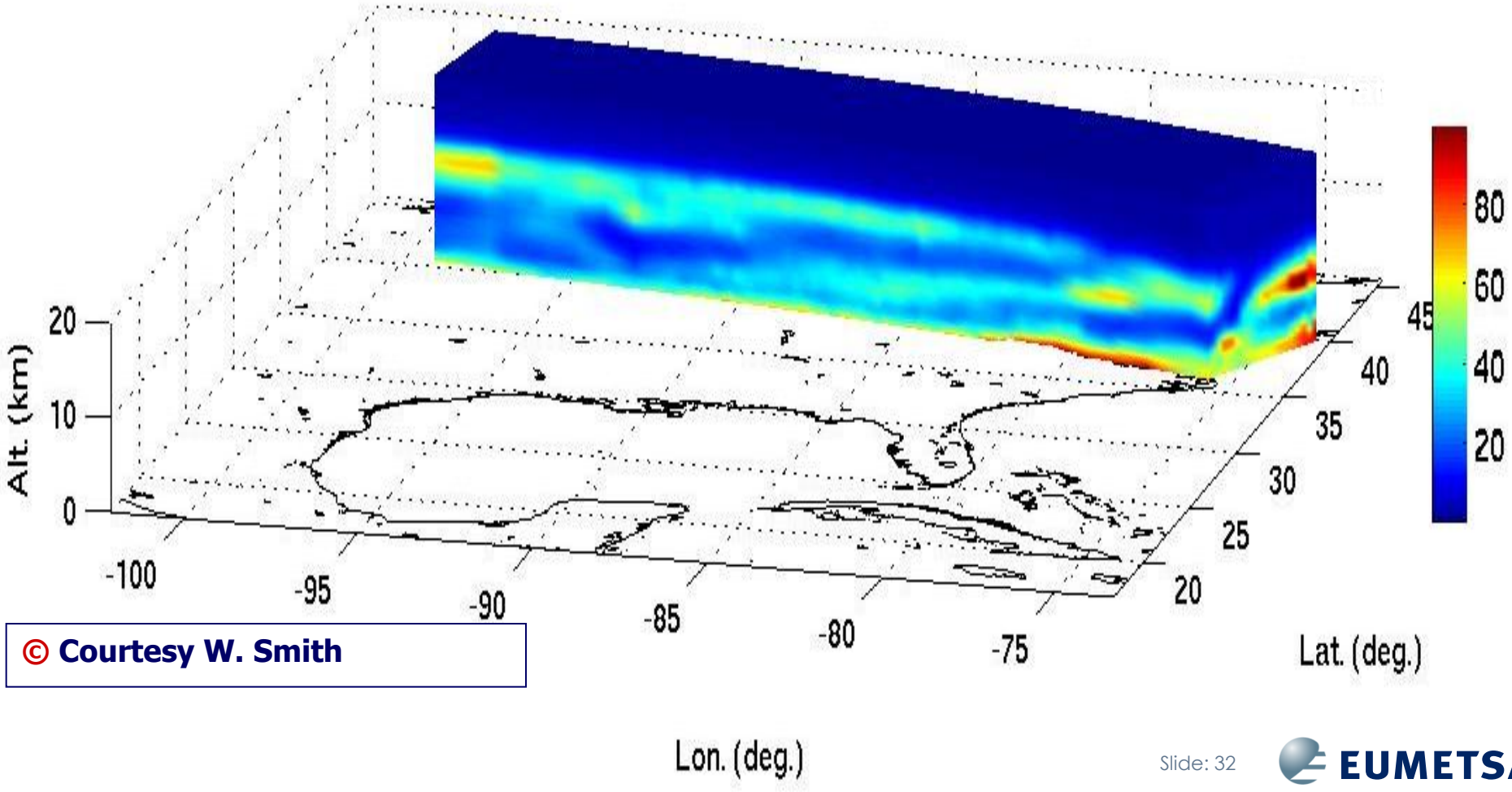


0.4 µm – channel @ 1km
MODIS 20070826 11:10

MTG-IRS to Detect 'River Like Moisture Flows'

Low level flow of moisture rivers.



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