Satellite Instruments and Data, a limided overview

NOA/ReACT

Athanasios Natsis

2026-02-20

Table of contents

Definitions

- **MTG**: Meteosat Third Generation system of geostationary satellites operated by EUMETSAT.

- **EUMETSAT**: Europe's meteorological satellite agency, intergovernmental organization.
- **General goals**: Produce satellite data on weather, climate, and the environment around the clock. Near-real time for members, partners, and people who use the data.
- **Fields**: Nowcasting, Numerical Weather Prediction models, Climate records, Other products and services (incl. firefighting, air quality forecasts, air traffic control, search and rescue missions, disaster risk reduction, agricultural productivity, marine and coastal management……)

Data scope

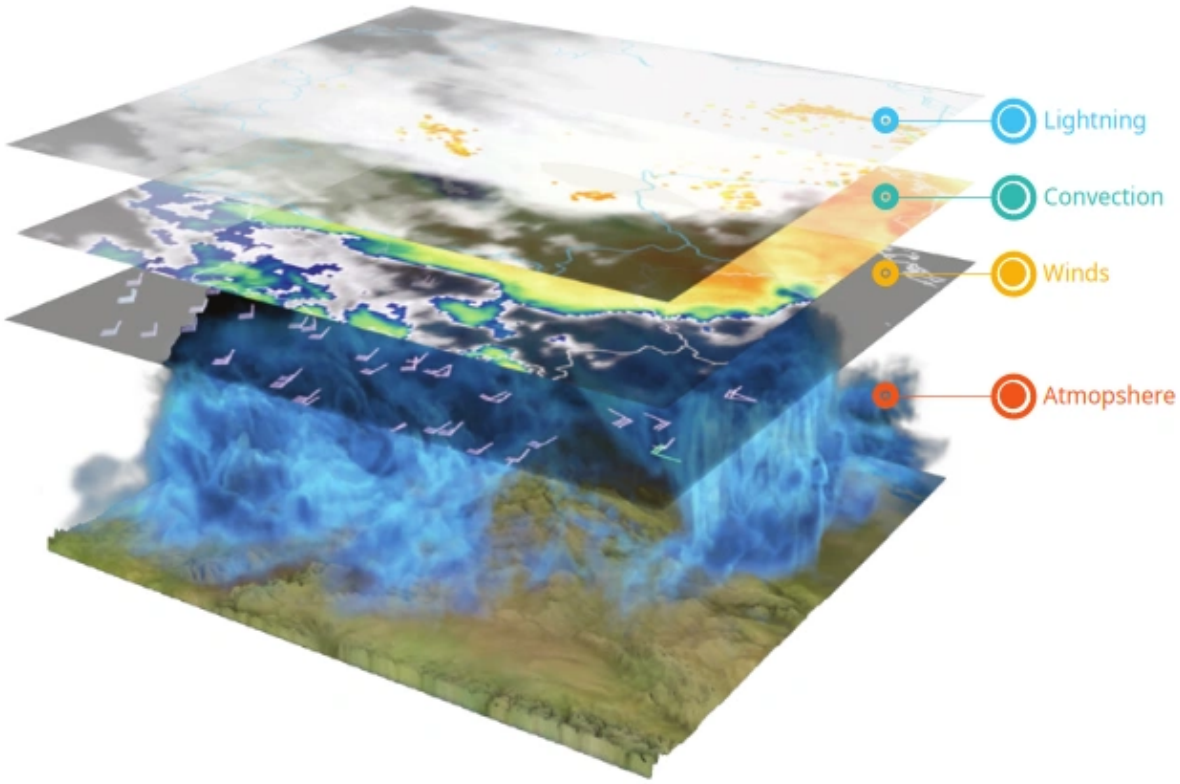


Figure 1: NRT 4d weather cube

Main data resources

- EUMETSAT data store / EUMETSAT data catalogue
- EUMETSAT 'data archive'
- AC SAF, Atmospheric Composition Monitoring, ozone, trace gases, aerosols and ultraviolet data
- H SAF, Operational Hydrology and Water Management, data for operational hydrological
- LSA SAF, Land Surface Analysis, land, land-atmosphere interactions and biosphere
- NWC SAF, Nowcasting and Very Short Range Forecasting, forecast for the next few hours
- NWP SAF, Numerical Weather Prediction, interface between satellite data and European activities in NWP
- OSI SAF, Ocean and Sea Ice, ocean-atmosphere interface
- ROM SAF, Radio Occultation Meteorology, high-quality GNSS Radio Occultation (RO) data for NWP and climate application areas

SAFs in general have data and Software

EUMETSAT, Satellite Application Facilities (SAF)

Main resources for reference

- EUMETView, interactive map and product explorer
- EUMETSAT User Portal, guides and products references
  - Training
  - Software
  - Guides
  - .....

MTG-I Imaging mission

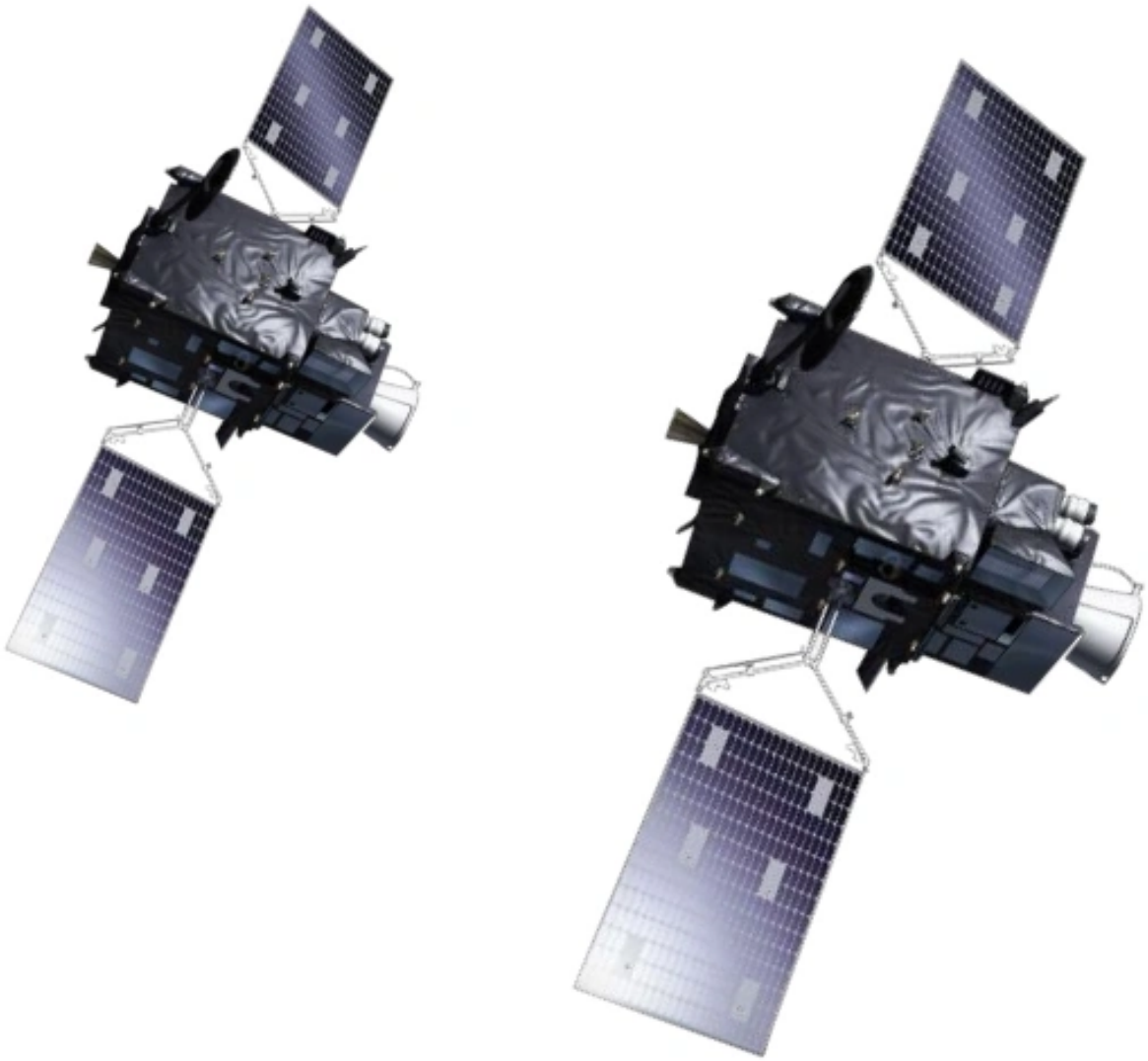


Figure 2: MTG-I

- *FCI* - Full disc scanning service
  - /10 minutes, 16 spectral bands
- *FCI* - Rapid scanning service
  - Europe /2.5 minutes, 16 spectral bands
- *LI* - Lightning Imager

- Full disc, continuous

www.eumetsat.int/meteosat-third-generation

user.eumetsat.int/resources/user-guides/mtg-in-operations

τι είναι οι MTG - 6 δορυφόροι - 4 MTG-I - 2 MTG-S

MTG-S Sounding mission

Figure 3: MTG-S

- Infrared Sounder (IRS)
  - 1/4 of Full disk /15 minutes

- Ultraviolet Visible Near-infrared (UVN) Sounder
  - Copernicus Sentinel-4

www.eumetsat.int/meteosat-third-generation

user.eumetsat.int/resources/user-guides/mtg-in-operations

Flexible Combined Imager FCI

Full Earth disk every 10 minutes

	Spectral ch.	Central wavelength	Spectral width	Spatial Sampling Distance
1	VIS 0.4	0.444 µm	0.060 µm	1.0 km
2	VIS 0.5	0.510 µm	0.040 µm	1.0 km
3	VIS 0.6	0.640 µm	0.050 µm	1.0 km 0.5 km (HR)
4	VIS 0.8	0.865 µm	0.050 µm	1.0 km
5	VIS 0.9	0.914 µm	0.020 µm	1.0 km
6	NIR 1.3	1.380 µm	0.030 µm	1.0 km
7	NIR 1.6	1.610 µm	0.050 µm	1.0 km
8	NIR 2.2	2.250 µm	0.050 µm	1.0 km 0.5 km (HR)
9	IR 3.8	3.800 µm	0.400 µm	2.0 km 1.0 km (HR)
10	WV 6.3	6.300 µm	1.000 µm	2.0 km
11	WV 7.3	7.350 µm	0.500 µm	2.0 km
12	IR 8.7	8.700 µm	0.400 µm	2.0 km
13	IR 9.7	9.660 µm	0.300 µm	2.0 km
14	IR 10.5	10.500 µm	0.700 µm	2.0 km 1.0 km (HR)
15	IR 12.3	12.300 µm	0.500 µm	2.0 km
16	IR 13.3	13.300 µm	0.600 µm	2.0 km

Visible (VIS), Near Infrared (NIR), Infrared (IR), Water Vapour (WV)

user.eumetsat.int/resources/user-guides/mtg-fci-level-1c-data-guide

---

EUMETSAT MTG available products (2026-02-01)

- Accumulated precipitation at ground by blended MW+IR and FCI
- Active Fire Monitoring (CAP, netCDF)
- All Sky Radiance (BUFR, netCDF)
- Atmospheric Motion Vectors (BUFR, netCDF)
- Clear Sky Reflectance Map
- Cloud Mask (GRIB2, netCDF)
- Cloud Top Temperature and Height
- Cloud Type
- FCI Level 1c High Resolution Image Data
- FCI Level 1c Normal Resolution Image Data
- FCI Level 3 Sea Surface Temperature
- FCI Snow detection (snow mask) by VIS/NIR radiometry
- Global Instability Indices
- LI Accumulated Flash Area
- LI Accumulated Flash Radiance
- LI Accumulated Flashes
- LI Lightning Events Filtered
- LI Lightning Flashes
- LI Lightning Groups
- Land Surface Temperature
- Optimal Cloud Analysis
- Outgoing LW radiation at TOA
- Precipitation rate at ground by blended FCI IR / LEO MW precipitation

26 products

data.eumetsat.int/extended?query=mtg

LSA SAF available products

- Land Surface Albedo (MTDAL)
- Fire Radiative Power (MTFRP)
- Land Surface Temperature (MTLST)

datalsasaf.lsasvcs.ipma.pt/PRODUCTS/MTG/

AC SAF available products

NRT products

- Total ozone column
- Total and tropospheric NO2 columns
- Total SO2 column
- Total HCHO column
- High-resolution ozone profile
- Absorbing aerosol height
- Absorbing aerosol index from PMDs
- Global 1-day UV index forecast
- Global tropospheric ozone column
- IASI CO
- IASI SO2
- IASI HNO3
- IASI total O3 and O3 profiles

Offline products

- Total ozone column
- Total and tropospheric NO2 columns
- Total SO2 column
- Total BrO column
- Total HCHO column
- Total H2O column
- High-resolution ozone profile
- Absorbing aerosol height
- Absorbing aerosol index from PMDs
- Surface UV
- Tropical tropospheric ozone column
- Global tropospheric ozone column
- GOME-2 level 3 daily trace gas columns
- GOME-2 level 3 monthly trace gas columns

Data records

- Total ozone column
- Total and tropospheric NO2 columns
- Total SO2 column
- Total BrO column
- Total HCHO column
- Total H2O column
- OCIO column

- Total CHOCHO column
- NO2 and H2O climate data records
- Tropospheric BrO column
- High-resolution ozone profile
- Absorbing aerosol height
- Absorbing aerosol index from PMDs
- Lambertian-equivalent reflectivity
- Surface UV
- IASI L2 O3
- IASI L2 CO
- IASI L2 SO2

Demonstrational products

- Daily IASI NH3 product
- Daily IASI dust product
- European UV product/data record

acsaf.org

FCI composites

Predefined composites of wavelengths...

```
from satpy import Scene
scn = Scene(filenames=files, reader='fci_l1c_nc')
print(scn.available_composite_names())
```

24h_microphysics, airmass, ash, cimss_cloud_type, cimss_cloud_type_raw, cloud_phase, cloud_phase_distinction, cloud_phase_distinction_raw, cloud_phase_raw, cloud_phase_with_night_ir105, cloud_type, cloud_type_with_night_ir105, cloudtop, colorized_ir_clouds, convection, day_essl_colorized_low_level_moisture, day_essl_low_level_moisture, day_microphysics, day_severe_storms, day_severe_storms_tropical, **dust**, essl_colorized_low_level_moisture, essl_low_level_moisture, fci_fire_channels_sum, fire_temperature, fire_temperature_38refl, fire_temperature_rad, flames_masked, fog, geo_color, geo_color_background_with_low_clouds, geo_color_high_clouds, geo_color_low_clouds, geo_color_night, green_snow, hrv_clouds, ir108_3d, ir_cloud_day, ir_sandwich, ir_sandwich_with_night_colorized_ir_clouds, **natural_color**, natural_color_raw, ndvi_hybrid_green, ndvi_hybrid_green_fully_sunzencorrected, ndvi_hybrid_green_raw, night_fog, night_ir105, night_ir_alpha, night_ir_with_background, night_ir_with_background_hires, night_microphysics, night_microphysics_tropical, overshooting_tops, rocket_plume_day, rocket_plume_night, simple_fci_fire_mask, snow, true_color, true_color_flames_with_night_ir105,

true_color_fully_sunzencorrected, true_color_raw, true_color_raw_with_corrected_green, true_color_reproduction, true_color_reproduction_corr, true_color_reproduction_uncorr, true_color_with_night_ir, true_color_with_night_ir105, true_color_with_night_ir_hires, volcanic_emissions

---

LI Lightning Imager

LI Lightning Imager Groups

Variable	Description
`group_time`	UTC time of the group
`latitude`	Avg latitude of the events in the group weighted by the event radiance
`longitude`	Avg longitude of the events in the group weighted by the event radiance
`radiance`	Total radiance of the group (Optical Characteristics of OTD Flashes and the Implications...)
`number_of_events`	Number of events in the group
`flash_id`	ID of the flash that allows one to relate the groups in the LI-2-LGR-x-FD-x to the LI-2-LFL-x-FD-x
`group_filter_qa`	Quality of the group computed at the group-rejection step (Rejection of groups prior to the comp...)

Key variables in LI-2-LGR-x-FD-x.

user.eumetsat.int/resources/user-guides/mtg-li-level-2-data-guide

---

LI Lightning Imager

LI Lightning Imager Flashes

Variable	Description
`flash_time`	UTC time of the first group in the flash
`flash_duration`	Duration of the flash, ie, time difference between the first a the last group of the flash
`latitude`	Average latitude of the events in the flash weighted by the event radiance
`longitude`	Average longitude of the events in the flash weighted by the event radiance
`radiance`	Total radiance of the flash (Optical Characteristics of OTD Flashes and the Implications...)

Variable	Description
number_of_events	Number of events in the flash
number_of_groups	Number of groups in the flash
flash_footprint	Size of the flash footprint in number of pixels
flash_id	ID of the flash
flash_filter_quality	Quality of the filter computed at the group-rejection step (Rejection of flashes)

Key variables in LI-2-LFL-x-FD-x.

user.eumetsat.int/resources/user-guides/mtg-li-level-2-data-guide

---

Infrared Sounder IRS

Hyperspectral infrared sounder

- Goal:
  - Derive the evolution of vertically resolved water vapour structures
  - Extract 3D wind fields with a vertical resolution ~ 2 km
  - Track the 3D structures
    - atmospheric water vapour and temperature
    - carbon monoxide and pollution
    - atmospheric dynamic variables
- Spatial: **4km** at nadir (1.025° x 1.025°)
- Temporal: 15 – 30 minutes for local zones, **60 minutes** for full disk

spatial on the Earth surface is 4km at nadir, increasing up to 10km, and above

160 x 160 interferograms and four broad-band high-resolution images for each spectral band

No concurrent 'full disc scan'

160 x 160 x (877;1076)

Infrared Sounder IRS

Band	Wavenumber Range	Channels	Main Targets
Long Wave IR (LWIR)	679.5 – 1210.0 cm^{-1}	887	H2O, CO2, O3, Surface, Clouds, Aerosols
Mid Wave IR (MWIR)	1600.0 – 2250.4 cm^{-1}	1076	H2O, CO, N20, NO

Vertical resolution TBD … (~ 2km)

https://user.eumetsat.int/resources/user-guides/mtg-irs-level-1-data-guide

---

Infrared Sounder IRS

L2 data

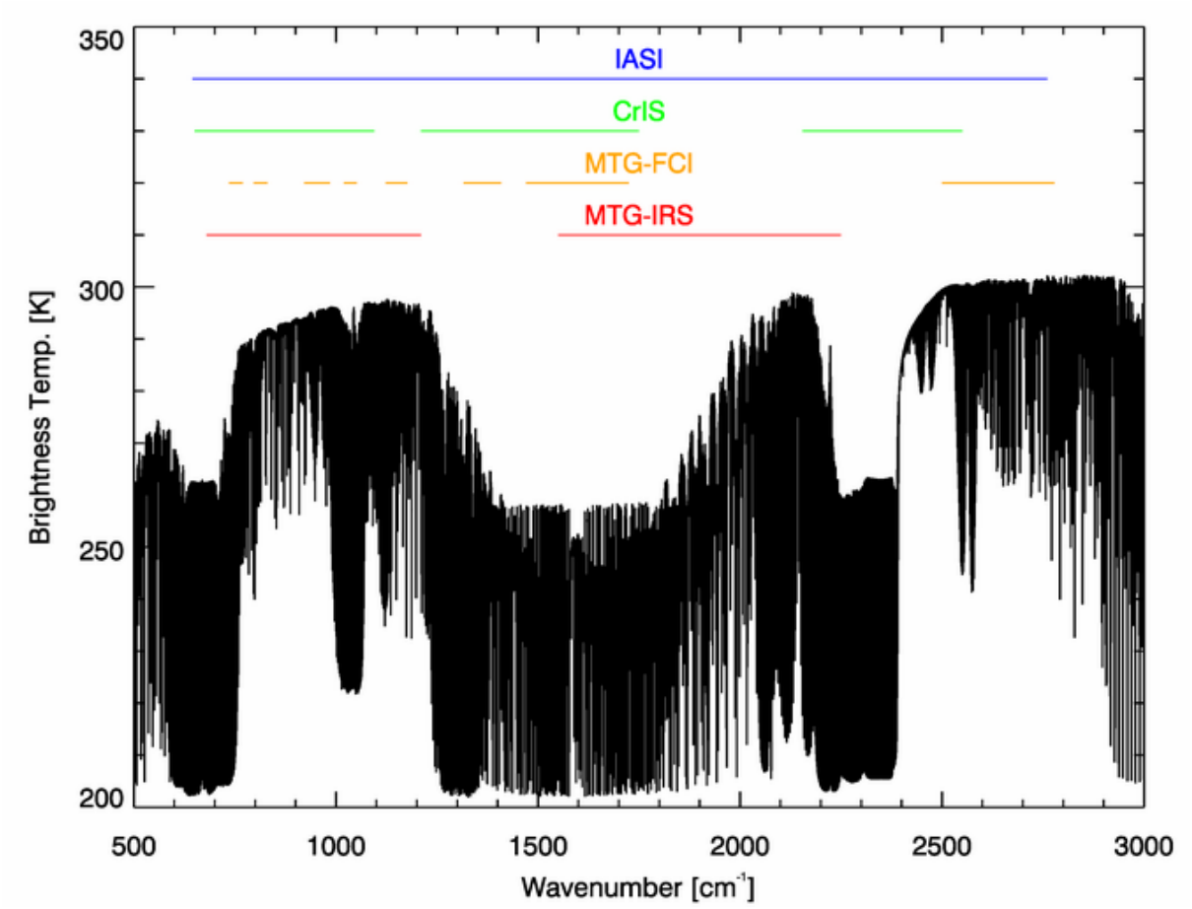
- Temperature, humidity, ozone profiles
- Surface parameters
- Instability indices and total vertical column
- Cloud products
- Contextual parameters

Test/Simulated data available here

https://user.eumetsat.int/resources/user-guides/mtg-irs-level-1-data-guide

---

Infrared Sounder IRS



Infrared Atmospheric Sounding Interferometer (LEO),
Cross-track Infrared Sounder (LEO),
MTG InfraRed Sounder (GEO),
MTG Flexible Combined Imager (GEO)

https://user.eumetsat.int/resources/user-guides/mtg-irs-level-1-data-guide

---

Sentinel-4/Ultraviolet, Visible and Near-infrared Spectrometer (S4 / UVN)

Objective: Observe the diurnal cycle of the tropospheric composition, trace gases, aerosol and cloud properties

O3 (Ozone), NO2 (Nitrogen dioxide), SO2 (Sulfur dioxide), HCHO (Formaldehyde), CHOCHO (glyoxal)

Instrument type	Passive imaging spectrometer
Spectrometric bands	**3**, Ultraviolet (305-400 nm), Visible (400-500 nm) and Near Infrared(750-775 nm) [1]
Spectrometric channels	**2**, (UV-VIS channel; NIR channel)
Field Of View	E-W: 30°W-46.5°E @ 40°N, N-S: 30°N-65°N
Spatial resolution	8 x 8 km²
Spectral resolution	0.5 nm for the UV-VIS channel; 0.12 nm for the NIR channel
Radiometric accuracy (absolute)	3% (2% goal) of the measured sun irradiance, earth radiance and spectral reflectance.
Revisit time	~ 60 min

Sentinel-4/Ultraviolet, Visible and Near-infrared Spectrometer (S4 / UVN)

L1 data

Level-1B product	Parameter(s)	Distributed
Earth Radiance	Spectrally and radiometrically calibrated and geo-located Earth radiance	To all users
Solar Irradiance	Spectrally and radiometrically calibrated Solar irradiance	To all users
DPPF	Data Processing Parameters	To Expert Users
Calibration	Calibration data.	To Expert Users
Star	Star calibration data	To Expert Users
Diagnostic	Instrument diagnostic data	To Expert Users

---

[1] VIS and NIR bands implemented in two spectrometers UVVIS & NIR)

Sentinel-4/Ultraviolet, Visible and Near-infrared Spectrometer (S4 / UVN)

L2 data

Level-2 products	Parameter(s)
O3	Ozone (O3) total column, tropospheric sub-column,
NO2	Nitrogen dioxide (NO2) total column, tropospheric sub-column
SO2	Sulfur dioxide (SO2) total column
HCHO	Formaldehyde (HCHO) total column
CHOCHO	Glyoxal (CHOCHO) total column
Cloud	Cloud optical thickness, cloud fraction, cloud altitude
Aerosol	Aerosol column optical thickness, type, layer height, absorbing index
Surface	Surface and aerosol characteristics

sentinels.copernicus.eu/missions/sentinel-4

Other Links

- MTG in operations
  Current status and operational information
- MTG test data
  If you want to test posible applications

ευχαριστώ!

contact: **anatsis@noa.gr**

source code: **github.com/thanasisn/presentations**

Figure 4: this Presentation