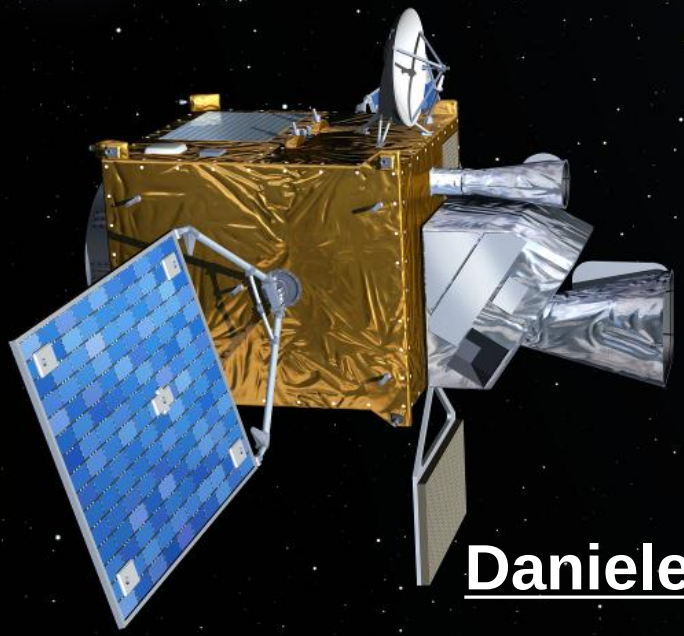
Meteosat Third Generation

Lightning Imager



Daniele Biron

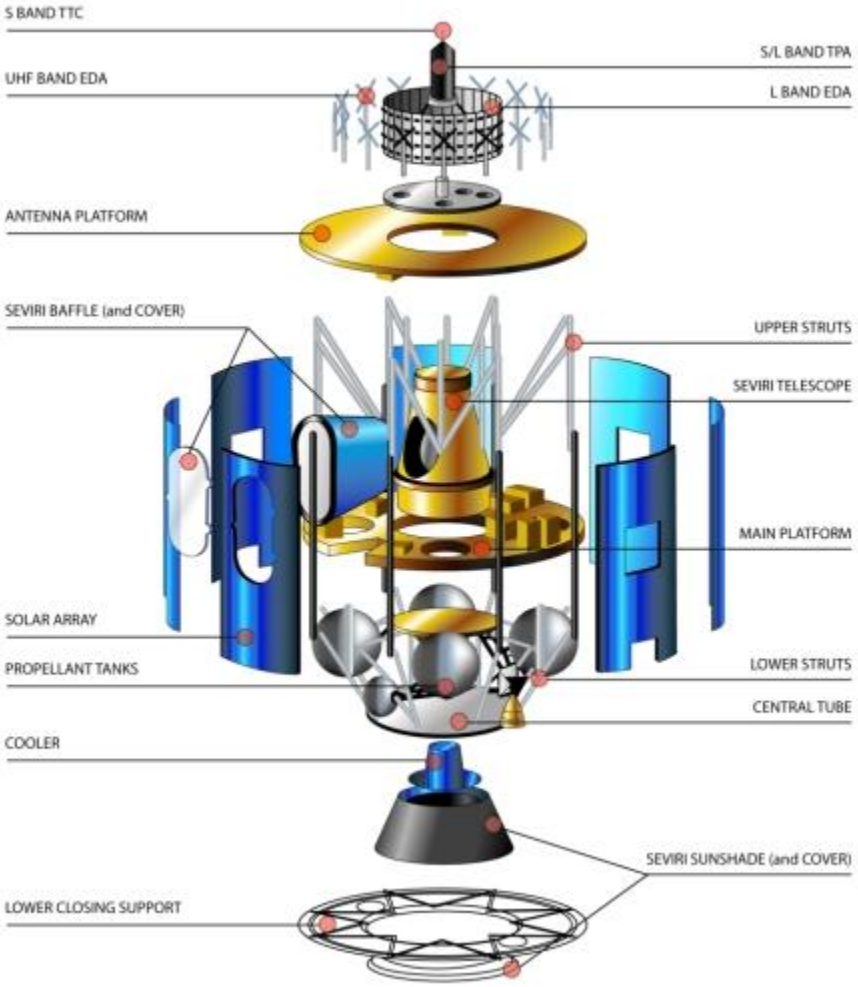
Centro Nazionale di Meteorologia e Climatologia Aeronautica

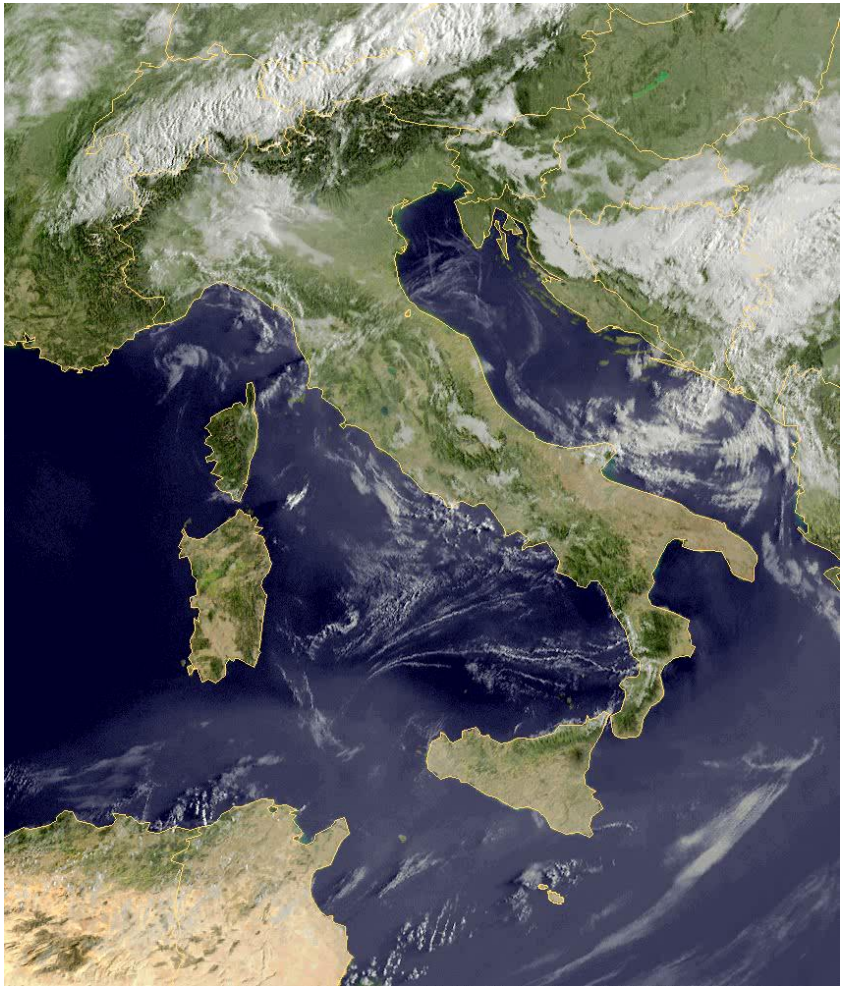
Introduction

For the next series of geostationary meteorological satellites EUMETSAT (European organization for the exploitation of operational meteorological and environmental satellites) has planned for Meteosat Third Generation (MTG) a Lightning Imager (LI). With Geostationary Lightning Mapper (GLM) on the next generation of NOAA (National Oceanographic and Atmospheric Administration) Geostationary Operational Environmental Satellite (GOES), and state of the art ground-based networks, LI will provide a global lightning detection capability. This continuous flow of lightning data will be critical in operational applications and crucial in climate and atmospheric physics research.

Public information available in ESA, NASA, EUMETSAT, NOAA sites.

Actual Meteosat Second Generation Spinning Enhanced Visible and InfraRed Imager (MSG-SEVIRI)





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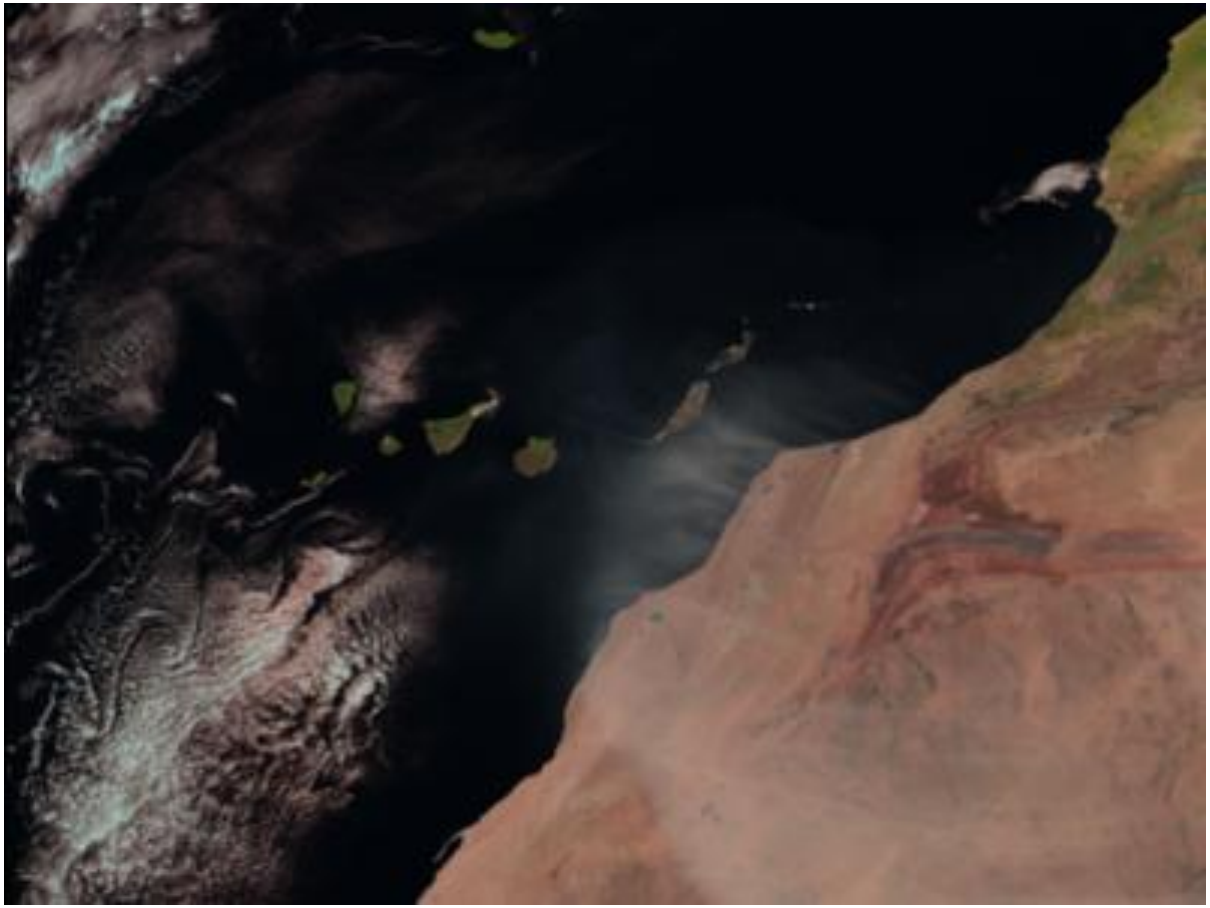
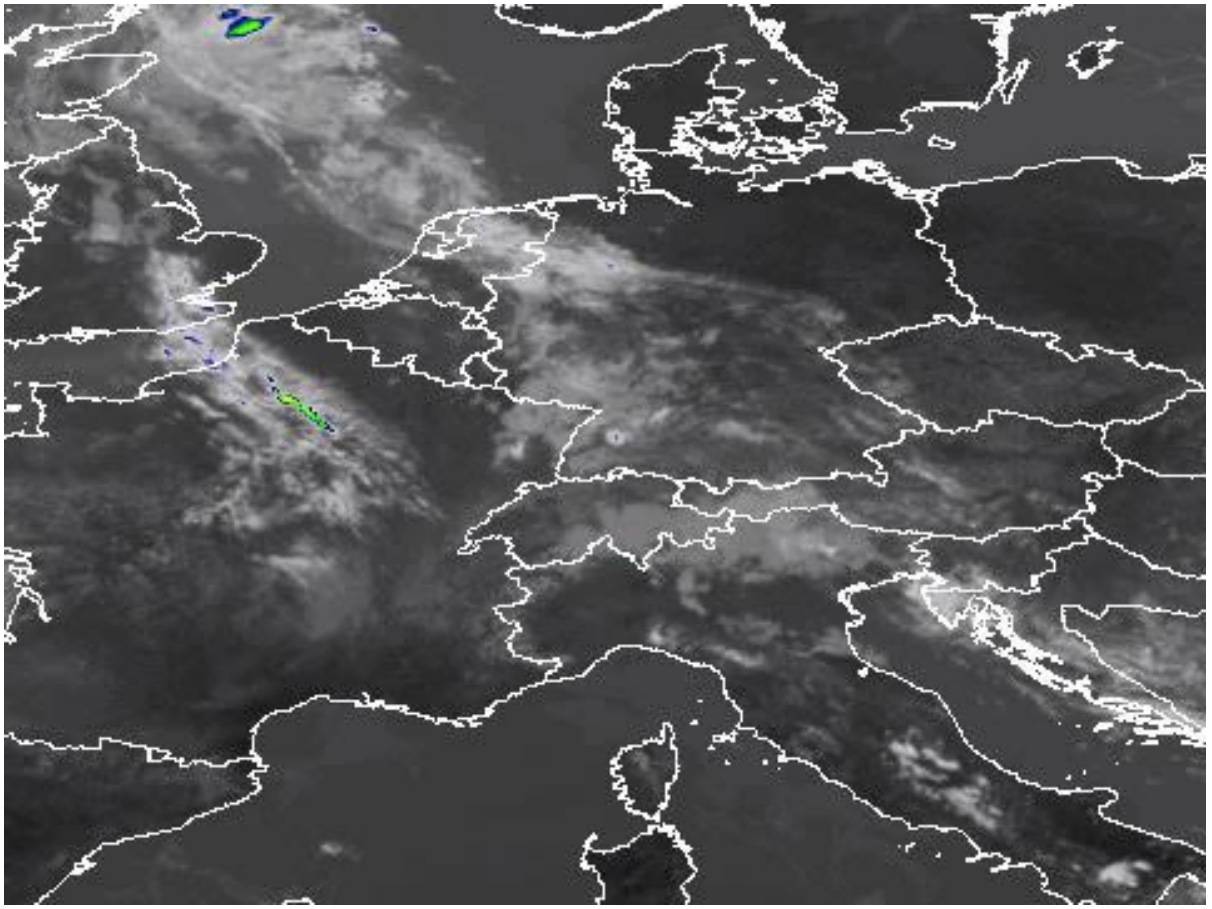


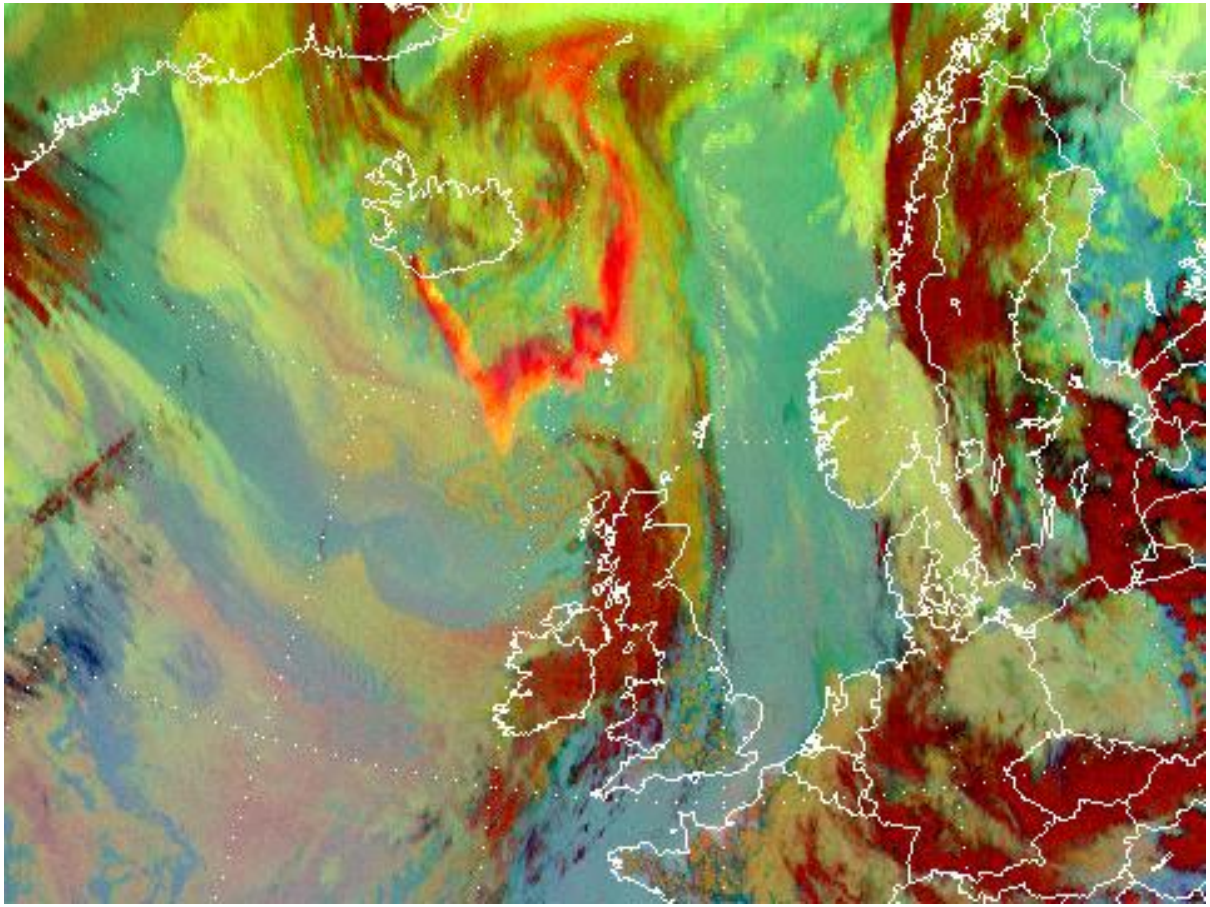
Climate Related Phenomena

Actual Meteosat Second Generation Spinning Enhanced Visible and InfraRed Imager (MSG-SEVIRI)



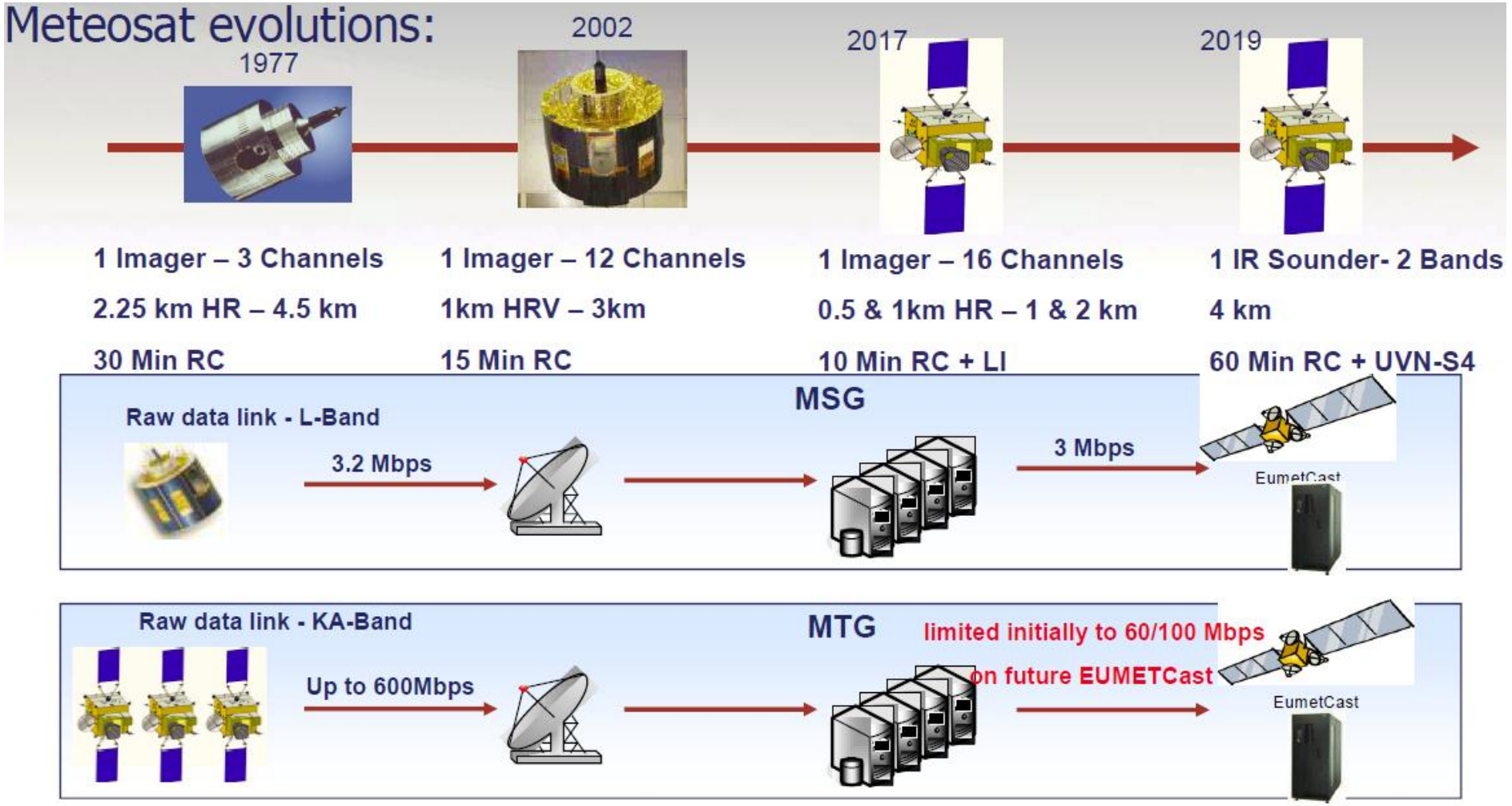
Operational Decision Making

Actual Meteosat Second Generation Spinning Enhanced Visible and InfraRed Imager (MSG-SEVIRI)

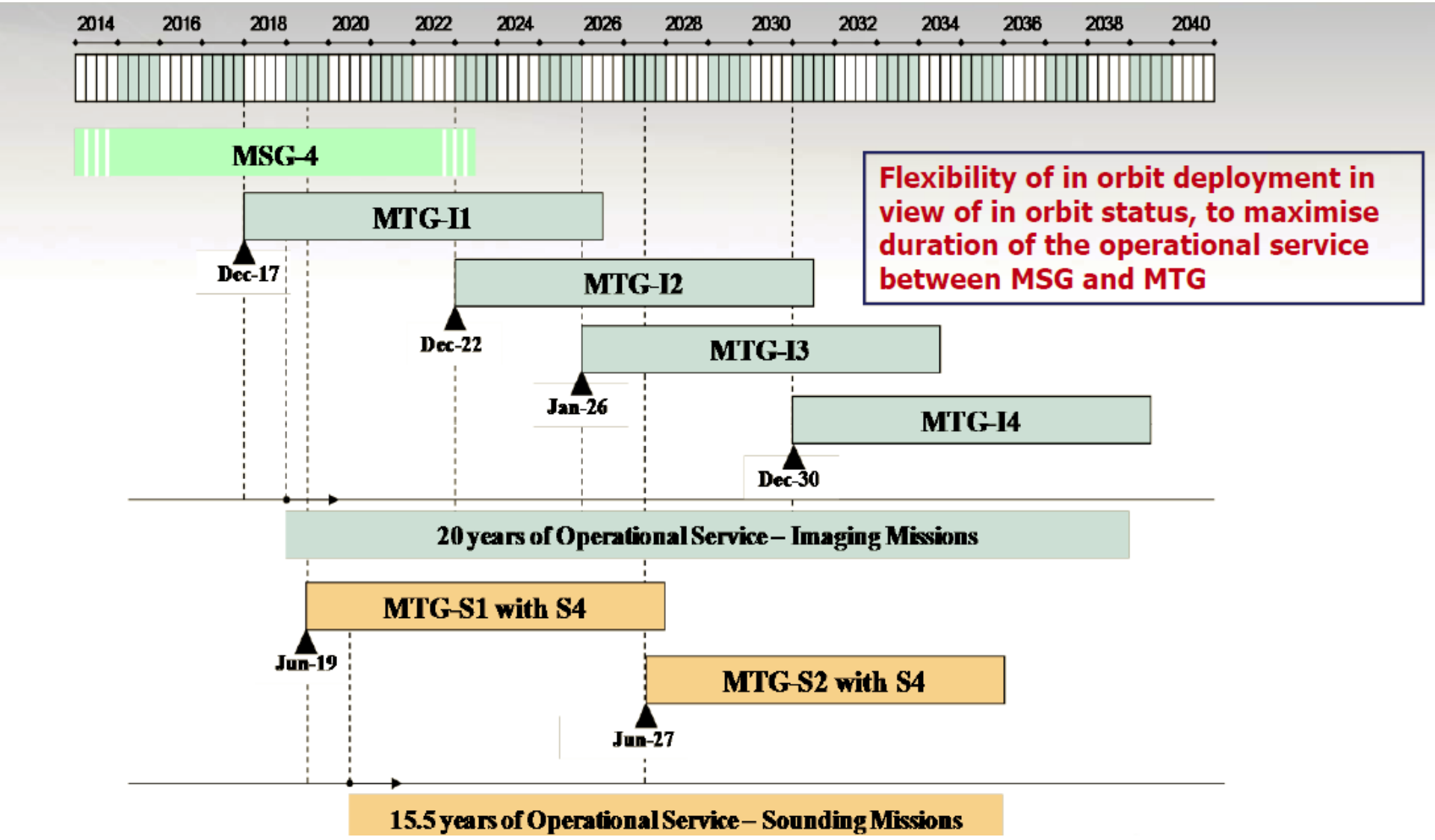


Renewed Airspace Knowledge

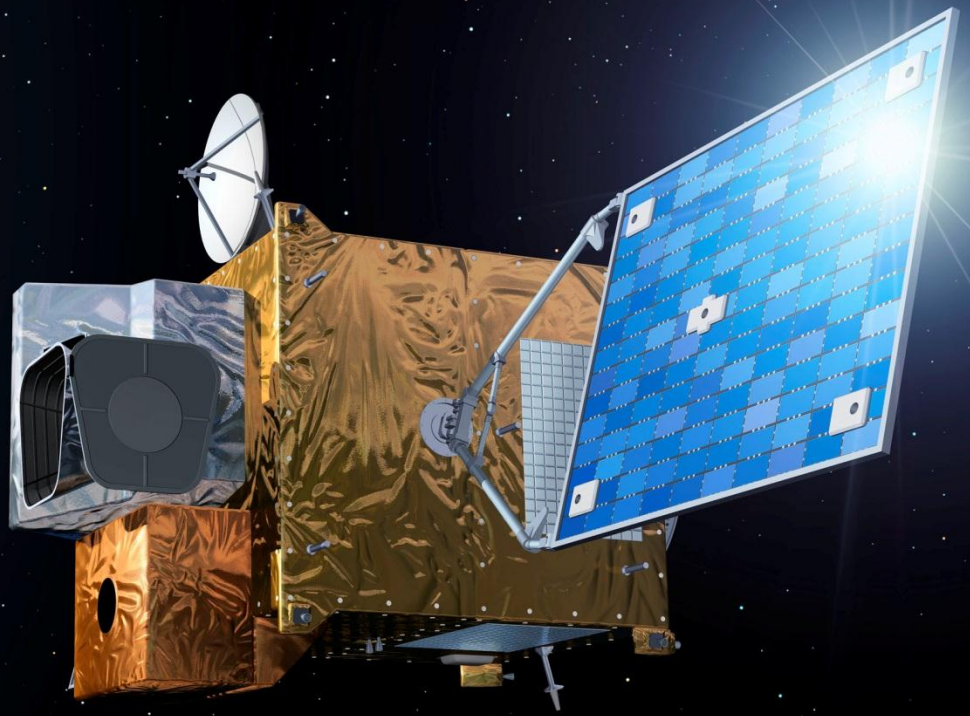
Towards Meteosat Third Generation
Not only an imaging mission



Meteosat Third Generation schedule



Meteosat Third Generation – S



– Infrared Sounding Instrument (IRS)

• High resolution spectral and spatial sampling in LWIR and MWIR Wave number range: 700 – 2175cm-1, repeat cycle = 60 min, channel interval: 0.625cm-1, Spatial sample: 4km,

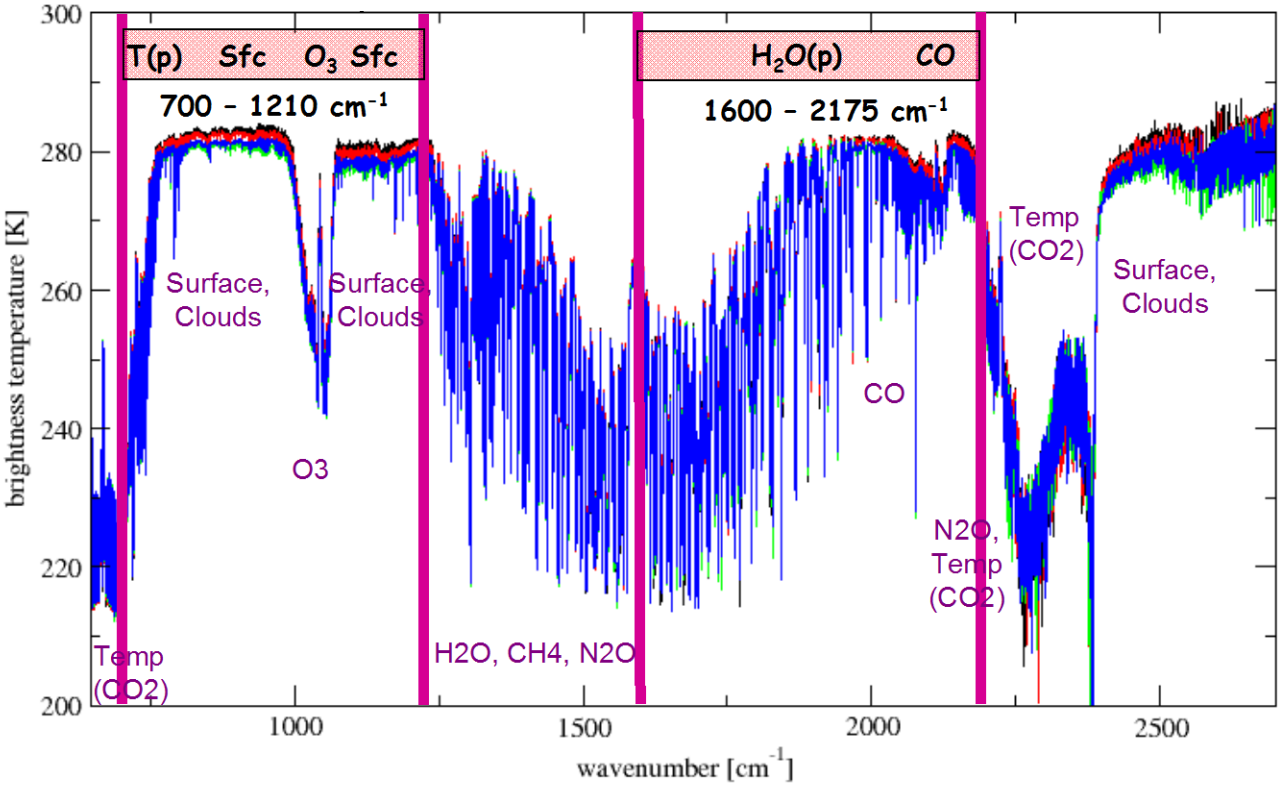
– Sentinel 4 (UVN) imaging instrument; to support the ESA GMES programme

Meteosat Third Generation – S IRS

InfraRedSounding (IRS), global scales (Full Disk) over a repeat cycle = 60 min at spatial resolution of 4 km, providing hyperspectralsoundings at 0.625 cm-1sampling in two bands:

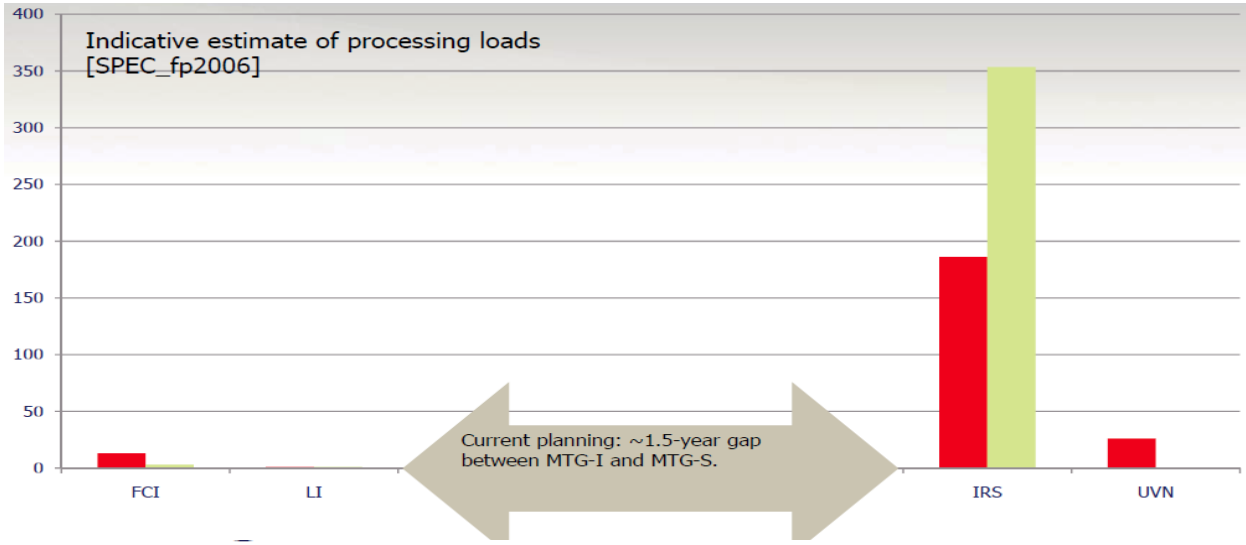
Long-Wave-IR (LWIR: 700 –1210 cm-1~ 820 spectral samples)

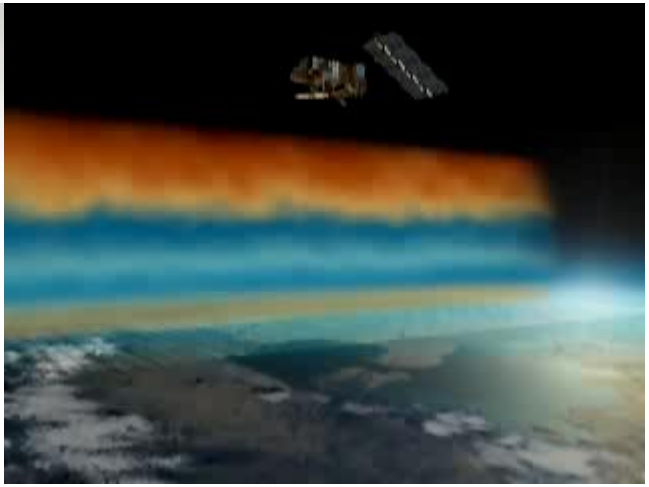
Mid-Wave-IR (MWIR: 1600 –2175 cm-1~ 920 spectral samples)

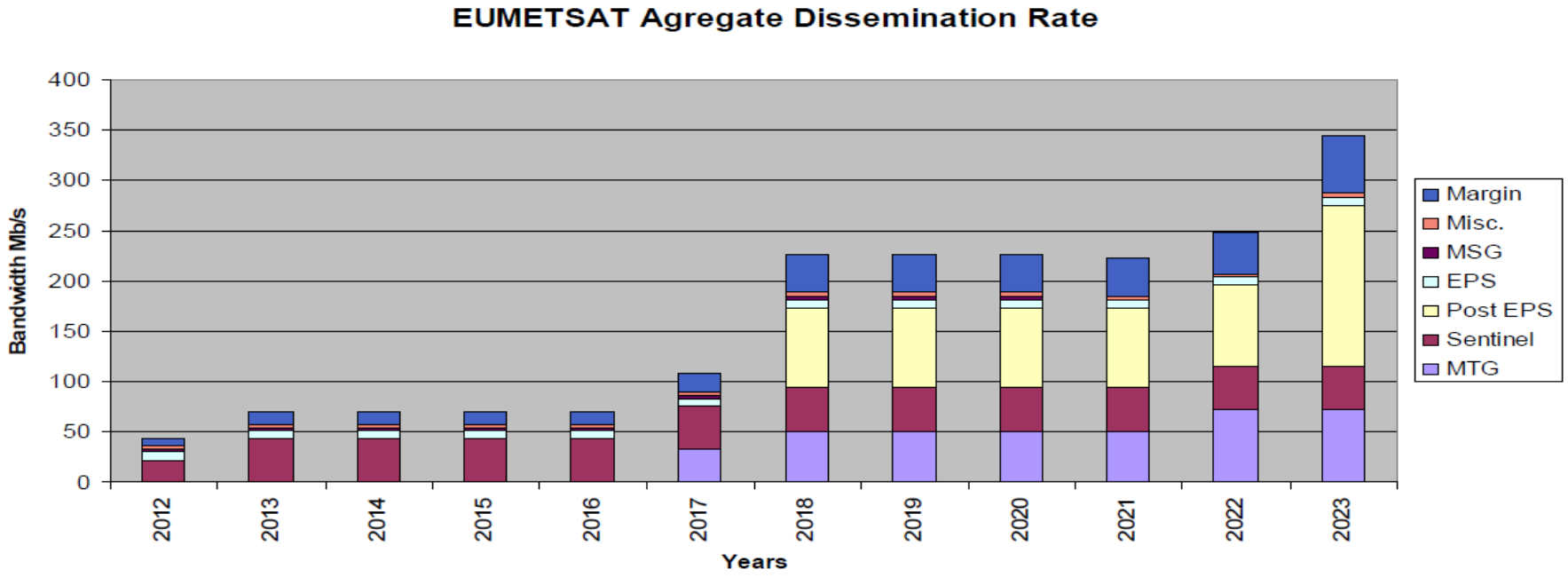


MTG spectral coverage

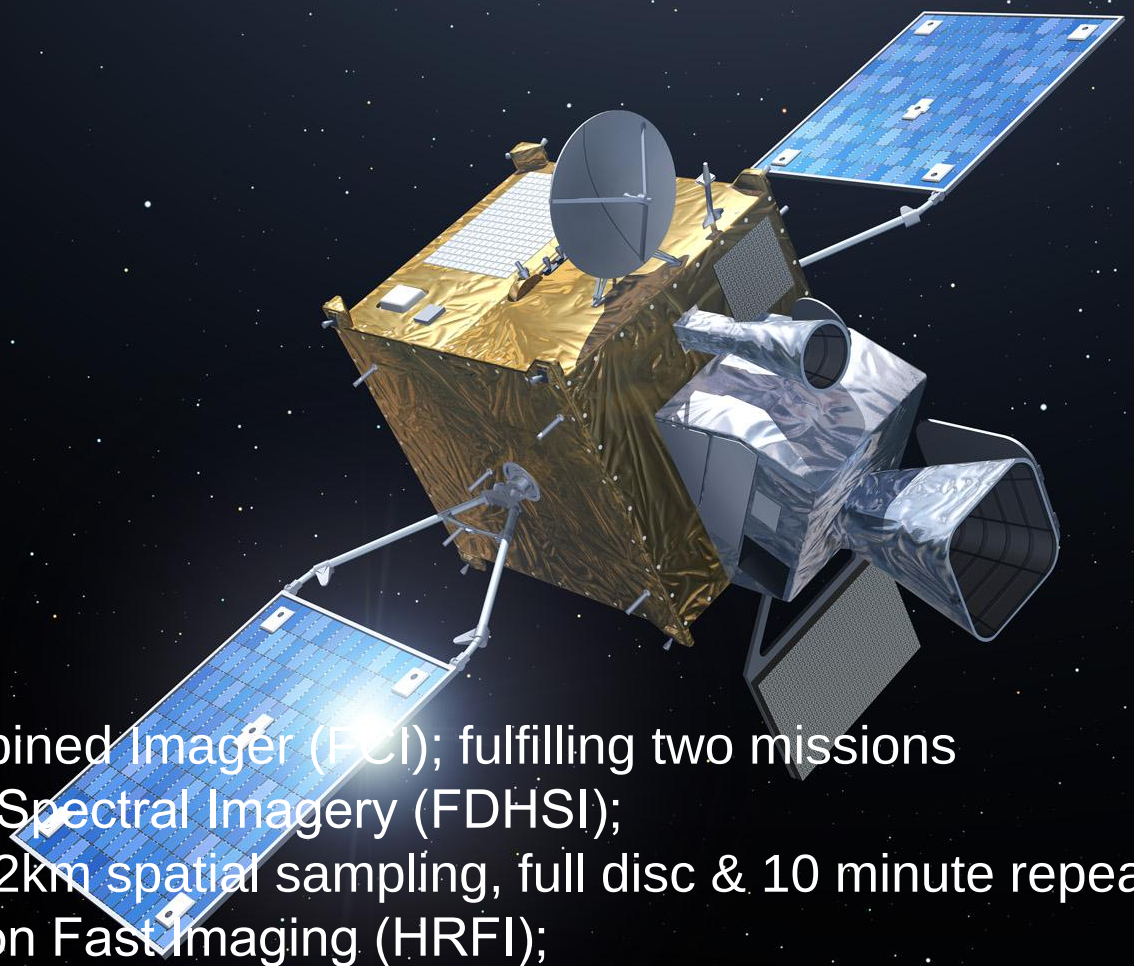
MTG – S IRS METOP- IASI heritage







Meteosat Third Generation – I

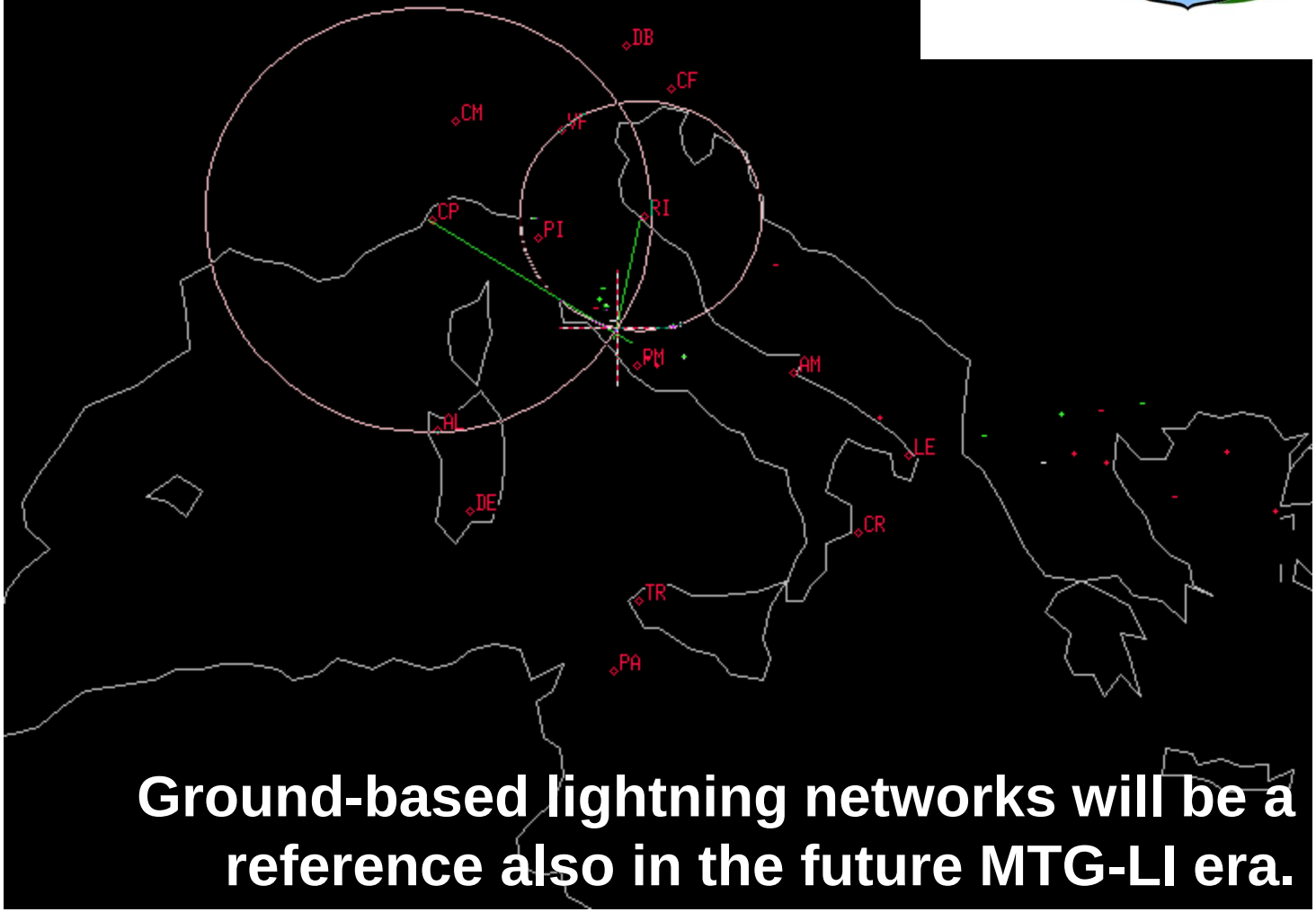


– Flexible Combined Imager (FCI); fulfilling two missions
• Full disk High Spectral Imagery (FDHSI);
16 channels, 1-2km spatial sampling, full disc & 10 minute repeat cycle
• High Resolution Fast Imaging (HRFI);
4 channels, 0.5-1.0km spatial sampling, local area cov. & 2.5 – 5 minute repeat
– Lightning Imager (LI);
• Detection of lightning events with spatial resolution of approx.10km

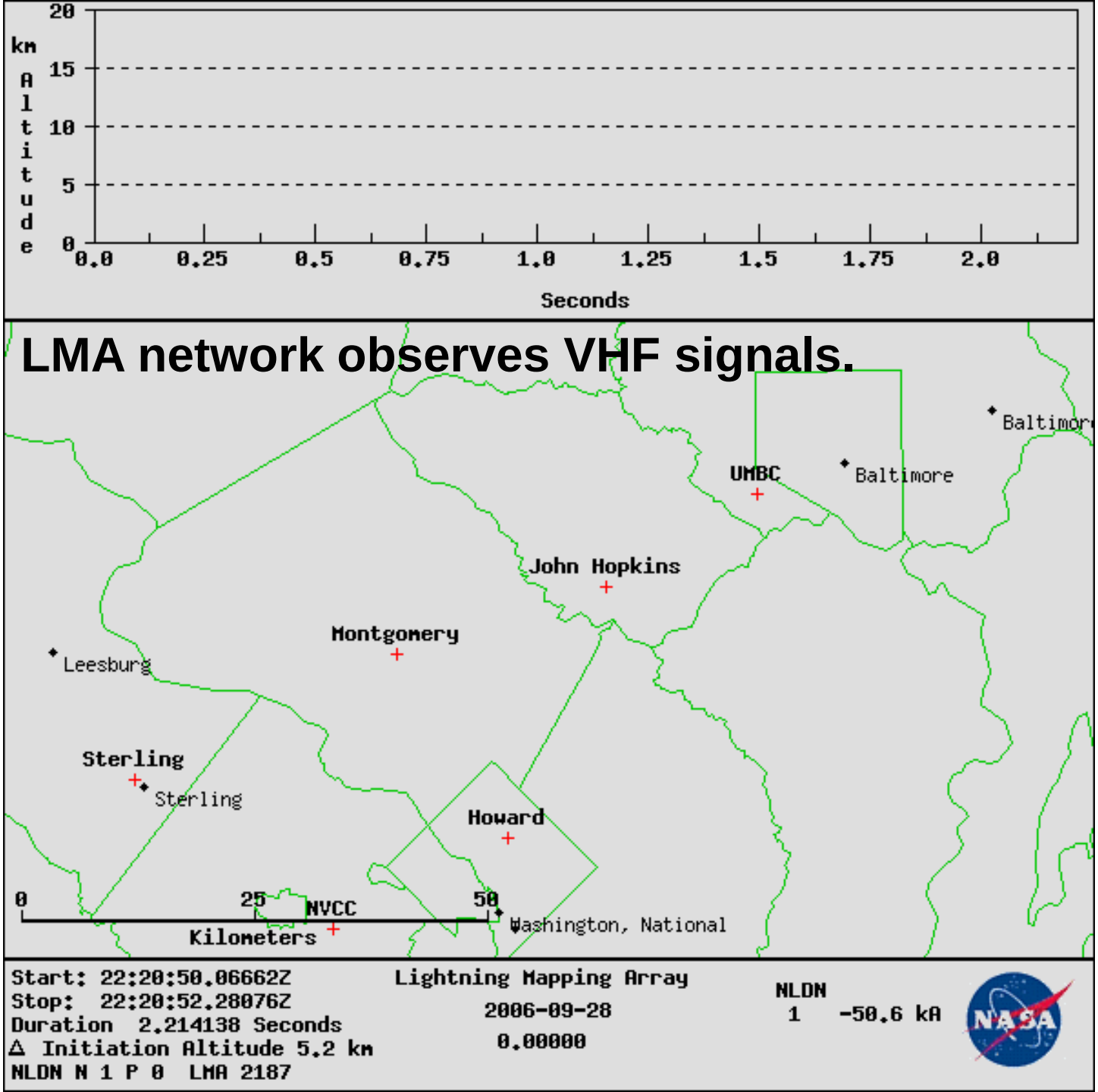
Meteosat Third Generation Lightning Imager (MTG-LI)
The phenomena we desire to observe

LAMPINET

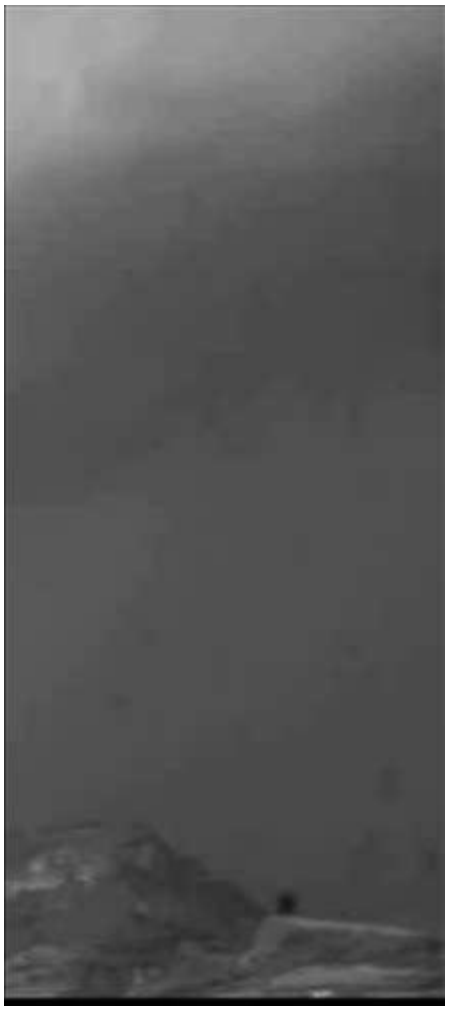
Usually ground-based lightning network observes LF signals.



Ground-based lightning networks will be a reference also in the future MTG-LI era.


km
Altitude
20
15
10
5
0
0.0
0.25
0.5
0.75
1.0
1.25
1.5
1.75
2.0
Seconds
LMA network observes VHF signals.
UMBC
Baltimore
John Hopkins
Montgomery
Leesburg
Sterling
Sterling
Howard
0
25
50
NVCC
Kilometers
Washington, National
Start: 22:20:50.06662Z
Stop: 22:20:52.28076Z
Duration 2.214138 Seconds
Δ Initiation Altitude 5.2 km
NLDN N 1 P 0 LMA 2187
Lightning Mapping Array
2006-09-28
0.00000
NLDN
1 -50.6 kA

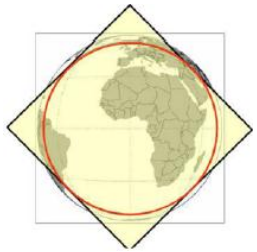
Lightning high speed video, 9000 fps
Optical signal

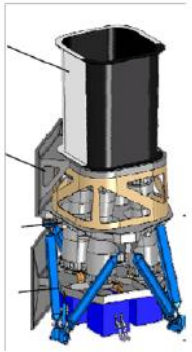


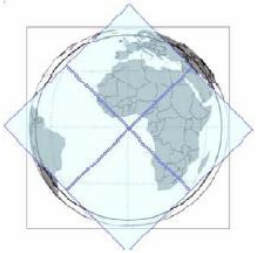
www.ztresearch.com

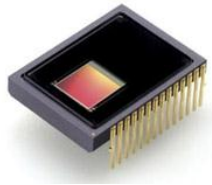
MTG-LI, near infrared signal, design to be known soon

- Optical design;
- Main electronics;
- Proximity electronics;
- Mechanical asset;
- Dynamic auxiliary;
- Static auxiliary.

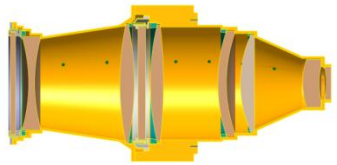




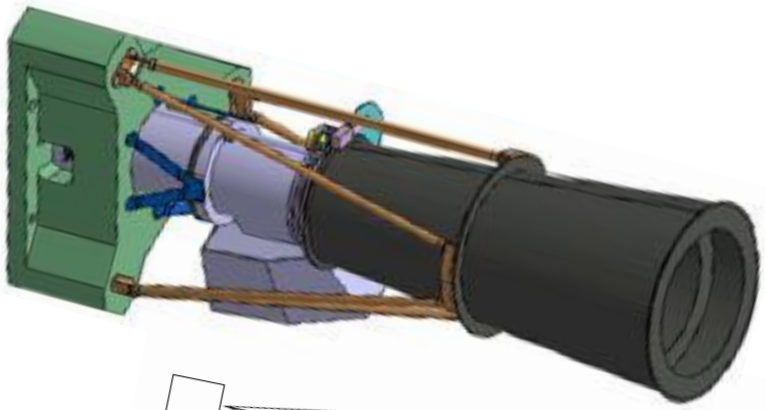


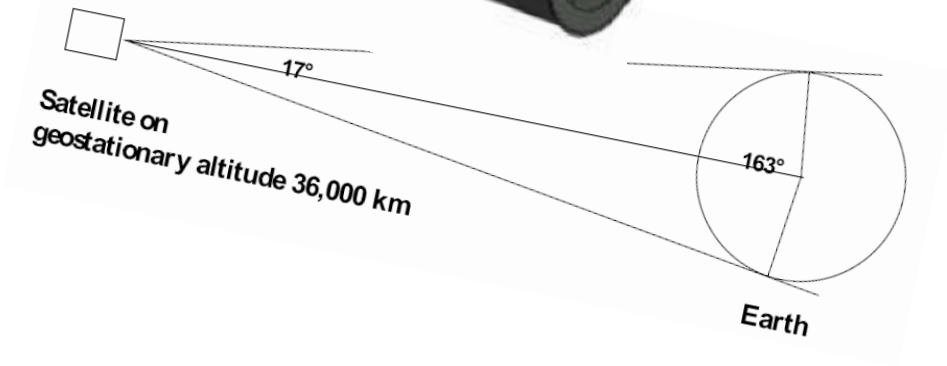


Matrix

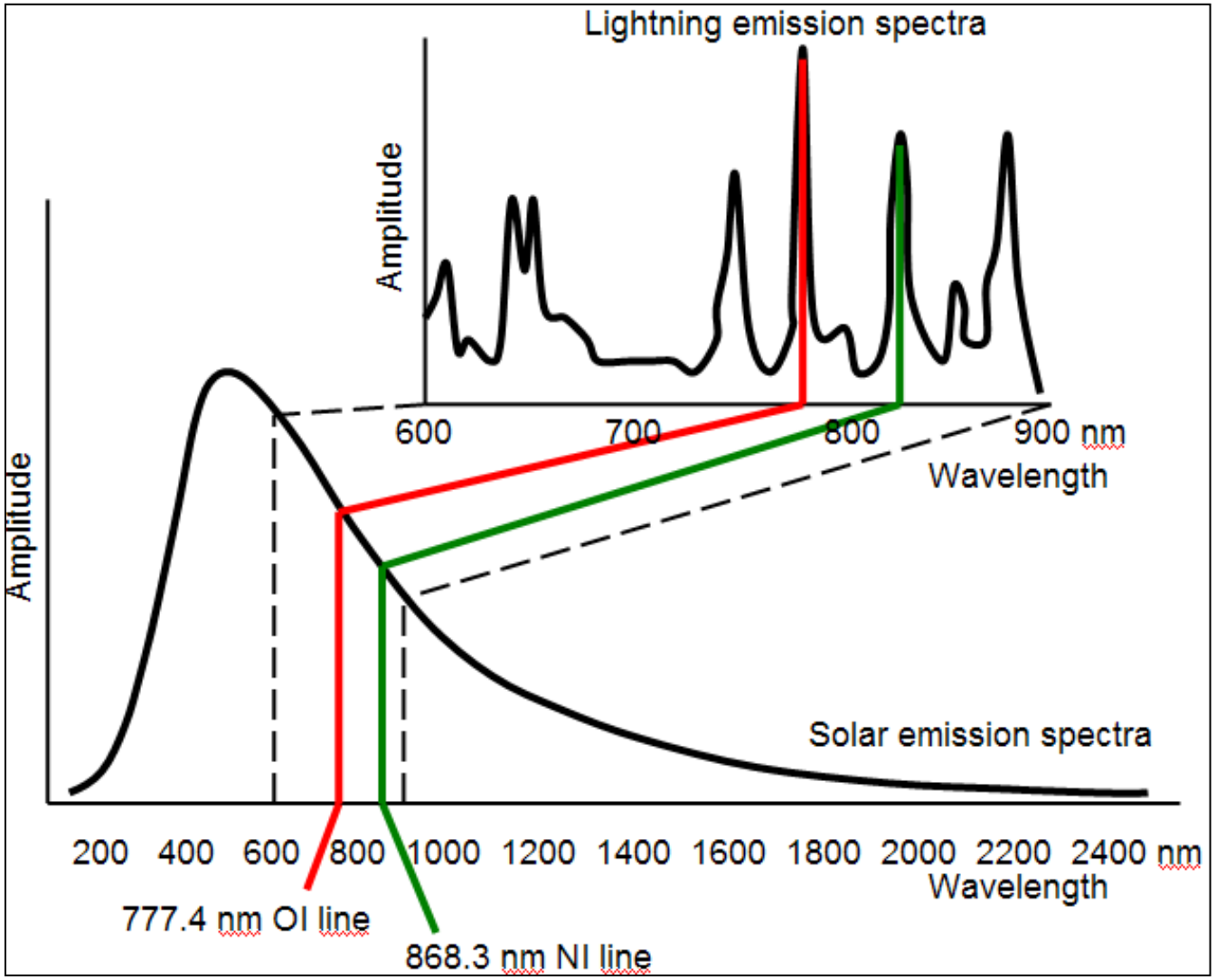


Optics

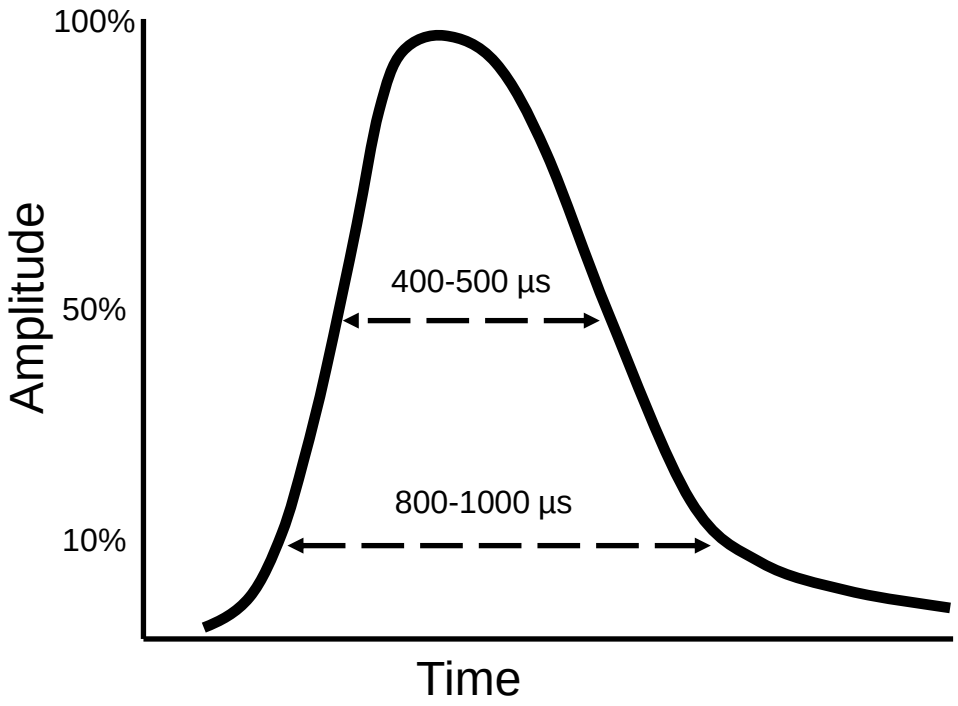


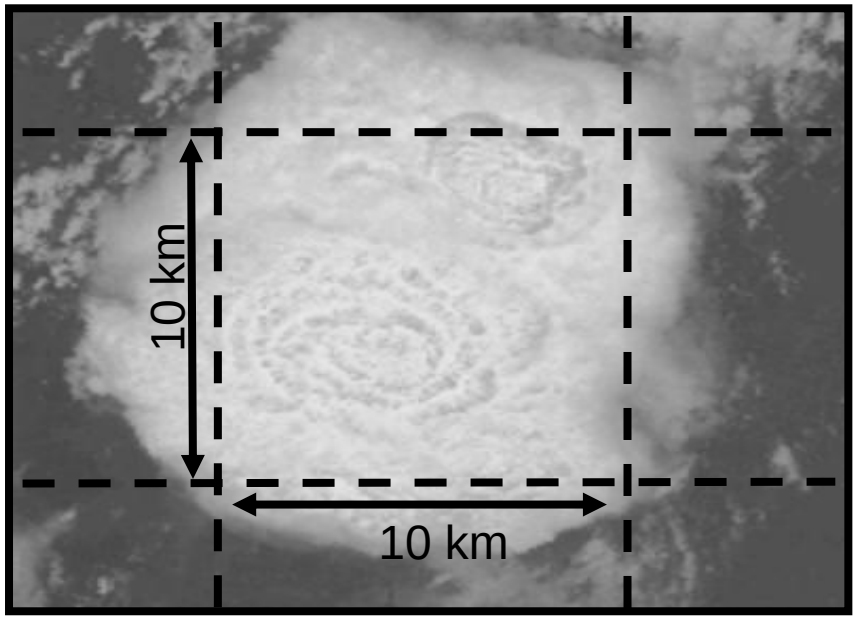


MTG-LI design based on 777.4 nm OI line observation



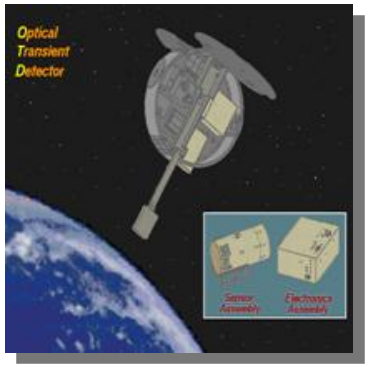
MTG-LI design, further user requirements



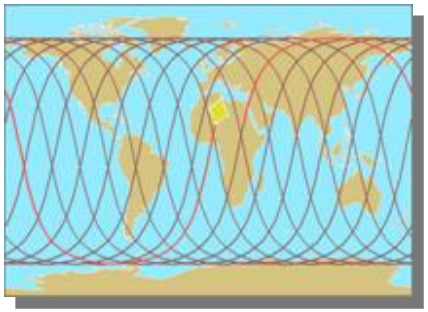


The detector is a unique CCD or CMOS matrix. Narrow filters for 777.4 nm are at top of optics to eliminate background. Integration time is 1 ms to minimize pulse splitting among frames and to reduce background noise.
10 km spatial sampling could be achieved.

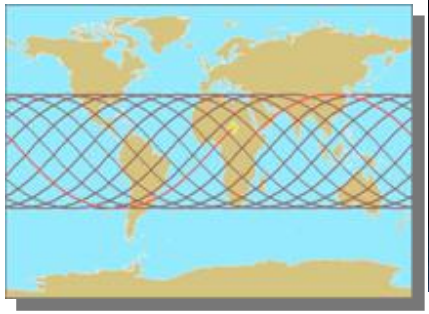
Lightning observation from space heritage

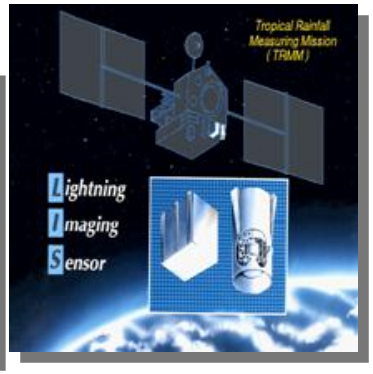


OTD 1995-2000

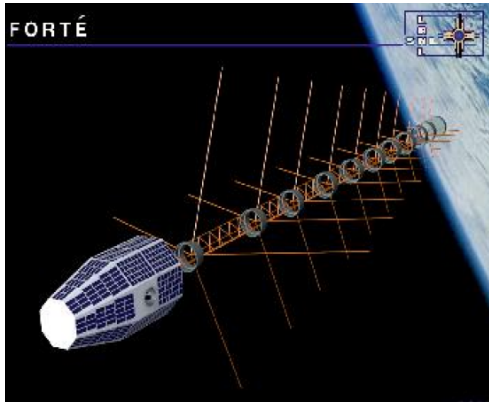


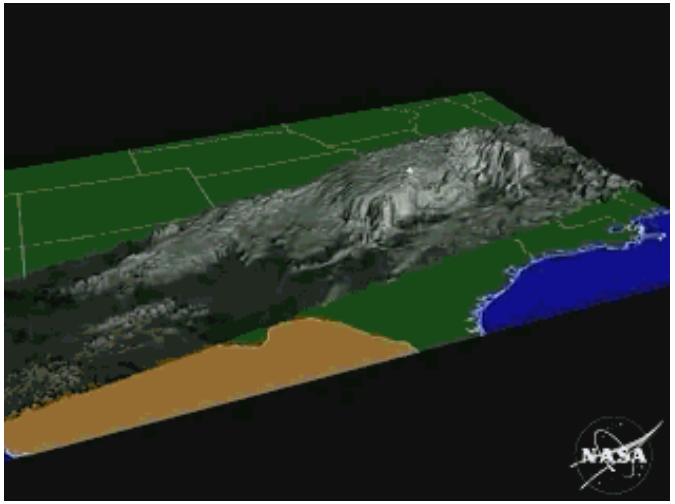
LIS 1997-now



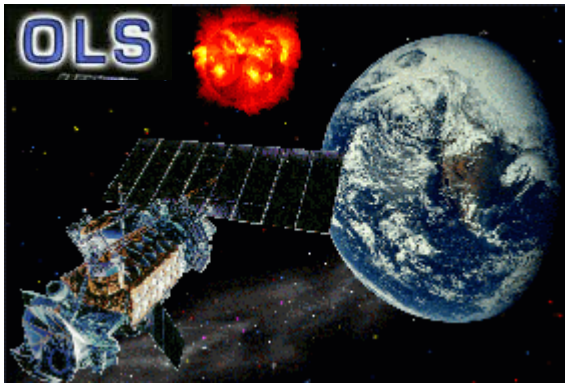


FORTE 1997-now

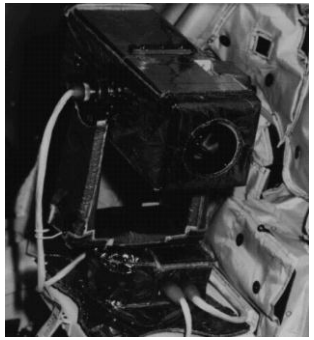




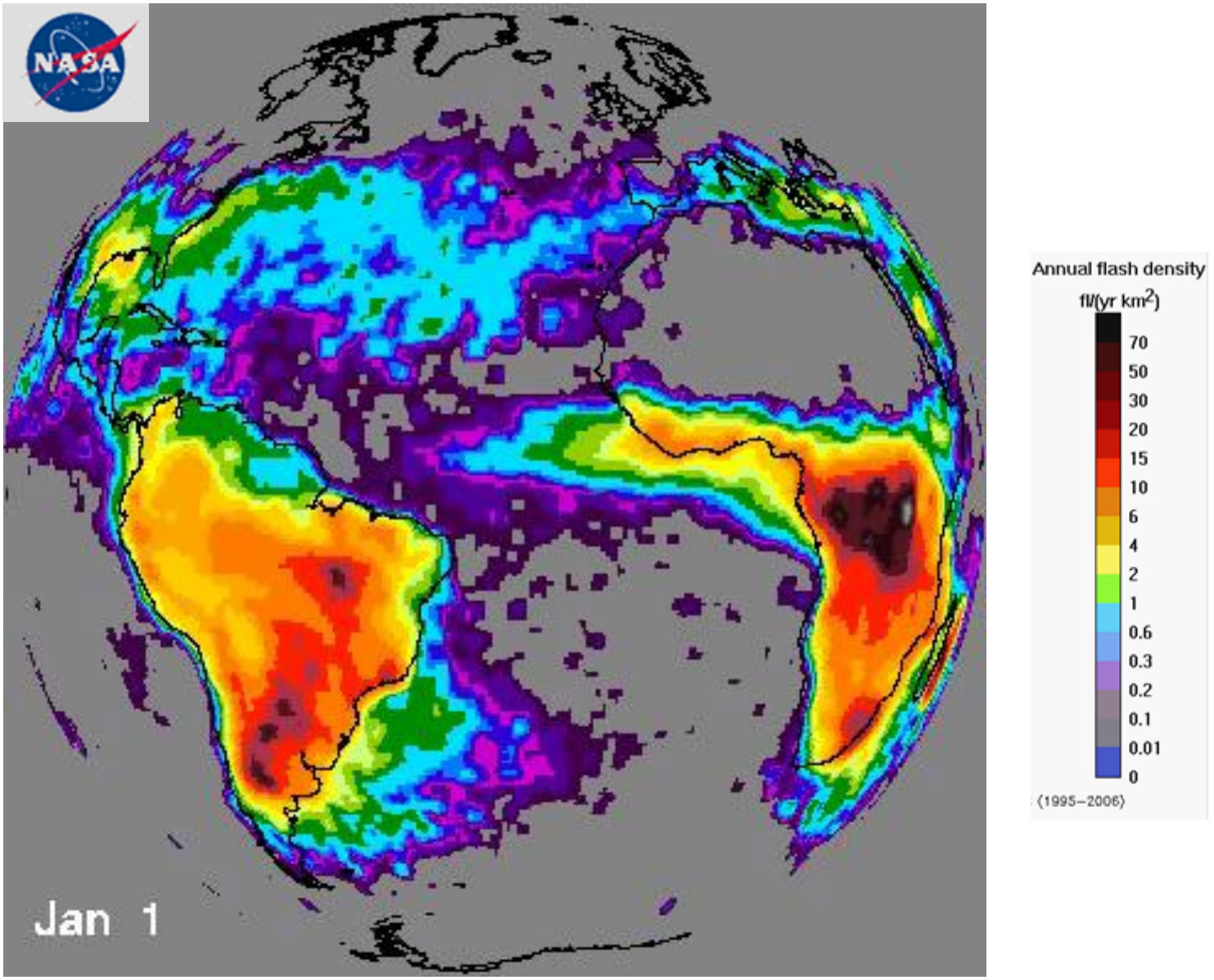
DMSP 1973-1996



STS-2,4,6…



LIS-OTD annual flash density

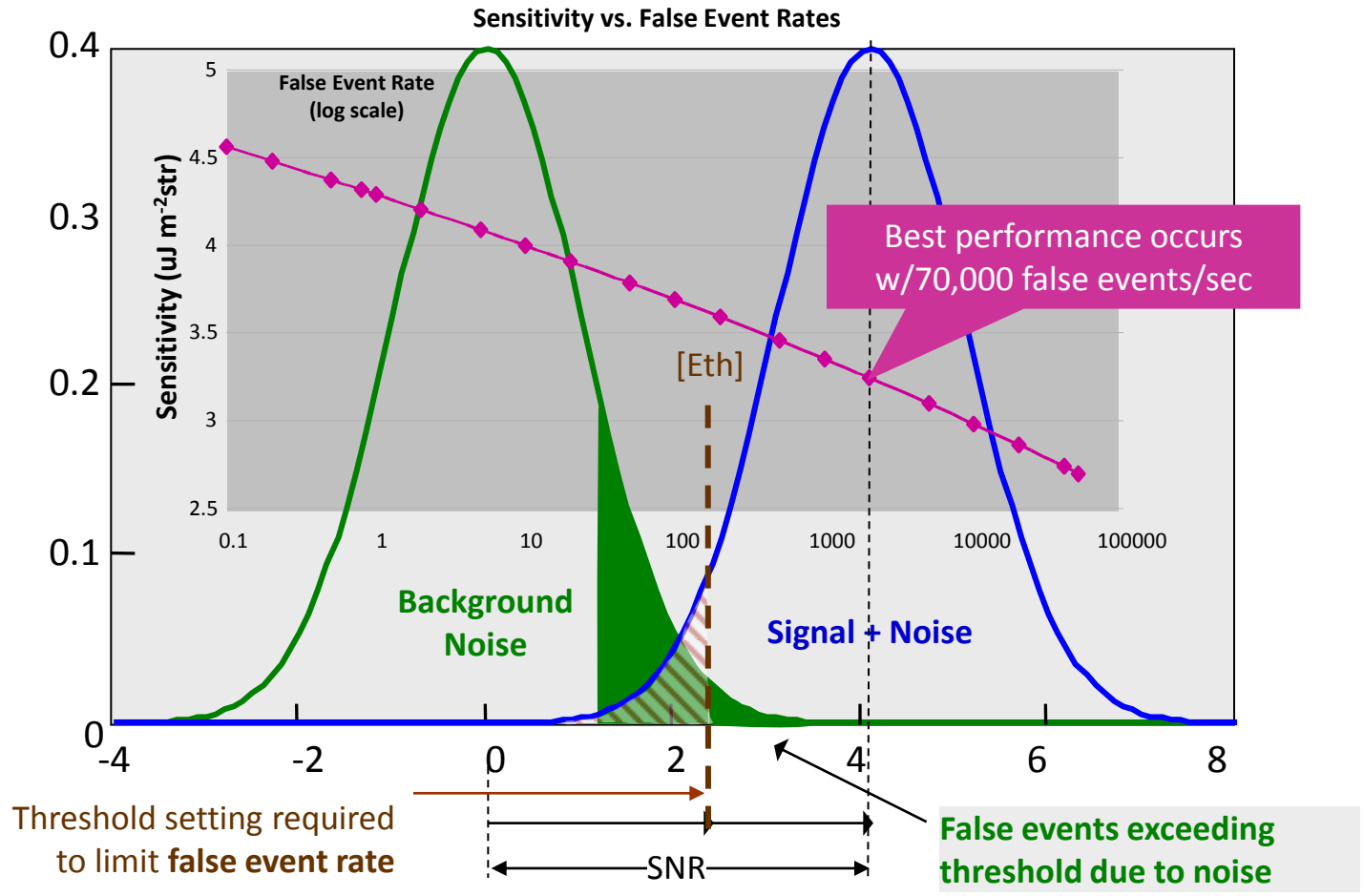


Threshold levels

Low threshold levels allow large numbers of lightning and false events: trade off between detection sensitivity and false event rates

SNR = Signal to Noise Ratio

Normalized Gaussian Distribution STD=1



As threshold (Eth) is lowered, the false event rate increases and more lightning signal is detected; false events are removed by robust algorithms in level 1b

Noise, noise and again noise

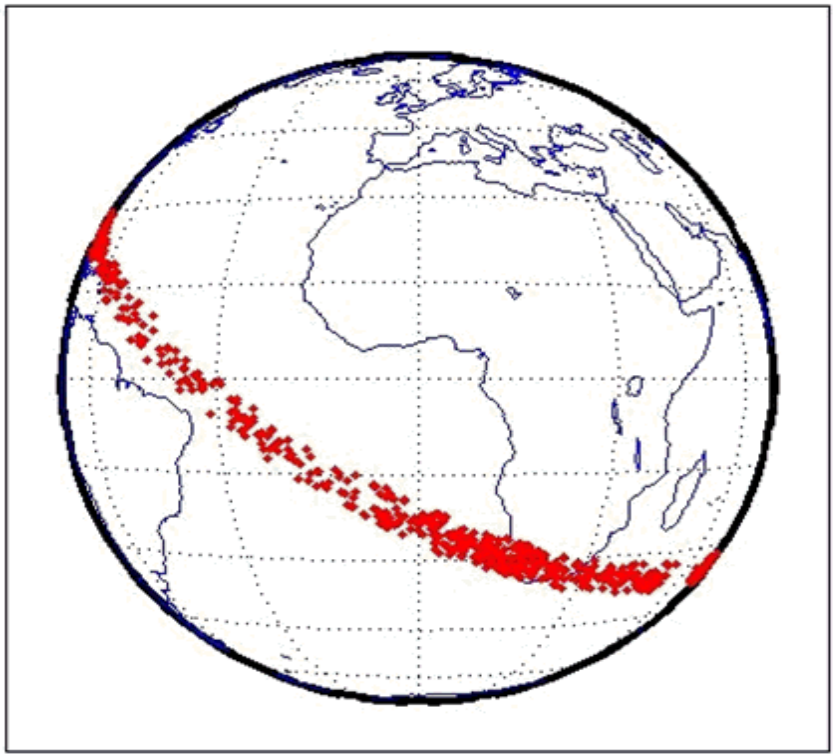
1. Internal Noise.

a. Electronic noise
b. Thermo-mechanical noise
c. Ghost noise
d. Stray light noise

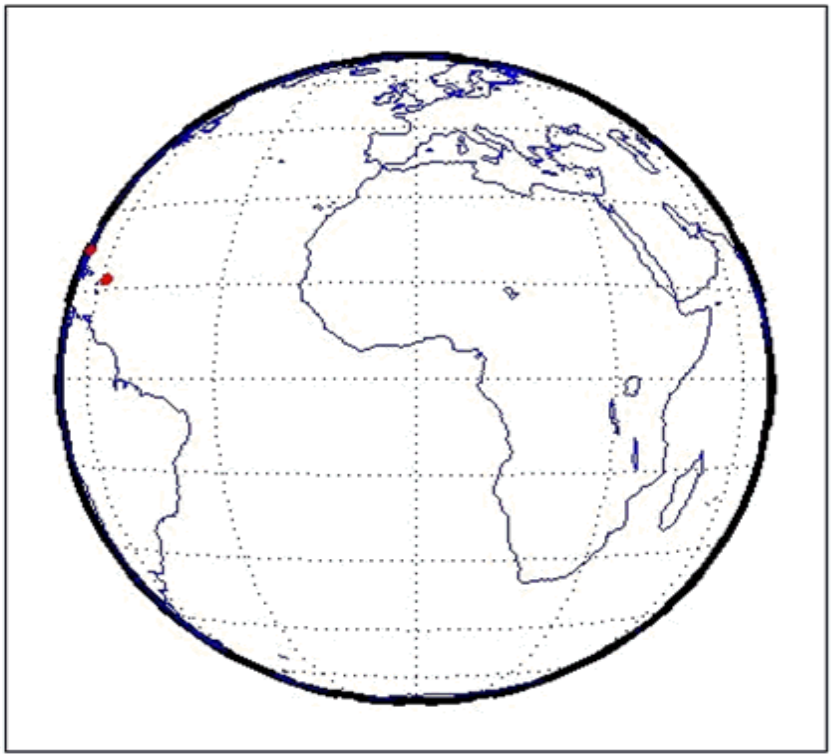
2. External Noise.

e. Cloud radiation
f. Sun glint and Solar eclipse
g. Particles flux
h. Jitter

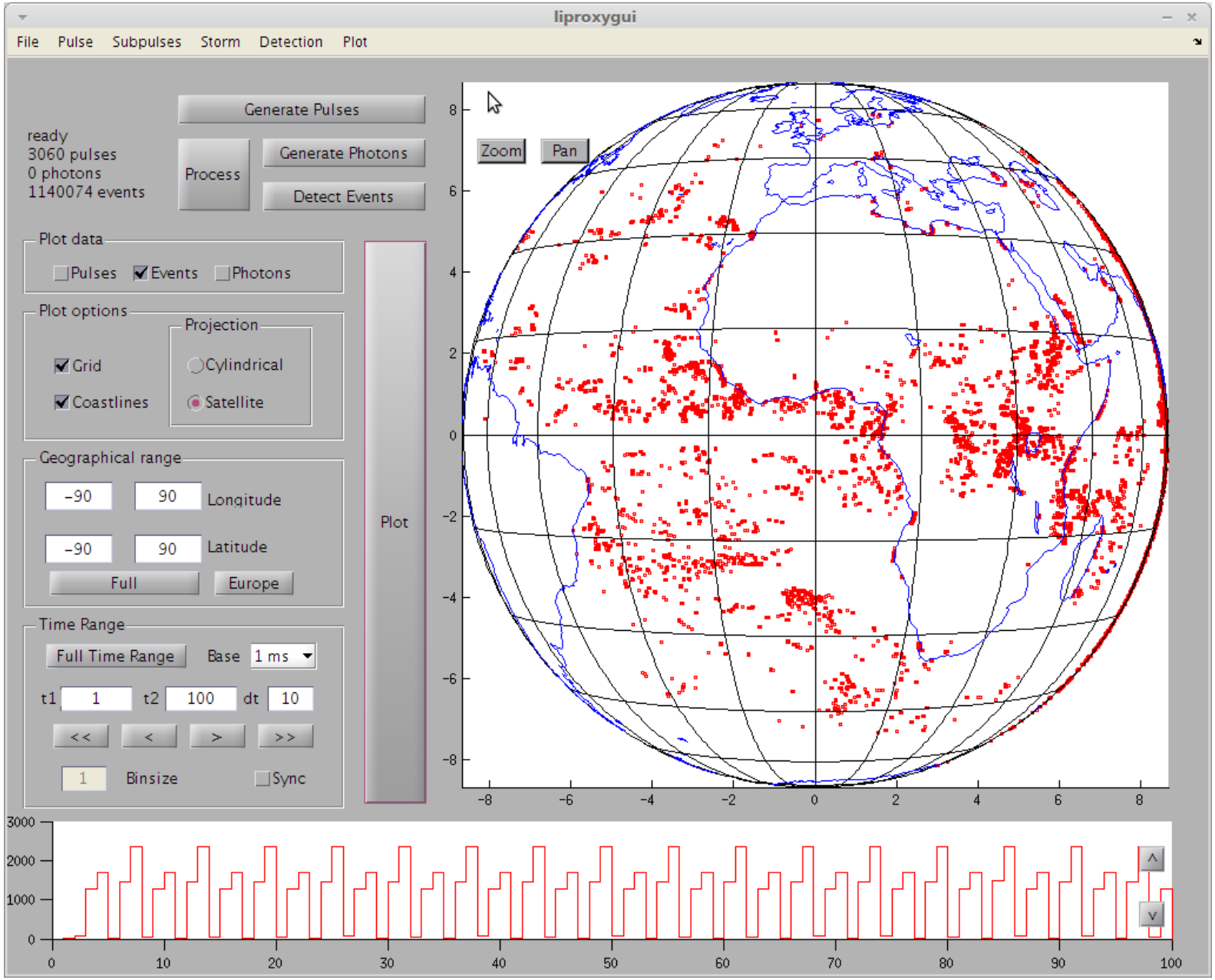
Noisy event data, 2007-176, orbit: 54740



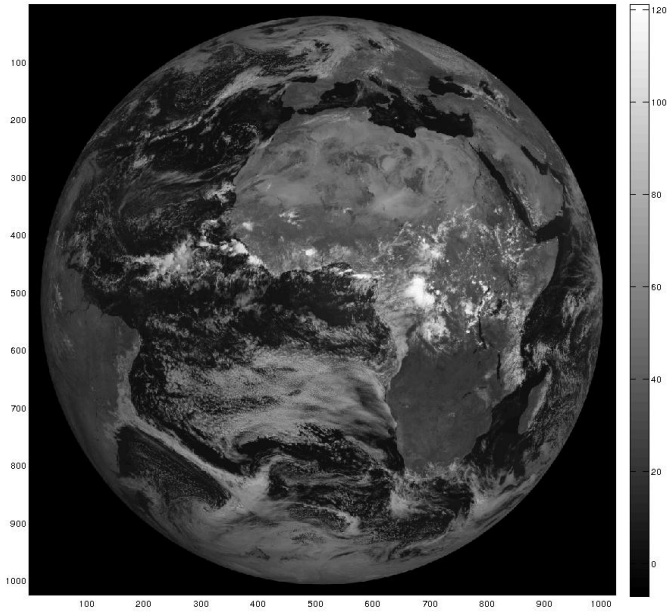
Filtered event data, 2007-176, orbit: 54740

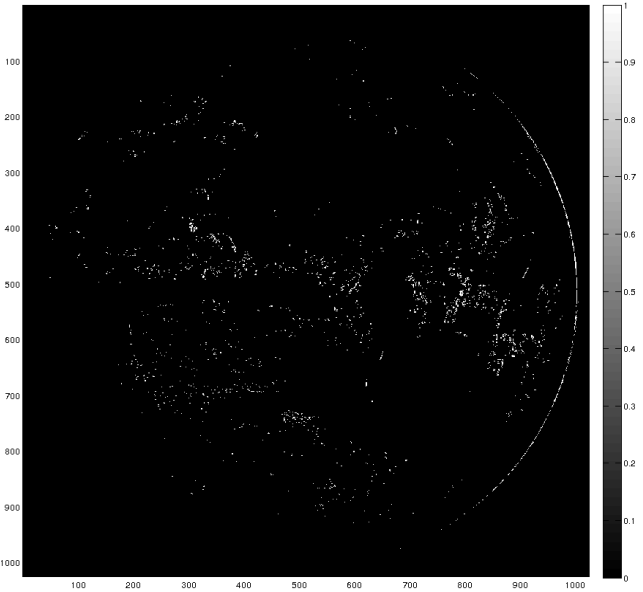


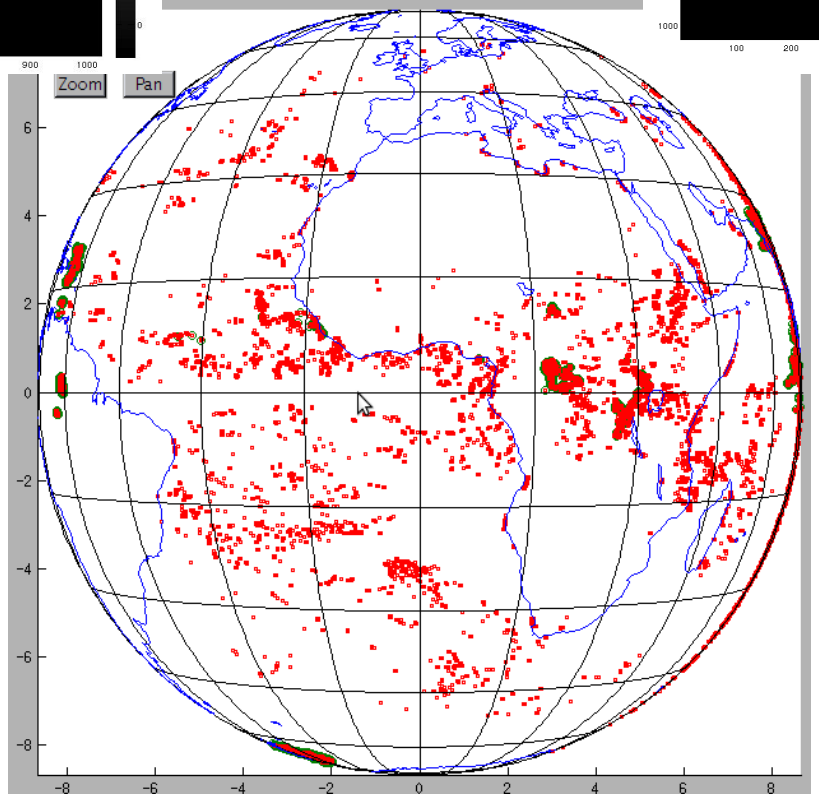
The need of a simulator: EUMETSAT LIProxy



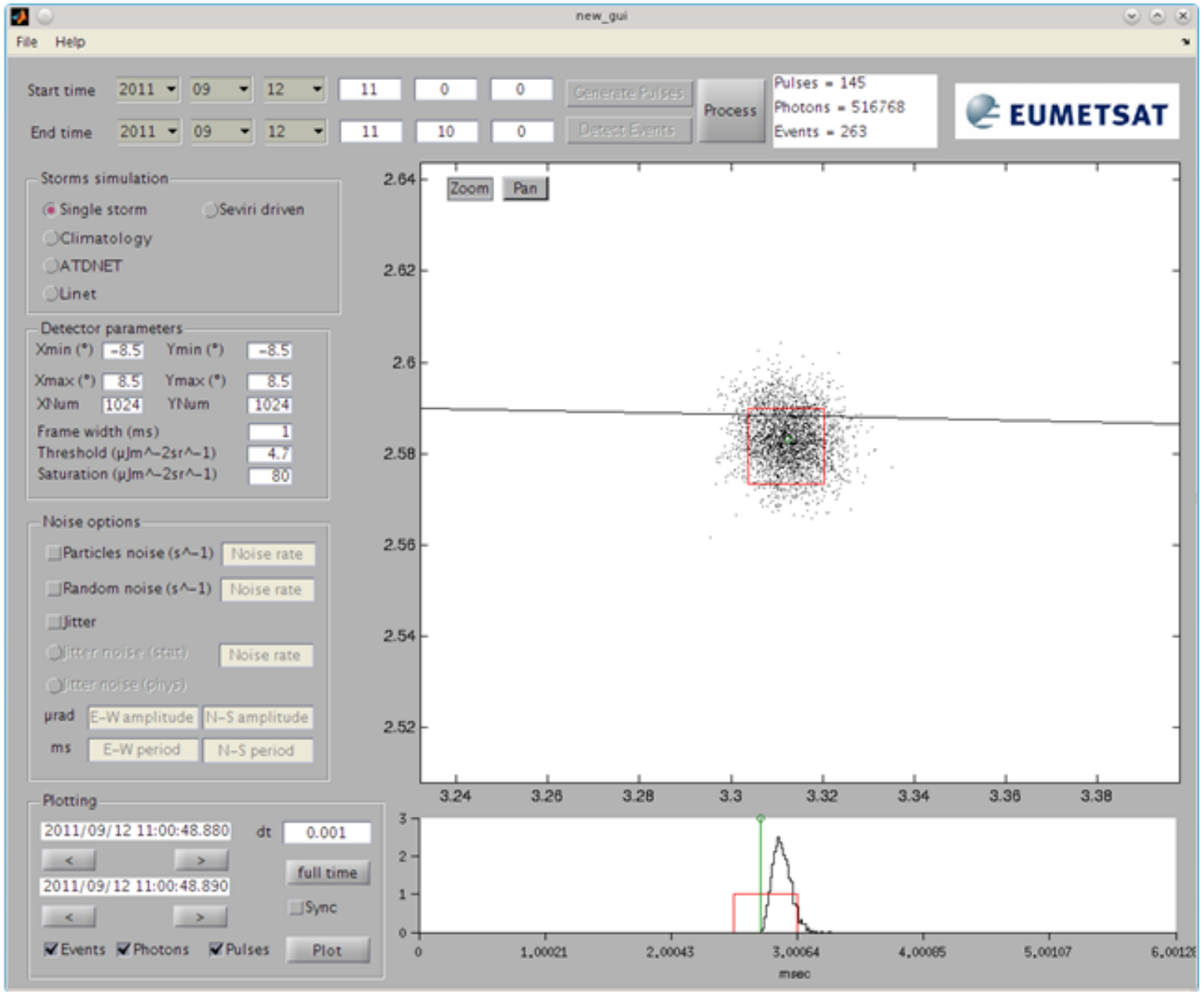
EUMETSAT LIProxy e.g. Jitter noise



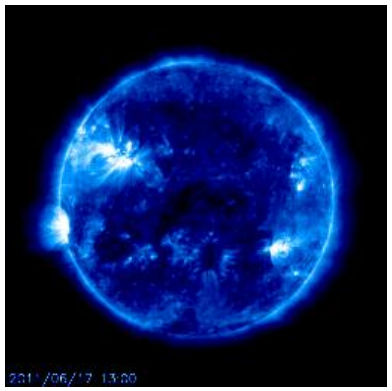


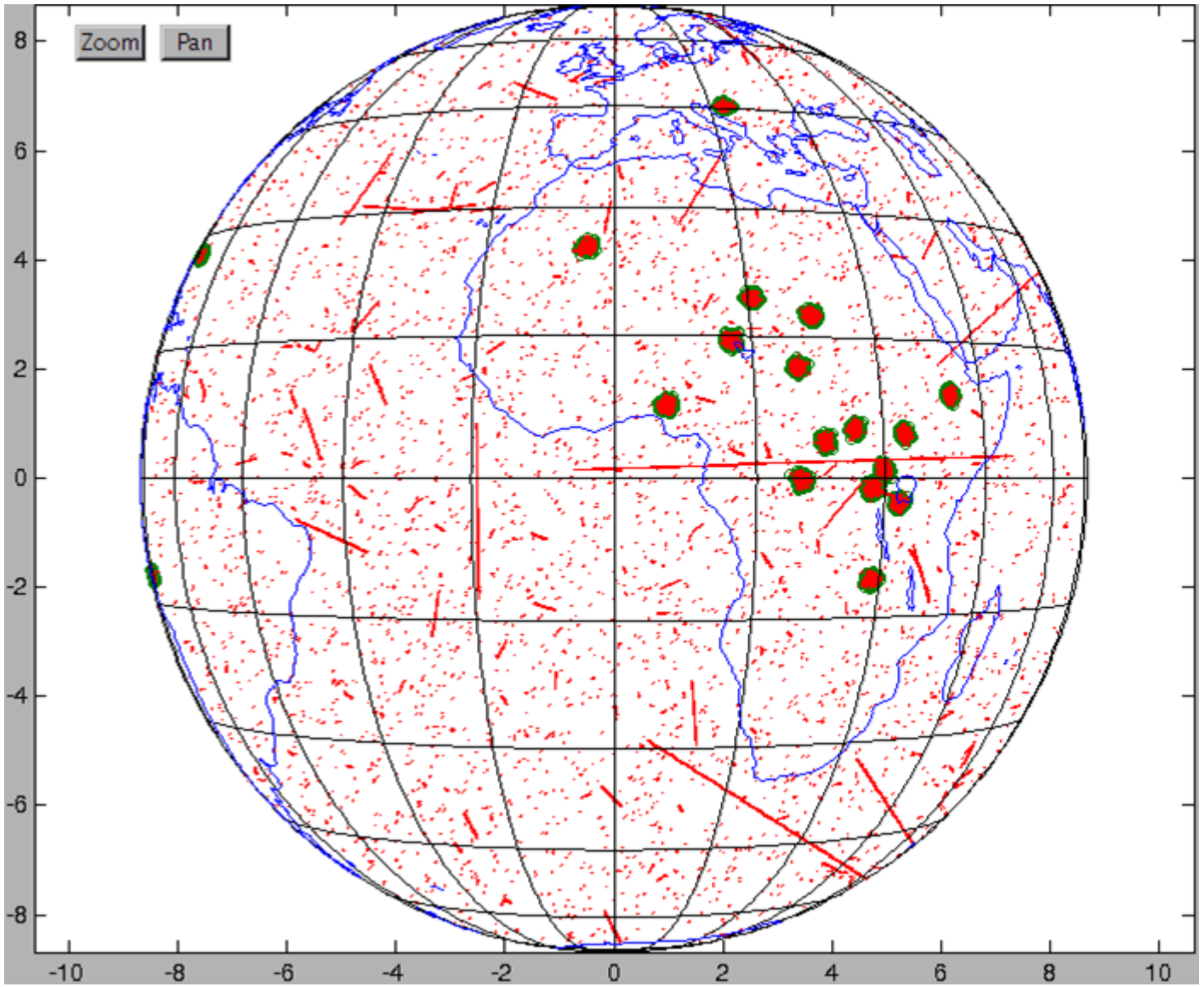


The need of a simulator: EUMETSAT LIProxy



The need of a simulator: EUMETSAT LIProxy
e.g. Particles noise





EUMETSAT - LIST
Lightning Imager Science Team
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6	Ullrich Finke	U Hannover Germany
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8	Dieter Just	EUMETSAT Germany
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10	Massimiliano Sist	CNMCA Italia
11	Daniele Biron	CNMCA Italia
12	Alessandro Galliani	USAM Italia
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16	Douglas Michael Mach	U Alabama Huntsville United States of America
17	Steven J Goodman	NOAA United States of America
18	Hugh Christian	U Alabama Huntsville United States of America