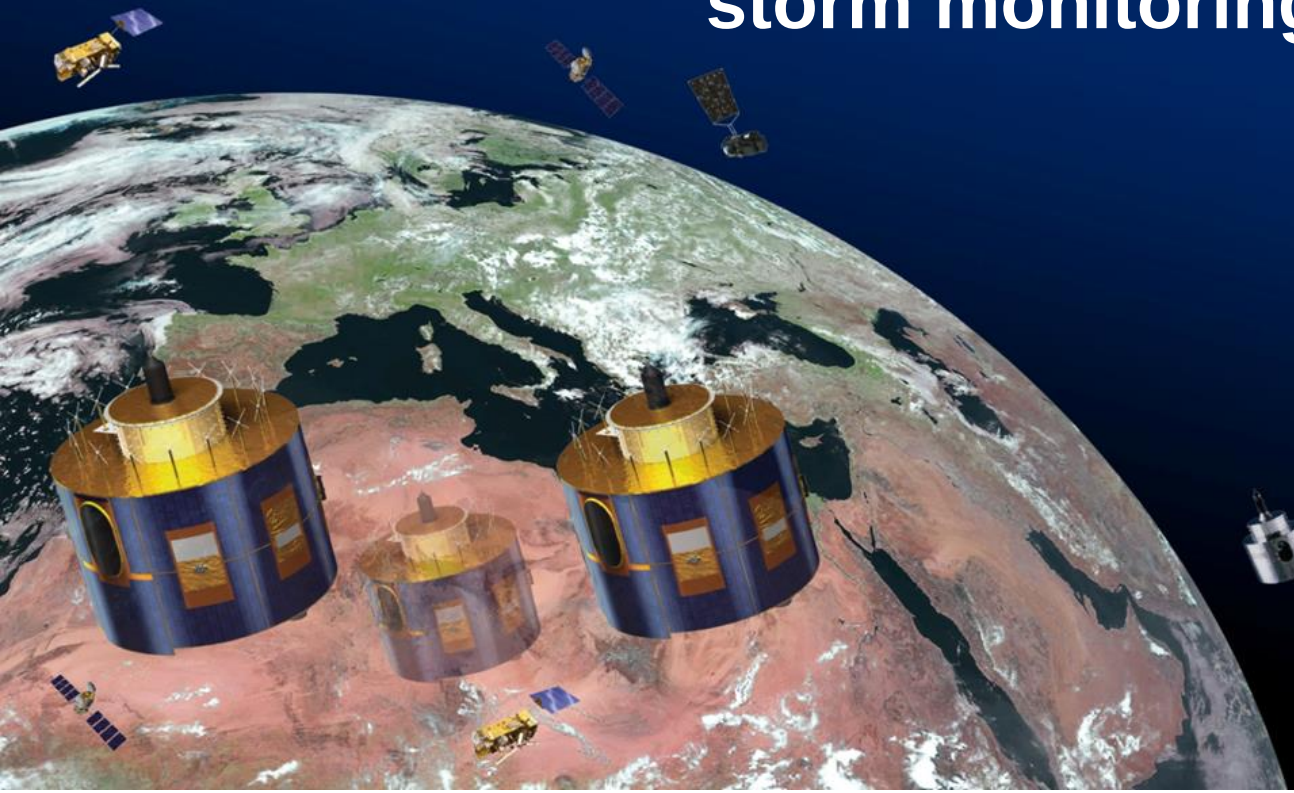
EUMETSAT: New observation capabilities for storm monitoring – Lightning Imager

Jochen Grandell



Topics

- What we are aiming at...
- Lightning monitoring from space – brief introduction to the concept
- MTG Lightning Imager (MTG-LI) – design and characteristics
- MTG-LI user products – flash and accumulated products

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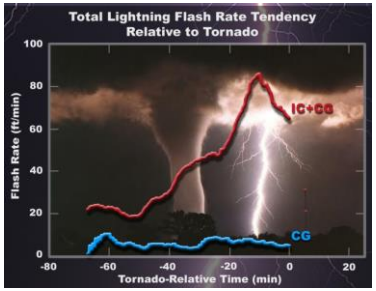
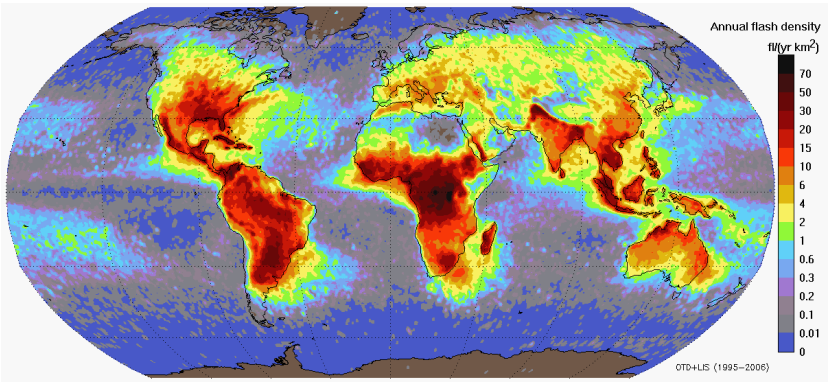
Lightning – Why do we observe it?



Lightning is a precursor of severe weather – where total lightning is the parameter to observe

Severe weather and lightning strikes are a big threat to public (and not only aviation)

One method of assessing the impact of climate change on thunderstorm activity is to globally monitor and analyse the long-term lightning characteristics.

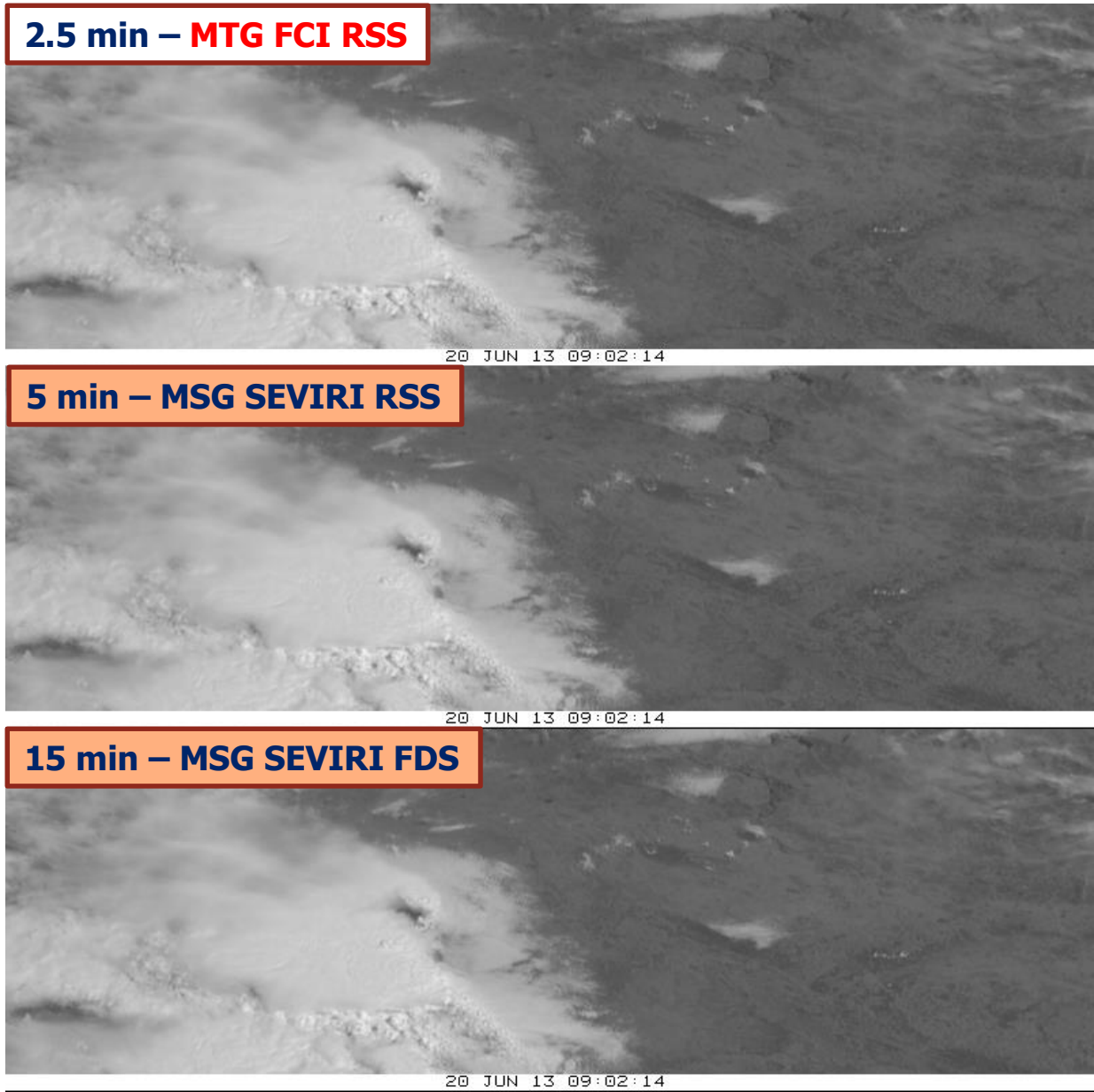


Linking also to other enhanced capability of MTG

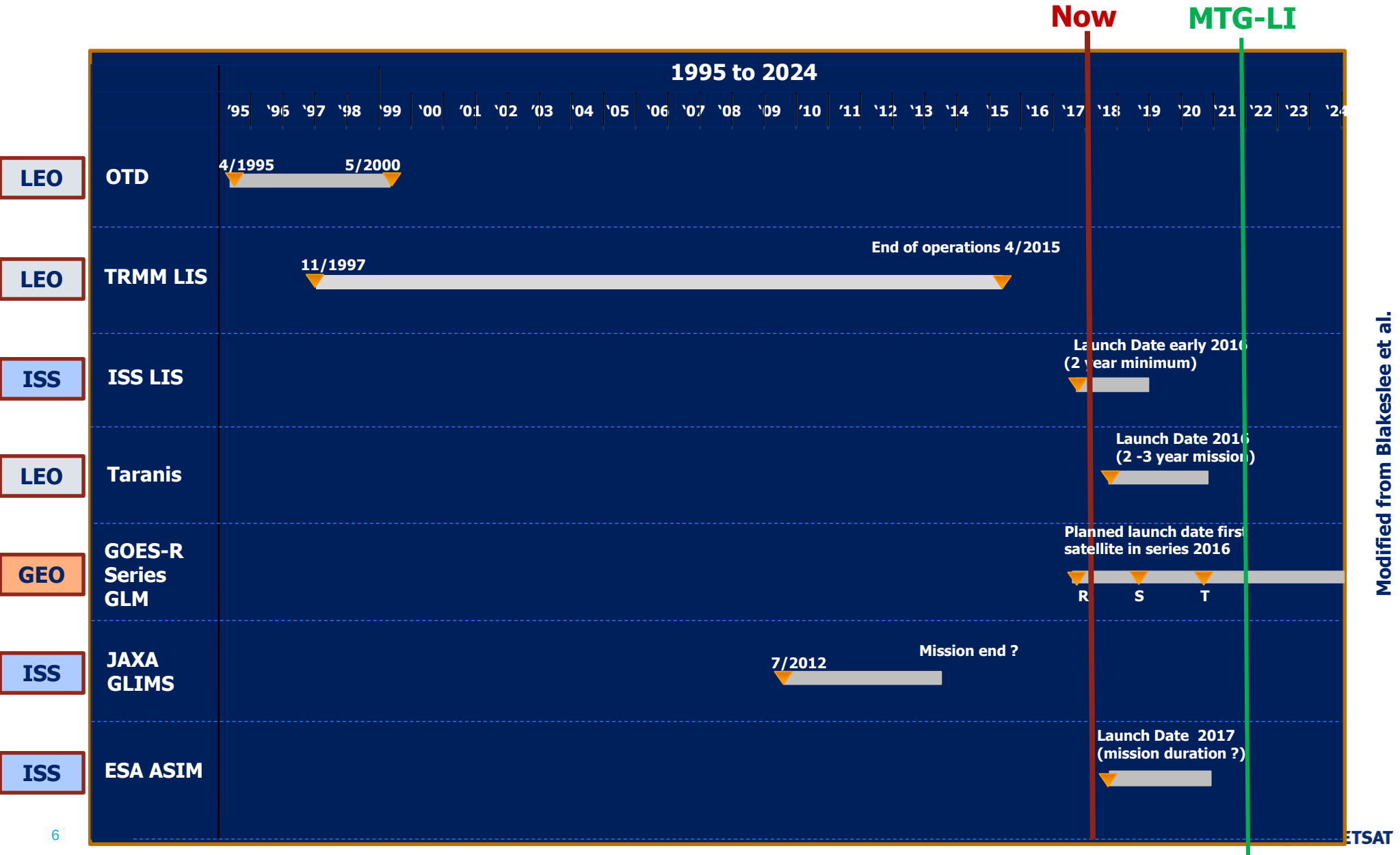
- 2.5 min rapid scanning provided by the MTG Flexible Combined imager (MTG-FCI)

Allows a combination of:

- 0.5 min update of MTG-LI accumulated lightning
- 2.5 min update of MTG-FCI rapid scan imagery



Other lightning related space missions



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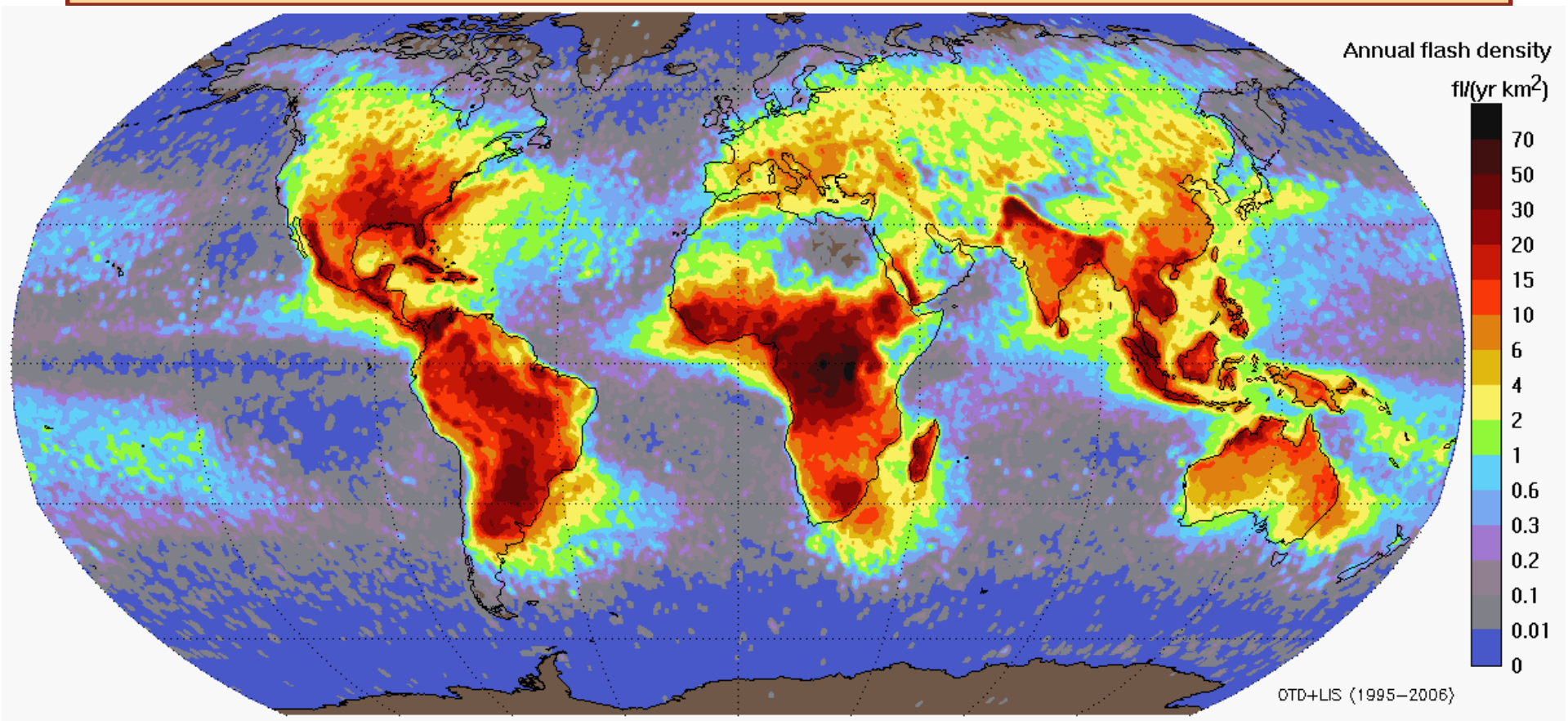
Lightning Detection from Space – from LEO to GEO

Lightning detection from space by optical sensors from the Optical Transient Detector (OTD) and Lightning Imaging Sensor (LIS)

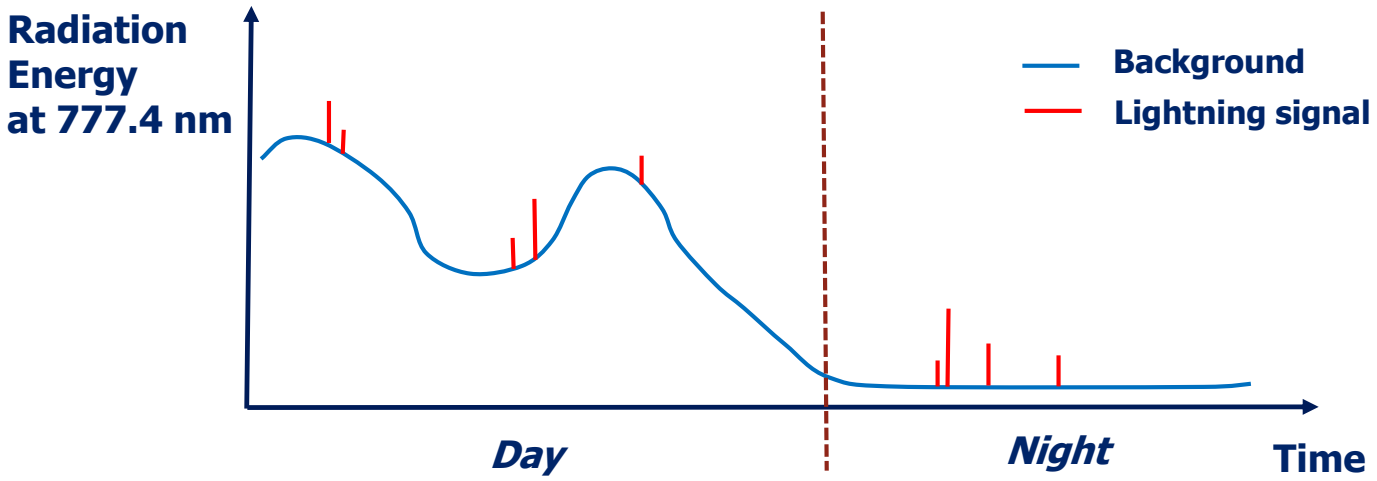
1995-2015 !!



Results from LIS/OTD: Global lightning distribution - Annual flash density

Detection of a Lightning Optical Signal

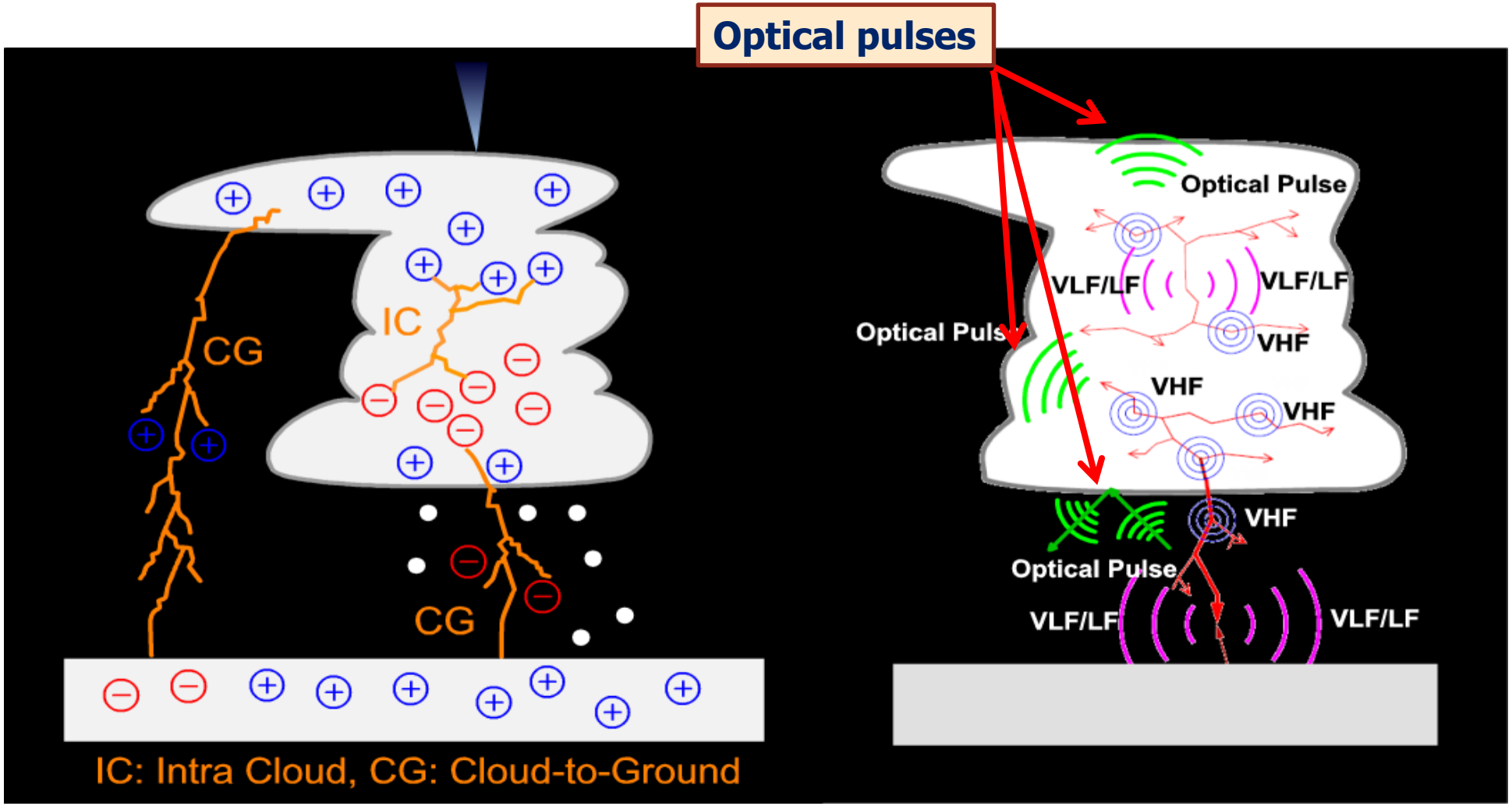
- Lightning with a background signal (bright clouds) changing with time:



- Lightning is **not recognized by its bright radiance alone, but by its transient short pulse character** (also against a bright background)

- Variable adapting threshold has to be used for each pixel which takes into account the change in the background radiance

Thunderstorm Electrification
Lightning and its Emissions



- VHF – Very High Frequency, (V)LF – (Very) Low Frequency

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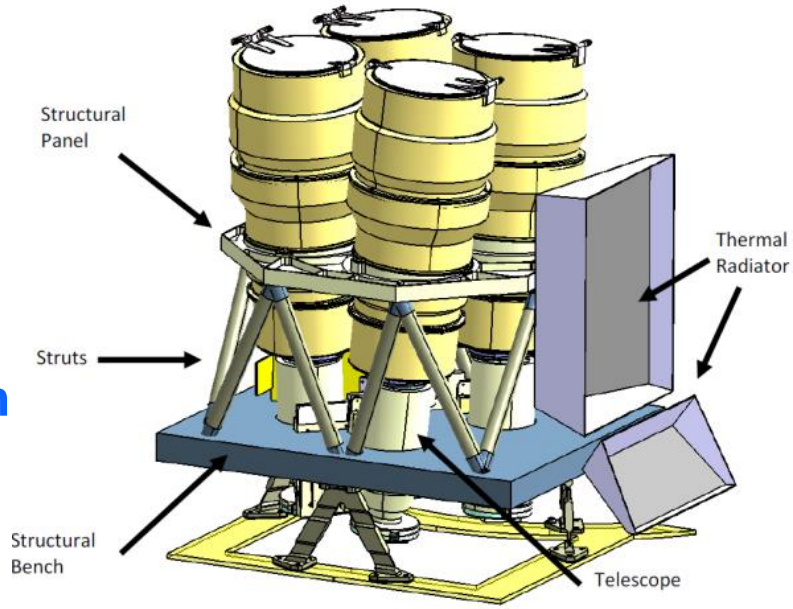
- Test data development

Lightning Imager (LI) – Main Characteristics

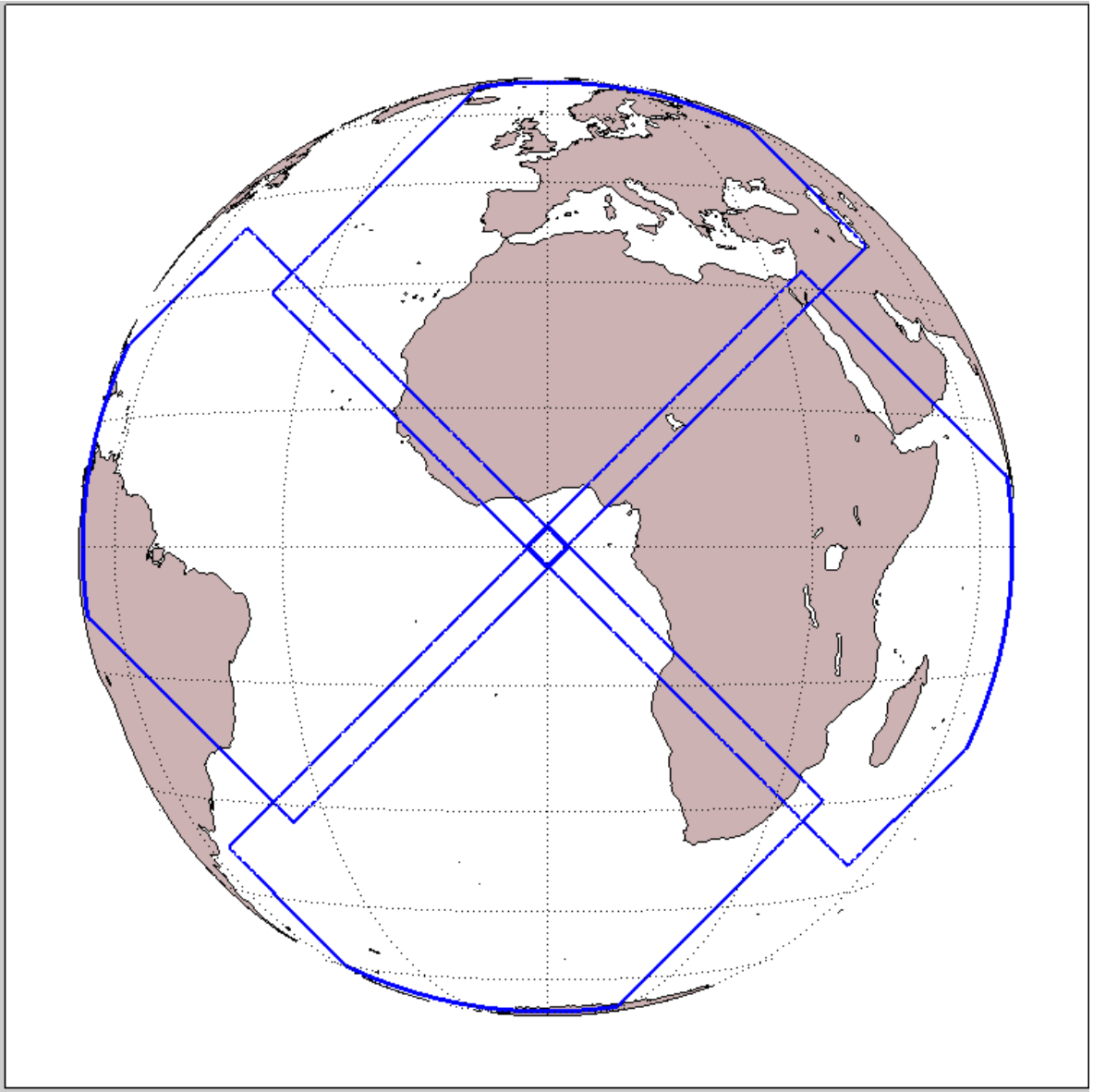
- **LI main characteristics:**
  - Measurements at 777.4 nm
  - Coverage close to visible disc
  - Observing total lightning (CG + CC/IC), with no separation
  - Continuous measurements of (lightning) triggered events
  - Ground sample distance at sub-satellite point ~4.5 km
  - Integration time per frame 1 ms (baseline)
  - Background subtraction and event detection in on-board electronics



The LI design is a 4-camera solution

1170 x 1000 pixels per camera

LI coverage – full disk view



Four identical detectors with small overlaps

End-users (Level 2) will not see the "detector structure"

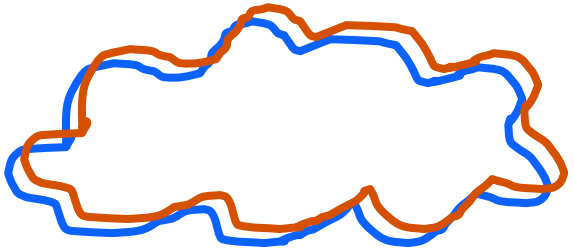
However, data contains information on from which detector(s) the observation is origination from

Issues to consider: FALSE events...

- The LI observes the rapid changes wrt background (transient short pulse character)
- This leads to:
  - Triggered events caused by lightning
  - Triggered events caused by something else
- The ratio of False/True events can be up to 99% / 1%
- Filtering steps needed for making data useful

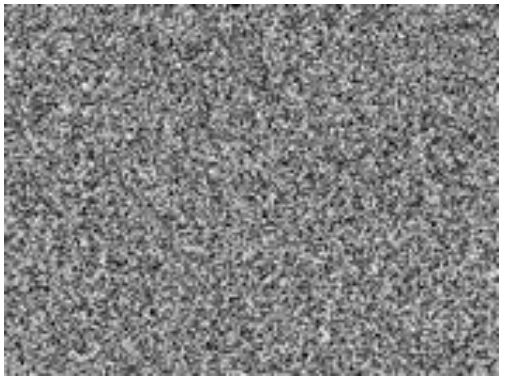
False transients are mainly caused by:

- Microvibrations affecting e.g. cloud edges



- Charged particles

- Electronics noise



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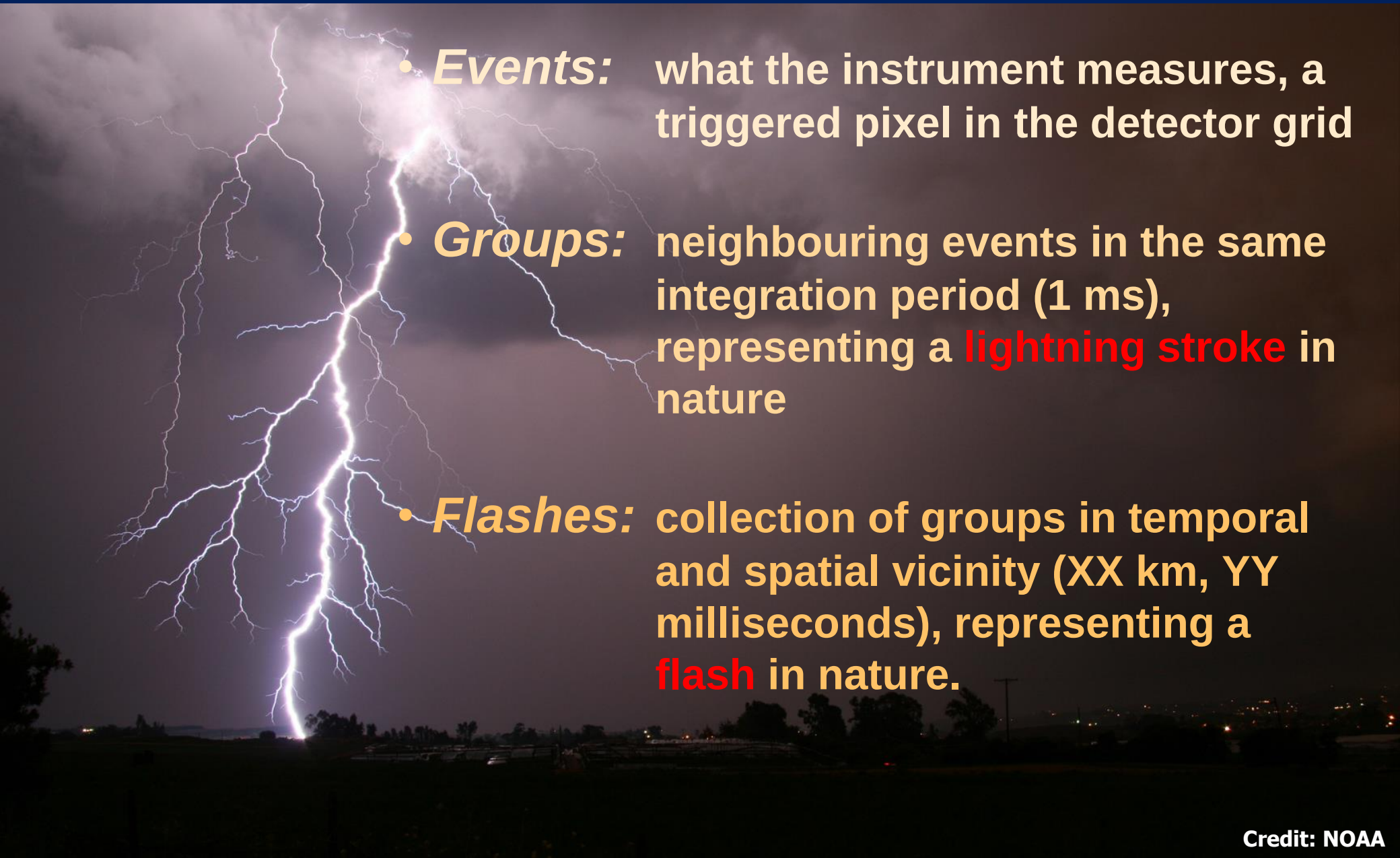
Product terminology same as for LIS/GLM



- ***Events:*** what the instrument measures, a triggered pixel in the detector grid
- ***Groups:*** neighbouring events in the same integration period (1 ms), representing a lightning stroke in nature
- ***Flashes:*** collection of groups in temporal and spatial vicinity (XX km, YY milliseconds), representing a flash in nature.

Credit: NOAA

Lightning Imager (LI) – User Products

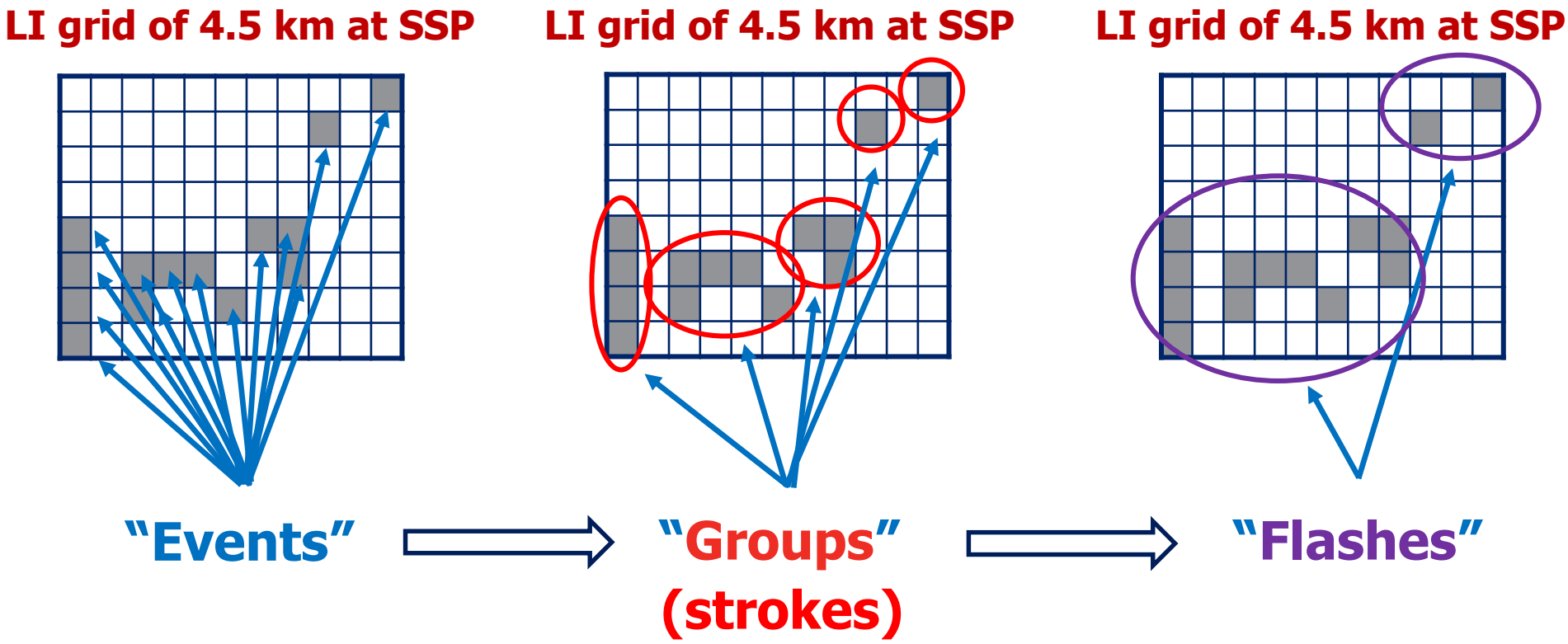
- **LI Initial Processing => point data**
  - **Groups (~strokes) & Flashes with geographical coordinates**

- **Accumulated products => gridded data**
  - **Product density shown in the fixed MTG-FCI (*) imager grid (same grid as for the FCI IR channels in the 2 km FDHSI resolution)**

(*) FCI = Flexible Combined Imager on MTG

Groups and Flashes

Example/Conceptual representation of a L2 processing sequence:



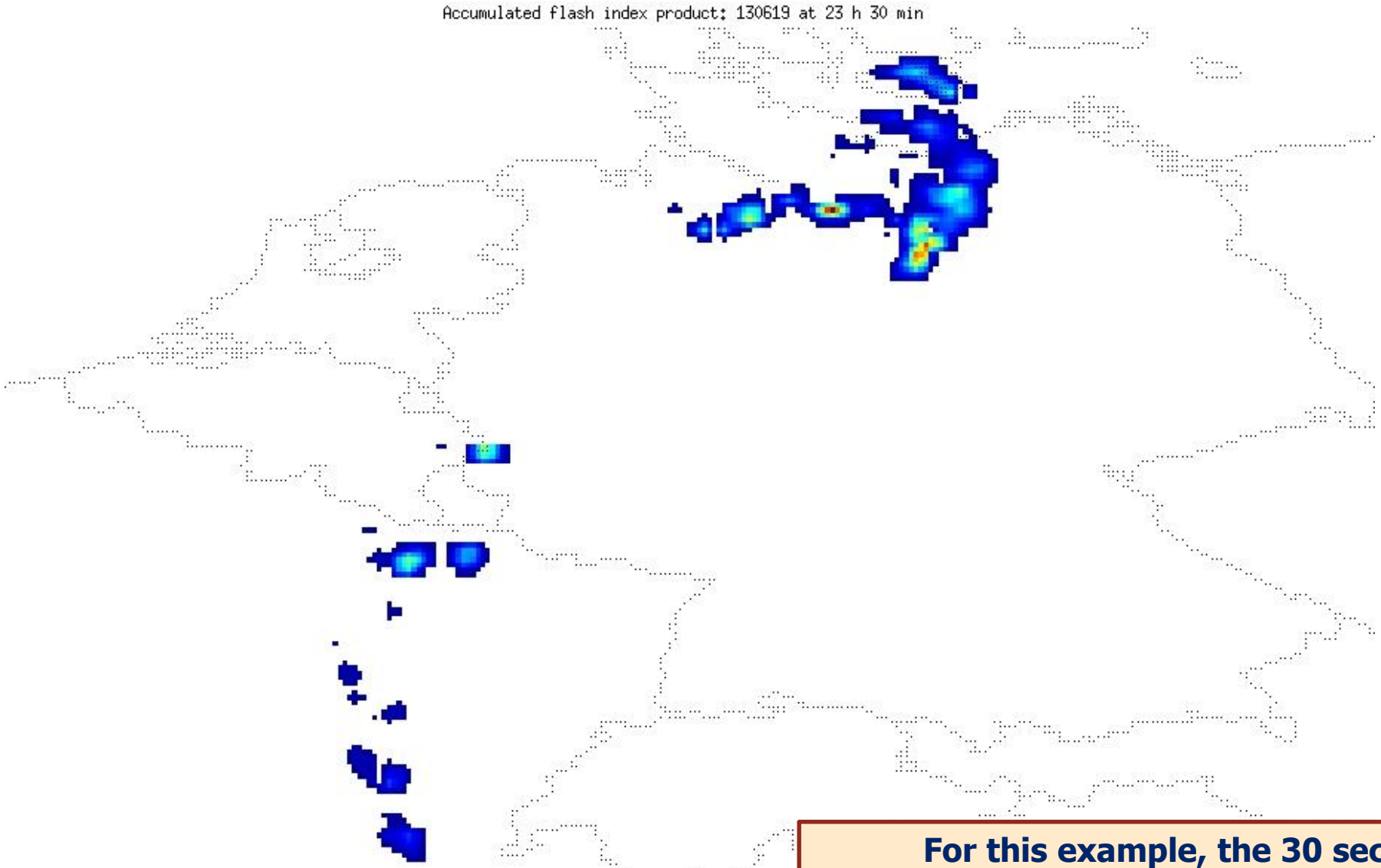
SSP = Sub-Satellite Point

L2 Accumulated Products

- **Accumulated products:**
  - **Collecting samples from a 30 second buffer**
  - **Presented in the same 2-km grid as the imager IR channel data for easier combining with imager information**
  - **Events define the extent in the products**
  - **Flashes define the values in the products**

  - **For a longer temporal accumulation, the 30 second products can be stacked according to users' preferences**

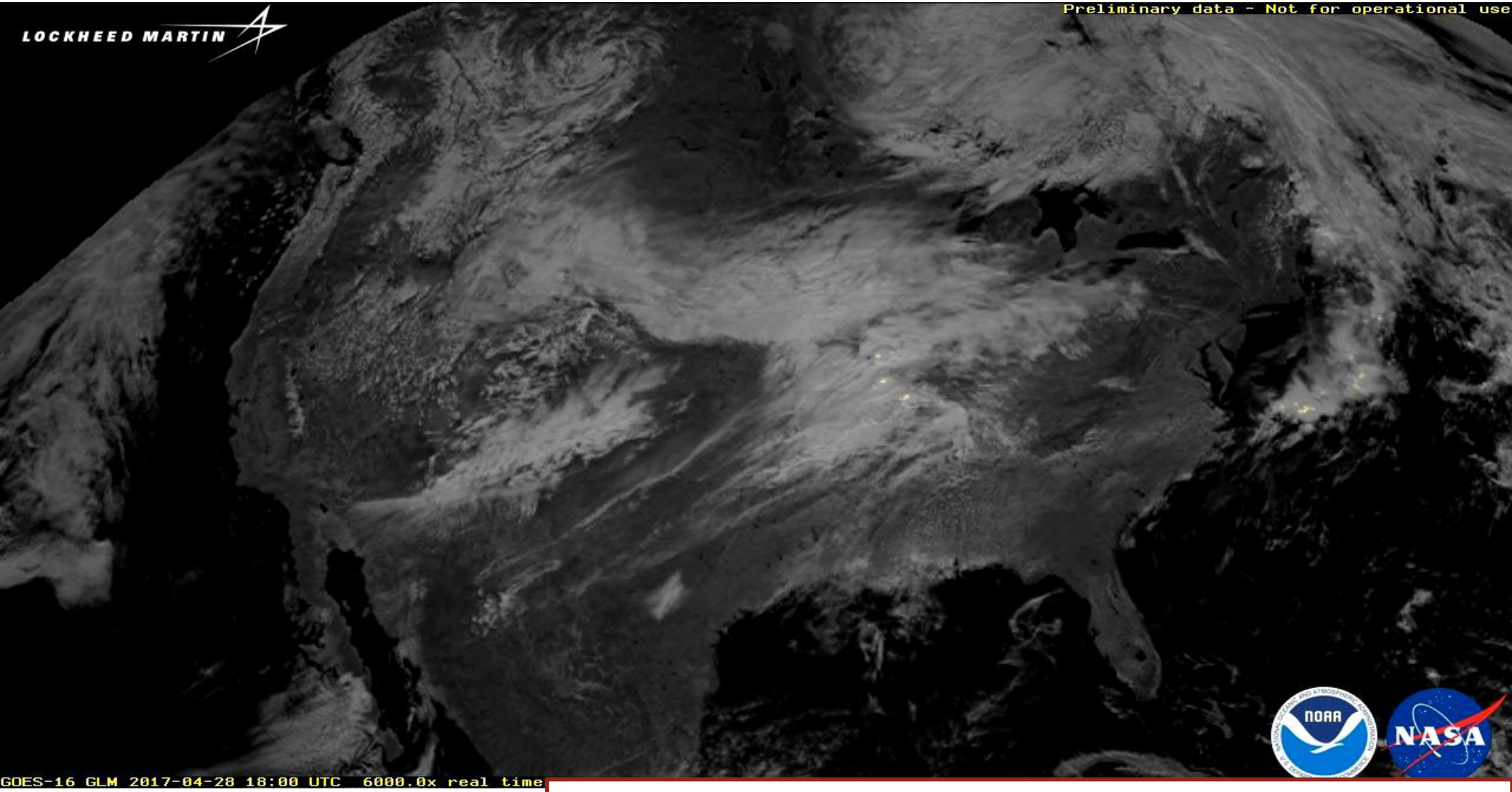
Example accumulated product – test data example



19 June 2013 at 23:30 UTC

For this example, the 30 sec accumulated products have been stacked for 600 seconds

Future capabilities: Lightning monitoring for NWC / VSRF



April 28-30, 2017

GOES-16 GLM lightning superimposed on GLM background

Summary

- The Lightning Imager is a new mission on Meteosat Third Generation, with no heritage in Europe (first GEO mission will be on GOES-R in 2016)
  - **(almost) Full disk coverage with 4 different detectors**
  - **Homogeneous and continuous observations of lightning flashes with a timeliness of 30 seconds**
  - **To be launched in 2019**
- User products consist of
  - **Initial processing data (groups and flashes)**
  - **Accumulated product data**
- The launch of GOES-16 with the GLM instrument provides us with an unprecedented data set for preparation for the MTG era

Further information on the EUMETSAT web-pages

- MTG in general:
  - http://www.eumetsat.int/website/home/Satellites/FutureSatellites/MeteosatThirdGeneration/index.html
- MTG Lightning Imager L2 ATBD:
  - http://www.eumetsat.int/website/home/Data/TechnicalDocuments/index.html
  - There: Meteosat services ⇒ Meteosat Third Generation (MTG) ⇒ ATBD