Meteosat Third Generation Lightning Imager (MTG-LI)

Status Update and Data Products

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25 September 2013

Presentation to the GLM Science Team (webex)

Topics of Presentation

- Meteosat Third Generation
- Lightning Imager status update
  - Instrument baseline
  - Detection logic
- Data Products generated – heritage and new products
  - LIS heritage Group/Flash products
  - New Accumulated products
- User readiness activities and proxy data
- Summary

- **The LI activities have been supported by the Lightning Imager Science Team (LIST) in 2009-2013:**

- **Due to program evolution, a new team (Science Advisory Group) will be set up in early 2014.**

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MTG to Secure Continuity and Evolution of EUMETSAT Services

1977 — 2002 — 2018 and 2020

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 3.6-ton

Implementation of the EUMETSAT Mandate for the Geostationary Programme

Atmospheric Chemistry Mission (UVN-S4): via GMES Sentinel 4
(Ultraviolet Visible Near-infrared spectrometer)

MTG System Status Update

- Preliminary Design Reviews for MTG instruments (FCI, IRS) have already taken place
  - **LI is on a separate track and will follow later**

- A “consistency checkpoint review” (CCR), a “delta” system PDR, took place in spring-summer 2013 where science was also part of the review
- The L1 and L2 processing facility procurements are starting in 2013-2014
  - **For that purpose, Processing Specifications (PS) are needed, also for the LI at the end of 2013.**
  - **This means also that final L2 ATBDs are available at that time**

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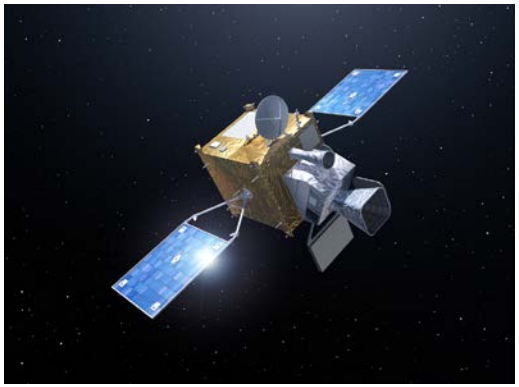
Lightning Detection from Space – from LEO to GEO

GEO lightning missions in preparation by several agencies (in USA, Europe, China) for this decade...
...all of these are building on LIS/OTD heritage

Geostationary Lightning Mapper (GLM) on GOES-R (USA)

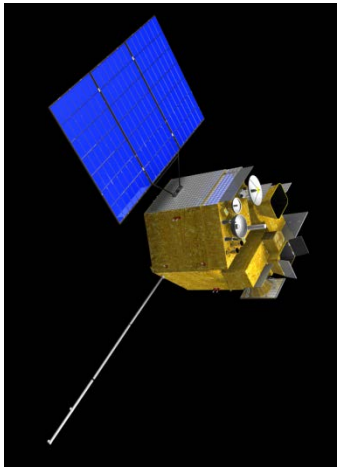
2015 ⇒

Lightning Imager (LI) on MTG (Europe)



2018 ⇒

Geostationary Lightning Imager (GLI) on FY-4 (China)



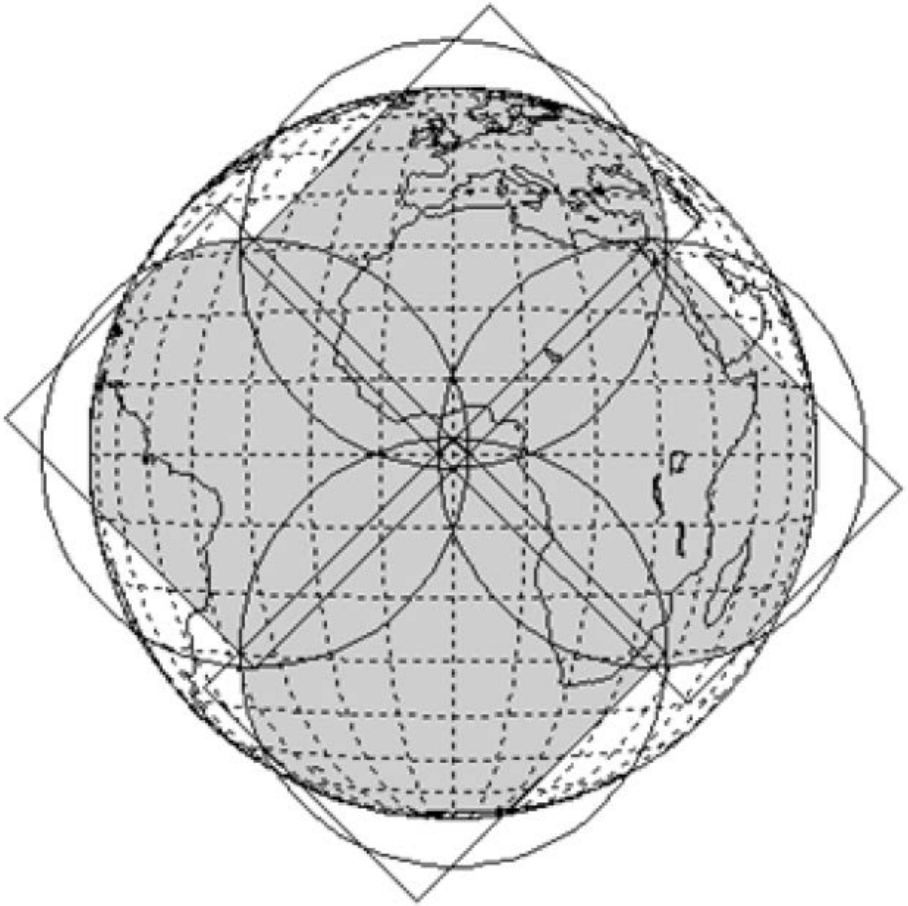
2015/2016

Lightning Imager (LI) Status Update

- LI instrument and mission prime contractor is Selex Galileo from Italy, which includes the:
  - Development of the LI instrument
  - ...and also the 0-1b data processing software
- MTG LI Phase B2 has been kicked off in 2012
- SRR (System Requirements Review) done in two parts, finished in spring 2013
- LI instrument PDR (Preliminary Design Review) expected around the end of 2013

Lightning Imager (LI) main characteristics

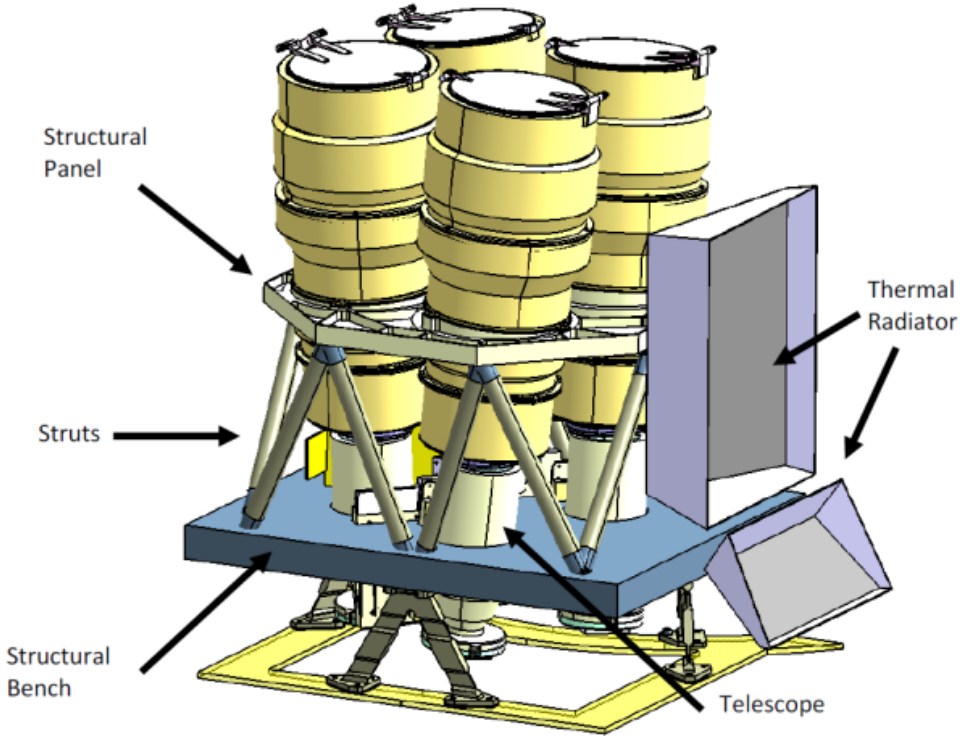
Coverage close to visible disc



CMOS Back-thinned backside illuminated detectors with integrated ADCs

The baseline for the LI is a 4-camera solution

1170 x 1000 pixels per camera.



Lightning Imager (LI) main characteristics

LI main characteristics:

- Measurements at 777.4 nm
- Coverage close to visible disc
- Continuous measurements of (lightning) triggered events – in addition, background images typically once every minute
- Ground sample distance at SSP ~4.5 km => 4.7 million pixels
- Integration time per frame 1 ms (parameterised)
- Background subtraction and event detection in on-board electronics
- Data rate <30 Mbps; Mass < 110Kg; Power < 320W

Topics of Presentation

- Meteosat Third Generation
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  - **Detection logic**
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Detection Logic Summary

- **Intention is to lower the number of single pixel events that would need to be sent to ground**
- According to this logic, if **two triggered pixels are adjacent**, it is considered a real event
    - **the data is sent to the main electronics with its surrounding pixels (window 9x9 pixels) during two frames.**
- **If no other triggered pixel is adjacent to the first one**, it is considered as a “single pixel”.
    - **Its value is compared with the averaged energy value of the surrounding pixels to evaluate its energy distribution.**
    - **If it matches with a predefined value interval (user adjustable) the triggered pixel is considered as a real event and processed further.**
    - **The above steps are done for every “single pixel”.**

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L2 User Products – baseline Group/Flash product

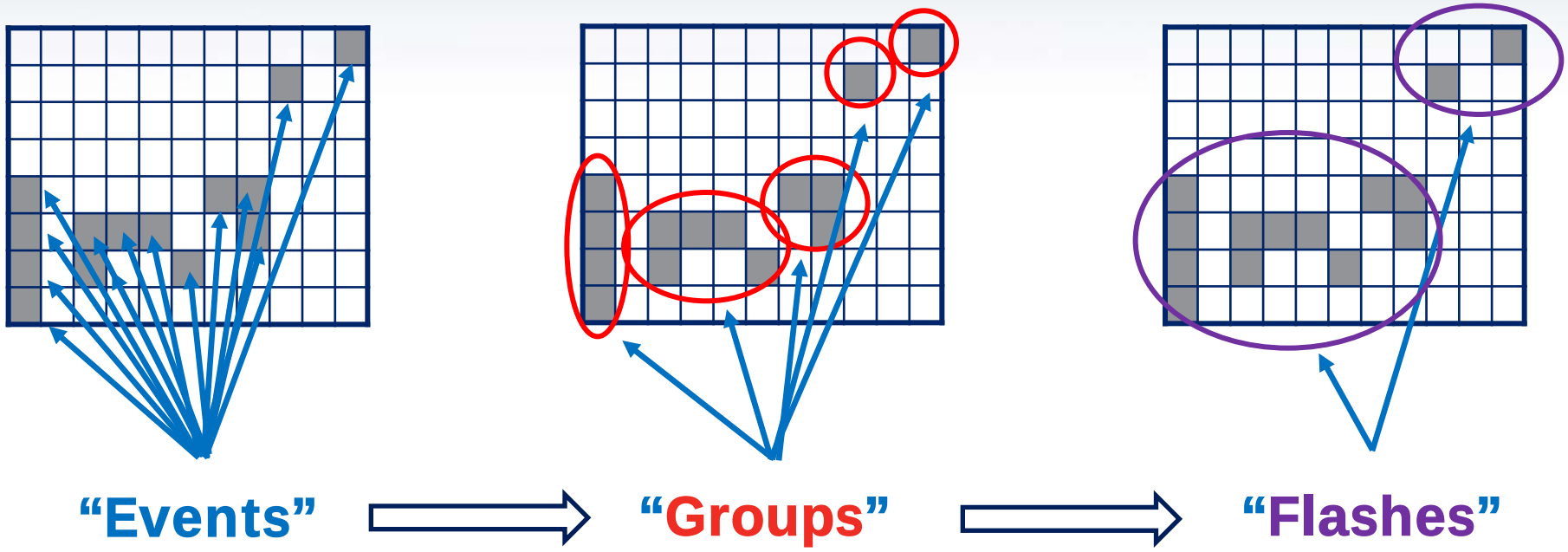
- **Groups**
  - Spatially neighbouring events in the same or neighbouring 1 ms integration frame
  - Representing “lightning strokes”

- **Flashes**
  - Spatially/temporally clustered groups (up to 330 ms and/or 16.5 km)
  - Product includes also contributing groups
  - Representing “lightning flashes”

Basic illustration on the next slide!

Groups and Flashes – LIS approach followed

Example / Conceptual representation of a L2 processing sequence:



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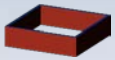
L2 Accumulated Products

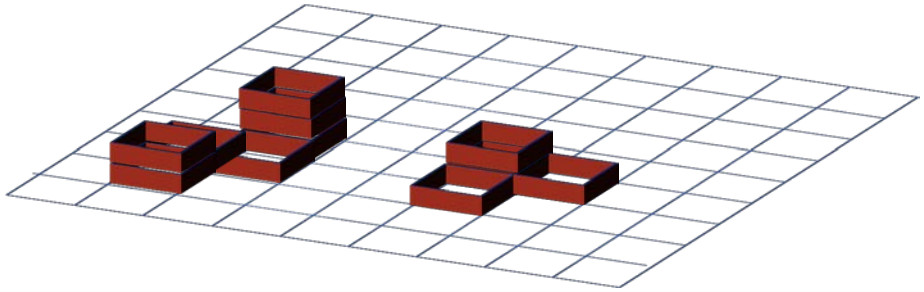
- **Accumulated products:**
  - Collecting samples from a **30 second** buffer
  - Resampled to the 2-km FCI-IR grid for simple visualising with FCI data
  - **Events** define the **extent** in the products
  - **Flashes** define the **values** in the products
  - For a longer temporal accumulation, the 30 second products can be stacked
- **Three products in all:**
  - Accumulated flashes
  - Accumulated flash index
  - Accumulated flash radiance

Illustration and details on the next slide(s)!

Accumulated flashes, status at *t* = 10s



= Events in Flash #1



Event count in the 30 sec buffer (still in LI grid)

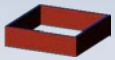
		3			2	1		
	1	1			1			
	2							

Flash count in the 30 sec buffer (still in LI grid)

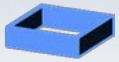
		1			1	1		
	1	1			1			
	1							

Conceptual illustration

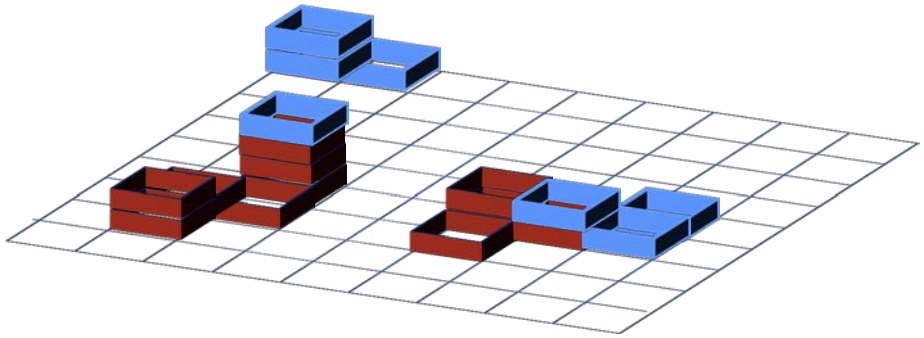
Accumulated flashes, status at *t* = 20s



= Events in Flash #1



= Events in Flash #2



Event count in the 30 sec buffer (still in LI grid)

2	1							
							1	
		4			2	2	1	
	1	1			1			
	2							

Flash count in the 30 sec buffer (still in LI grid)

1	1							
							1	
		2			1	2	1	
	1	1			1			
	1							

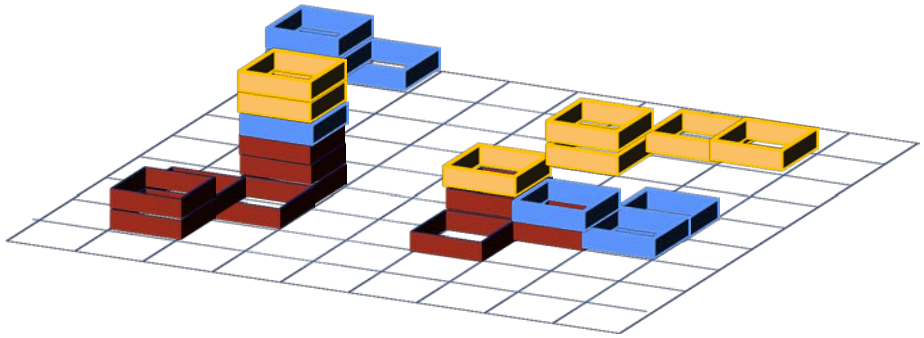
Conceptual illustration

Accumulated flashes, status at *t* = 29s

= Events in Flash #1

= Events in Flash #2

= Events in Flash #3



Event count in the 30 sec buffer (still in LI grid)

2	1							
						1	1	
					2			
							1	
		6			3	2	1	
	1	1			1			
	2							

Flash count in the 30 sec buffer (still in LI grid)

1	1							
						1	1	
					1			
							1	
		3			2	2	1	
	1	1			1			
	1							

Conceptual illustration

Accumulated Flashes

- Periodicity: **30 seconds (can be stacked)**
- Grid: **2 km (= FCI IR grid)**
- Unit: **flashes/30 sec**

- **Grid box values are the accumulated flashes (in all those grid boxes affected by the LI events responsible for the flash) during 30 seconds and dividing by the number of grid boxes subject to each flash.**
- **This allows the user to integrate over a sub-area of the full FOV to get the cumulative flash count for that sub-area.**

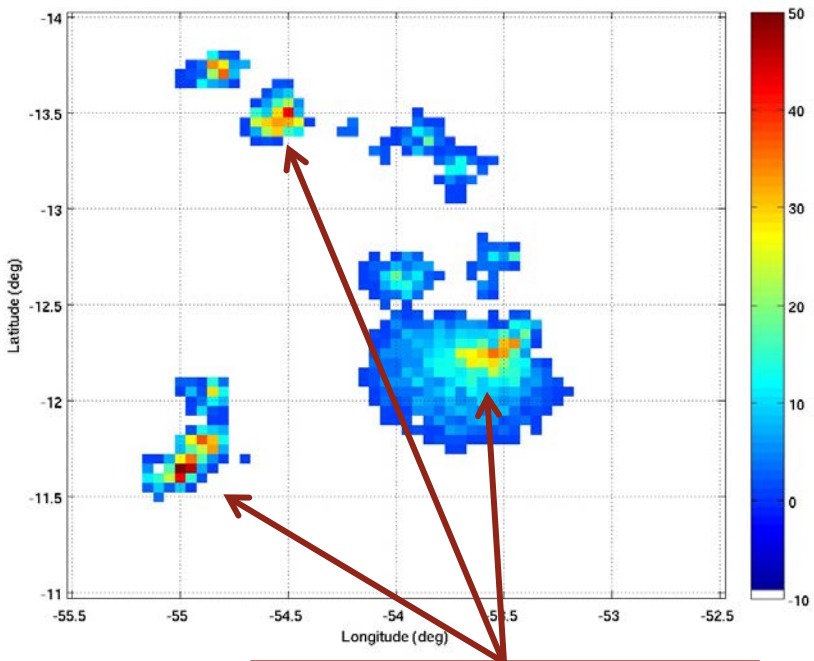
Accumulated Flash Index

- Periodicity: **30 seconds (can be stacked)**
- Grid: **2 km (= FCI IR grid)**
- Unit: **flashes / 30 sec**

- **Grid box values are the accumulated flashes (in all those grid boxes affected by the LI events responsible for the flash) during 30 seconds. No division by the number of grids affected.**
- **The accumulated flash amount is only correct for each grid element alone in the accumulated product grid, i.e. answers the question, "how many flashes affect this pixel?"**

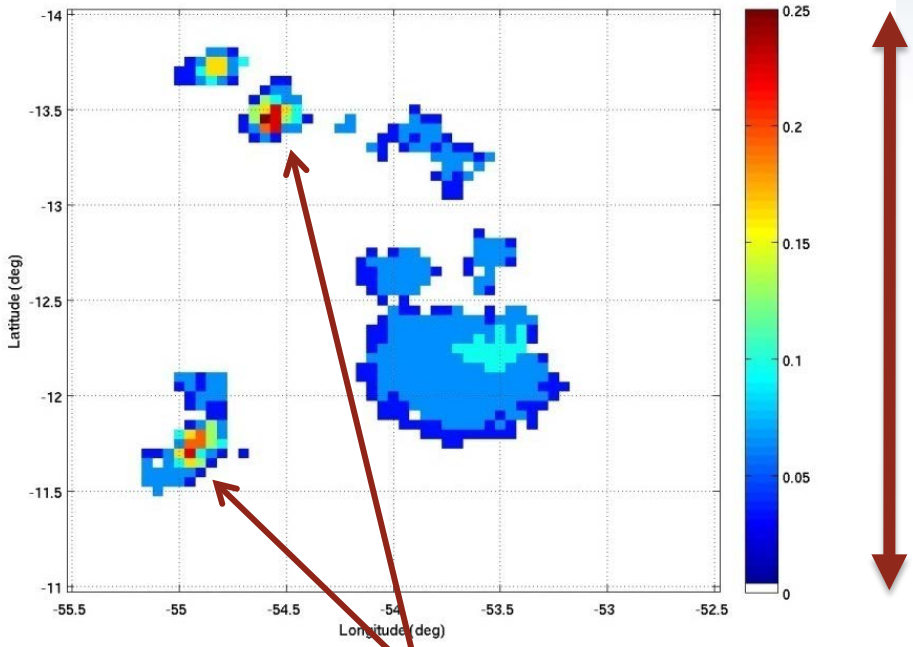
Accumulated product example (based on LIS data)

Cumulative events in the LIS ~5 km grid (30 seconds)



Three areas of interest in cumulative events

Example of a cumulative flash product in the LIS ~5 km grid (30 seconds)



...but only two in the flash density image

MTG-LI User Products – NOT Disseminated

- There are products resulting from the L1b processing, which are:
  - not disseminated to users
  - ...but are archived

- L1b Events
  - with geolocation, UTC time stamp and calibrated radiance, with a flag indicating false events
- L2 Events
  - As L1b Events, but without false events
- Background images
  - Every 60 seconds all detector elements triggered
  - Mainly used for image navigation
  - Other uses currently TBC

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User readiness activities

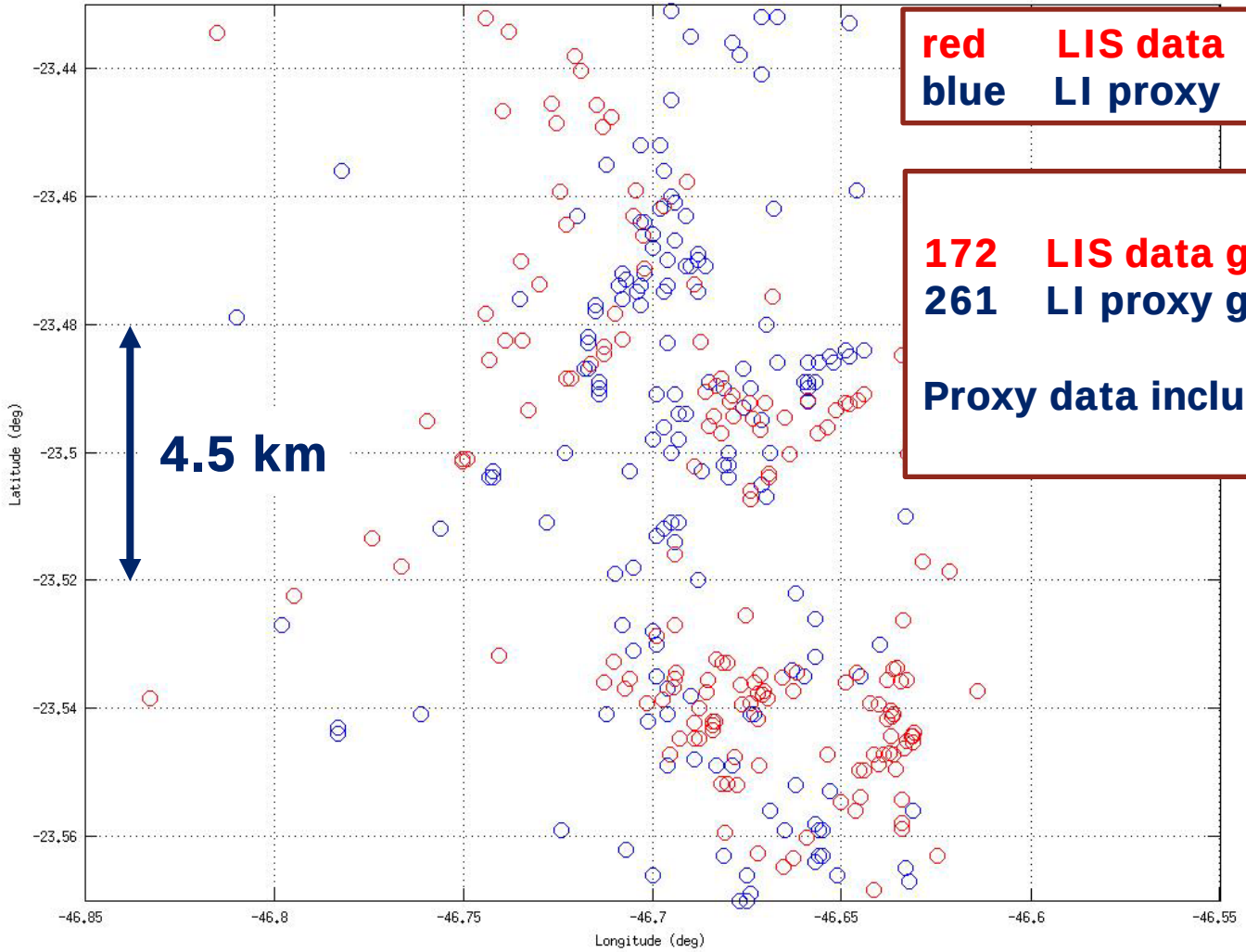
- There is a need to **inform**, **prepare** and **train** the users for a new data sources well before launch

- **Proxy data** to have an important role in the activities
  - **The main source of proxy data is currently based on the ground-based LINET network data (European wide LF/VLF system)**
  - **CHUVA campaign data used to refine the methodology**

- Partnering the National Met services' operational forecasters for trials with proxy data, starting in 2014

LINET based LI proxy data - link to CHUVA campaign

27 March 2012



red **LIS data**
blue **LI proxy**

172 **LIS data groups in sample**
261 **LI proxy groups in sample**

Proxy data includes also "weak pulses"

LI proxy is based on ground-based measurements => LIS parallax also present

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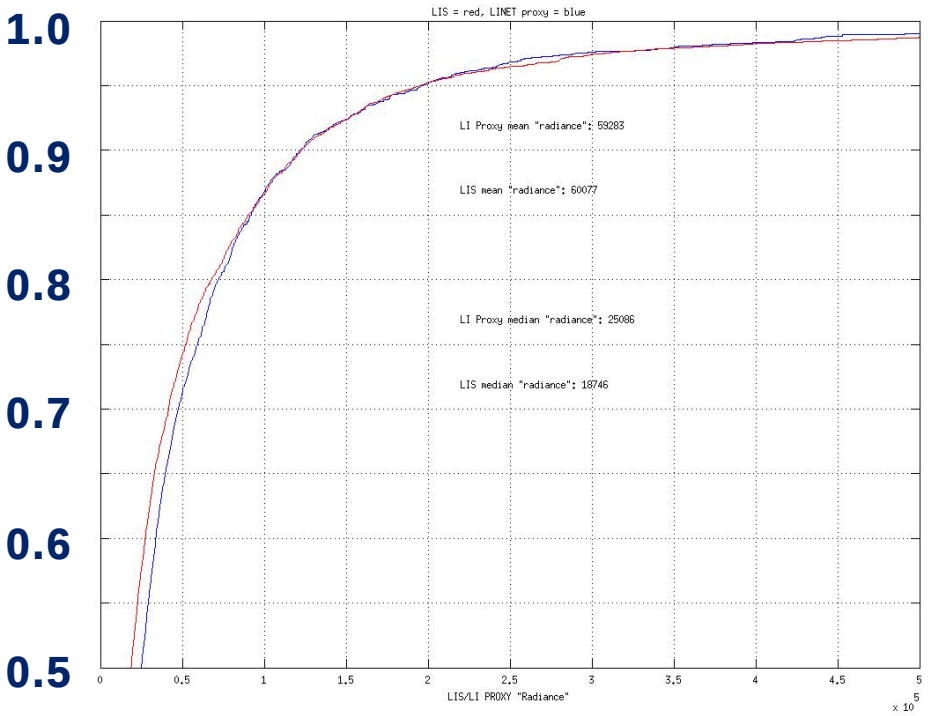
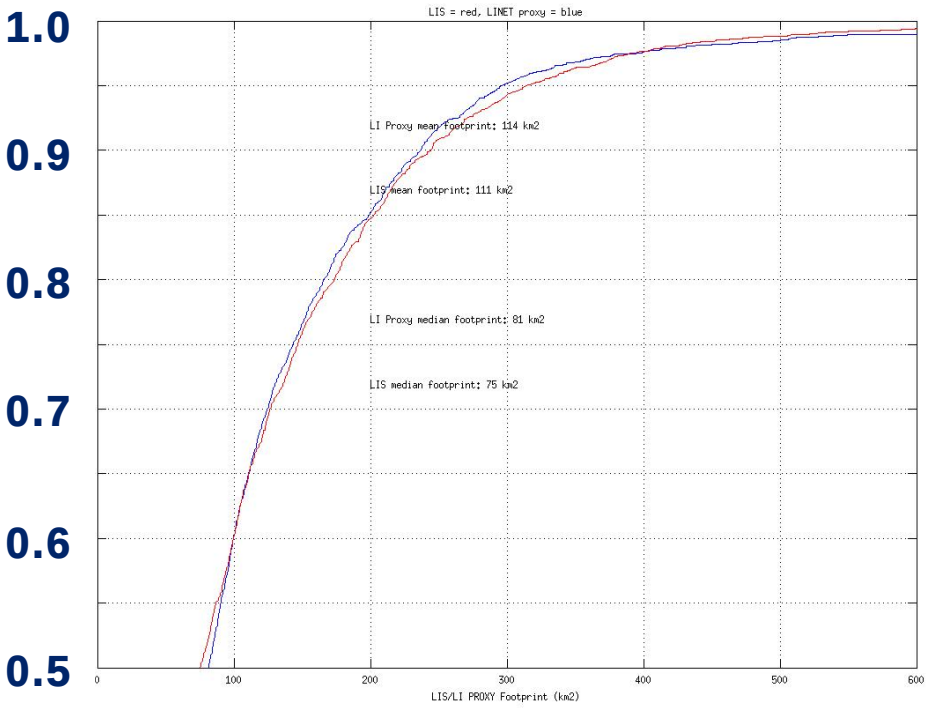
LINET based LI proxy data – Statistics (CDF plots)

LIS & LI proxy group "radiances"



LIS mean value = 60077 µJ/ster/m2/µm
LI proxy mean value = 59283 µJ/ster/m2/µm

LIS & LI proxy group footprints



LIS mean value = 111 km²
LI proxy mean value = 114 km²

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- **Meteosat Third Generation**
  - Continuity and evolution of EUMETSAT geostationary services from 2018 onwards
- **Lightning Imager status update**
  - LI instrument and mission prime Selex Galileo
  - Four-camera solution, detector logic to treat single events
- **L2 data products: both heritage and new products**
  - LIS heritage Group/Flash products
  - New Accumulated products
- **User readiness activities to get increasingly more attention**
  - Proxy data trials with users from 2014 onwards

Thank you!

Further information and contact:

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