Lightning observations during the GLM-CHUVA campaign and implications for MTG-LI proxy data generation

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Lightning flashes, city lights, sunset, Aurora Australis, atmospheric glow and some stars, seen over Argentina on 4/23/2003 (Courtesy of NASA Johnson Space Ce

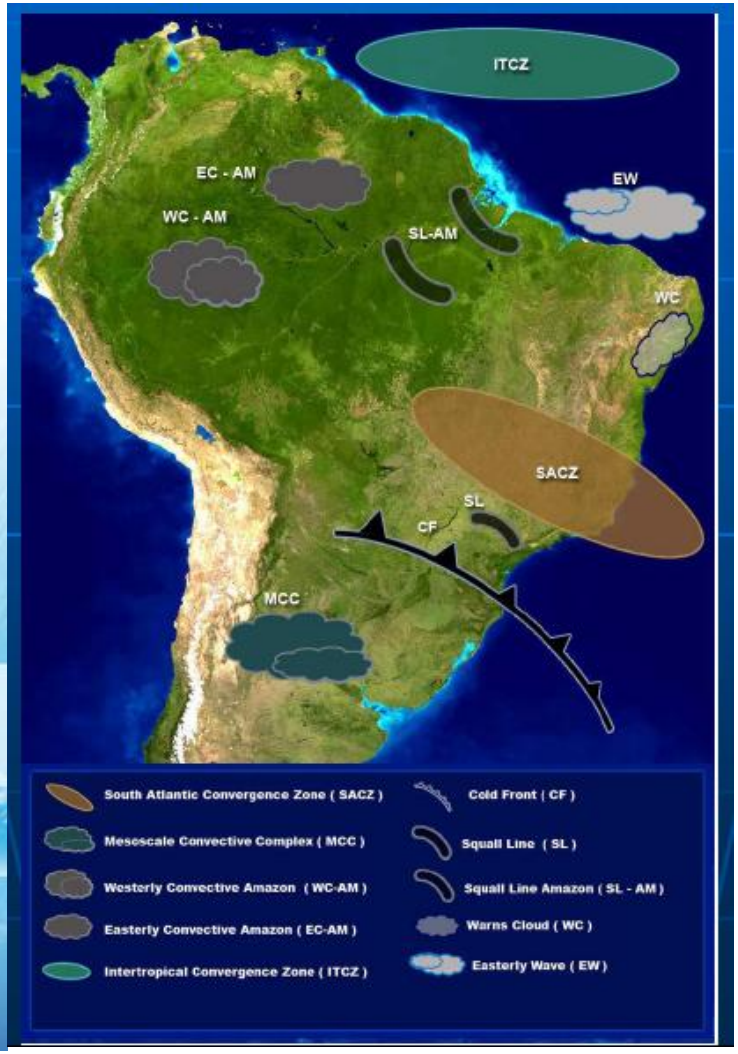
CHUVA
Project Objectives

CHUVA

(Portuguese for RAIN)

Cloud processes of tHe main precipitation systems in Brazil:

A contribUtion to cloud resolVing modeling and to the GPM (GlobAl Precipitation Measurement)



Experimental area in Sao Paulo State

INPE USP NOAA EUMETSAT DLR NASA

UniVap CESP UFRJ CPTEC

Lightning Detection Networks during GLM-CHUVA
and related observations Oct 2011 – April 2012

Deployed total lightning networks :

12 LMA sites (VHF)

NOAA/NASA

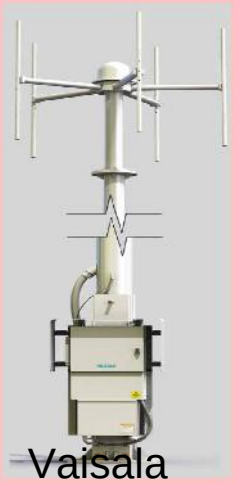
INPE

7 LINET sites (VLF-LF)

DLR/nowcast

USP

5 TLS200 sites (LF-VHF)



Vaisala

7 EN sites (ELF-LF)

Earth Network

Operational networks :

- RINDAT (LF)
- STARNET (VLF)
- WWLLN (VLF)
- GLD360 (VLF)
- ATDnet (VLF)
- BrasilDAT (ELF-LF)

6 High Speed Video Cameras

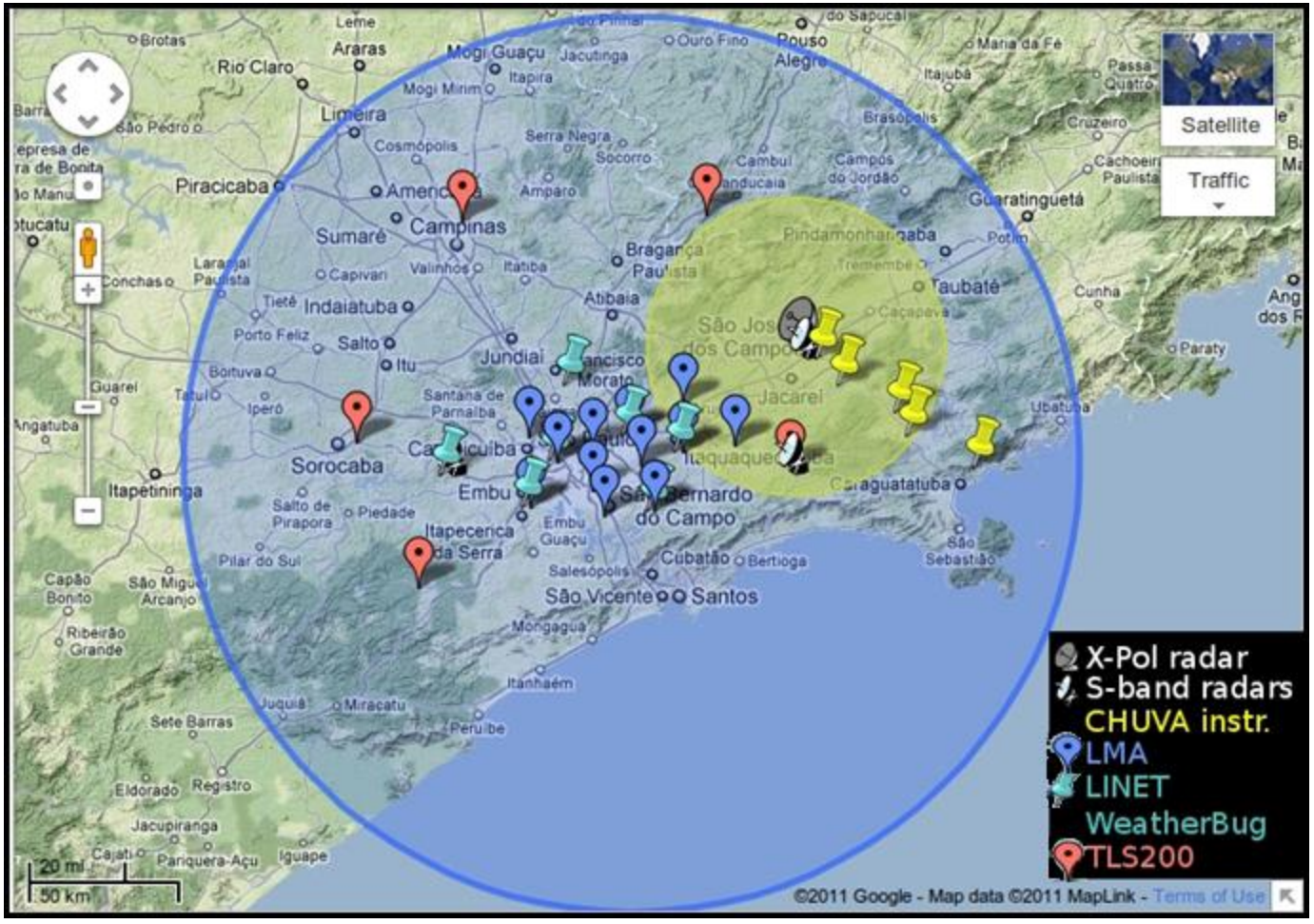
8 Field-Mills

Satellite Observations :

- GOES-12
- MSG
- TRMM

CHUVA-GLM Vale do Paraíba

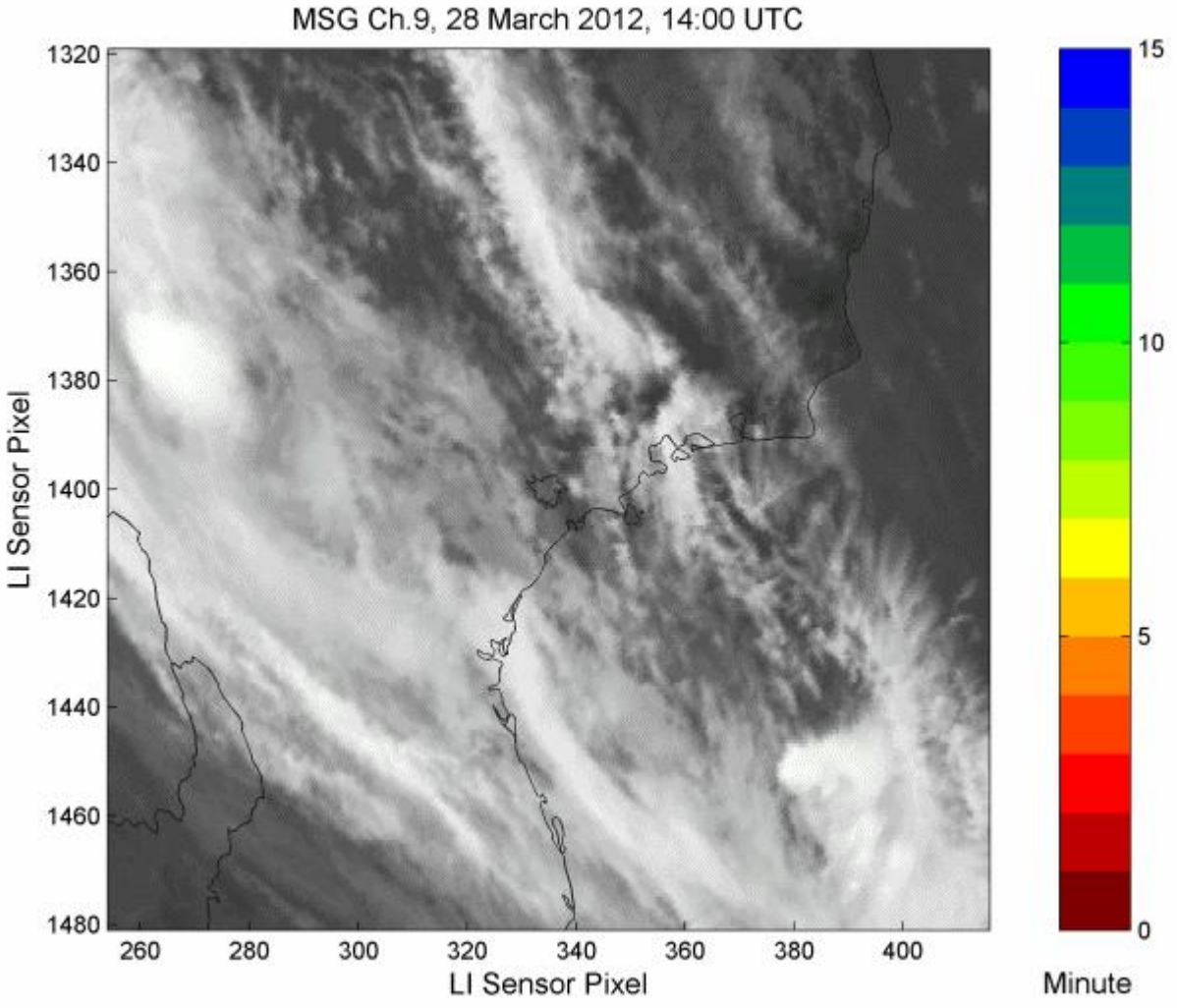
Sensor Sites

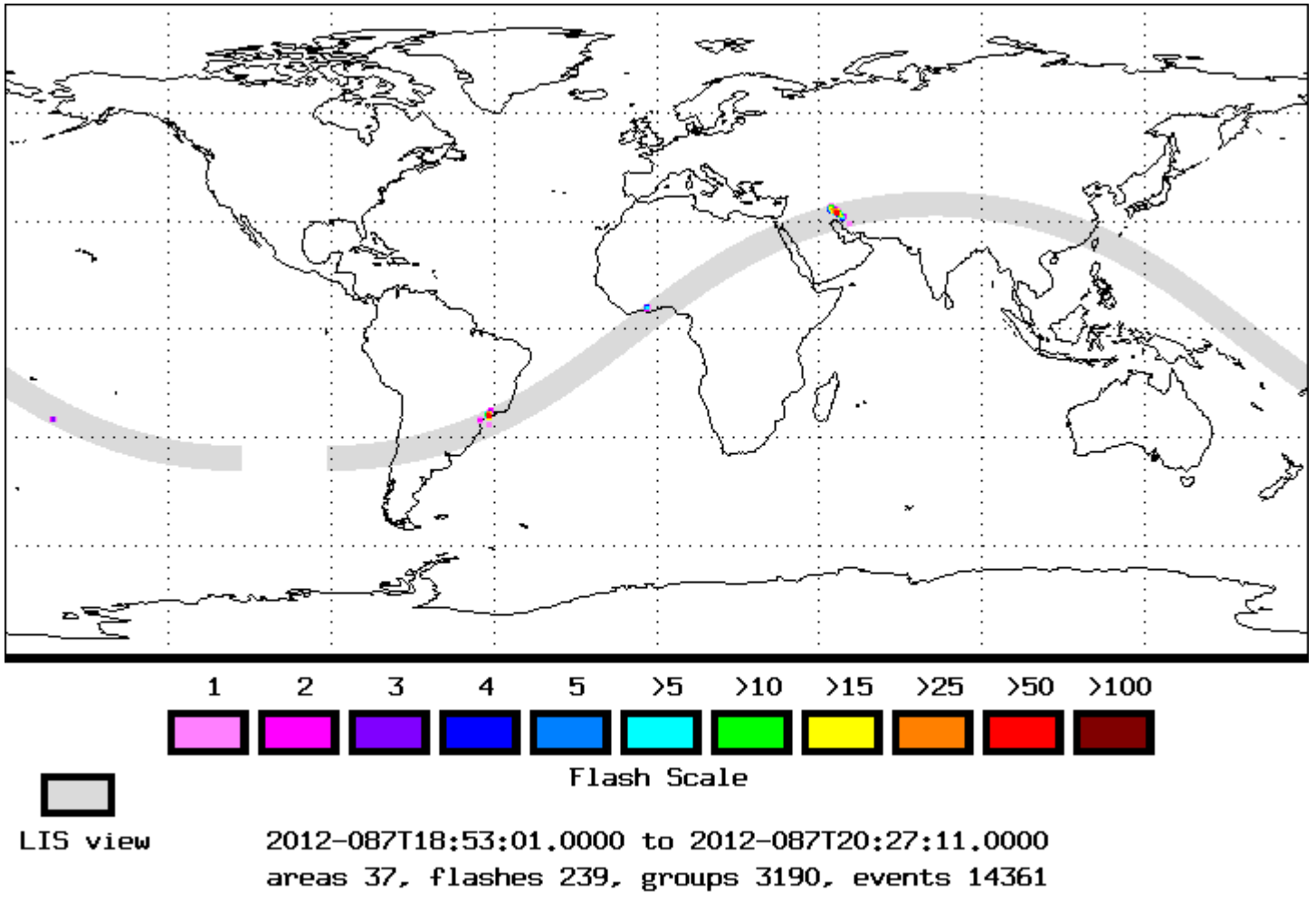


Sensor sites of the different lightning location systems

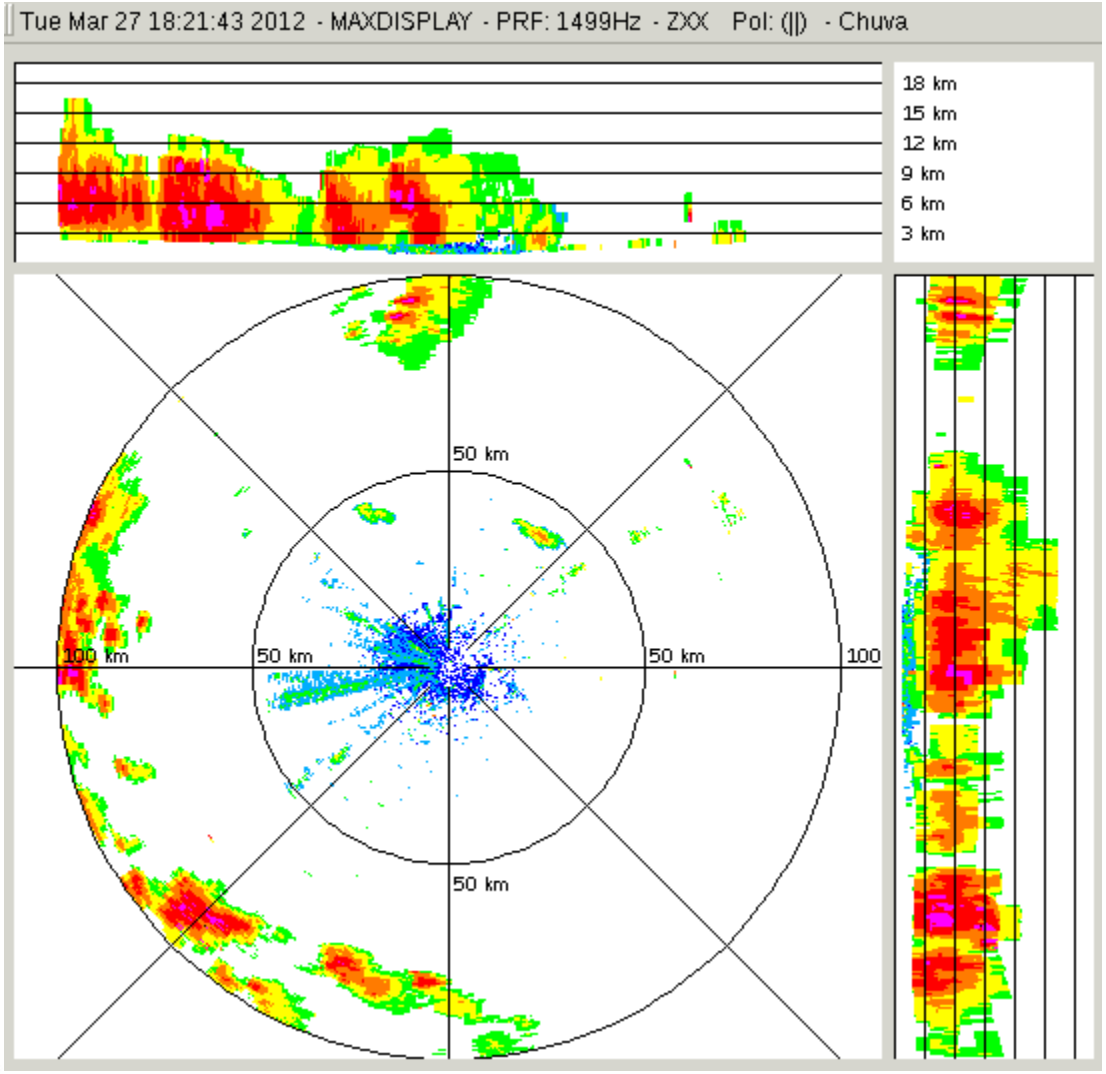
MSG on 27 March 2012

LIS overpass from 19:04 - 19:06 UTC




1
2
3
4
5
>5
>10
>15
>25
>50
>100
Flash Scale
LIS view
2012-087T18:53:01.0000 to 2012-087T20:27:11.0000
areas 37, flashes 239, groups 3190, events 14361

XPOL Radar on 27 March 2012

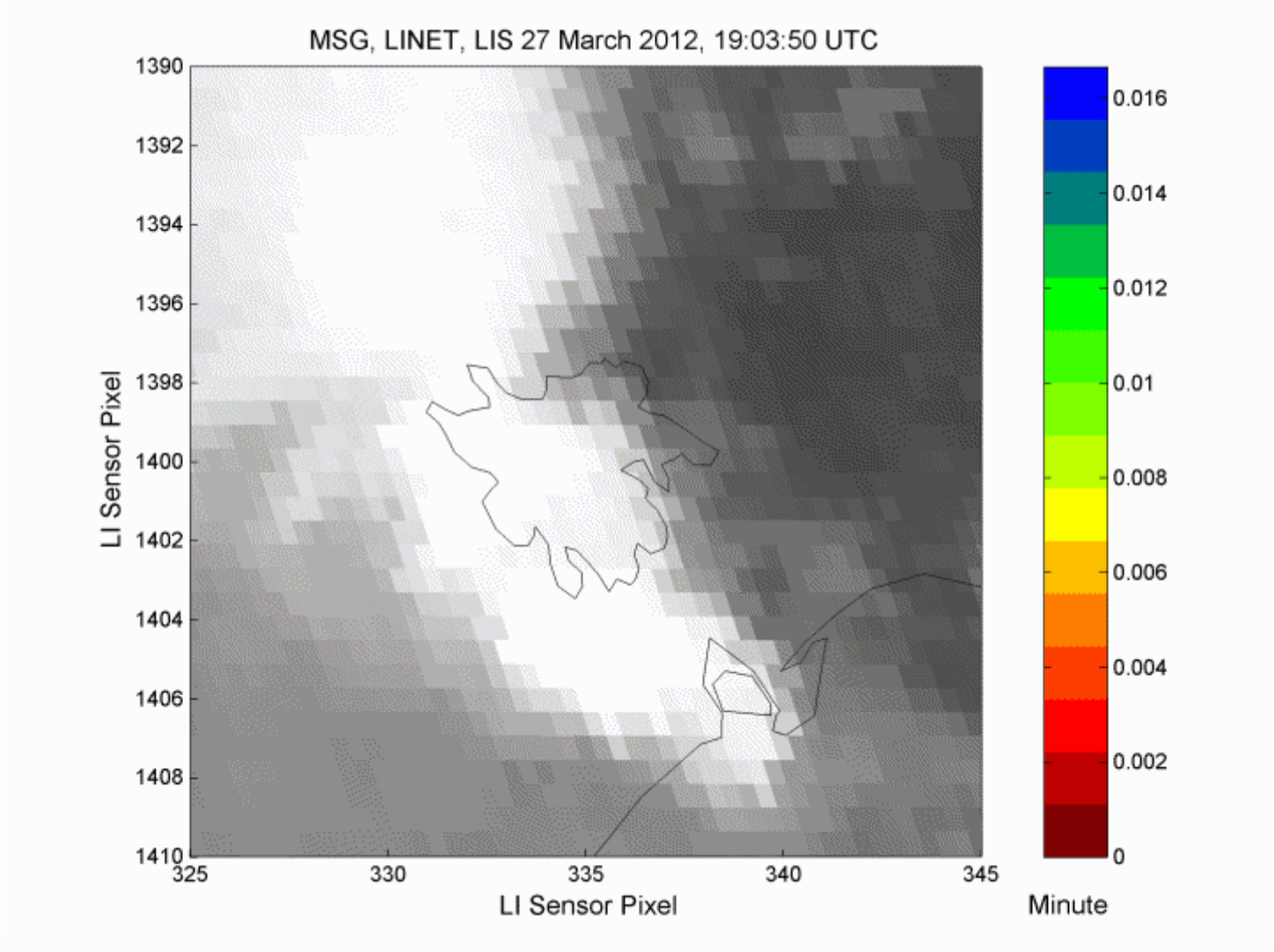


Max-cappi projection 18:18 – 20:00 UTC

Volume scans every 6 min

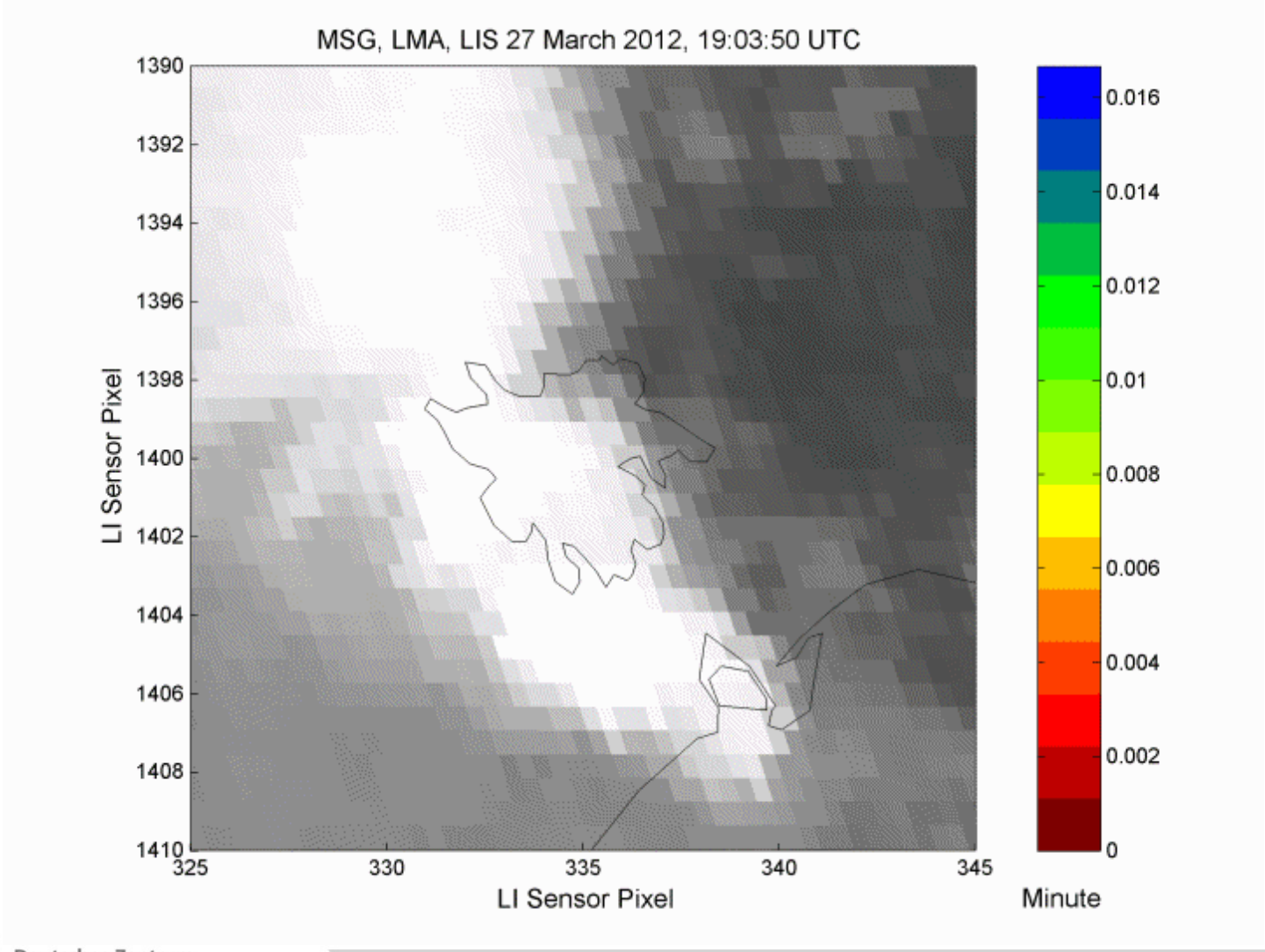
Cloud tops reach 20 km

LIS and LINET on 27 March 2012
One Second Frames

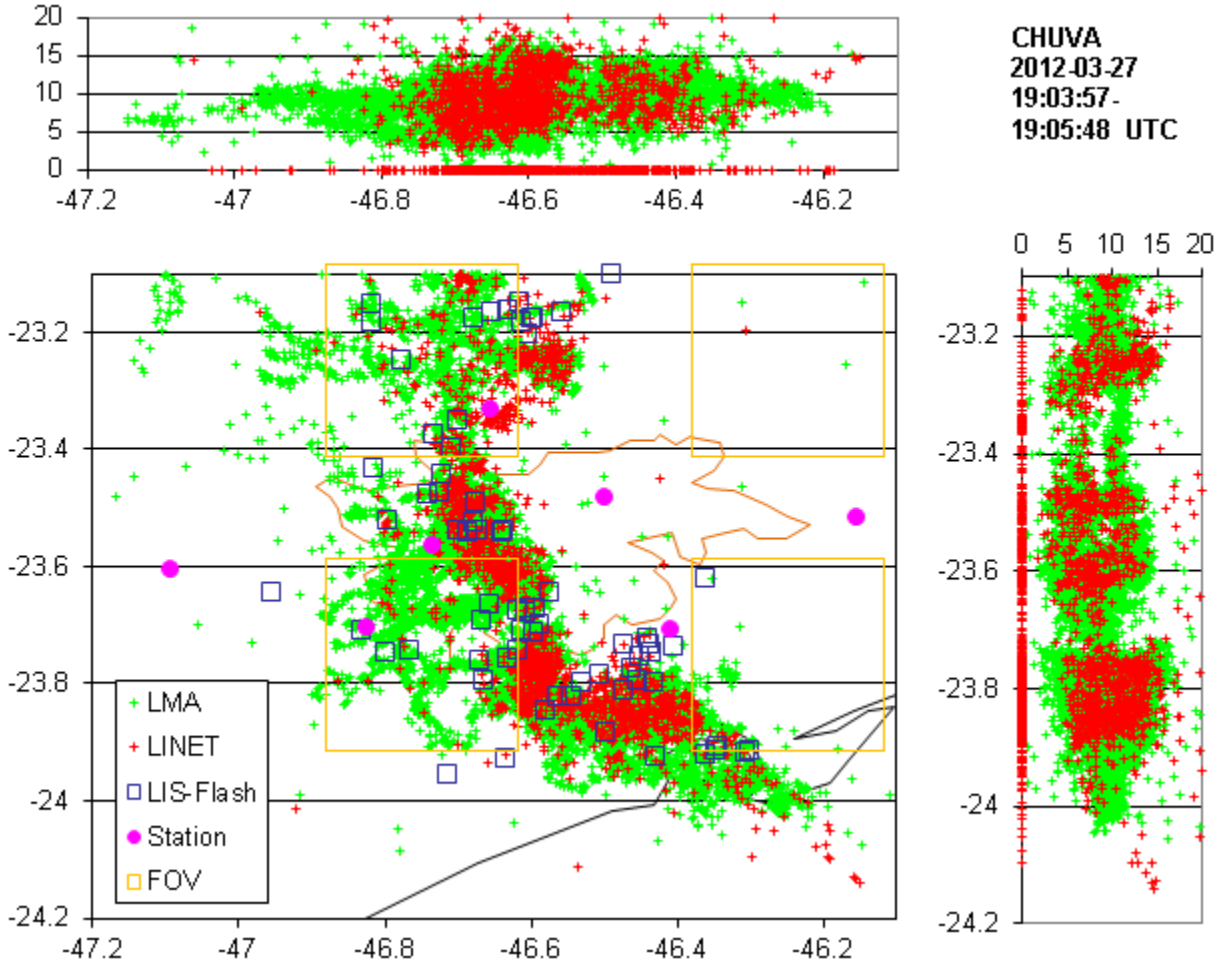


LIS and LMA on 27 March 2012

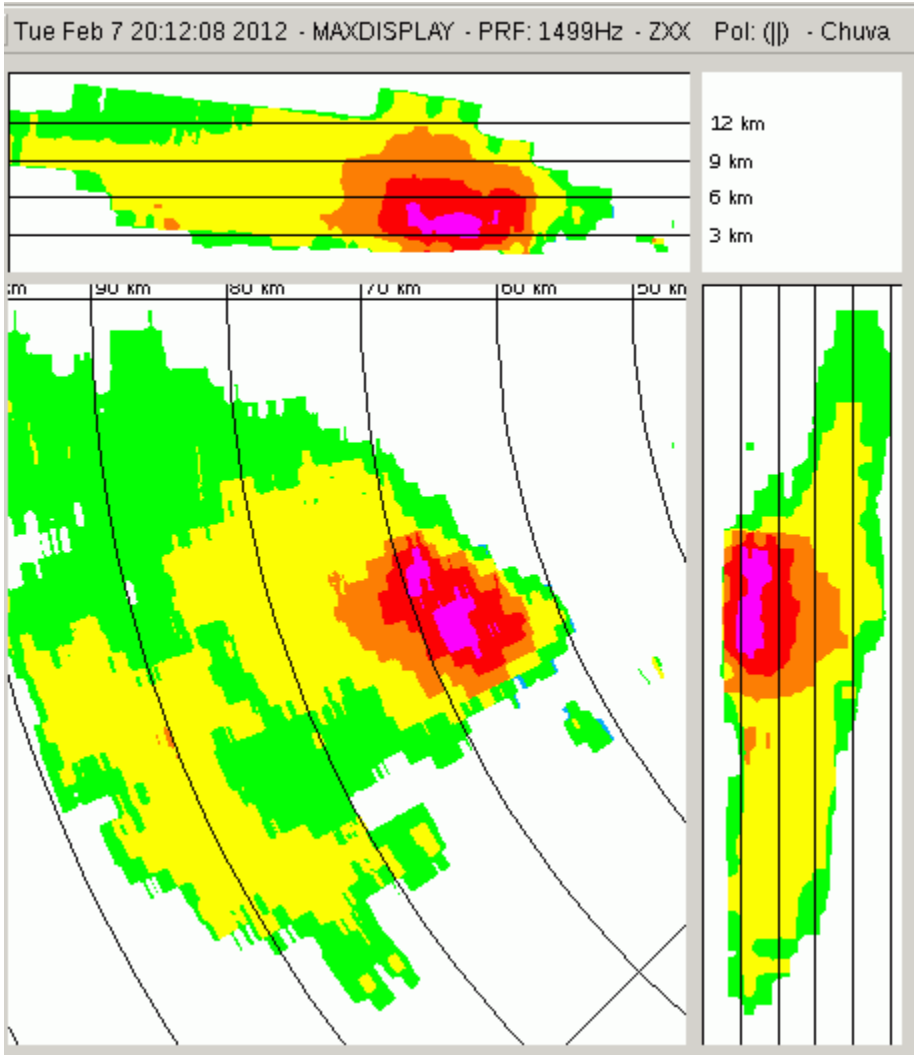
One Second Frames



Case Studies
27 March 2012



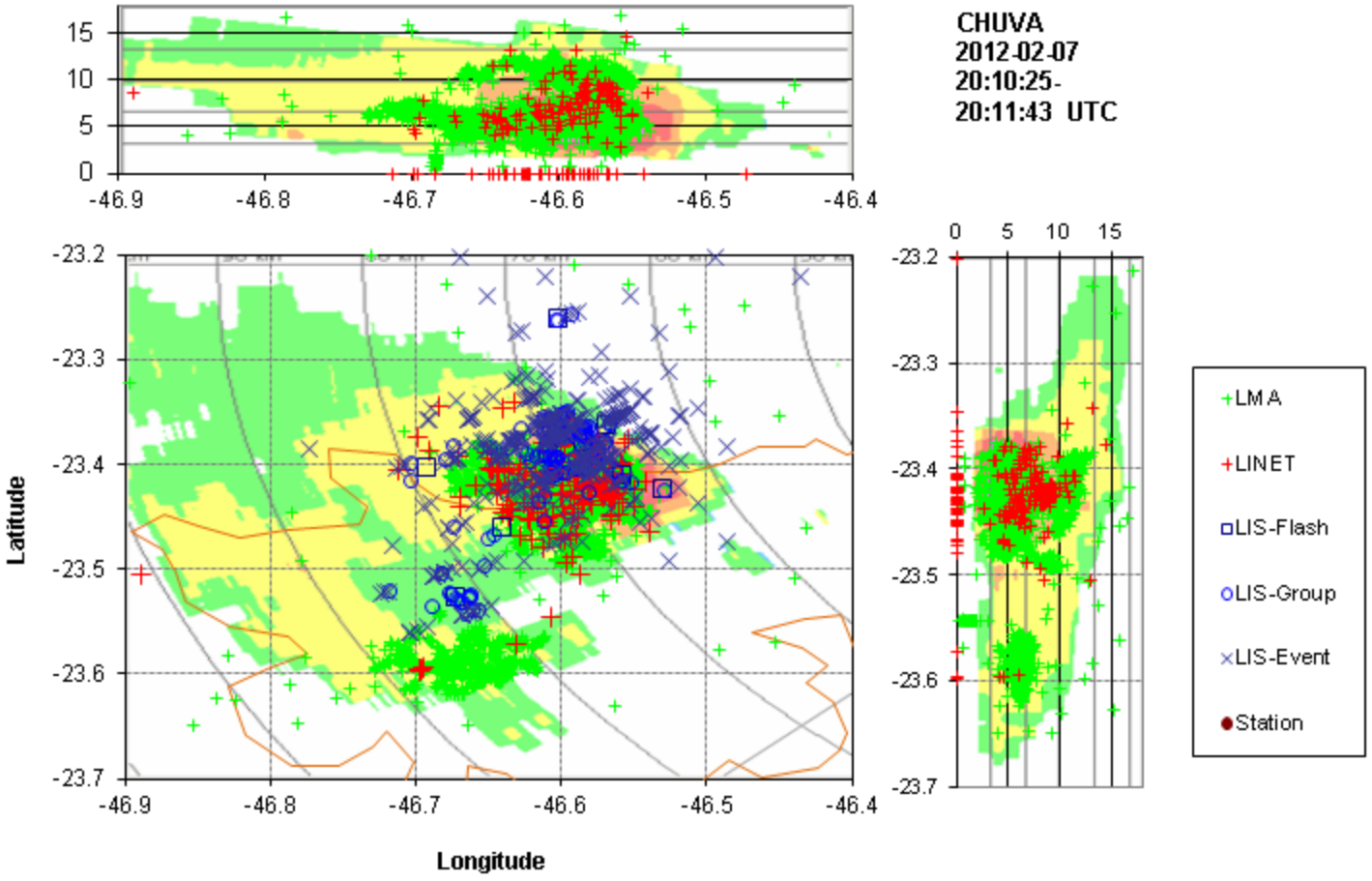
Case Studies
7 Feb 2012



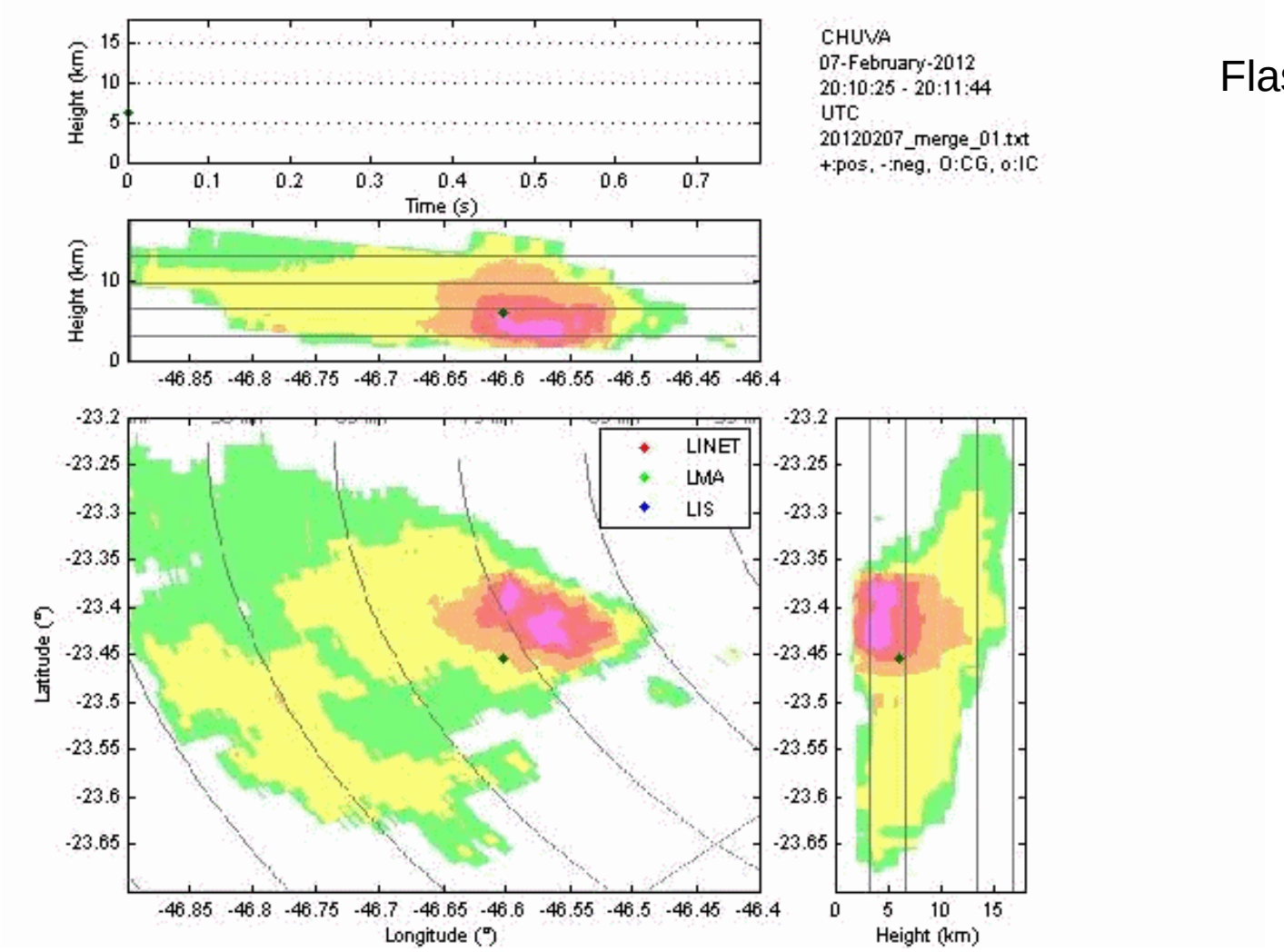
XPOL Radar

20:10 UTC

Case Studies
7 Feb 2012

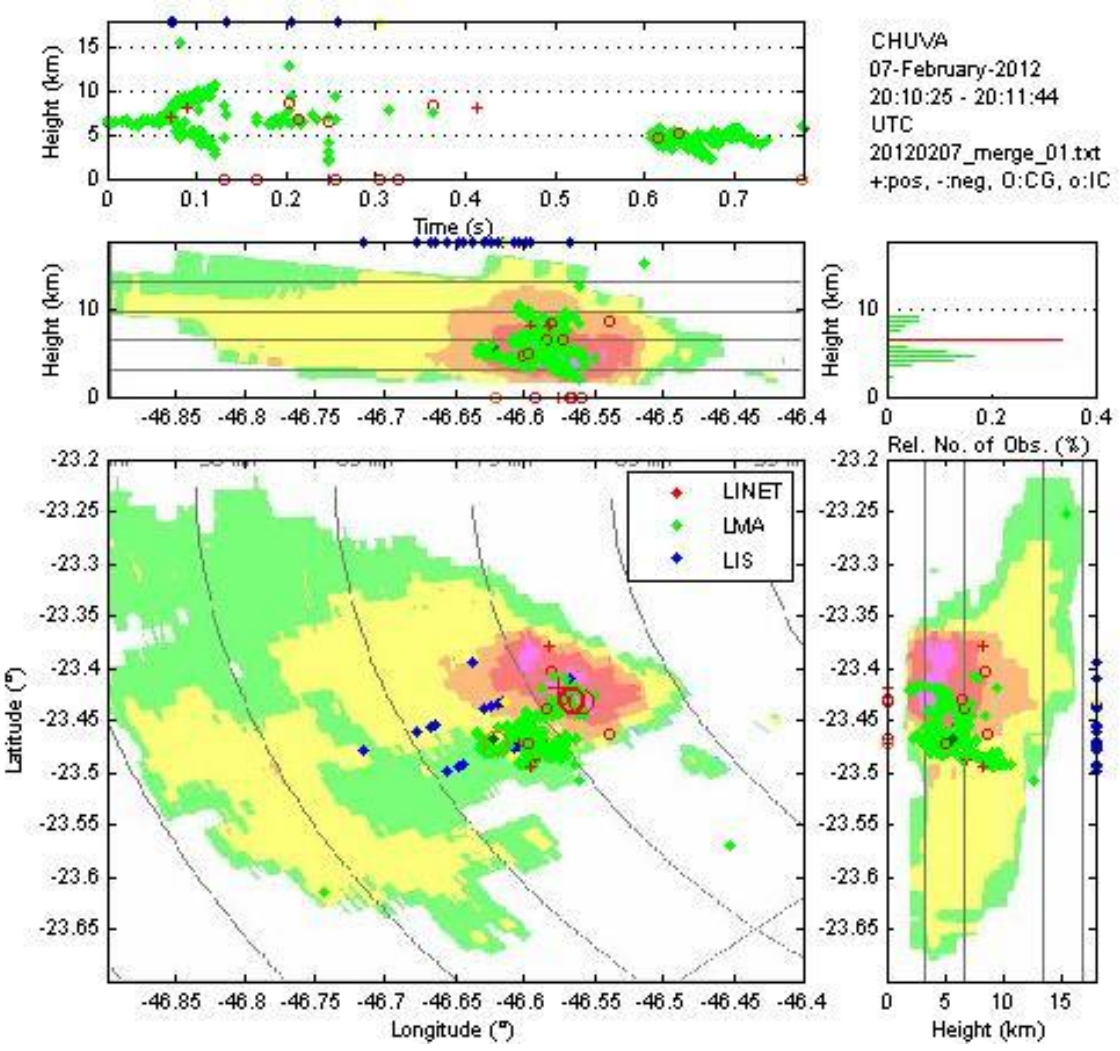


Case Studies
7 Feb 2012



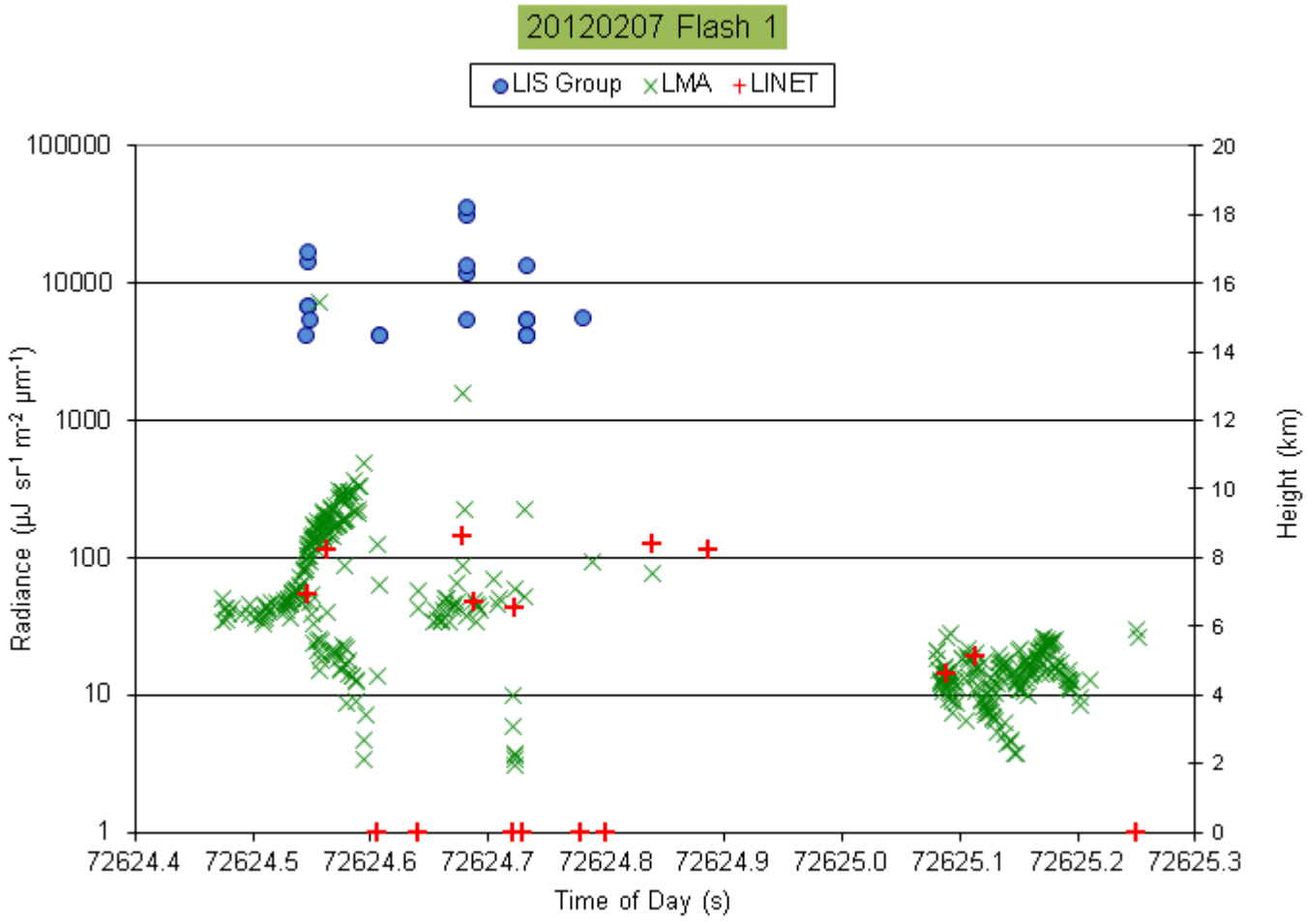
Flash 01

Case Studies
7 Feb 2012



Flash 01

Case Studies
7 Feb 2012



Flash 01

LIS group radiance

LMA and LINET source height

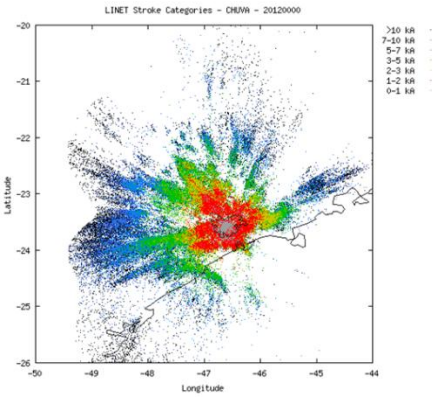
No optical signal from low level part of flash

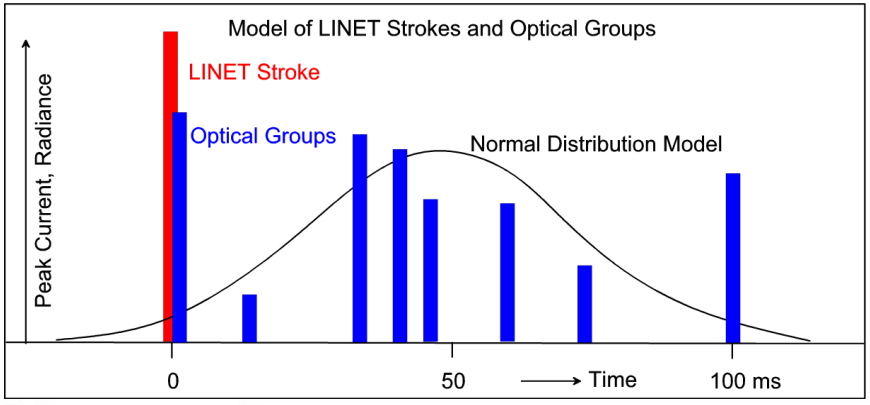
Modeling of MTG-LI Optical Signals
Strategy for Proxy Data Generation

Transformation of LINET RF stroke data into optical groups by a 2-step process:

- Model of cloud top optical emission
  - Simulation of the number of optical groups per stroke (depending on LINET detection efficiency (sensor baseline) in the area)

  If this number is ≥ 1:
  - Generation of one direct coincident optical group per LINET stroke
  - Random generation of additional optical groups per LINET stroke according to a log-normal model for radiance, footprint and time
- Projection of group areas to optical plane of LI pixel matrix



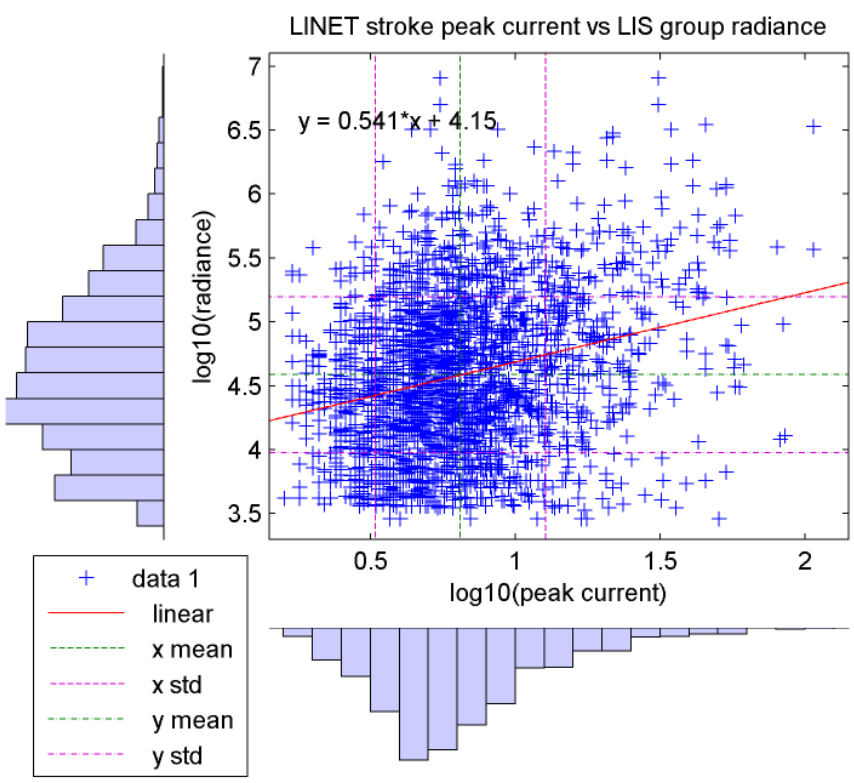


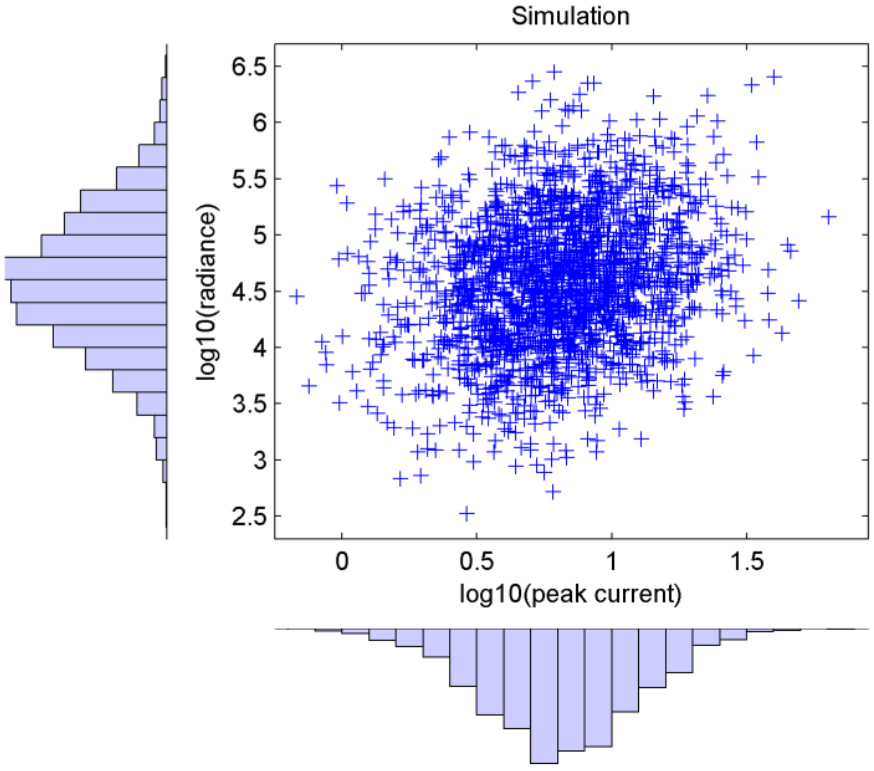
Generation of optical events from RF stroke data

Modeling of MTG-LI Optical Signals
Proxy Group Generation from LINET strokes

- Model of cloud top optical emission
  - Random generator for group radiance (and footprint)

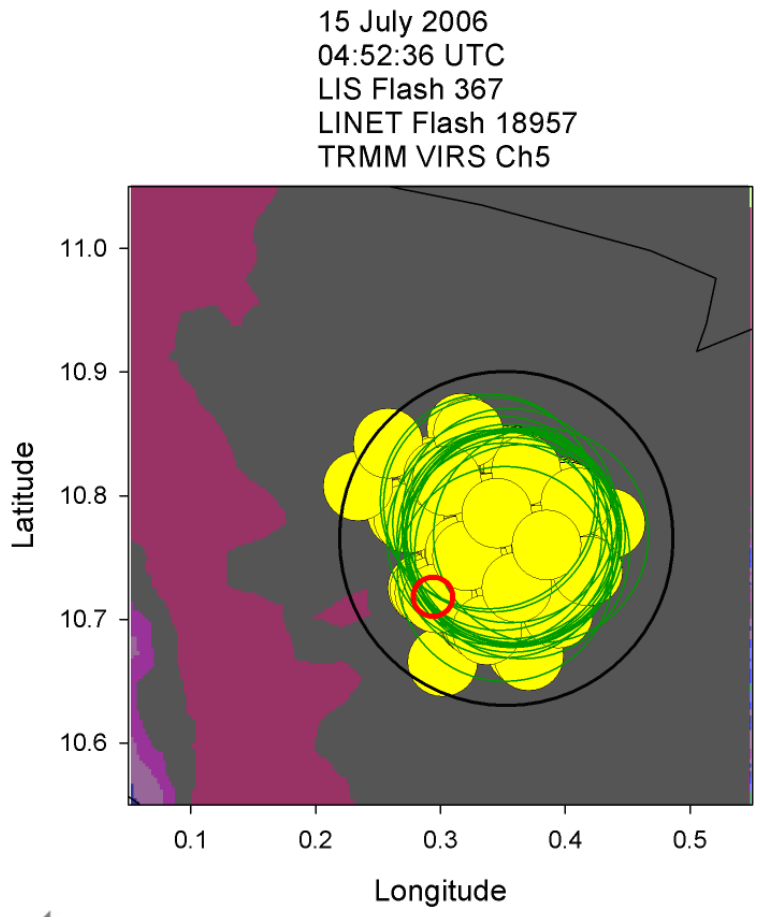
Radiances: Statistics Simulation (log-normal)



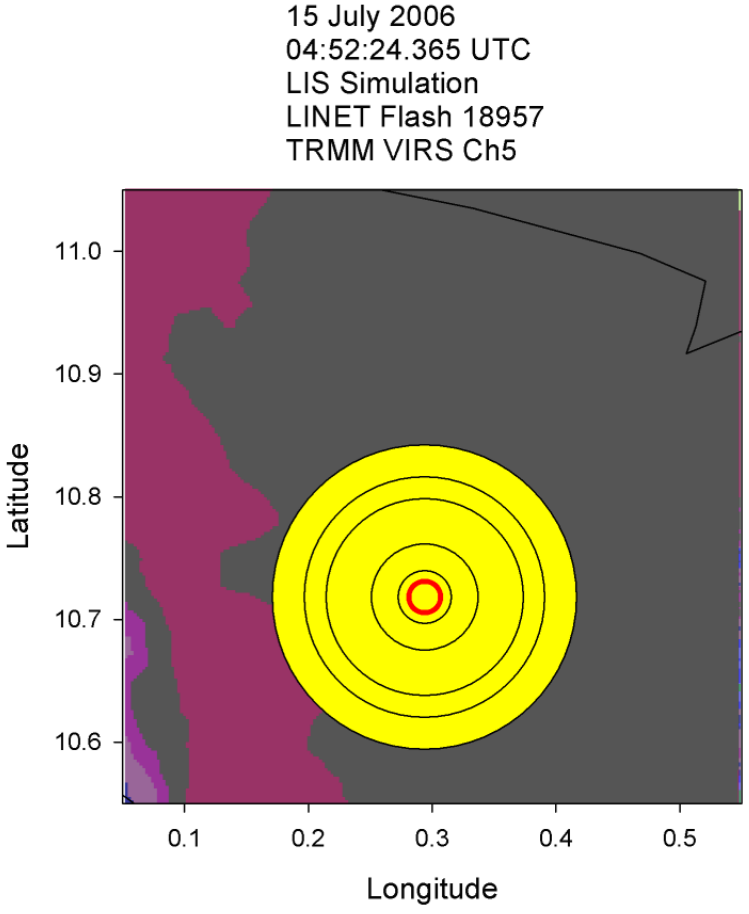


Modeling of MTG-LI Optical Signals
The Model Flash, Horizontal View

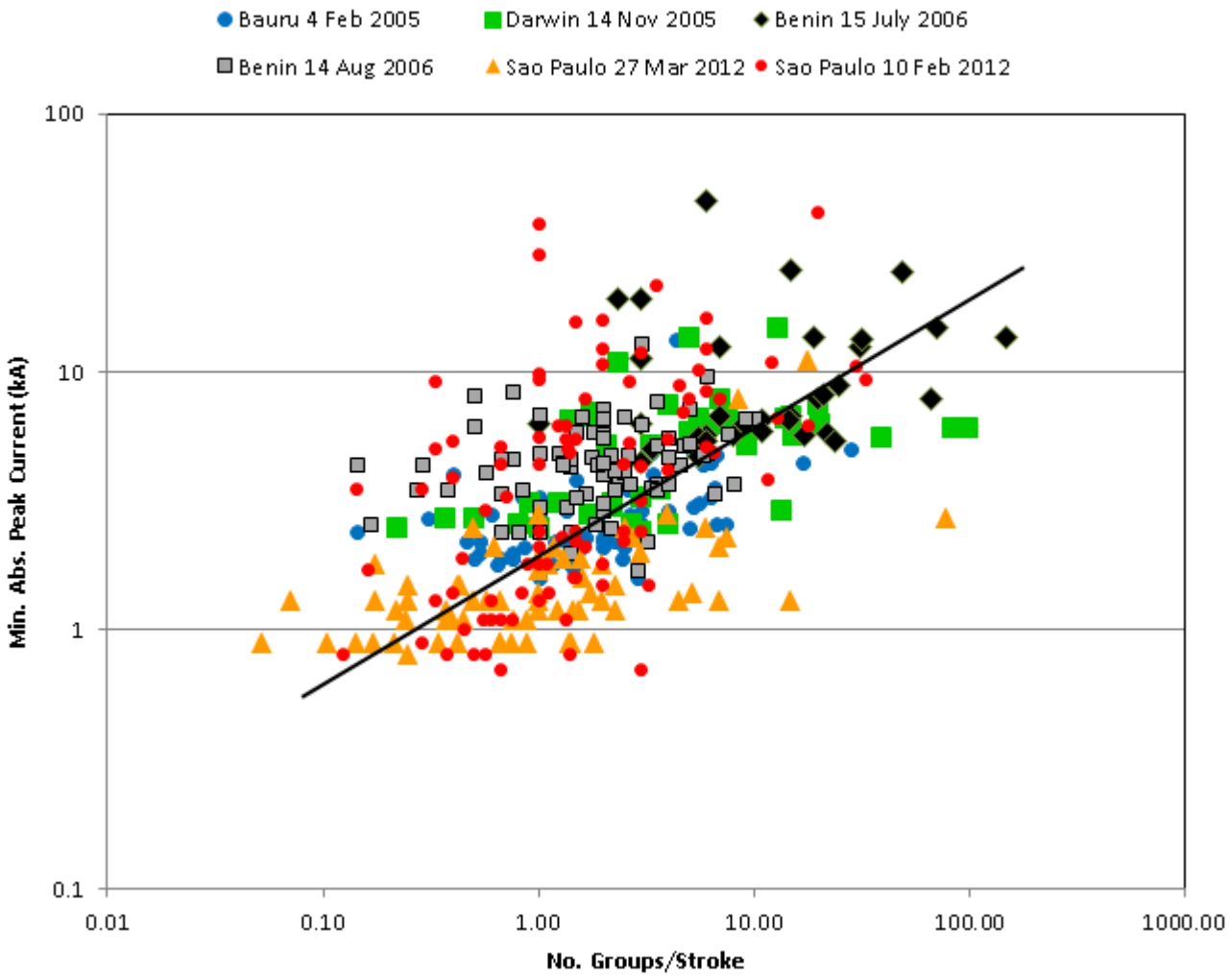
LIS events, groups (green), flash (black) and LINET stroke (red)



Simulation of circular shaped groups around LINET stroke (red)



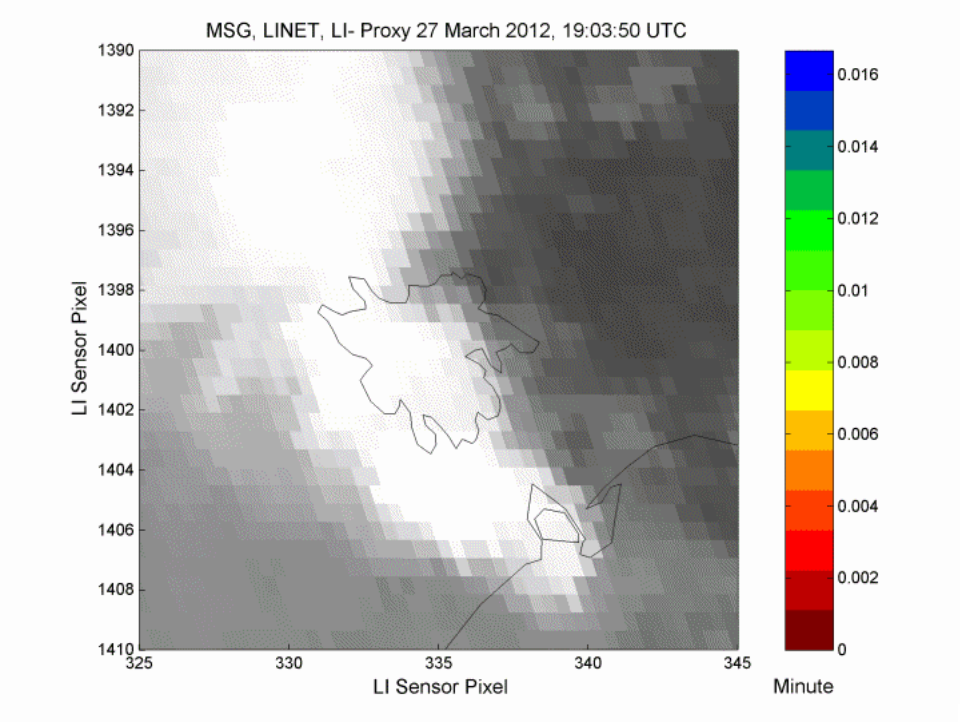
LIS Groups per LINET Stroke
Relation to Network Sensitivity

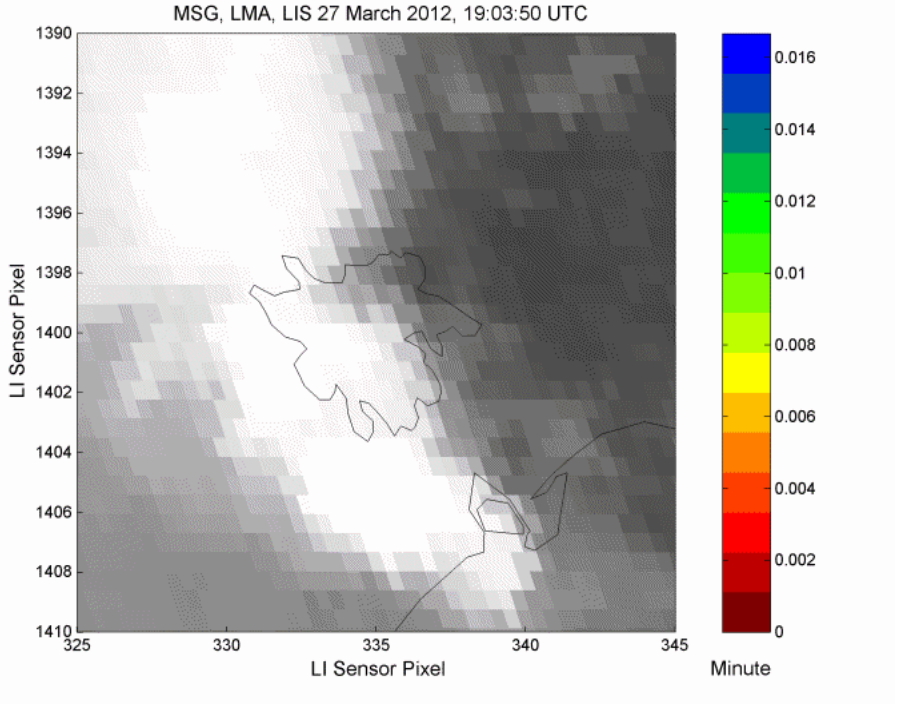


LIS groups per LINET stroke (GPS) from coincident flash observations for LIS overpasses in different areas

CHUVA data add additional information in the low peak current regime

MTG-LI Proxy Data for LIS Overpass
27 March 2012



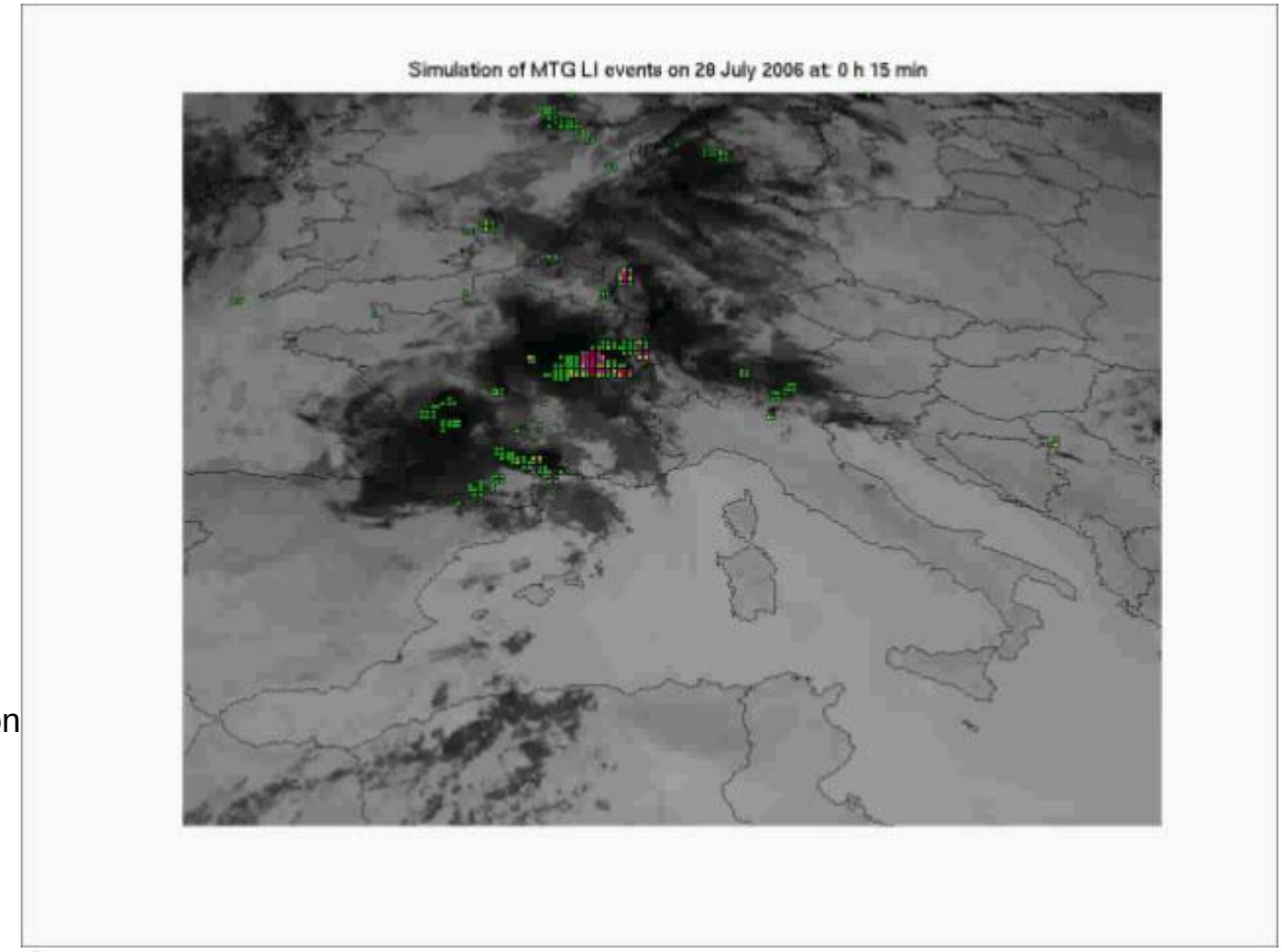


Time of last event

Radiance of last event

before end of 1 s interval

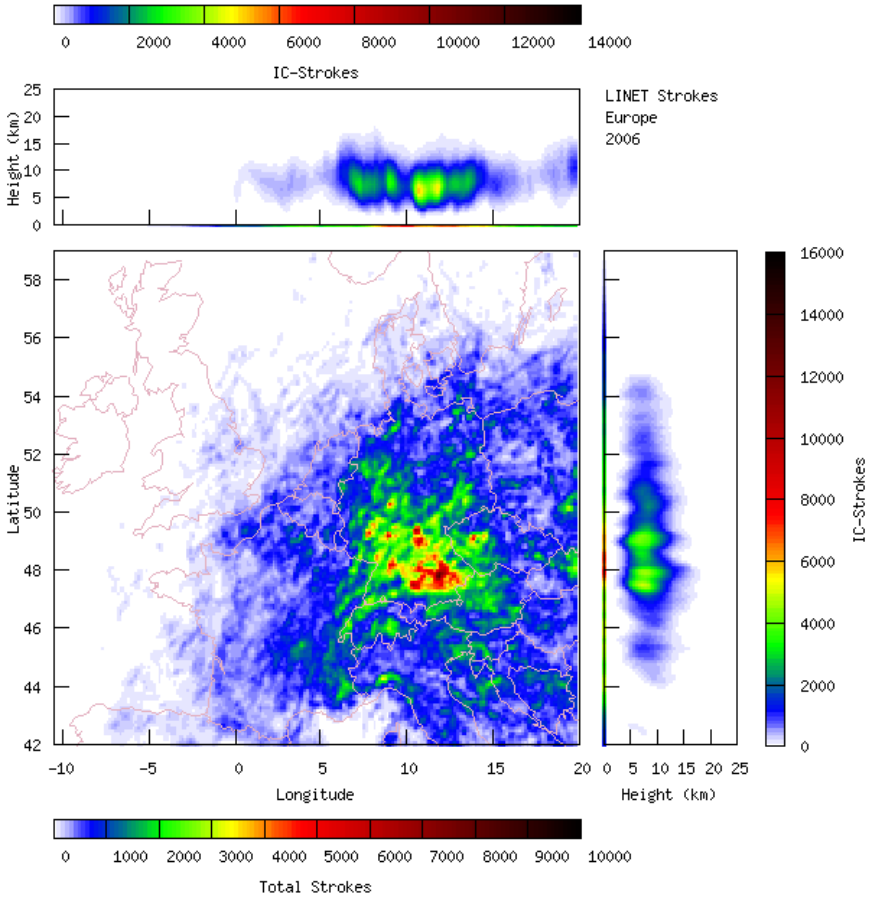
Case Studies
Europe, 28 July 2006



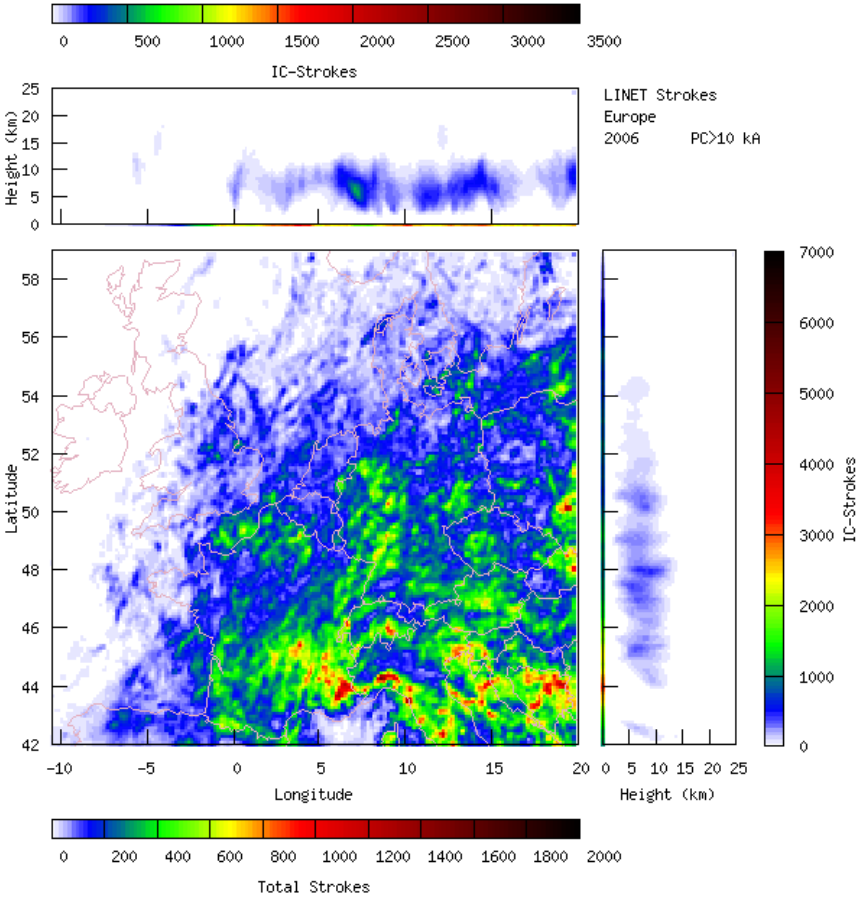
Movie generation by Jochen Grandell (EUMETSAT)

LINET Stroke Density
Europe 2006

All strokes

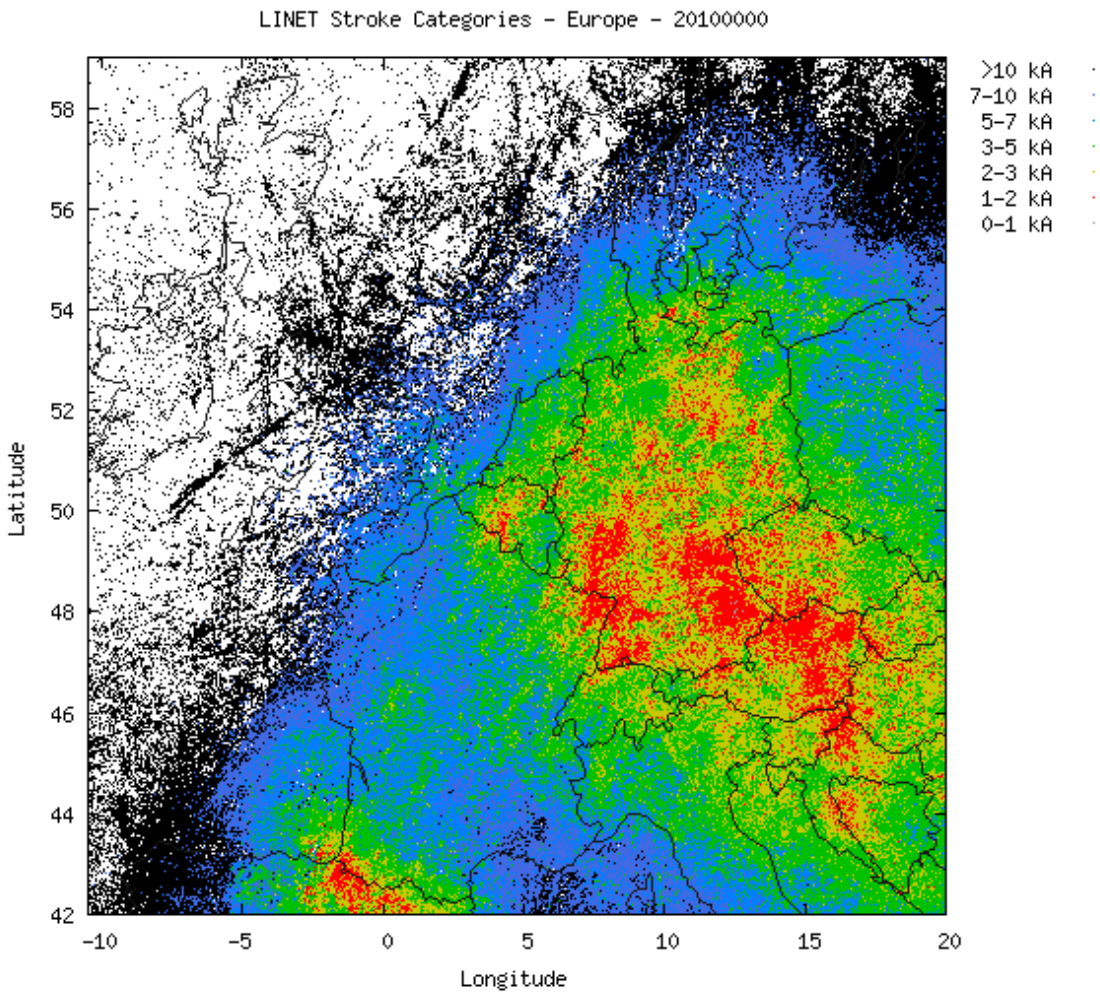


strokes > 10 kA



LINET Detection over Europe 2010

Smallest Detected Peak Current



Distribution of the smallest detected peak current during 2010

Depends on sensor baseline

Summary and Conclusions (1)

- All the different lightning detection system measure different parts of the lightning process with different resolution and efficiency, thus they are complementary to each other
- As found in previous study, LINET strokes and LIS groups are often coincident
- LINET strokes map the flash branches similar to LMA (but with considerably less data points)
- An initial breakdown phase of vertically propagating sources can be often found in LINET and LMA data
- Higher level LINET and LMA signals have higher probability to be optically detected
- Lower level LINET and LMA signals are optically detected from above in case of missing high level precipitation (e.g. from radar)

Summary and Conclusions (2)

- XPOL radar helps in interpretation of 3D cloud structure important for scattering of light
- Improvement of proxy data generation
  - a small baseline (~30 km) LINET configuration provided a high DE network thus closing the gap in coverage at weak LINET strokes (flashes)
  - The number of LIS groups per LINET stroke should not be considered as constant but rather as dependent on minimum peak current
- The next step of proxy data development will be the application to Europe, user readiness aspects, test bed demonstration
- ISS-LIS, proposed launch date late 2014 or early 2015, would enable observations over Europe

The End