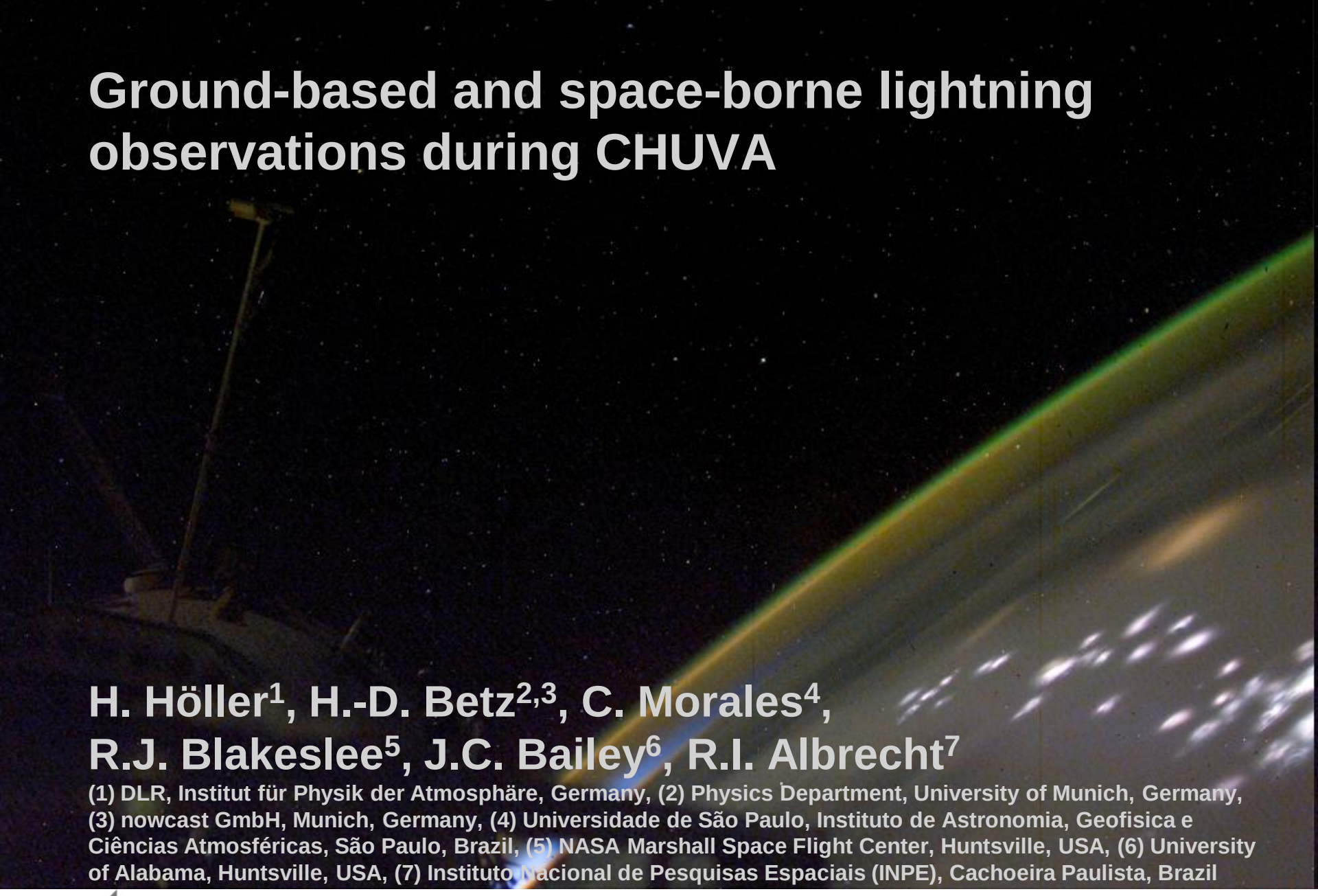
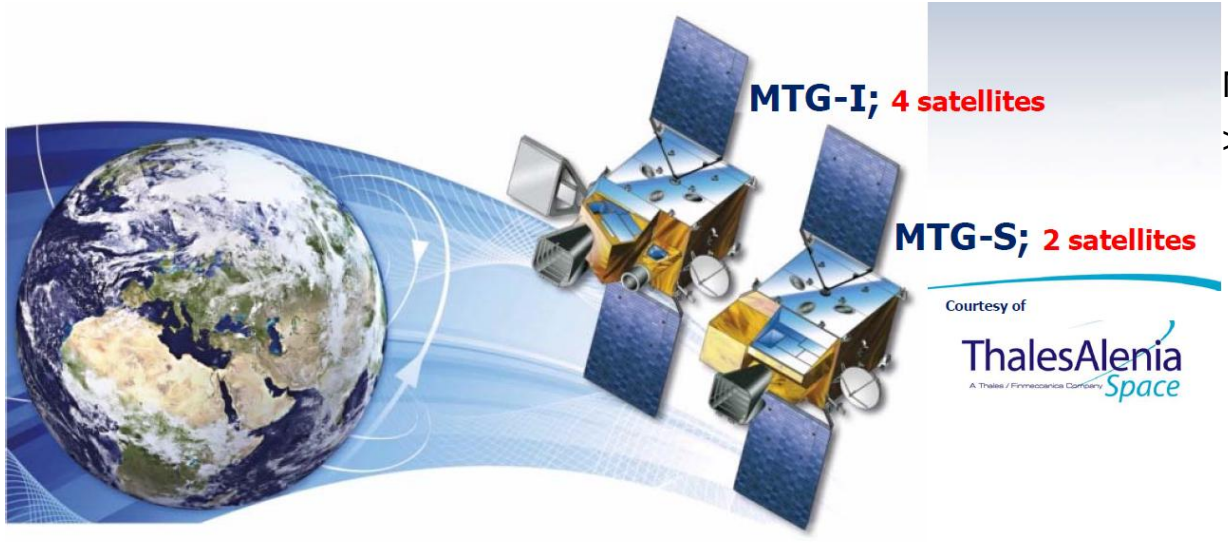
Ground-based and space-borne lightning observations during CHUVA



H. Höller[1], H.-D. Betz[2,3], C. Morales[4], R.J. Blakeslee[5], J.C. Bailey[6], R.I. Albrecht[7]

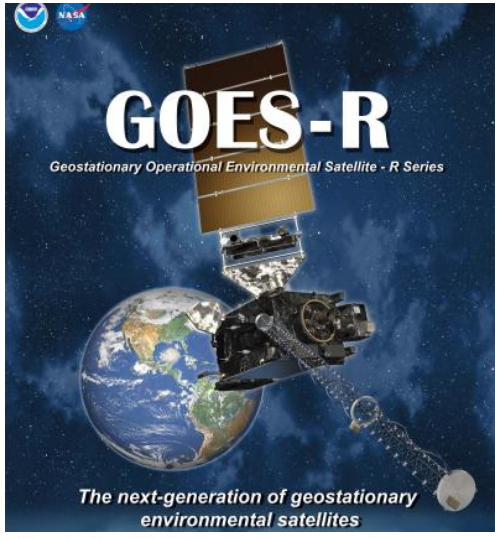
(1) DLR, Institut für Physik der Atmosphäre, Germany, (2) Physics Department, University of Munich, Germany, (3) nowcast GmbH, Munich, Germany, (4) Universidade de São Paulo, Instituto de Astronomia, Geofisica e Ciências Atmosféricas, São Paulo, Brazil, (5) NASA Marshall Space Flight Center, Huntsville, USA, (6) University of Alabama, Huntsville, USA, (7) Instituto Nacional de Pesquisas Espaciais (INPE), Cachoeira Paulista, Brazil

MTG and GOES-R
New Geostationary Satellite Systems



Meteosat Third Generation

> 2018

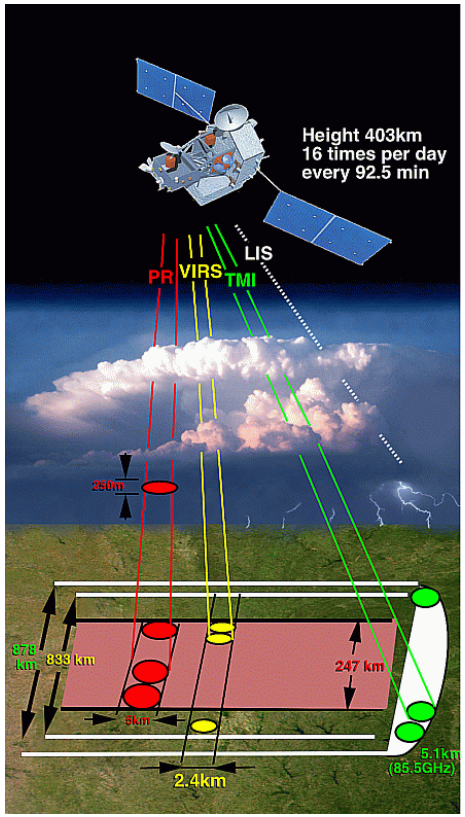


Geostationary Operational Environmental Satellite-R Series (GOES-R)

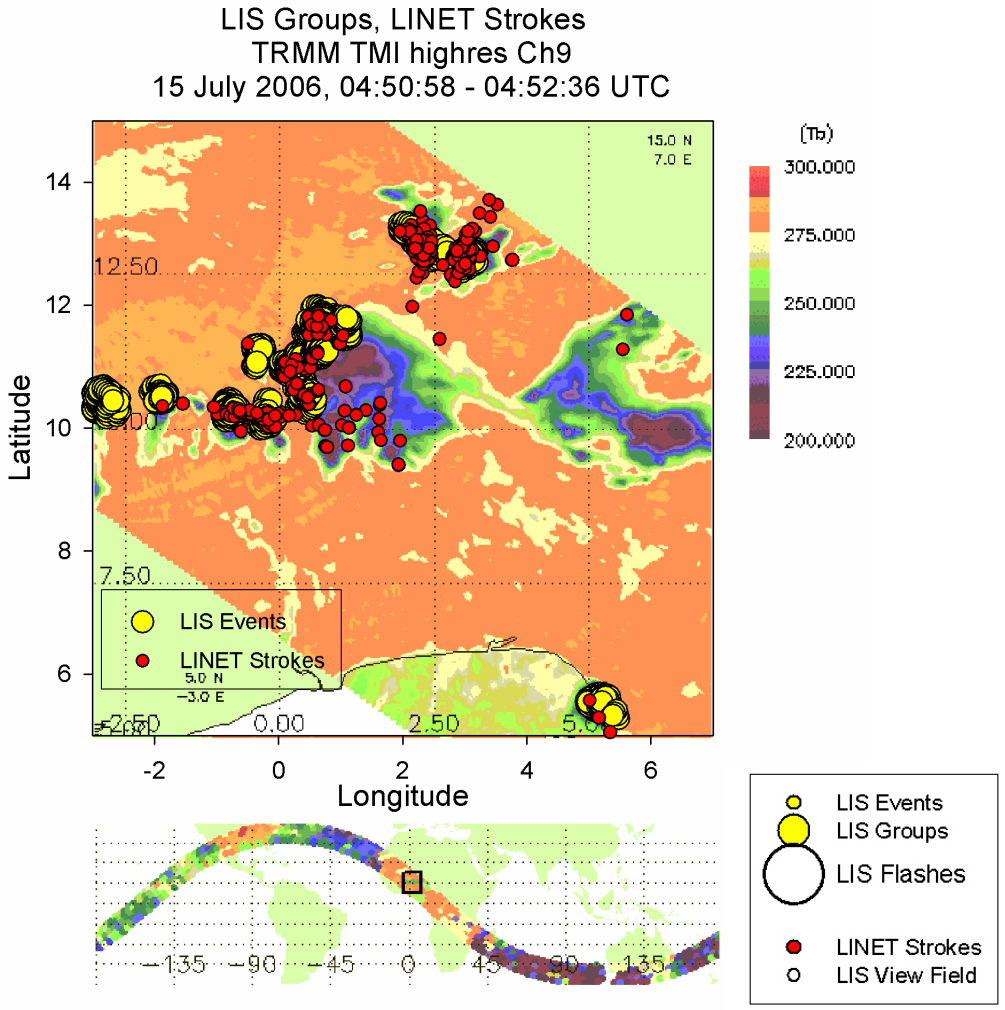
> 2015

TRMM (Tropical Rainfall Measuring Mission)

TRMM Instruments

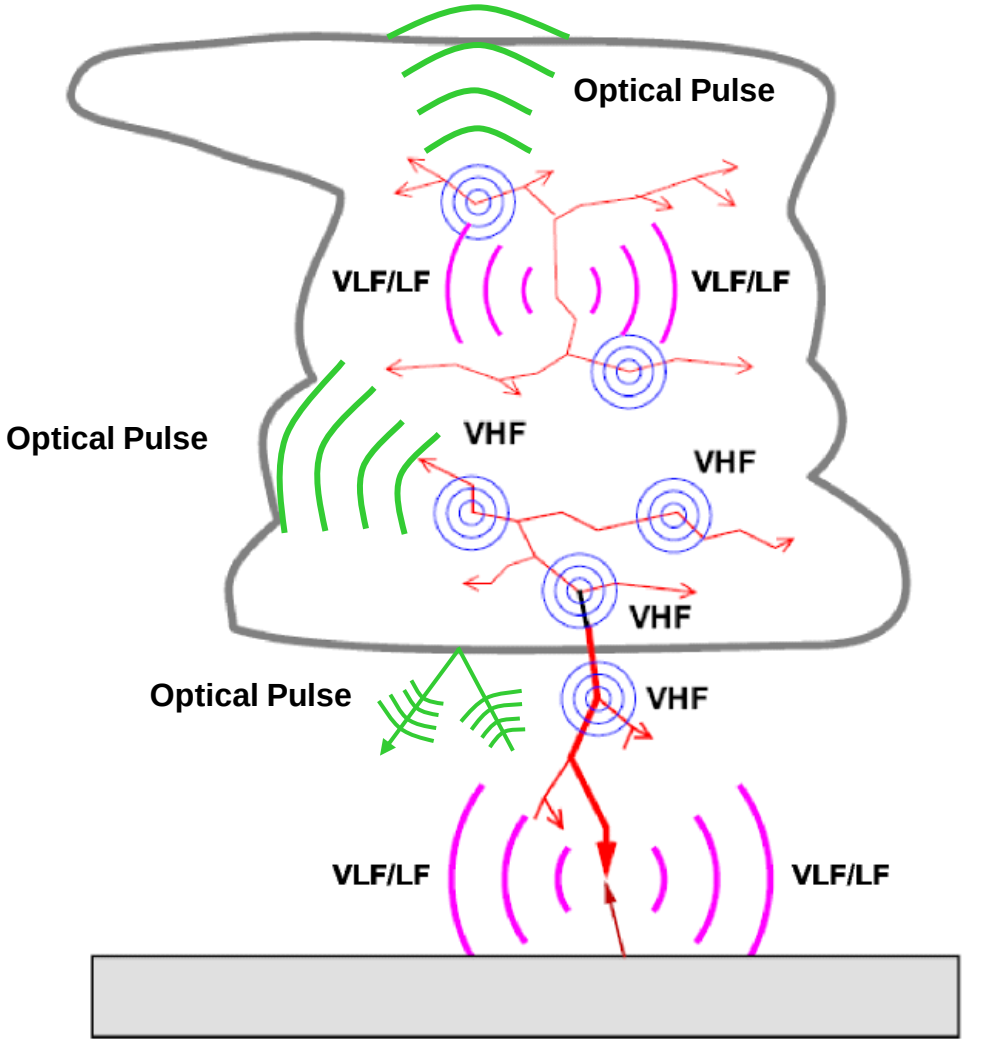


- Visible and InfraRed Scanner (VIRS)
- TRMM Microwave Imager (TMI)
- Precipitation Radar (PR)
- Lightning Imaging Sensor (LIS)



Flash Types and Emissions

CG, IC and VLF/LF, VHF, Light



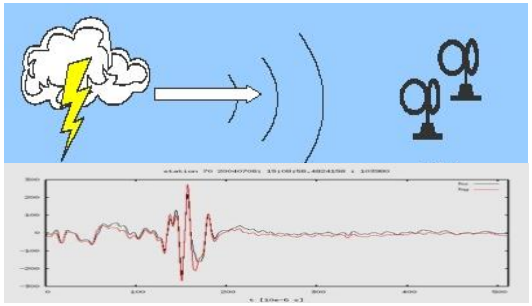
Intra-cloud (IC) and cloud-to-ground flashes emit VLF/LF, VHF and optical radiation

Long wavelength VLF/LF signals have one or several source points per flash arising from long channel segments

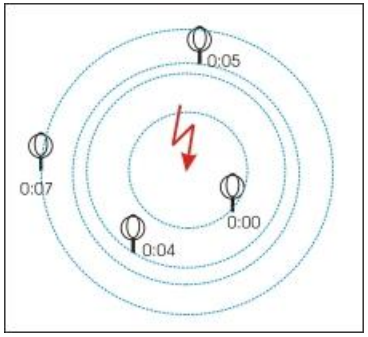
Short wavelength VHF signal have many source points per flash and allow for reconstructing short scale channel details

LINET (Lightning Detection Network)
System Characteristics

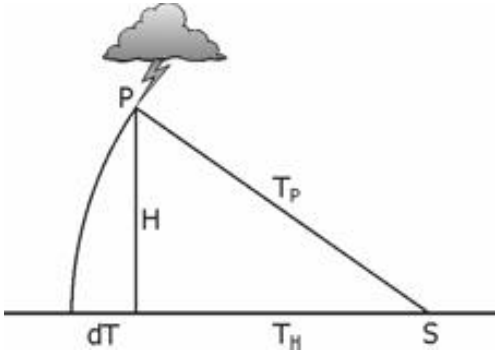
- Measurement of magnetic field

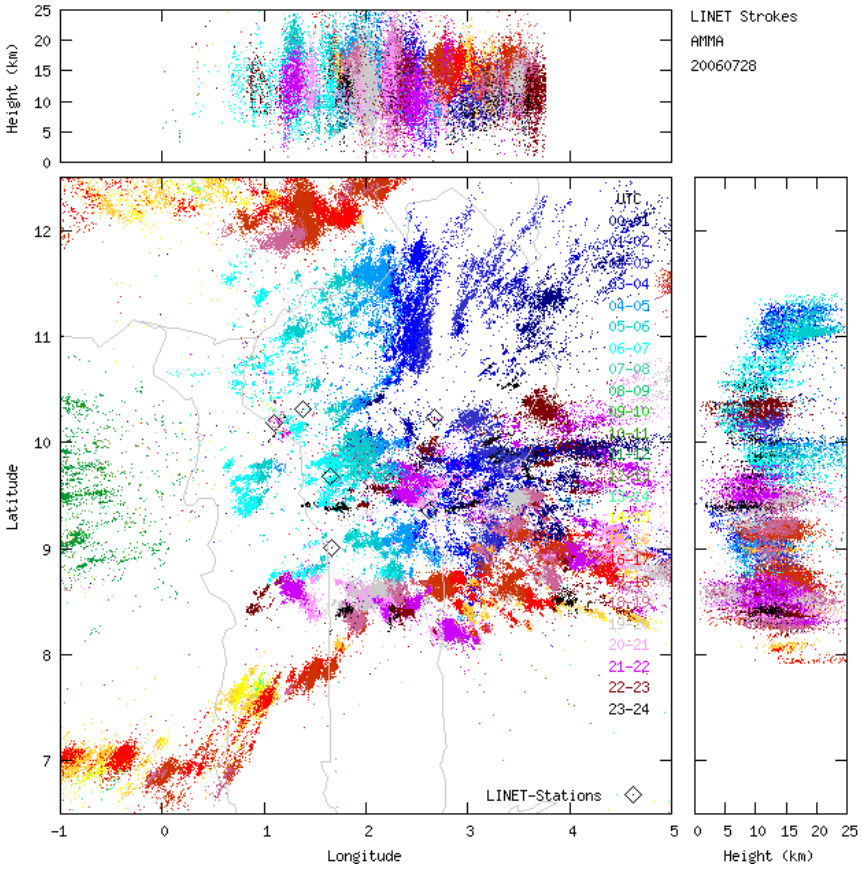


- TOA Method for lightning location



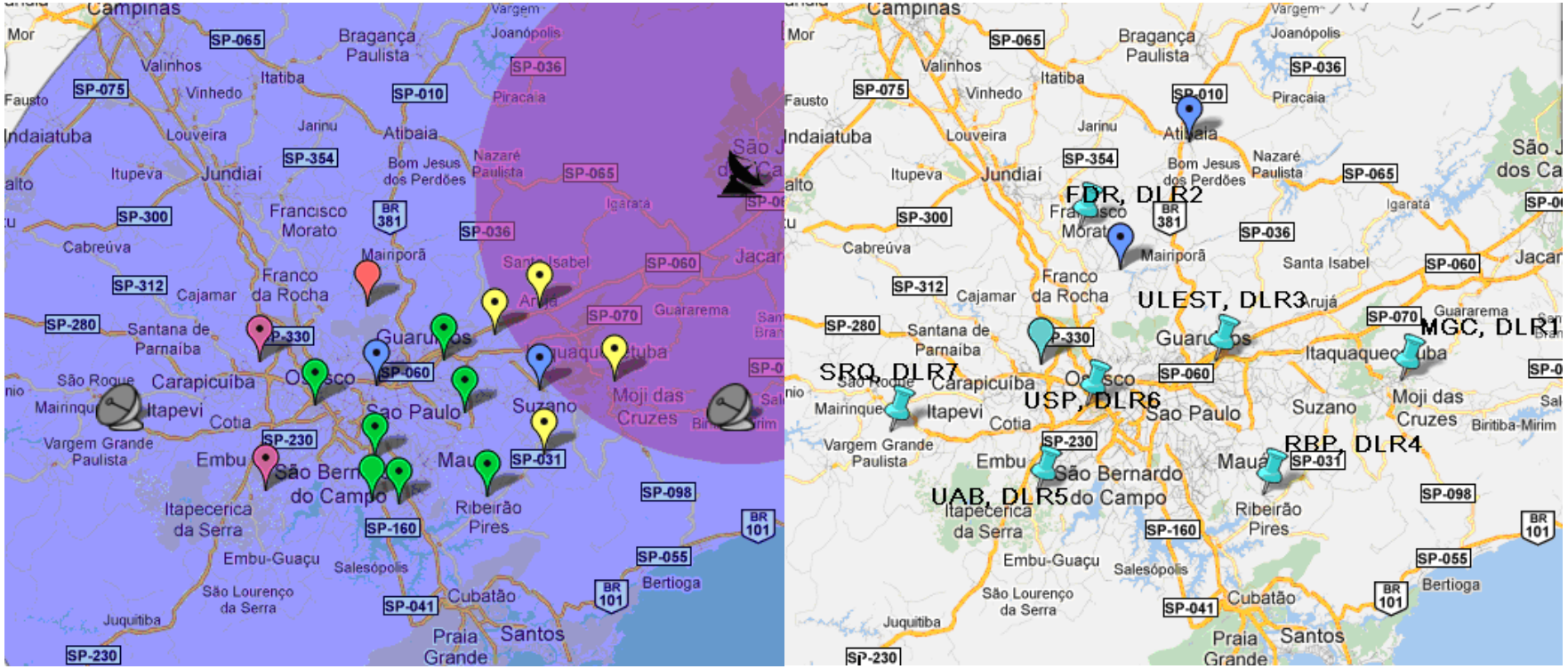
- IC - CG discrimination
- Height of IC events





LMA and LINET Sites

XPOL and operational radars



LMA and LINET

LMA and LINET configuration, XPOL and operational radars

LINET Sites
CHUVA, Sao Paulo








LIS Overpasses
Summary

1. ((29.10.2011 23:36 UTC))
2. (11.11.2011 16:24 UTC)
3. ((7.12.2011 20:15 UTC))
4. ((10.12.2011 02:40 UTC))
5. (28.12.2011 17:11 UTC)
6. (17.1.2012 23:19 UTC)
7. **19.1.2012 23:03 UTC**
8. (20.1.2012 22:10 UTC)
9. (21.1.2012 21:16 UTC)
10. (23.1.2012 21:00 UTC)
11. **24.1.2012 20:02 UTC**
12. **7.2.2012 20:13 UTC**
13. 8.2.2012 19:17 UTC
14. **10.2.2012 19:05 UTC**
15. 11.2.2012 18:10 UTC
16. (14.2.2012 17:01 UTC)
17. 27.2.2012 03:15 UTC
18. 11.3.2012 20:50 UTC
19. 12.3.2012 19:54 UTC
20. (15.3.2012 18:45 UTC)
21. **27.3.2012 19:07 UTC**
22. ((30.3.2012 17:55 UTC))

Priority

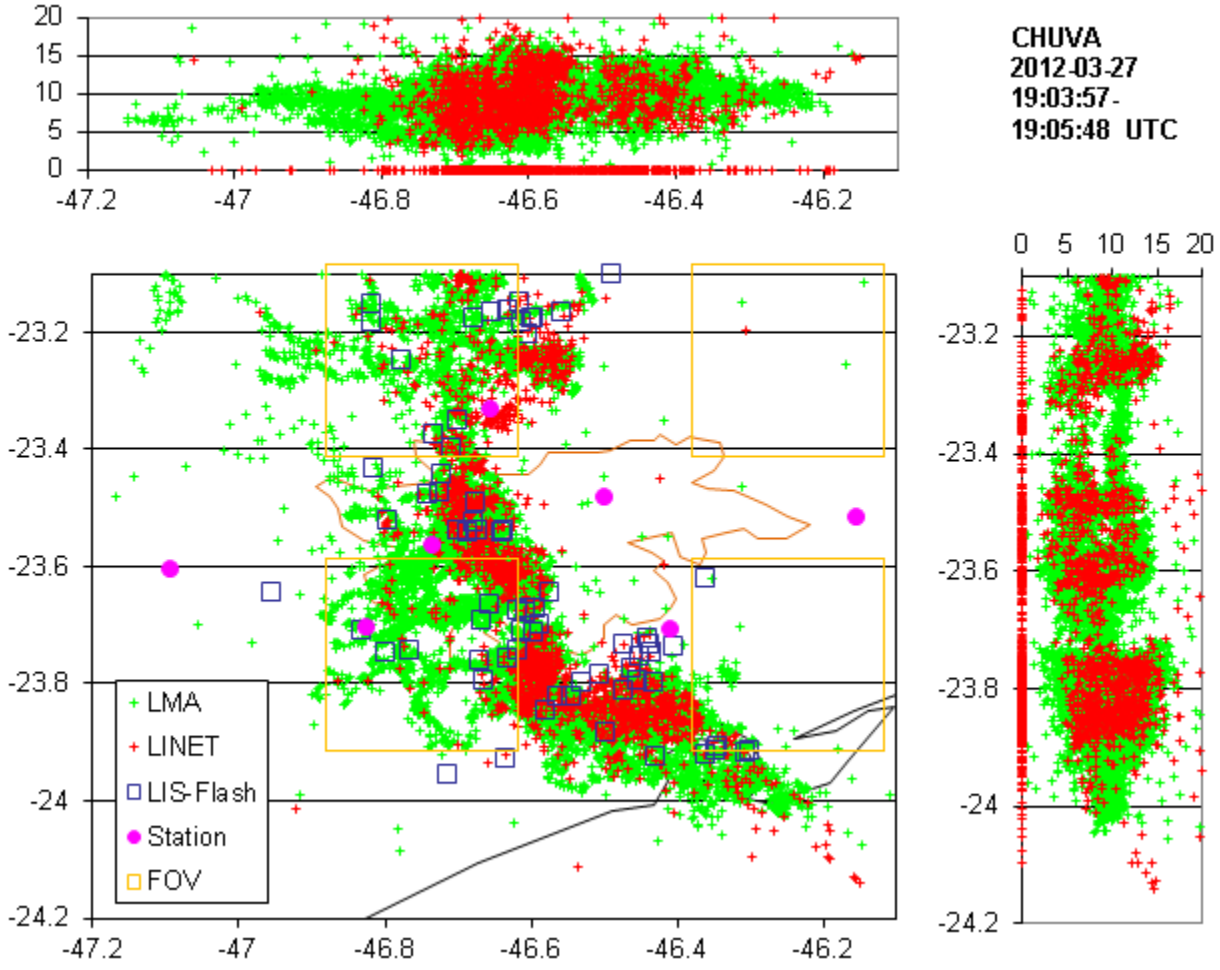
High

Normal

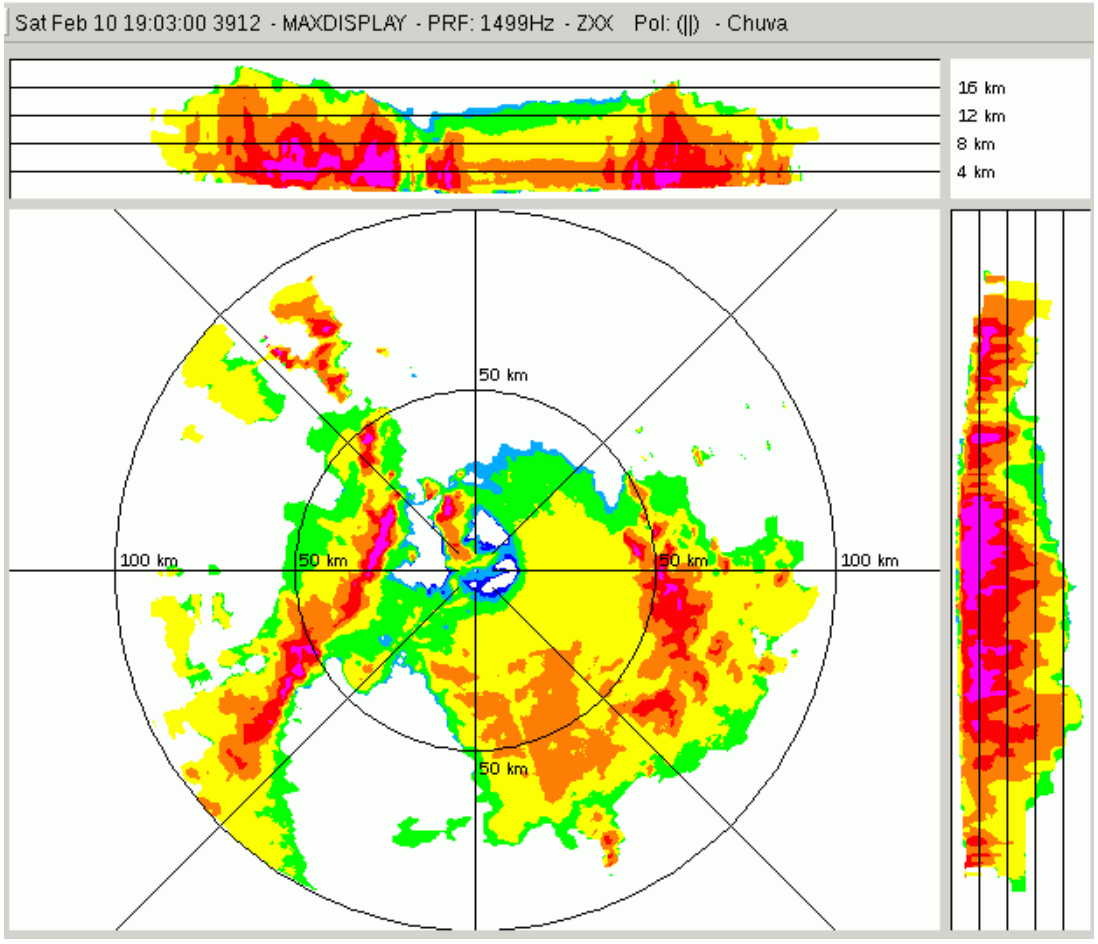
(Low)

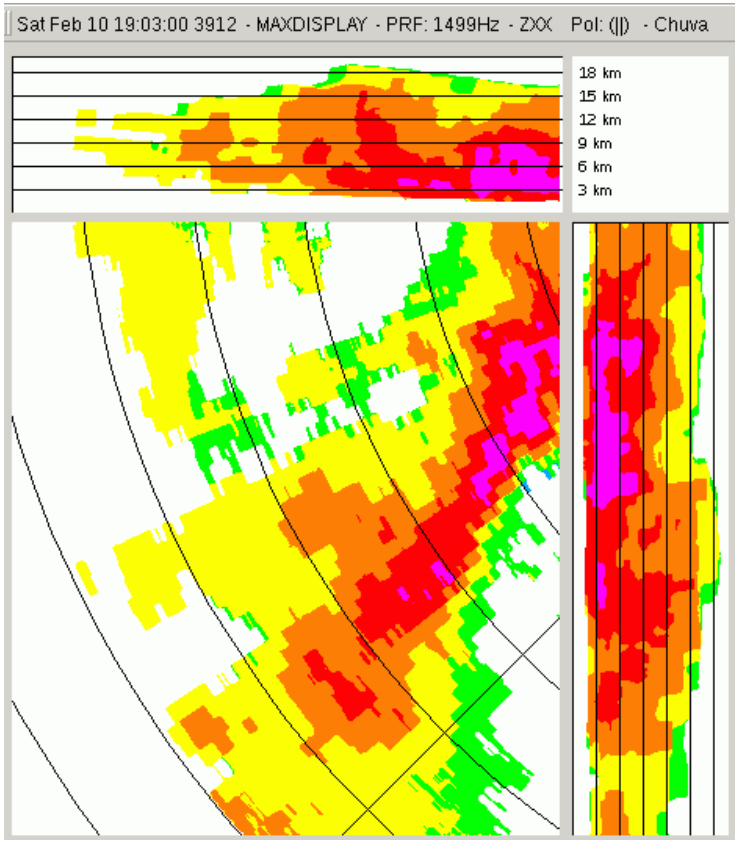
((lowest))

Case Studies
27 March 2012



Case Studies
10 Feb 2012





Case Studies
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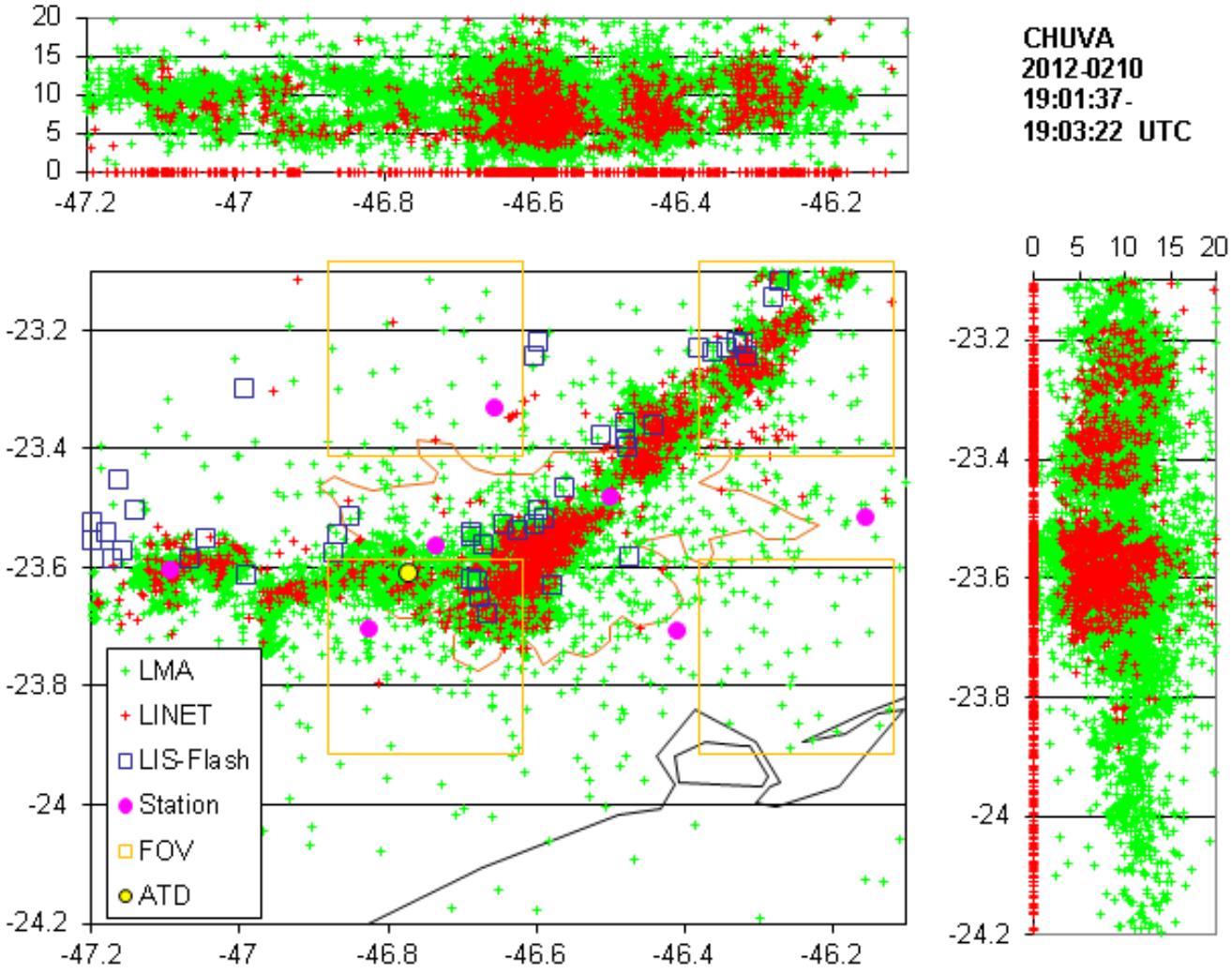
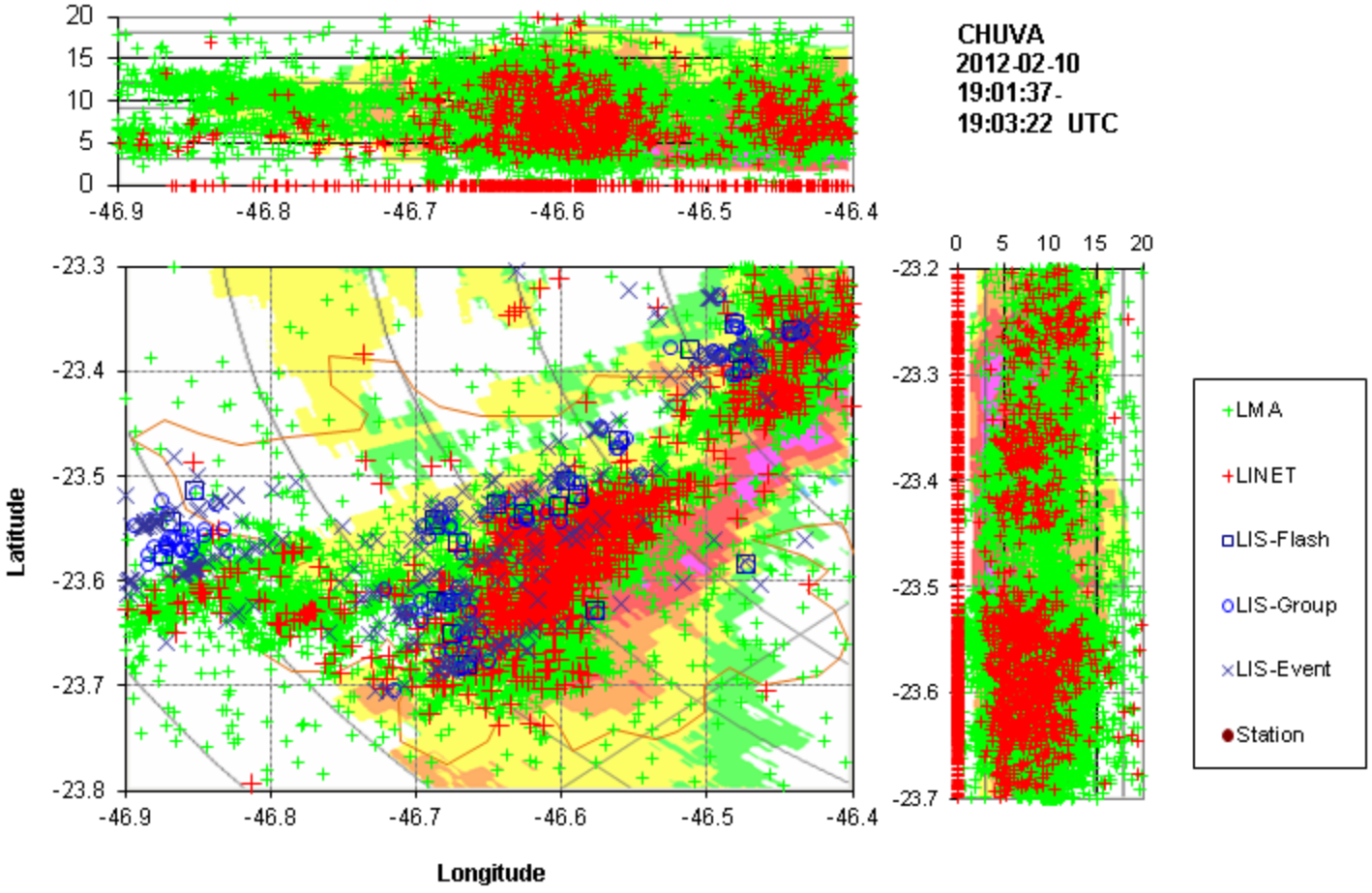
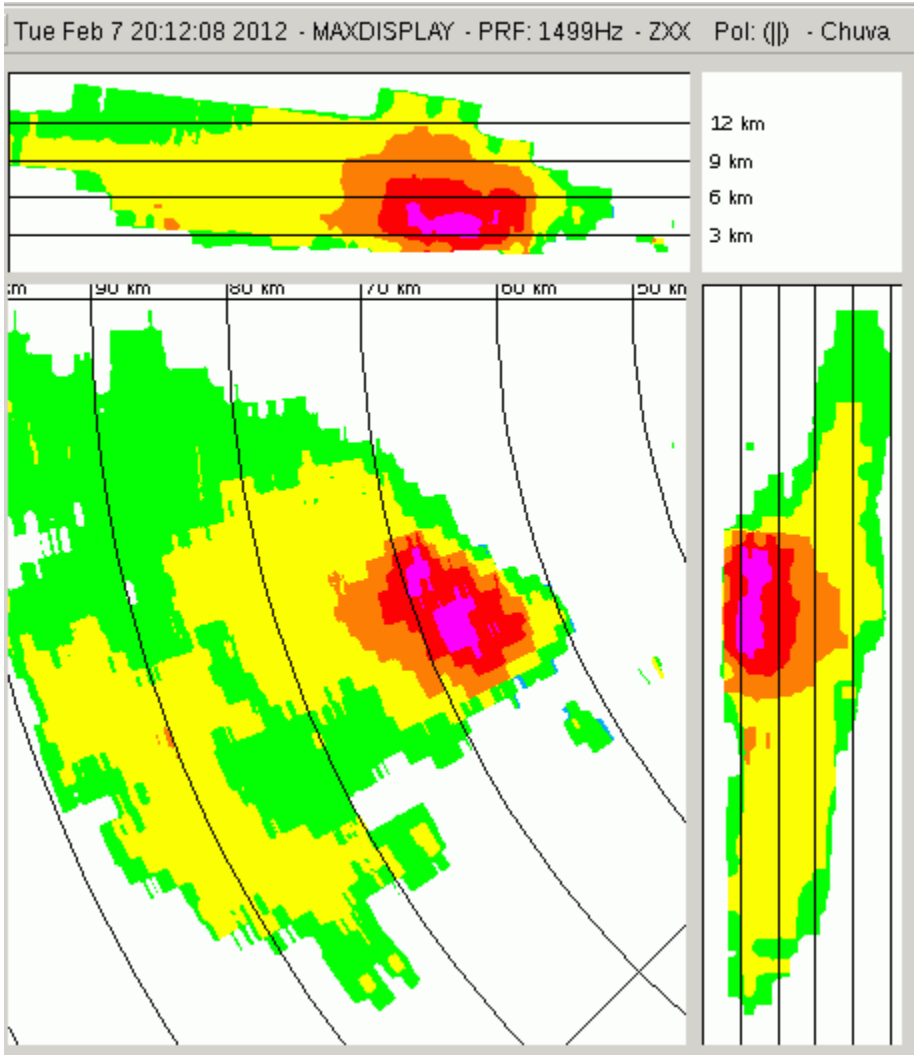


Case Studies
10 Feb 2012



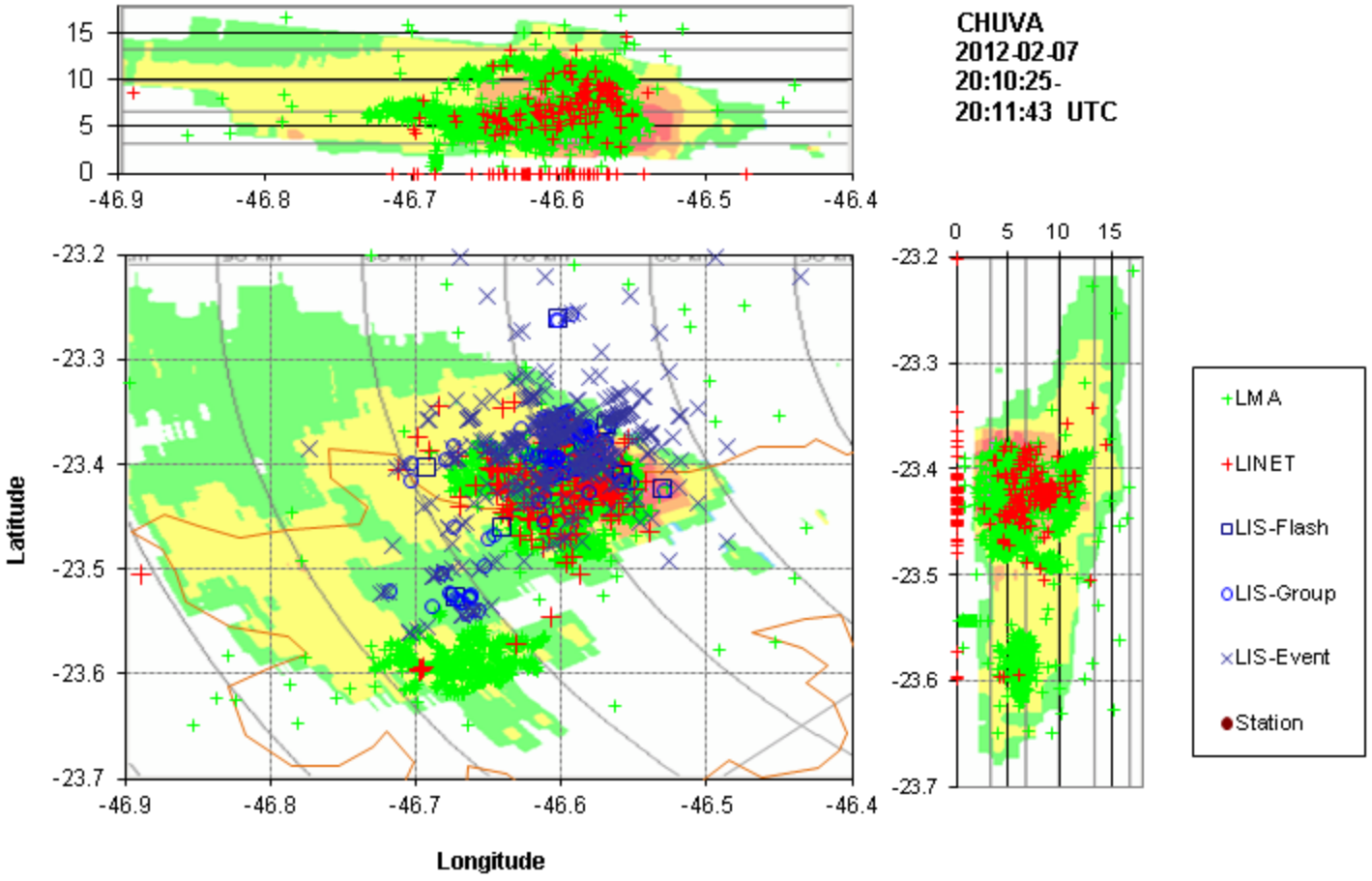
Case Studies
7 Feb 2012



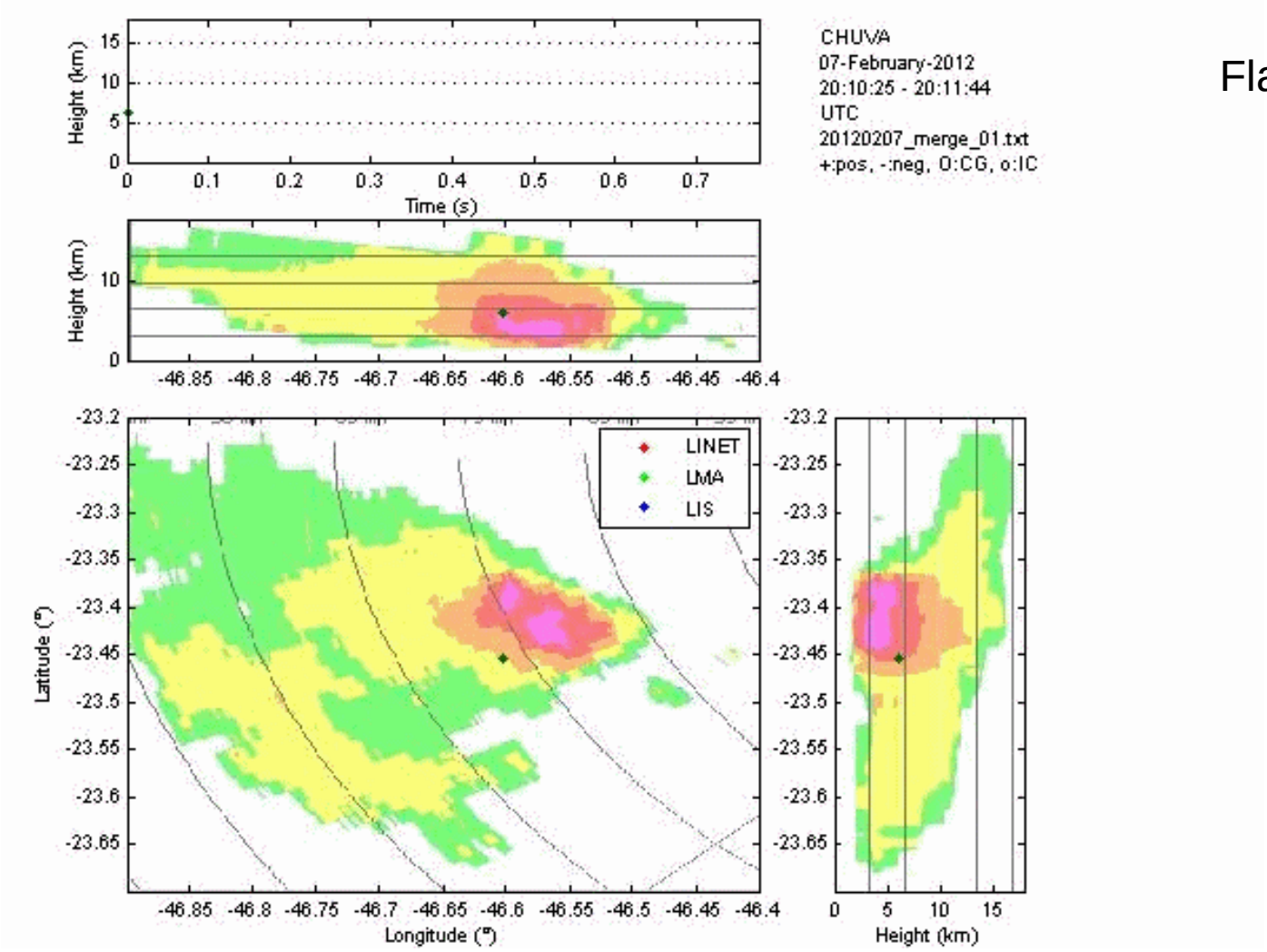
XPOL Radar

20:10 UTC

Case Studies
7 Feb 2012

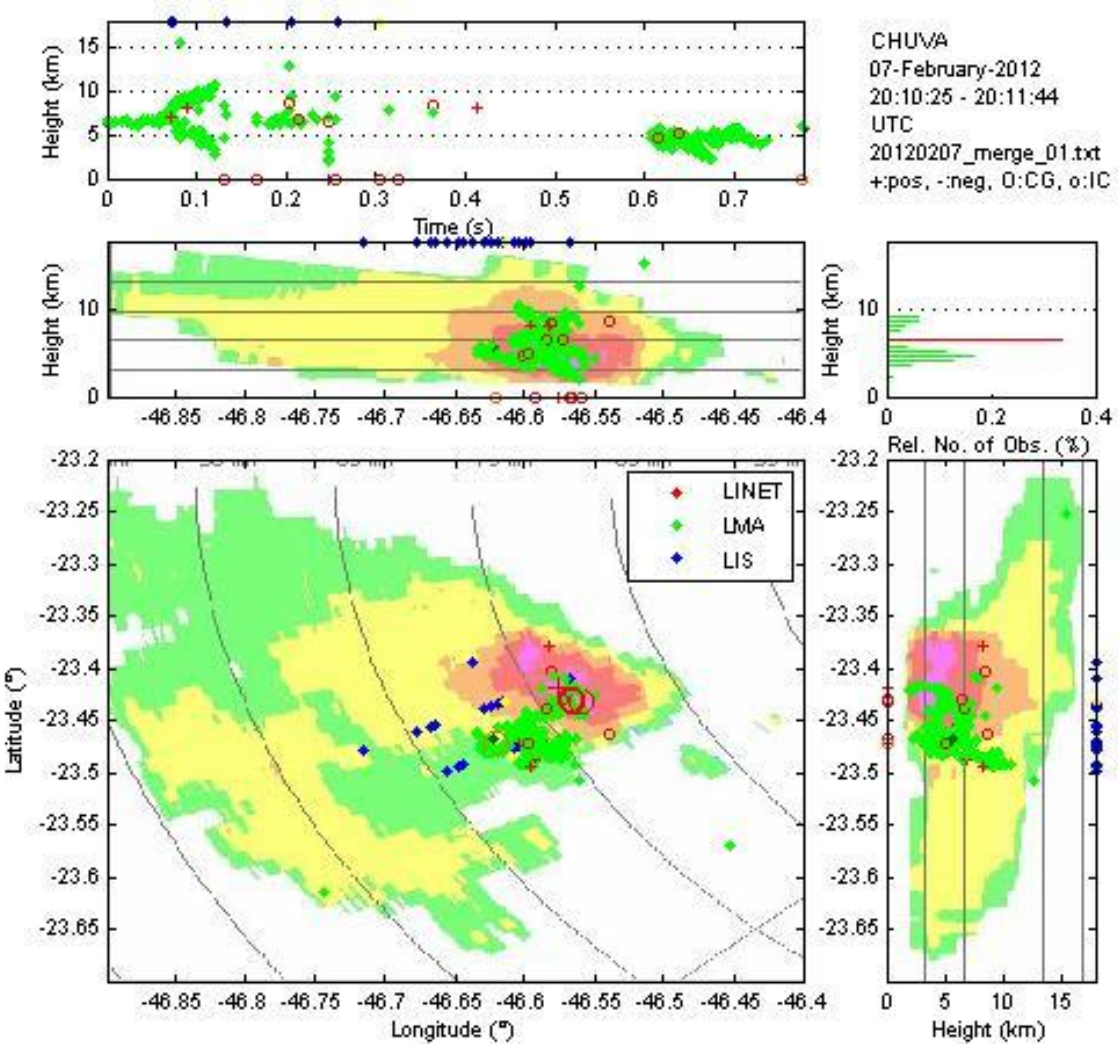


Case Studies
7 Feb 2012



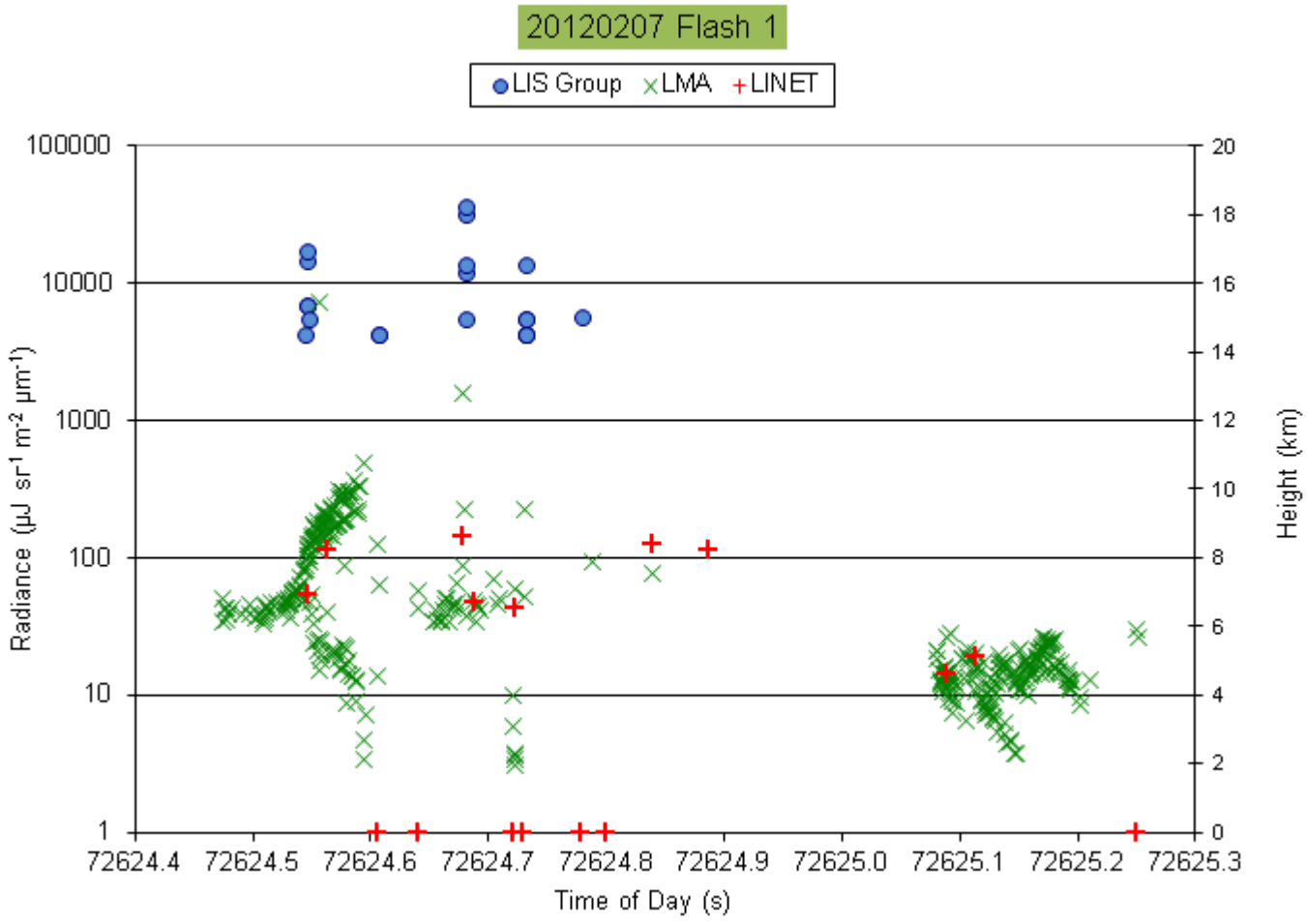
Flash 01

Case Studies
7 Feb 2012



Flash 01

Case Studies
7 Feb 2012



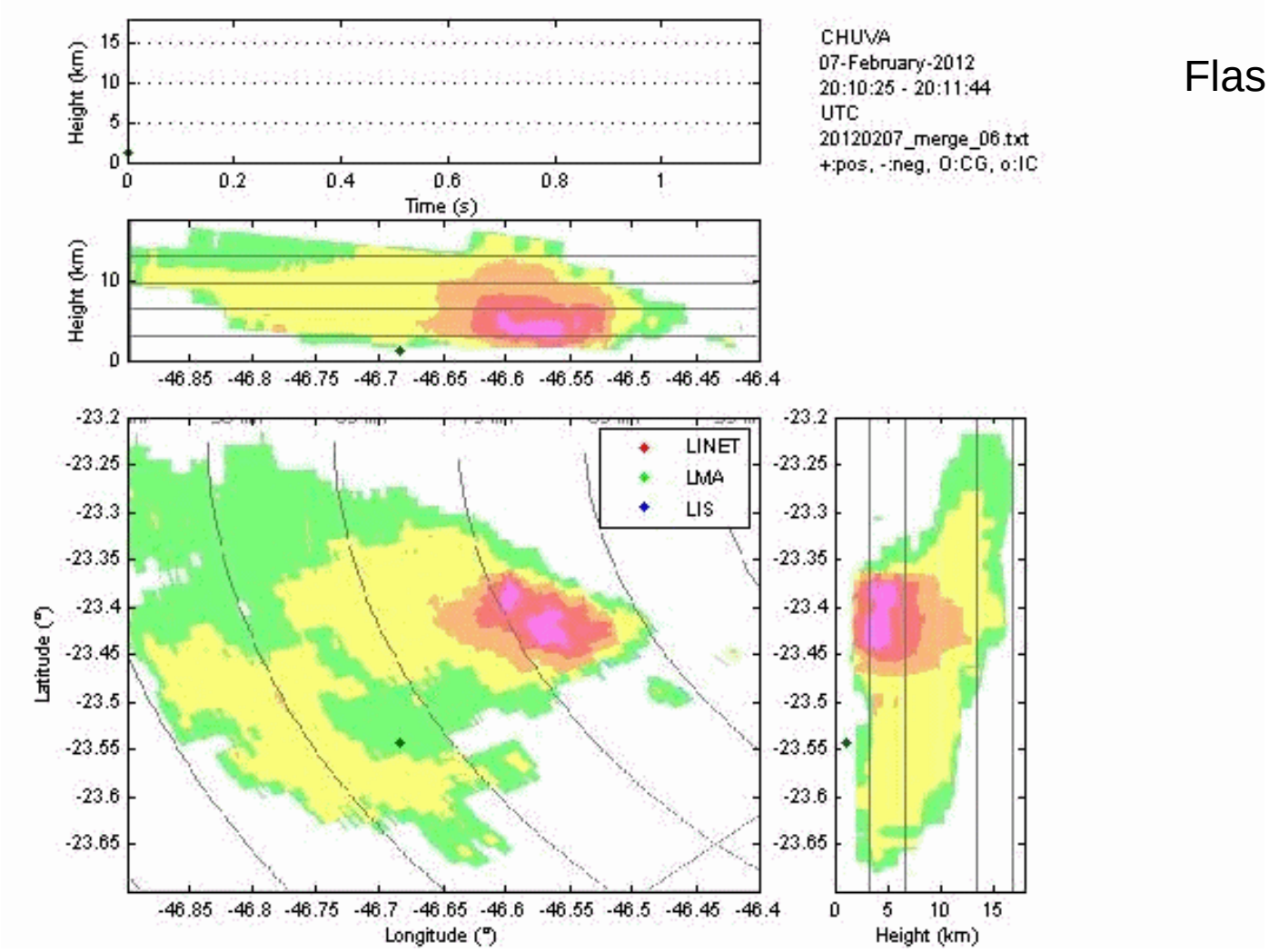
Flash 01

LIS group radiance

LMA and LINET source height

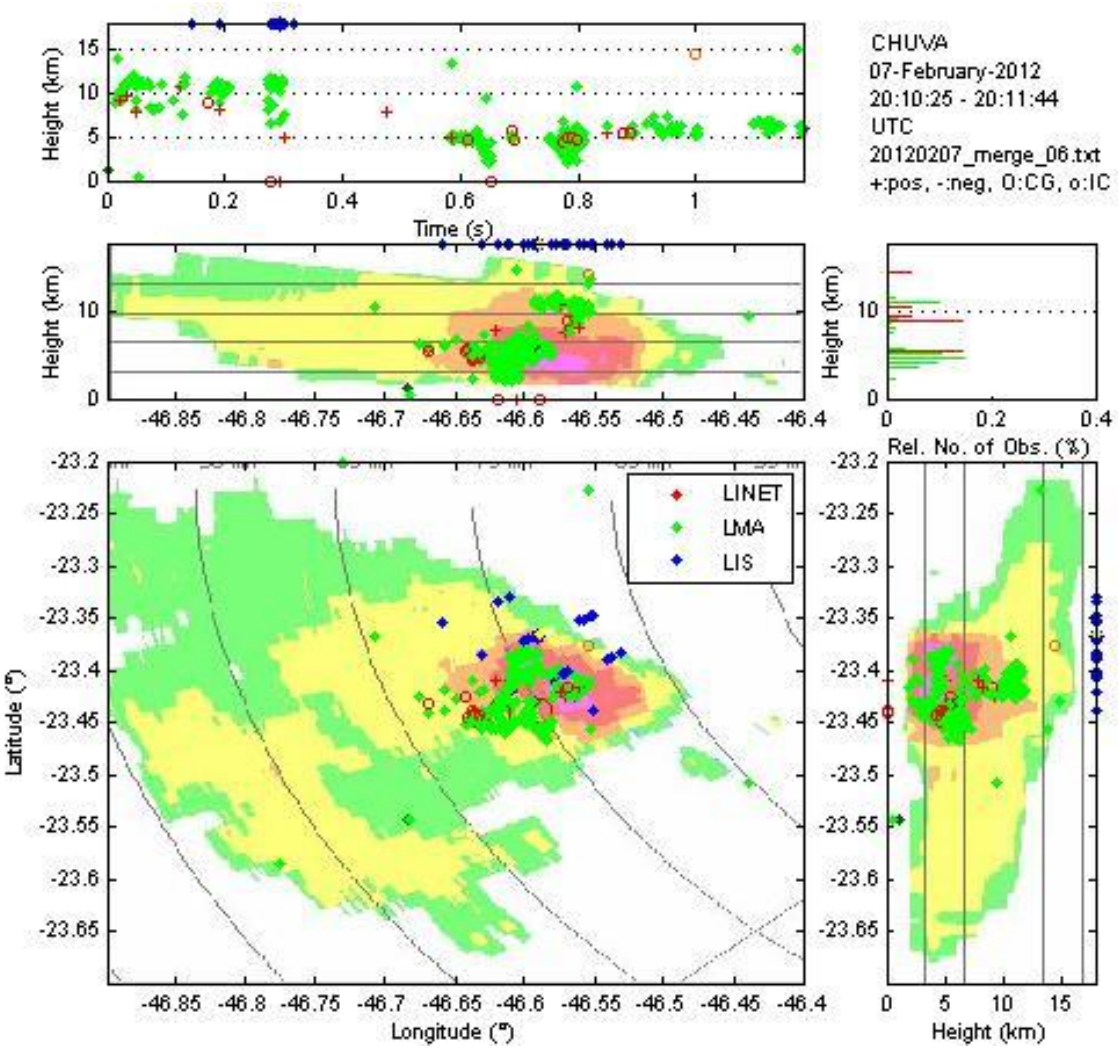
No optical signal from low level part of flash

Case Studies
7 Feb 2012



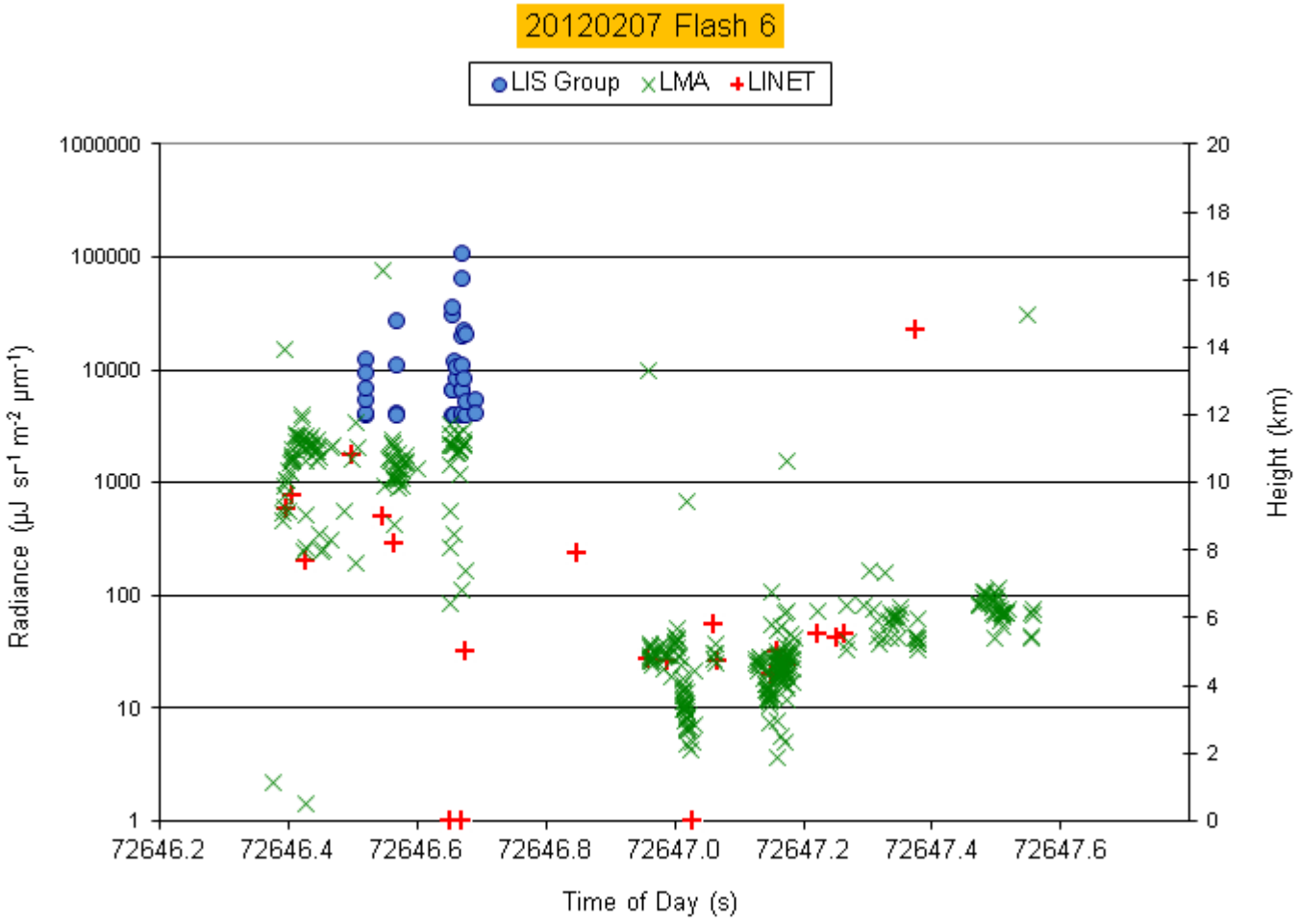
Flash 06

Case Studies
7 Feb 2012



Flash 06

Case Studies
7 Feb 2012



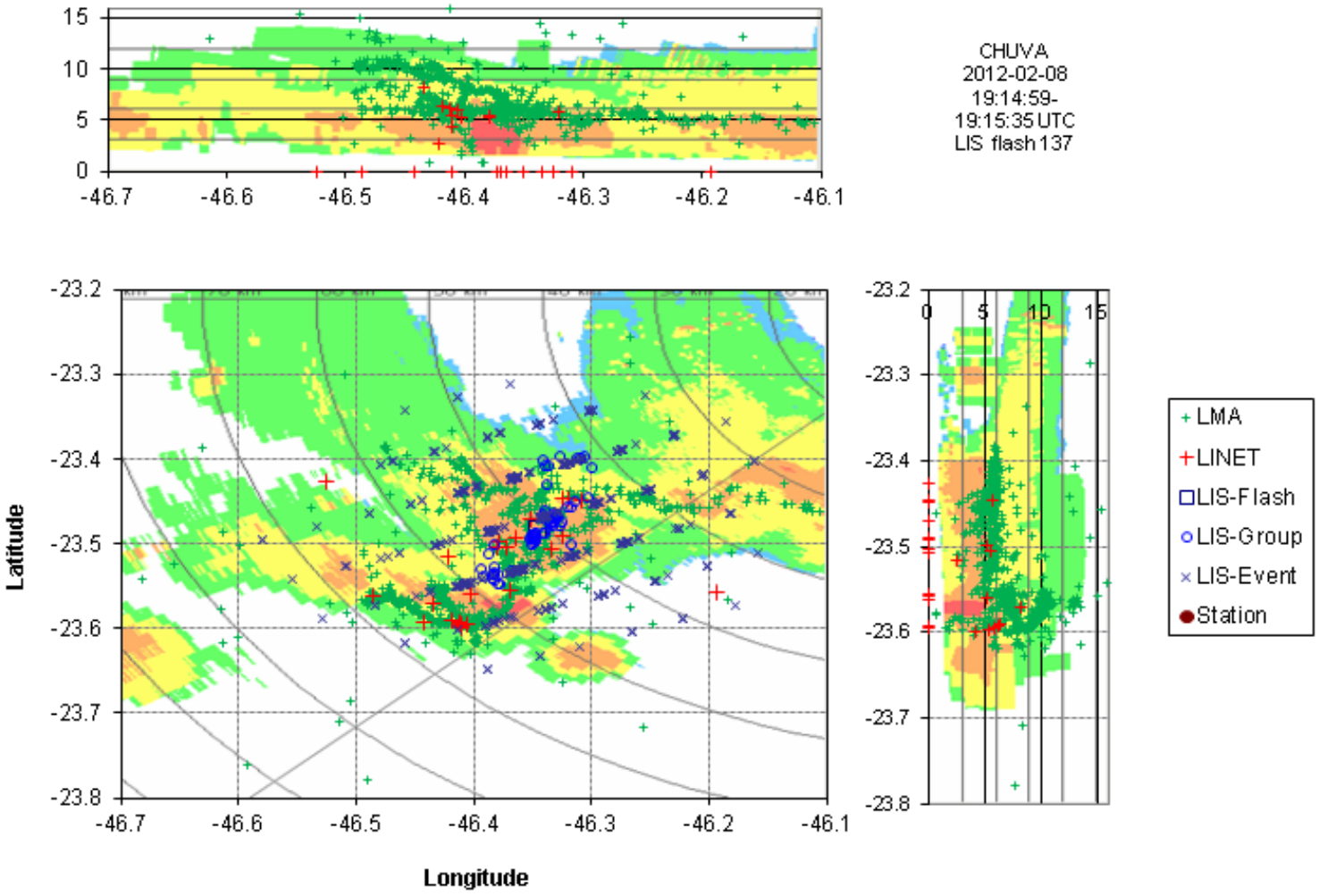
Flash 06

LIS group radiance

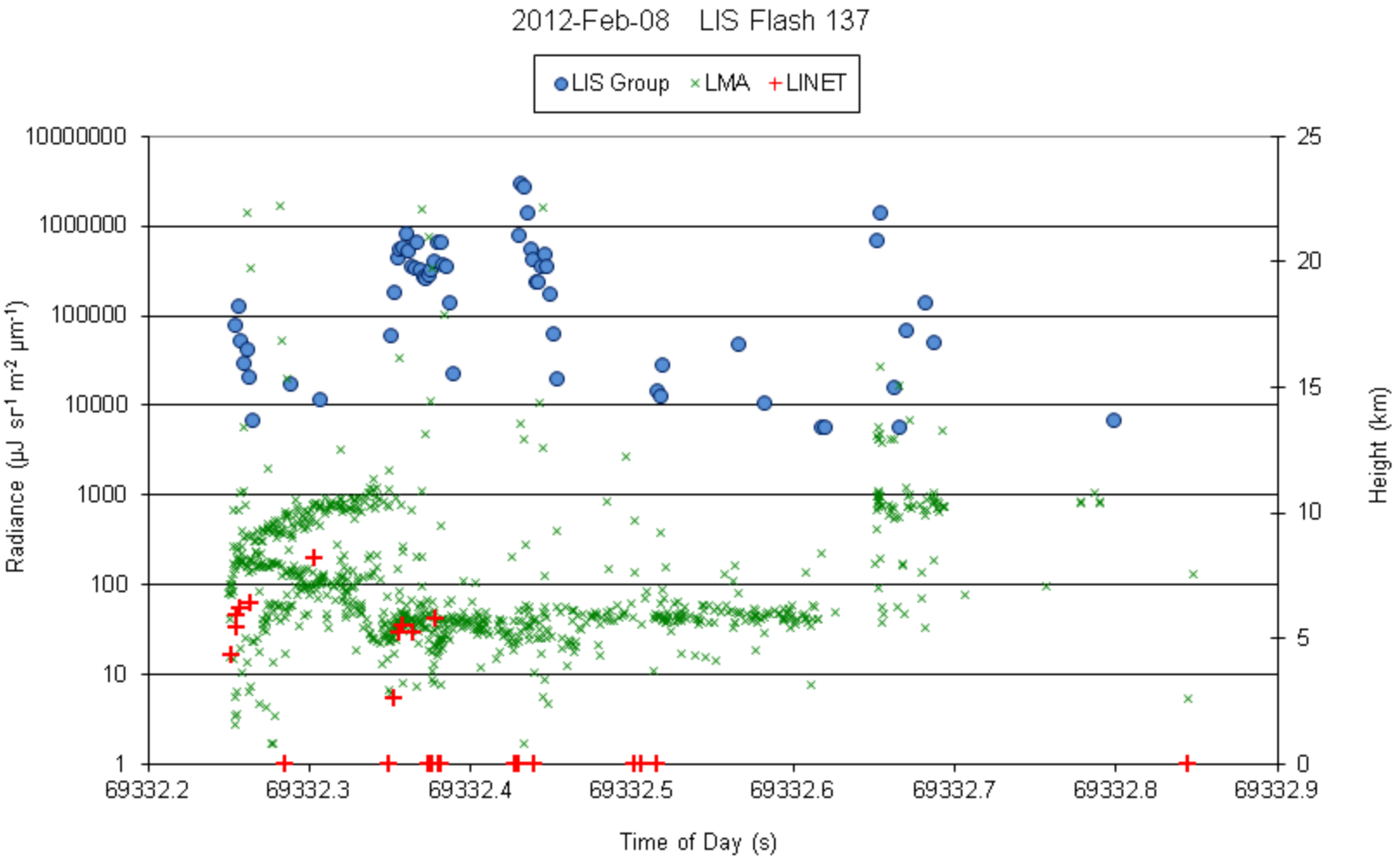
LMA and LINET source height

No optical signal from low level part of flash

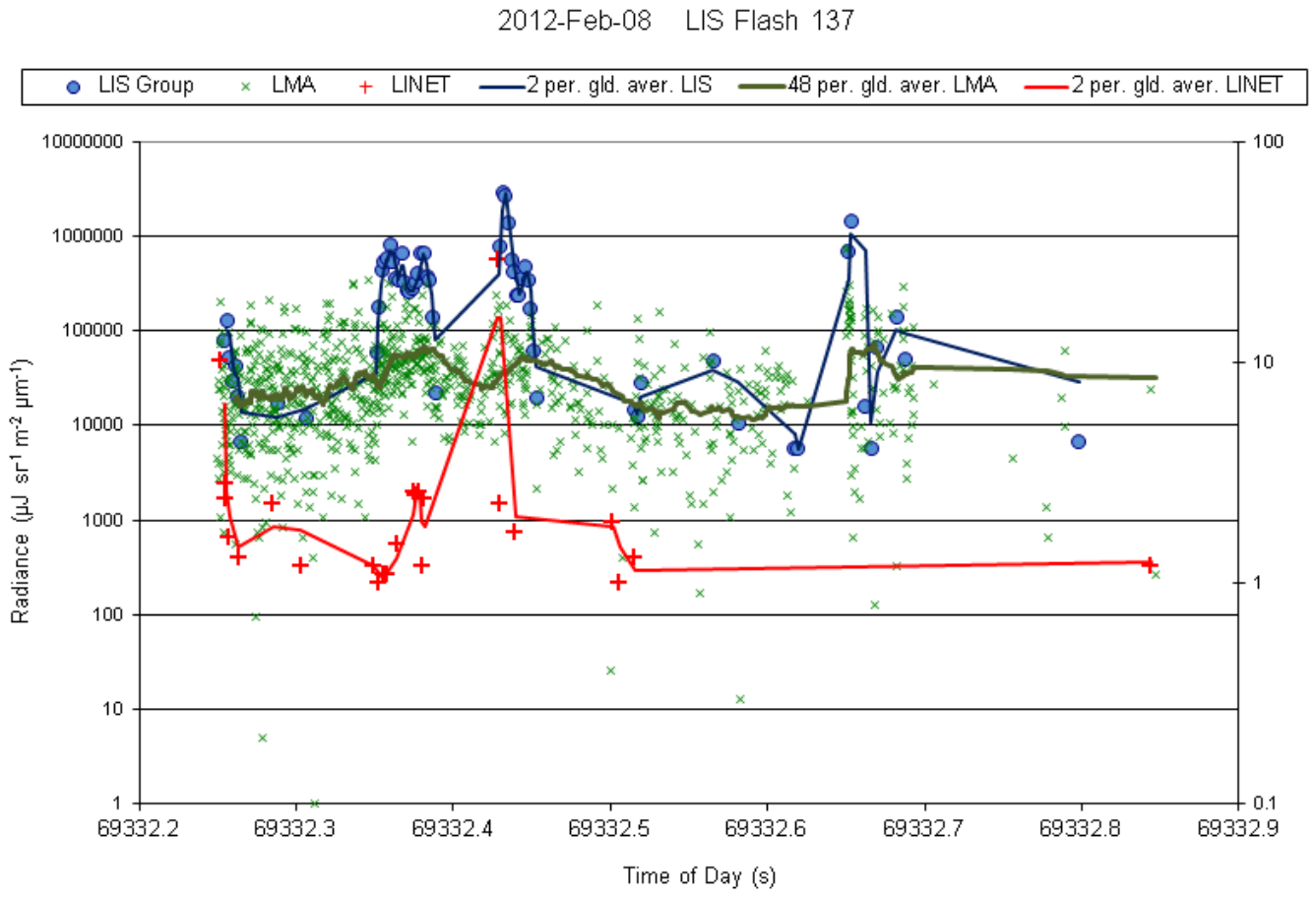
Case Studies
08 Feb 2012



Case Studies
08 Feb 2012



Case Studies
08 Feb 2012

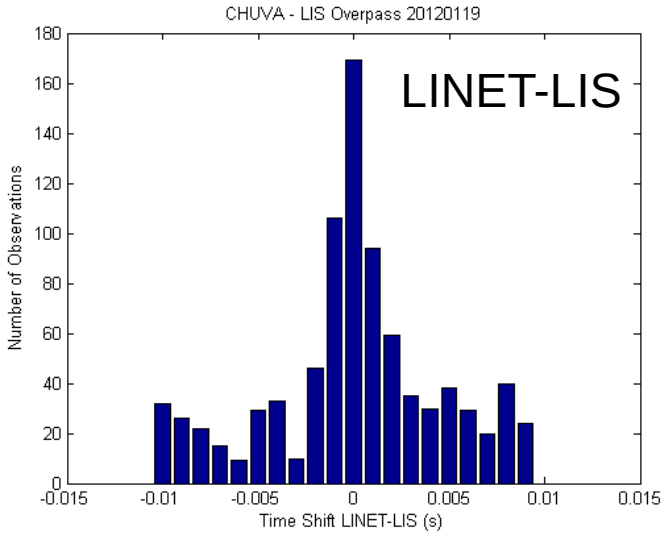


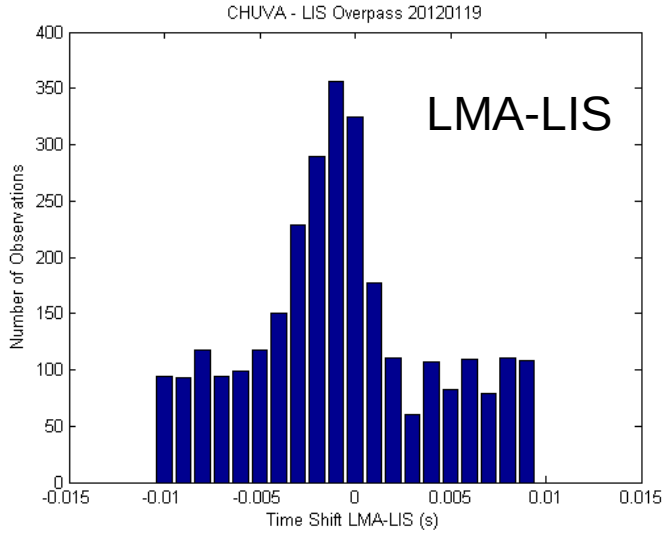
LIS Flash 137

LIS group radiance

LMA and LINET source strengths correlate to some extent

Case Studies
19 Jan 2012

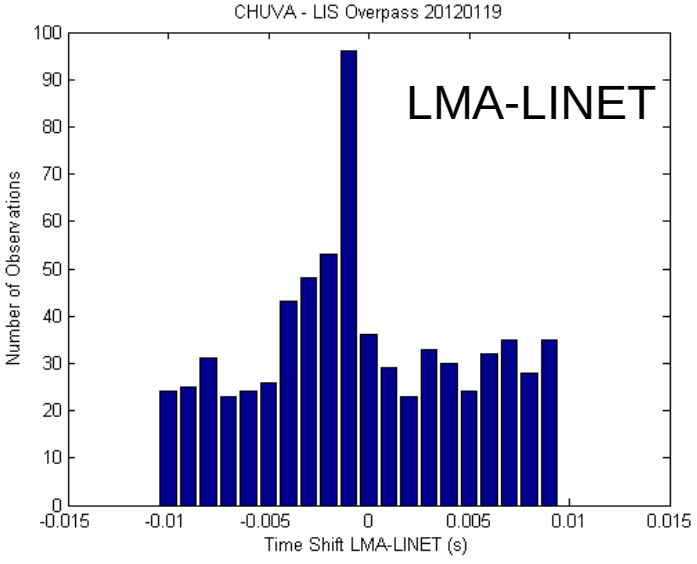




Time differences of closest signals

LMA followed by LINET and LIS

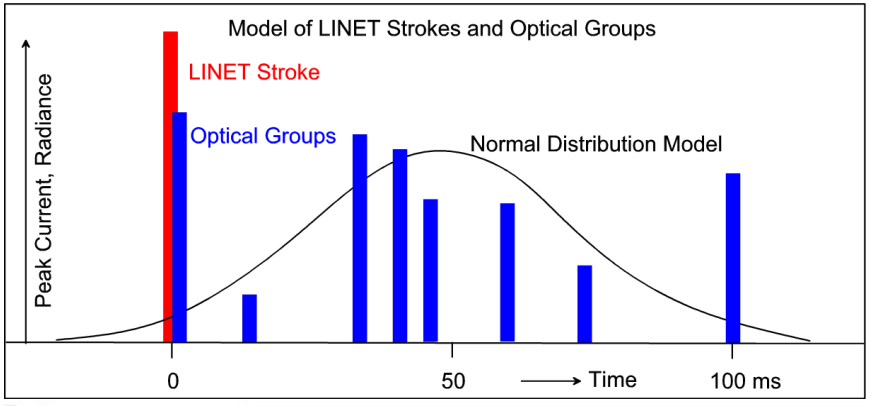
LINET and LIS correspond well



Modeling of MTG-LI Optical Signals
Model Strategy

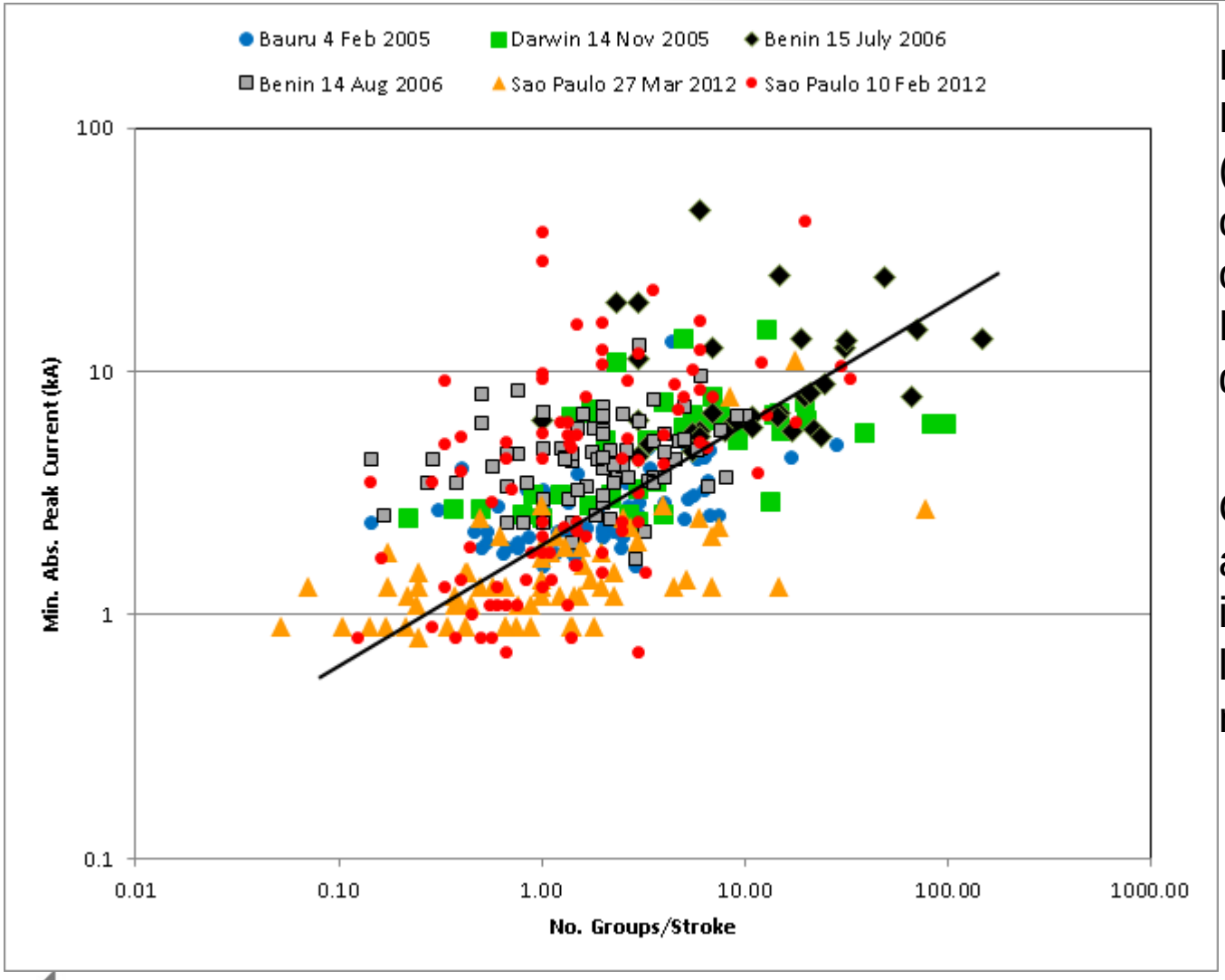
Transformation of LINET RF stroke data into optical groups by a 2-step process:

- Model of cloud top optical emission
  - Number of optical flashes equals number of LINET flashes
  - One direct coincident optical group per LINET stroke
  - Distribution of additional optical groups per LINET flash 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

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

Summary and Conclusions (1)

- CHUVA lightning campaign was very successful with respect to the objectives
  - 7 months (Oct 2011 – April 2012) of lightning data available for analysis complemented by XPOL radar data
  - 4-6 good cases with LIS overpasses of the inner network area (more than 20 cases in a wider area)
- 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

Summary and Conclusions (2)

- 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)
- 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