Lightning Mapping Observations: An Update

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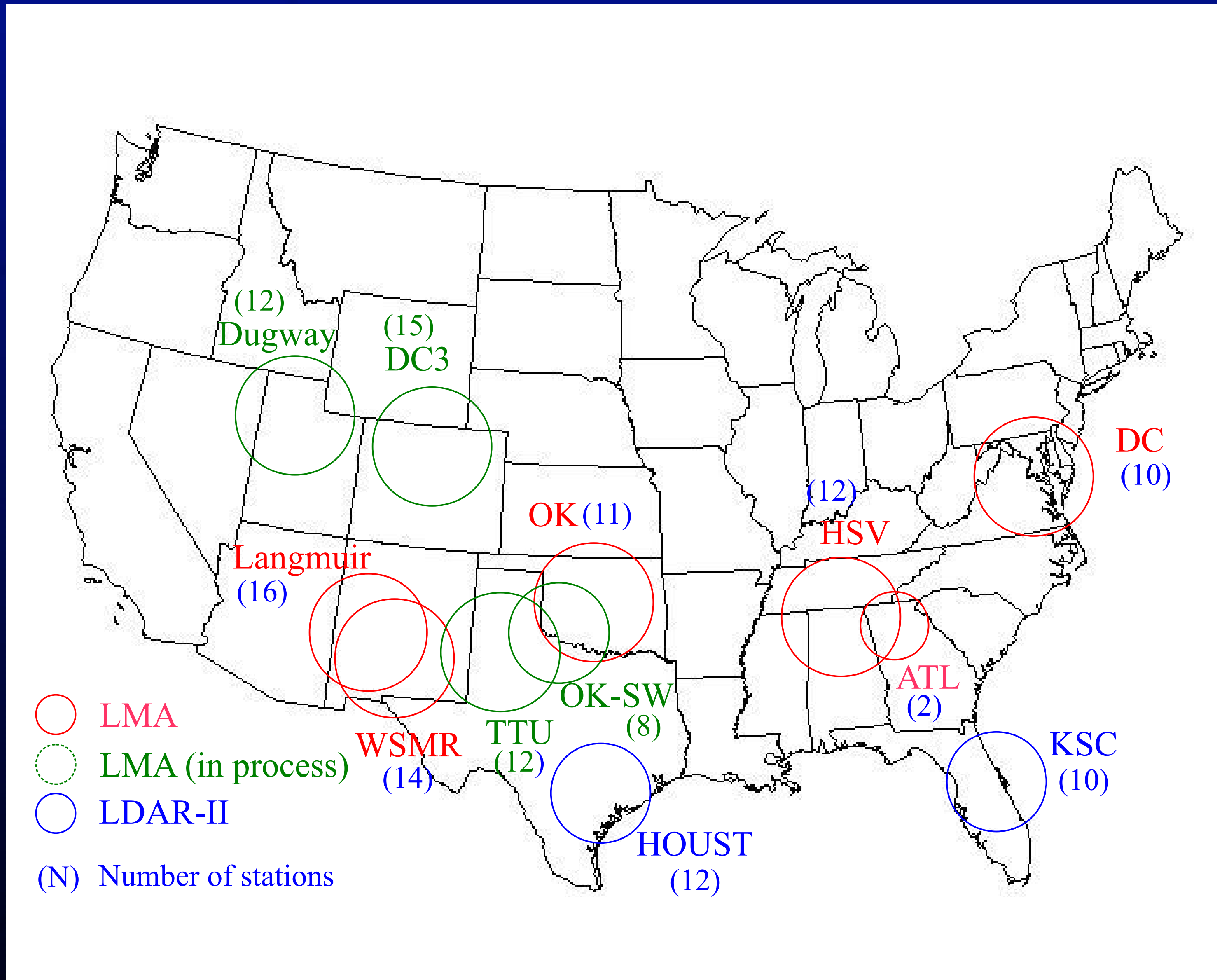
Southern Thunder 2011
11-14 July, Norman OK

VHF Time-Of-Arrival Total Lightning Mapping Networks



Recent LMA Developments

- Stations becoming successively more compact and readily deployed.
- New “solar” electronics design: RF-sealed, no cooling required, VHF antenna close to electronics, solar or a.c. powered (Langmuir Laboratory, Texas Tech LMAs).
- Nearing completion of an operational version of “LiveLMA” (second-by-second updates – Harald Edens)
- Significantly increased network sensitivities:
  - Solar operation allows station deployment in RF-quiet locations,
  - Conversion to digital TV has taken many VHF channels off the air into UHF (e.g., Channel 3, 60-66 MHz).
- Good news: It looks like resulting Channel 3,4 spectral 'whitespace' will be retained and not go away.
- DC3 project (May-June 2012): LMA network will use cell phone data links, making real-time communications and data processing relatively easy.h
- Development of a high-quality lightning electric field change recording system ('slow antenna'; Bill Rison)

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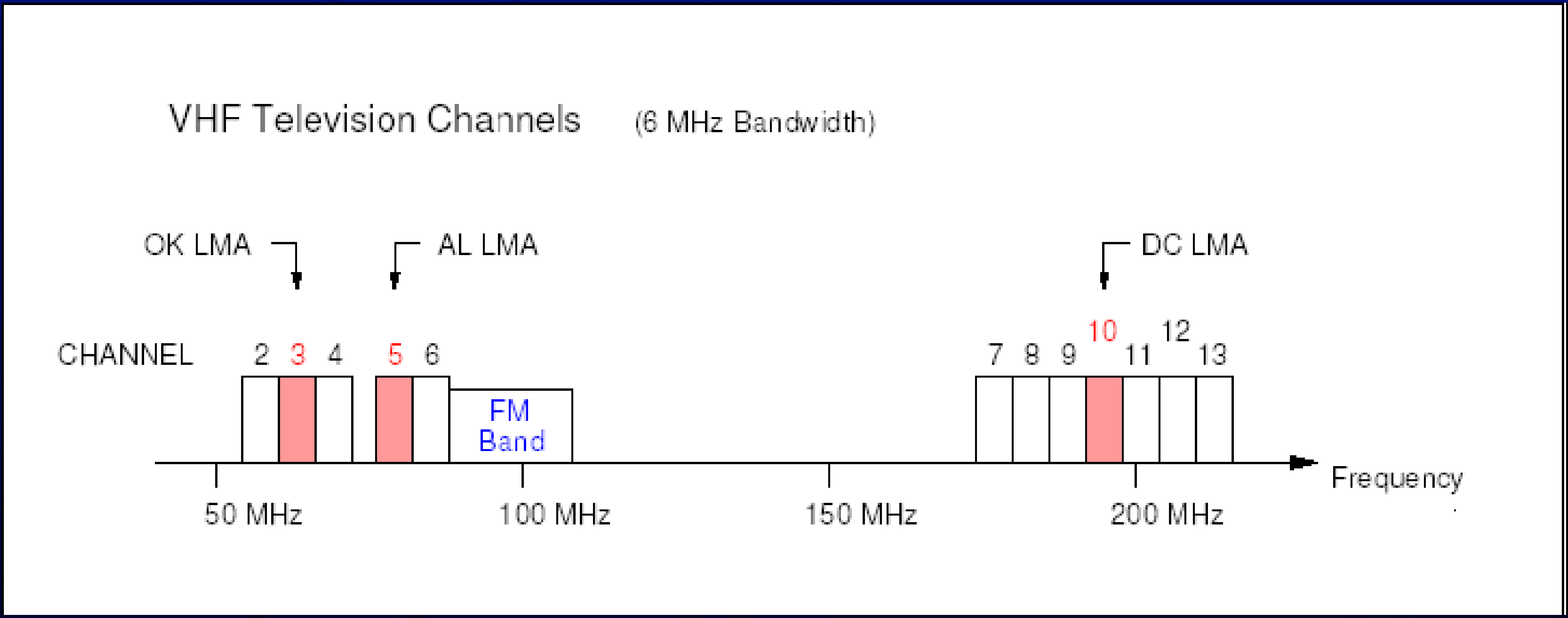
VHF Frequency Spectrum



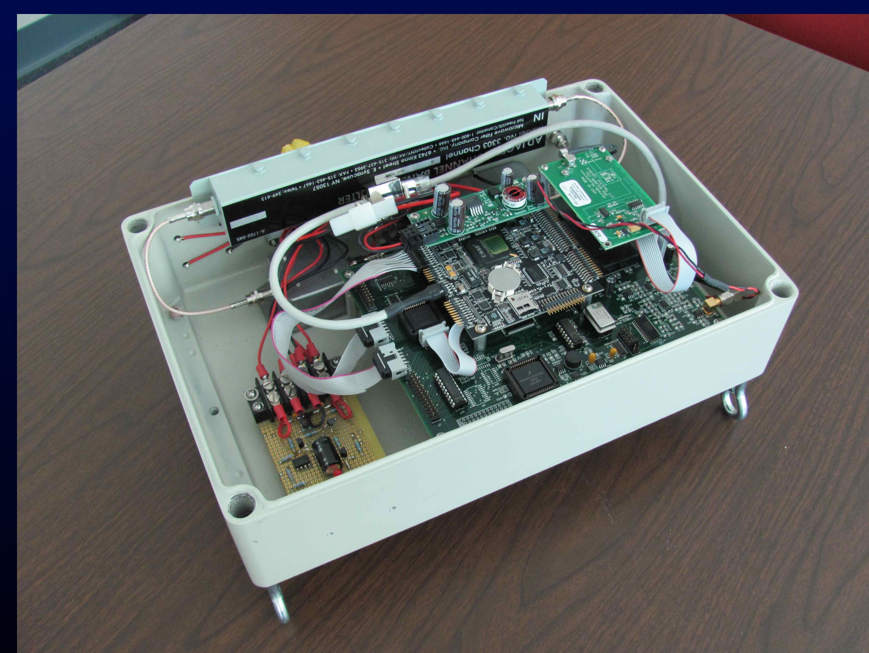
LMA stations 'listen' on a locally unused TV channel (e.g., Ch. 3)

Langmuir Laboratory Solar LMA

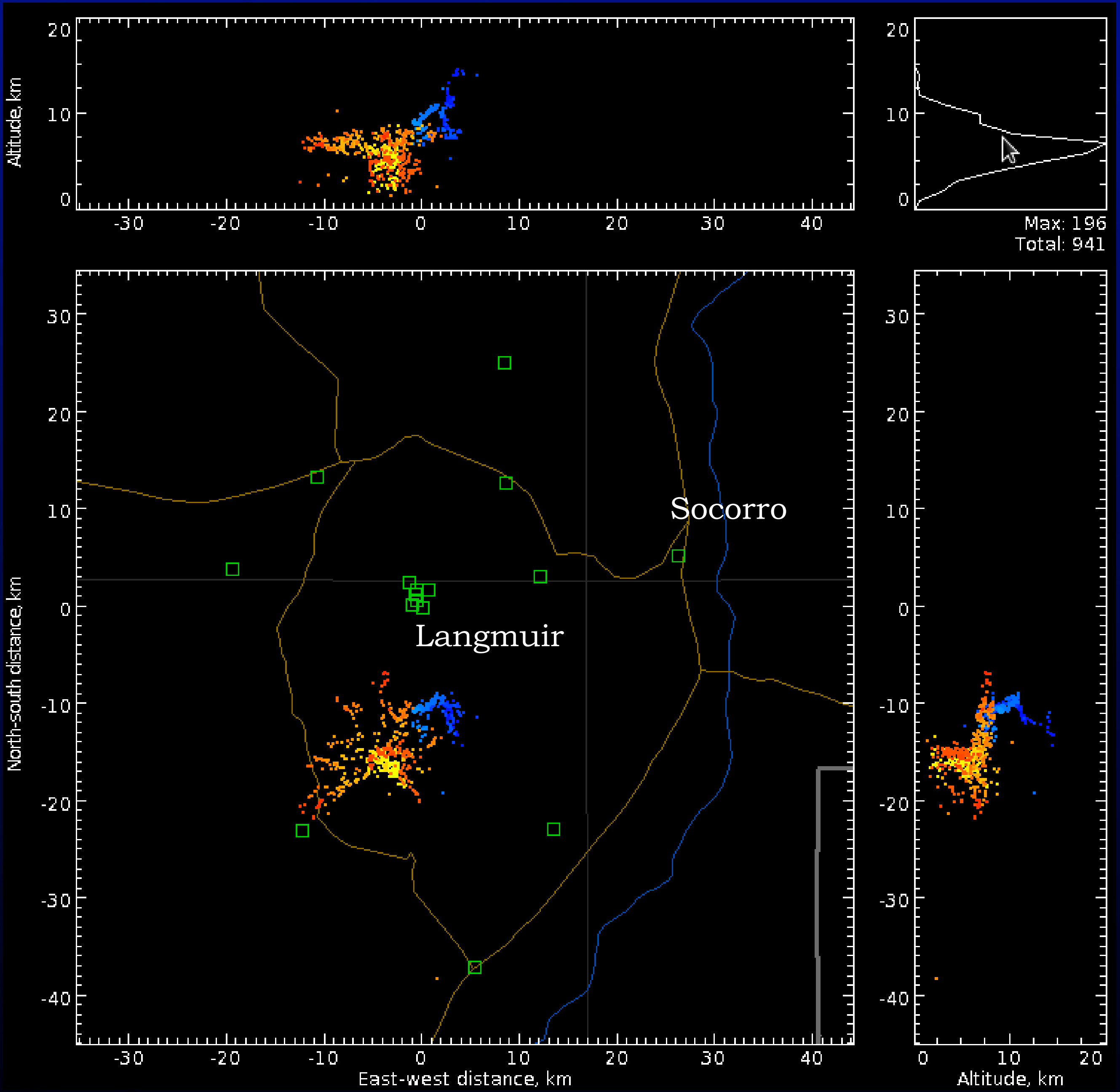
Solar-powered station

- 16 station network, most sensitive LMA
- Low station thresholds due to RF-quiet environment
- See individual lightning discharges in excellent detail.

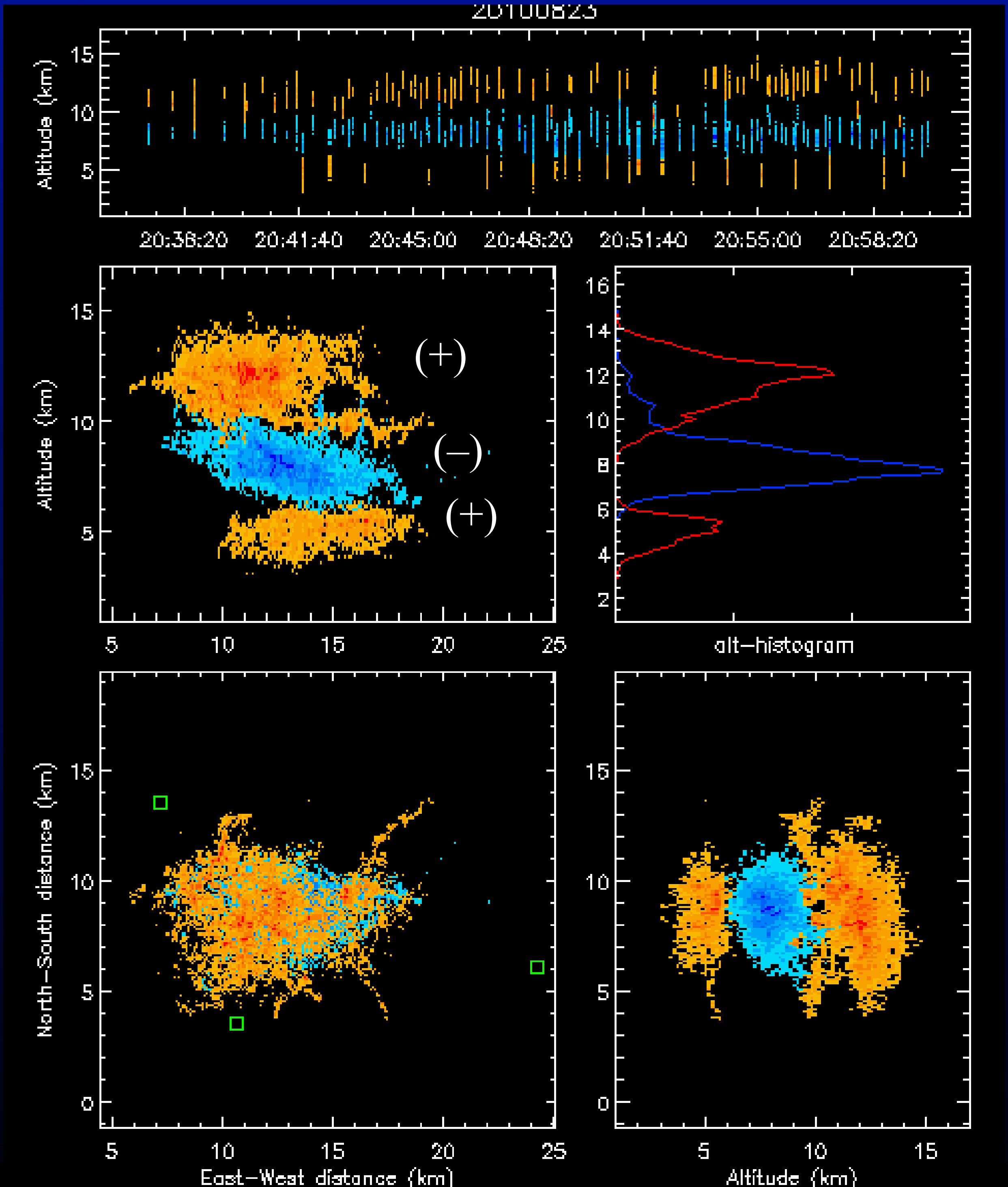
Electronics package



Langmuir Laboratory LMA



August 23, 2010 Langmuir storm

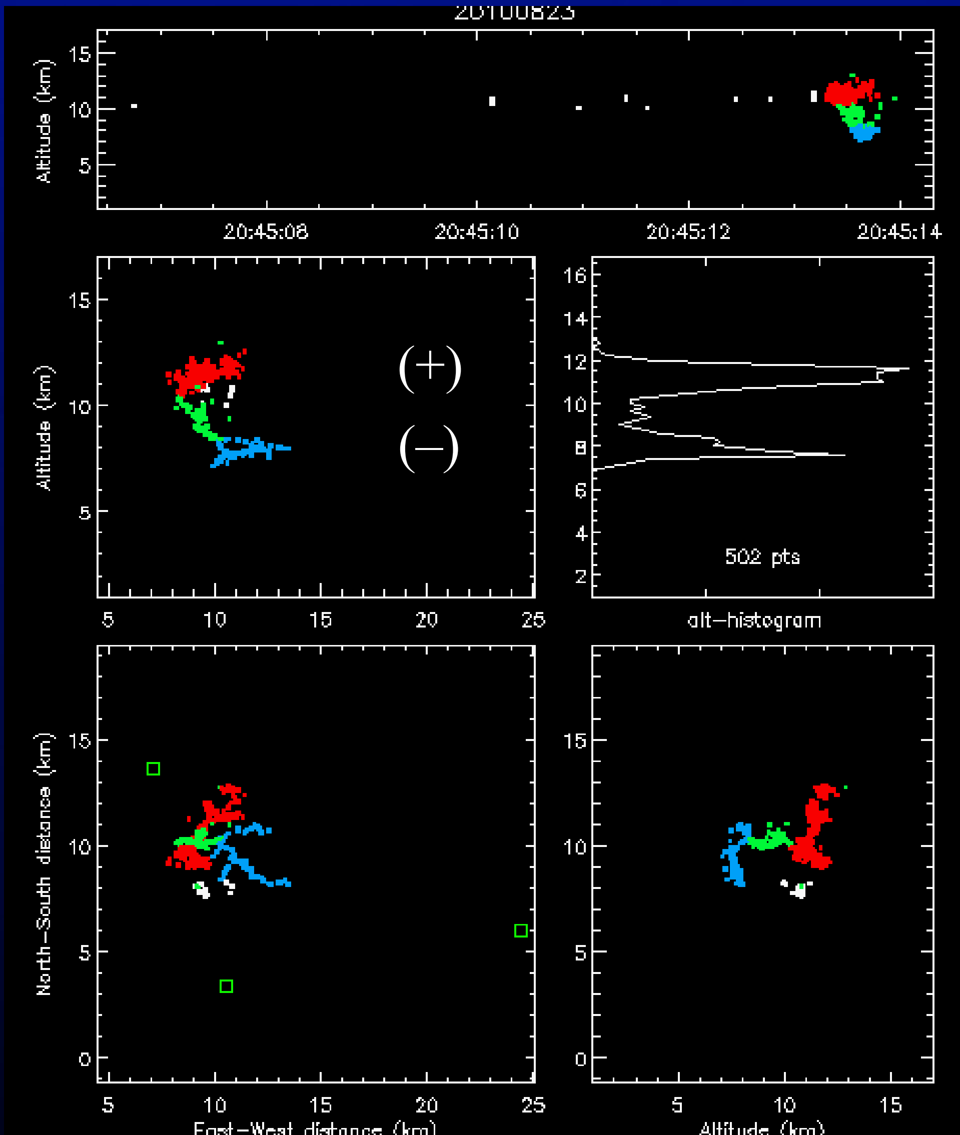


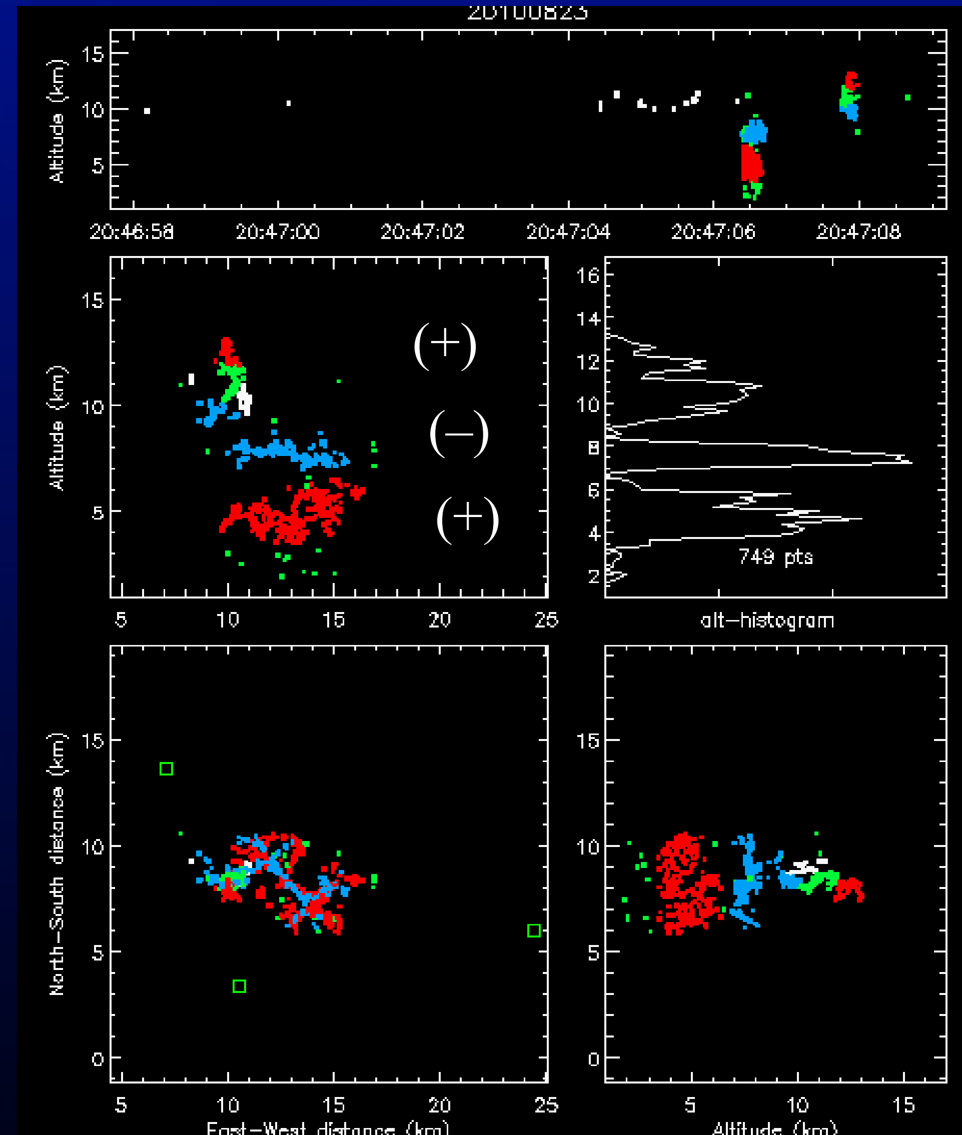
- Initial 24 minutes of activity.
- Lightning-inferred electrical charge structure of the storm.
- Classic, normal-polarity tripolar charge structure.
- Orange = (+), blue = (–).
- Several bolt-from-the-blue (BFB) flashes

LMA working beautifully: 16 stations, all solar-powered with low local noise; distant Ch 3 TV transmitters decommissioned. Very sensitive network.

Precursor activity

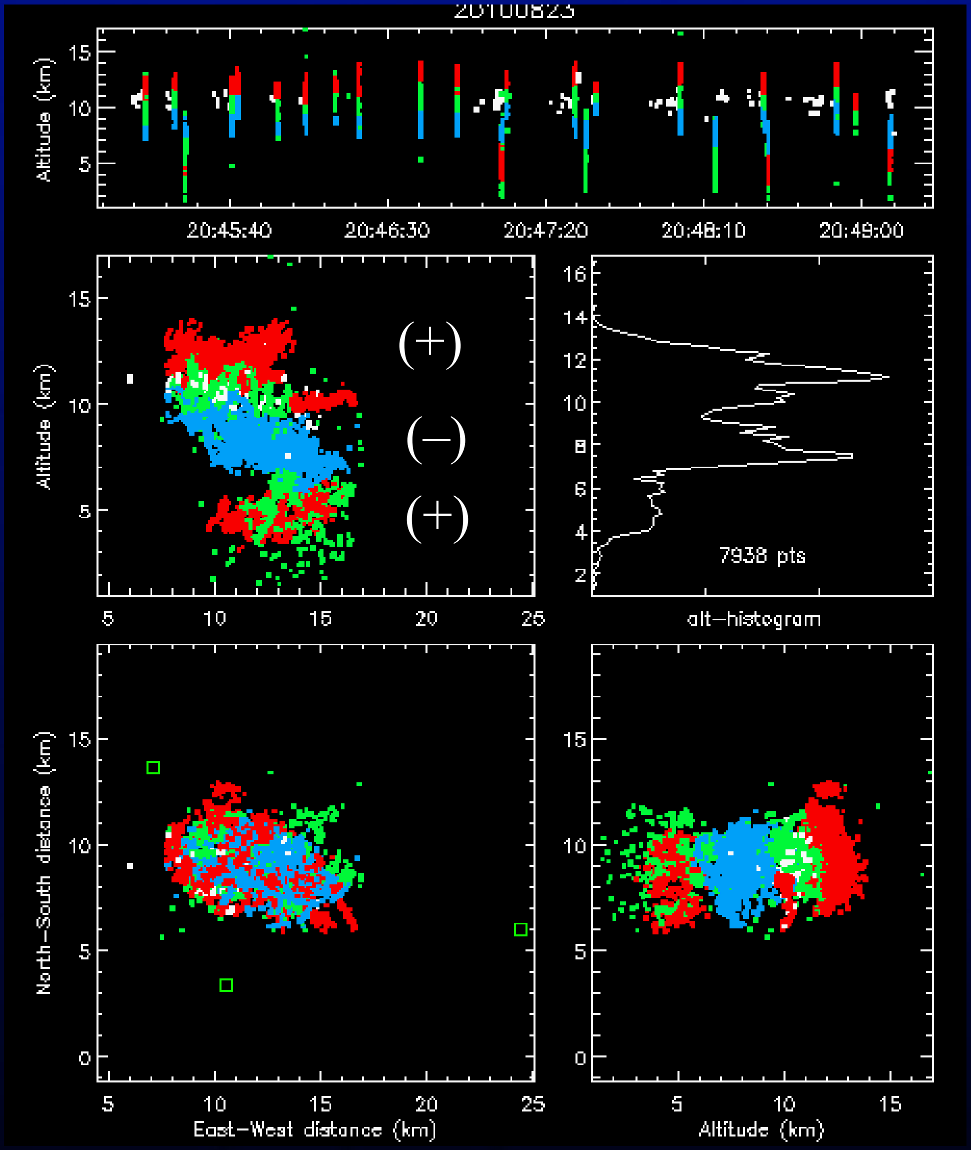
Repeated breakdown events, beginning several seconds prior to IC flashes

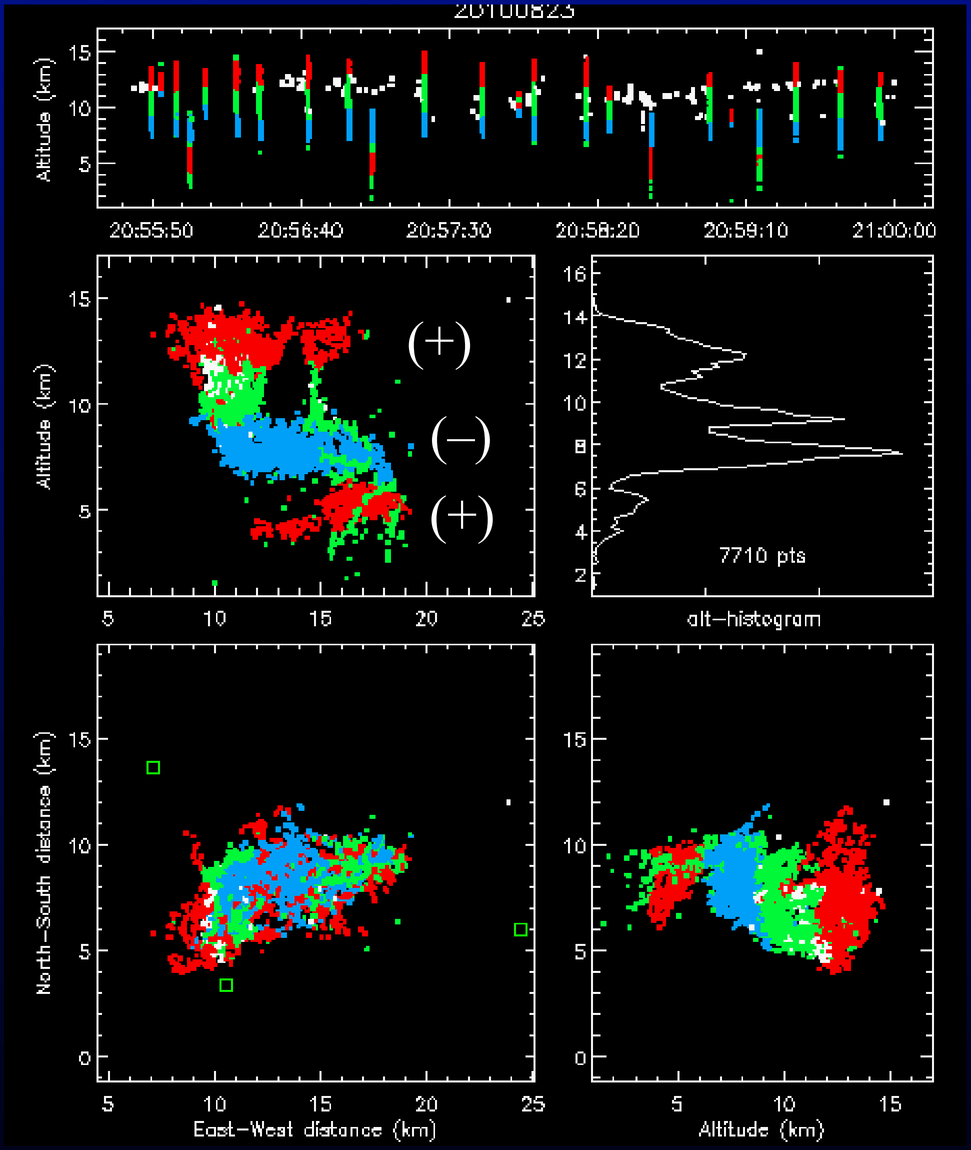




Precursor activity

White sources; very weak (10 mW);
seen due to increased sensitivity





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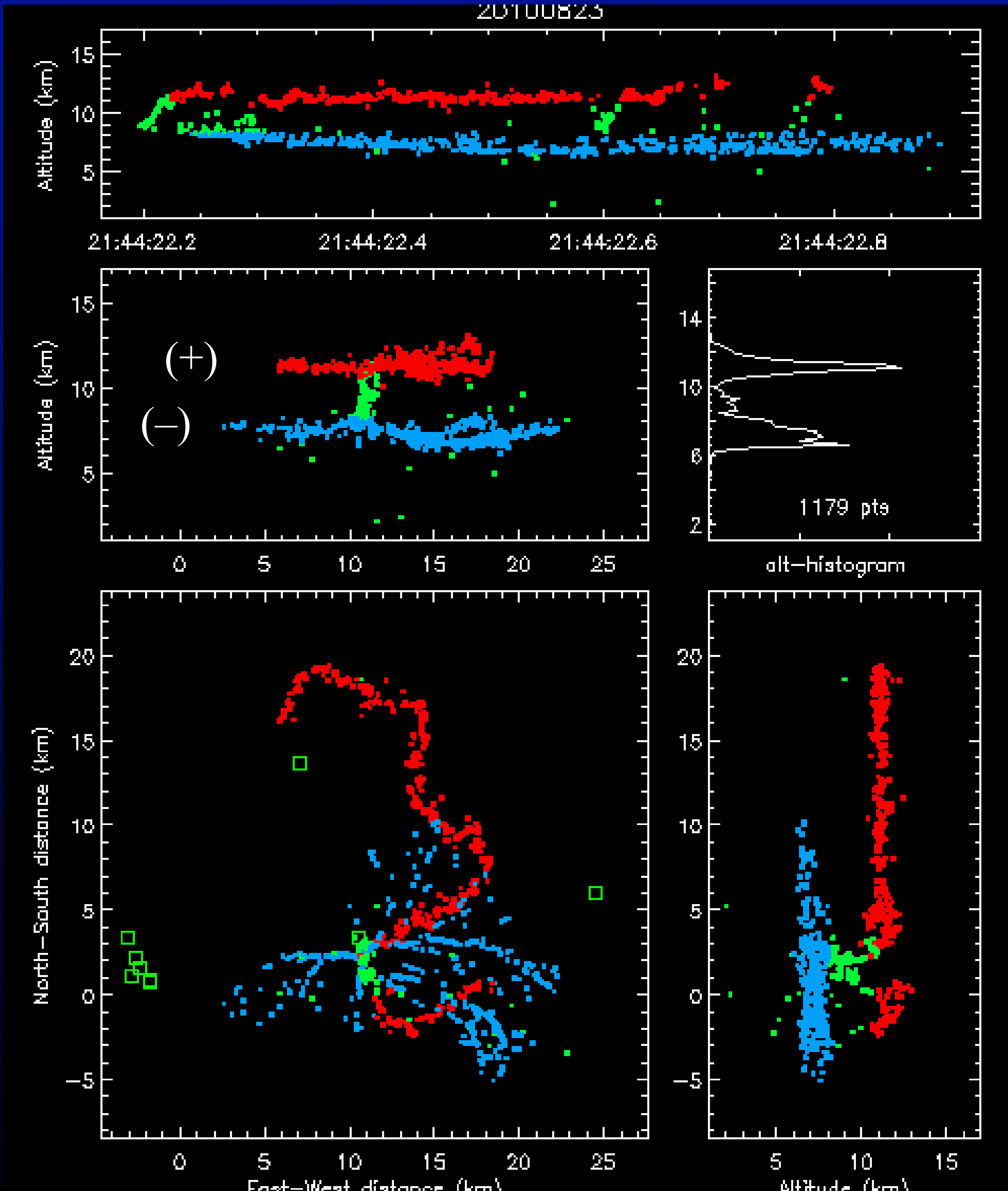
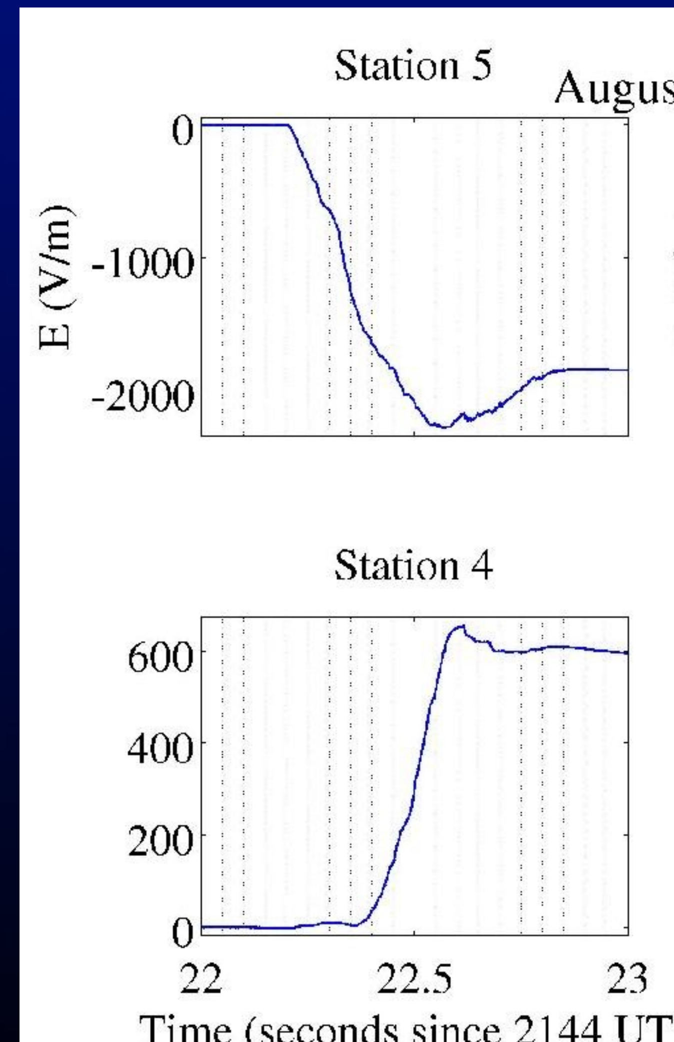
Bi-level intracloud flash

- Negative leader: ~ 6 x 10^4 m/s
- Positive leaders: ~ 2 x 10^4 m/s





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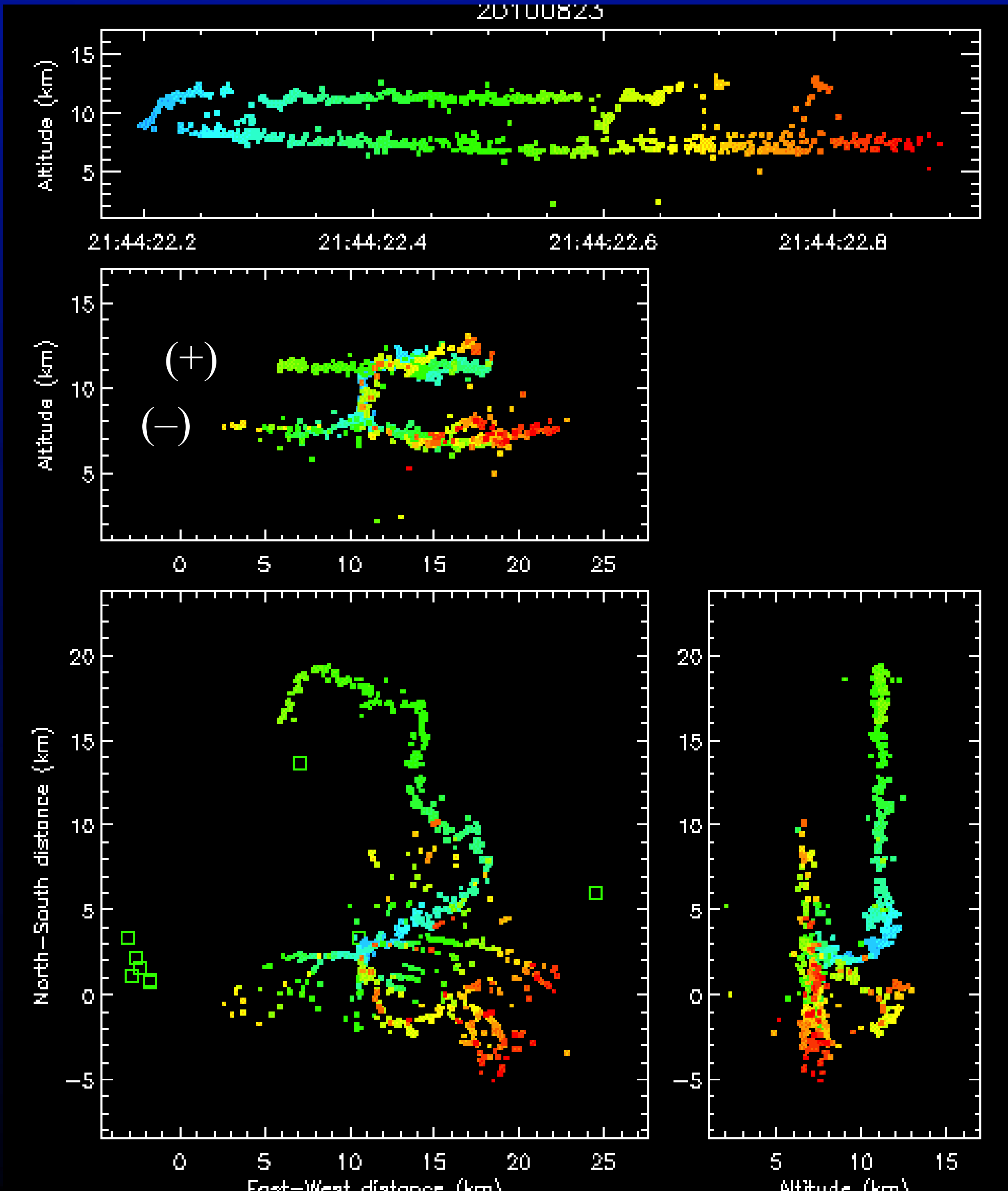
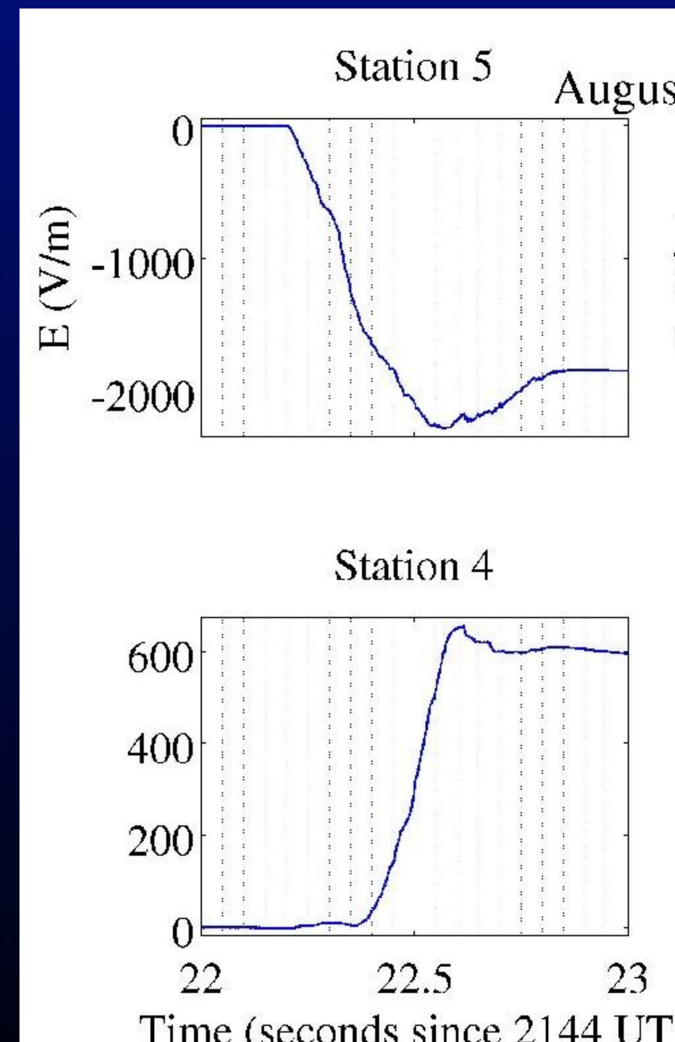
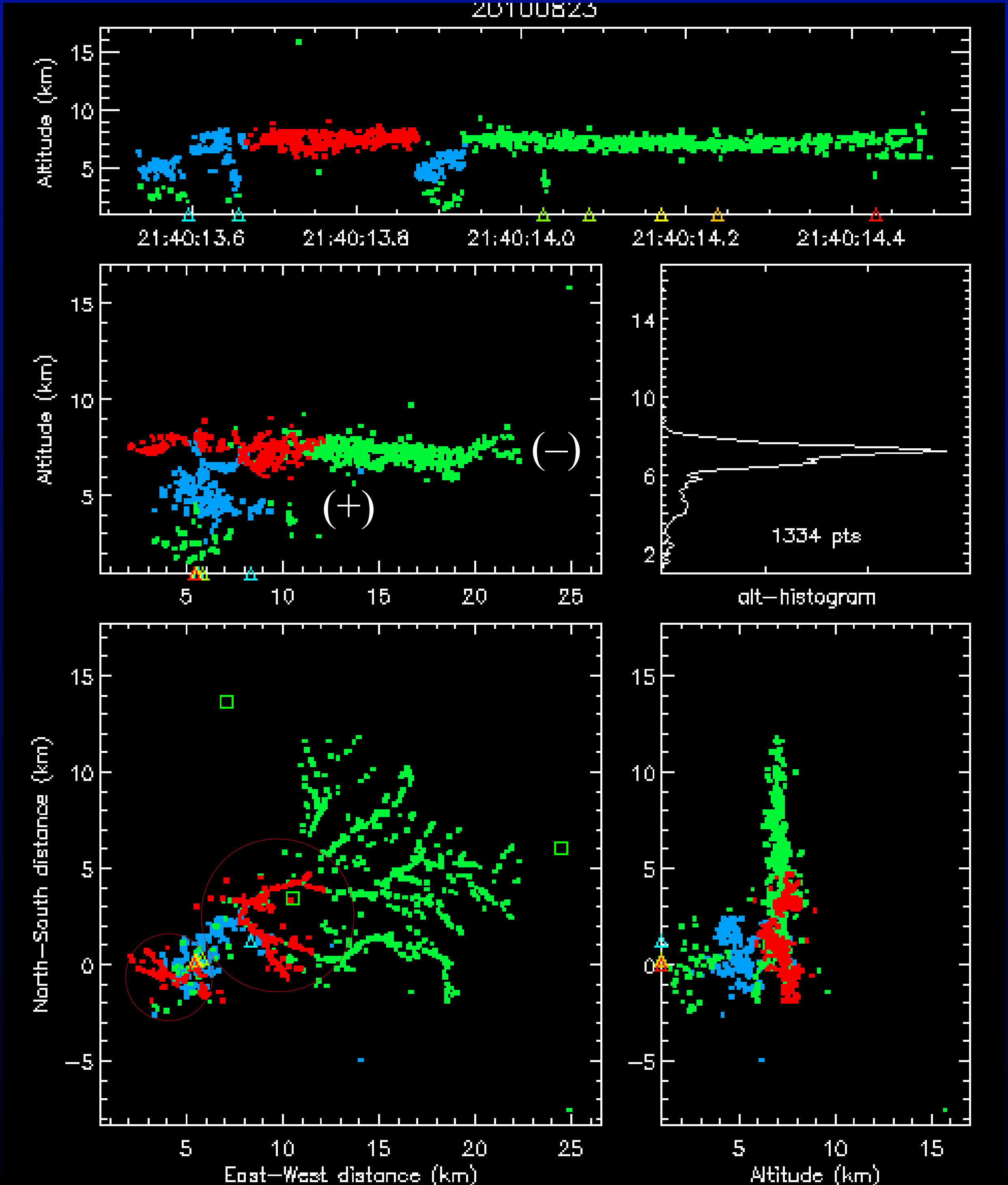
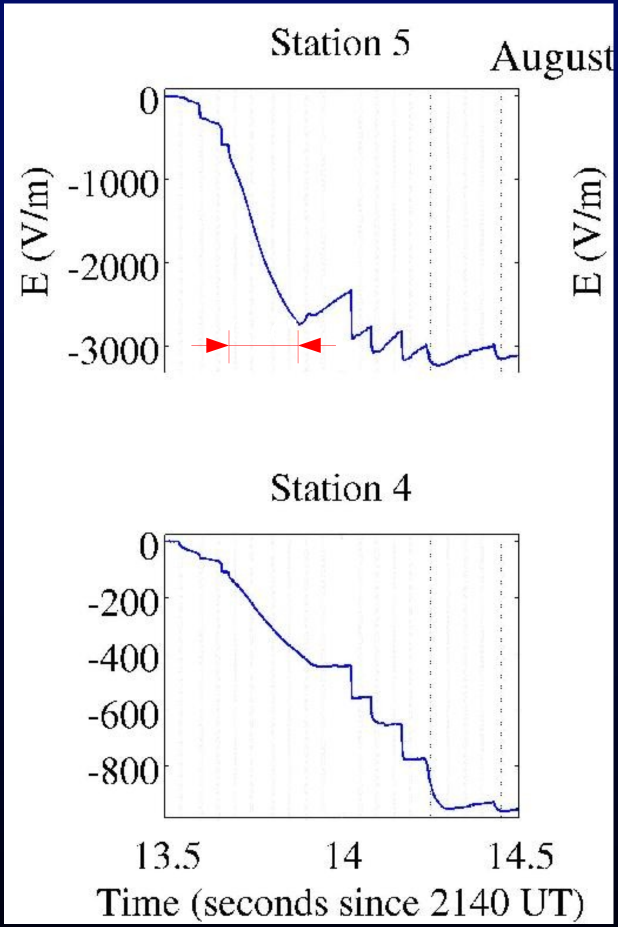


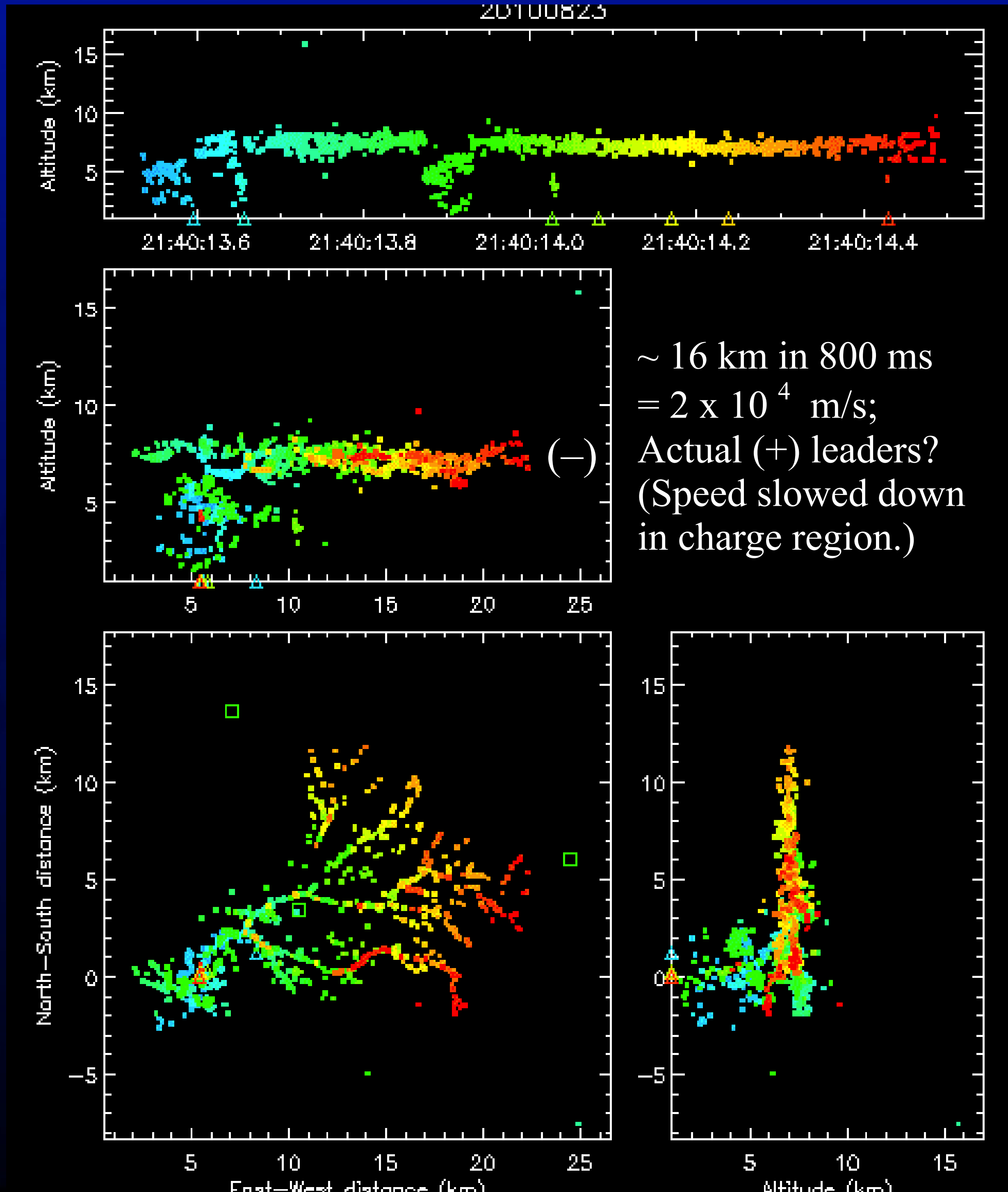


Continuing current –CG flash



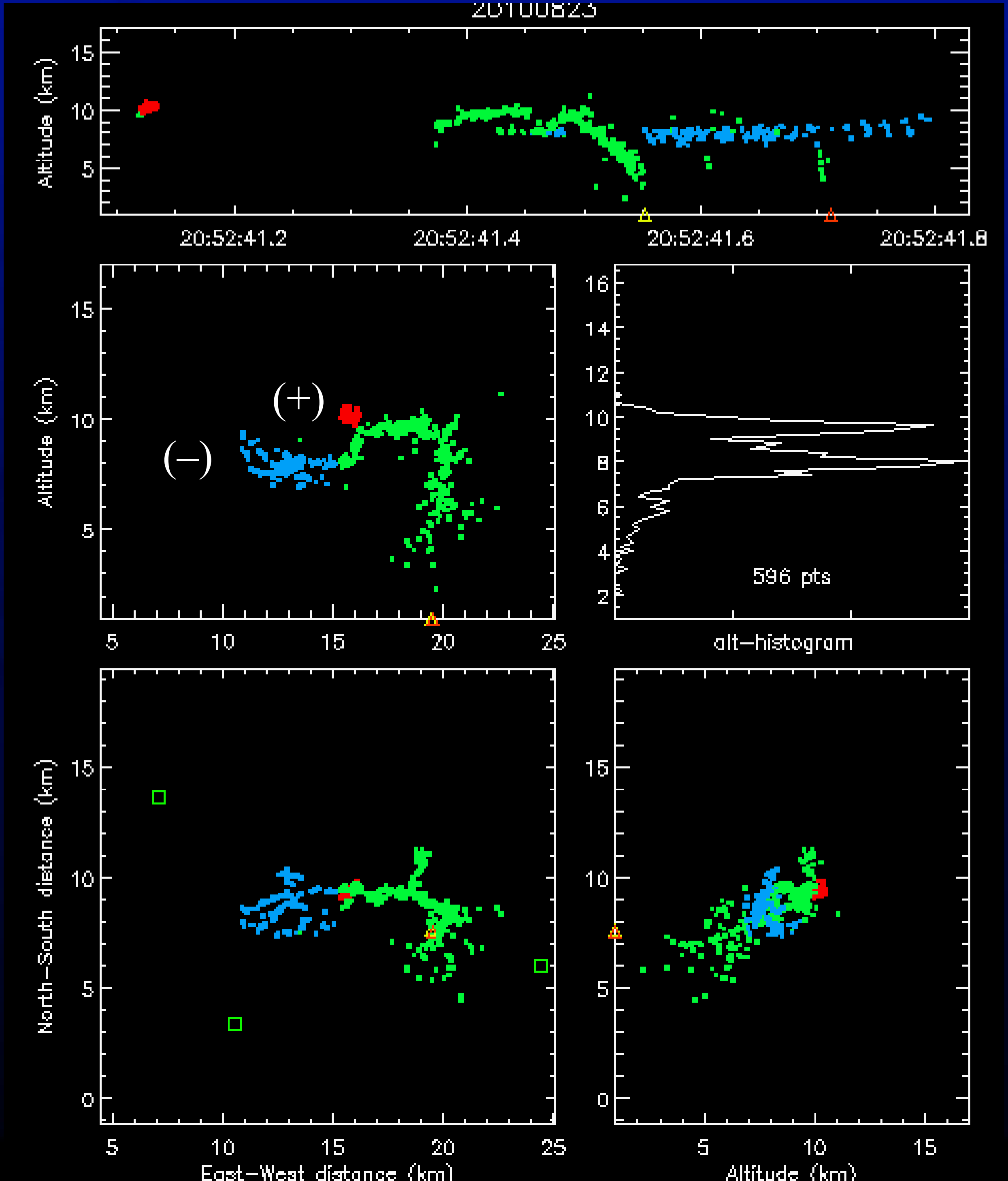
- 8 strokes to ground.
- 3rd stroke initiated 250 ms continuing current to ground.
- CC sources in red.
- Two charge regions – can't fit Delta_E values with single point charge model.





~ 16 km in 800 ms
= 2 x 10^4 m/s;
Actual (+) leaders?
(Speed slowed down
in charge region.)

Bolt-from-the-Blue flash (44 kA –CG)



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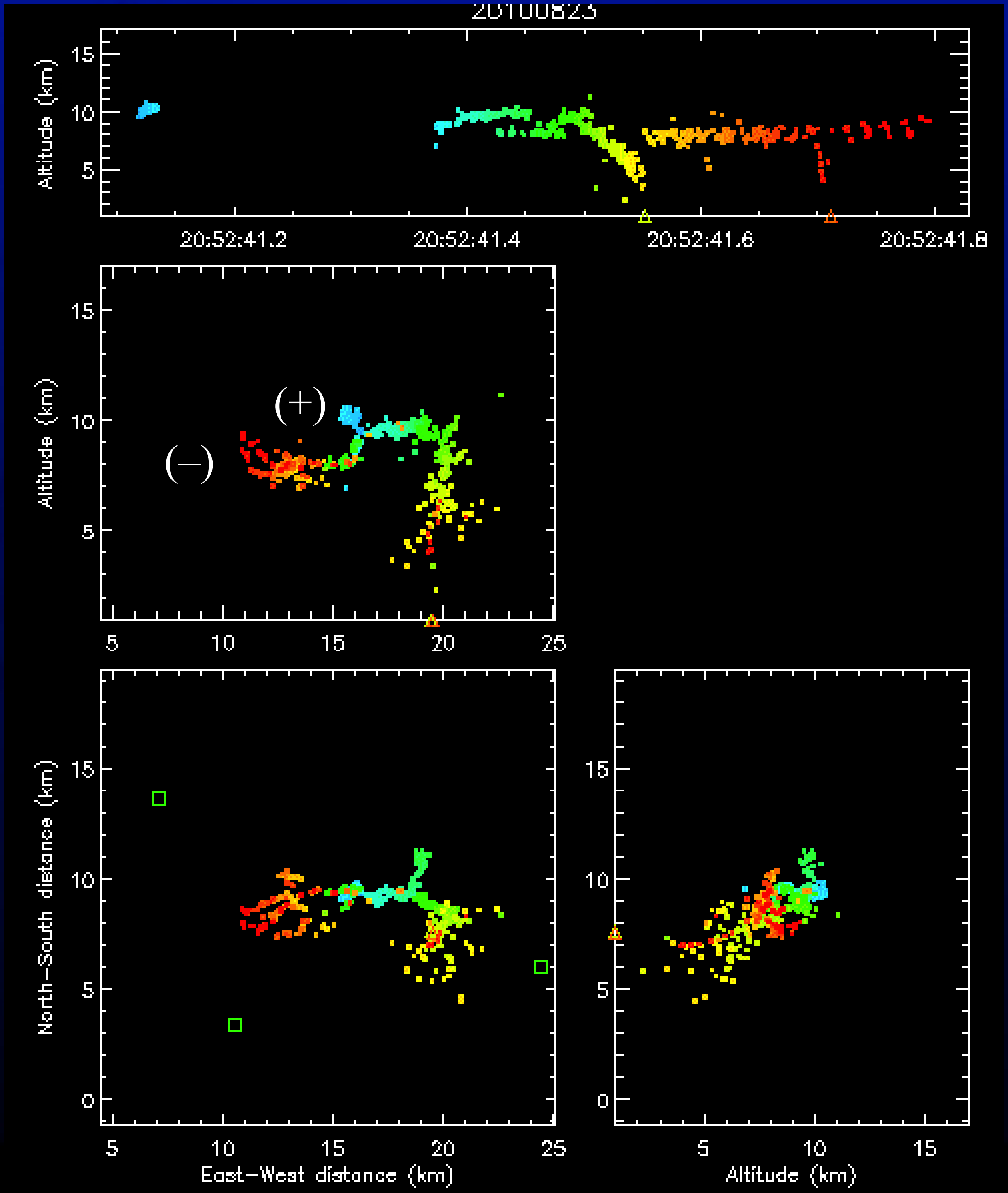
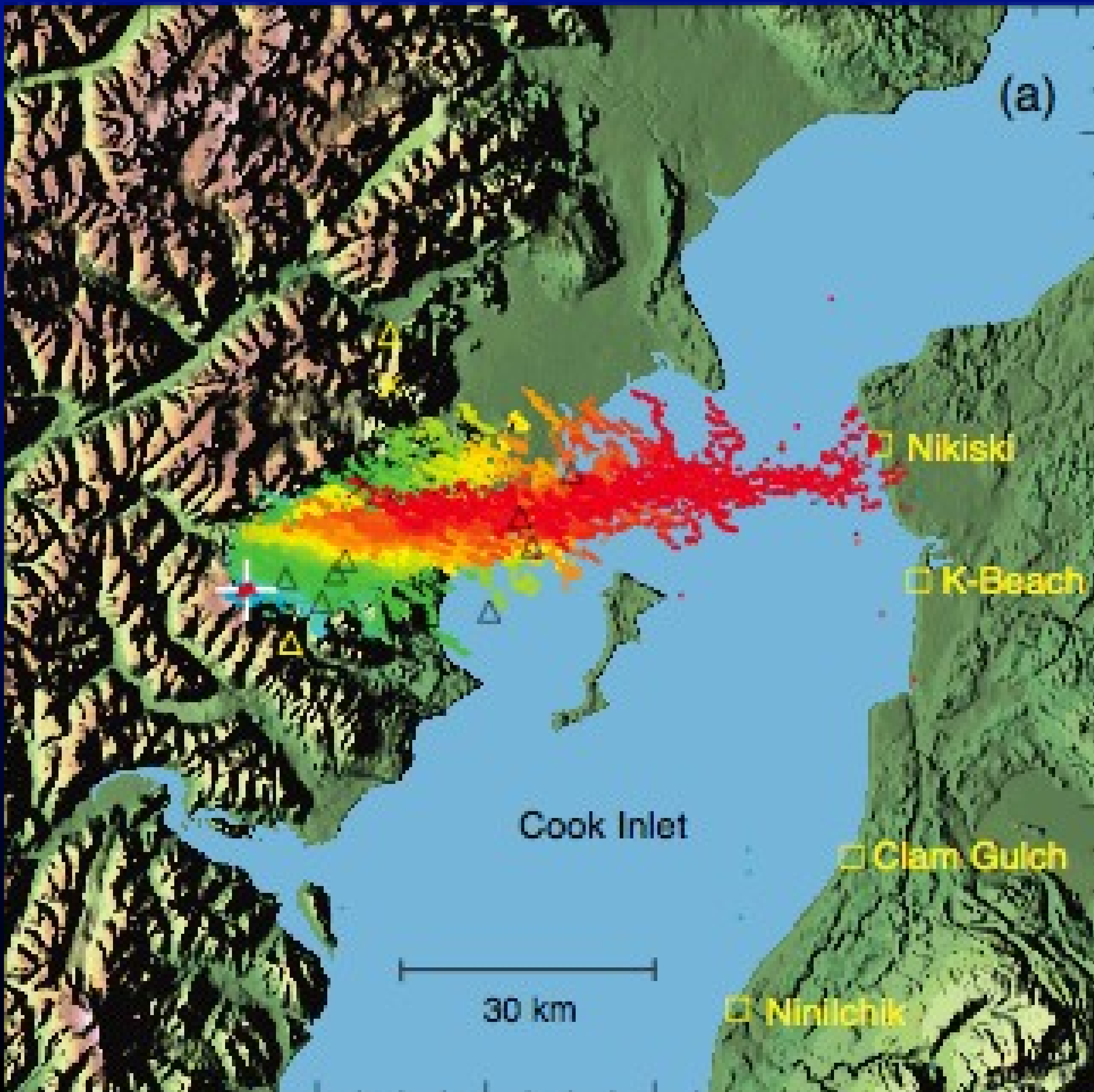
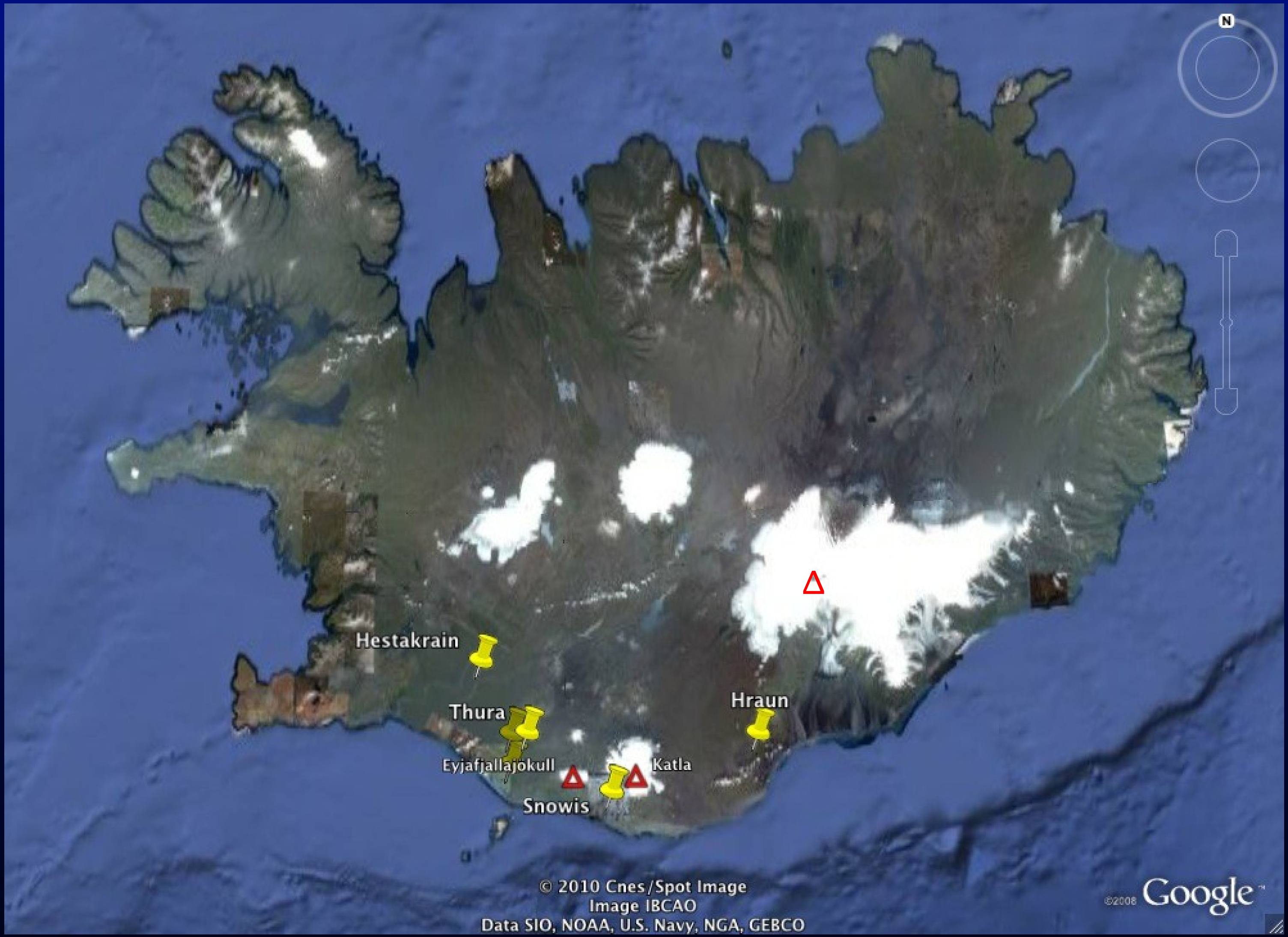


Eruption of Alaska's Mt. Redoubt Volcano; March 28, 2009



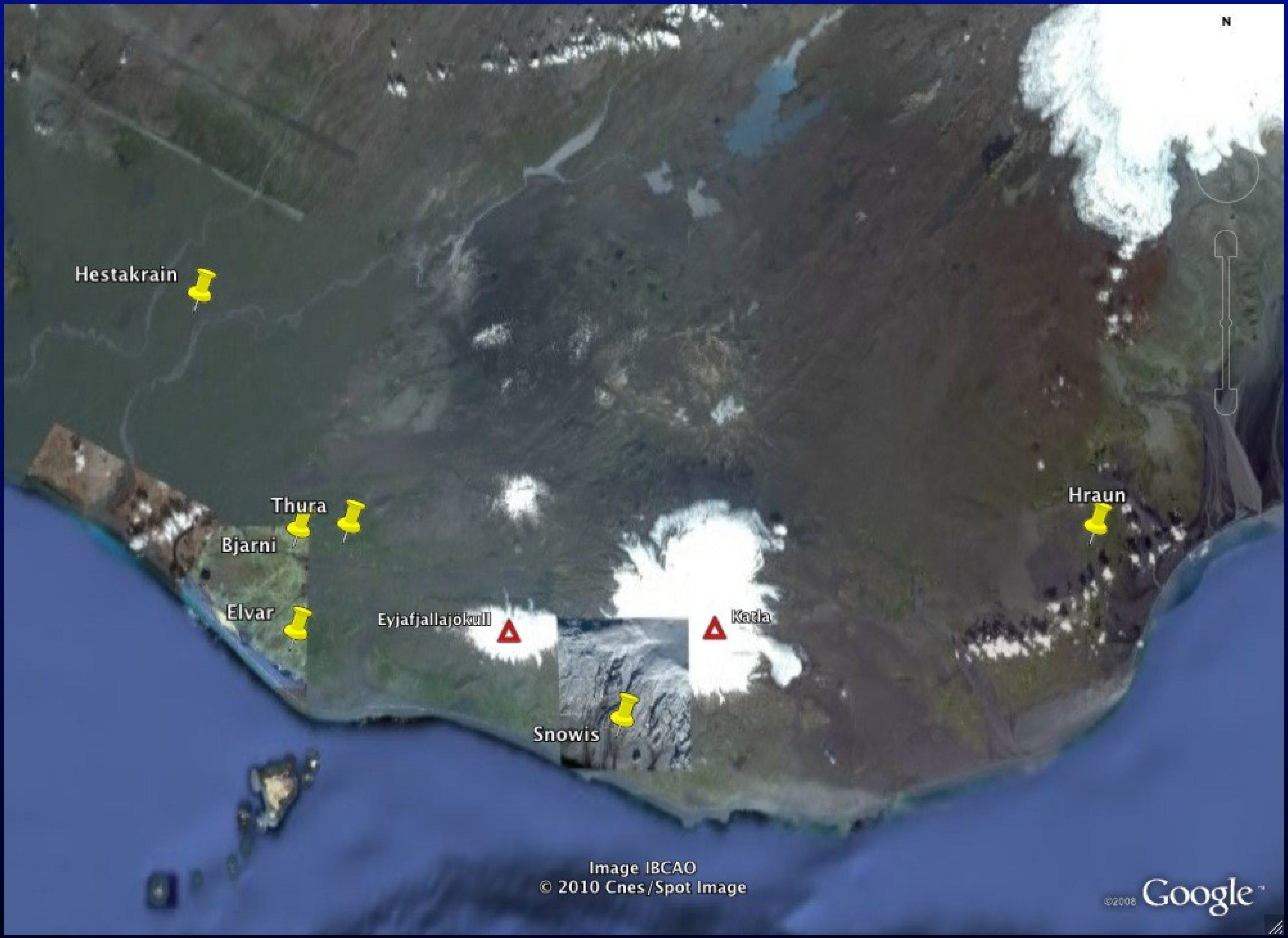
Iceland Volcanoes
(Eyjafjallayokull, Grimsvotn, Katla)



Eyjafjallayokull Eruption (May 2010)

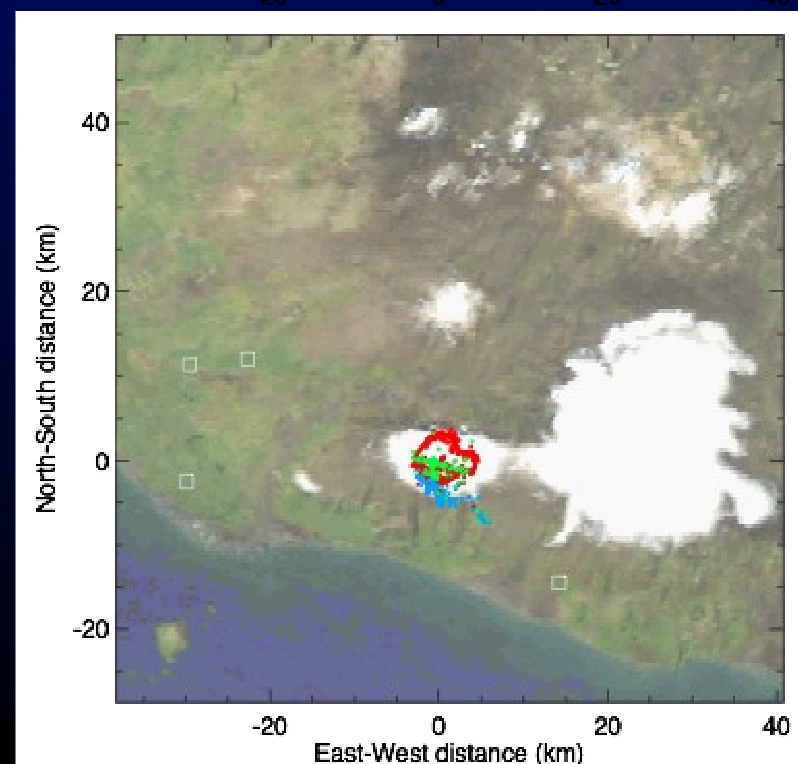
Photo: Sonja Behnke

Lightning mapping network (6 stations)



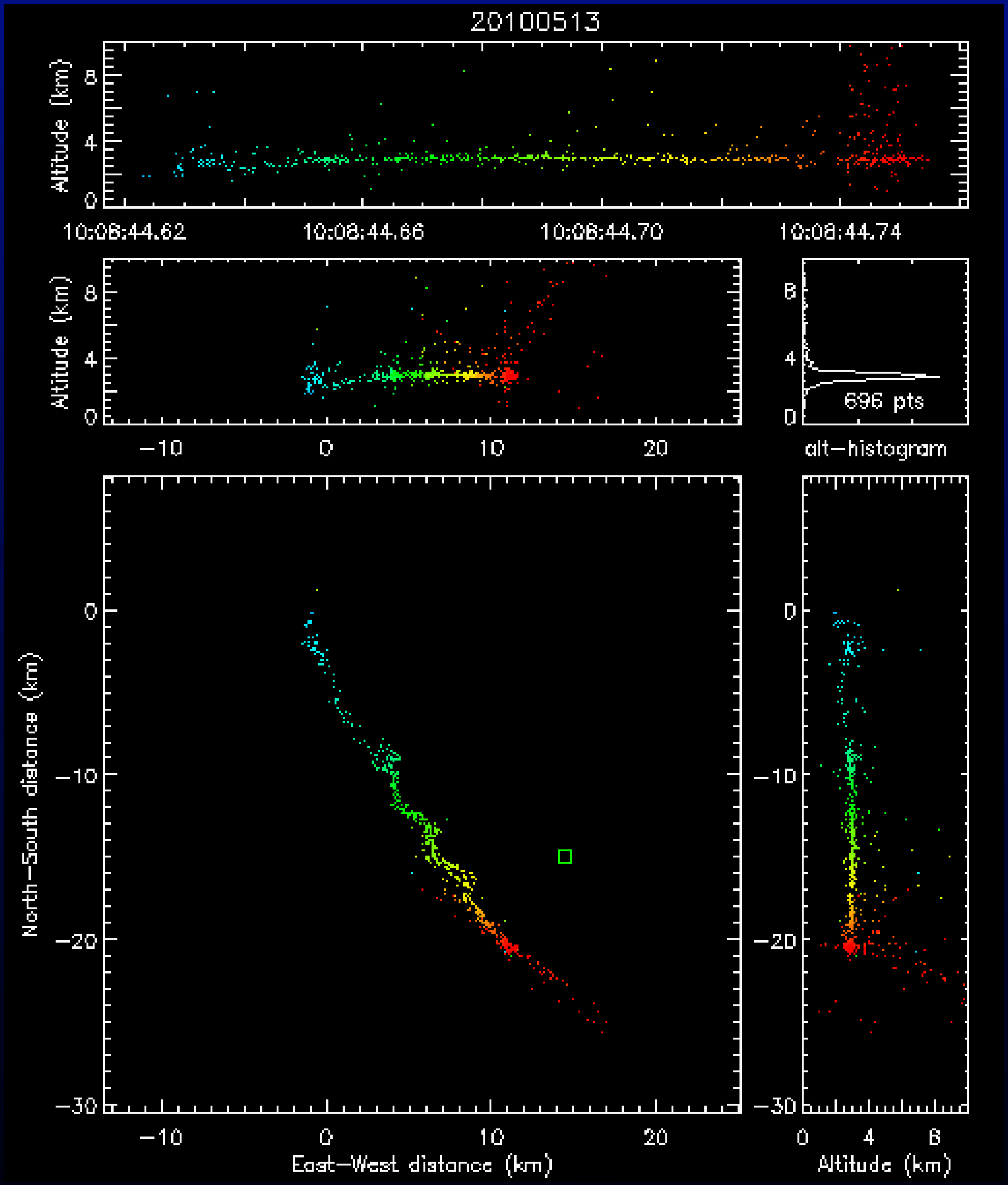
Eyjafjallayokull Eruption (May, 2010)

- 6 station LMA network around volcano
- First 3-D volcanic lightning data

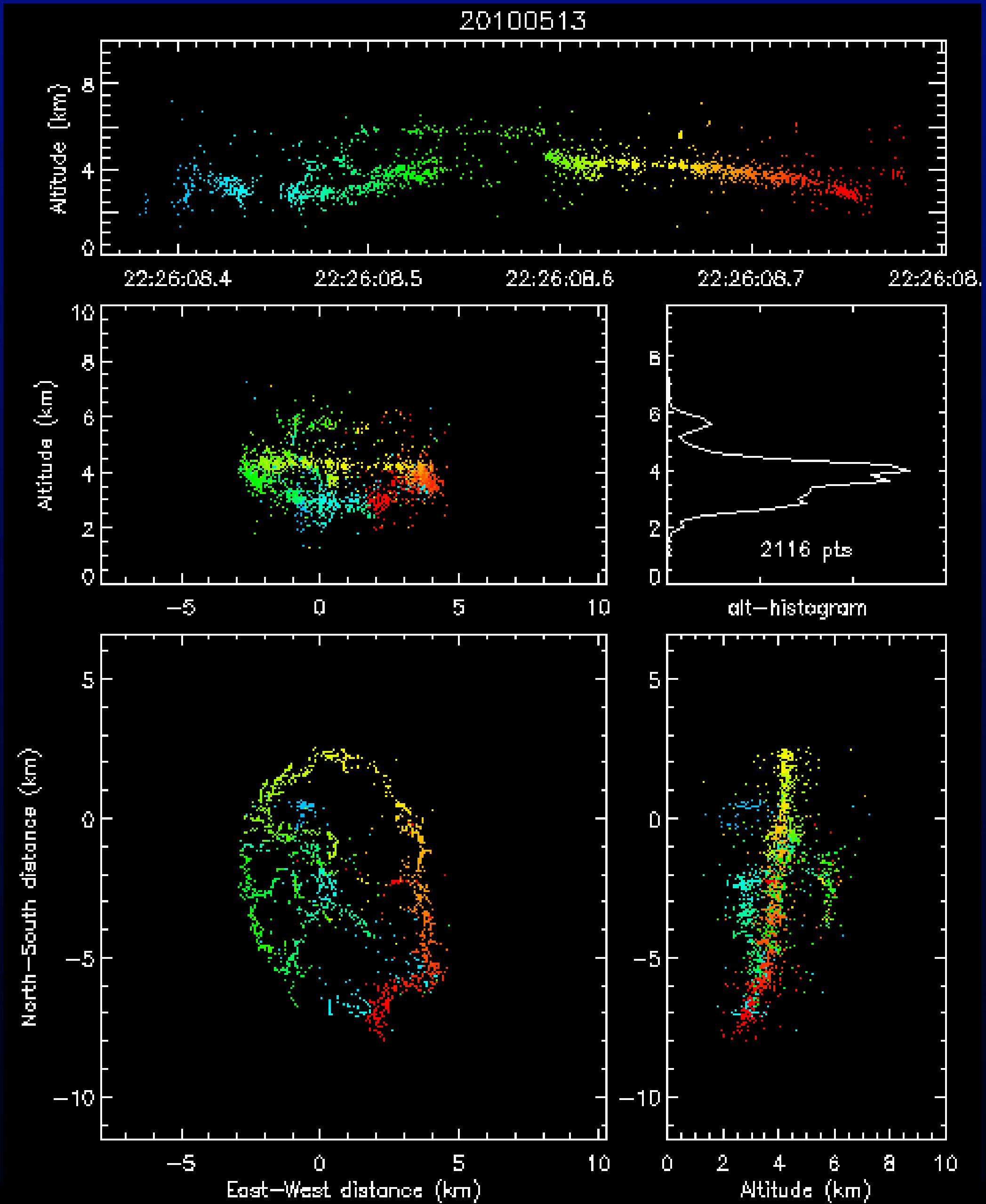


Eyja Lightning Discharge

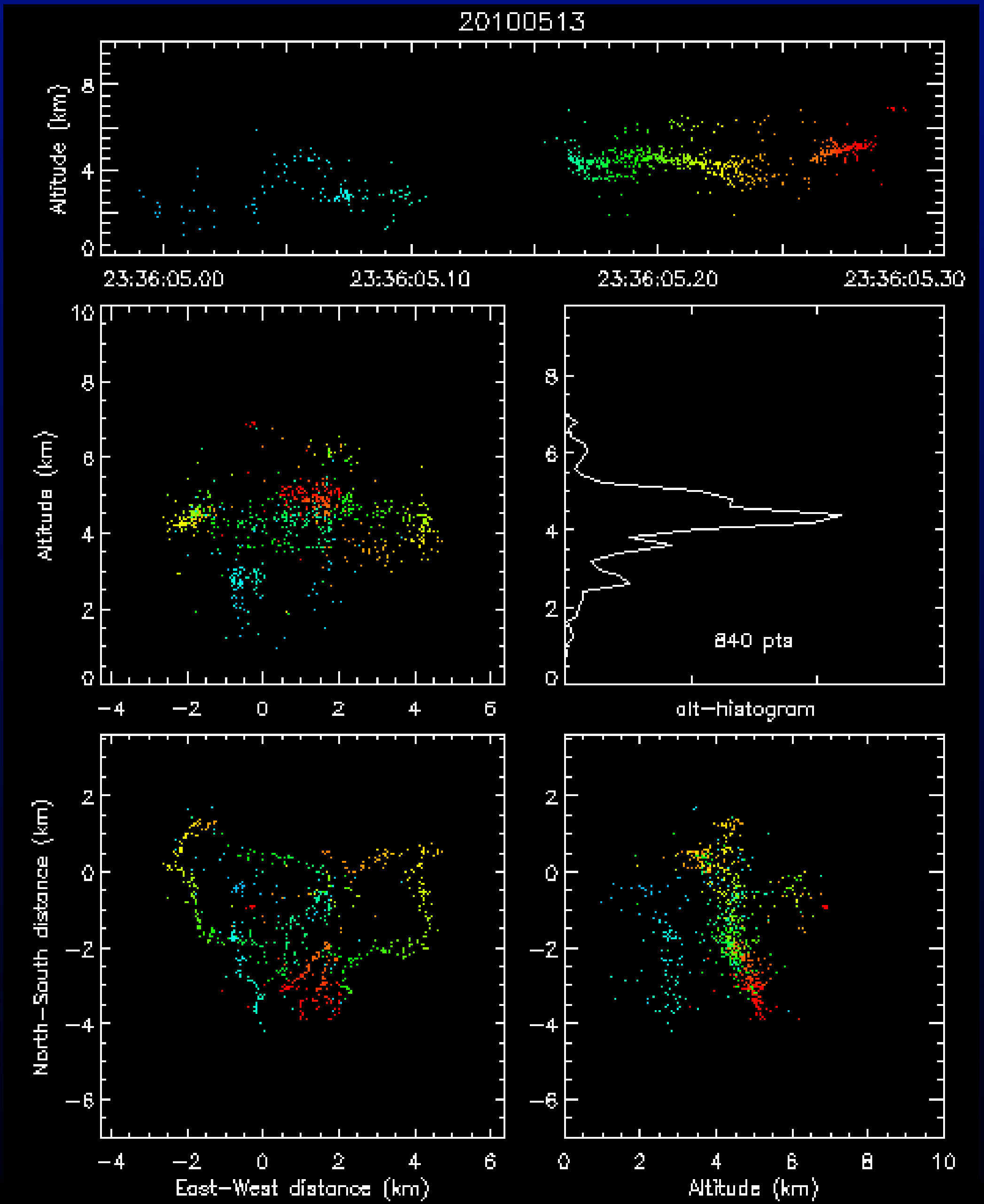
30 km extent into downwind ash cloud, positively charged, 3 km altitude, 1.2 s duration



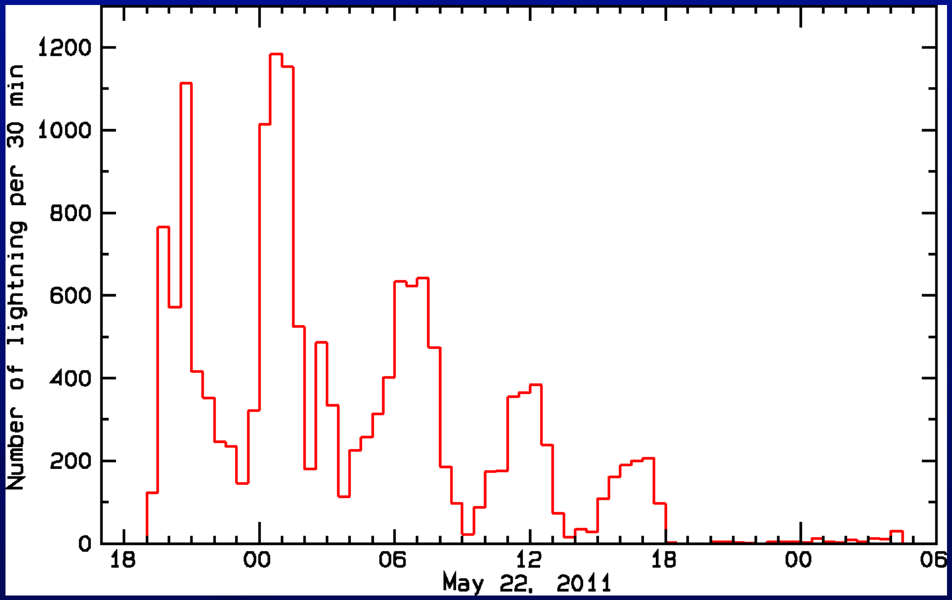
Inverted IC between upper (–) and lower (+) charge, CW circular pattern



Inverted IC between upper (–) and lower (+) charge, bi-rotational pattern; (Earlier, lower altitude discharge)

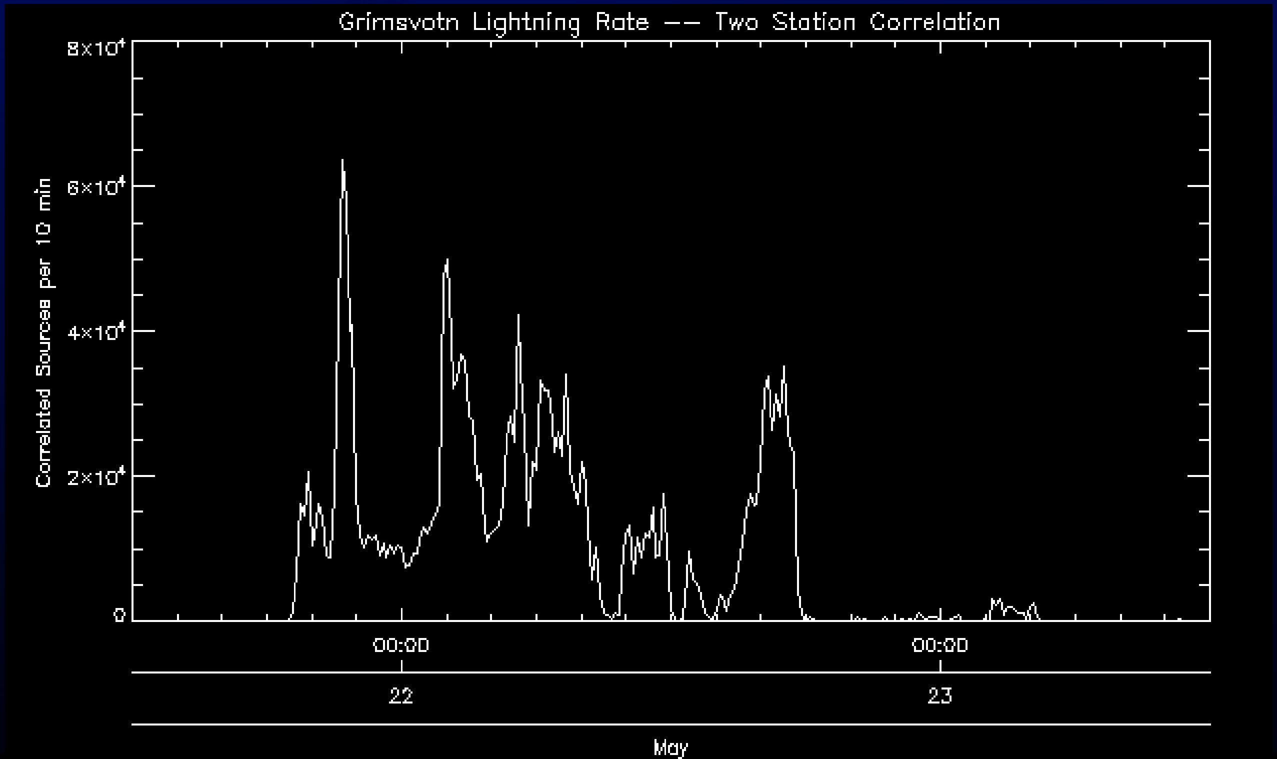


Grimsvotn Eruption (May 21-25, 2011)



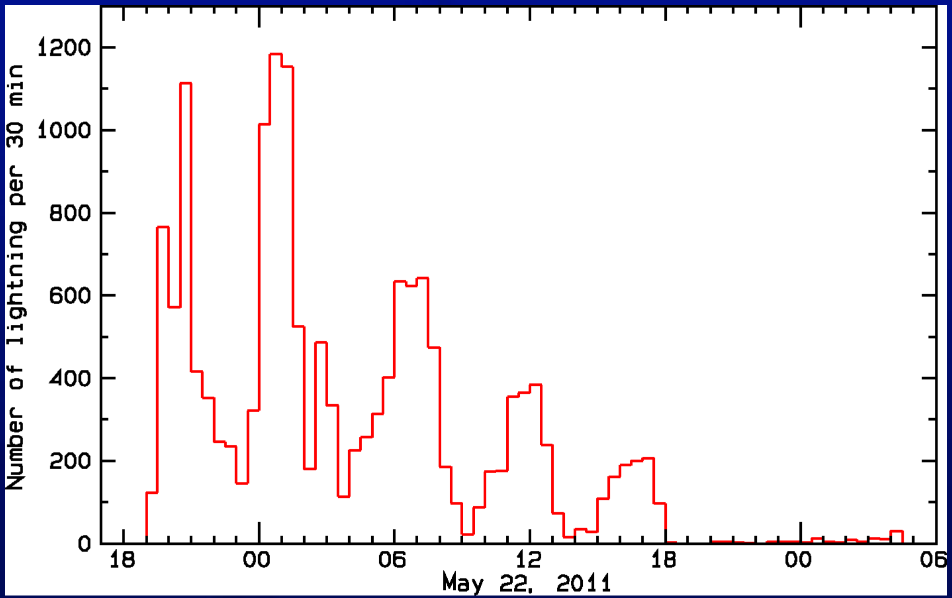
ATDNet sferics data, Grimsvotn eruption
5 pulses over 23 hours; May 21-22, 2011

Courtesy Thordur Arason,
Icelandic Meteorological Office



VHF radiation source rate.
2-station LMA data

Grimsvotn Eruption (May 21-25, 2011)



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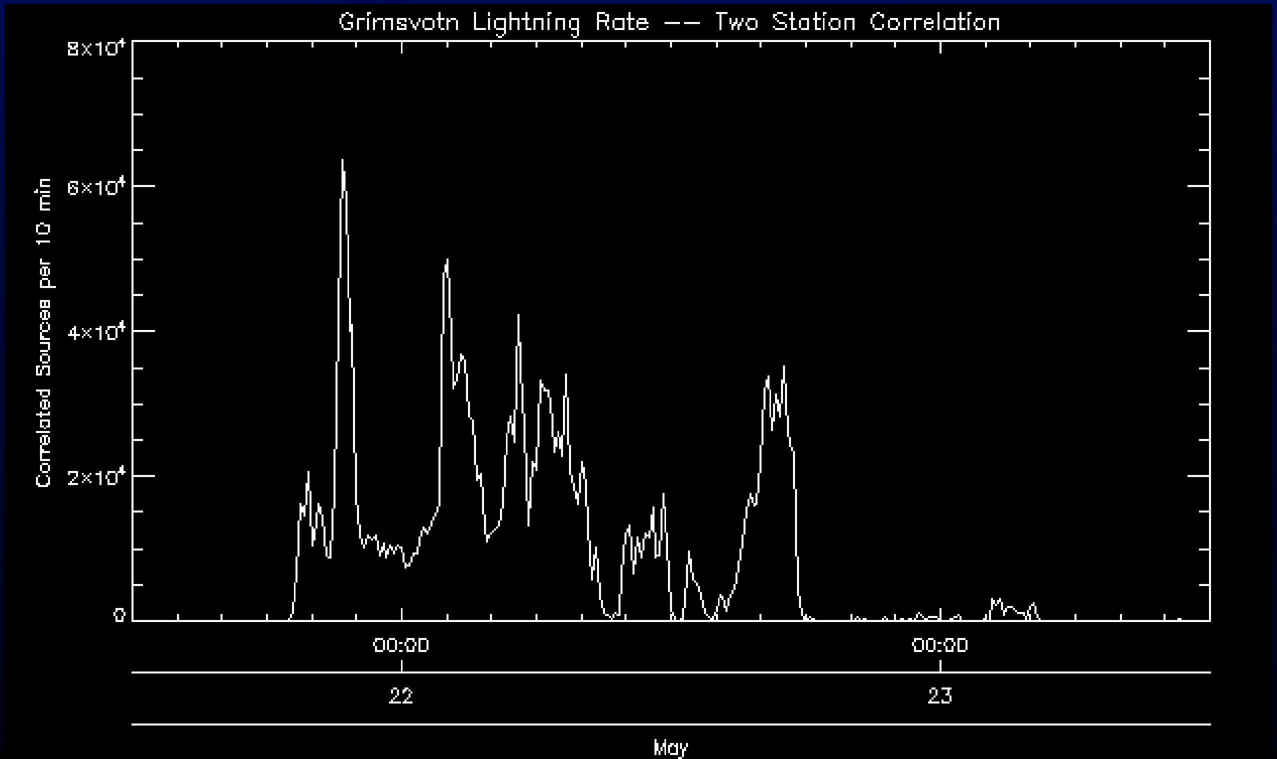


VHF radiation source rate.
2-station LMA data

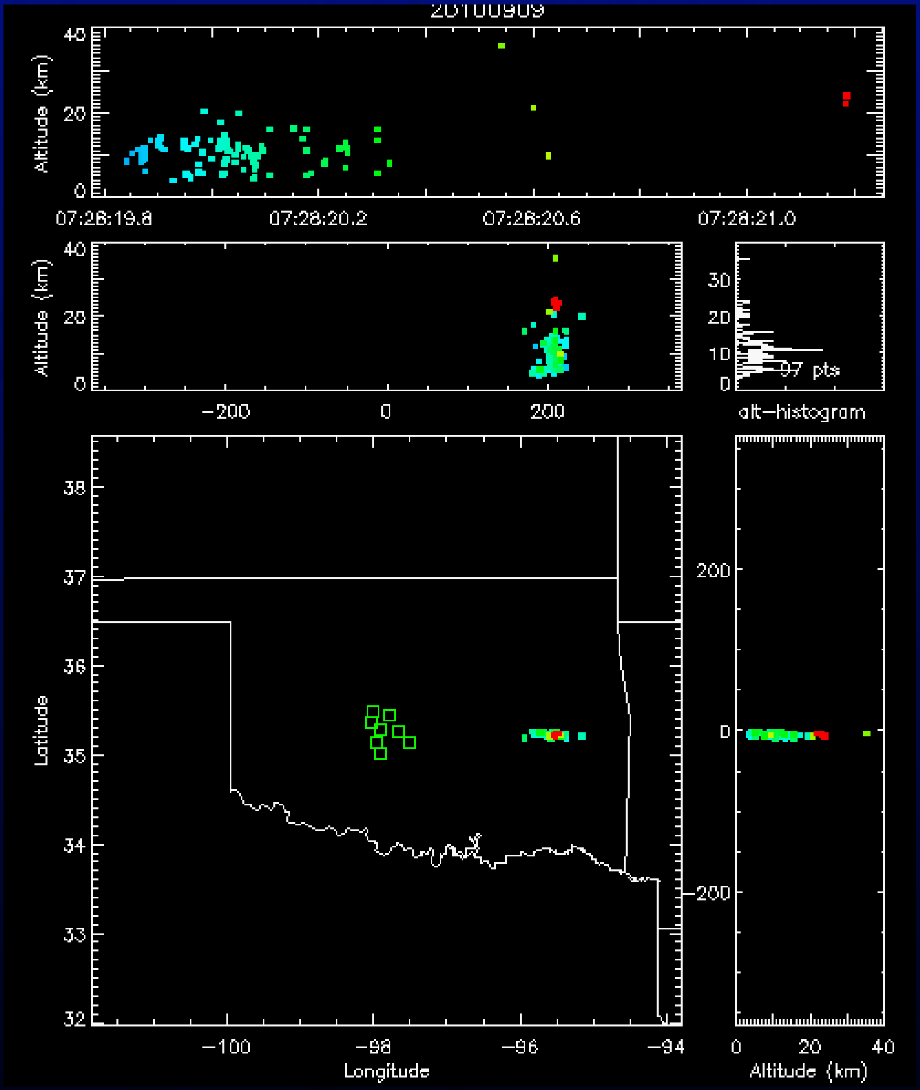
Katla starting to erupt,
July 8, 2011;
Highly dangerous volcano

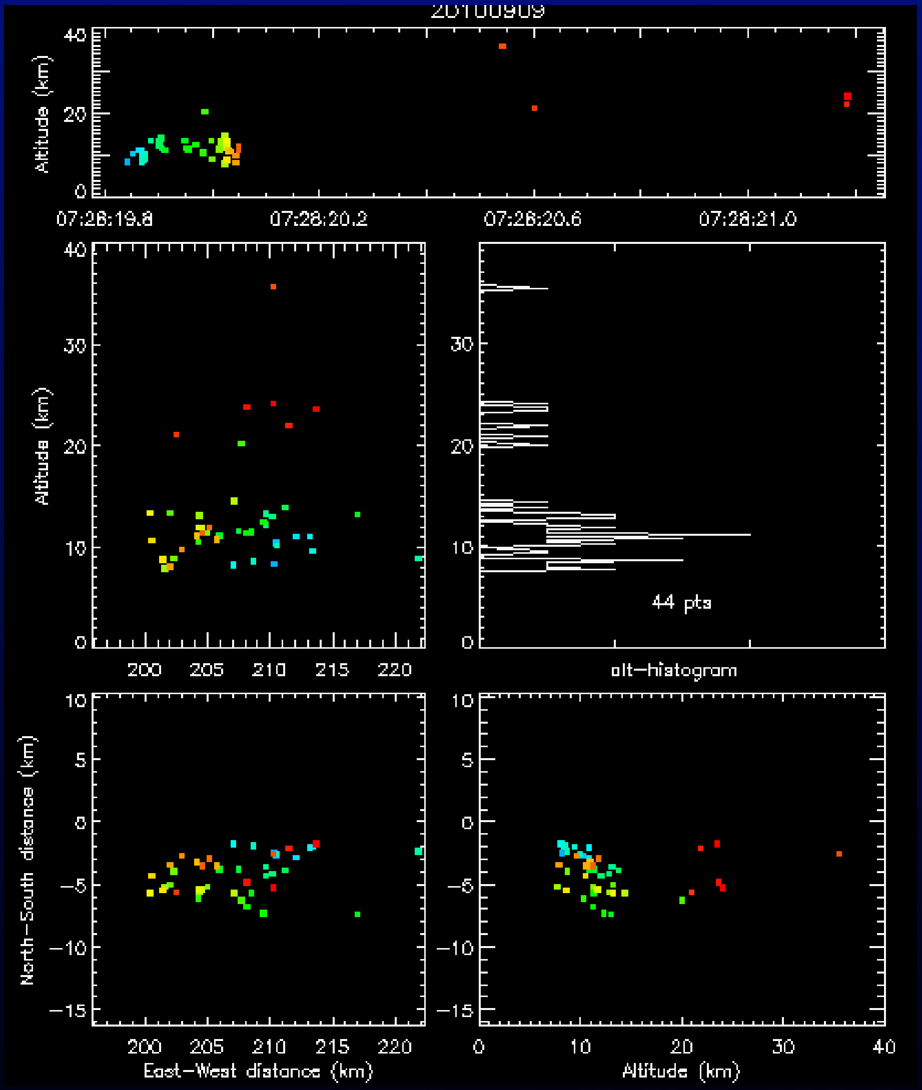
Gigantic Jet Flash

Sept. 9, 2009; 200 km east of OK LMA

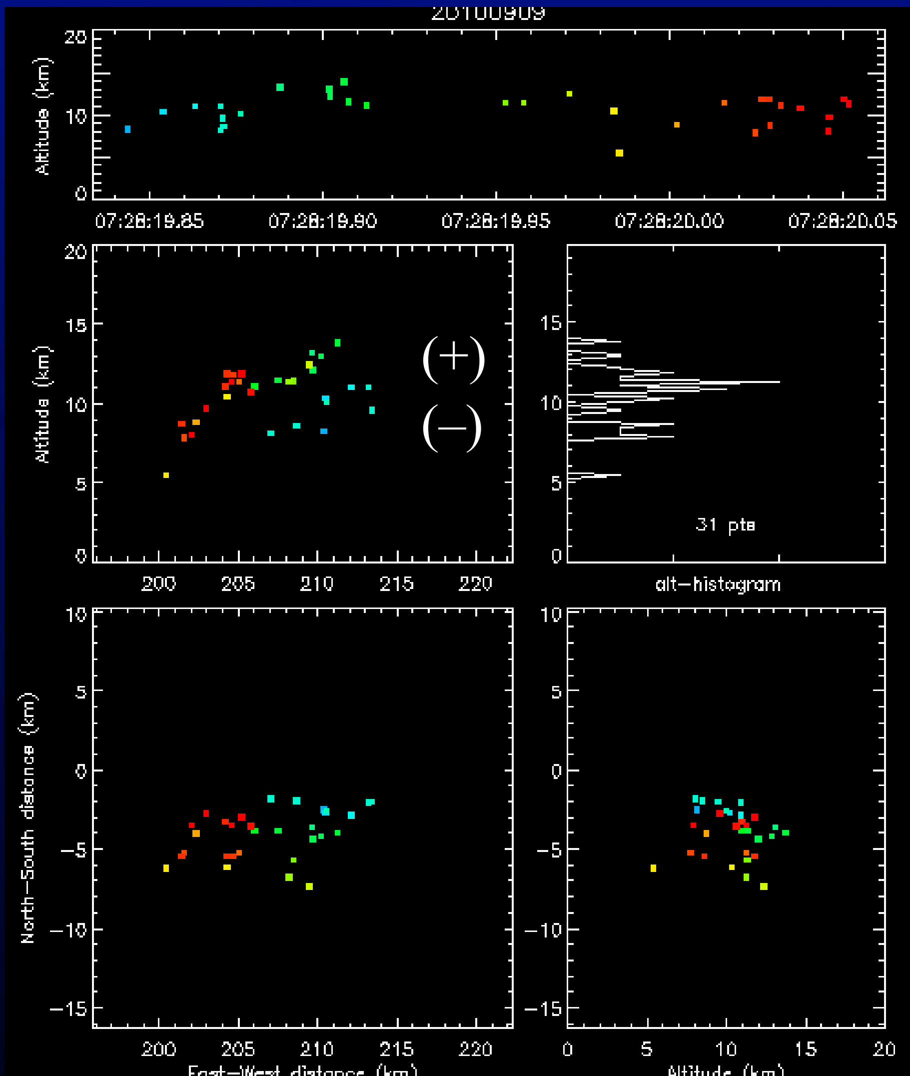
VHF sources detected up to 38 km altitude

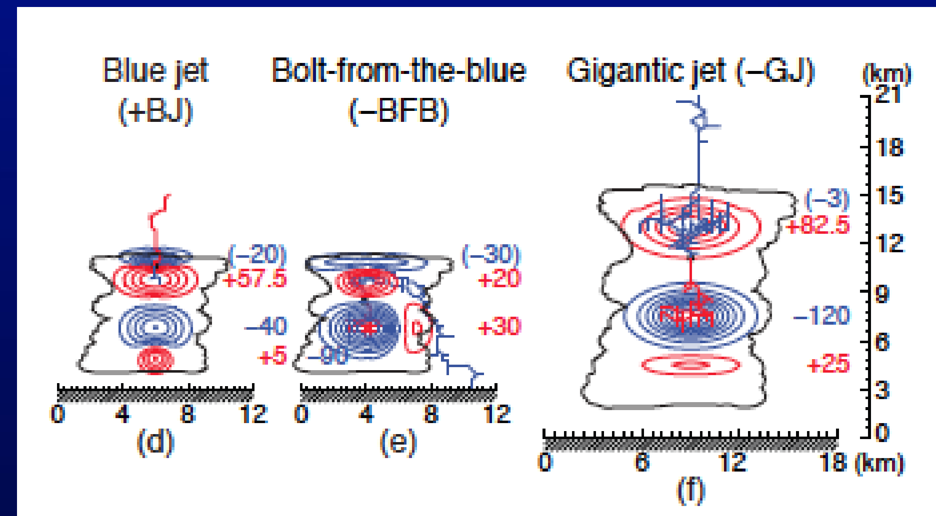
Produced by a parent flash that began as an attempted BFB





Attempted BFB at beginning of flash depleted the upper positive charge, enabling the IC flash to escape upward as a gigantic jet (GJ).





Good agreement with proposed mechanism for GJs, as being similar to BFB discharges; in both cases resulting from a depleted upper positive charge (Krehbiel et al., Nature Geoscience, 2008).

END