Lightning Location with LINET Technology

Methodology and Performance

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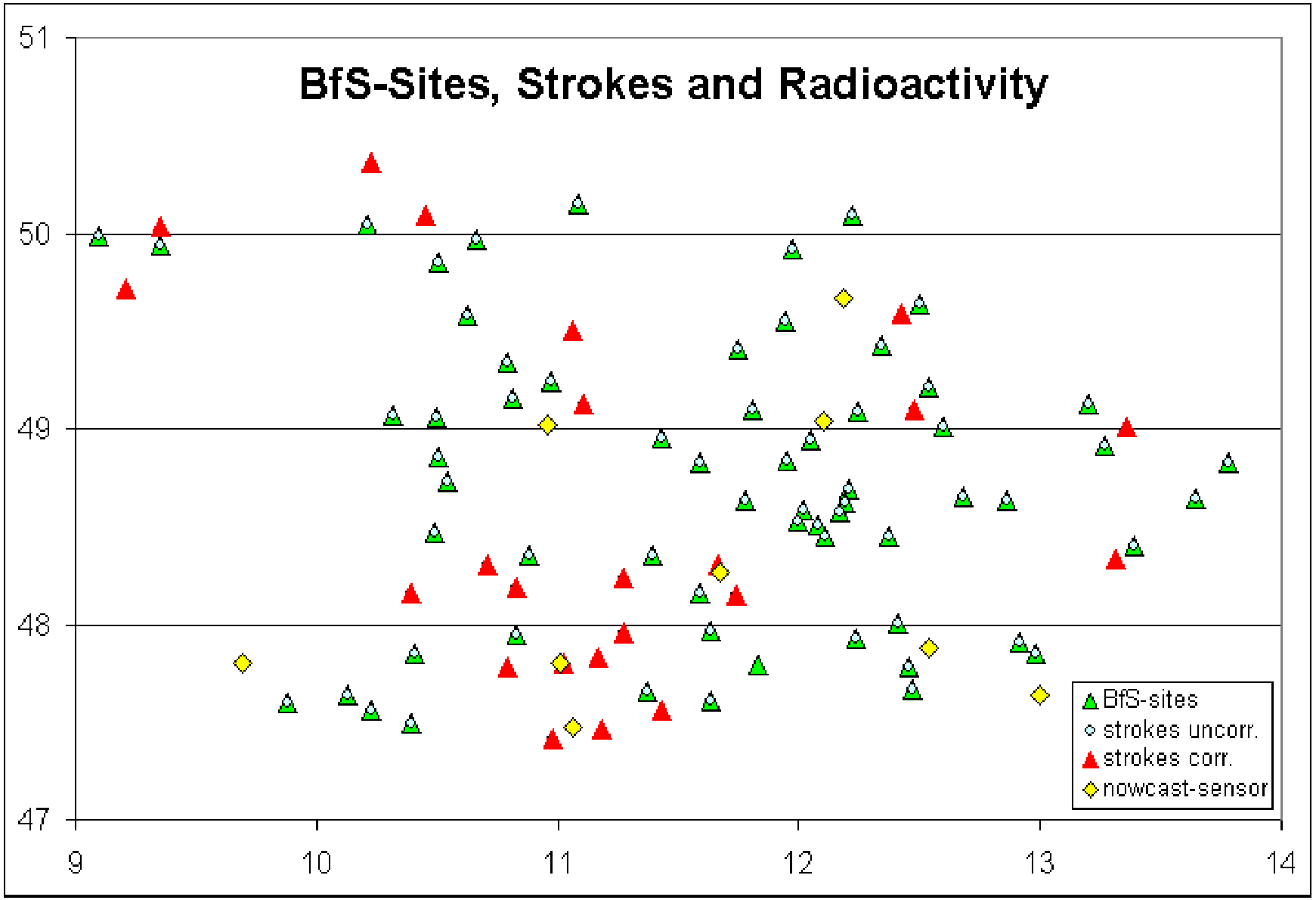
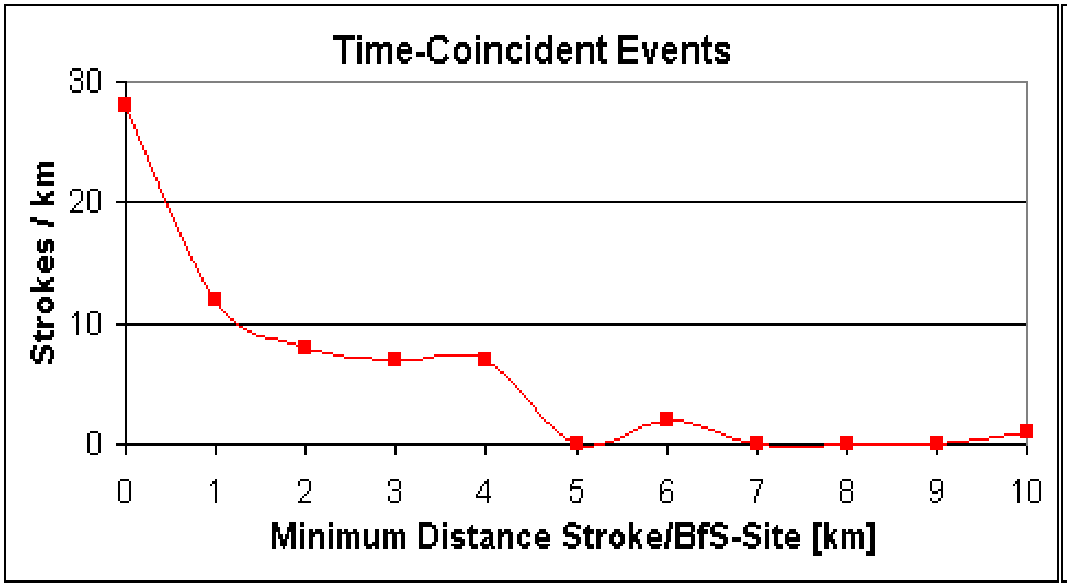
10th AGILE Workshop, 18 April 2012, Frascati, Italy

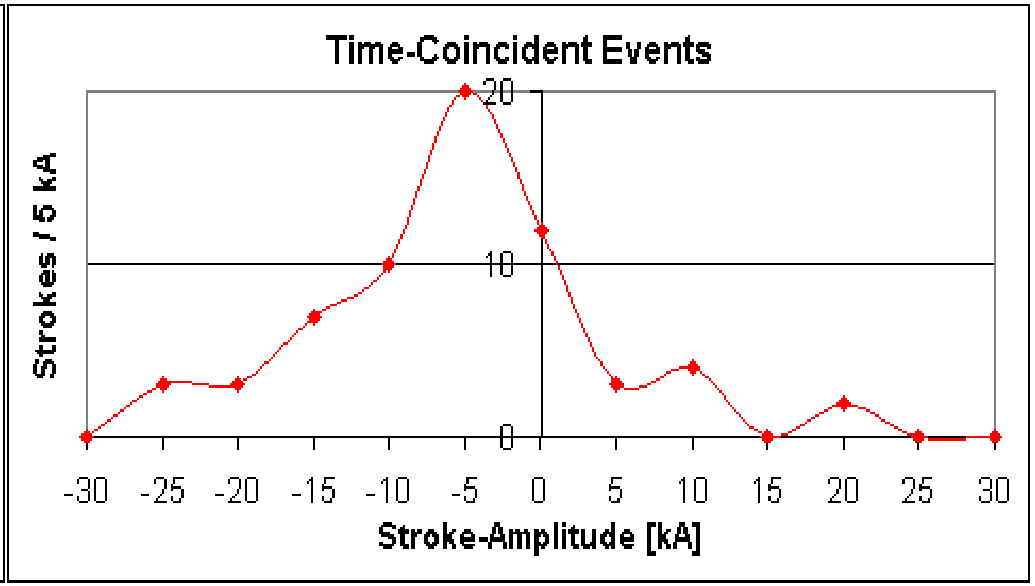
Measurement of Radioactivity with BfS-Counters in Germany

(BfS operates ~4000 monitoring sites)



Lightning Strokes during Counter Responses





Result: clear correlation between lightning impact and counter response

only **particle showers** could have triggered the final counter report

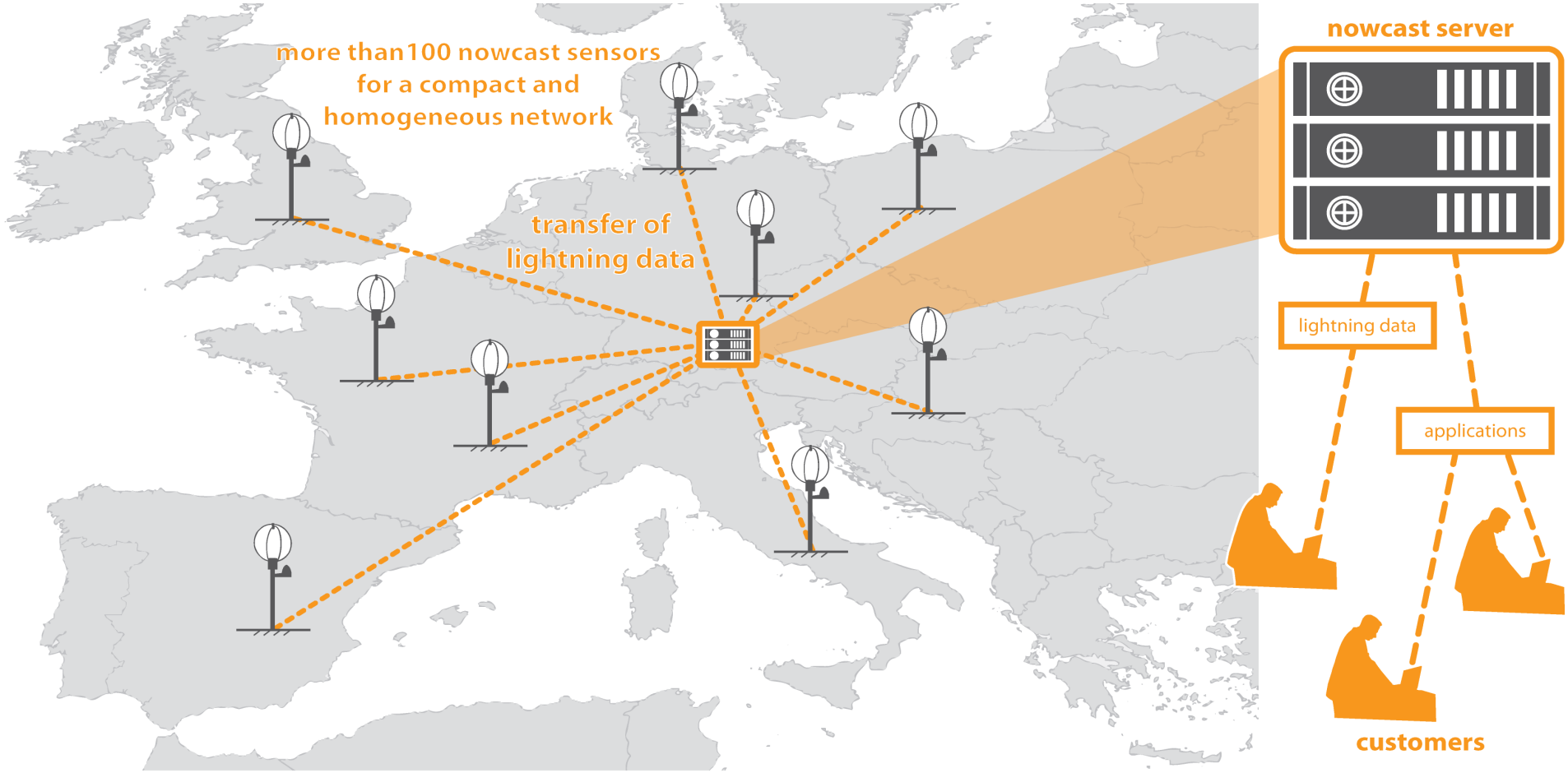
Gamma Counter (design for monitoring of enduring radioactivity in the air):

Geiger-Müller for 0,02 - 2 $\cdot 10^7$ µGy/h and 40 keV – 2 MeV; dead-time 22 µs; positioned 1 m above ground

Logged response requires minimum dose and minimum pulse rate (no response for a single particle)

Modules:

- Field Antenna
- Field Processor
- GPS Antenna
- Central Processing / Monitoring



The sensor-sites demonstrated in the graphic above do not correspond to real locations.

LINET Detection Principle

- VLF/LF frequency range	long range
- magnetic flux	less disturbance
- direct measurement of H_x and H_y	higher sensitivity
- no dead-time	no loss of signals
- analysis of all pulses irrespective of pulse shape	no loss of strokes
- single technique for ground- and cloud lightning	total lightning
- Fourier analysis and filter for ‚technics‘	noise reduction
- TOA (time-of-arrival) for locating strokes	accuracy, less scatter
- 3D stroke type discrimination in central analyzer	enhanced reliability

LINET – high-precision Lightning Detection.

Total Lightning

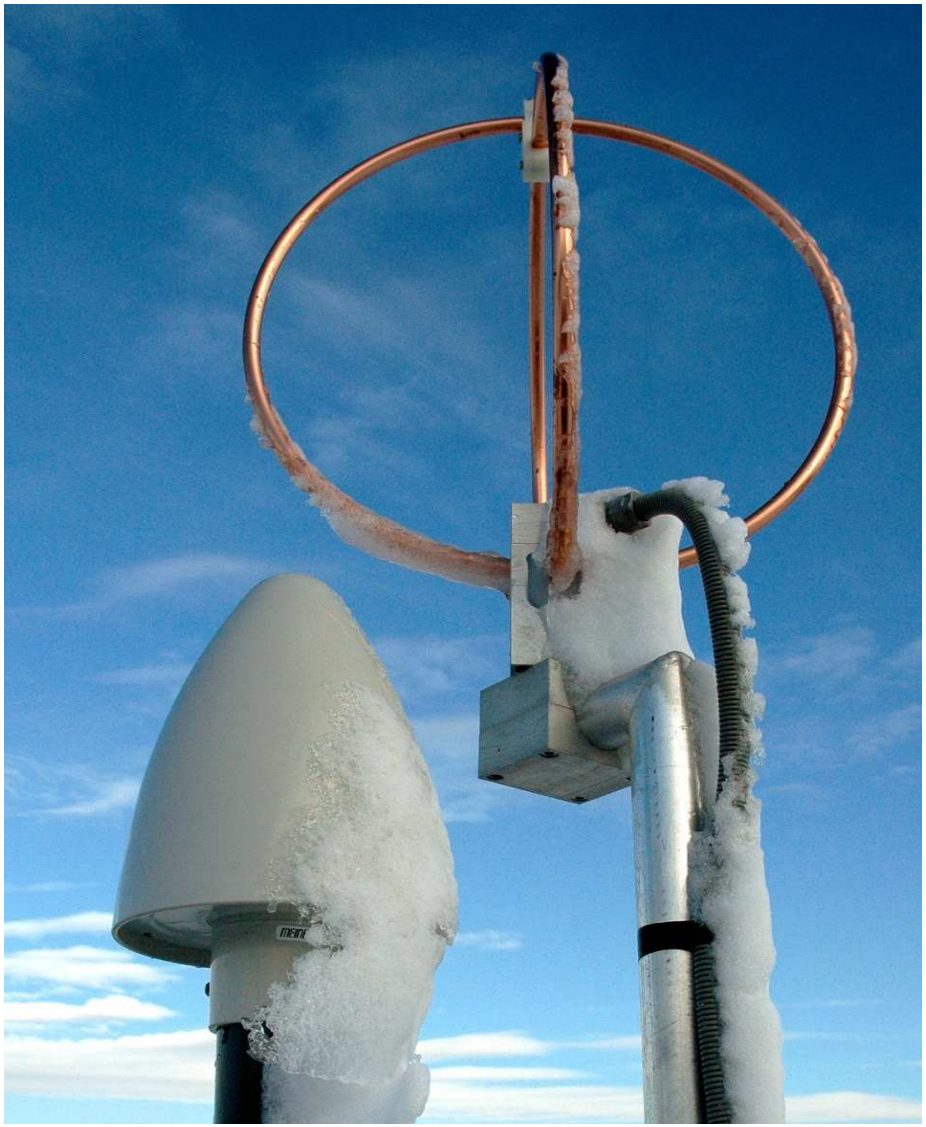
Reliable distinction between intra-cloud (IC) and cloud-to-ground (CG) strokes (3D-locating)

Stroke Detection Efficiency

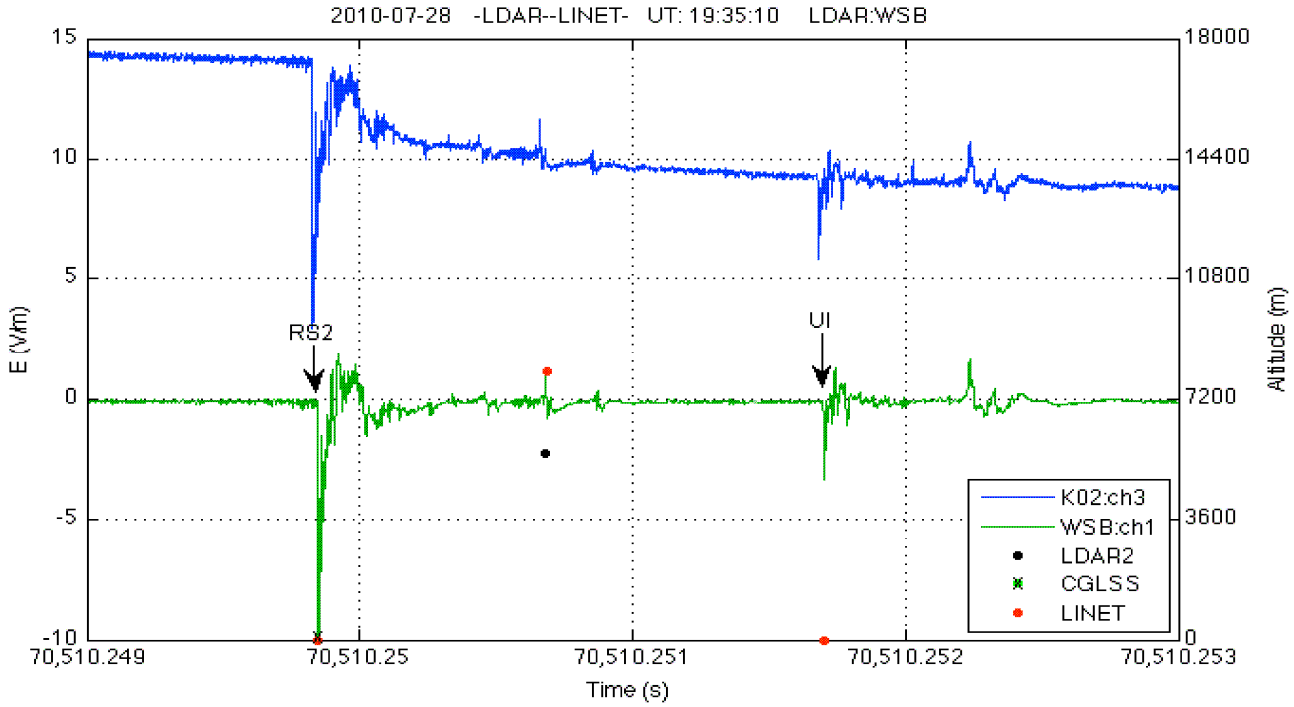
Unparalleled efficiency: more than 90% of ground strokes are detected with sensor-baselines ~250 km

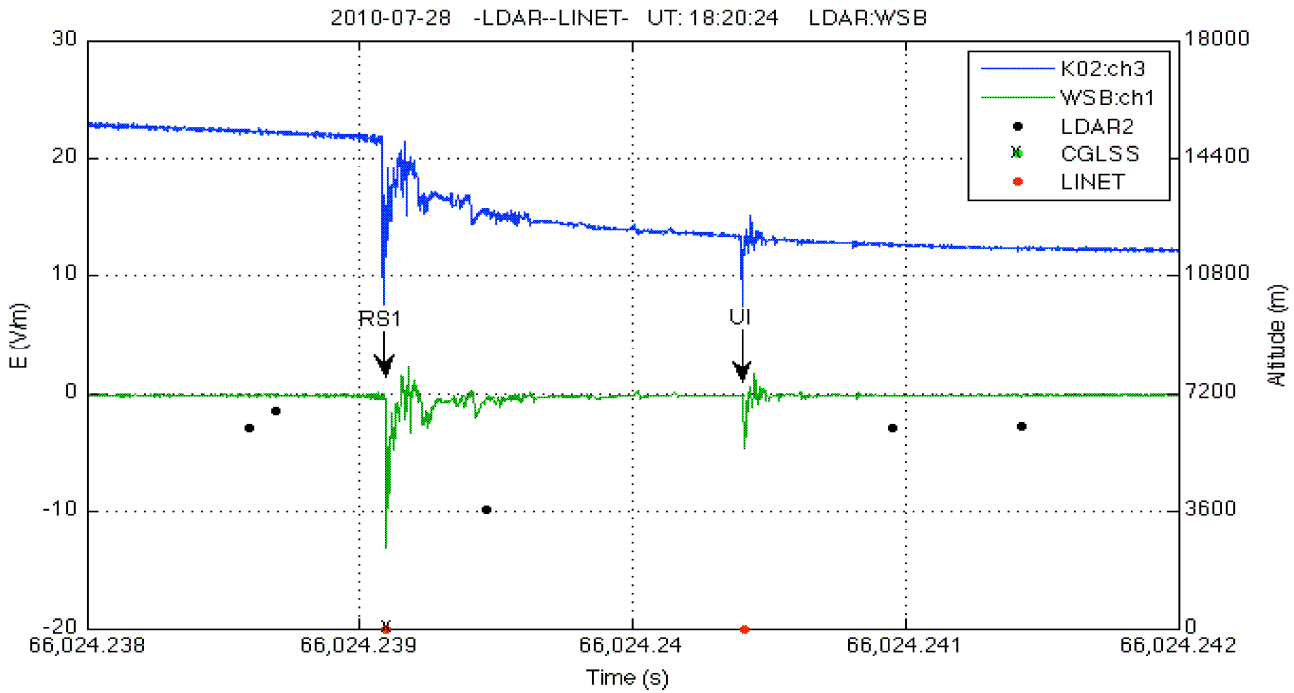
Location Accuracy

High location accuracy with an average statistical location error of down to ~100 m only minor scatter of locations



LINET in Europe





Broadband measurements and network results

LINET detects and locates the weak stroke, labelled UI (Upward Illumination).

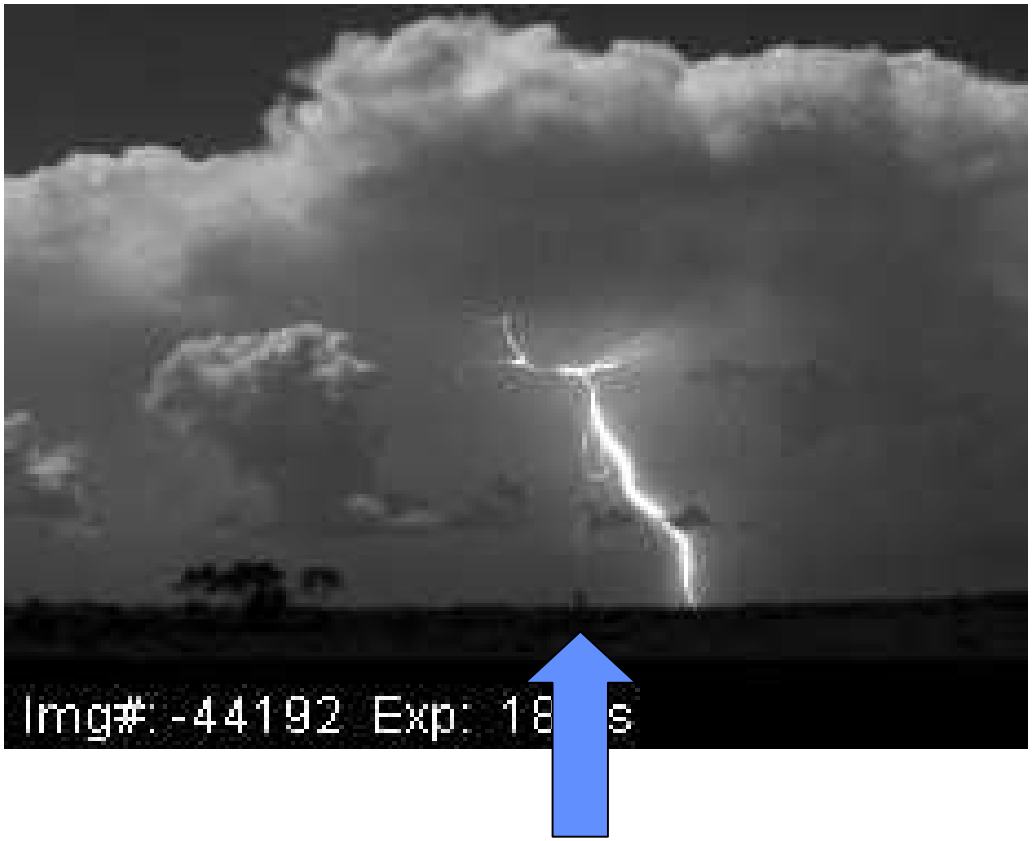
No other network was able to locate this type of ground stroke; these were:

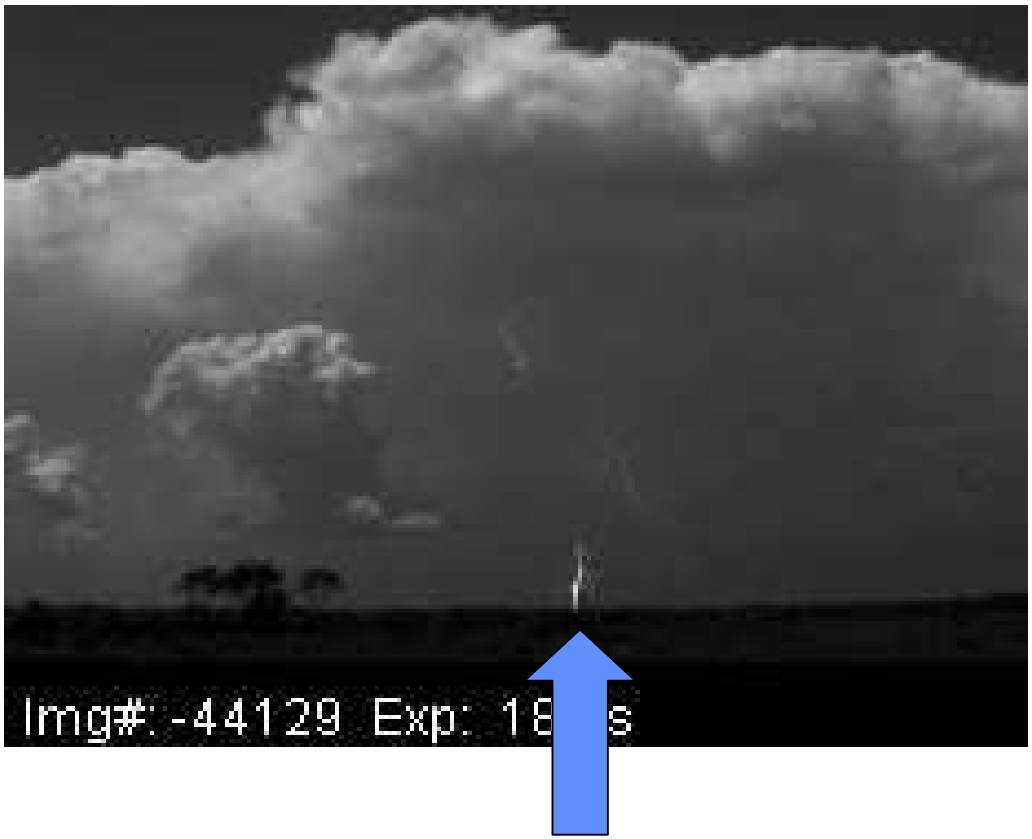
NLDN, CGLSS, LDAR2

Other flash example for the same phenomenon

High-Speed Video for Stroke Verification

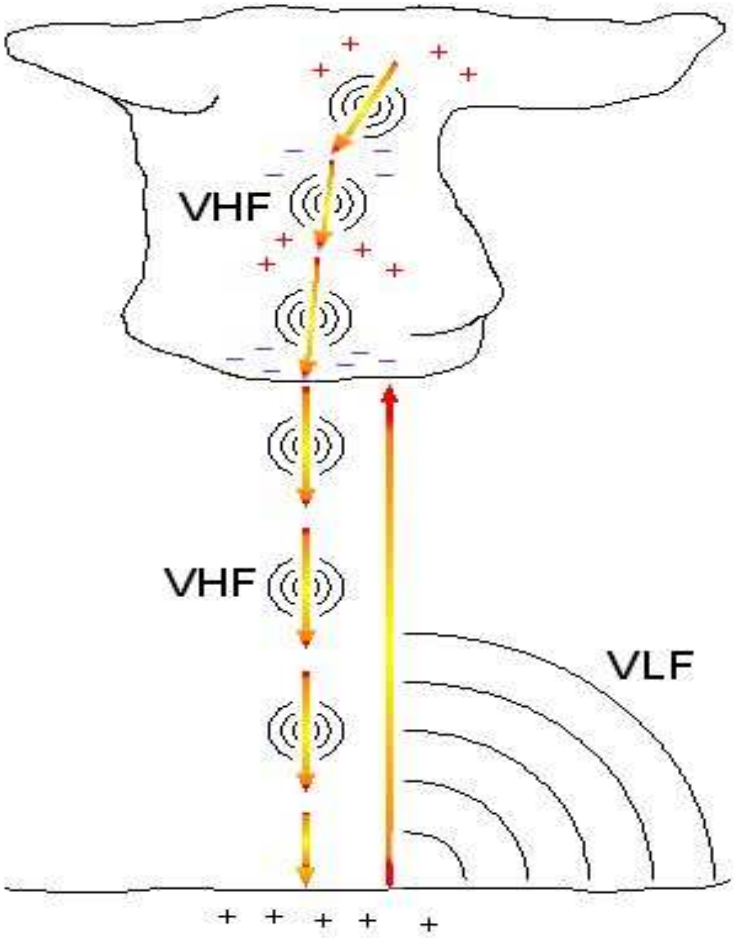
After a strong return stroke (left) a weak ground stroke occurs after 2 ms and several km in a separate left of the previous return stroke (positions marked by the arrows)



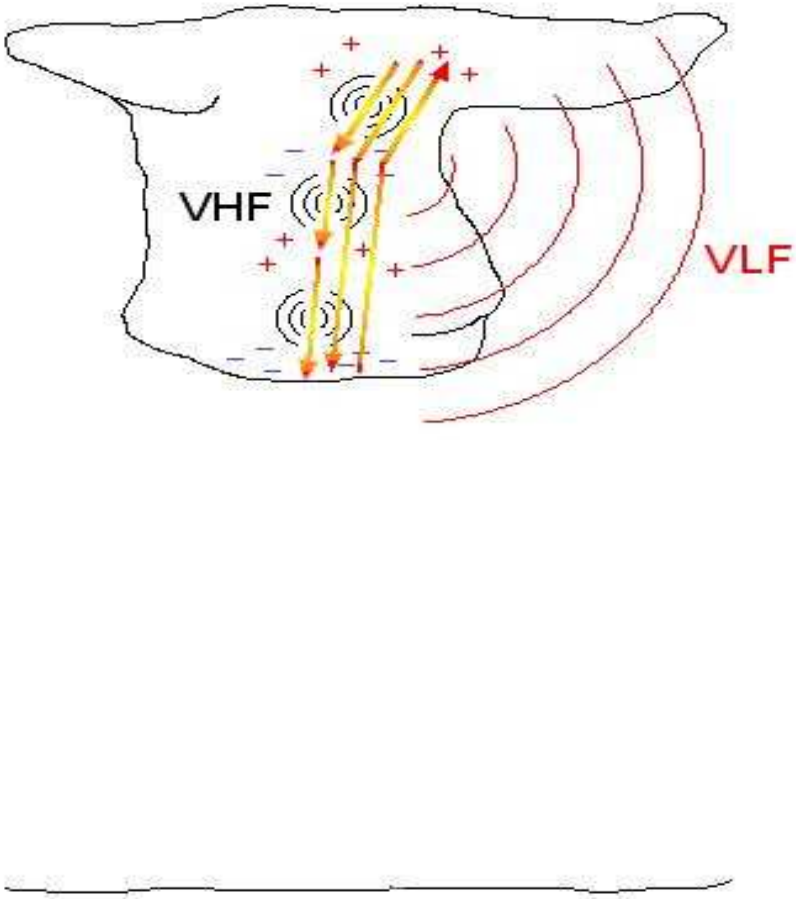


VHF and VLF/LF Emission

CG



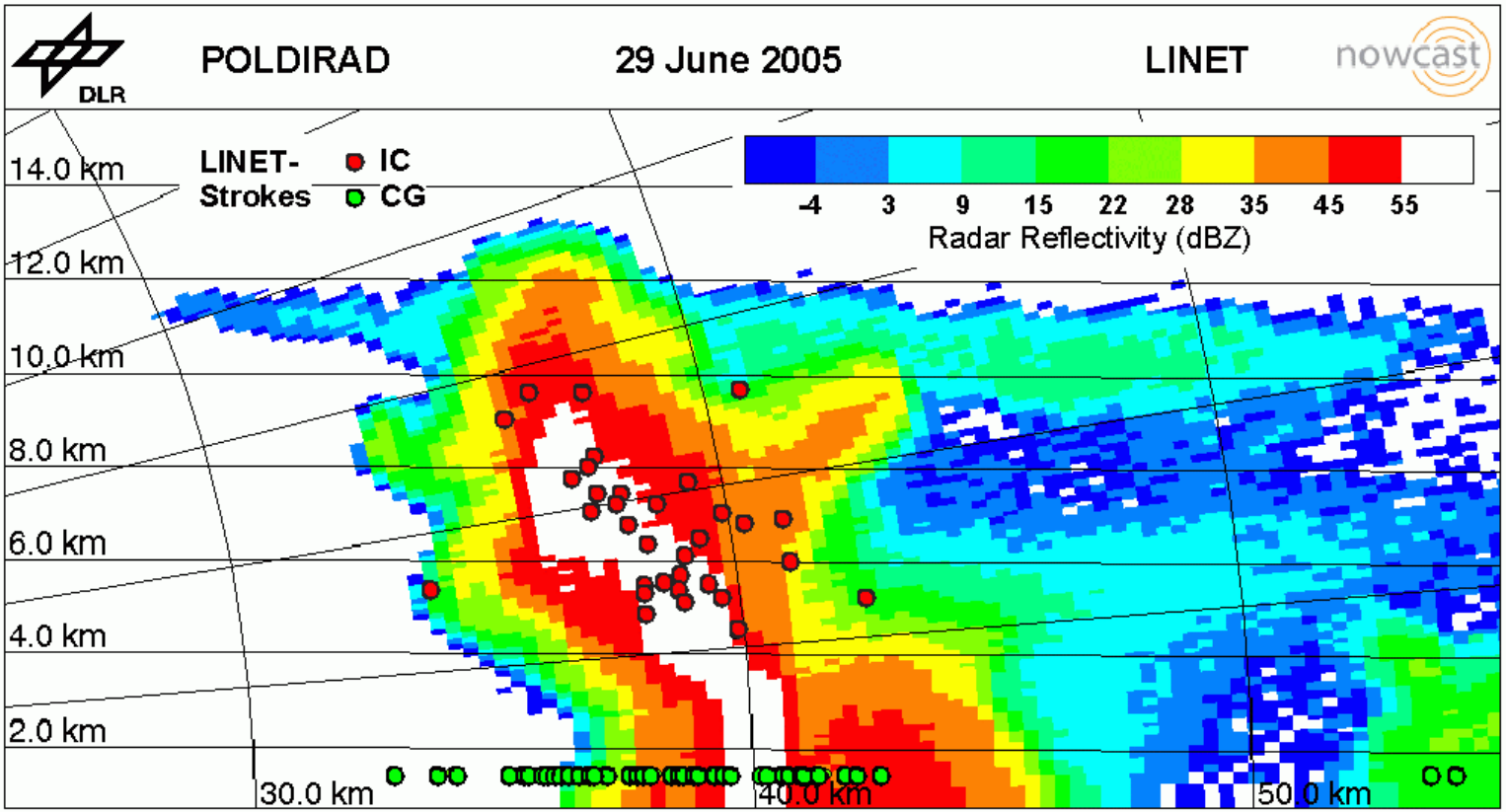
IC



Lightning and Radar

LINET – Lightning Detection Network (nowcast GmbH)
3D information for cloud- and ground strokes

Polarisation radar POLDIRAD (DLR)
Identification of different hydrometeors

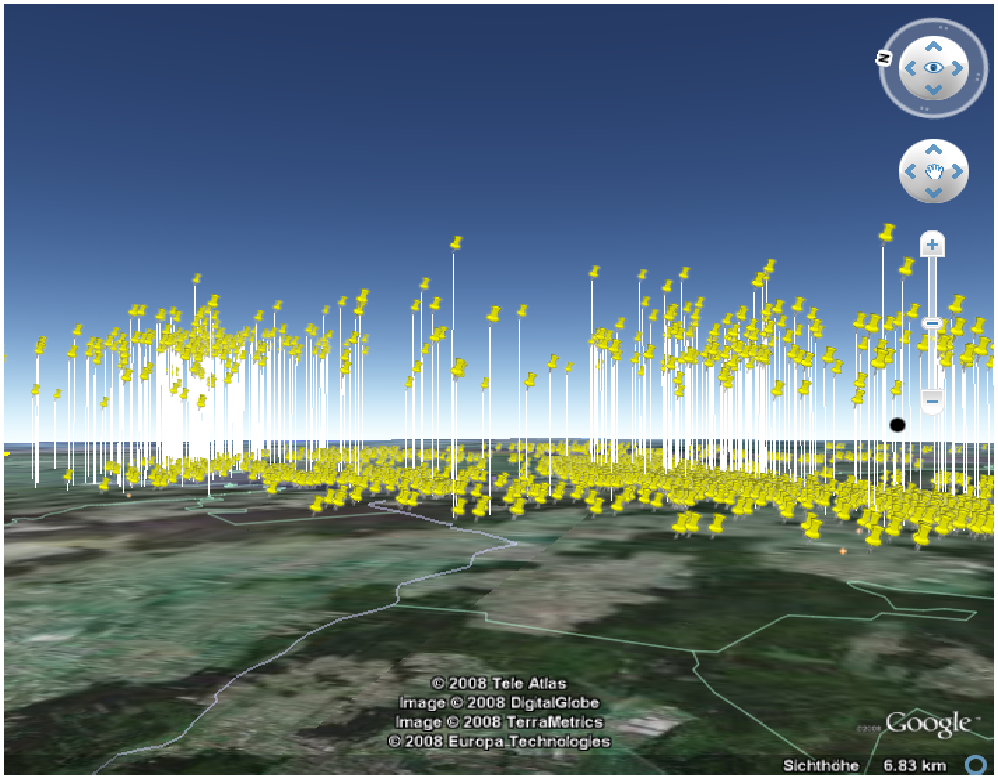


Vertical cut
289° azimuth
LINET strokes (2 min)
13:57 UTC
29 June 2005
cloud strokes (red)
ground strokes (green)

IC heights agree with high-reflectivity areas

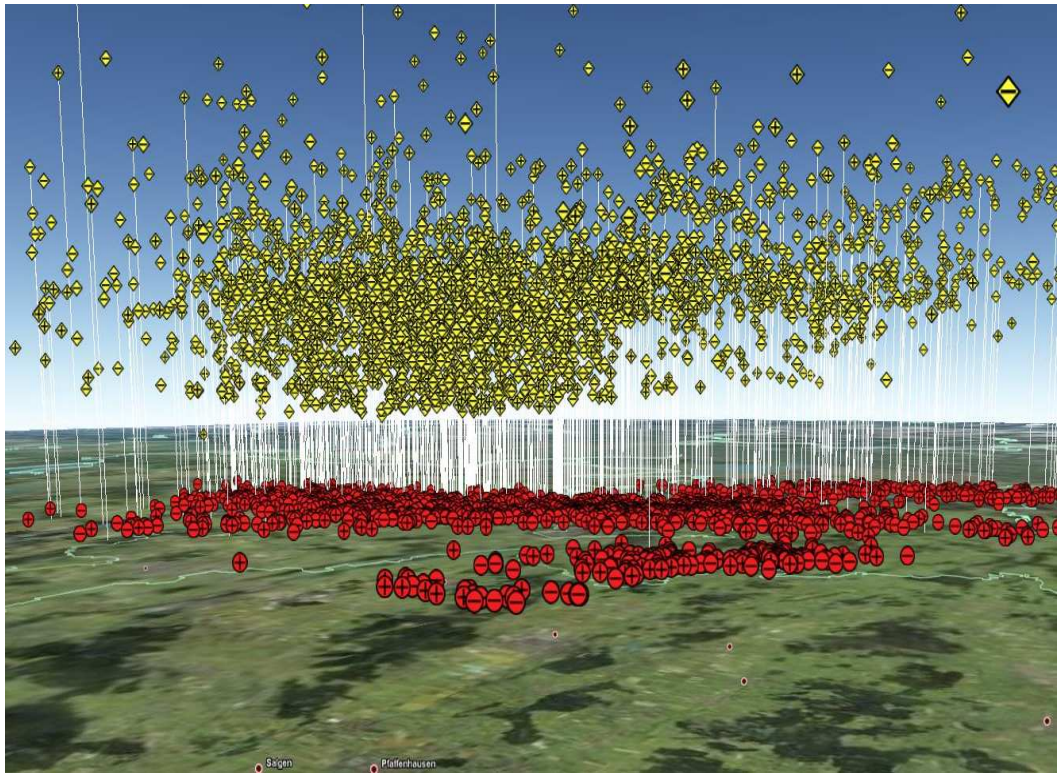
3D-Visualization of Ground- and Cloud Strokes

‚normal' storm



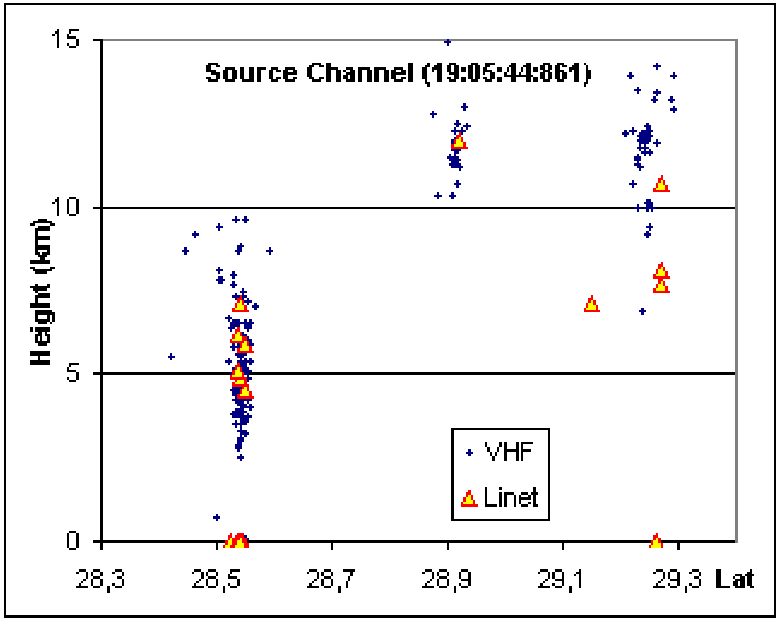
few IC

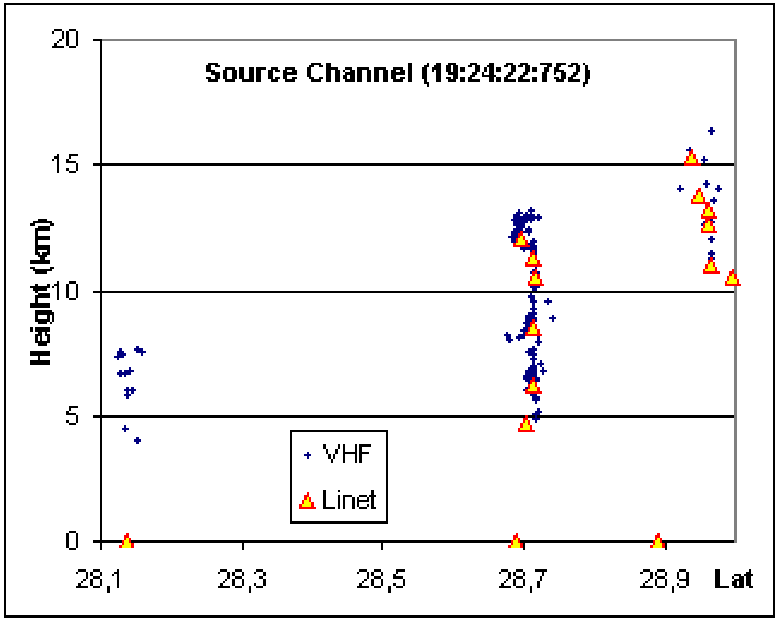
severe weather

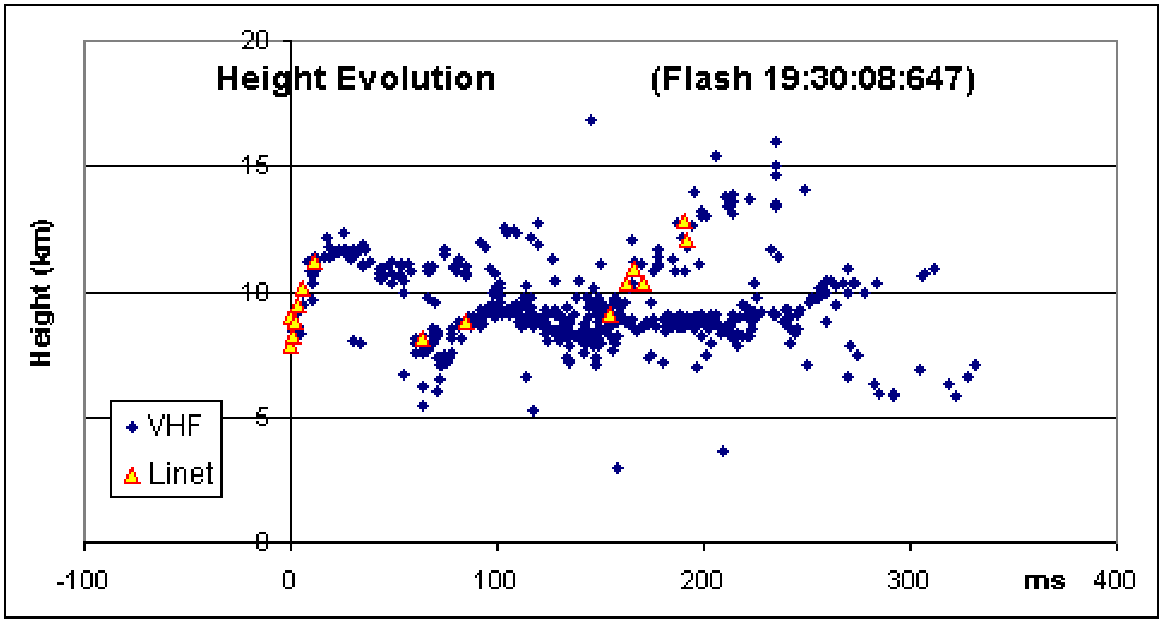


many IC

LADAR-II and LINET -- VHF and VLF/LF



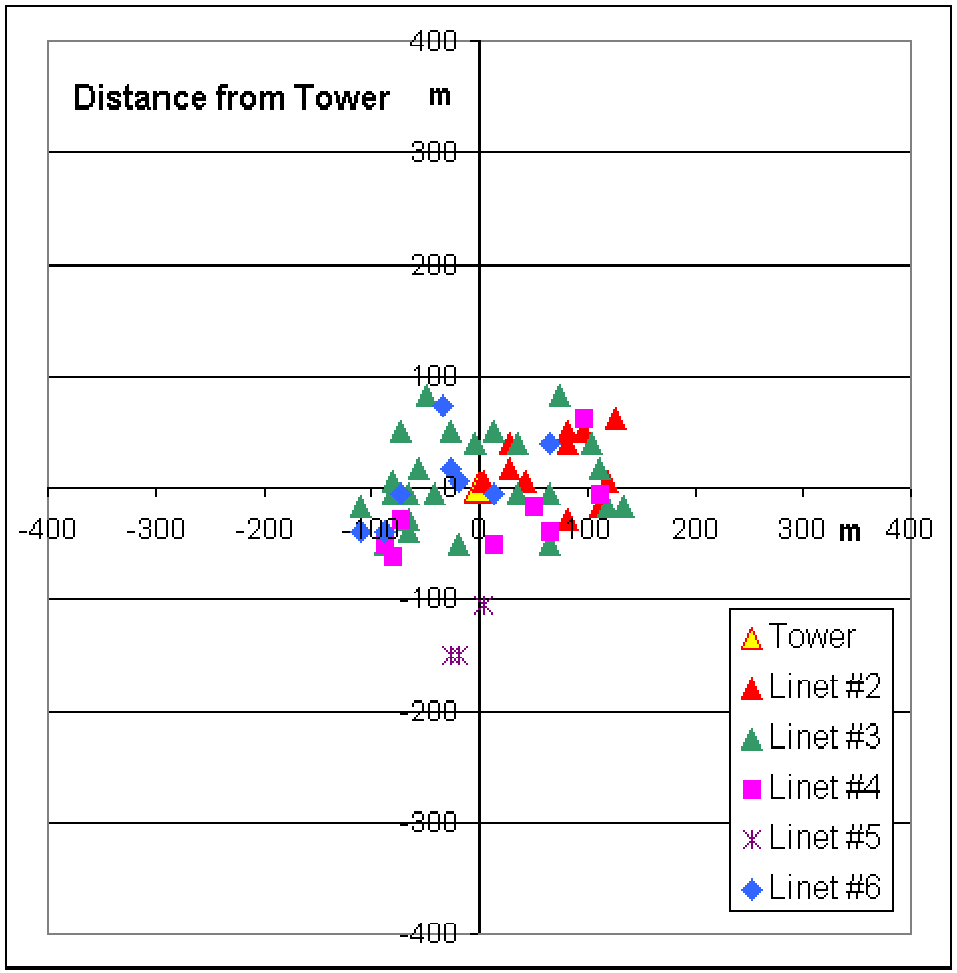




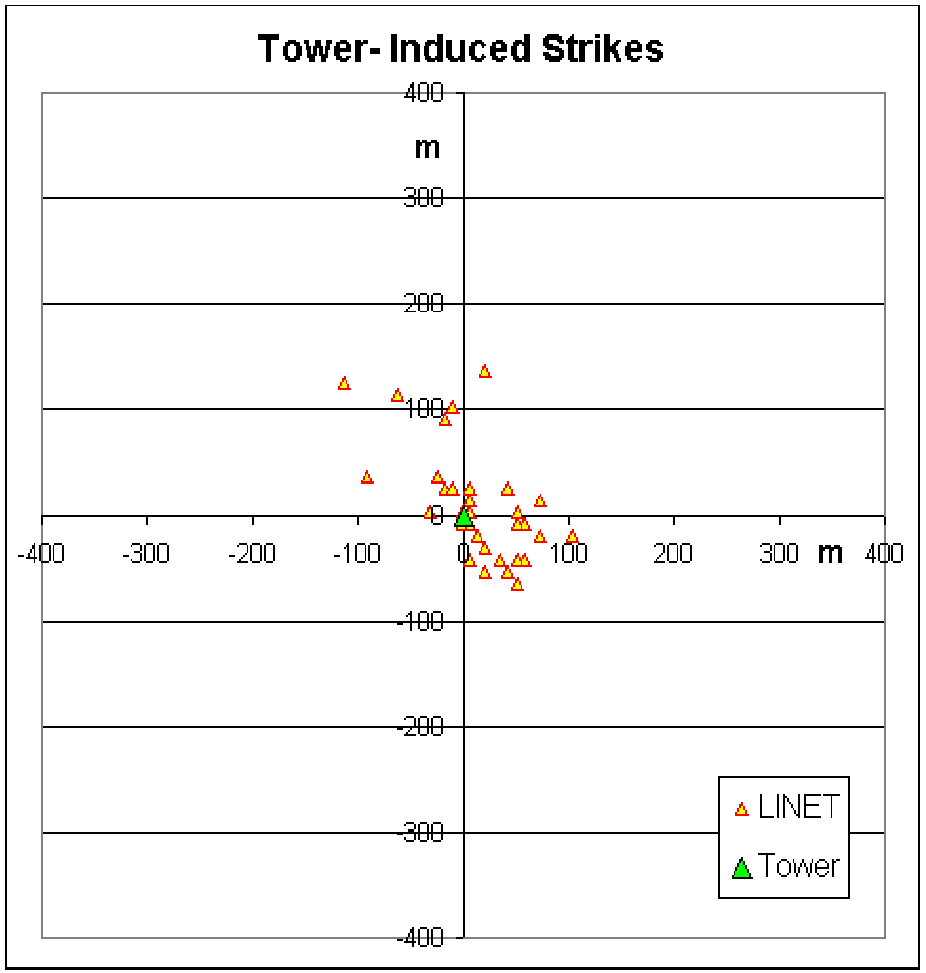
Location Accuracy

Locating Strikes into Towers

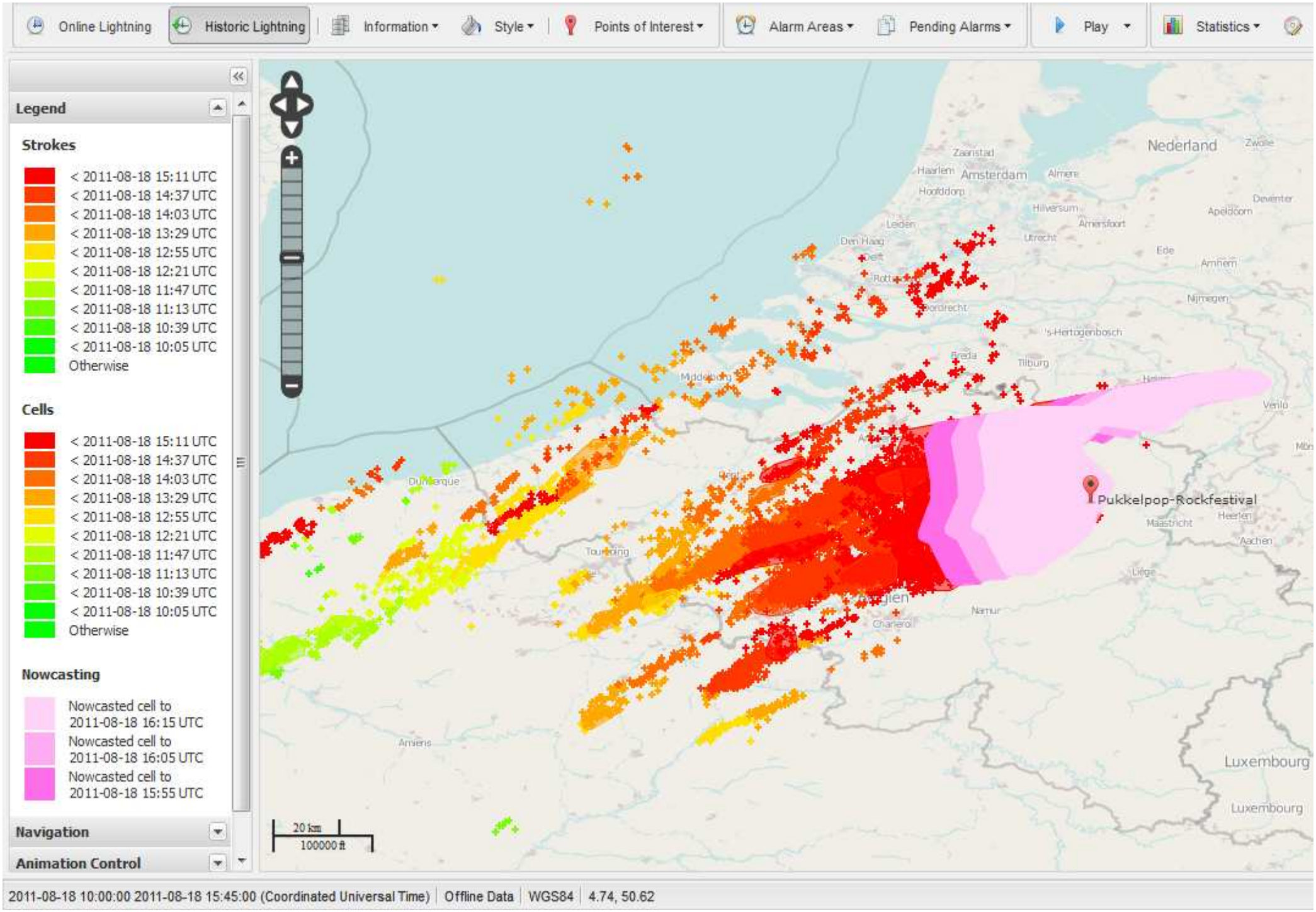
error below 100 m, after site-error correction



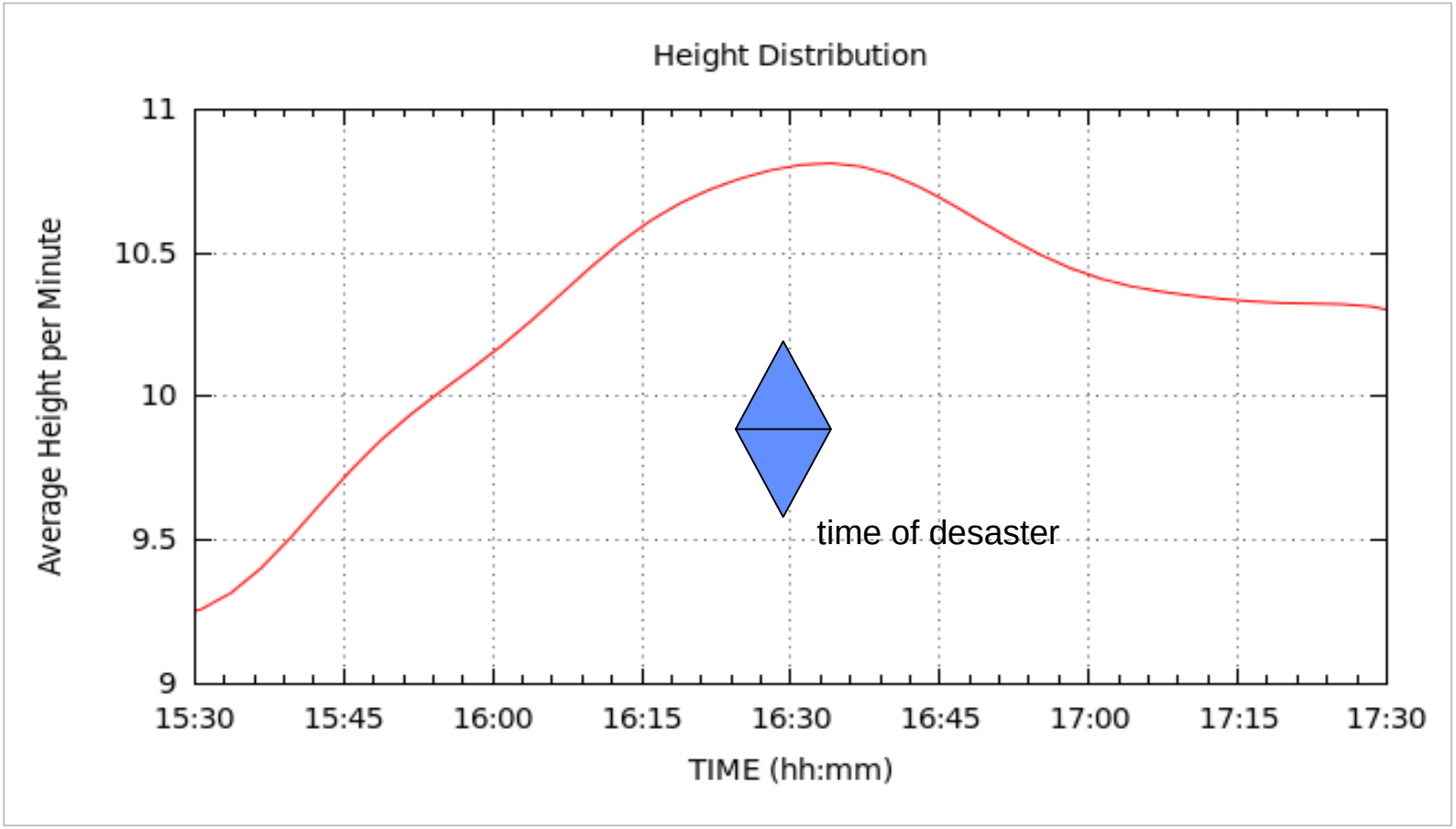
Slovenia; 01 Januar 2007



Gaisberg, Austria, 2007


Online Lightning
Historic Lightning
Information
Style
Points of Interest
Alarm Areas
Pending Alarms
Play
Statistics
Legend
Strokes
< 2011-08-18 15:11 UTC
< 2011-08-18 14:37 UTC
< 2011-08-18 14:03 UTC
< 2011-08-18 13:29 UTC
< 2011-08-18 12:55 UTC
< 2011-08-18 12:21 UTC
< 2011-08-18 11:47 UTC
< 2011-08-18 11:13 UTC
< 2011-08-18 10:39 UTC
< 2011-08-18 10:05 UTC
Otherwise
Cells
< 2011-08-18 15:11 UTC
< 2011-08-18 14:37 UTC
< 2011-08-18 14:03 UTC
< 2011-08-18 13:29 UTC
< 2011-08-18 12:55 UTC
< 2011-08-18 12:21 UTC
< 2011-08-18 11:47 UTC
< 2011-08-18 11:13 UTC
< 2011-08-18 10:39 UTC
< 2011-08-18 10:05 UTC
Otherwise
Nowcasting
Nowcasted cell to 2011-08-18 16:15 UTC
Nowcasted cell to 2011-08-18 16:05 UTC
Nowcasted cell to 2011-08-18 15:55 UTC
Navigation
Animation Control
Nederland
Amsterdam
Pukkelpop-Rockfestival
Luxembourg
20 km
100000 ft
2011-08-18 10:00:00 2011-08-18 15:45:00 (Coordinated Universal Time)
Offline Data
WGS84
4.74, 50.62

Severe Weather – Evolution of IC-Heights



Pukkelpop – Desaster, Belgium, 18 August 2011

nowcasted by LINET IC-Rates and IC-Heights