Los Alamos Sferic Array Investigation of Lightning VLF/VHF Phenomenology

Los Alamos NATIONAL LABORATORY
LAUR-00-4198

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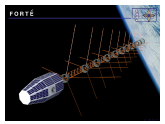
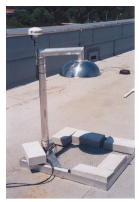


FORTE Satellite


LASA Station

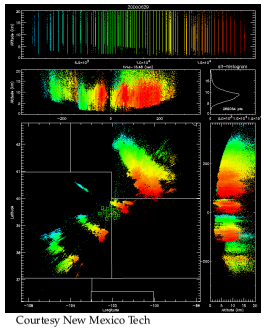
Abstract

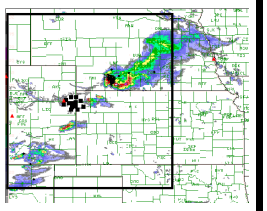
The Los Alamos Sferic Array consists of eleven VLF electric field change meters that have been operated continuously since Spring 1997. The primary purpose for the design and deployment of the Los Alamos Sferic Array (LASA) has been to support observations by the FORTE satellite, which has both VHF and optical sensors. In April 1998, five sferic array stations were located in Florida, one of the specific purposes being to attempt coincident observations with the Kennedy Space Center Lightning Detection and Ranging (LDAR) system. Prior to the 2000 North American summer, three of the LASA stations were moved to Colorado for the purpose of conducting coincident studies with the wide range of instruments that were part of the Severe Thunderstorm Electrification Study (STEPS) campaign, and specifically with the Lightning Mapping Array (LMA) operated by New Mexico Tech.

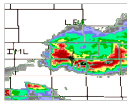
Both the LDAR and LMA sensors record VHF emissions associated with lightning discharge processes (at ~66 MHz). The Los Alamos Sferic Array electric field change meters record sferic (VLF) signals (between ~300 Hz - 500 kHz). Understanding the relationship between the LDAR and LMA VHF observations and the much lower frequency lightning observations of the Los Alamos Sferic Array provides insight into lightning discharge processes, and specifically into interpretation of coincident FORTE (VHF) and National Lightning Detection Network (VLF) observations (also presented at Fall AGU 2000).

STEPS Results

During the 2000 STEPS campaign, 3 LASA stations were deployed in Colorado for coordinated lightning observations. The June 29, 2000 lightning activity recorded by LASA included a 10 minute period (23:19 - 23:29 UT) with 49 Narrow Bipolar Events (NBE, see [2]), compared to only 37 non-NBE events. A tornado occurred between 23:29 and 23:44 and is analyzed by Harlin *et al*, poster A52C-25, this session. No LASA events were recorded from the tornadic cell, while the large number of NBEs were observed in a larger cell at a greater distance from the KI LASA station. The LMA, LASA, and RADAR composite observations are presented.

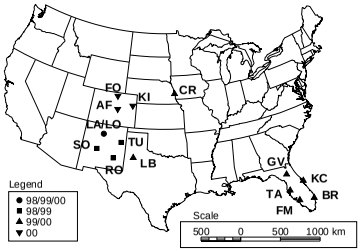

Courtesy New Mexico Tech

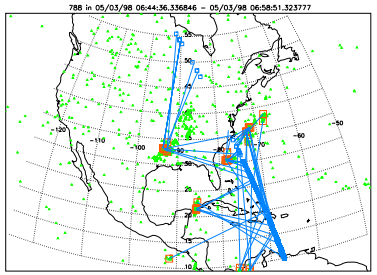

Above: RADAR Summary, LMA Stations (black squares), LASA stations(red triangles), LASA NBEs (black 'P's), LASA non-NBEs (black dots).


Left: LMA
Right: RADAR w/ NBEs

Los Alamos Sferic Array

The locations of the LASA stations are shown at right. Each station is comprised of a flat plate electric field antenna, a GPS for timestamp accuracy greater than 2 μs, and a computer for collecting data and providing remote operation capabilities. The 1998 and 1999 array operations are described by [1].

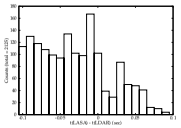


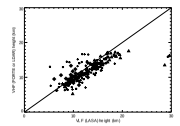


Motivation

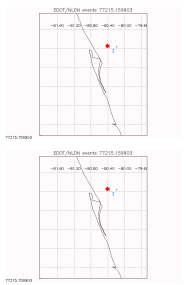
The Los Alamos Sferic Array was originally deployed for ground truthing of the FORTE satellite lightning observations. Studies of coincident National Lightning Detection Network (NLDN) and FORTE observations found that FORTE and NLDN have reasonable coincident observation of some storms while other storms are apparently missed. One example FORTE overpass (~ 14 min.) is shown at left (see Jacobson *et al.*, A52C-20, this session).

Florida/KSC LDAR Results


LASA/LDAR Event Time Difference


VLF/VHF Event Height Comparison

The 1999 LASA Florida expansion provided coordinated observations with the Kennedy Space Center (KSC) Lightning Detection and Ranging (LDAR) system. At left, the histogram of delays between LDAR and LASA events associated with LASA Narrow Bipolar Events (NBE) are shown. The temporally nearest LDAR event height is plotted as a function of the LASA derived height, overplotted on the FORTE/LASA height distribution for NBEs. At right, two examples of the LASA, LDAR, and NLDN observations for .5 s of a lightning flash is presented.



Conclusions

The 2000 STEPS results identify a storm with strong VHF emissions and no recorded VLF triggers, reflecting cases with FORTE RF events without coincident NLDN VLF events. Closer examination of the storm is underway. The Florida/KSC results show: 1. the height distribution of the closest temporal LDAR VHF source vs LASA VLF/LF Narrow Bipolar source is reasonably consistent with earlier EDOT/FORTE comparisons of height; 2. Work remains to understand the exact VLF/LF emission source and the VHF emissions recorded by LDAR.

References

[1] D. A. Smith, K. B. Eack, J. Harlin, M. J. Heavner, A. R. Jacobson, R. S. Massey, X. M. Shao, and K. C. Wiens. The Los Alamos Sferic Array: Ground truth for the FORTE satellite. *J. Geophys. Res.*, 2000. in preparation.

[2] D. A. Smith, X. M. Shao, D. N. Holden, C. T. Rhodes, M. Brook, P. R. Krehbiel, M. Stanley, W. Rison, and R. J. Thomas. A distinct class of isolated intracloud lightning discharges and their associated radio emissions. *J. Geophys. Res.*, 104(D4):4189–4212, February 1999.