The Initial Test Deployment of a 2nd-generation Broadband VHF Interferometer System

Authors

Dr. Mark Stanley - Langmuir Laboratory for Atmospheric Research, New Mexico Institute of Mining and Technology

Prof. Paul Krehbiel - Langmuir Laboratory for Atmospheric Research, New Mexico Institute of Mining and Technology

Dr. Harald Edens - Langmuir Laboratory for Atmospheric Research, New Mexico Institute of Mining and Technology

Mr. Daniel Rodeheffer - Langmuir Laboratory for Atmospheric Research, New Mexico Institute of Mining and Technology

Prof. William Rison - Langmuir Laboratory for Atmospheric Research, New Mexico Institute of Mining and Technology

Abstract

In October of 2018, a new 2nd-generation broadband VHF system was deployed for initial tests at the Magdalena Airport in New Mexico. The system utilizes a custom inverted-V antenna design which is sensitive to one horizontal polarization with a broad and uniform gain pattern which is peaked at the zenith. The antenna was modeled after the Long Wavelength Array (LWA) antennas and Low Frequency Array (LOFAR) antennas in particular, but was scaled down in size by about 40% in order to have a more uniform gain pattern at higher frequencies of up to 150 MHz. Particular attention was paid in the design to making the antennas rigid as well as lightweight and portable for future deployments.

Five VHF antennas were placed at near uniform separations along the perimeter of a 25 meter radius circle with a sixth VHF antenna placed at the center. This created a total of 15 baselines which could be used for primitive 2D imaging of VHF non-point sources. A few days later, a seventh VHF antenna was added about 125 meters to the northeast of the central antenna in order to add 6 additional longer baselines. This was motivated in part to test more advanced techniques such as the 3D location of VHF sources within a few kilometers of the system.

The antenna bandwidth extended from a few MHz up to about 150 MHz. The raw VHF data from all 7 antennas was simultaneously sampled with 14-bit resolution at 360 MHz. This was double the sample rate of the prior generation interferometer system. Like the earlier system, a broadband VHF trigger in software was used to trigger the system. The pre- and post-trigger lengths were set to 0.4 and 0.7 seconds, respectively, which was usually sufficient to capture continuous data for entire flashes. Precise timing from a GPS unit was integrated directly into the data stream for absolute timing accuracy which is potentially on the order of a few nanoseconds.

Over 1200 lightning flashes triggered the system in the 16 days that it was operational between October 13th and 29th. This amounted to 7.9 TB of data. While most of the flashes were distant, there were several flashes on October 23rd which were within a few kilometers of the system. The advantages of the new antenna design were immediately obvious with improved sensitivity for all but the lowest elevation angles. Lightning channels were mapped in great detail up to high elevation angles where the older flat plate antenna design had a sensitivity null.

Topic Areas

Lightning Detection Systems Technology and Performance

Submission Format

Oral