Title: Houston Lightning Mapping Array Flash-level data

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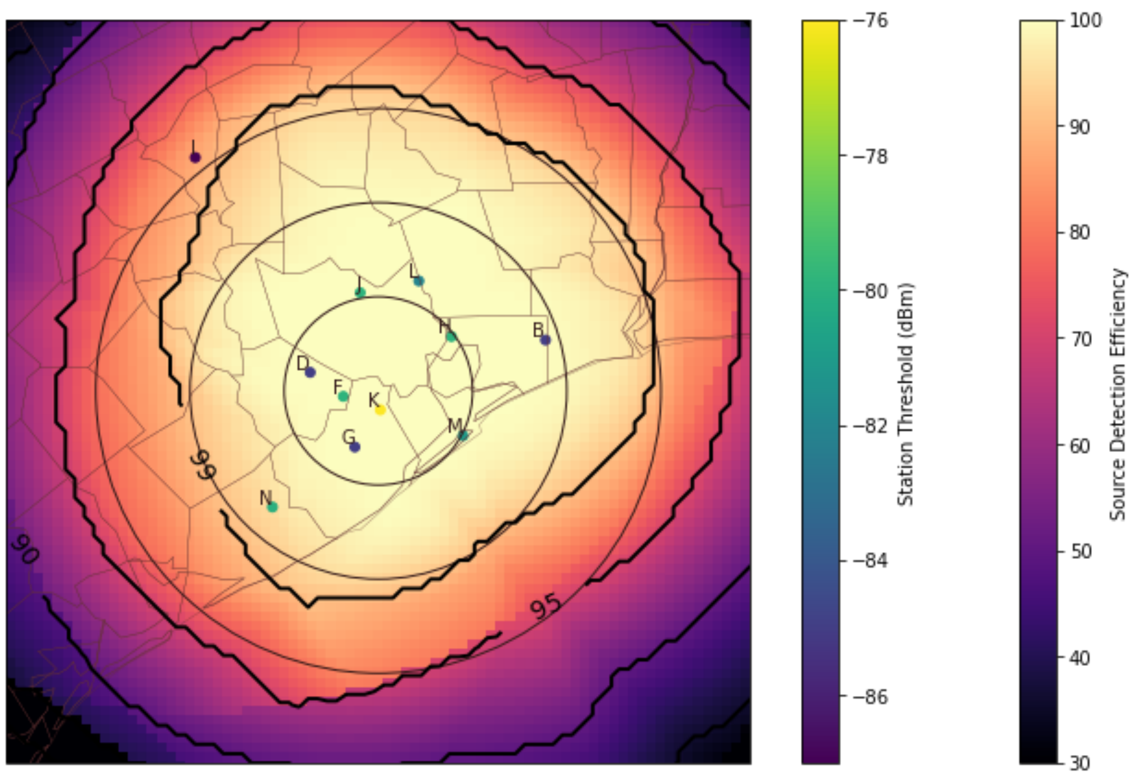
1.0 Data Set Description

- This document describes post-processed (L2+) data from the Houston Lightning Mapping Array, processed uniformly with reasonable default quality control parameters. Included are VHF sources (events), flashes, and gridded accumulations of event and flash data. Data include the NSF ESCAPE IOP period (June 2022) and the remaining DOE TRACER IOP period (July-Sep 2022)
- Data Status: ***Preliminary***
- Version 0.7, 12 October 2022
- Time coverage: Days with lightning during June and July 2022 (future preliminary v. 0.8 will add August, 0.9 will add September). Complete version 1.0 will include June-Sep 2022, including all non-lightning days.
- Network center: 29.7600000, -95.3700000, -200.00 m (lat/lon/elev, WGS84)
- Data Frequency: Continuous
- Data source: Texas A&M University, Texas Tech University
- HLMA website: http://lightning.tamu.edu
  ESCAPE website: https://www.eol.ucar.edu/field_projects/escape
  TRACER website: https://www.arm.gov/research/campaigns/amf2021tracer
- Please cite dataset DOI provided by NCAR/EOL. Dataset dissemination is according to the ESCAPE field project data policy, with restrictions for the initial post-field period as documented therein.

2.0 Instrument Description

- The Houston Lightning Mapping Array (LMA) as in this dataset is a network of eleven radio receivers in the 60-66 MHz band that locate lightning channels in space (3D) and time by time-of-arrival geolocation of radio noise sources produced as lightning channels develop. From June-Sep 2022, the network was supplemented by two stations (station codes B, G, near Angleton, TX and Winnie, TX) from Texas Tech University. These stations replaced two others that were down for maintenance during the project period. The HLMA shares its basic functionality and data quality characteristics with other LMAs, as documented in, for example, Rison et al. (1999), Thomas et al. (2001), Thomas et al. (2004) and Chmielewski and Bruning (2016). The channels are only mapped along line of sight, and detect channels that are part of both in-cloud and cloud-to-ground discharges. The instrument is not optimized to detect ground strike locations, which are better mapped by commercial, operational LF/VLF systems.



The figure above shows the estimated (method of Chmielewski and Bruning, 2016) flash detection efficiency (black contours) source detection efficiency (purple-yellow shading) and the location and receiver threshold at each LMA station, indicted by their letter codes. Range rings from the CSAPR radar are shown at 50, 100, and 150 km.

- Typical Performance:
  - Flash detection efficiency: >99% over the network, decreasing with range
  - Range: 3D mapping to 100 km from network center, 2D to 300 km.
  - Timing precision: 25 ns
  - Location precision: <100 m over the network, increasing with range.
  - Located VHF sources per lightning flash: 100s (range: 1 to 1000s)

3.0 Data Collection and Processing

- Data were collected continuously and autonomously at each LMA station, and full-quality raw trigger data were transmitted daily over a cellular modem to a central processing computer. Raw data files from each station were processed at TAMU into VHF source locations (see the “event_algorithm_name” and “history” global attributes), and stored as ASCII data files. TTU further processed these ASCII data files to cluster sources into flashes using the pyxlma DBSCAN algorithm (see the “flash_algorithm_name” global attribute; this is essentially the flash algorithm in Fuchs et al., 2016) to identify flash properties, and to produce gridded spatiotemporal products from these flashes. Parameters used in flash processing and gridding are described in the data format section below.
- Data intercomparisons: None

4.0 Data Format

- Data files are in NetCDF format, with the structure as indicated by ncdump or similar utilities. Key features are described here.
  - There are event (VHF source), flash (clustered sources, with minimum 10 events per flash, 6 contributing stations, and a chi-sq maximum of 1.0), and LMA station dimensions, which are primiarly associated with 1D variables that serve as columns in a tabular data layout. Each event_id is linked by event_parent_flash_id to a flash given by flash_id. The 2D variable event_contributing_stations with values of 0 or 1 indicates which station contributed to each event, and are summed in the variable event_stations.
  - There are several dimensions associated with gridded variables that accumulate event and flash properties on a 500 m, 5 min grid in various ways. The grid is defined in an azimuthal equidistant projection with a spherical earth of radius 6367.0 km, centered at lat = 29.47190094, lon=-95.07873535. 2D latitude and longitude variables are provided to indicate the center location of each grid box, with latitude and longitude defined for a spherical earth of radius 6367.0 km.
    - For convenience, both grid box center and grid box edge locations are provided for the grid projection and time coordinates.
  - Events not assigned to a flash are given the ID -1.

5.0 Data Remarks

- PI's assessment of the data (i.e., disclaimers, instrument problems, quality issues, etc.): No known issues at this time.
- Missing data periods, if applicable: Days without lightning were not processed into flash-level files for preliminary use but will be added to the final dataset.
- The flash-level LMA data files are standard NetCDF files, and so can be read by one of the many NetCDF readers that are widely available.

- A description of the LMA, its low-level data files, data processing, and the flash-level dataset described in this document is available at https://github.com/deeplycloudy/lmaworkshop/tree/master/TRACER-2021. Following the README and Agenda will produce a working software environment for using these data.
- The primary package for working with these data files is pyxlma (https://github.com/deeplycloudy/xlma-python). A preliminary sample notebook using pyxlma to display these data alongside other ESCAPE and TRACER field campaign data is available at https://github.com/deeplycloudy/TRACER-PAWS-NEXRAD-LMA/blob/main/notebooks/LMA-radar-aircraft-quicklook.ipynb.

6.0 References

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7.0 Appendix

Suggested GCMD Keywords: LIGHTNING, URBAN AREAS