

Title: The North Alabama Lightning Mapping Array (NALMA) dataset

Updated 14 December 2017: Update includes additional source-level and flash-processed data from mobile LMA sensors for IOPs 0-1 through 7.

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1.0 Data Set Overview:

This dataset is source-level and flash-level measurements from the North Alabama Lightning Mapping Array. For the following dates and time periods, either quality-controlled or decimated VHF source data and lightning flash data are provided. The flash data were obtained via a flash clustering algorithm that groups sources using spatial and temporal constraints.

Center of LMA: 34.7246100 -86.6453300

Data source: NASA MSFC

LMA website: <https://ghrc.nsstc.nasa.gov/pub/lma/nalma/solutions/data>

- IOP_0-0: 2/23-2/24/16; 2200-1200 UTC
- IOP_0-1: 3/1-3/2/16; 1500-0500 UTC
- IOP_1: 3/14/16; 0500-1200 UTC
- IOP_2: 3/24-3/25/16; 0900-0100 UTC
- IOP_3: 3/31-4/1/16; 1700-0700 UTC
- IOP_4: 4/27-4/28/16; 1800-0500 UTC
- IOP_5: 4/29-4/30/16; 1600-0300 UTC
- IOP_6: 4/30/16; 1600-0000 UTC
- IOP_7: 5/1/16; 1600-2300 UTC

2.0 Instrument Description:

Instrumentation overview and information: <http://weather.msfc.nasa.gov/sport/lma/>

Table of specifications and limitations: see Koshak et al. 2004, JTECH, Vol .21, 543-558.

3.0 Data Collection and Processing:

Long-term data collection occurs through 11 sensors across North Central Alabama, one sensor in South Tennessee, and two sensors near Atlanta, Georgia. Additional mobile sensors were deployed by NASA and Texas Tech University during the VORTEX-SE field project. The number of active mobile sensors contributing to source location solutions varied between IOPs. Information about active sensors specific to each hour of data collection is available in the header of each source-level data file. Sensors in the network each sample peak VHF radiation during the breakdown of lightning in 80 μ s intervals. Decimated data is relayed in wider intervals for more efficient communication. In practice, at least six sensors are used to retrieve the location of each source using a time of arrival technique documented by Thomas et al. (2004). The McCaul et al. (2009) algorithm is implemented to cluster sources into flashes.

The following articles provide more information on LMA technology:

Rison et al. 1999, GRL, VOL. 26, NO. 23, PAGES 3573-3576, DECEMBER 1, 1999

Krehbiel et al. 2000, EOS, Vol 81, No. 3, 21-32

Thomas et al. 2001, GRL, VOL. 28, NO. 1, PAGES 143-146, JANUARY 1, 2001

Thomas et al. 2004, JGR, VOL. 109, D14207, doi:10.1029/2004JD004549, 2004

Please contact Jeff Bailey (email: Jeffrey.C.Bailey@nasa.gov, collection of data), for specific details on the collection or reprocessing procedure.

4.0 Data Format:

4.0.1 NALMA VHF Sources

Data file structure is ASCII. Processed data are of the format “nalma_lylout_yyyymmdd_hh_duration(secs).dat” for hourly processed data.

Data Format: Length of header information varies in each VHF source file, depending on the number of stations in the array at the time of data collection. Header information includes the following:

LMA center location

Station location

Station status

Number of sources detected by each station

Chi-squared used in reprocessing

Minimum number of stations used in processing

List of parameters with units, sampling intervals, frequency, range:

Sampling rate: 80 μ s

Range: Koshak et al. 2004, JTECH, notes location errors of < 500 m in the horizontal and <1000 m in the vertical error within 150 km of the center of the LMA. Data are most accurate within 150 km of the LMA center.

ASCII Columns:

time (UTC sec of day), latitude (decimal degrees), longitude (decimal degrees), altitude (m), reduced χ^2 (unit less), Power (dBW), mask (unit less)

format(f15.9 f10.6 f11.6f 7.1 f5.2 f5.1 4x)

4.0.1 NALMA Flashes

Two types of flash-sorted data are available, one in which each source is listed along with the flash number to which it was assigned and one in which information concerning the initiation source point of each flash is listed along with the number of sources comprising the flash. Data file structure of available hourly flash-sorted source and flash files is ASCII. The file naming convention for these is “sorted_sources_yyyymmdd_hh.dat” and “sorted_flashes_yyyymmdd_hh.dat” for flash-sorted source and flash files, respectively. Each file has a one-line header with the ASCII column information. Additionally, all sources and flashes for each IOP are provided in single continuous files, labeled “all_sorted_source_IOP_x.dat” and “all_sorted_flash_IOP_x.dat,” respectively.

ASCII Columns (hourly sorted sources):

time (UTC sec of day), latitude (decimal degrees), longitude (decimal degrees), altitude (km), number of stations that detected source (unit less), flash number to which the source belongs (unit less)

format(f11.5 f7.4 f9.4 f7.3 i4 i7)

ASCII Columns (hourly sorted flashes):

time (UTC sec of day), latitude (decimal degrees), longitude (decimal degrees), altitude (km), number of sources in the flash (unit less), consecutive flash number in the file (unit less)

format(f11.5 f7.4 f9.4 f7.3 i4 i7)

ASCII Columns (IOP-cumulative sorted sources):

date (UTC) time (UTC sec of date), latitude (decimal degrees), longitude (decimal degrees), altitude (m), number of stations that detected source (unit less), flash number to which the source belongs (unit less)

format(i8 f11.5 f7.4 f9.4 f7.1 i4 i7)

ASCII Columns (IOP-cumulative sorted flashes):

date (UTC) time (UTC sec of date), latitude (decimal degrees), longitude (decimal degrees), altitude (m), number of sources in the flash (unit less), consecutive flash number in the file (unit less)

format(i8 f11.5 f7.4 f9.4 f7.1 i4 i7)

VHF sources with the same “flash number” belong to the same flash according to the clustering criteria of McCaul et al. (2005). As noted earlier, no minimum source number per flash has been applied to the hourly flash files. We recommend defining valid flashes as containing ≥ 10 sources per flash to mitigate the presence of noise. The more experienced NALMA data user may wish to use a different source number per flash threshold to define a valid lightning flash, which is why all potential flashes are provided regardless of number of sources.

5.0 Data Remarks:

Missing data periods: No missing data period from the times provided. NALMA stations that are not active and do not contribute to source identification and location solutions are marked in the header section of the source files. There is a column that lists the number of sources detected as well. A number of 0 in this column corresponds to a down station.

Software compatibility (i.e., existing software to view/manipulate the data): XLMA software package. Contact Dr. Ron Thomas, New Mexico Tech, to obtain the software (Email: thomas@nmt.edu).

6.0 References:

Koshak et al. 2004, JTECH, Vol .21, 543-558
Krehbiel et al. 2000, EOS, Vol 81, No. 3, 21-32
McCaul et al. 2009, WF, VOL. 24, PAGES, 709–729, JUNE 2009
Rison et al. 1999, GRL, VOL. 26, NO. 23, PAGES 3573-3576, DECEMBER 1, 1999
Thomas et al. 2001, GRL, VOL. 28, NO. 1, PAGES 143-146, JANUARY 1, 2001
Thomas et al. 2004, JGR, VOL. 109, D14207, doi:10.1029/2004JD004549, 2004