



Data User Guide

Lightning Instrument Package (LIP) ***IMPACTS***

Introduction

The Lightning Instrument Package (LIP) IMPACTS dataset consists of electrical field measurements of lightning and navigation data collected by the Lightning Instrument Package (LIP) flown onboard the NASA ER-2 aircraft during the Investigation of Microphysics and Precipitation for Atlantic Coast-Threatening Snowstorms (IMPACTS) field campaign. IMPACTS was a three-year sequence of winter season deployments conducted to study snowstorms over the U.S. Atlantic coast (2020-2022). IMPACTS aimed to (1) Provide observations critical to understanding the mechanisms of snowband formation, organization, and evolution; (2) Examine how the microphysical characteristics and likely growth mechanisms of snow particles vary across snowbands; and (3) Improve snowfall remote sensing interpretation and modeling to significantly advance prediction capabilities. The V2 LIP IMPACTS data have been further filtered to remove field mill offsets that were identified in the prior V1 data. These data are available from January 15 through February 27, 2020 in ASCII format.

Notice:

This dataset is not continuous as flights did not occur every day.

Citation

Mach, Douglas, Monte Bateman, and Christopher Schultz. 2020. Lightning Instrument Package (LIP) IMPACTS [indicate subset used]. Dataset available online from the NASA Global Hydrology Resource Center DAAC, Huntsville, Alabama, U.S.A. doi: <http://dx.doi.org/10.5067/IMPACTS/LIP/DATA101>

Keywords:

NASA, GHRC, IMPACTS, LIP, lightning, radiance, electrical field

Campaign

The Investigation of Microphysics and Precipitation for Atlantic Coast-Threatening Snowstorms (IMPACTS), funded by NASA's Earth Venture program, is the first comprehensive study of East Coast snowstorms in 30 years. IMPACTS will fly a complementary suite of remote sensing and in-situ instruments for three 6-week deployments (2020-2022) on NASA's ER-2 high-altitude aircraft and P-3 cloud-sampling aircraft. The first deployment began on January 17, 2020 and ended on March 1, 2020. IMPACTS samples U.S. East Coast winter storms using advanced radar, LiDAR, and microwave radiometer remote sensing instruments on the ER-2 and state-of-the-art microphysics probes and dropsonde capabilities on the P-3, augmented by ground-based radar and rawinsonde data, multiple NASA and NOAA satellites (including GPM, GOES-16, and other polar orbiting satellite systems), and computer simulations. IMPACTS addressed three specific objectives: (1) Provide observations critical to understanding the mechanisms of snowband formation, organization, and evolution; (2) Examine how the microphysical characteristics and likely growth mechanisms of snow particles vary across snowbands; and (3) Improve snowfall remote sensing interpretation and modeling to significantly advance prediction capabilities. More information is available from [NASA's Earth Science Project Office's IMPACTS field campaign webpage](#).

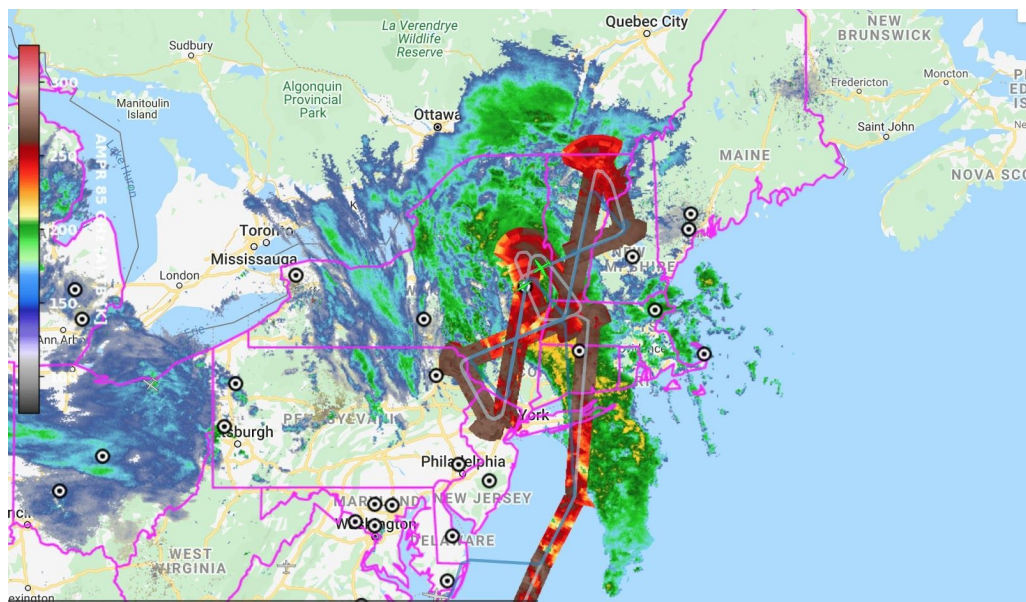


Figure 1: IMPACTS field campaign operations on January 25, 2020 with plots of ER-2 and P-3 flight tracks in addition to ground radar sites and radar reflectivity over the region (Image source: Dr. Timothy Lang, NASA MSFC)

Instrument Description

The Lightning Instrument Package (LIP) operated on the NASA ER-2 high-altitude aircraft and consists of eight state-of-the-art digital electric field mills, a dual-tube Gerdien conductivity probe, and a distributed computer system. The field mills are mounted on the ER-2 aircraft (Figure 2) and calibrated so that one can derive the external electric field (i.e., E_x , E_y , E_z) where the aircraft is located. The field mills also provide a measurement of the electric charge (Q) on the aircraft. These data can greatly improve knowledge of the electrical structure of storms from ER-2 overflights, particularly when the ER-2 passes storms off-center or encounters complex storm geometries.

The conductivity probe is installed on either the right or left hand superpod nose cone (Figure 2). It measures the air conductivity at the aircraft flight altitude. The probe consists of a pair of Gerdien capacitor type sensors so that the contributions to the total conductivity due to positive and negative ions are obtained simultaneously throughout each flight. Storm electric currents can be derived using the electric field and air conductivity measurements. The distributed computer system records and transmits decimated data to the ground. The system is also capable of being commanded from the ground to change various parameters.



Figure 2: Locations of the eight field mills and the conductivity probe as mounted on the ER-2 aircraft.

(Image source: Richard J. Blakeslee)

Investigators

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Data Characteristics

The Lightning Instrument Package (LIP) IMPACTS dataset files contain vector components of electric fields and aircraft parameters. The data are available in ASCII format at a Level 1A data processing level. More information about the NASA data processing levels are available on the [EOSDIS Data Processing Levels webpage](#). These are V2 data that have been further filtered to remove field mill offsets that were identified in the prior V1 data. The characteristics of this dataset are listed in Table 1 below.

Table 1: Data Characteristics

Characteristic	Description
Platform	NASA Earth Resources 2 (ER-2) aircraft
Instrument	Lightning Instrument Package (LIP)
Spatial Coverage	N: 44.760, S: 31.900, E: -71.690, W: -118.280 (United States of America)
Spatial Resolution	point
Temporal Coverage	January 15, 2020 - February 27, 2020
Temporal Resolution	1 file per flight
Sampling Frequency	0.02 seconds
Parameter	Atmospheric electricity
Version	2
Processing Level	1A

File Naming Convention

The Lightning Instrument Package (LIP) IMPACTS dataset files are available in ASCII format. The dataset files are named using the following convention:

Data files: IMPACTS_LIP_ER2_MMDDYYYY.txt

Table 2: File naming convention variables

Variable	Description
MM	Two-digit month
DD	Two-digit day
YYYY	Four-digit year
.txt	ASCII format

Data Format and Parameters

The LIP IMPACTS data files are in ASCII format. There are 15 data fields, including vector components of electric fields and aircraft parameters, in each data file (Table 3).

Table 3: Data Fields for LIP ASCII files

Column	Data Field	Unit
1	Time (UTC) in DD-MMM-YYYYThh:mm:ss.sss	UTC
2, 3, 4	Vector components of the electric field (E_x , E_y , E_z) in the aircraft frame of reference	kV/m
5	Electric field due to charge on the aircraft (E_q)	kV/m
6	Roll	degrees
7	Pitch	degrees
8	Headings	degrees
9	Latitude	Degrees North
10	Longitude	Degrees East
11	Altitude	km
12-15	Vector components of the electric fields (E_n , E_w , E_u , E_m) in the aircraft frame of reference	kV/m

Algorithm

LIP is able to detect the electrical activity surrounding storms by observing the changes in the electric field environment. The total lightning (i.e., cloud-to-ground, intra-cloud) is identified from the abrupt electric field changes in the data; and it is often possible to differentiate between intra-cloud and cloud-to-ground discharges. Storm electric currents can be derived using the electric field and air conductivity measurements. More information on the relationship between electric field changes and lightning is detailed in [Marshall et al. \(2005\)](#).

Quality Assessment

Each electric field mill incorporates self-calibration capabilities that reduce the time required to obtain a full aircraft calibration ([Mach and Koshak, 2007](#)). In addition, the electric field signals are digitized at each mill and transmitted as a digital data stream, reducing signal noise and simplifying aircraft integration ([Bateman et al., 2007](#)). To create the V2 LIP IMPACTS data, the V1 data were further filtered to remove field mill offsets that had been detected.

Software

No software is required to view these ASCII data files.

Known Issues or Missing Data

This dataset is not continuous as flights did not occur every day. Missing values are set as 'NaN'.

References

Bateman, M. G., M. F. Stewart, R. J. Blakeslee, S. J. Podgorny, H. J. Christian, D. M. Mach, J. C. Bailey, and D. Daskar (2007). A low-noise, microprocessor-controlled, internally digitizing rotating-vane electric field mill for airborne platforms. *J. Atmos. Ocean. Tech.*, 24, 1245–1255. doi: <https://doi.org/10.1175/JTECH2039.1>

Koshak, W. J., D. M. Mach, H. J. Christian, M. F. Stewart, and M. G. Bateman (2006). Retrieving storm electric fields from aircraft field mill data. Part II: Applications. *J. Atmos. Oceanic Technol.*, 23, 1302–1322. doi: <https://doi.org/10.1175/JTECH1918.1>

Mach, D. M., and W. J. Koshak (2007). General matrix inversion technique for the calibration of electric field sensor arrays on aircraft platforms. *J. Atmos. Oceanic Technol.*, 24, 1576–1587. doi: <https://doi.org/10.1175/JTECH2080.1>

Marshall, T. C., Stolzenburg, M., Maggio, C. R., Coleman, L. M., Krehbiel, P. R., Hamlin, T., ... Rison, W. (2005). Observed electric fields associated with lightning initiation. *Geophysical Research Letters*, 32, L03813. <https://doi.org/10.1029/2004GL021802>

Related Data

All other datasets collected as part of the IMPACTS campaign are considered related and can be located by searching the term "IMPACTS" in the GHRC [HyDRO2.0](#) search tool. Listed below are datasets from other field campaigns and studies that used the LIP instrument:

TCSP ER-2 LIGHTNING INSTRUMENT PACKAGE (LIP)
(<http://dx.doi.org/10.5067/TCSP/LIP/DATA101>)

CAMEX-4 DC-8 LIGHTNING INSTRUMENT PACKAGE (LIP)
(<http://dx.doi.org/10.5067/CAMEX-4/LIP/DATA001>)

CAMEX-3 LIGHTNING INSTRUMENT PACKAGE (LIP)
(<http://dx.doi.org/10.5067/CAMEX-3/LIP/DATA001>)

GRIP LIGHTNING INSTRUMENT PACKAGE (LIP)
(<http://dx.doi.org/10.5067/GRIP/LIP/DATA201>)

TRMM-LBA LIGHTNING INSTRUMENT PACKAGE (LIP)
(<http://dx.doi.org/10.5067/LIS/LIP/DATA101>)

CAMEX-4 ER-2 LIGHTNING INSTRUMENT PACKAGE (LIP)
(<http://dx.doi.org/10.5067/CAMEX-4/LIP/DATA002>)

GOES-R PLT Lightning Instrument Package (LIP)
(<http://dx.doi.org/10.5067/GOESRPLT/LIP/DATA101>)

Contact Information

To order these data or for further information, please contact:

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User Services

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