

The Lightning Instrument Package Dataset

Presented by

Christopher J. Schultz

NASA/Marshall Space Flight Center

LIP Team:

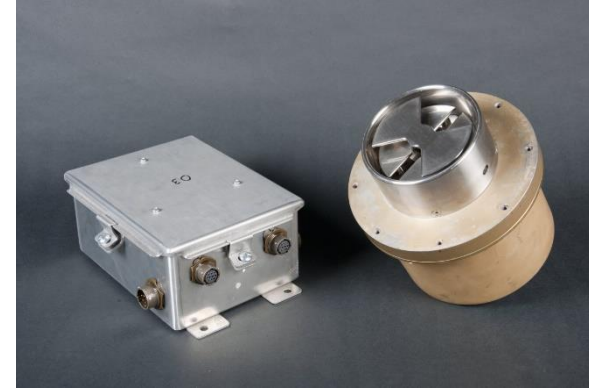
*Monte Bateman, Doug Mach, Sebastian Harkema, Dennis
Buechler, Rich Blakeslee, Tim Lang, Walt Petersen, Michael
Stewart, Scott Podgorny, David Corridor*

IMPACTS Data Science Team Meeting

October 2020

LIP Measurements

- Instrumentation
 - Electric Field Mills (7)
- Measurements
 - Vector components of the electric field (E_x , E_y , E_z)
 - Aircraft Charge
 - Lightning statistics (identified from electric field changes)
 - Storm electric currents (derived result)
 - Storm charge structure (derived result)
- Measurement Range / Accuracy
 - Electric Field : few V/m to ten's of kV/m 10 - 20%



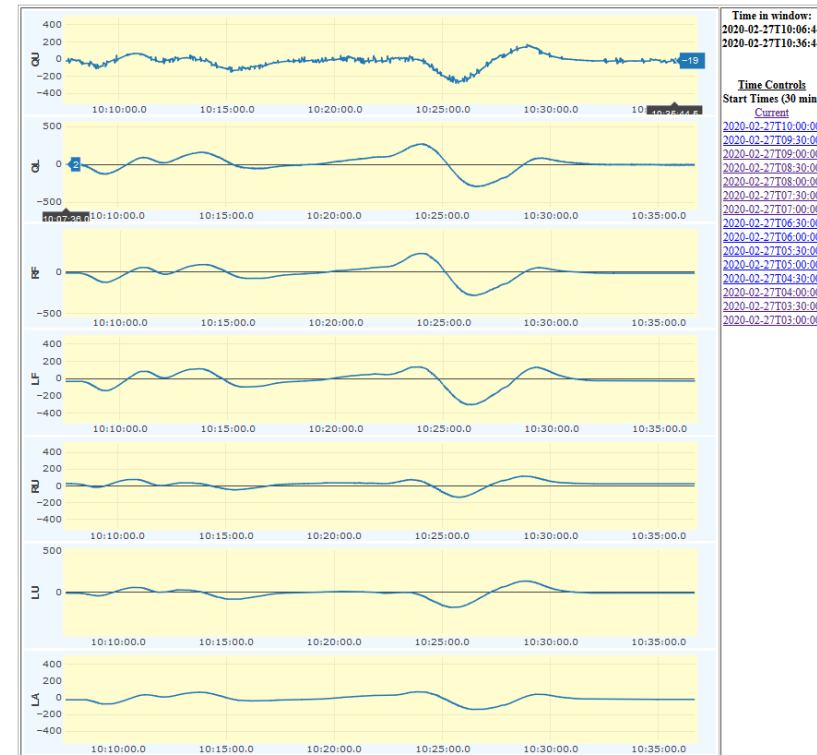
LIP Data Resolution and Products

A. Electric field components (Ex, Ey, and Ez) and aircraft self-charge

- **period:** continuous record, entire flight
- **resolution:** 0.1s (data are oversampled at 50 Hz)
- **comments:** Total lightning (cloud-to-ground, intracloud) determined from electric field changes. Data also provides information on the electrical structure within and around the thunderstorms overflown.

B. Real-time monitoring

- **period:** continuous, entire flight
- **resolution:** 0.1s to a few seconds
- **comments:** Electric fields will be monitored in real-time for mission situational awareness and guidance



Real-time electric field monitoring during the 27 February 2020 Flight.

Data Format

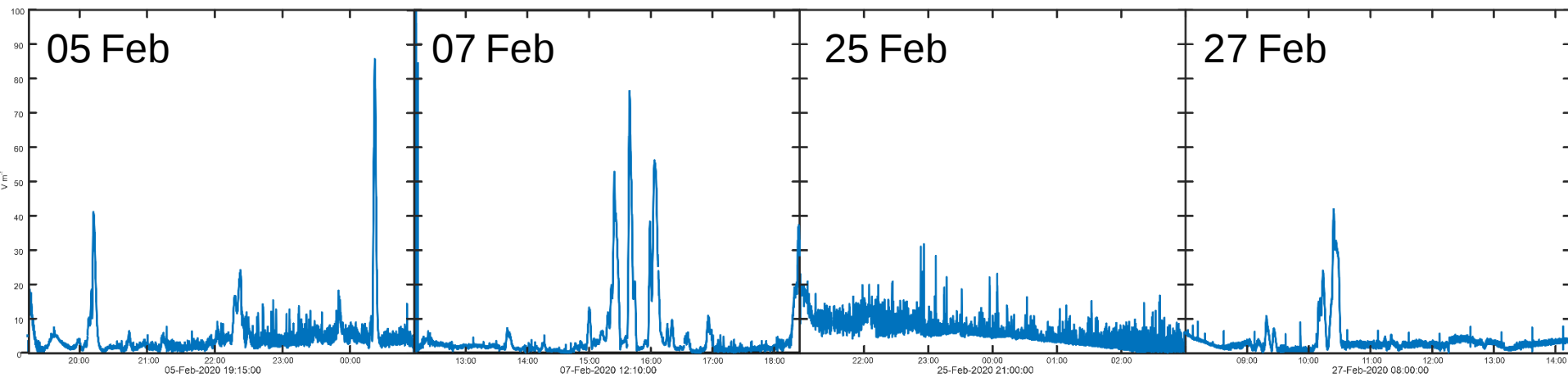
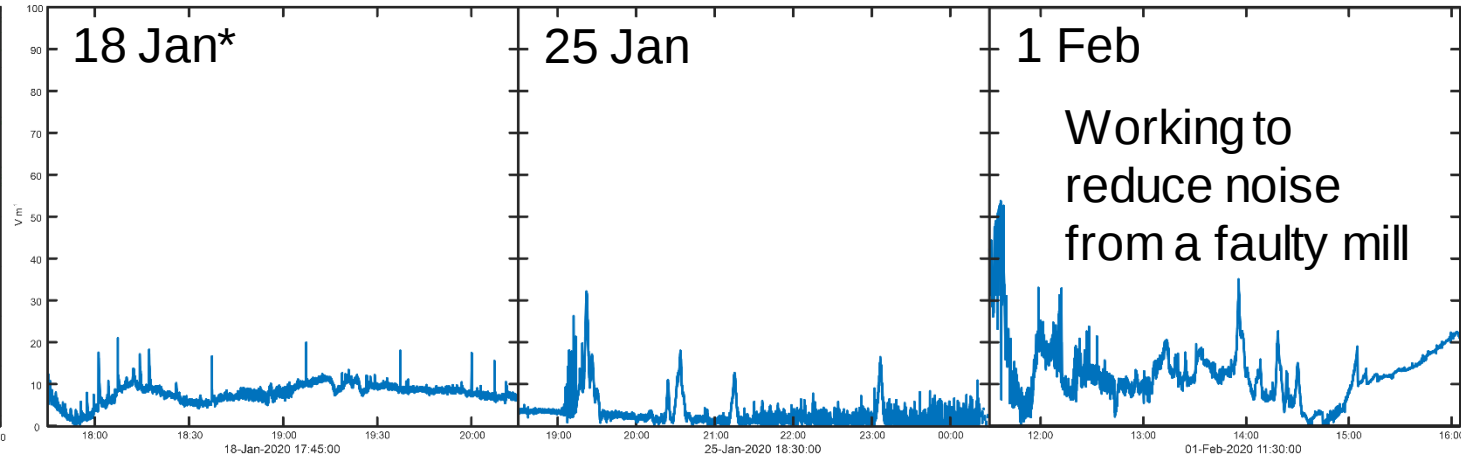
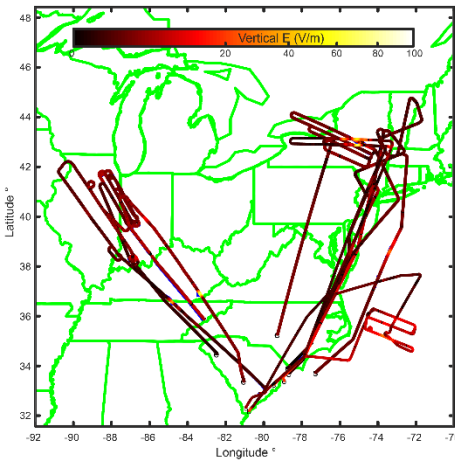
- Ascii format
- 10 samples per second
- Ex, Ey, and Ez are the horizontal and vertical components of the electric field in the reference frame of the aircraft; Eq is the total electric field magnitude.
 - Ex is toward the nose, Ey is toward the left wing, and Ez is toward the top of the tail.
- En, Ew, and Eu are the horizontal and vertical components relative to earth. Em is the total electric field magnitude.
 - En is north, Ew is West, and Eu is up.
 - ***These are independent of aircraft orientation.***

```

05-Feb-2020T19:07:46.400 0.009 0.012 -0.004 -0.069 0.4 5.6 34.5 32.42 -80.87 10.99 0.015 0.005 -0.002 0.015
05-Feb-2020T19:07:46.500 0.011 0.013 -0.004 -0.074 0.4 5.6 34.5 32.42 -80.87 10.99 0.016 0.005 -0.003 0.017
05-Feb-2020T19:07:46.600 0.012 0.013 -0.004 -0.083 0.4 5.6 34.5 32.42 -80.87 10.99 0.018 0.004 -0.003 0.019
05-Feb-2020T19:07:46.700 0.012 0.014 -0.004 -0.088 0.4 5.6 34.5 32.42 -80.87 10.99 0.019 0.005 -0.002 0.019
05-Feb-2020T19:07:46.800 0.013 0.015 -0.005 -0.088 0.5 5.6 34.5 32.42 -80.87 10.99 0.020 0.005 -0.003 0.021
05-Feb-2020T19:07:46.900 0.015 0.016 -0.005 -0.094 0.5 5.6 34.5 32.42 -80.87 11.00 0.022 0.005 -0.003 0.023
05-Feb-2020T19:07:47.000 0.015 0.017 -0.005 -0.093 0.5 5.6 34.5 32.42 -80.87 11.00 0.022 0.006 -0.003 0.023
05-Feb-2020T19:07:47.100 0.012 0.018 -0.005 -0.083 0.5 5.6 34.5 32.42 -80.87 11.00 0.021 0.008 -0.003 0.022
05-Feb-2020T19:07:47.200 0.012 0.018 -0.005 -0.076 0.5 5.6 34.5 32.42 -80.87 11.00 0.021 0.008 -0.003 0.023
05-Feb-2020T19:07:47.300 0.012 0.018 -0.005 -0.069 0.5 5.6 34.5 32.42 -80.87 11.00 0.021 0.008 -0.003 0.022
05-Feb-2020T19:07:47.400 0.012 0.018 -0.005 -0.067 0.5 5.6 34.5 32.42 -80.87 11.00 0.020 0.008 -0.003 0.022
05-Feb-2020T19:07:47.500 0.013 0.018 -0.006 -0.064 0.4 5.6 34.5 32.42 -80.87 11.00 0.021 0.007 -0.003 0.023
05-Feb-2020T19:07:47.600 0.014 0.018 -0.006 -0.063 0.4 5.6 34.5 32.42 -80.87 11.00 0.022 0.007 -0.004 0.023
05-Feb-2020T19:07:47.700 0.014 0.018 -0.006 -0.063 0.4 5.6 34.5 32.42 -80.87 11.01 0.022 0.007 -0.004 0.023
05-Feb-2020T19:07:47.800 0.013 0.018 -0.006 -0.059 0.4 5.6 34.5 32.42 -80.87 11.01 0.021 0.007 -0.004 0.023
05-Feb-2020T19:07:47.900 0.013 0.018 -0.006 -0.058 0.4 5.6 34.5 32.42 -80.87 11.01 0.022 0.007 -0.004 0.023
05-Feb-2020T19:07:48.000 0.014 0.018 -0.006 -0.056 0.3 5.6 34.5 32.42 -80.87 11.01 0.022 0.007 -0.004 0.024
05-Feb-2020T19:07:48.100 0.014 0.019 -0.006 -0.054 0.3 5.6 34.5 32.42 -80.87 11.01 0.023 0.007 -0.004 0.024
05-Feb-2020T19:07:48.200 0.014 0.019 -0.006 -0.050 0.4 5.6 34.5 32.42 -80.87 11.01 0.023 0.008 -0.004 0.024
05-Feb-2020T19:07:48.300 0.014 0.019 -0.006 -0.047 0.4 5.6 34.5 32.42 -80.87 11.01 0.023 0.008 -0.004 0.025
05-Feb-2020T19:07:48.400 0.014 0.019 -0.006 -0.043 0.4 5.6 34.5 32.42 -80.87 11.02 0.023 0.008 -0.004 0.024
05-Feb-2020T19:07:48.500 0.014 0.019 -0.006 -0.039 0.4 5.6 34.5 32.42 -80.87 11.02 0.023 0.008 -0.004 0.025
05-Feb-2020T19:07:48.600 0.014 0.019 -0.006 -0.034 0.4 5.6 34.5 32.42 -80.87 11.02 0.023 0.008 -0.004 0.025
05-Feb-2020T19:07:48.700 0.013 0.019 -0.006 -0.029 0.4 5.6 34.5 32.42 -80.86 11.02 0.022 0.008 -0.004 0.024
05-Feb-2020T19:07:48.800 0.013 0.019 -0.006 -0.024 0.4 5.6 34.5 32.42 -80.86 11.02 0.022 0.008 -0.004 0.024
05-Feb-2020T19:07:48.900 0.014 0.019 -0.006 -0.021 0.4 5.6 34.5 32.42 -80.86 11.02 0.022 0.008 -0.004 0.024
05-Feb-2020T19:07:49.000 0.013 0.019 -0.006 -0.017 0.4 5.6 34.5 32.42 -80.86 11.02 0.022 0.008 -0.004 0.024
05-Feb-2020T19:07:49.100 0.013 0.019 -0.006 -0.013 0.4 5.6 34.5 32.42 -80.86 11.02 0.022 0.008 -0.004 0.023
05-Feb-2020T19:07:49.200 0.013 0.018 -0.006 -0.012 0.4 5.6 34.5 32.42 -80.86 11.03 0.022 0.008 -0.004 0.024
05-Feb-2020T19:07:49.300 0.015 0.018 -0.006 -0.014 0.4 5.6 34.5 32.42 -80.86 11.03 0.023 0.007 -0.004 0.025
05-Feb-2020T19:07:49.400 0.013 0.019 -0.006 -0.007 0.4 5.6 34.5 32.42 -80.86 11.03 0.022 0.008 -0.004 0.024
05-Feb-2020T19:07:49.500 0.013 0.018 -0.006 -0.004 0.4 5.6 34.5 32.42 -80.86 11.03 0.022 0.008 -0.004 0.023
05-Feb-2020T19:07:49.600 0.013 0.018 -0.006 -0.001 0.4 5.6 34.5 32.42 -80.86 11.03 0.021 0.008 -0.004 0.023
05-Feb-2020T19:07:49.700 0.013 0.018 -0.006 0.003 0.4 5.3 34.5 32.42 -80.86 11.03 0.021 0.008 -0.004 0.023
05-Feb-2020T19:07:49.800 0.013 0.018 -0.006 0.004 0.4 5.3 34.5 32.42 -80.86 11.03 0.021 0.008 -0.004 0.023
05-Feb-2020T19:07:49.900 0.013 0.018 -0.006 0.007 0.4 5.3 34.5 32.42 -80.86 11.04 0.021 0.007 -0.004 0.022
05-Feb-2020T19:07:50.000 0.012 0.018 -0.006 0.008 0.4 5.3 34.5 32.42 -80.86 11.04 0.021 0.008 -0.004 0.022
05-Feb-2020T19:07:50.100 0.013 0.018 -0.006 0.011 0.4 5.3 34.5 32.42 -80.86 11.04 0.021 0.007 -0.004 0.022
05-Feb-2020T19:07:50.200 0.012 0.017 -0.006 0.012 0.4 5.3 34.5 32.42 -80.86 11.04 0.020 0.008 -0.004 0.022
05-Feb-2020T19:07:50.300 0.012 0.017 -0.006 0.015 0.4 5.3 34.5 32.42 -80.86 11.04 0.020 0.007 -0.004 0.022
05-Feb-2020T19:07:50.400 0.012 0.017 -0.005 0.015 0.4 5.3 34.5 32.42 -80.86 11.04 0.020 0.007 -0.004 0.022
05-Feb-2020T19:07:50.500 0.011 0.023 -0.004 -0.006 0.3 5.3 34.5 32.42 -80.86 11.04 0.022 0.012 -0.001 0.025
05-Feb-2020T19:07:50.600 0.012 0.017 -0.006 0.015 0.3 5.3 34.6 32.43 -80.86 11.04 0.020 0.007 -0.004 0.022
05-Feb-2020T19:07:50.700 0.012 0.017 -0.006 0.015 0.3 5.3 34.6 32.43 -80.86 11.05 0.020 0.007 -0.004 0.022
05-Feb-2020T19:07:50.800 0.012 0.017 -0.006 0.017 0.3 5.3 34.6 32.43 -80.86 11.05 0.020 0.007 -0.004 0.022
05-Feb-2020T19:07:50.900 0.013 0.017 -0.006 0.016 0.3 5.3 34.6 32.43 -80.86 11.05 0.020 0.007 -0.004 0.022
05-Feb-2020T19:07:51.000 0.013 0.017 -0.005 0.017 0.3 5.3 34.6 32.43 -80.86 11.05 0.020 0.007 -0.004 0.022
05-Feb-2020T19:07:51.100 0.013 0.017 -0.005 0.018 0.3 5.3 34.6 32.43 -80.86 11.05 0.021 0.007 -0.003 0.022
05-Feb-2020T19:07:51.200 0.013 0.017 -0.005 0.018 0.3 5.3 34.6 32.43 -80.86 11.05 0.020 0.007 -0.004 0.022
05-Feb-2020T19:07:51.300 0.012 0.017 -0.005 0.016 0.3 5.3 34.6 32.43 -80.86 11.05 0.020 0.007 -0.004 0.022
05-Feb-2020T19:07:51.400 0.013 0.017 -0.006 0.016 0.3 5.3 34.6 32.43 -80.86 11.05 0.021 0.007 -0.004 0.022
05-Feb-2020T19:07:51.500 0.012 0.017 -0.006 0.015 0.3 5.3 34.6 32.43 -80.86 11.06 0.020 0.007 -0.004 0.022
05-Feb-2020T19:07:51.600 0.012 0.017 -0.006 0.013 0.3 5.3 34.6 32.43 -80.86 11.06 0.020 0.007 -0.004 0.022
05-Feb-2020T19:07:51.700 0.013 0.017 -0.006 0.010 0.3 5.3 34.6 32.43 -80.86 11.06 0.021 0.007 -0.004 0.022
05-Feb-2020T19:07:51.800 0.014 0.018 -0.006 0.004 0.3 5.3 34.6 32.43 -80.86 11.06 0.022 0.007 -0.004 0.023
05-Feb-2020T19:07:51.900 0.015 0.018 -0.006 0.000 0.4 5.3 34.6 32.43 -80.86 11.06 0.022 0.006 -0.004 0.024
05-Feb-2020T19:07:52.000 0.015 0.018 -0.007 -0.004 0.4 5.3 34.6 32.43 -80.86 11.06 0.023 0.006 -0.004 0.024
05-Feb-2020T19:07:52.100 0.016 0.019 -0.007 -0.010 0.3 5.3 34.6 32.43 -80.86 11.06 0.024 0.006 -0.004 0.026
05-Feb-2020T19:07:52.200 0.017 0.019 -0.007 -0.015 0.3 5.3 34.6 32.43 -80.86 11.07 0.025 0.006 -0.005 0.026
05-Feb-2020T19:07:52.300 0.017 0.020 -0.007 -0.017 0.3 5.3 34.6 32.43 -80.86 11.07 0.025 0.007 -0.005 0.027
05-Feb-2020T19:07:52.400 0.016 0.020 -0.007 -0.018 0.3 5.3 34.6 32.43 -80.86 11.07 0.025 0.007 -0.005 0.027
05-Feb-2020T19:07:52.500 0.016 0.020 -0.007 -0.021 0.3 5.3 34.6 32.43 -80.86 11.07 0.025 0.007 -0.005 0.027
05-Feb-2020T19:07:52.600 0.017 0.020 -0.007 -0.026 0.3 5.3 34.6 32.43 -80.86 11.07 0.026 0.007 -0.005 0.028
05-Feb-2020T19:07:52.700 0.018 0.021 -0.007 -0.027 0.3 5.3 34.6 32.43 -80.86 11.07 0.027 0.007 -0.005 0.028
05-Feb-2020T19:07:52.800 0.019 0.021 -0.008 -0.027 0.3 5.3 34.6 32.43 -80.86 11.07 0.027 0.007 -0.005 0.028

```

Data from The Campaign



* Early ER-2 RTB because of aircraft issues.

Looking to collaborate with the P-3 Probe Data Teams

Questions? Ask one of us!

LIP Team POCs

Chris Schultz (christopher.j.schultz@nasa.gov)

Doug Mach (dmach@nasa.gov)

Timothy Lang (timothy.j.lang@nasa.gov)

GHRC DAAC POCs

Leigh Sinclair (slb0012@uah.edu)

Geoffrey Stano (gts0007@uah.edu)