Electric field and lightning observations during PISTON 2018

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• Global electric circuit is driven by charge separation and lightning in thunderstorms
• Leads to sustained electric field in atmosphere, even during fair weather
• Diurnal variability in thunderstorms leads to diurnal variability in fair weather electric field
Carnegie Curve
- The global diurnal variability in fair wx

Carnegie Institution of Washington
Seven cruises (1909-1929)
Destroyed in fuel explosion in Samoa

Peterson et al. (2017)
Rotating shield alternately exposes and shields E-field sensors to environmental electric field. This induces charge, which is then converted to a measured voltage.

Voltage related to electric field component normal to sensors.

Resolution ~1 V/m
Dynamic range – up to ~500 kV/m
EFM Installation

• EFMs adapted from normal airborne installation
• Passive sensor, sensitive and insensitive channels
• Loaned to CSU from NASA MSFC

• Installed on forward O2 deck
• Pole mounted, sensor head oriented downward
• Data system strapped to railing inside dry bag
• Sensor head later wrapped in foil-covered plastic bag
• Power supply and network connection hosted in NOAA W-band seatainer
• NASA laptop in computer lab for data monitoring and management
Calibration Analysis

• Ship mounting introduces electric field enhancement factor
• To account for this, concurrent measurements with a second ground-plane sensor are needed
• Ground plane built from foil-covered cardboard
• Three attempts:
  ▪ 8/12 (nearby pier, successful)
  ▪ 9/13 (nearby pier, sensor failure)
  ▪ 10/16 (athletic field, sensor failure)
• Enhancement factor ~4x, further calibration would require modeling pier arrangement
10 days in 2018 selected:
• Fair weather
• Good sensor performance
• 8/26, 8/27, 8/30, 9/17, 9/22, 10/5, 10/6, 10/7, 10/8, 10/9

Peterson et al. (2017)
EFM Data Info

• Data submitted to PISTON repository
• 4.0x enhancement factor and periodic calibration pulse removed
• Daily netCDF files, include sensitive and insensitive channels

EFM Data Issues

• EFM s intended for episodic airborne use, and previously untested for long-term “always-on” deployments
• EFM s not designed for harsh marine environment
• Unplanned outages: 9/4-7, 9/18-19, 9/25-30, 10/3-4, 10/10-12, 10/14 (partial outages on bookend days)
• Calibration uncertainty, recommend only use data for relative analyses
World-Wide Lightning Location Network (WWLLN)

- Global network of VLF sensors
- Primarily sensitive to energetic return strokes
- Good for locating thunderstorms, not good for total lightning monitoring

- Data purchased from University of Washington, archived at NASA MSFC
  - Aug-Oct 2018
  - Global

- Similar Aug-Oct 2019 data purchase planned
- 2018 data now available from Timothy Lang (timothy.j.lang@nasa.gov), co-authorship required
Lightning near ship
Typhoon Mangkhut
Lightning and Electric Field Conclusions

- EFM deployed on forward O2 deck during both 2018 cruises
- EFM data submitted to PISTON repository
- Multiple EFM outages, particularly on the second cruise
- Calibration uncertainty, use data for relative analyses

- Carnegie curve observed for group of 10 fair weather days
- Good correspondence between enhanced electric fields and nearby WWLLN-detected lightning
- WWLLN lightning data for 2018 available from Timothy Lang (timothy.j.lang@nasa.gov), co-authorship required.