

History of NASA Global Lightning Observations

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Why does NASA study lightning from space?

- Lightning is a natural hazard - threatening lives, damaging infrastructure, causing wildfires, and posing a risk to NASA rocket launches.

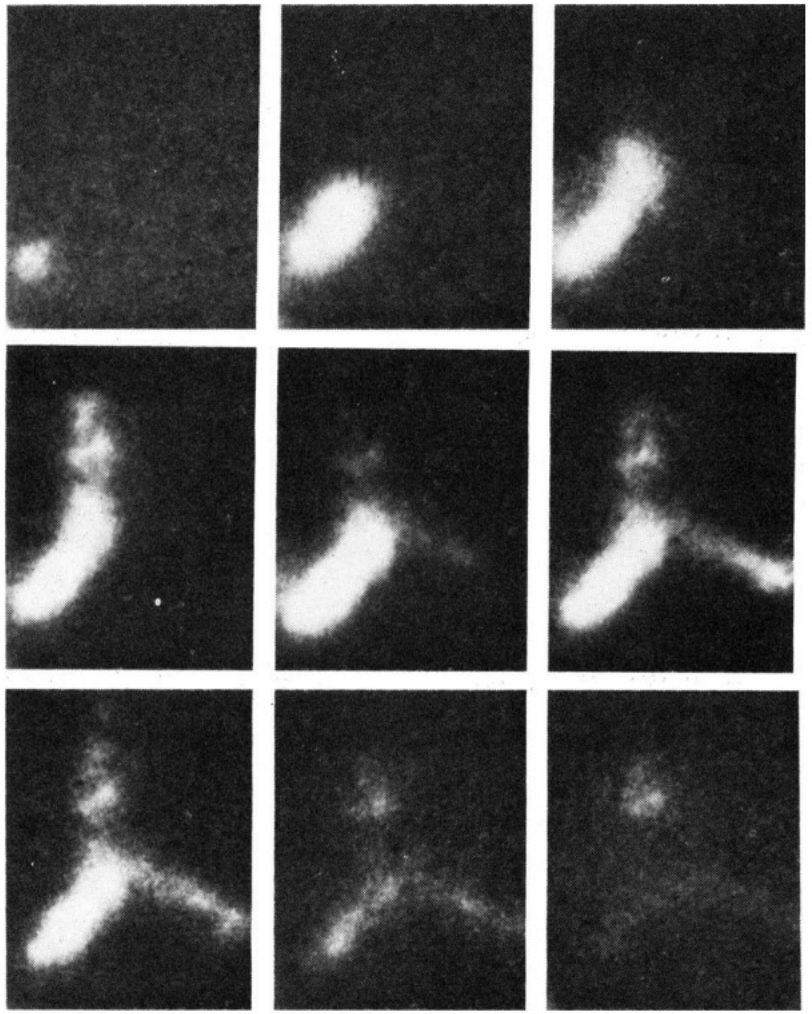
- Lightning is related to processes within deep convection, and by studying lightning we learn more about how storms impact Earth's weather and climate.

- Lightning produces nitrogen oxides, which modulate ozone levels in the atmosphere. These gases are important for biogeochemical cycles and Earth's climate.

- Lightning affects regions beyond Earth's troposphere and occurs on other planets.

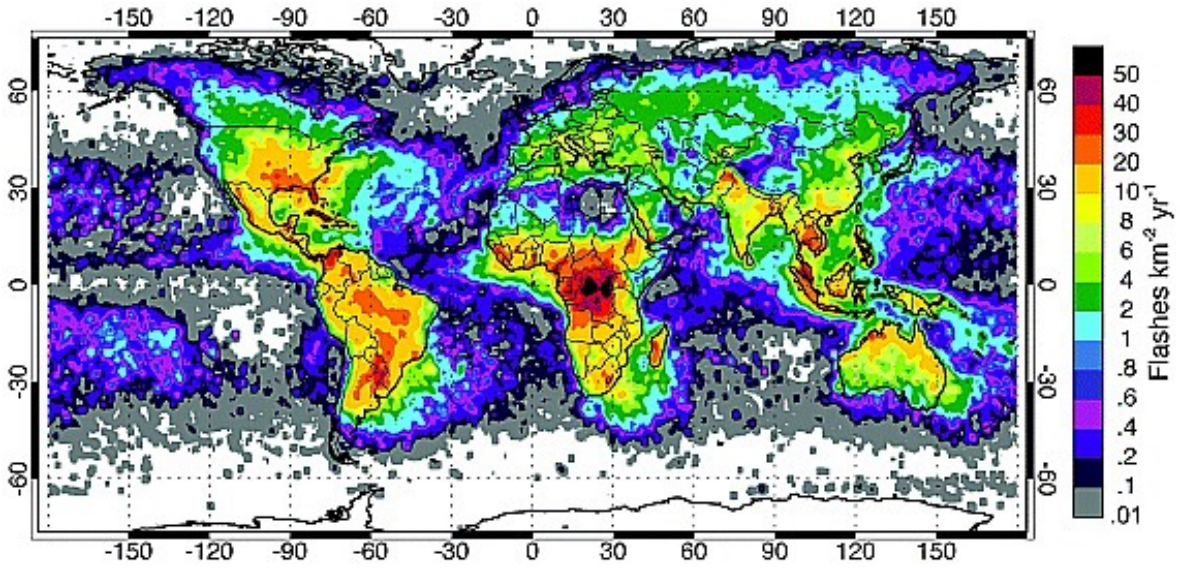
Nighttime/Daytime Optical Survey of Lightning (NOSL) and the Mesoscale Lightning Experiment (MLE)

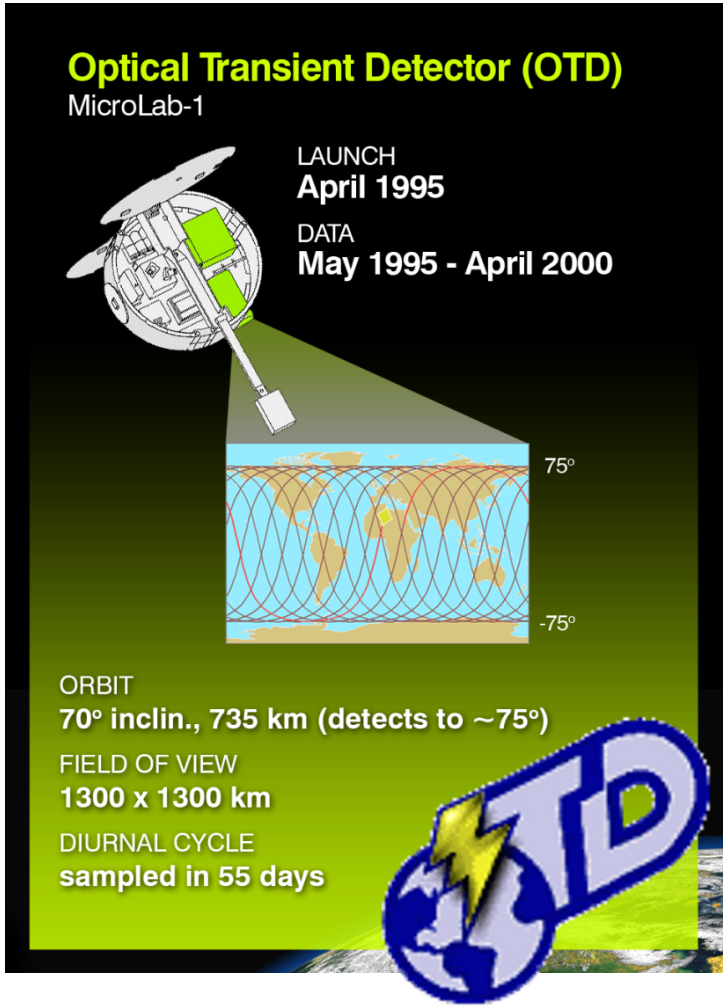
- Space shuttle campaigns in 1980s using low-light television cameras to observe lightning from space
- Enabled photogrammetry and other quantitative analysis of lightning
- Also detected “vertical discharges” above cloud top (i.e., transient luminous events like sprites)



Optical Transient Detector (OTD) – 1995-2000

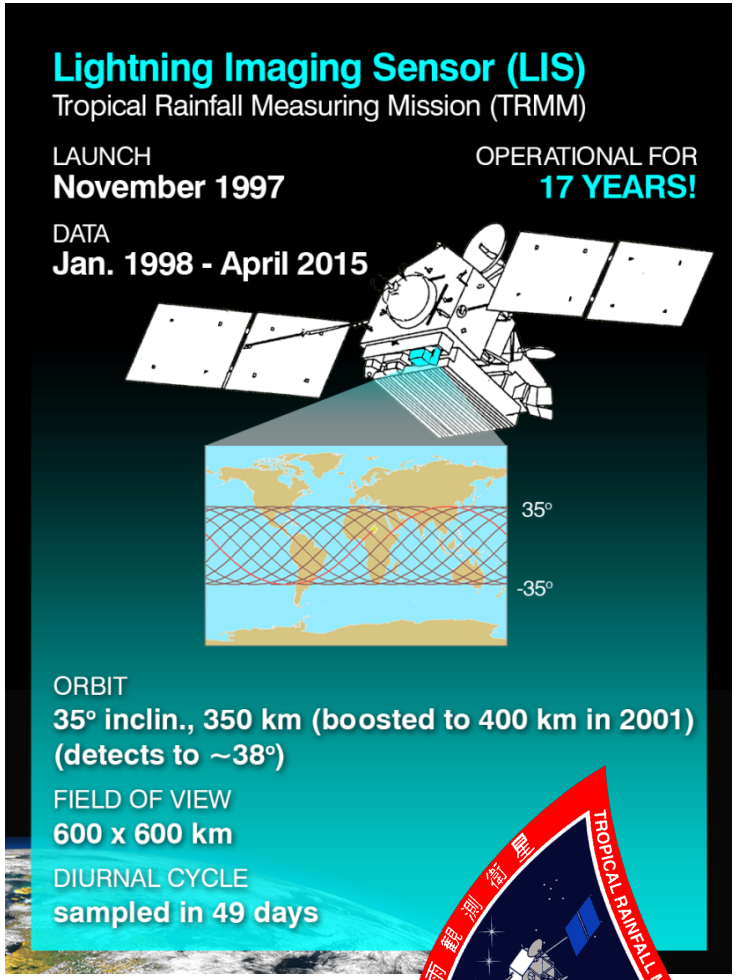
- First NASA spaceborne global lightning mapper
- Used 777-nm oxygen emission line to detect lightning during both day and night
- Demonstrated lightning's preference for tropical land masses, and provided accurate estimate of global flash rate

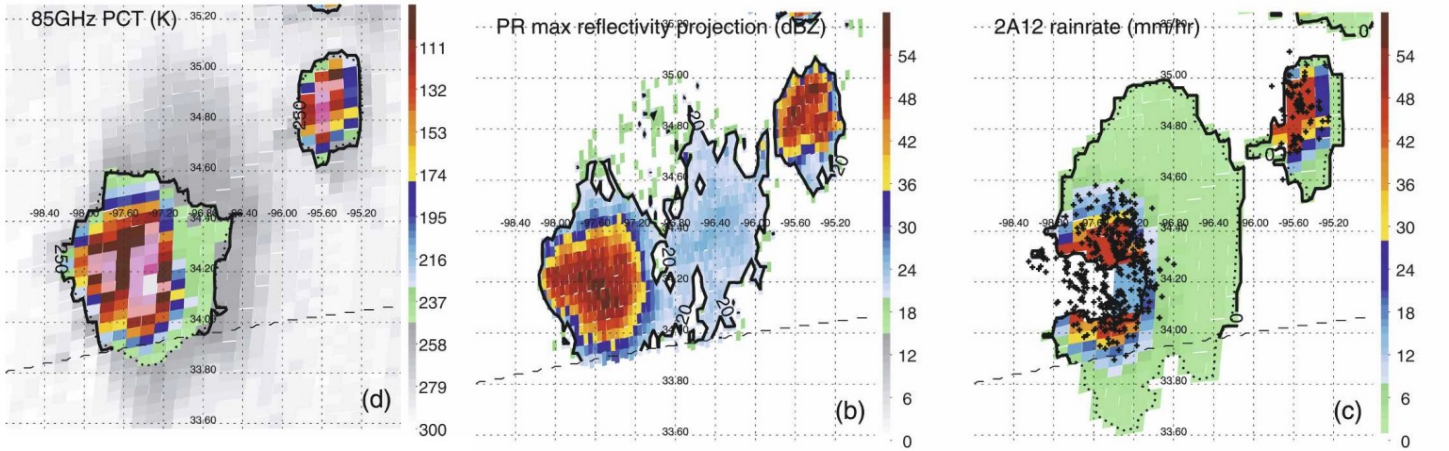




Tropical Rainfall Measuring Mission Lightning Imaging Sensor (TRMM LIS) – 1997-2015

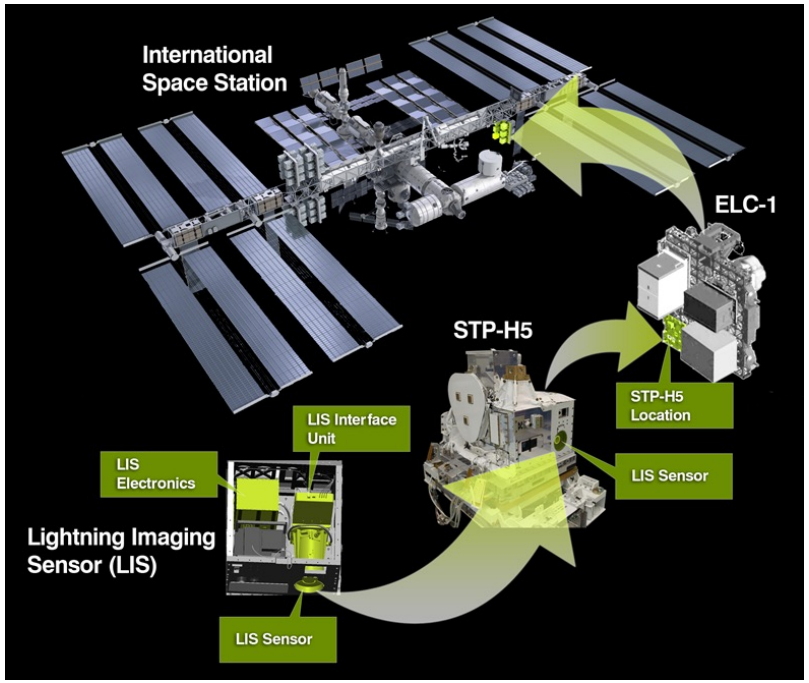
- Same basic observational approach as OTD
- First combined spaceborne observations of lightning with other sensors, including microwave radars and radiometers
- Long life enabled ultra-high-resolution climatology of tropical lightning

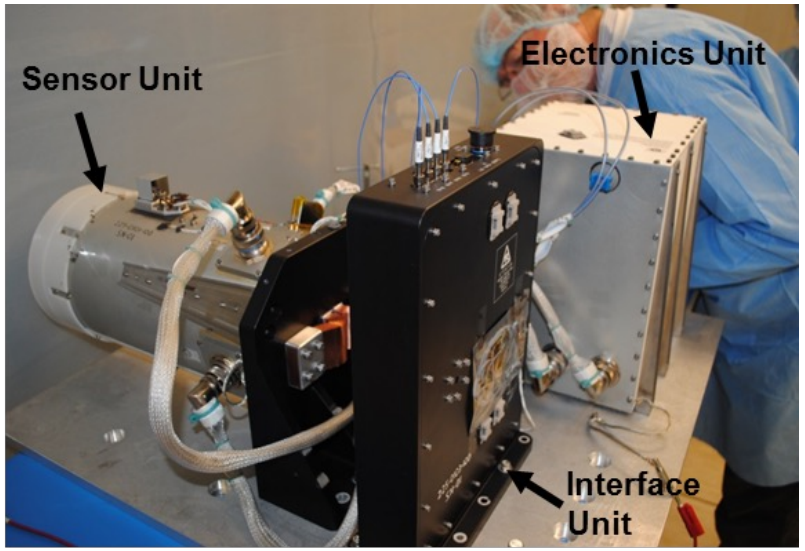


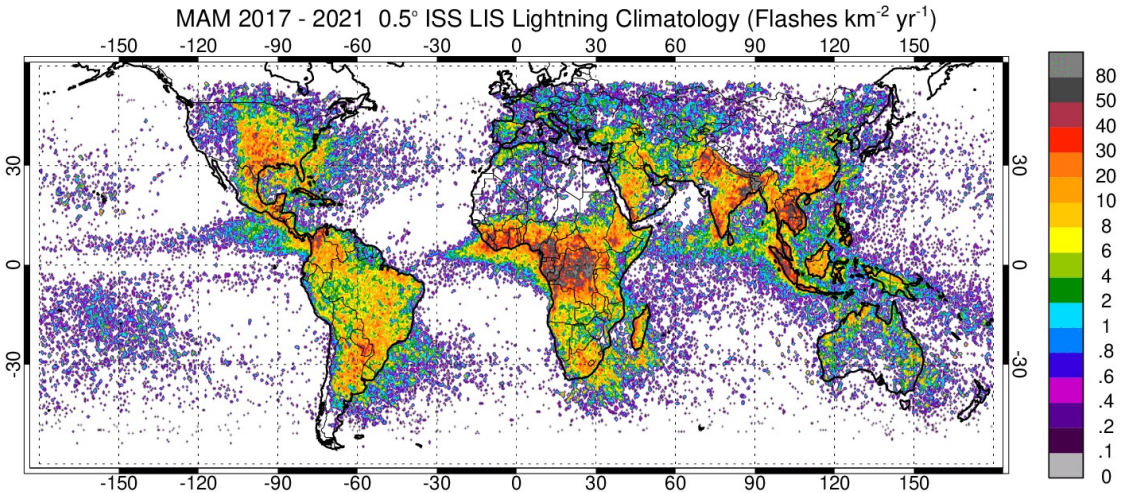


International Space Station Lightning Imaging Sensor (ISS LIS) – 2017-present

- Modified flight spare of TRMM LIS instrument
- Extends and expands TRMM time series, and provides near-realtime data for applications

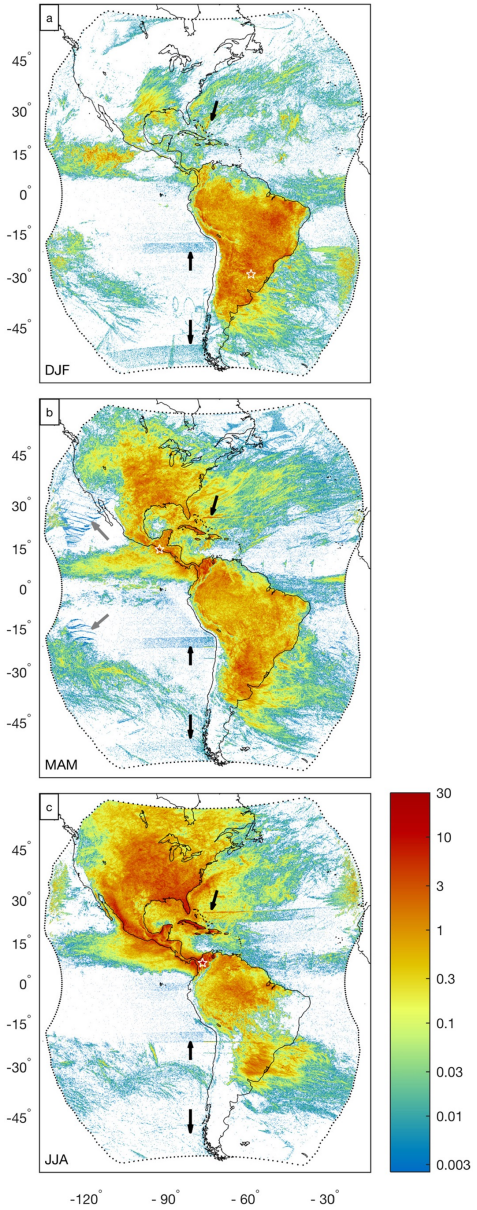






Geostationary Lightning Mapper (GLM) – 2017-present

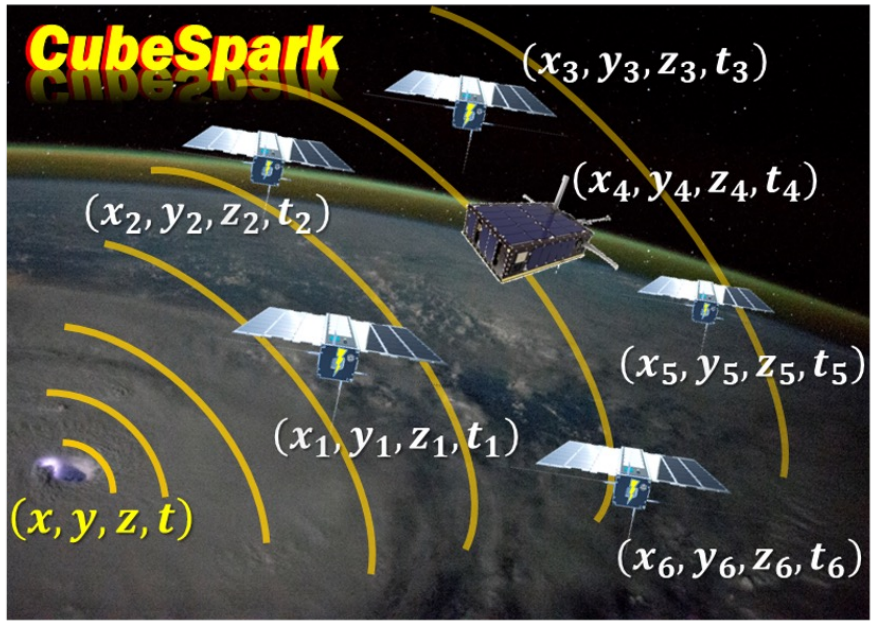
- GLM updates the LIS/OTD measurement approach for geostationary orbit
- Continuous monitoring of lightning over the hemisphere
- NASA plays a major role in validation of GLM observations



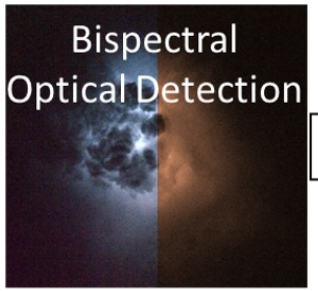


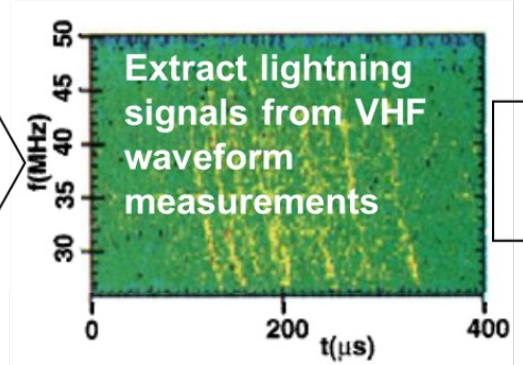


- **CubeSpark** is a mission concept being developed by NASA Marshall Space Flight Center and Los Alamos National Laboratory to improve the detection of optically dim flashes and retrieve 3D lightning structure

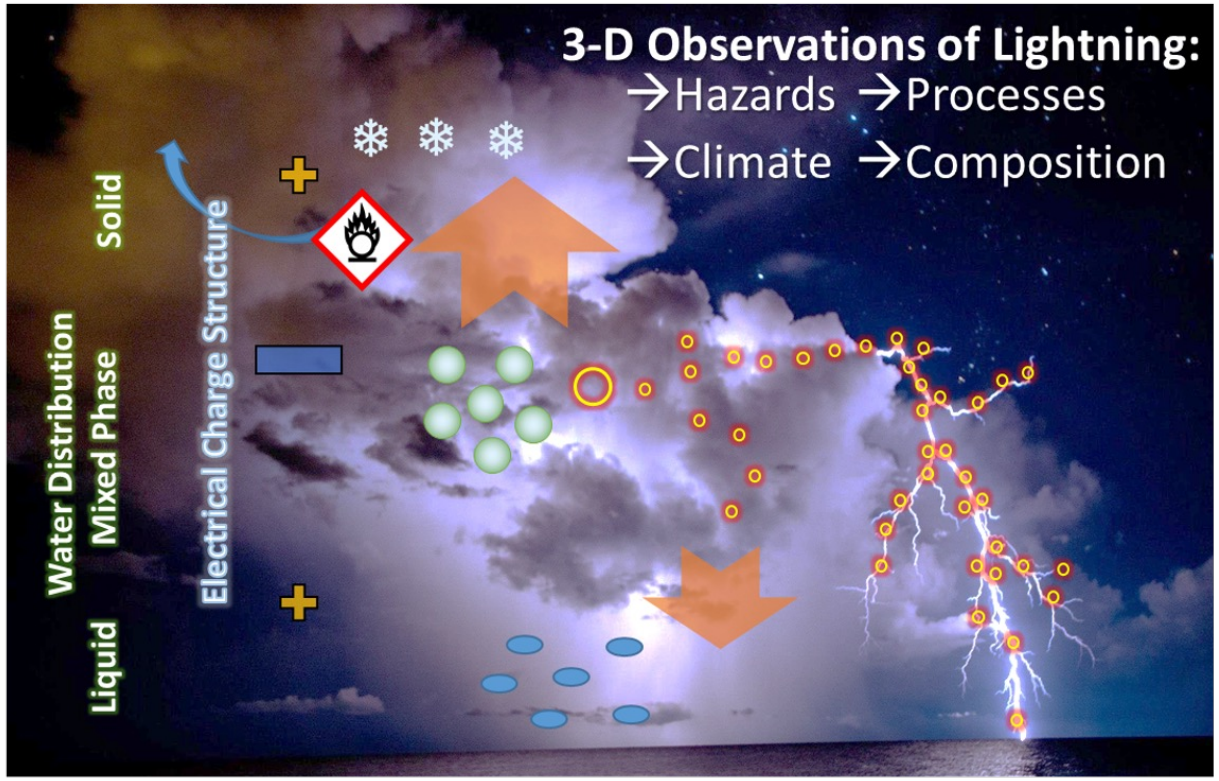


Measurement Concept





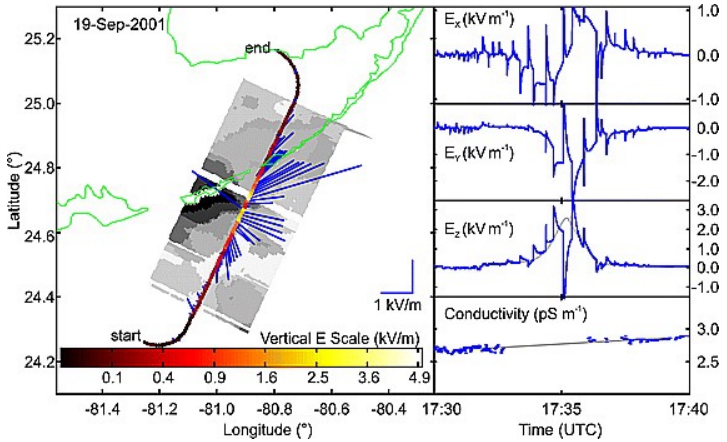
Enabled Science and Applications

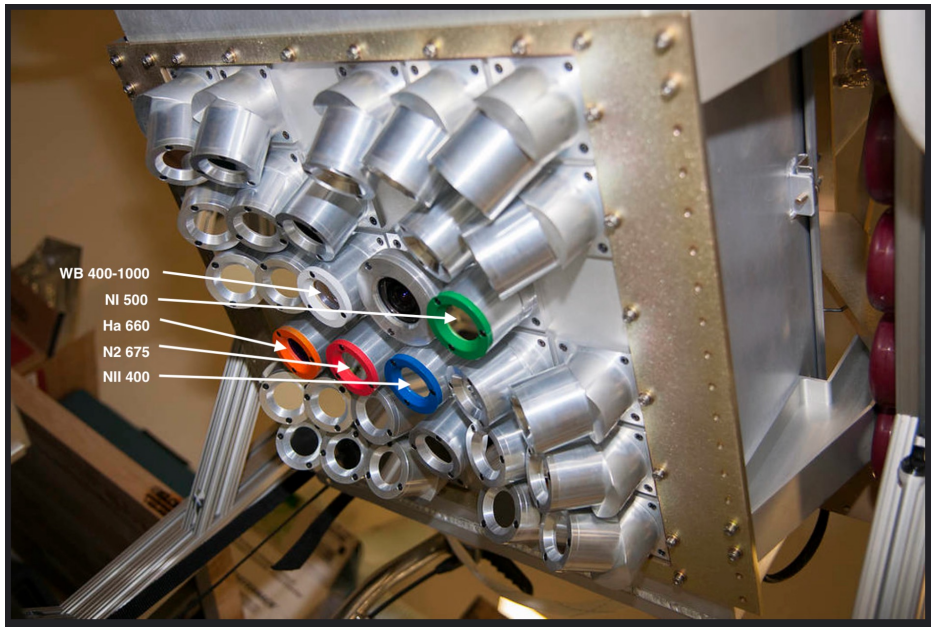


Suborbital Observations of Lightning

- Suborbital (airborne and ground-based) observations of lightning have played a major role at NASA since the 1970s
- These observations test concepts for spaceborne instruments, support rocket launches, and validate on-orbit observations of lightning









Summary

- NASA has produced a multi-decadal record of global lightning from space, and is looking toward continuing this mission in the future

- Present challenge – How do we merge these observations in order to infer accurate climatological trends?

