

## THE MISSION SCENARIO



## THE ALOFT MISSION

ALOFT (Airborne Lightning Observatory for FEGS and TGFs) is a flight campaign designed to observe Terrestrial Gamma-ray Flashes (TGF) and gamma-ray glows close to their production source. The campaign consists of 60 flight hours of a NASA ER-2 research aircraft taking off from Florida and is scheduled for July 2023. The ER-2 cruise altitude of 20 km allows flying over active thunderstorms in the Gulf of Mexico and Caribbean region, one of the most TGF-active region on the planet. The synergy between airborne gamma-ray, optical and electric field measurements, combined with ground-based radio observations, will provide a unique set of observations to constrain the source properties and their physics.

## DATA FROM AIRCRAFT

### Gamma-rays

Is there a TGF or a glow?

### Optical

Are there 'hot' processes? (Blue vs. red discharges)

### Electric field

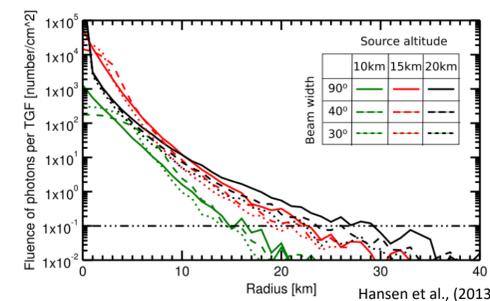
What is the cloud charge structure?

### Radar / passive radiometer

What is the cloud structure / microphysics?

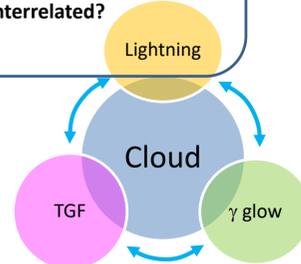
## THE DYNAMIC RANGE CHALLENGE

- 4 to 5 orders of magnitude in TGF fluence are expected at aircraft altitude, depending on radial distance to source (Hansen et al., 2013, JGR 118, 2333)
- The maximum flux that a single gamma-ray detector can stand depends on its dimension, timing performance, and readout logic
- A realistic approach is to use a suite of gamma-ray detectors sensitive in different flux ranges, to cover the wide dynamic range requested



## SCIENTIFIC OBJECTIVES

- How and under what conditions are Terrestrial Gamma Flashes (TGF) produced?
- How extended in space and time are gamma-ray glows?
- Are gamma-ray glows and TGFs interrelated?



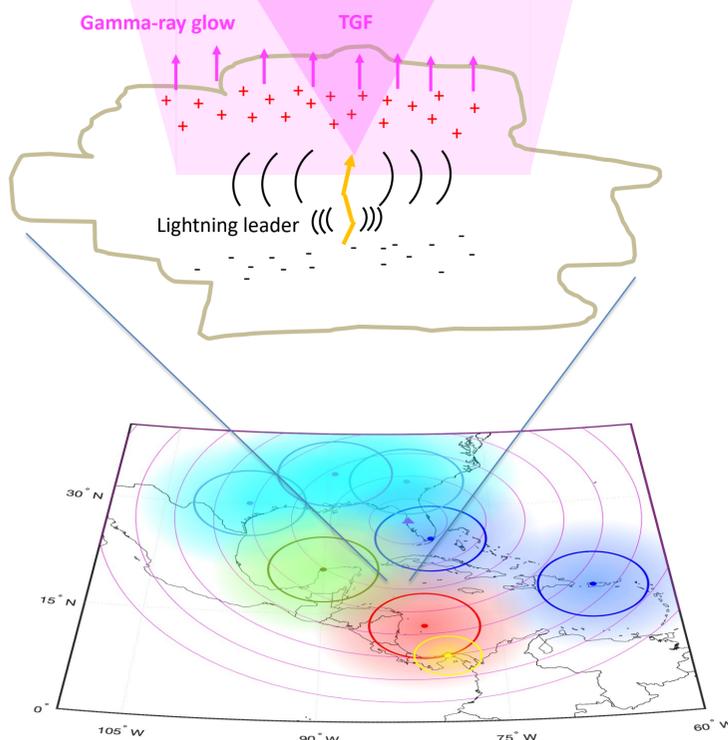
## DATA FROM GROUND

### LF radio

How much charge is moved? Are there 'slow' processes?

### VHF radio (interferometry)

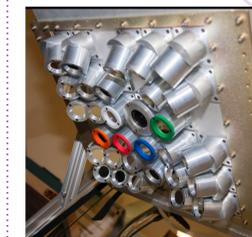
What is the discharge spatial morphology? What are the characteristics (length, speed...) of the associated leader?



The network of ground sensors in support of the ALOFT mission

## THE OPTICAL PAYLOAD

Fly's Eye Geostationary Lightning Mapper (GLM) Simulator (FEGS)  
PI Mason Quick, NASA MSFC, USA



- Array of optical photometers (100 kHz sampling) 10x10 km field of view:
  - 25x 780 nm
  - 1x 340 nm
  - 1x 500 nm
  - 1x 870 nm
  - 1x 1600 nm
  - 1x 400-1100 nm (VNIR)
- 1.6 μm photometer from Sandia Lab (Pis: R. Longenbaugh and T. Edwards, Sandia National Laboratory, USA)
- 400-1000 nm HD camera

- FEGS Spectrometer:
  - Range: 200-850 nm
  - Resolution: 1.5 nm
  - Rate: 500 spectra/second (2ms integration)

## THE ELECTRICAL ENVIRONMENT PAYLOAD

Electric Field Change Meter (EFCM) – PI: Hugh Christian, University of Alabama Huntsville, USA

- Fast channel: 10 MHz sampling rate, 100 μs decay time constant
- Slow channel: 1 MHz sampling rate, 150 ms decay time constant

Lightning Instrument Package (LIP) - PI: Chistofer J. Schultz, NASA MSFC

- Three component Electric field, 0.1 s time resolution

## THE CLOUD CHARACTERIZATION PAYLOAD

Advanced Microwave Precipitation Radiometer (AMPR) - PI: Timothy Lang, NASA MSFC, USA

- 10-85 GHz microwave radiometer, ~40-km wide swath

Conically Scanning Sub-millimeter-wave Imaging Radiometer (CoSSIR) - PI: Rachael Kroodsma, NASA Goddard SFC, USA

- 16-channel total power imaging radiometer in 170-684 GHz microwave band

Cloud Radar System (CRS) - PI: Gerry Heymsfield, NASA Goddard SFC, USA

- 94 GHz (W-band) doppler radar

X-band Radar (EXRAD) - PI: Gerry Heymsfield, NASA Goddard SFC, USA

- X-band Doppler radar

## REFERENCES

The ALOFT webpage [The ALOFT webpage](#) Attend the ALOFT presentation by N. Østgaard et al. (EGU23-3116): Tue, 25 Apr, Room M2, 10:00-10:10



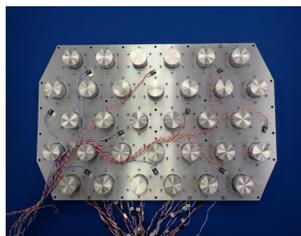
## THE GAMMA-RAY PAYLOAD

UiB-BGO – PI: Nikolai Østgaard, University of Bergen, Norway



| Type / readout | Geometrical area (cm <sup>2</sup> ) | Usage                     | Fluence range in 100 μs (distance range) |
|----------------|-------------------------------------|---------------------------|--|
| BGO + PMT      | 225                                 | Spectroscopy 0.3 – 40 MeV | 0.05 - 1 cm <sup>-2</sup> (~15 – 25 km)  |
| LYSO + SIPM    | 25                                  | Spectroscopy 0.3 – 40 MeV | 0.5 - 50 cm <sup>-2</sup> (~8 – 20 km)   |
| LYSO + PMT     | 1                                   | Counter > 0.3 MeV         | 10 - 1000 cm <sup>-2</sup> (~12 – 5 km)  |
| LYSO + SIPM    | 0.09                                | Counter > 0.3 MeV         | 500 - 10000 cm <sup>-2</sup> (<~6 km)    |

iSTORM – PIs: Eric J. Grove / Daniel Shy, U.S. Naval Research Laboratory, USA



- 32 CeBr<sub>3</sub> scintillators with SIPM readout
- 100 keV – 8 MeV energy range
- High spectral resolution