

# Cross-Referencing GLM and ISS-LIS with Ground-Based Lightning Networks

Katrina S. Virts  
*NPP, NASA/MSFC*

Richard J. Blakeslee  
*NASA/MSFC*

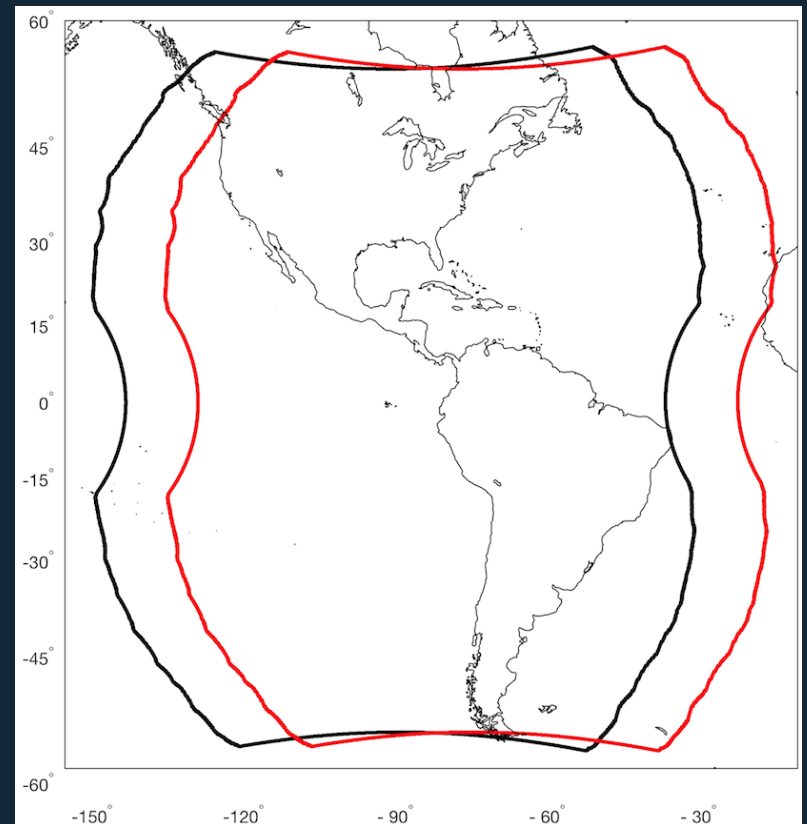
Steven J. Goodman  
*NOAA/NESDIS GOES-R Program Office*

William J. Koshak  
*NASA/MSFC*

*2017 AGU Fall Meeting*

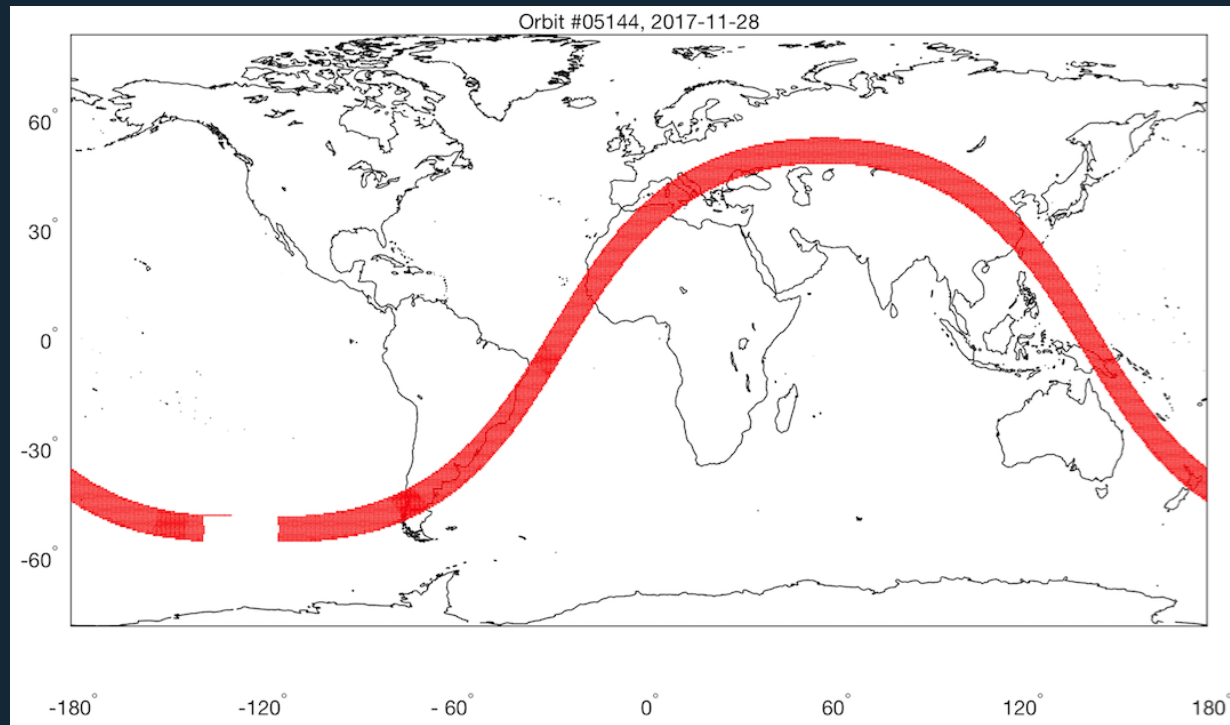
# Geostationary Lightning Mapper on GOES-16

- Launched on November 19, 2016
- Test position: 89.5W
- Transitioning to GOES-East position: 75.2W
- Latest ground system update on November 28, 2017



# Lightning Imaging Sensor on the International Space Station (ISS-LIS)

- Launched on February 19, 2017
- Low earth orbit (425 km)
- Field of view approx. 600 km x 600 km
- 54° inclination
- Provisional data available soon



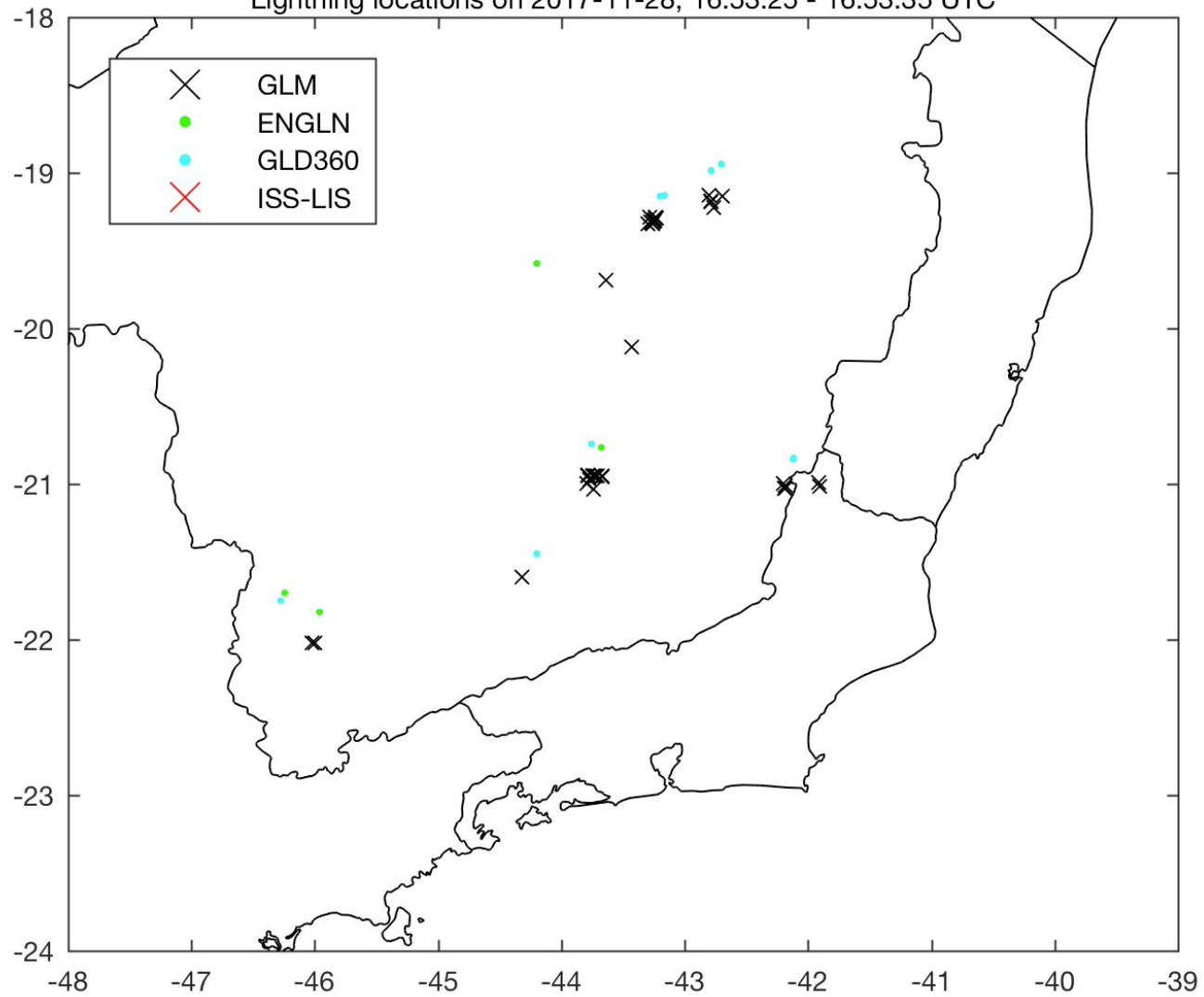
# Lightning clustering

- Events
  - Single pixels that exceed background level during a single frame
- Groups
  - Clusters of events within the same 2 ms frame and in adjacent pixels
- Flashes
  - Clusters of groups that occur within 330 ms and 5.5 km (LIS) or 16.5 km (GLM)

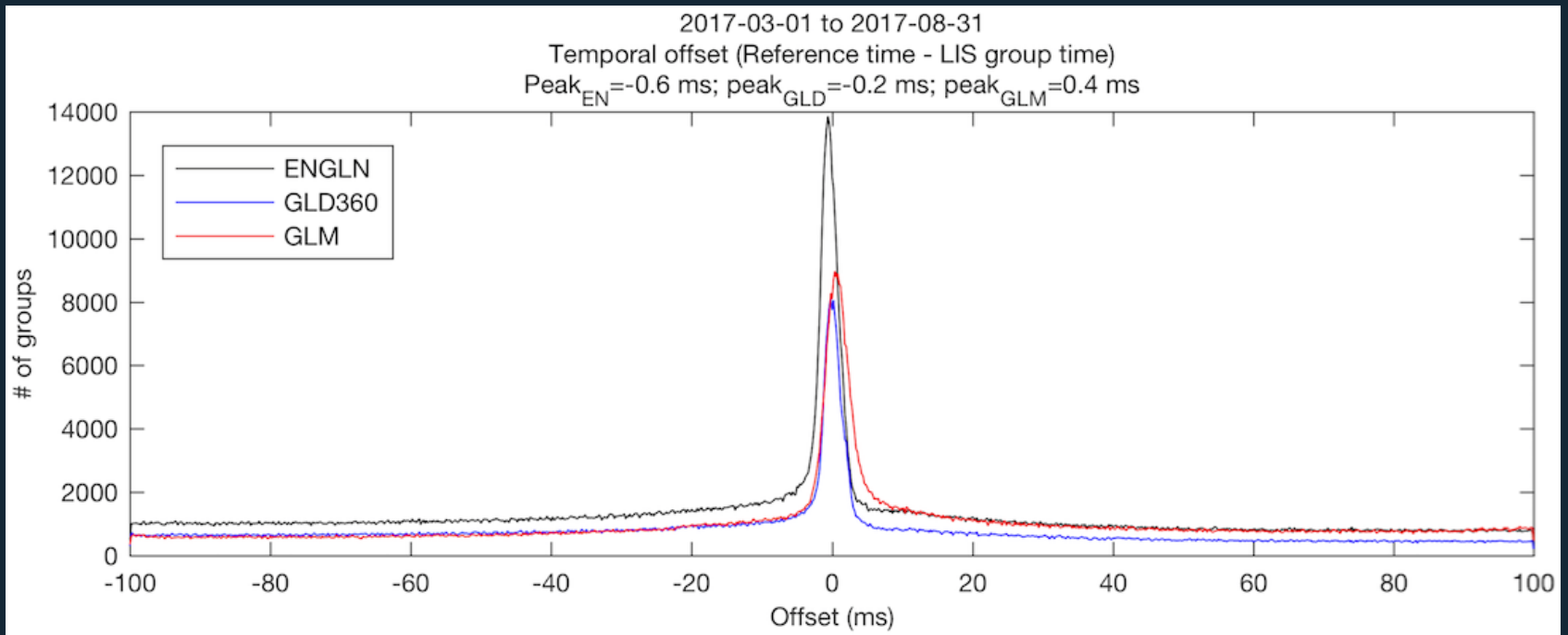
# Reference lightning networks

- Earth Networks Global Lightning Network (ENGLN)
  - LF-HF lightning detection network
  - Total lightning
  - Includes WWLLN strokes
- Vaisala Global Lightning Dataset (GLD360)
  - VLF lightning detection network
  - Primarily ground flash location/time
- Match GLM and LIS group data to reference networks using spatial/temporal windows
  - GLM: 4 ms, 75 km
  - LIS: 100 ms, 50 km

Lightning locations on 2017-11-28, 16:53:25 - 16:53:35 UTC

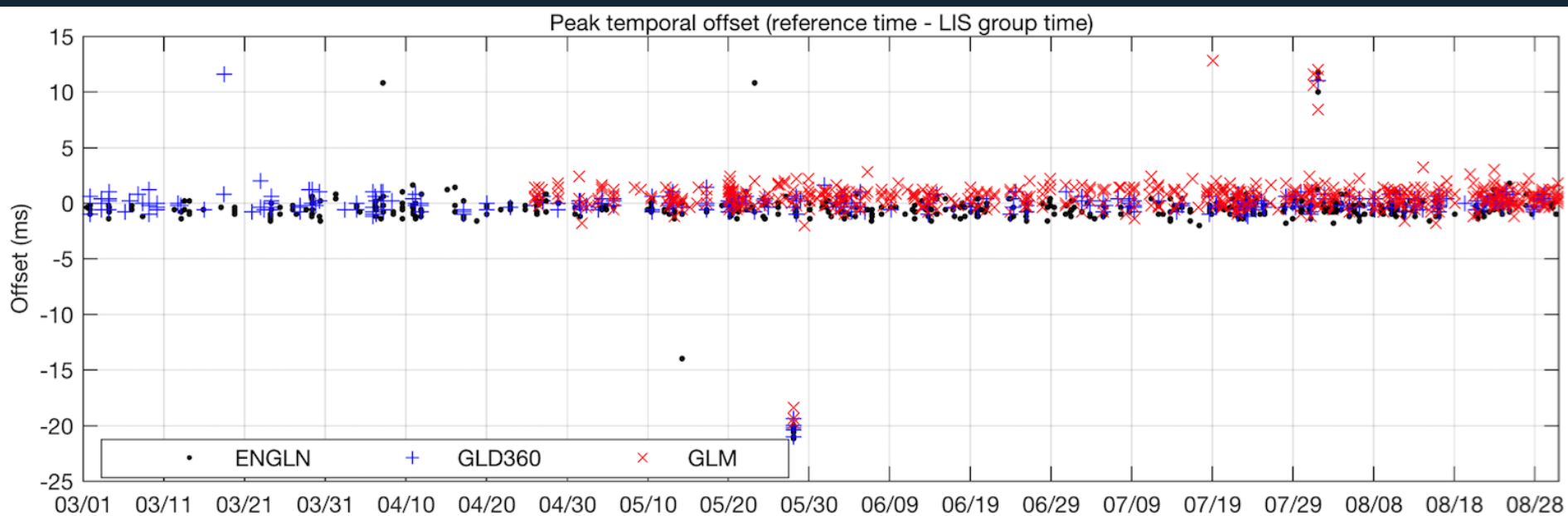


# LIS has sub-ms timing accuracy



# LIS timing is stable...with a couple excursions

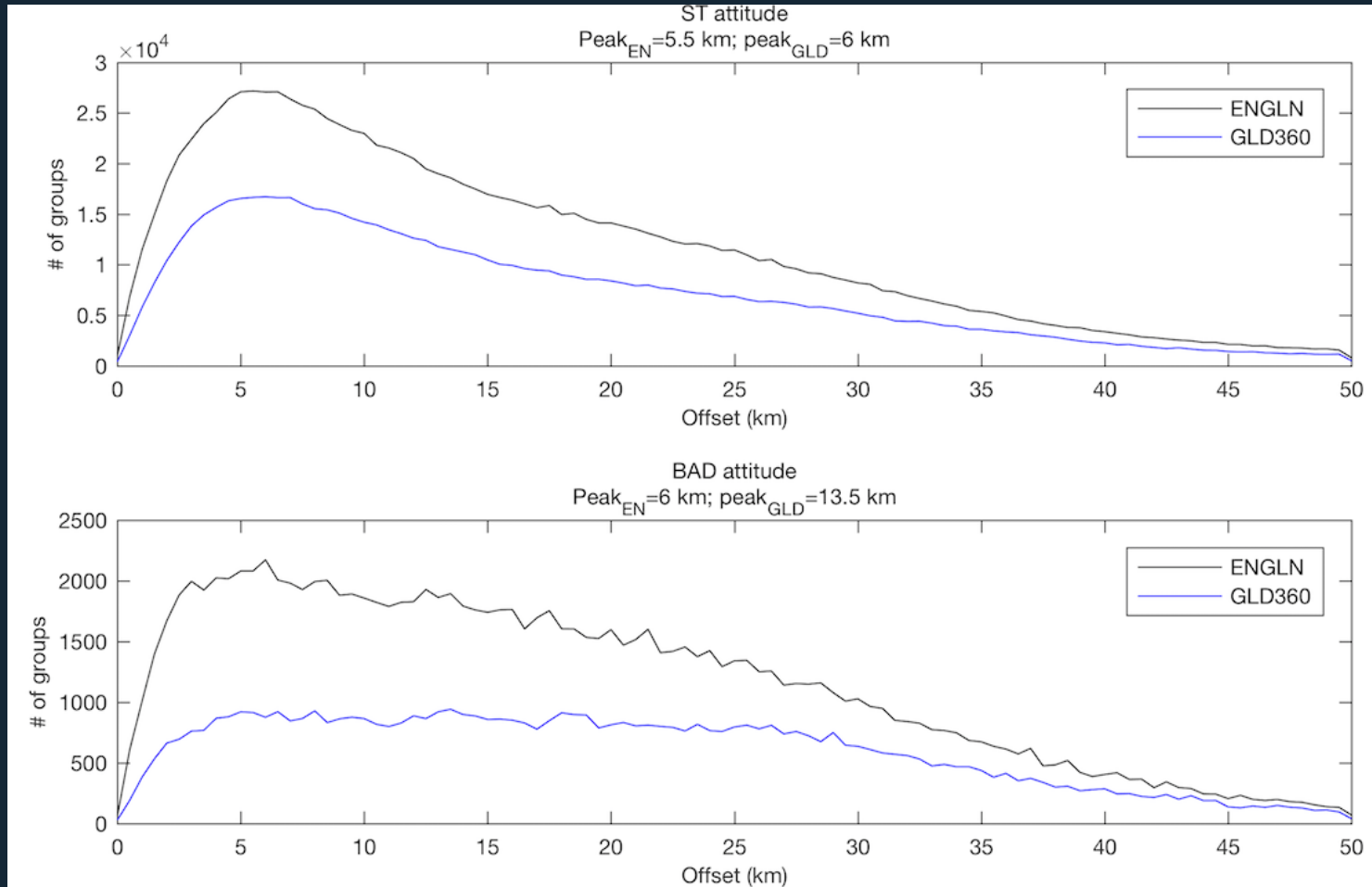
- Histograms of temporal offsets for each reference dataset during each 30-second interval of LIS orbit
- Plot peak of histogram





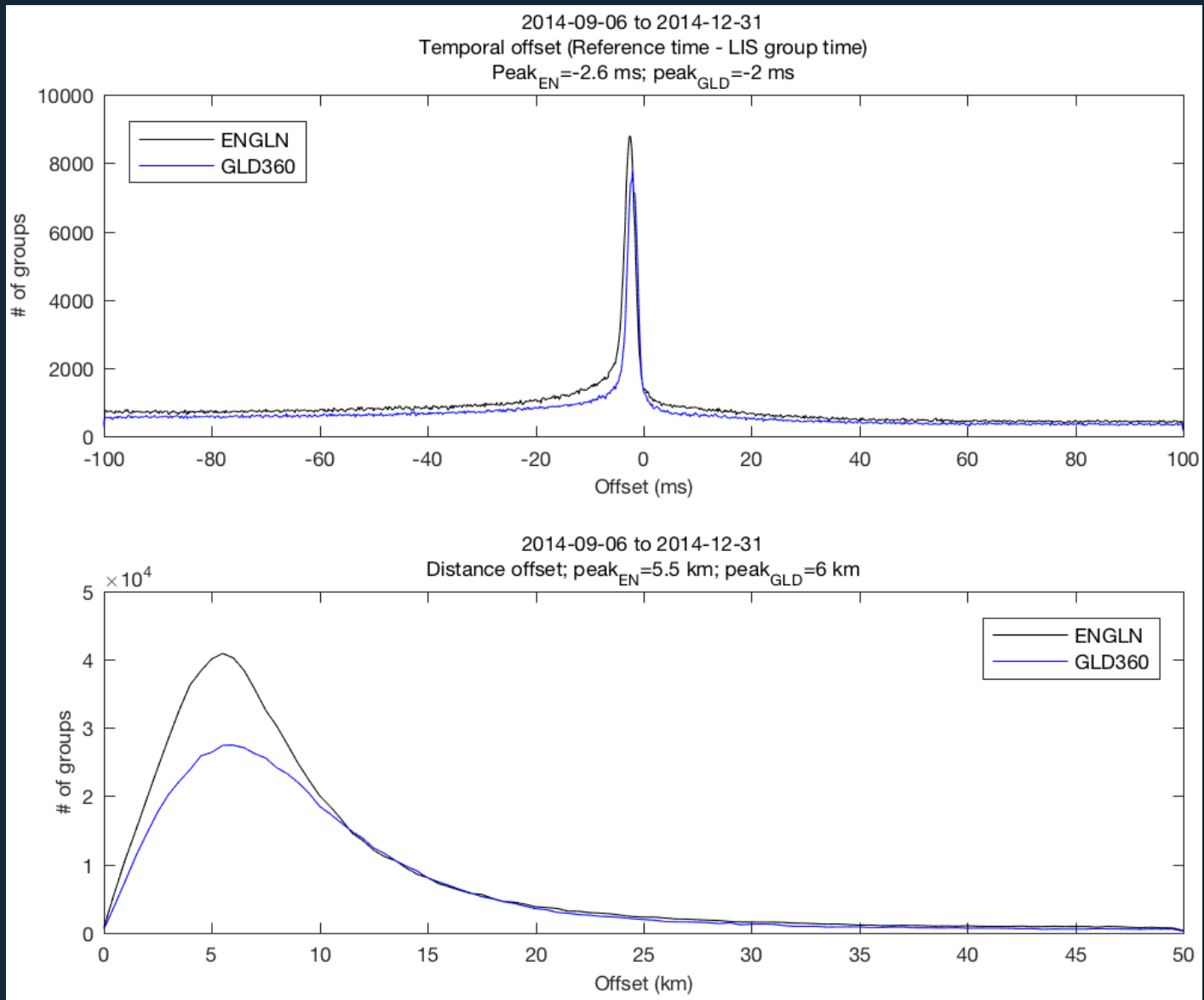
# LIS geolocation

Star Tracker



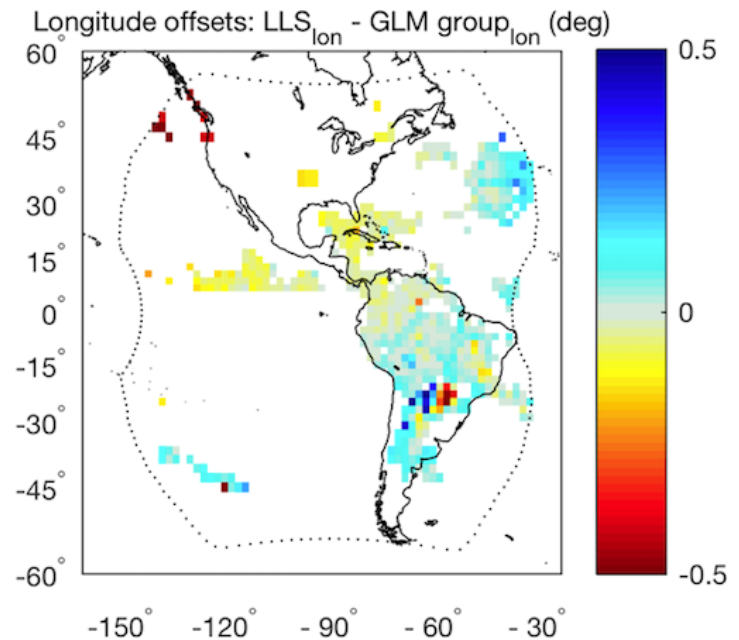
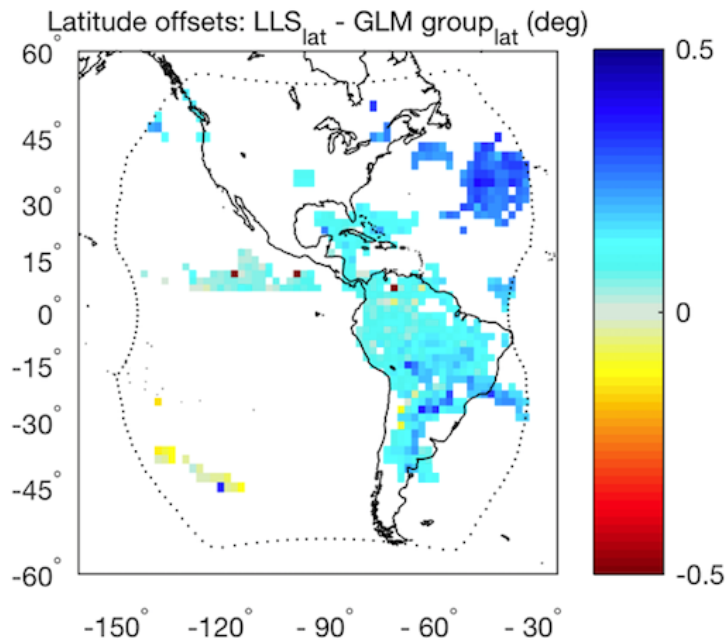
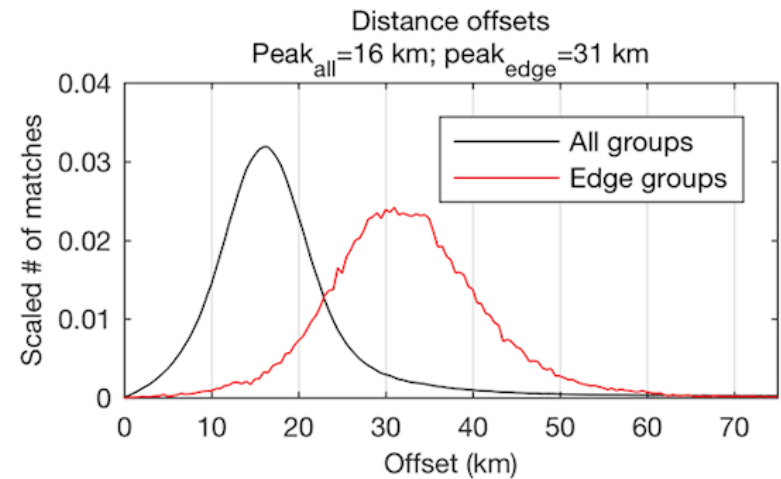
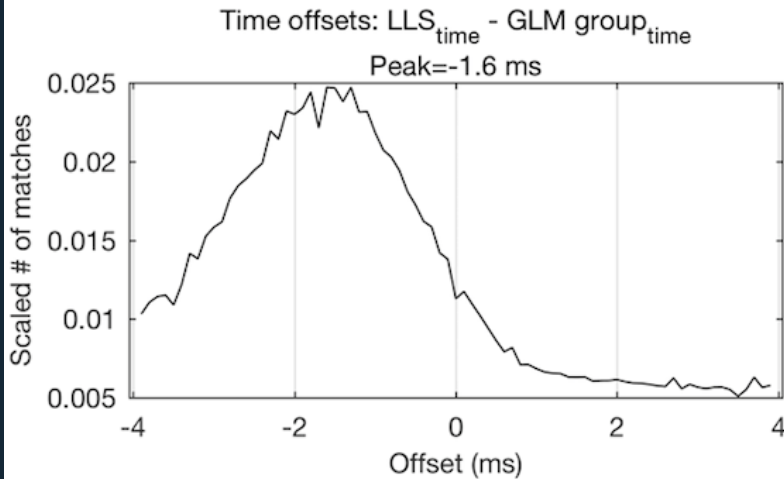
Basic Ancillary Data

# TRMM-LIS statistics



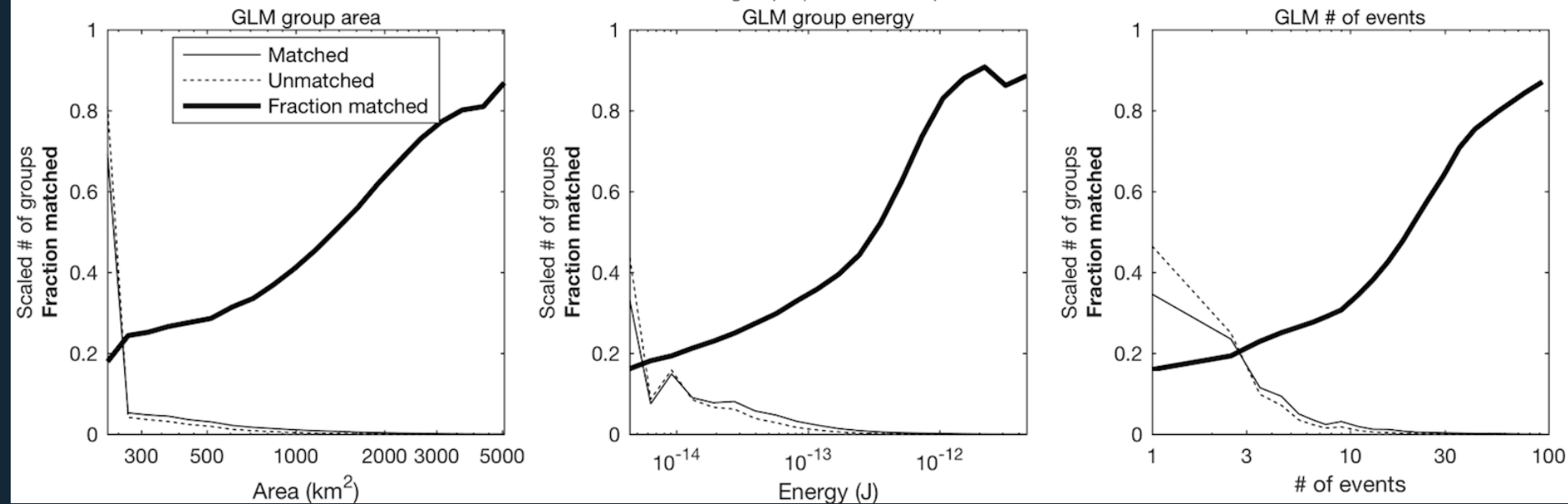
# GLM ground system data

2017-11-28 to 2017-11-30



# GLM ground system data

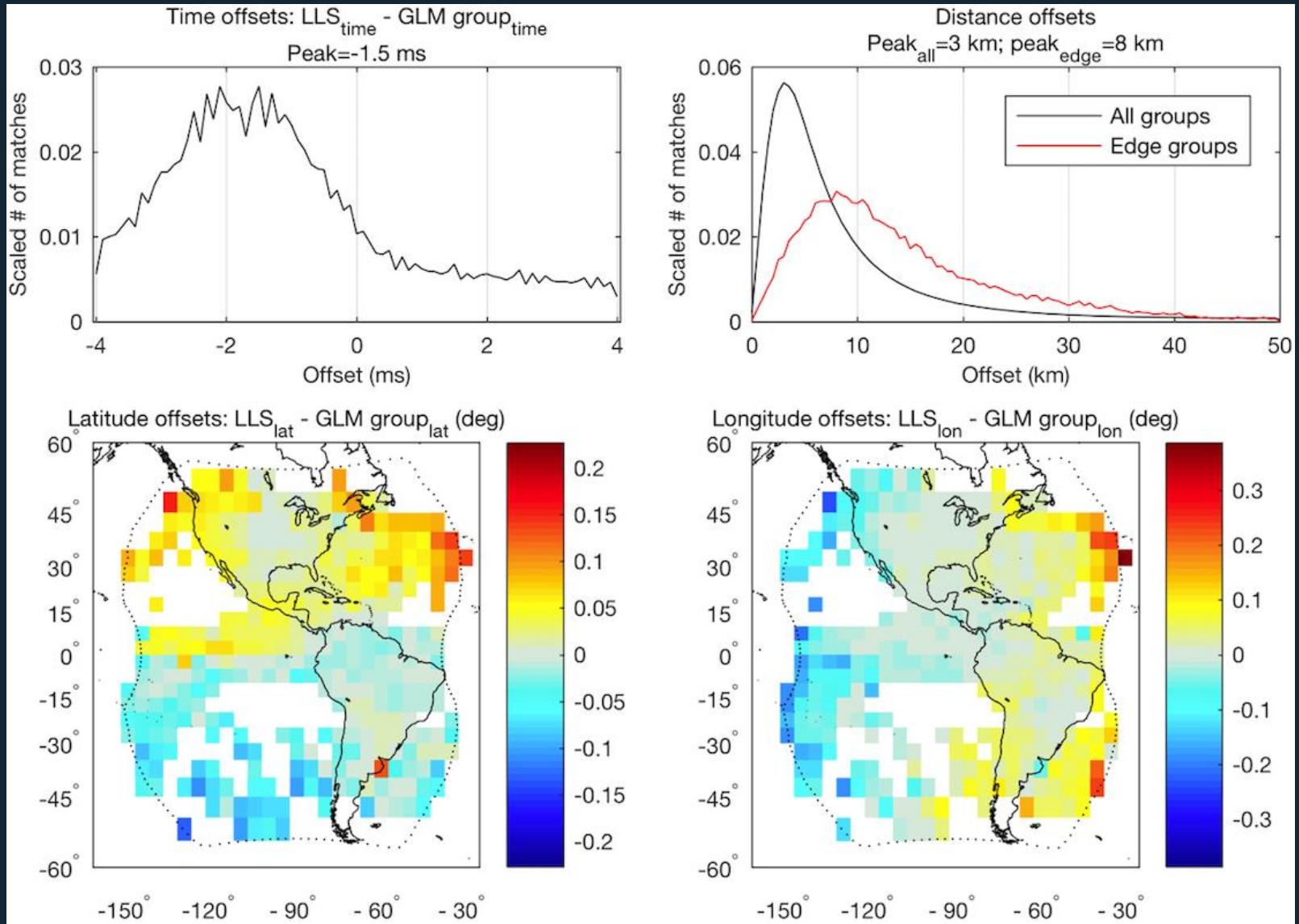
GLM groups matched by any LLS (4 ms, 300 km), 2017-11-28 to 2017-11-30  
All GLM groups (20% matched)



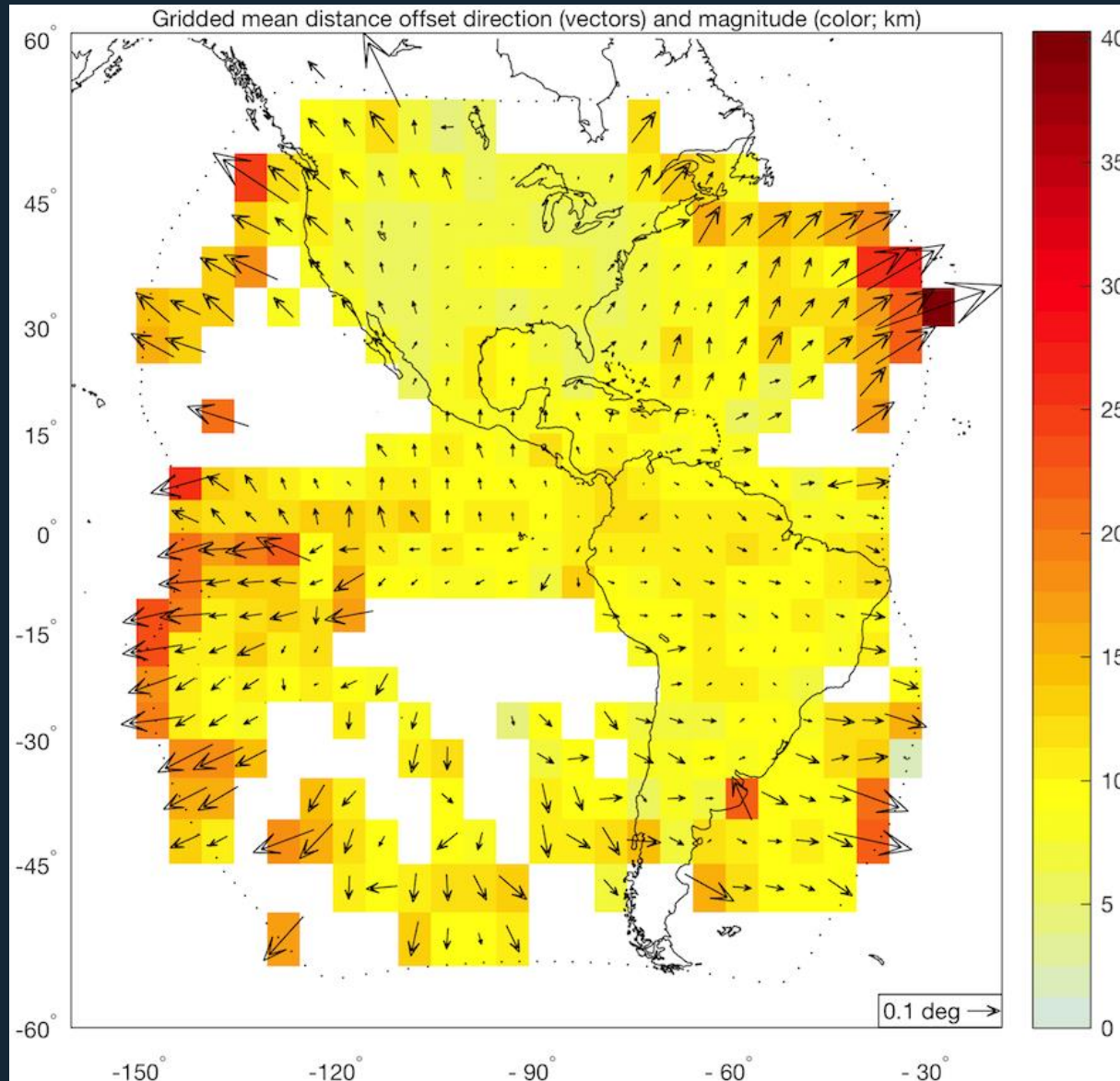
# GLM reprocessed data

- “Best” time and geolocation
- Available during ER-2 flights during field campaign
  - Over 65 total hours from March 21 to May 17

# Statistical overview



# Systematic inward shift near limb

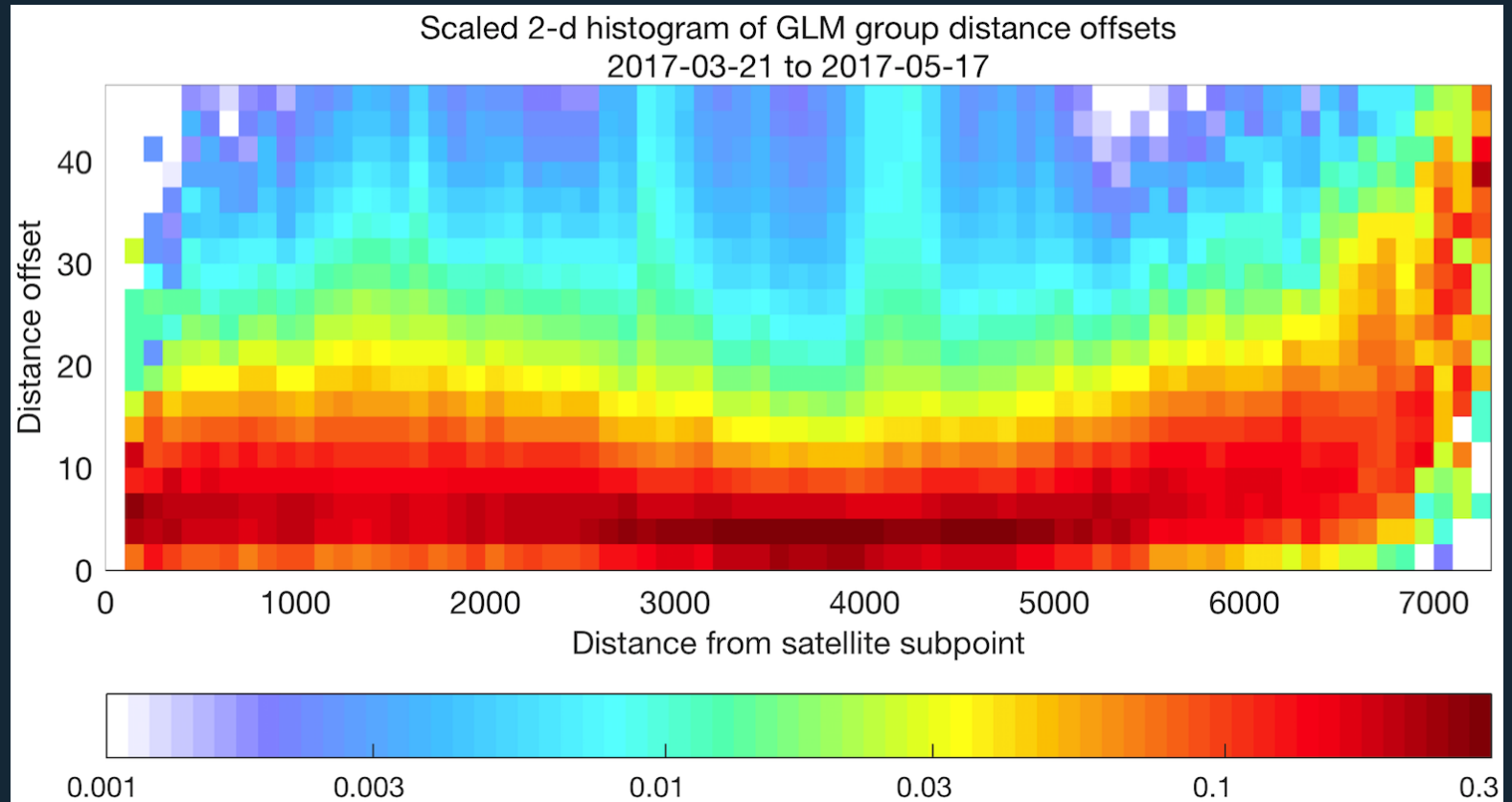


# Lightning ellipsoid

- Current geolocation: assume GLM sees lightning at cloud top, approximated by a lightning ellipsoid with constant equatorial height ( $e_1$ ) = 16 km and constant polar height ( $p_1$ ) = 6 km.
- Problem: near limb, GLM sees lightning from the side of the clouds
- Renavigate groups from ( $lat_1, lon_1$ ) for ( $e_1, p_1$ ) to ( $lat_2, lon_2$ ) for ( $e_2, p_2$ )
- Alternate lightning ellipsoids:
  - Constant  $e_2$  and constant  $p_2$ , with a lower ellipsoid
  - Variable  $e_2$  and constant  $p_2$ 
$$e_2 = e_{2,nadir} \times \cos(lon_1 - lon_{nadir})$$



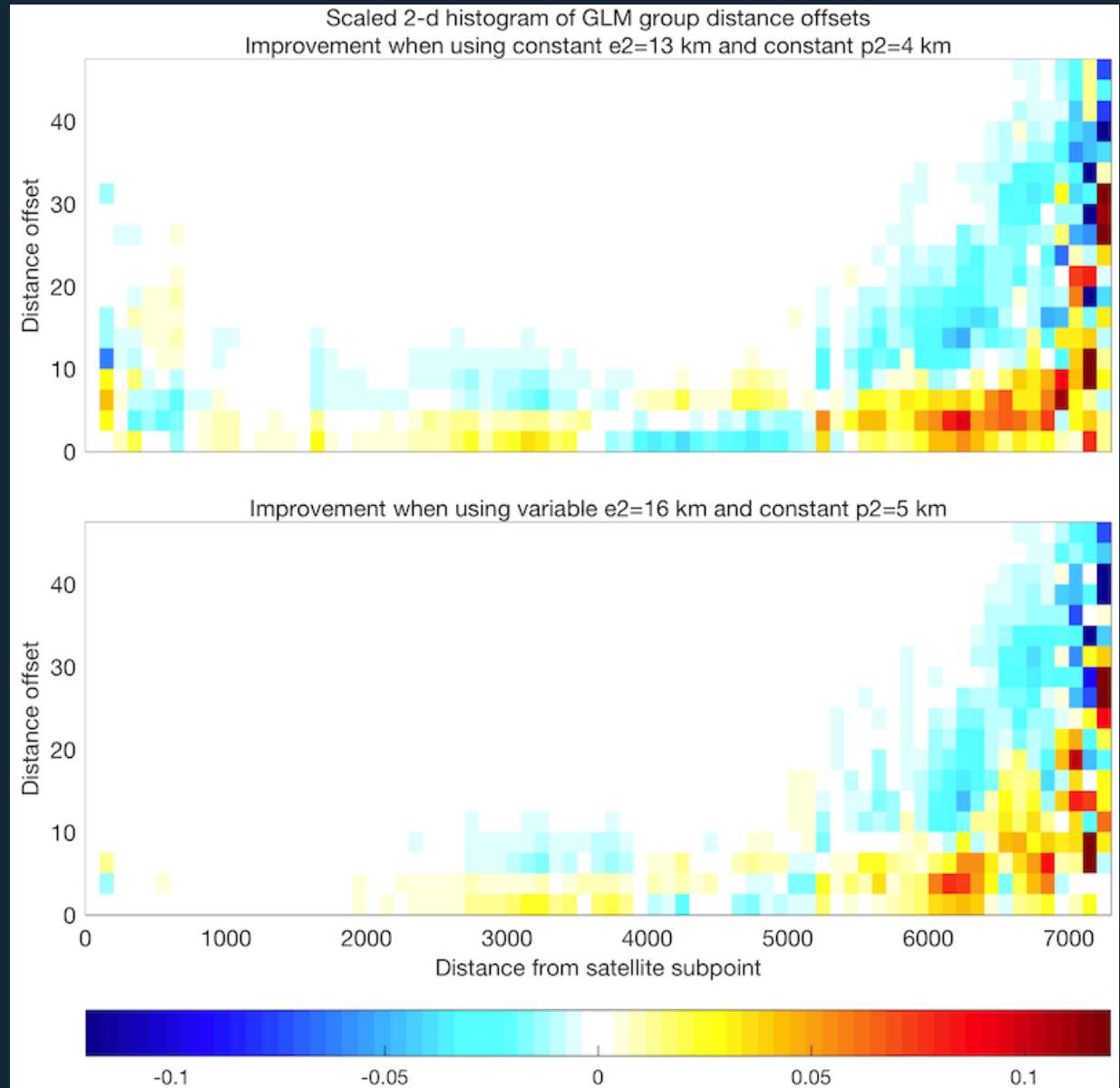
# Distance errors for current ellipsoid



# Improvement for alternate ellipsoids

Constant  $e_2 = 13$  km  
Constant  $p_2 = 4$  km

Variable  $e_2 = 16$  km  
at nadir  
Constant  $p_2 = 5$  km



# Conclusions

- LIS
  - Peak distance offsets ~6 km
  - Sub-ms timing
  - Provisional data available by January 1, 2018
- GLM
  - Peak distance offsets ~16 km for ground system data, ~3 km for reprocessed data
  - Sub-ms timing after correction to origination time
  - Potential adjustments to lightning ellipsoid to improve geolocation of groups near limb

Questions?



