

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



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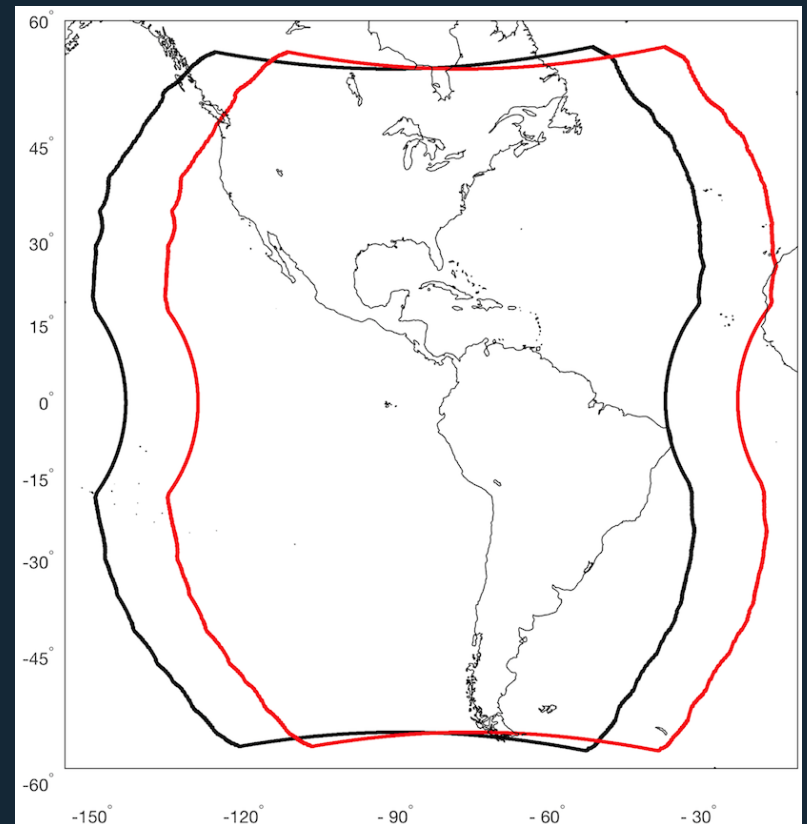
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2017 AGU Fall Meeting

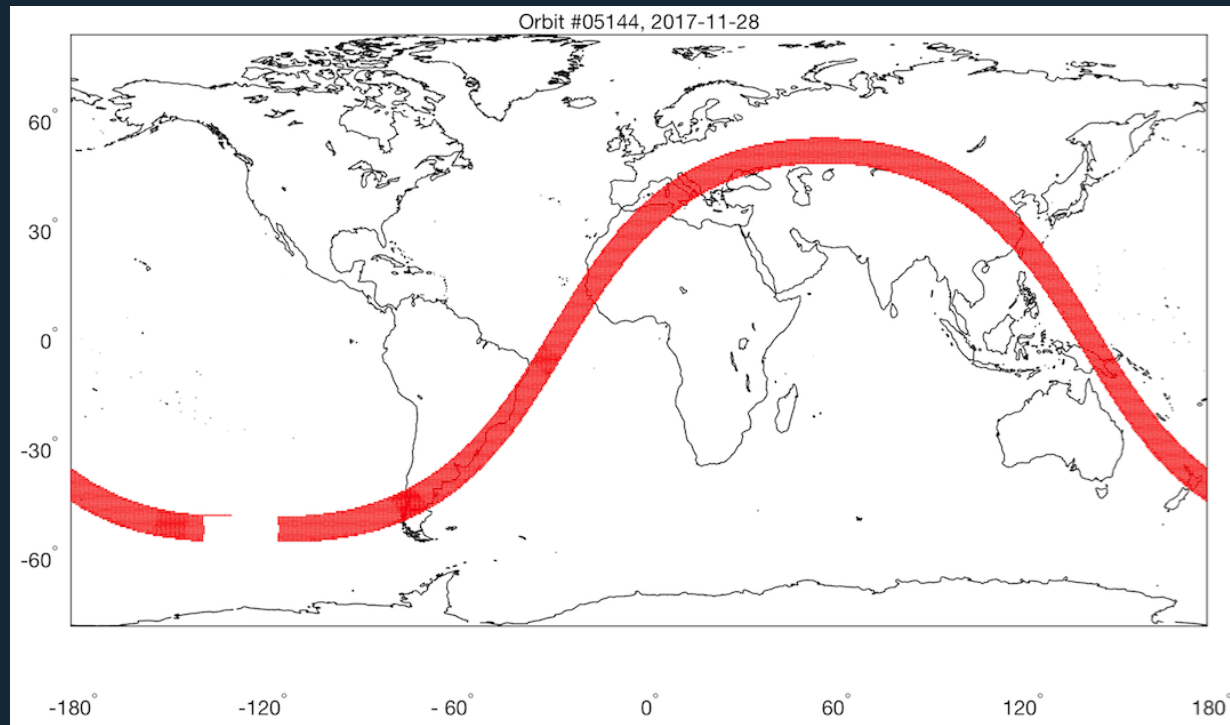
Geostationary Lightning Mapper on GOES-16

- 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



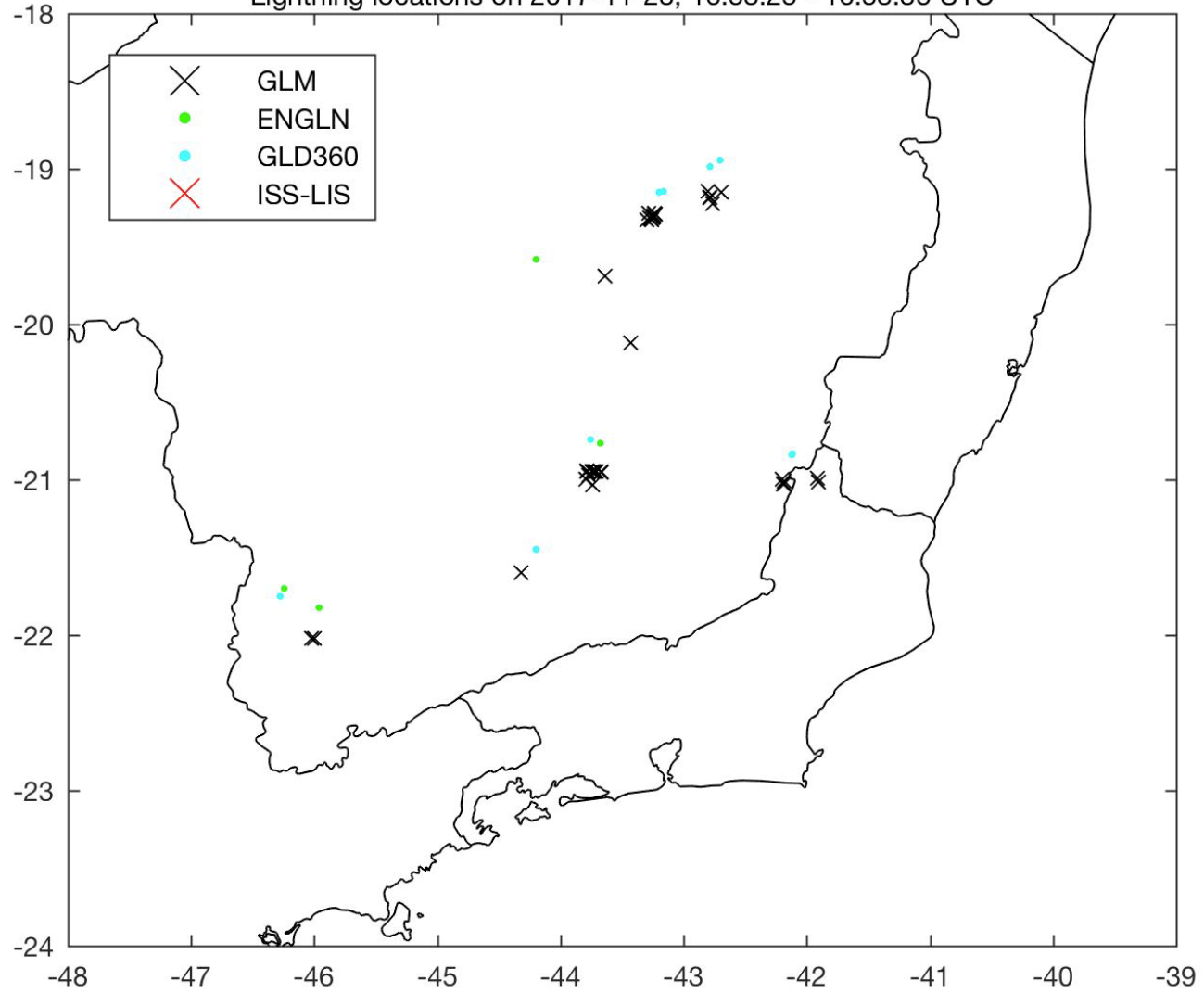
Lightning clustering

- 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)

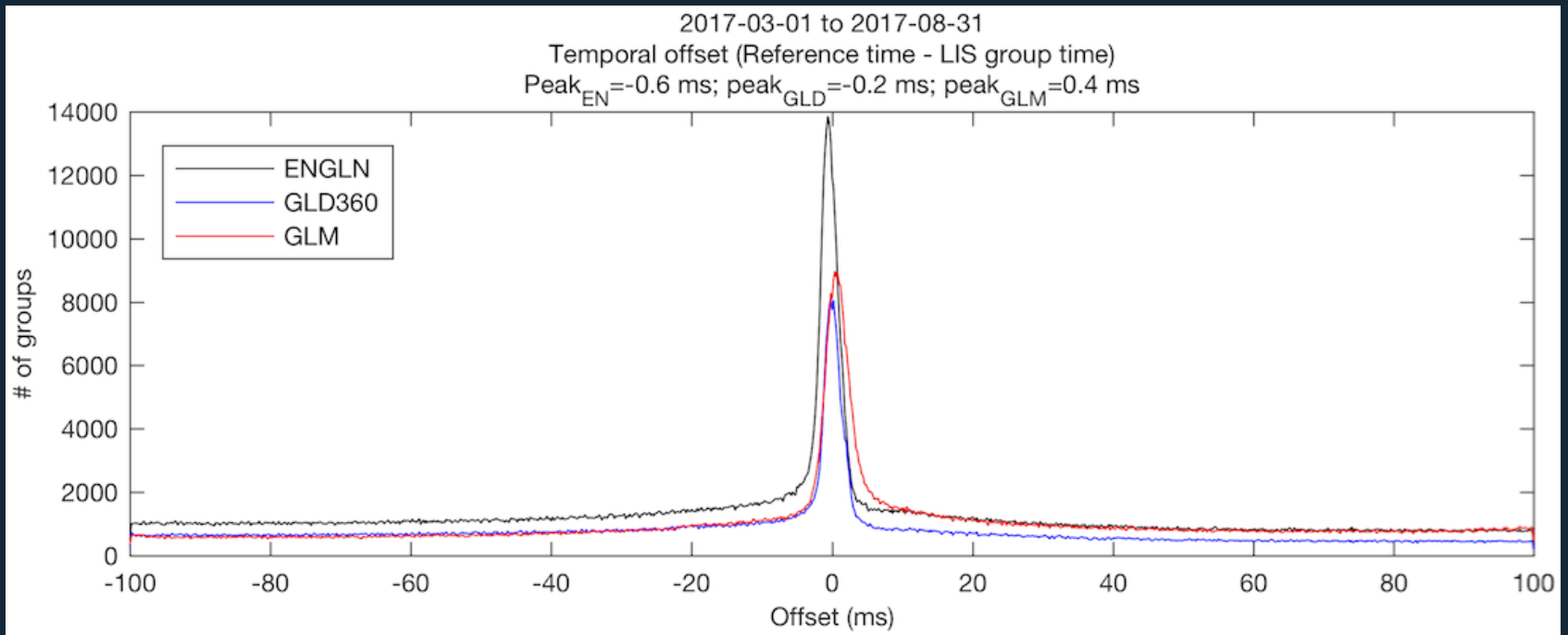
Reference lightning networks

- 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

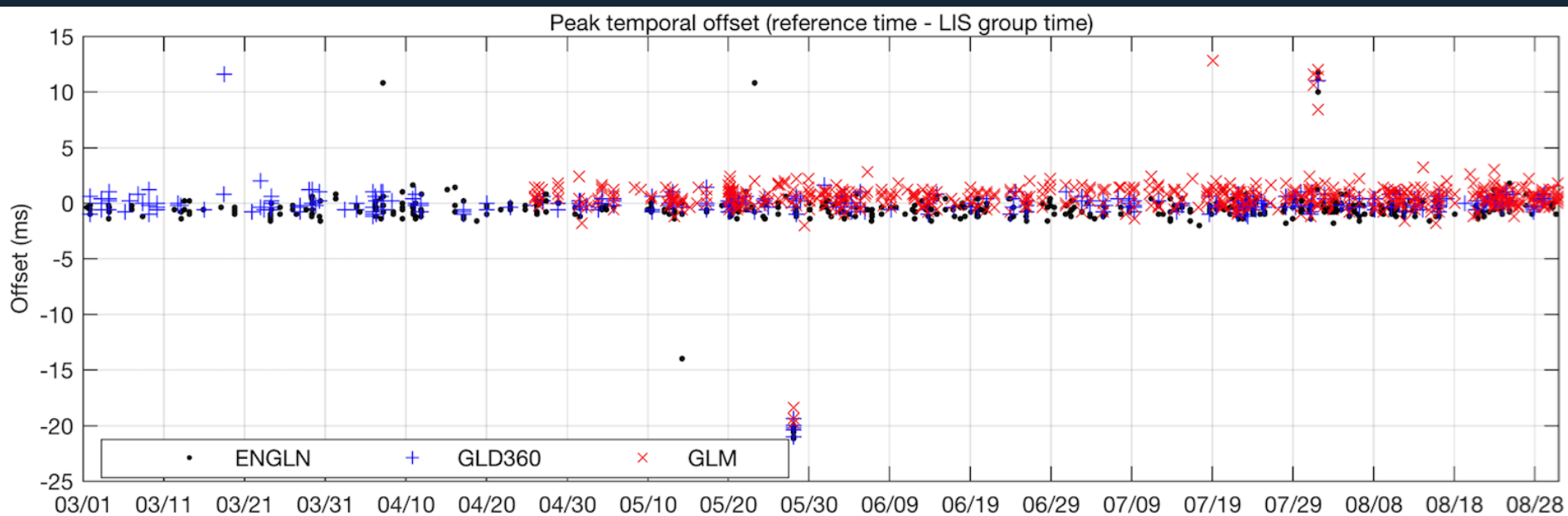


LIS has sub-ms timing accuracy



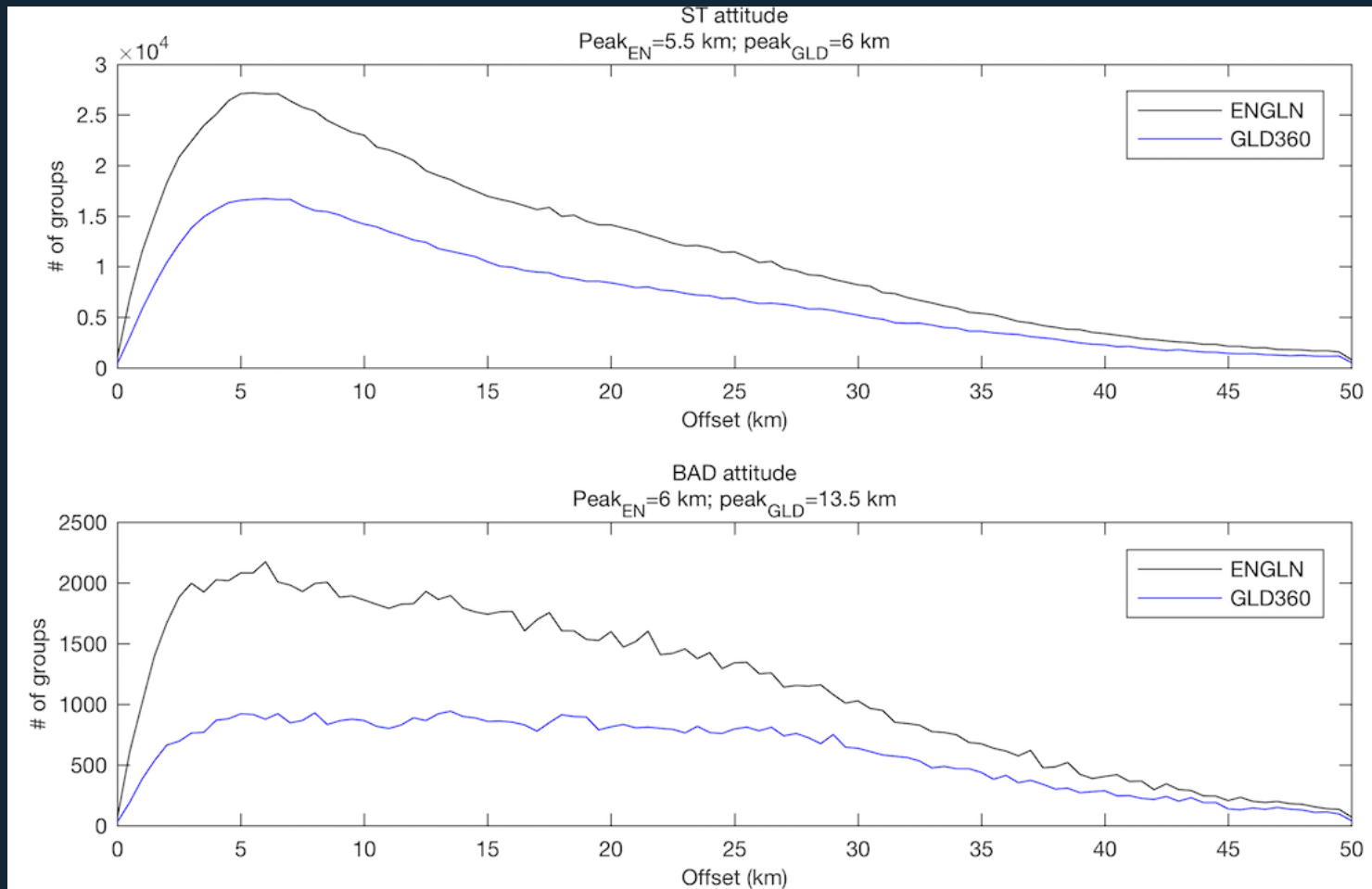
LIS timing is stable...with a couple excursions

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



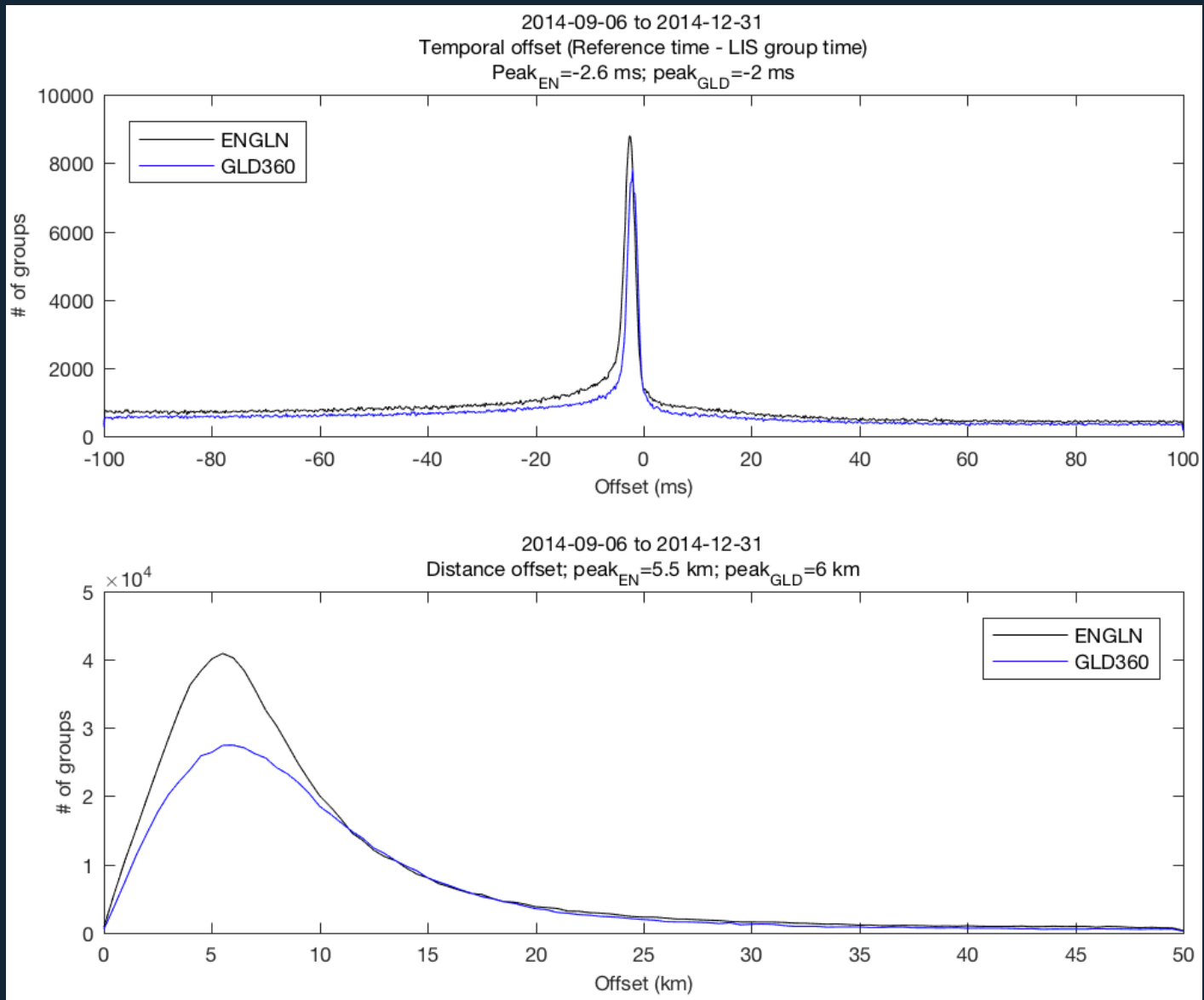
LIS geolocation

Star Tracker



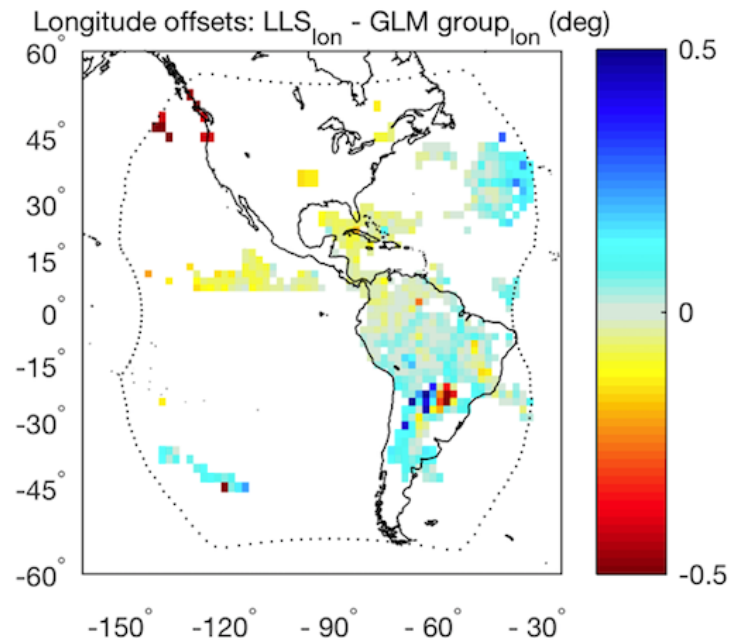
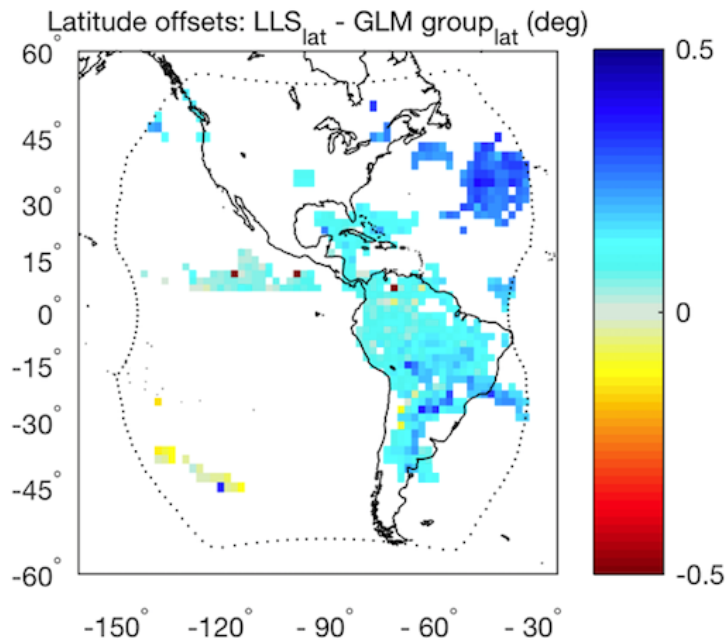
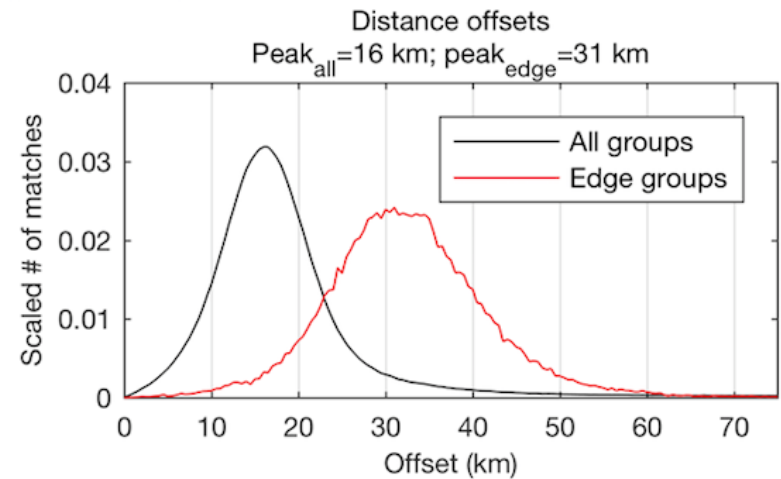
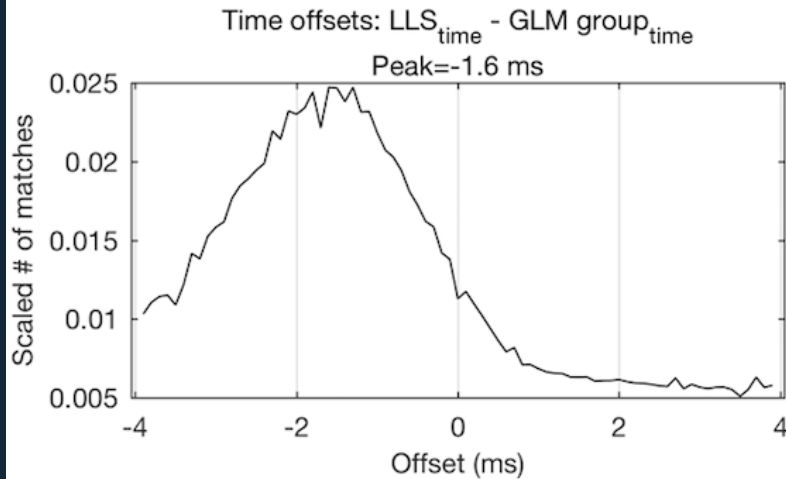
Basic Ancillary
Data

TRMM-LIS statistics



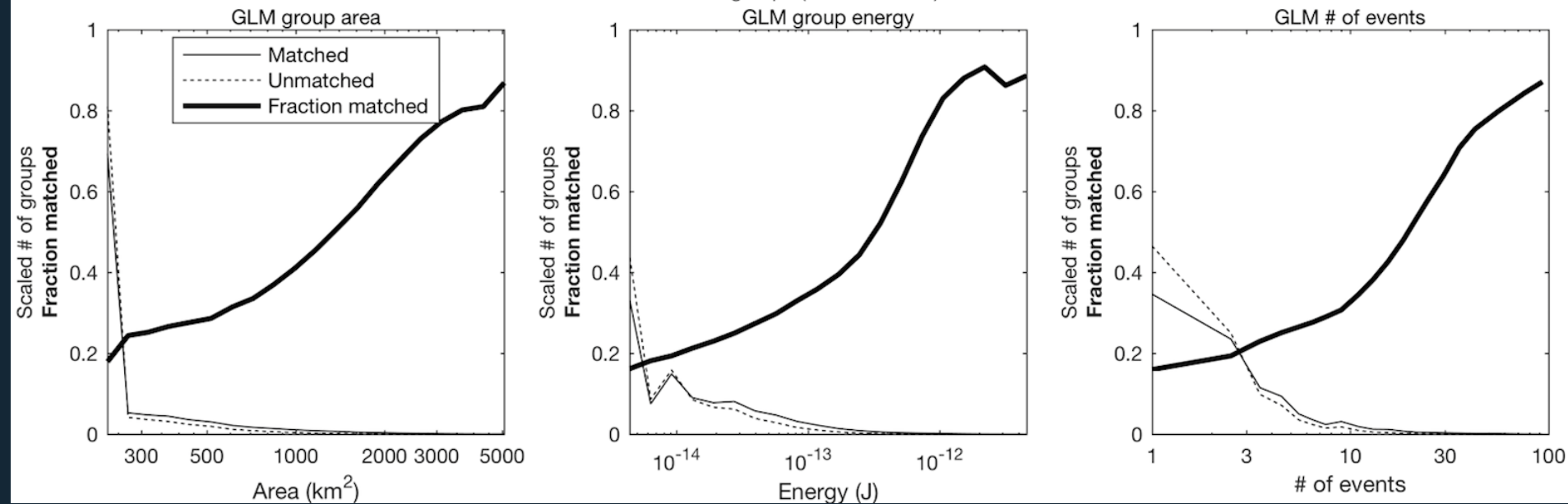
GLM ground system data

2017-11-28 to 2017-11-30



GLM ground system data

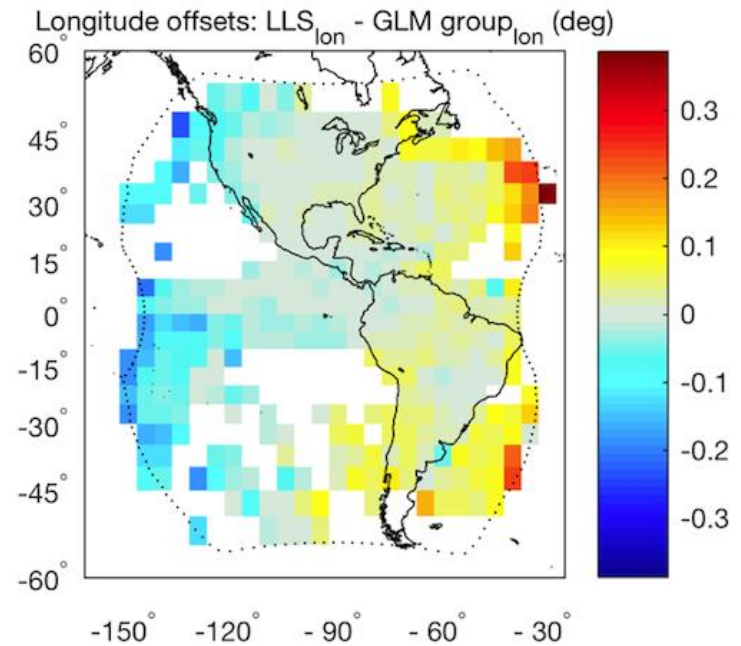
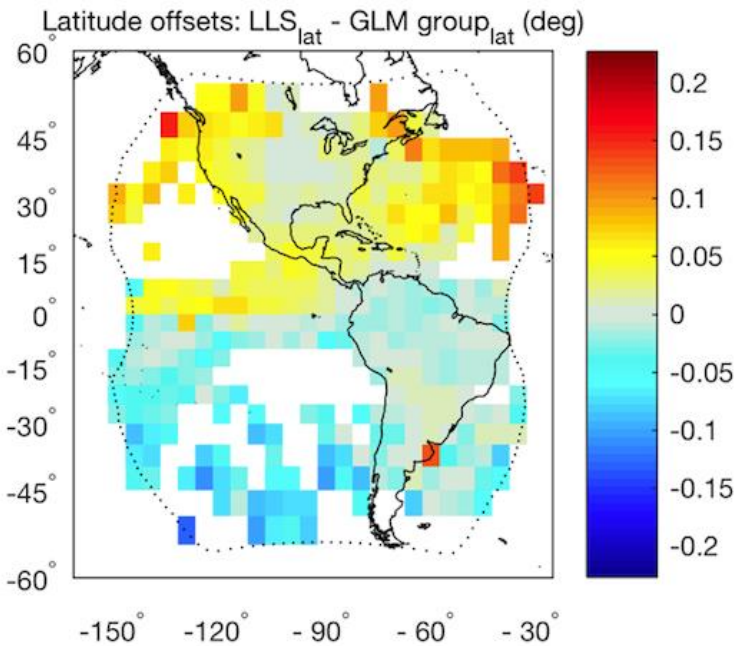
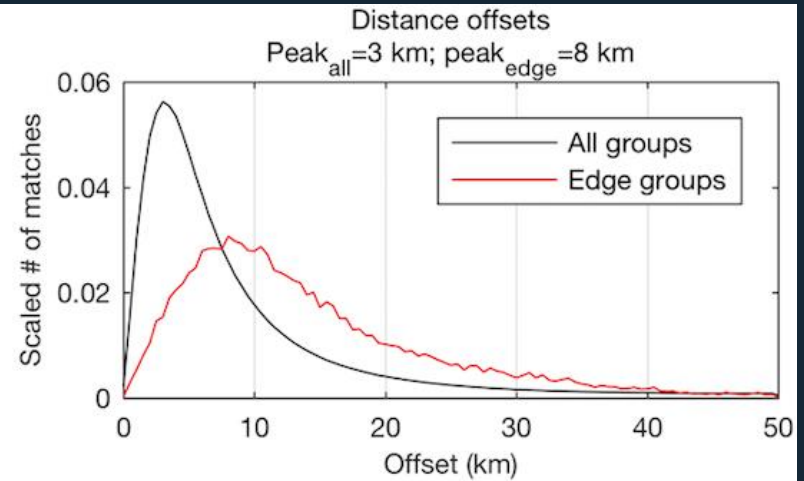
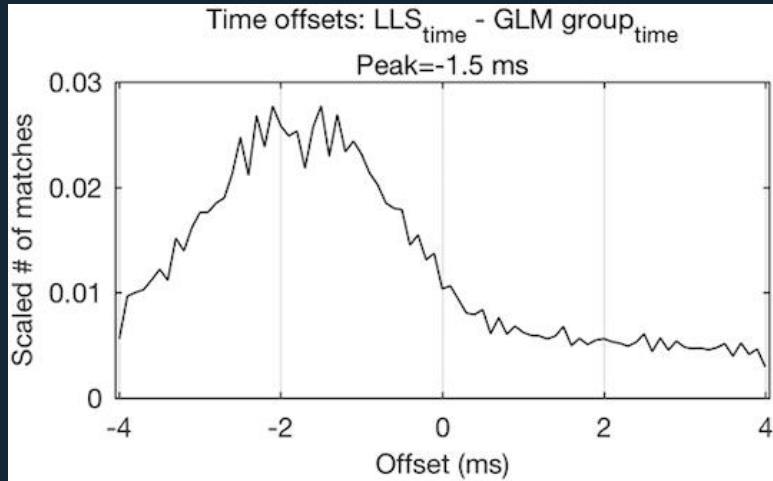
GLM groups matched by any LLS (4 ms, 300 km), 2017-11-28 to 2017-11-30
All GLM groups (20% matched)



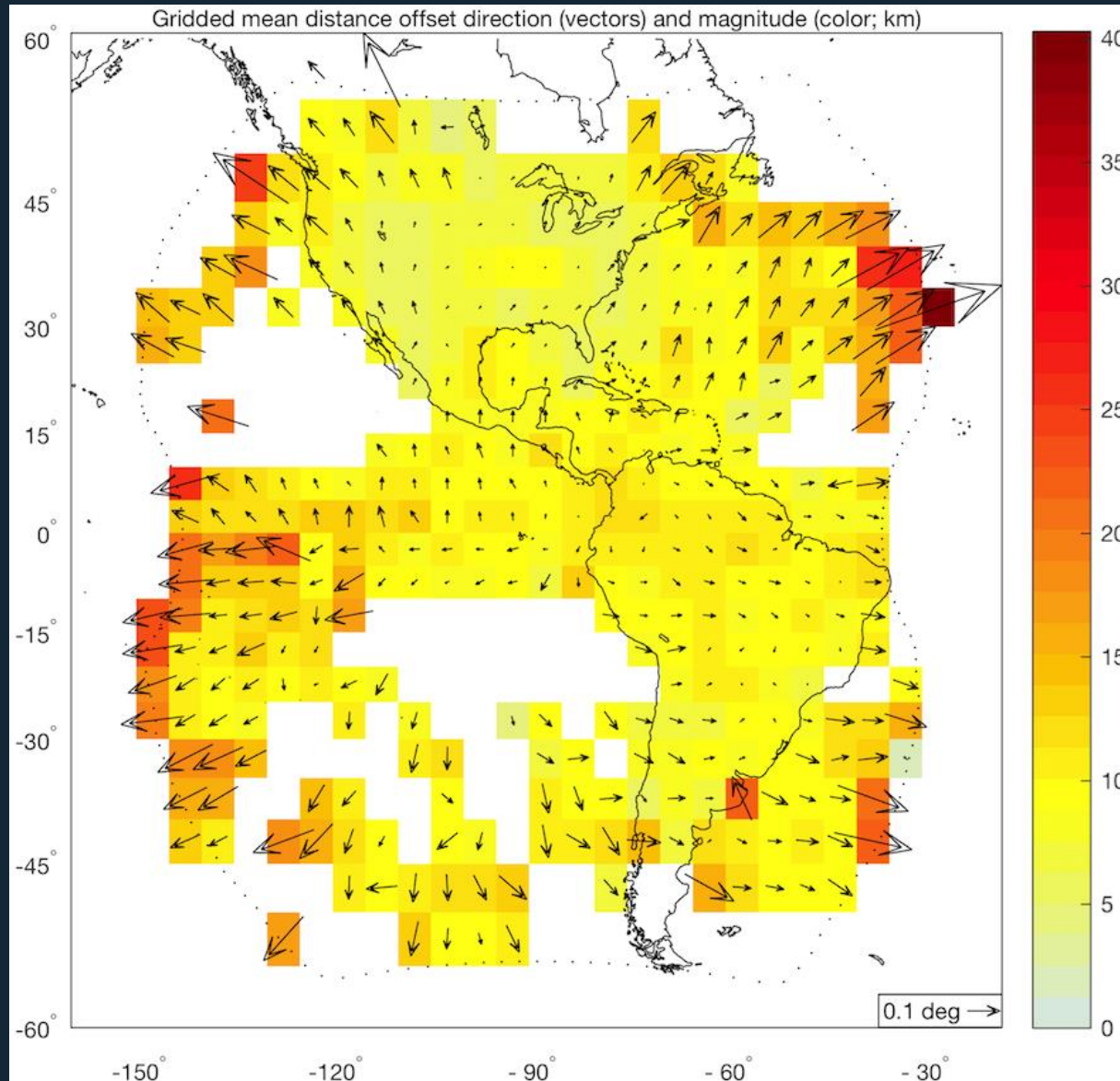
GLM reprocessed data

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

Statistical overview



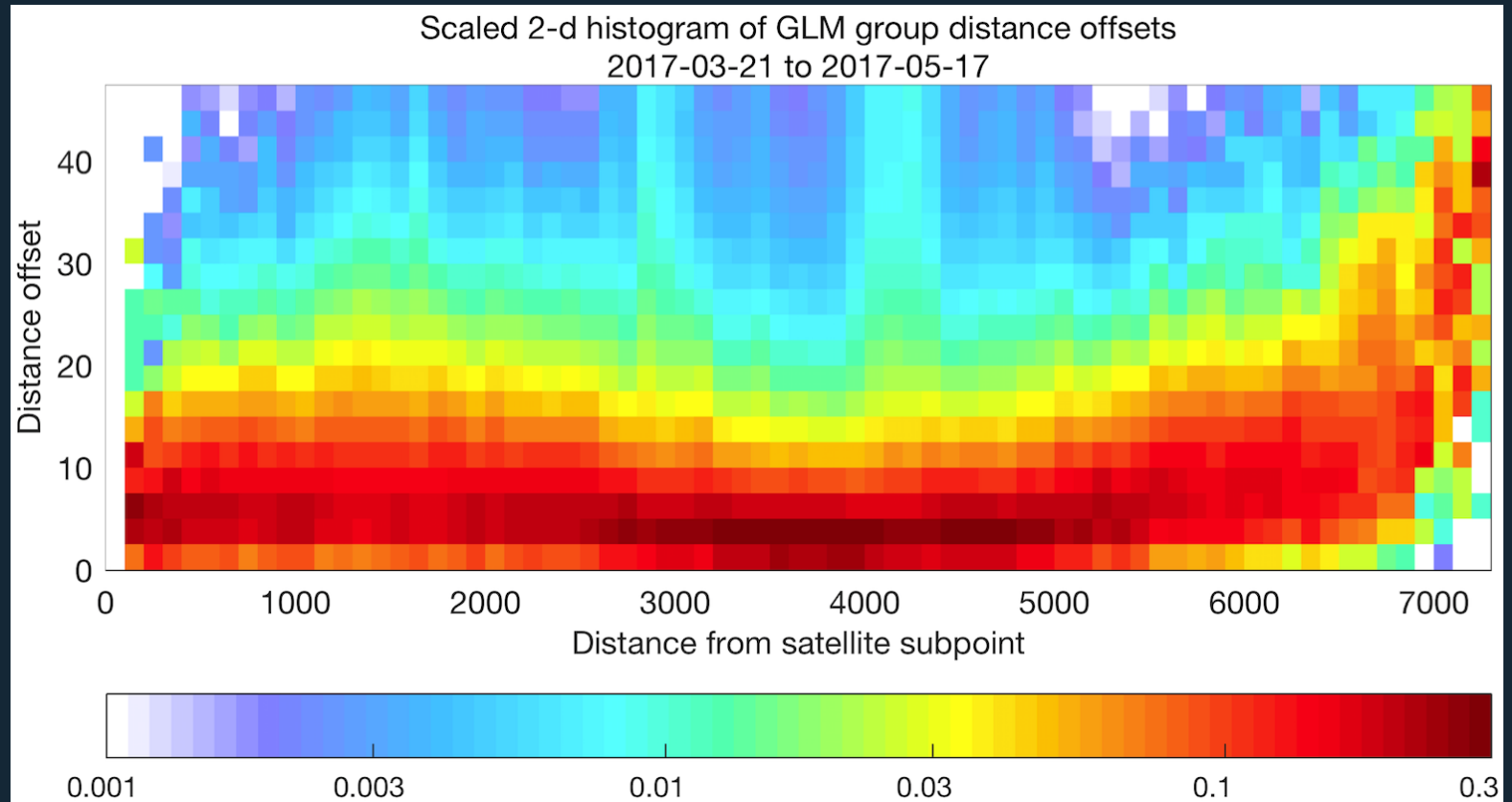
Systematic inward shift near limb



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 $(\text{lat}_1, \text{lon}_1)$ for (e_1, p_1) to $(\text{lat}_2, \text{lon}_2)$ 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
$$e_2 = e_{2,nadir} \times \cos(\text{lon}_1 - \text{lon}_{nadir})$$

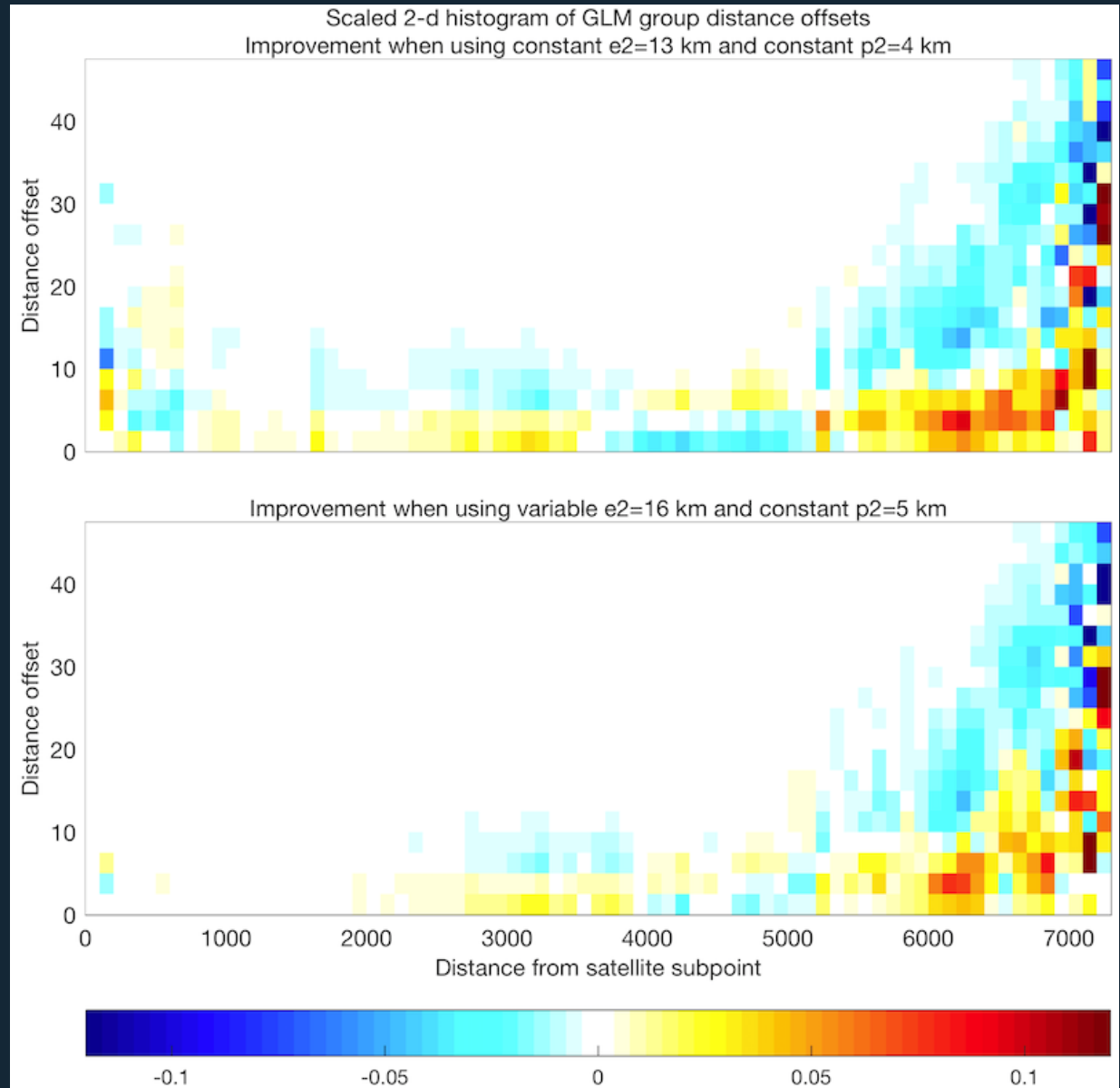
Distance errors for current ellipsoid



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?



