

GLM Discharge Process Classification by Broadband VHF Interferometry

Mark Stanley
Langmuir Laboratory
New Mexico Tech

Contributors: William Rison, Paul Krehbiel, Dan Rodeheffer,
Robert Brown and Jennifer Wilson

Overview

- NMT VHF broadband interferometer:
 - Three flat plate VHF antennas: 14-88 MHz
 - Fast antenna (E_z , $\tau \sim 100 \mu\text{s}$)
 - Output: 2D Az/EI maps, up to $>100\text{k}$ points/flash
 - Trigger source: broadband VHF (one antenna)
 - Trigger lengths: typically 0.3/0.5 sec pre/post
- Objectives of GLM comparison:
 - Determine what types of events GLM detects
 - Search for any GLM timing errors

2017 - Kennedy Space Center Field Campaign

- Feb. 15 – July 4
 - *Site lost power on July 4th*
- More compact layout than 2016
- Data: ~45 TB (*about the same as the 2016 KSC field campaign*)

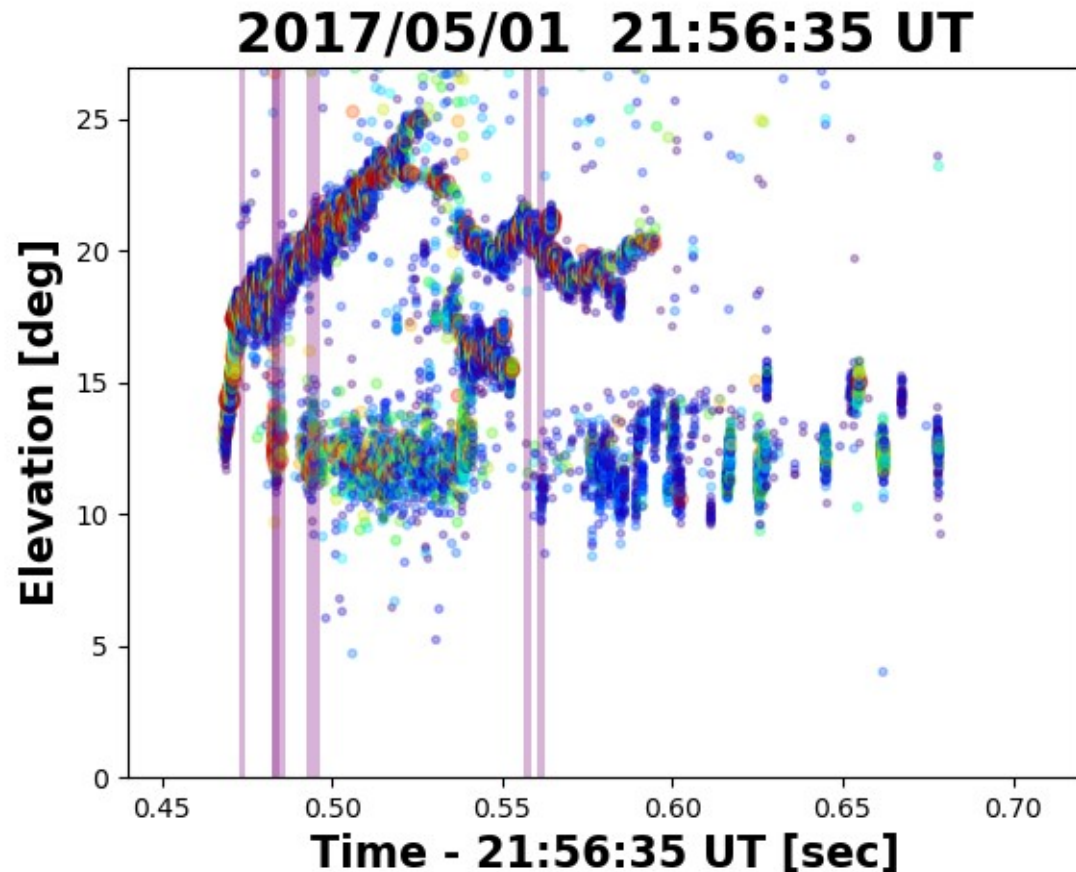


INTF-GLM Comparison Setup

- Primarily interested in flashes within ~20 km of the INTF (useful mapping range is ~40 km)
- Filter for GLM events within a ± 0.5 degree box around INTF center coordinates. This corresponds roughly to a 100x100 km box:
 - Latitude: 28.05° to 29.05°
 - Longitude: -81.12° to -80.12°
- Ignore multiple flashes within time region of interest and in/near bounding box

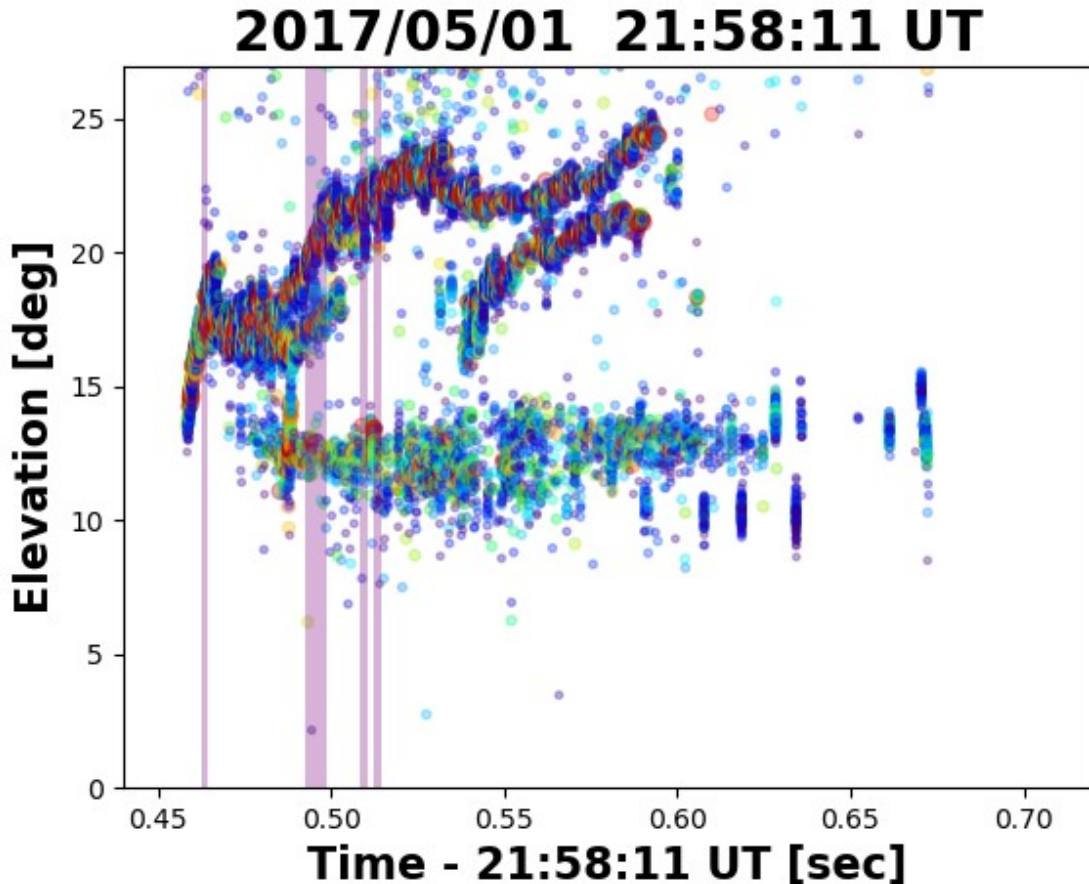
Bilevel Intracloud Example

- One GLM detect near flash onset: Initial Breakdown Pulse (IBP)?
- Some detects when -leader active
- Late K-changes not detected



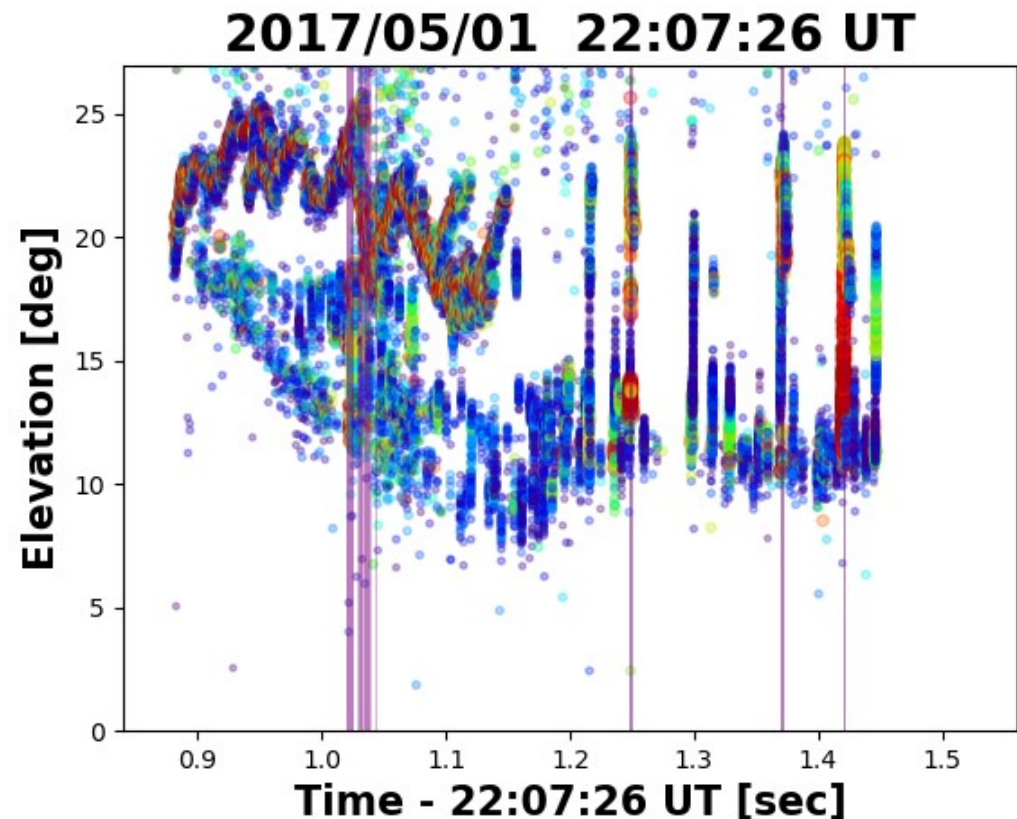
Another Bilevel IC

- Similar to prior example with an early GLM event, some during -leaders and none from late K-changes

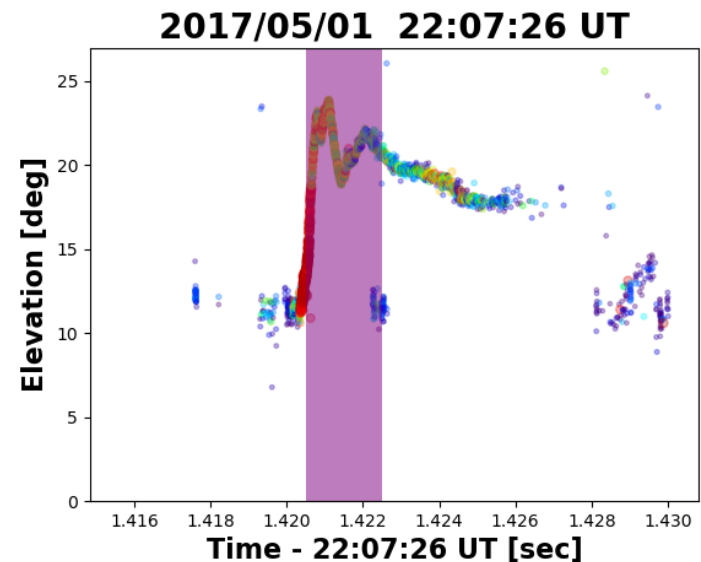
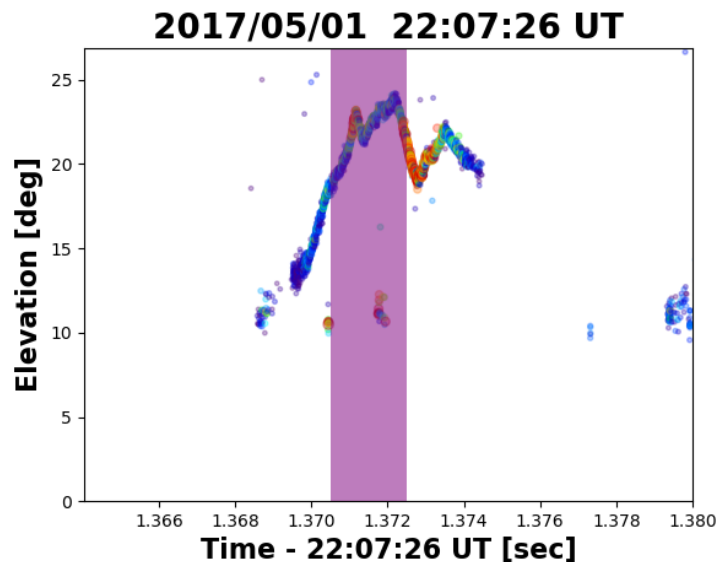
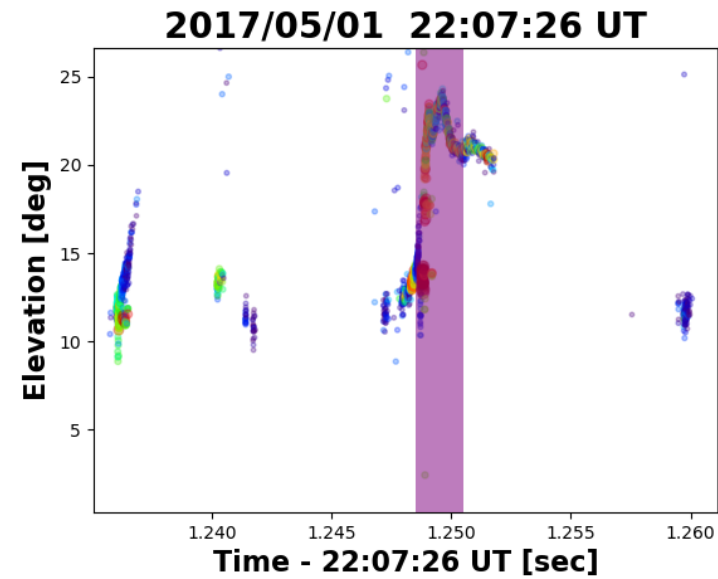
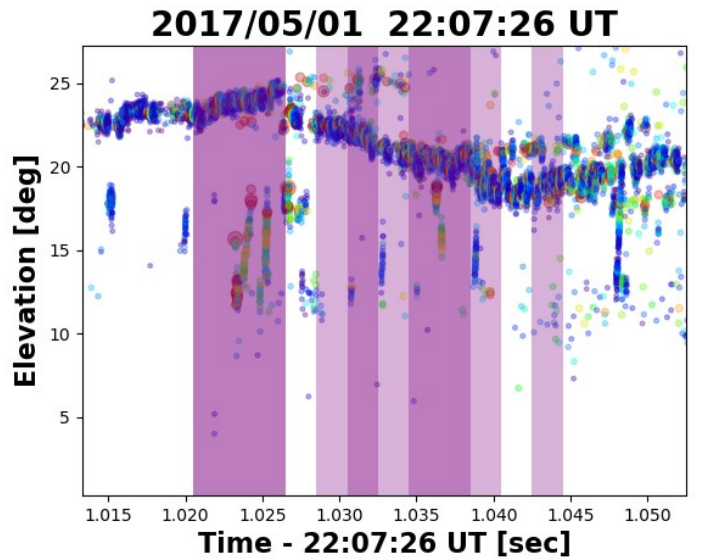


GLM Bilevel K-change Detects

- Consistent with a known bias towards events near cloud top, the only K-changes seen by GLM are those which develop into the upper levels (but not all of those are detected)

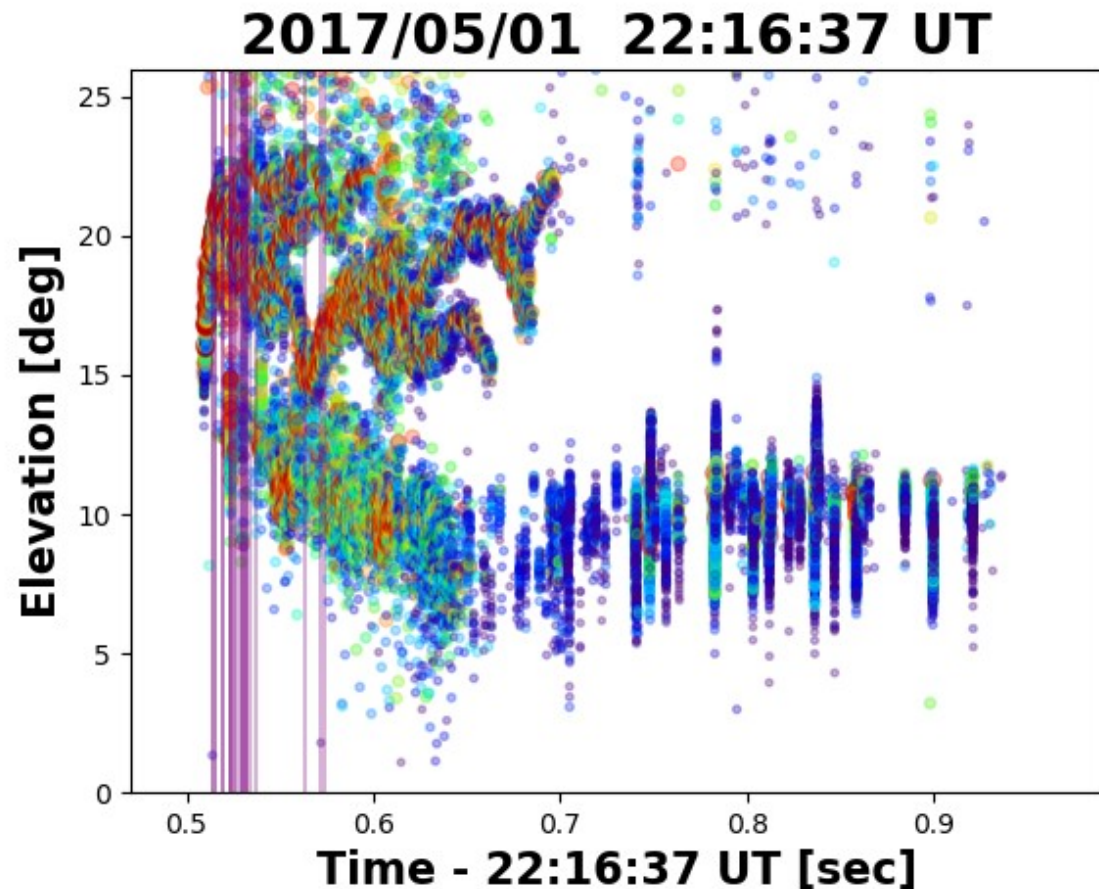


Zoom of GLM Events in Bilevel K-change Flash



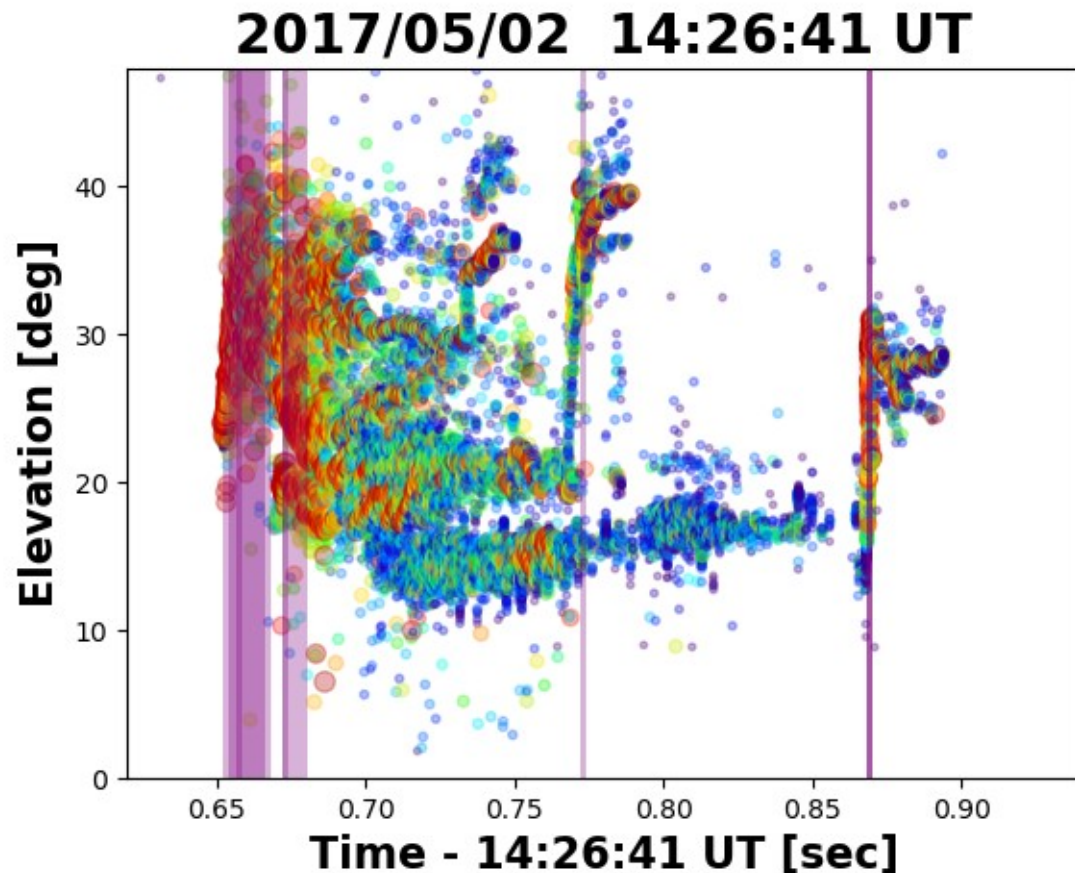
Bilevel IC

- Both the initial -leader and a subsequent -leader are detected
- K-changes in the lower level are missed, as before



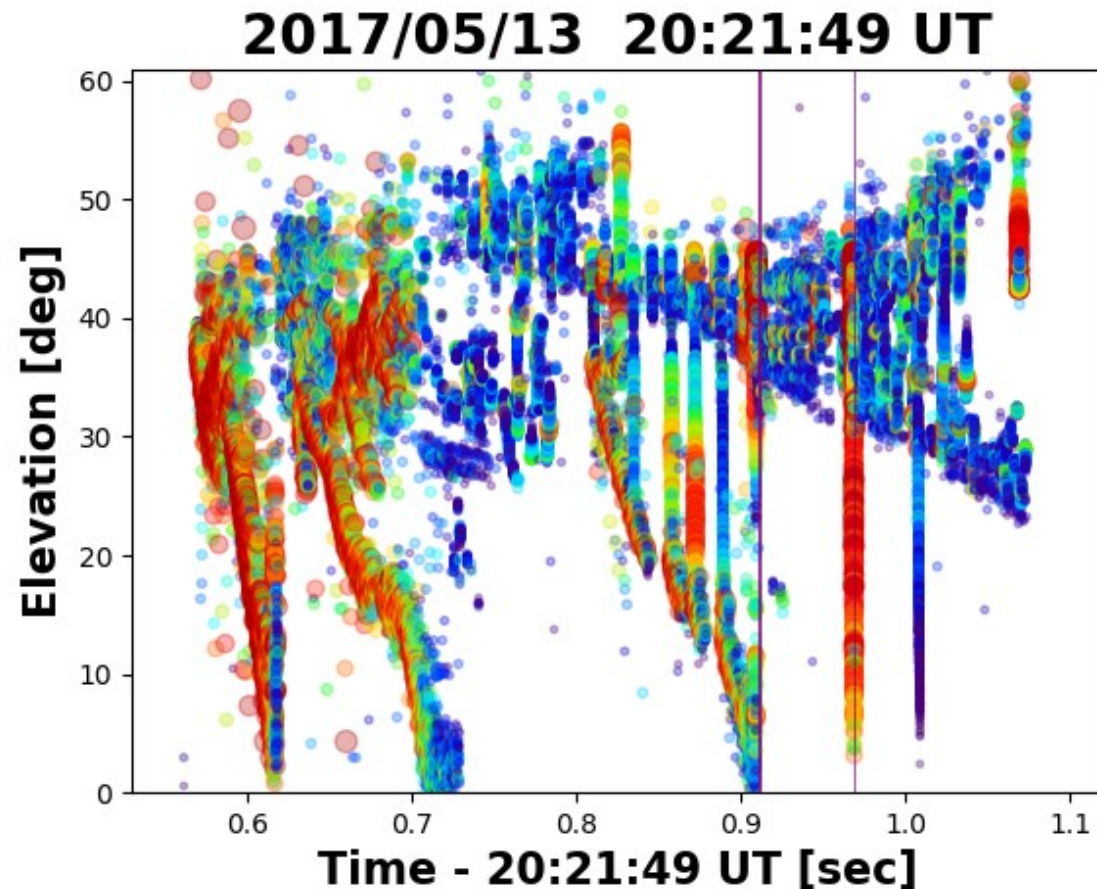
Bilevel IC on May 2nd

- The initial IC activity, -leaders and later bilevel K-changes are detected by GLM

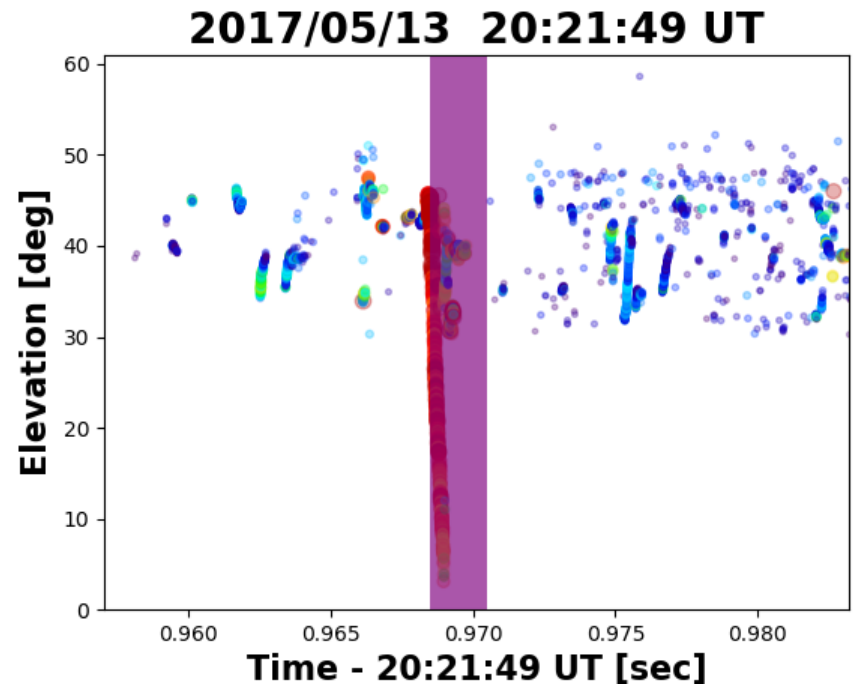
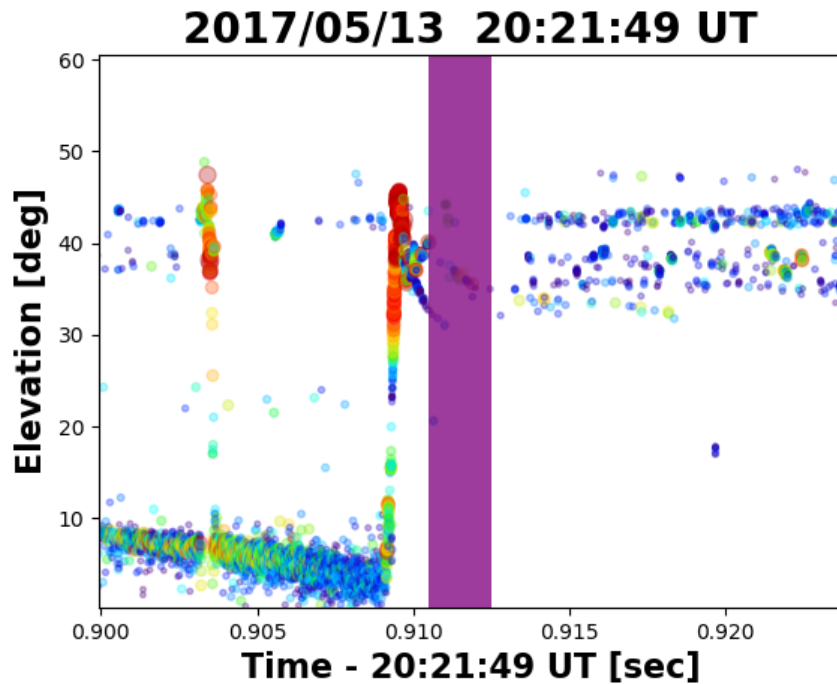


Negative Cloud-to-Ground

- Five strokes:
the 3rd and 4th
of which are
seen by GLM
- The third
leader to
ground is a
dart-stepped
- The fourth is a
dart leader



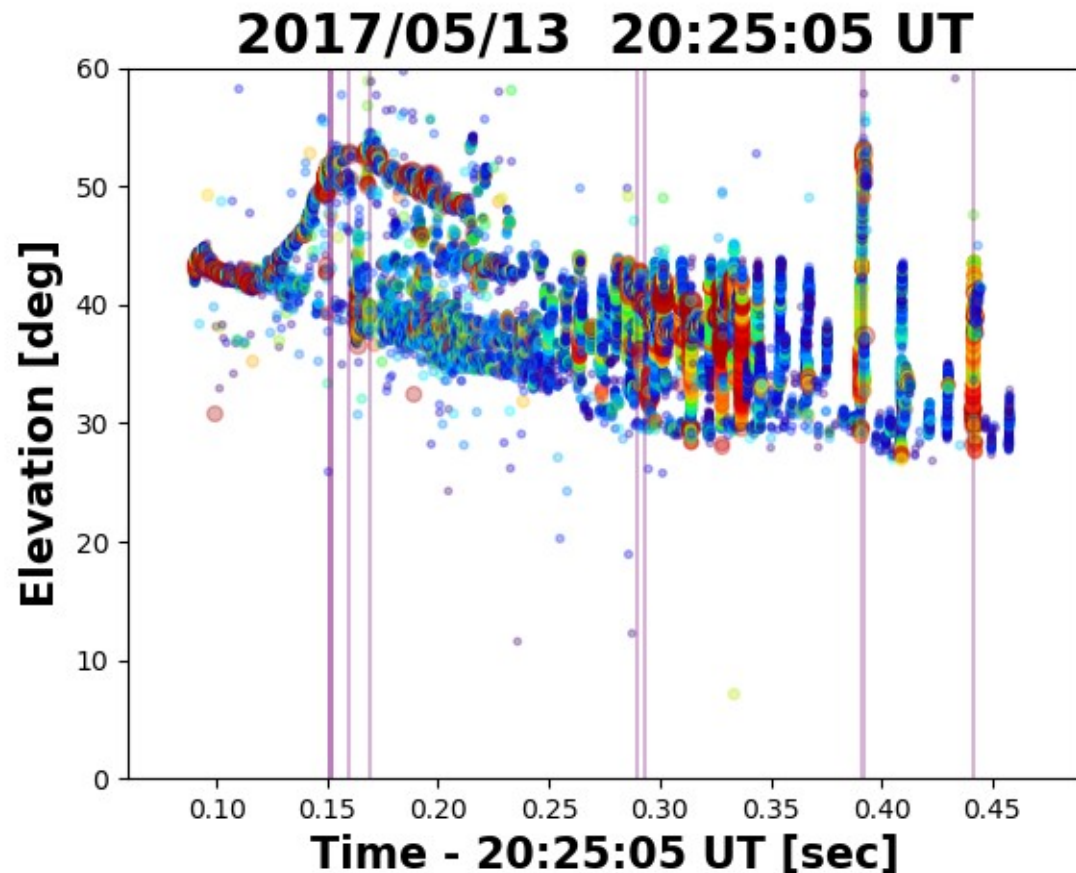
Zoom of GLM detects for CG Flash



- Return stroke (fast upward motion) in above left figure was likely detected, but discarded because it was the first event.

Bilevel IC on May 13th

- Some -leader activity seen by GLM
- Three K-changes are detected by GLM, one of which is bilevel



Summary

- GLM event classification is on-going
- Case studies indicate that GLM detects:
 - Initial IC activity (probably Initial Breakdown Pulses)
 - Negative leader activity, primarily in upper part of bilevel intracloud flashes (near cloud top). Some of these detects correlate with early K-changes in the lower level which attach to conducting channels
 - K-changes which propagate into upper levels
 - Some dart leaders and/or return strokes
- Good time alignment (when distinctive features present)