# GLM Evaluation Using Raspberry Pi-based Camera Network

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# Raspberry Pi Network Updates


- 8 new stations in 4 states (total 15 stations in 5 states)
- 5 new stations in the GLM overlapping region
- 2 outdoor setups, 1 portable station as needed
- Network-wide algorithm upgrade

# Raspberry Pi Network Updates (cont.)

Outdoor setups

Portable setups

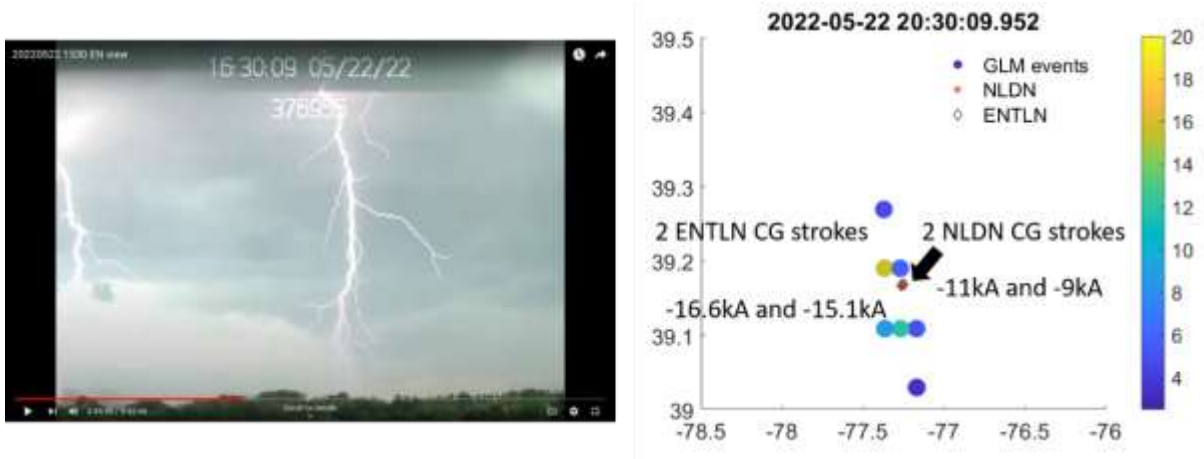
Indoor setups

# 2022 Flash Statistics & Comparison

| Variables | Raspberry Pi | US (Poelman et al, 2021) |
|---|---|---|
| Mean multiplicity (strokes/flash) | 3.2 | 3.9 |
| Recurrent strokes in multi-strike flash frequency (%) | 55 | N/A |
| Single stroke flash frequency (%) | 34 | 25.6 |
| Average flash duration (ms) | 239.7 | 236 |
| Average stroke duration (ms) | 36.00 | N/A |
| Average duration between strokes in a multi-stroke flash (ms) | 62.24 | N/A |

- Good network for GLM evaluation

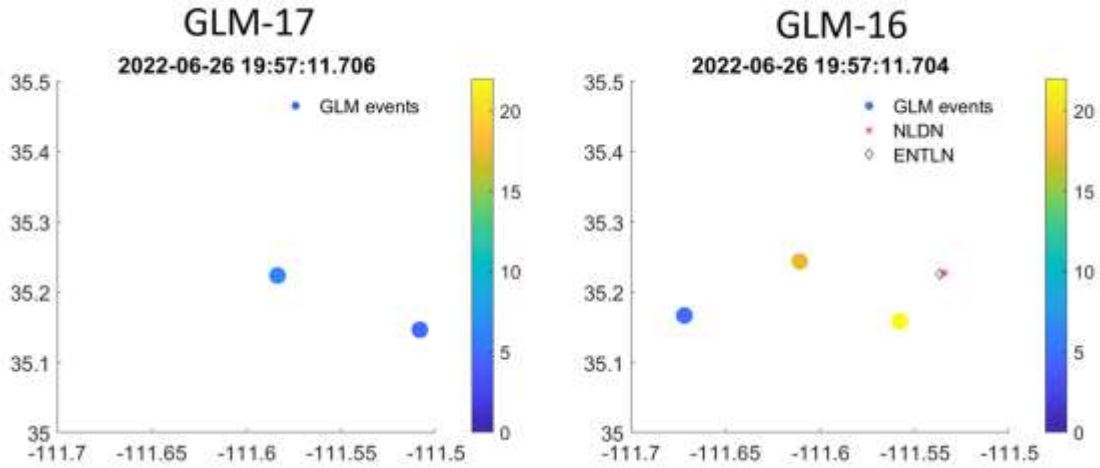
# GLM16 Evaluation




Left: Two strokes in the same frame captured by a Raspberry Pi camera; Right: Plan view of the GLM16 pixels geolocations color-coded by optical energy (fJ), ENTLN (black diamonds), and NLDN (red stars).

- Overall, GLM16 detected most CG flashes based on the Raspberry Pi camera observations.
- GLM16 has a reduced detection efficiency for the first one or two strokes of a flash. (see Zhang and Cummins, 2020)
- GLM16 has a reduced detection efficiency for CG strokes with continuing currents.
- GLM16 has a reduced detection efficiency for some CG strokes when the clouds were thick.

# GLM Evaluation – 16 vs. 17


An example of a stroke-by-stroke analysis. The flash was captured at Flagstaff, AZ

- Overall, GLM-16 and -17 match well.
- GLM-16 tends to report more events and higher event energy.
- GLM-17 tends to miss strokes within a flash.
- GLM-16 matches better in time with NLDN/ENTLN.

# GLM Evaluation – Long Continuing Current

- Long cc defined as same channel in at least consecutive 3 frames (>30ms, with 90fps)
- GLM Lcc DE = 14/26 ≈ 50% (see Zhu's talk at the same meeting)
- GLM+NLDN+ENTLN combined Lcc DE = 23/26 = 88.5%
- Typically lit up 3-5 pixels, but could be more.


# 2023 Statistics (Arizona only, so far)

FDE_GLM16 = 0.78 (7/9)

GDE_GLM16 = 0.57 (12/21)

ccDE_GLM16 = 0 (0/4)

FDE_GLM18 = 0.89 (8/9)

GDE_GLM18 = 0.86 (18/21)

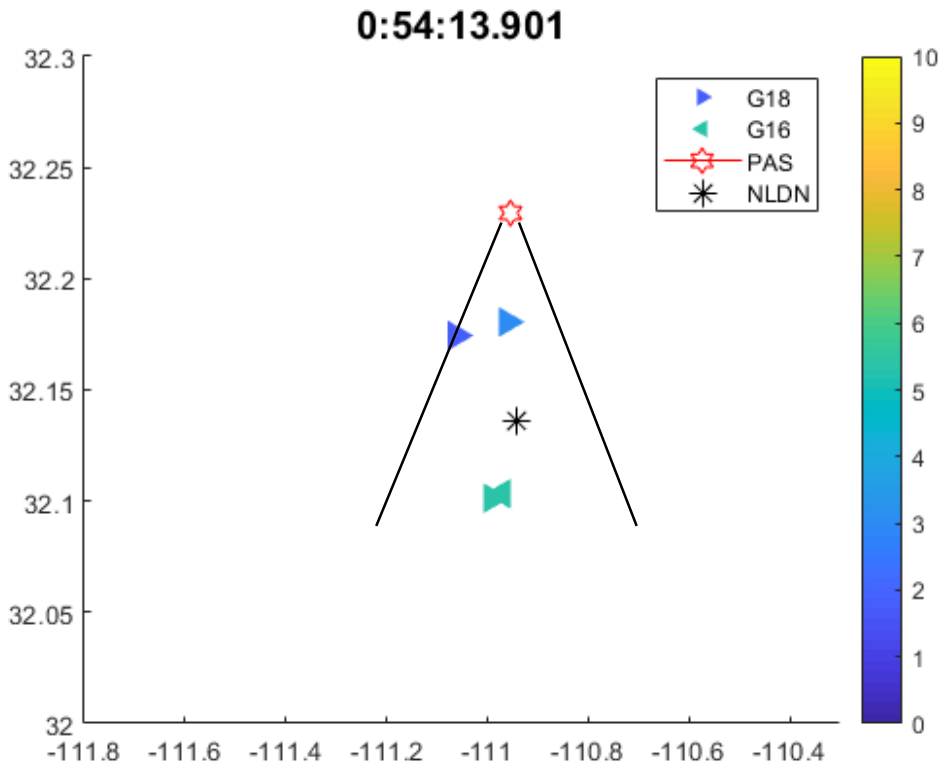
ccDE_GLM18 = 0.75 (3/4)

* Reported one that NLDN missed

GLM 18 reported additional groups either not seen on the video (or out of FOV) or reported by NLDN – more IC components reported.

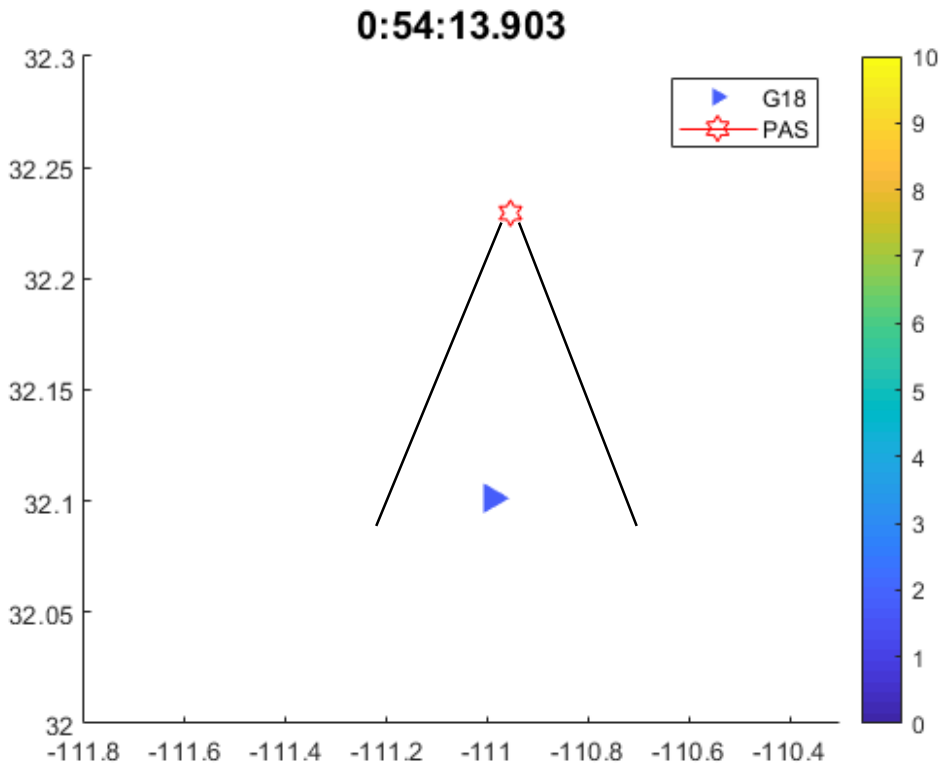
# A Video Example – Tucson, AZ

# 1st: IC pulse

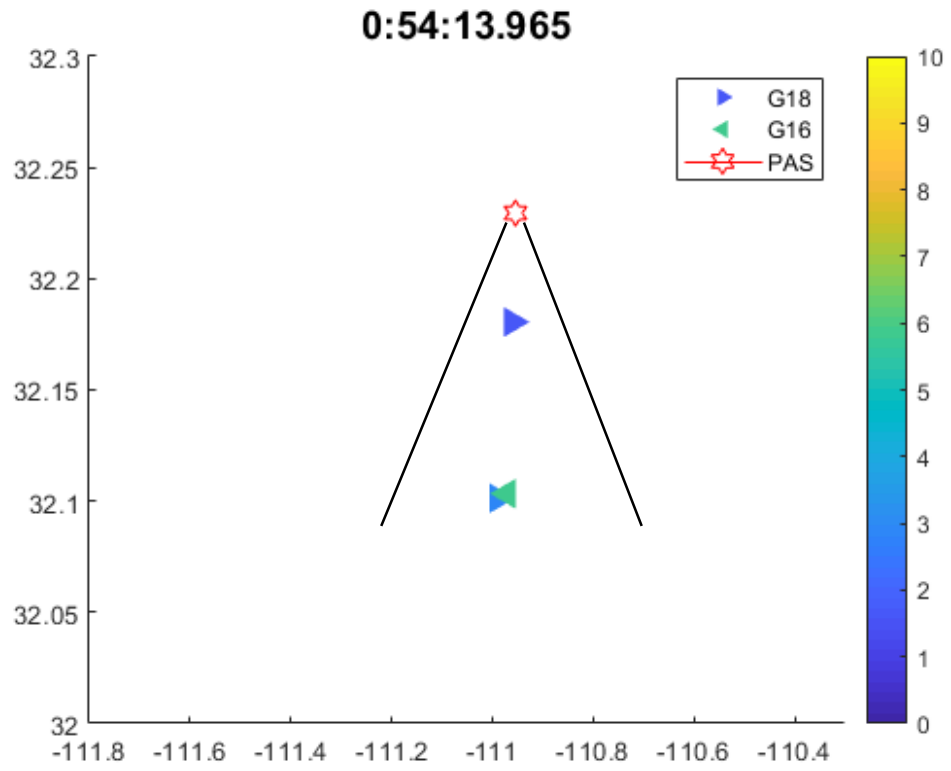

Both G16 (1 pixel) and G18 (3 pixels) detected the pulse.

# 1st: IC pulse

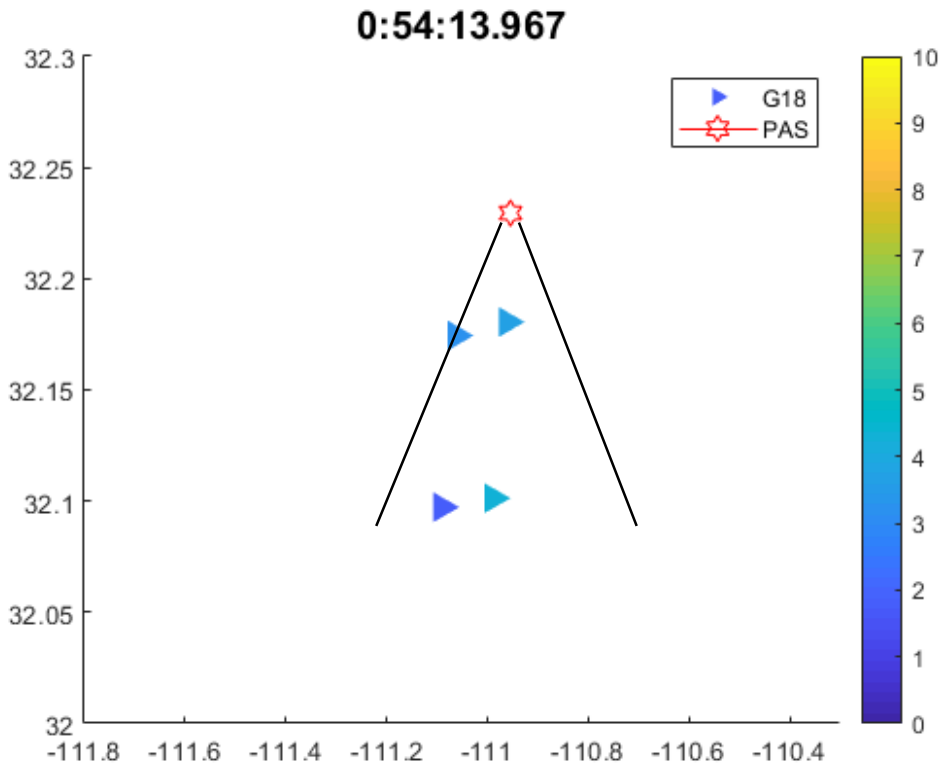

G18 reported a consecutive frame

# 2nd: IC before the CG


Both G16 (1 pixel) and G18 (2 pixels) detected the IC

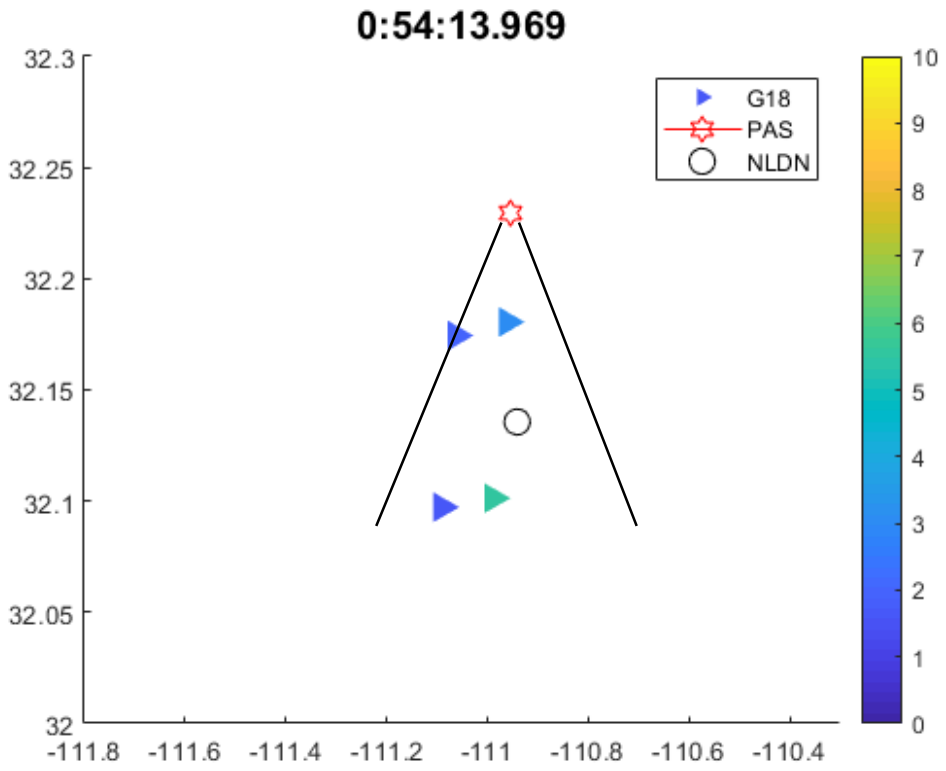
# 2nd: IC before the CG

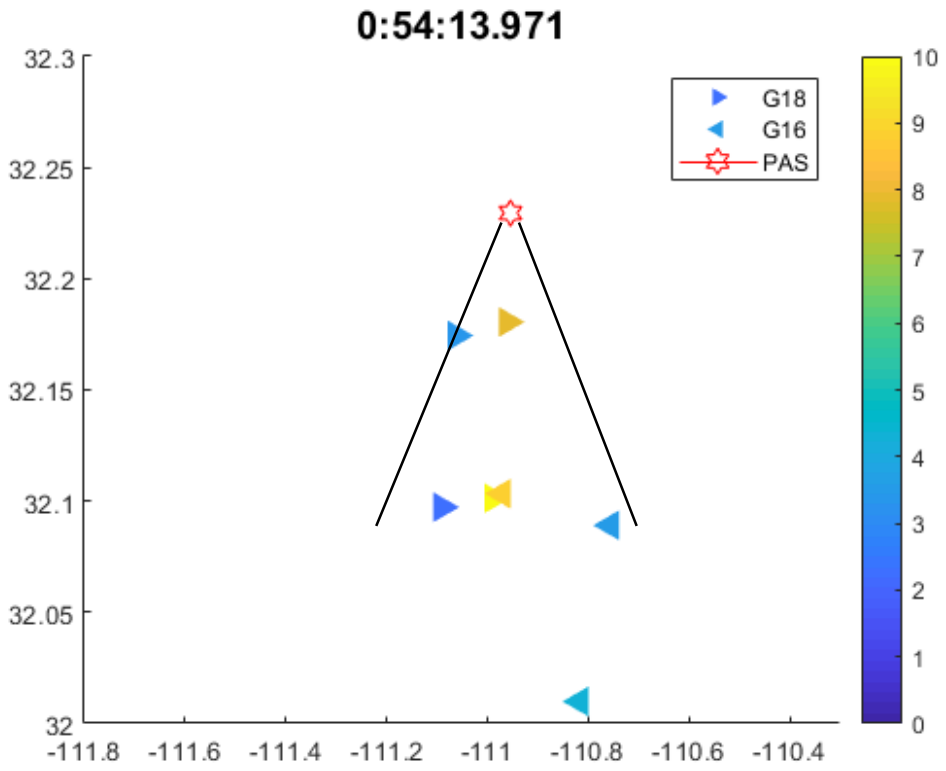

G18 reported a consecutive frame

# 3rd: First CG


00:54:13 08/01/23
1765354

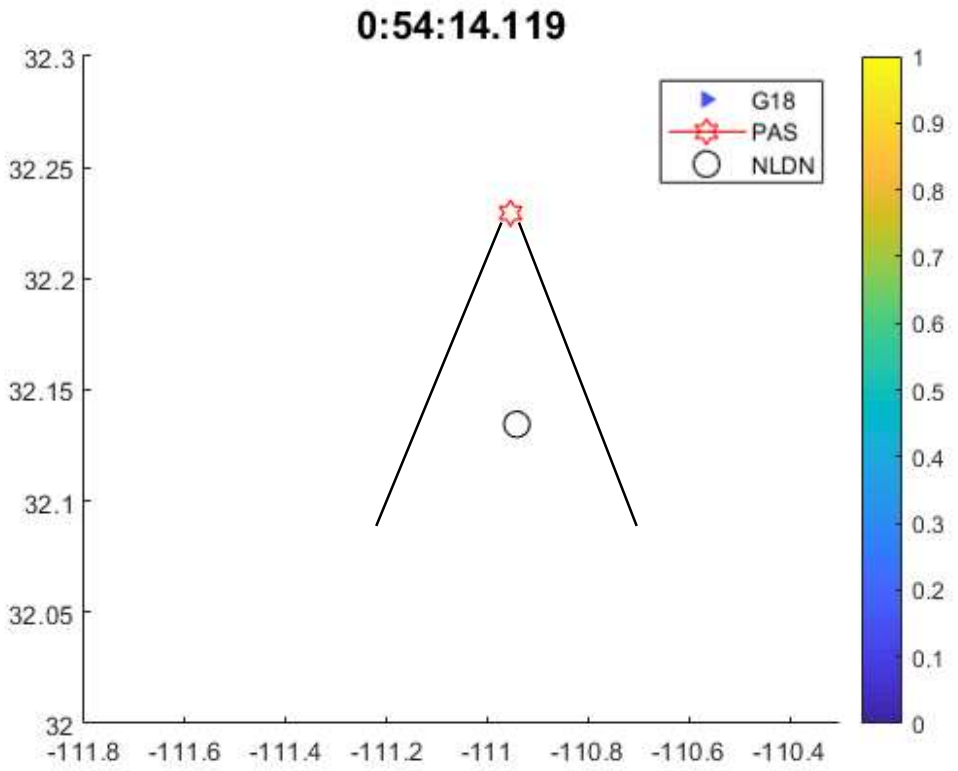

0:54:13.969
G18
PAS
NLDN
32.3
32.25
32.2
32.15
32.1
32.05
32
-111.8
-111.6
-111.4
-111.2
-111
-110.8
-110.6
-110.4
10
9
8
7
6
5
4
3
2
1
0

# 3rd: First CG

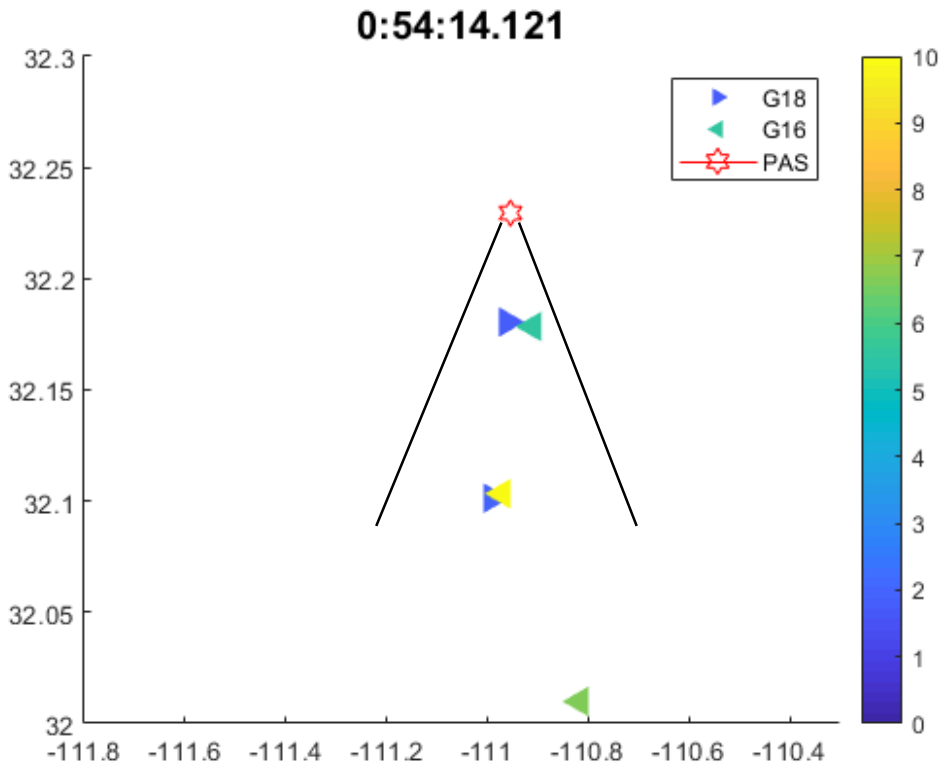




Both G16 (3 pixels) and G18 (4 pixels) detected the CG

# 4th: Second CG

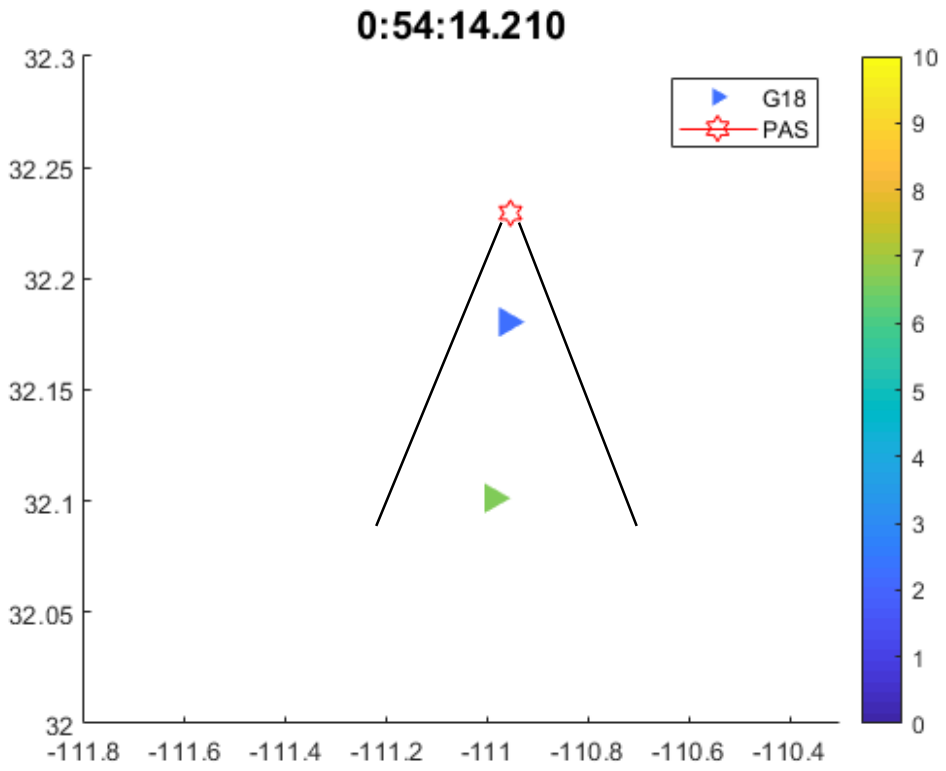



# 4th: Second CG

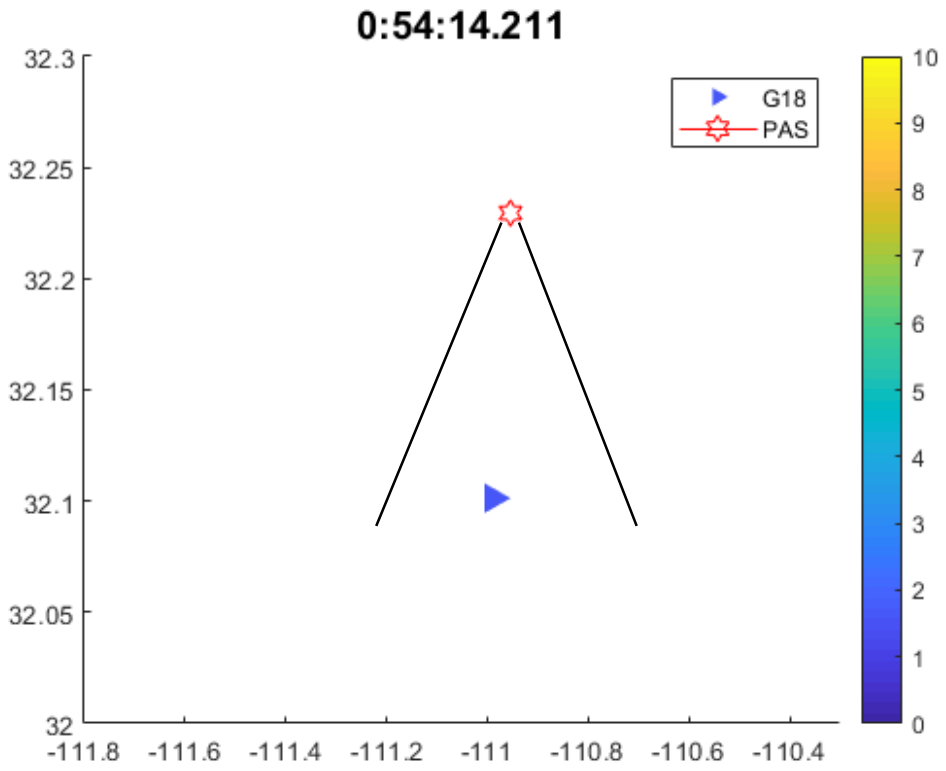

Both G16 (3 pixels) and G18 (2 pixels) detected the CG

# 5th: Last CG with cc


Only G18 detected the CG

# 5th: Last CG with cc


G18 reported a consecutive frame

# Summary

- Overall, GLM-18 has a better detection efficiency than GLM-16.
- GLM-18 tends to have a higher detection efficiency in cc strokes.
- GLM-18 tends to detect more in-cloud components.


14:08:00 05/26/23
44549
Thank you!
Activate Windows