Lightning observations and investigations in the western Pacific

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Thanks to Steve Goodman for providing LIS impetus to this study!

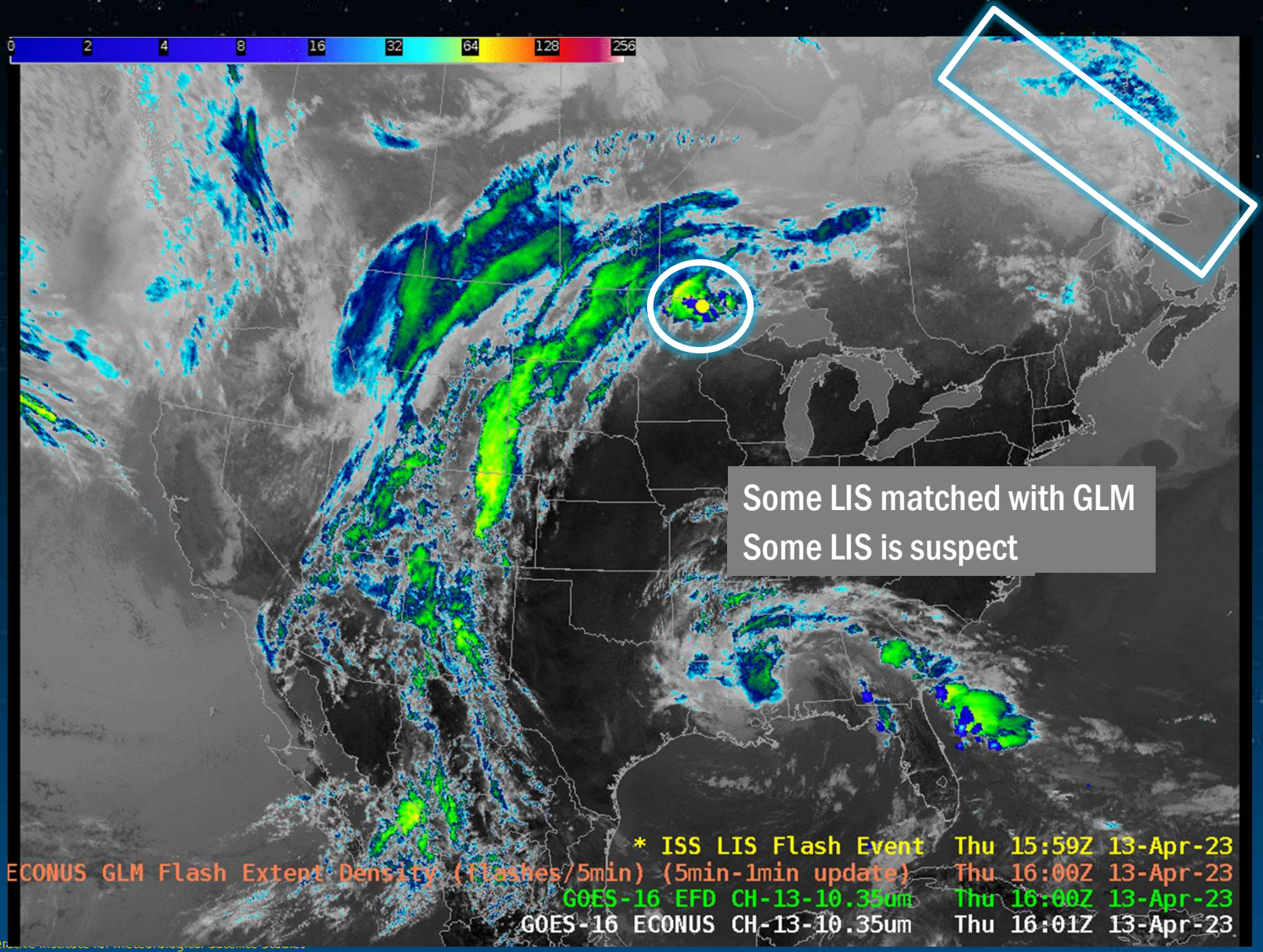
Why lightning?

- The NWS Office on Guam has responsibility for runway safety at Antonio B. Won Pat International Airport
  - Airport workers are pulled from the tarmac if lightning is observed
- How is lightning anticipated
  - Radar data can be used; rules of thumb about reflectivity and IR cloudtop temperatures that commonly accompany lightning events on Guam
  - Starting in 2021, LightningCast probability has been used; this is a machine-learning tool developed for NOAA at CIMSS that predicts the probability of a GLM observation in the next 60 minutes given the current observations by **ABI**.
    - RealEarth instance created
    - Gives useful information during Island-type convection
    - Gives less-useful information during tradewind convection
    - Data are now flowing into the AWIPS display at the NWS office on Guam
    - Of course, Guam uses AHI, not ABI data, and uses GLD360 lightning

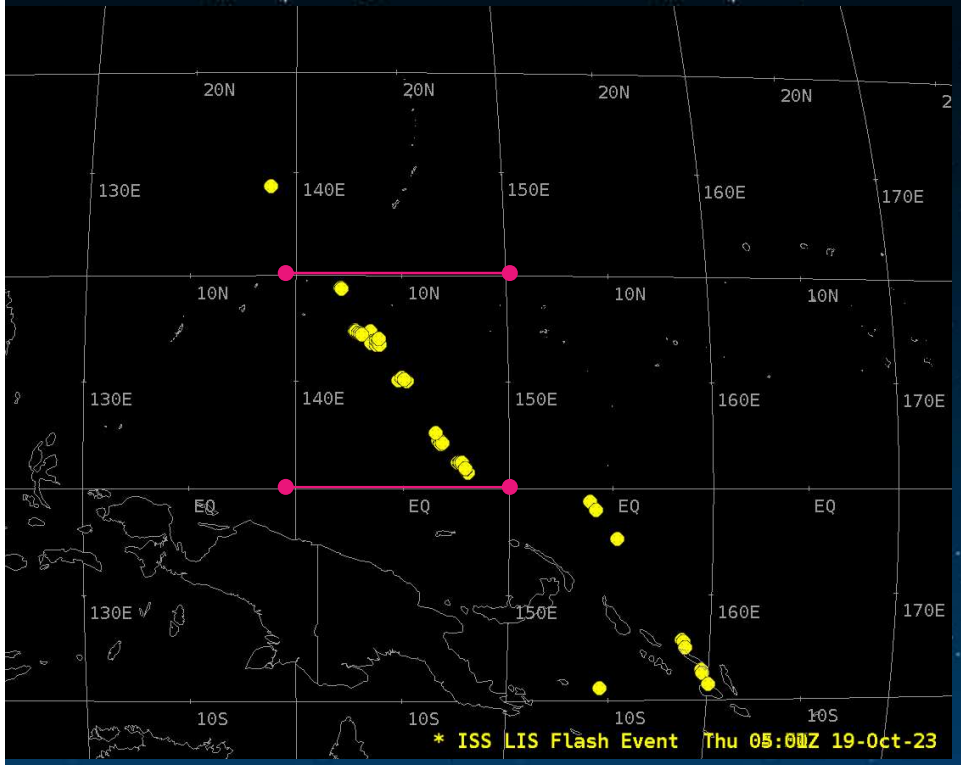
Lightning Imaging Sensor

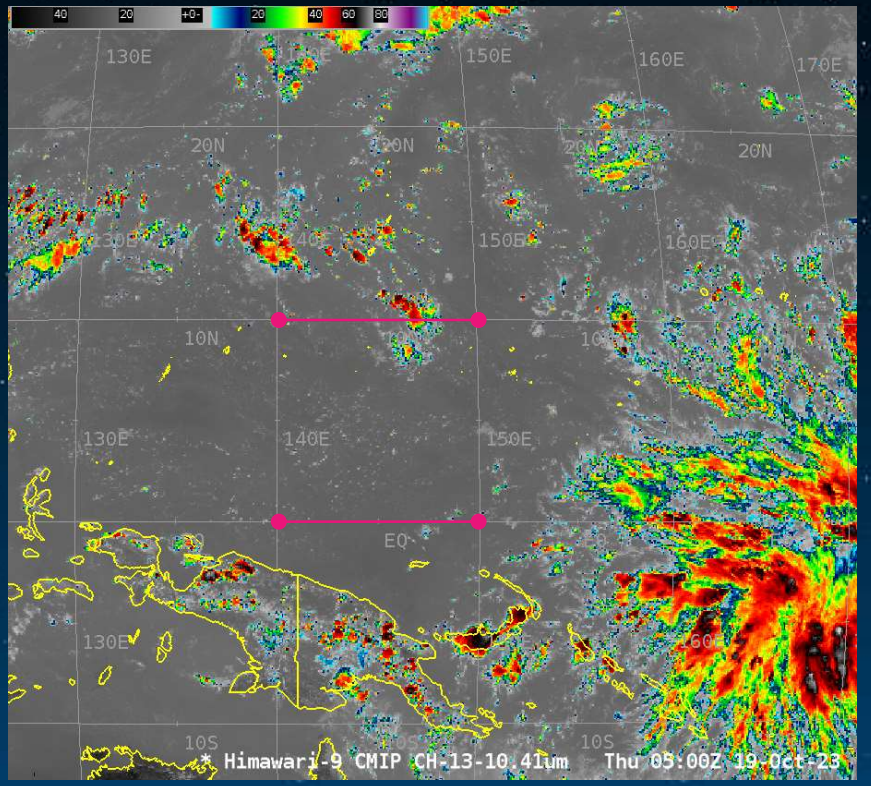
- Flies on the International Space Station (ISS)
  - 2017 to present – set to be removed ~~this month~~ in December
- Task: Compare LIS observations with GLD360 in/around Guam AOR
  - How well does LIS Gap-Fill when the terrestrial-based system doesn't detect?

LIS compared to GLM data



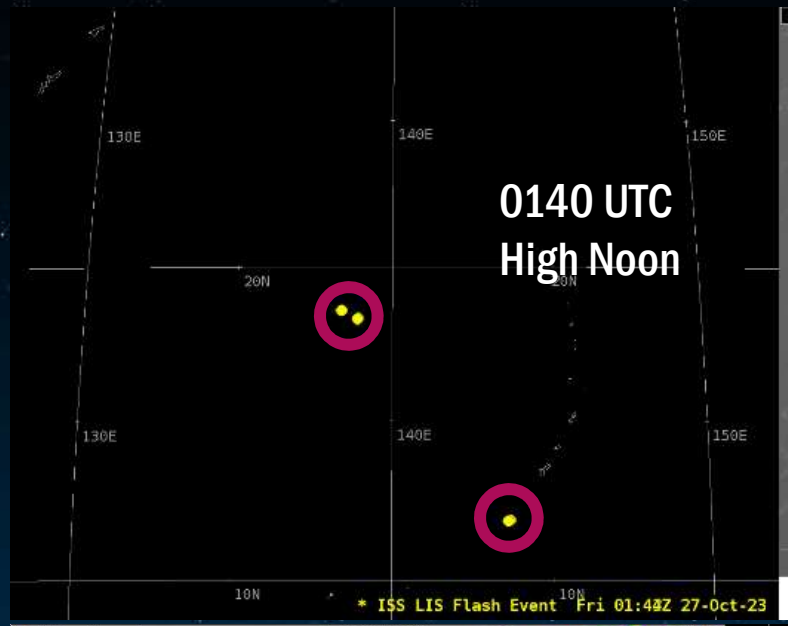
What about over the West Pacific?

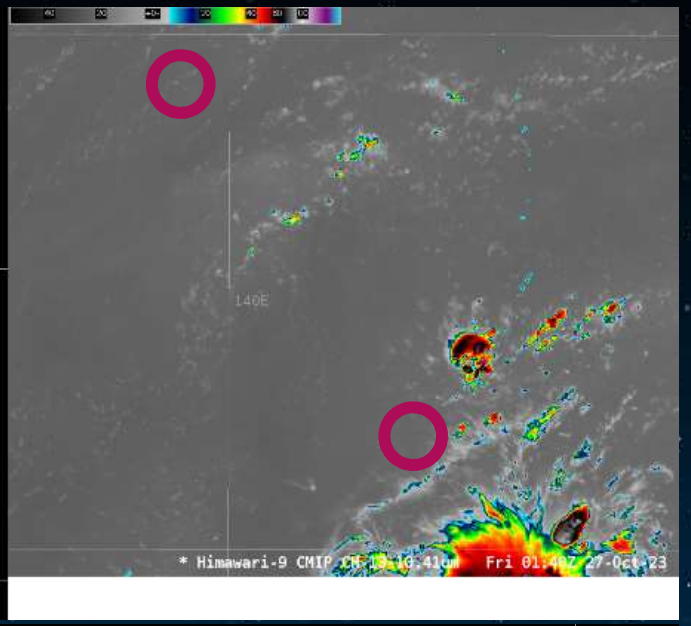


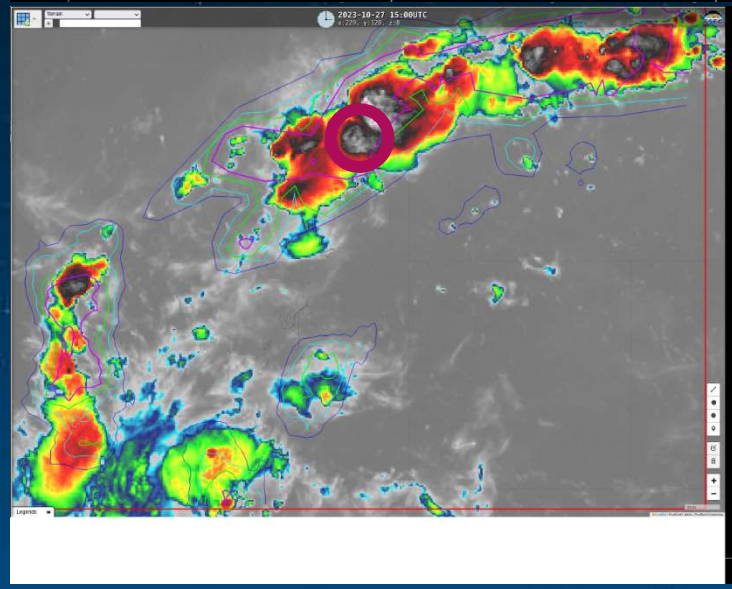


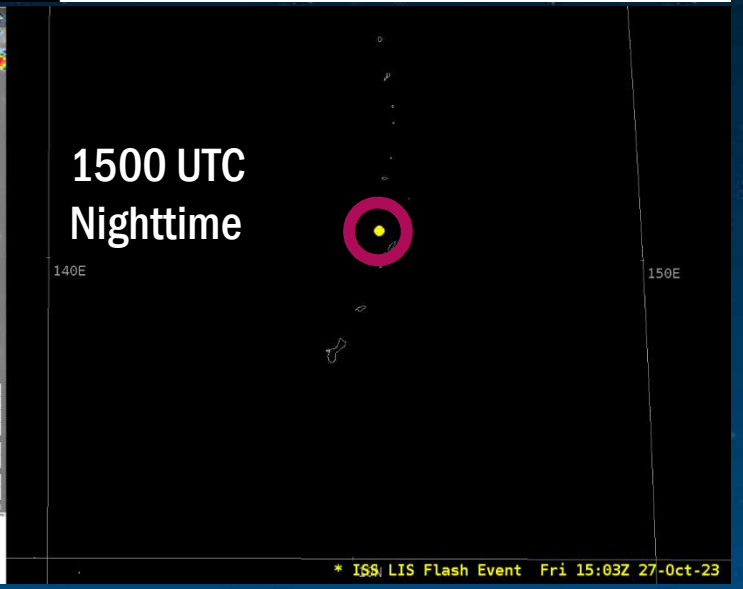
What's going on between 0 and 10 ^{o} N?

Sometimes good and bad on one day









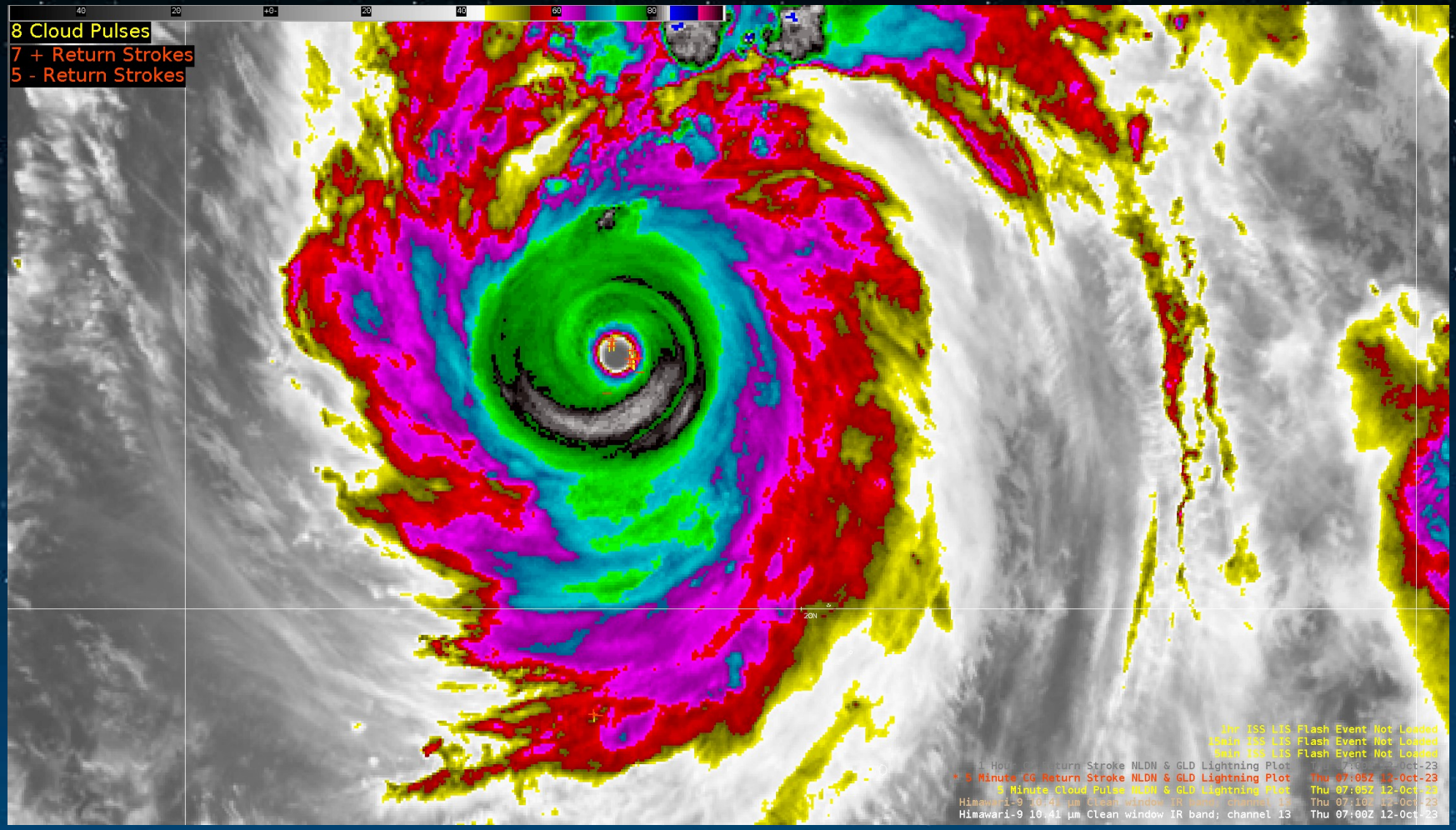
Relatively Frequent Occurrences of LIS observations where Himawari wasn't really showing convection

- May be related to High Energy particles, or reflection off the ISS Solar panels.

- I believe those are being caused by glint. The scene is bright and there are some high clouds in the area. The on-ground filtering usually filters these out but [...] sometimes these make it through the filtering algorithms as lightning. Sometimes the instrument just has noise- sometimes very bad (I think you've seen this before) and other times just a few flashes. ***We will add this to the list of anomalies to look at in improving the filtering algorithms***.
- This appears to be another instance of noise from the ISS LIS. From the path of the lightning in the animation it appears there's a pixel or two on the instrument that are generating false events. These are usually filtered out but not always.
- GLM data are also being examined constantly and ground systems are being changed as reasons for data anomalies are defined.

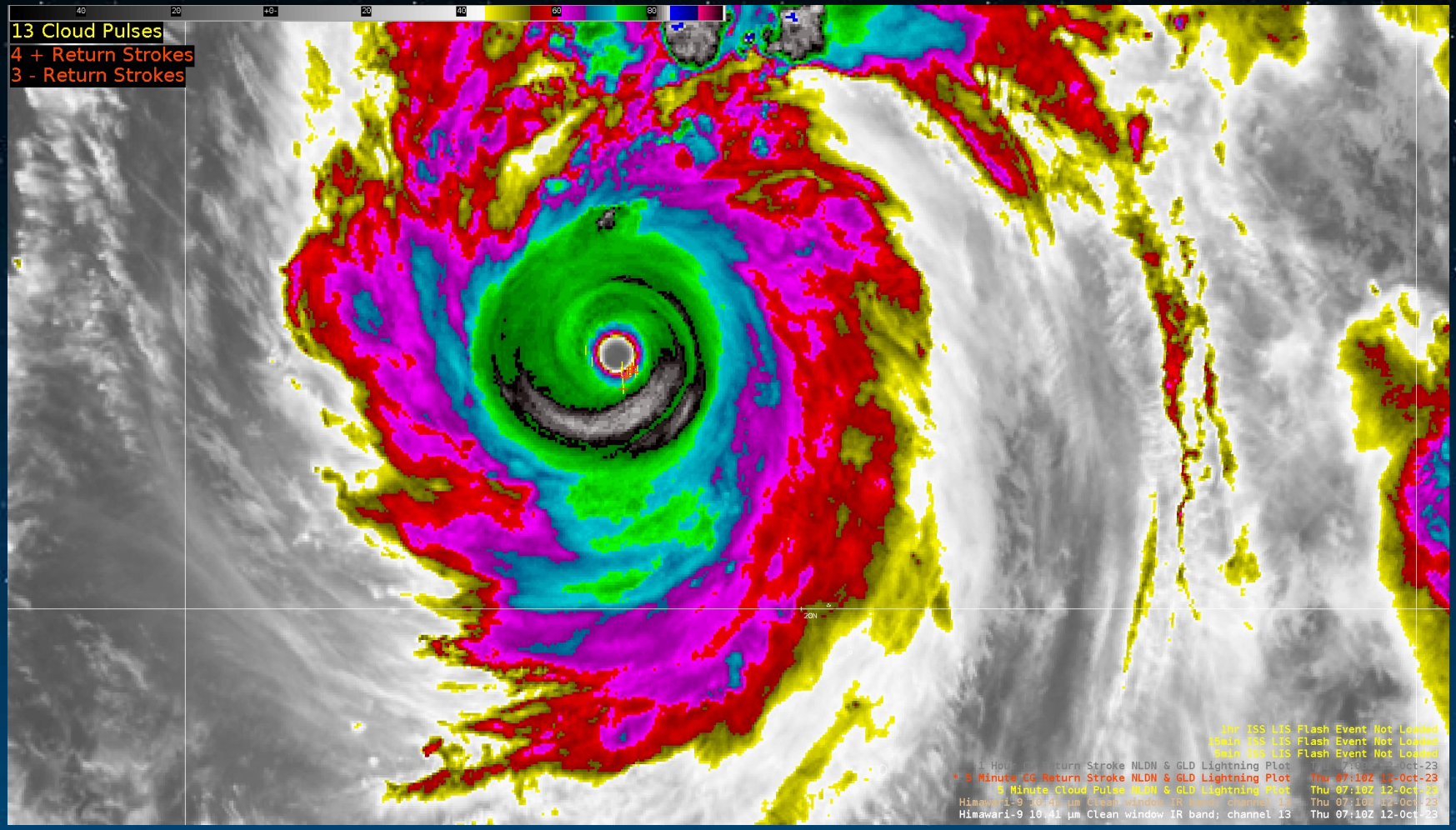
NLDN/GLD360 Lightning in Bolaven Eyewall

Why is lightning an important variable?



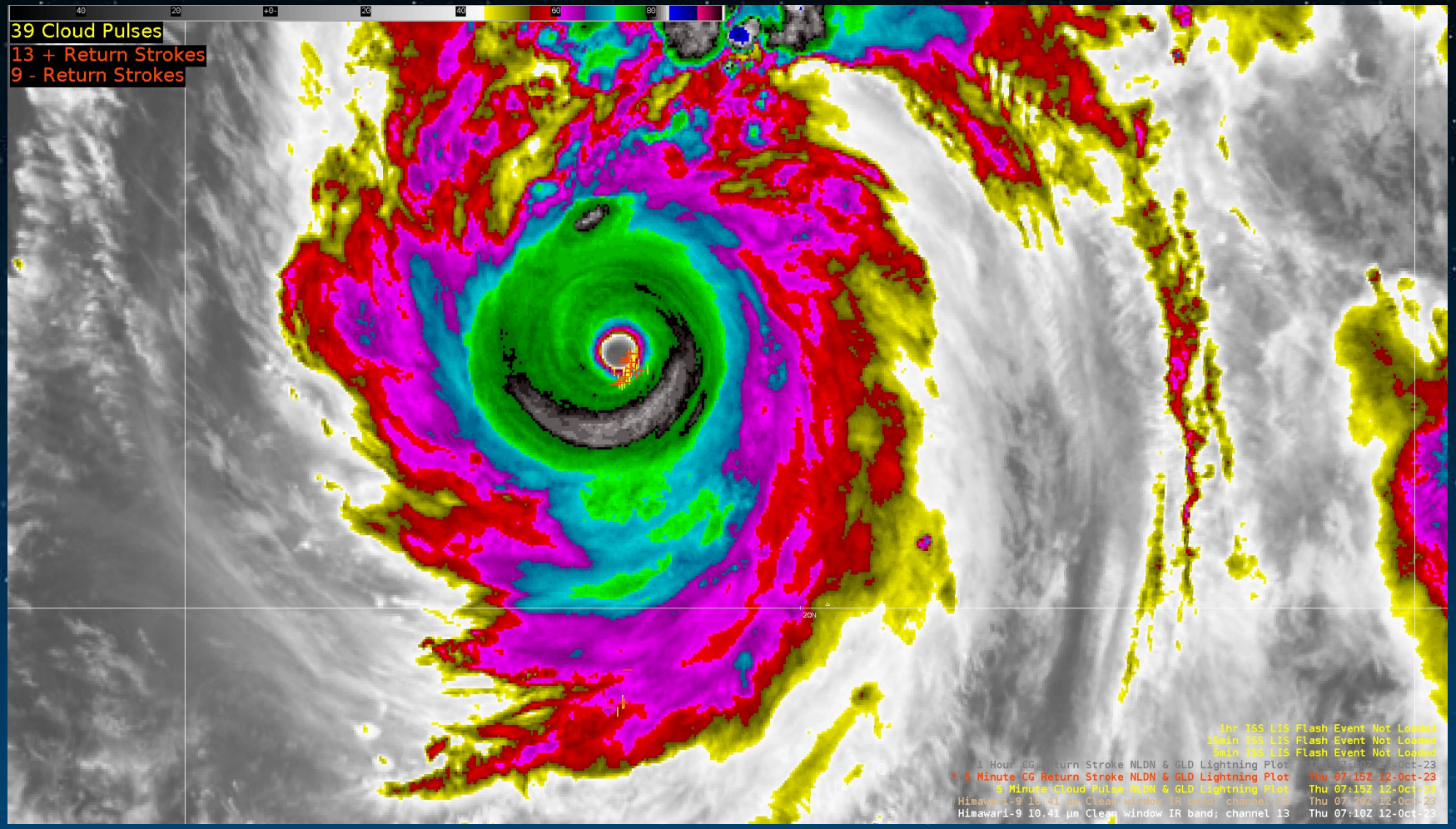
1 of 8, NLDN at 0705

NLDN/GLD360 Lightning in Bolaven Eyewall



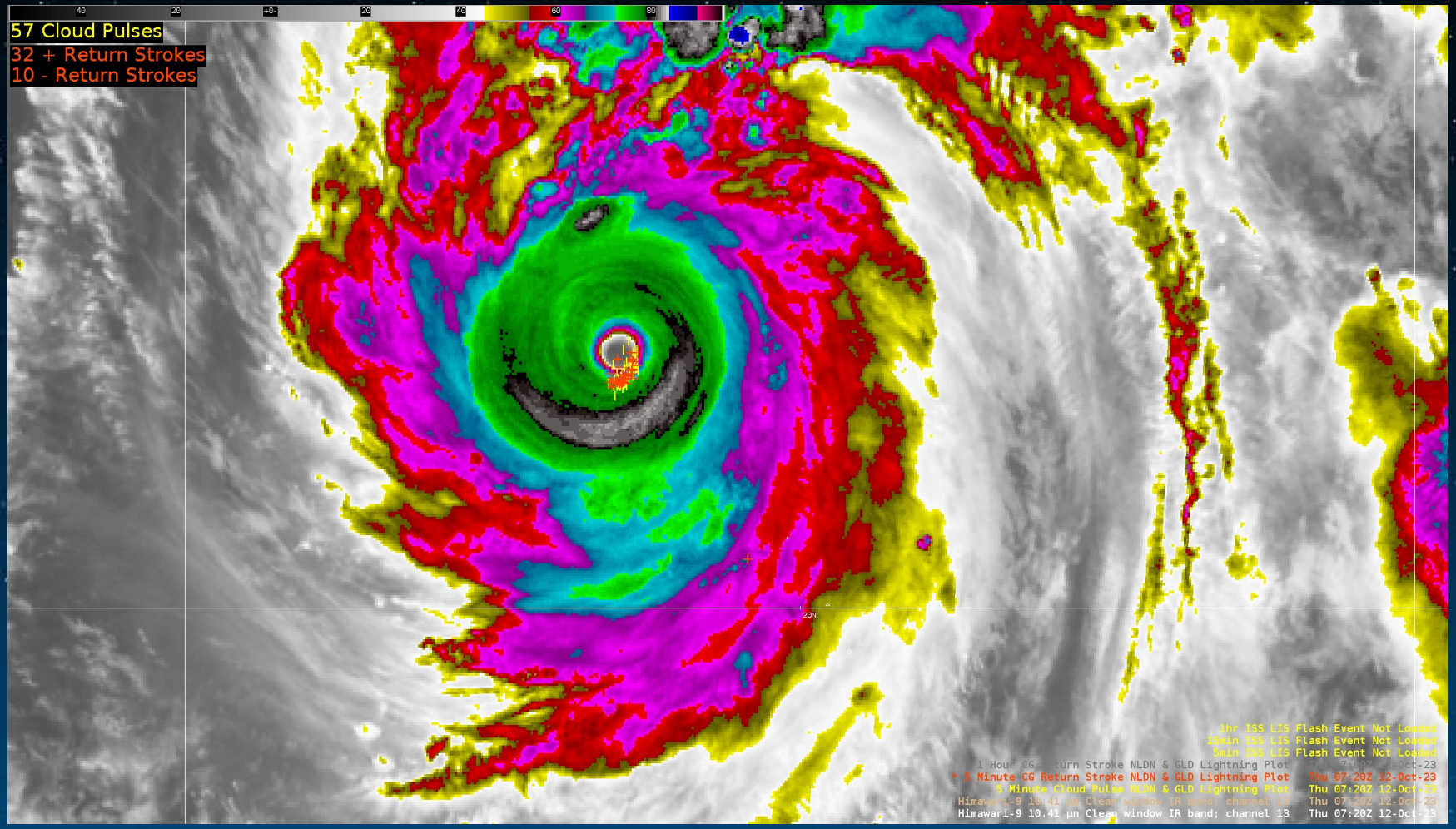
2 of 8, NLDN at 0710

NLDN/GLD360 Lightning in Bolaven Eyewall



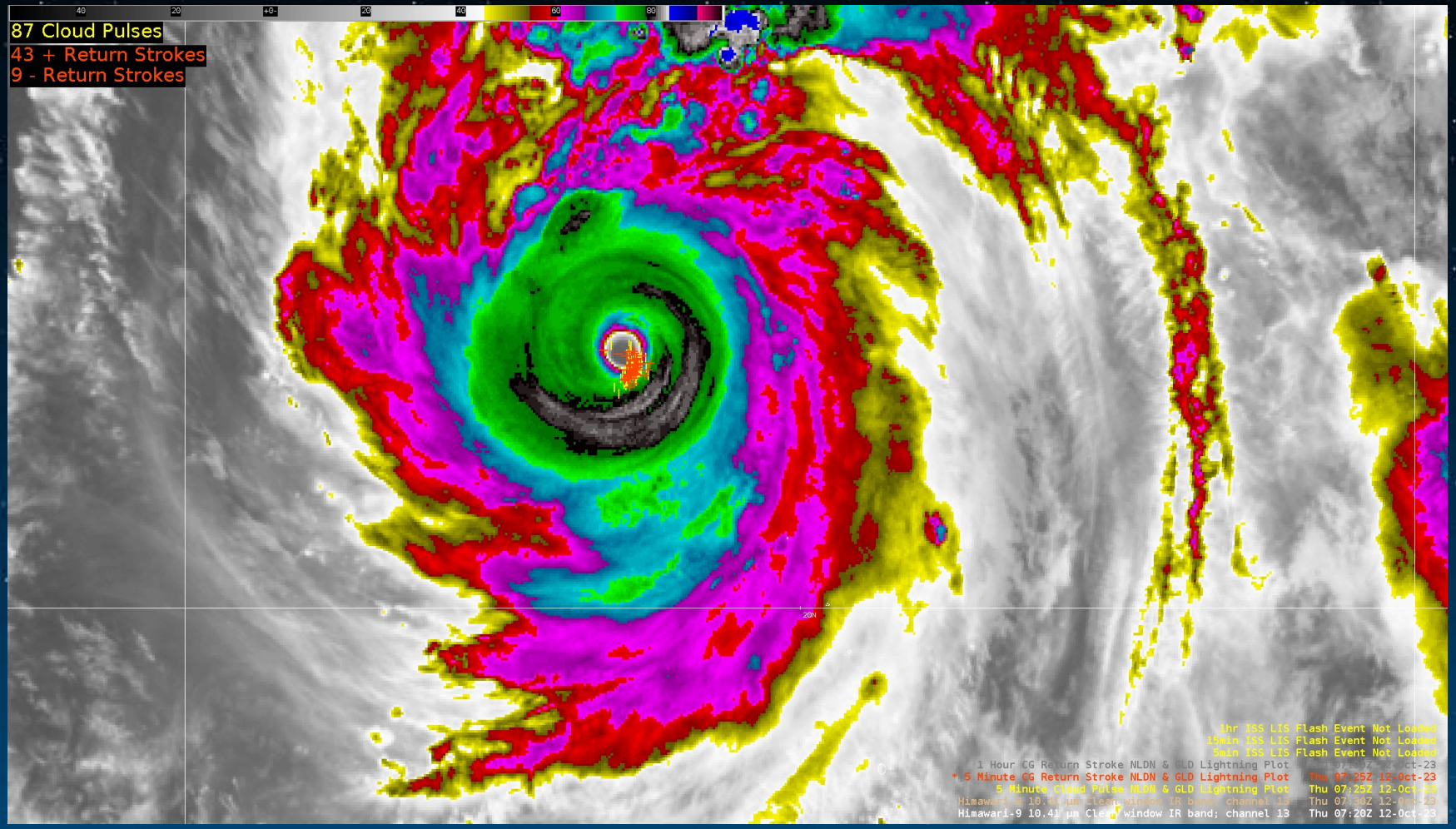
3 of 8, NDLN at 0715

NLDN/GLD360 Lightning in Bolaven Eyewall



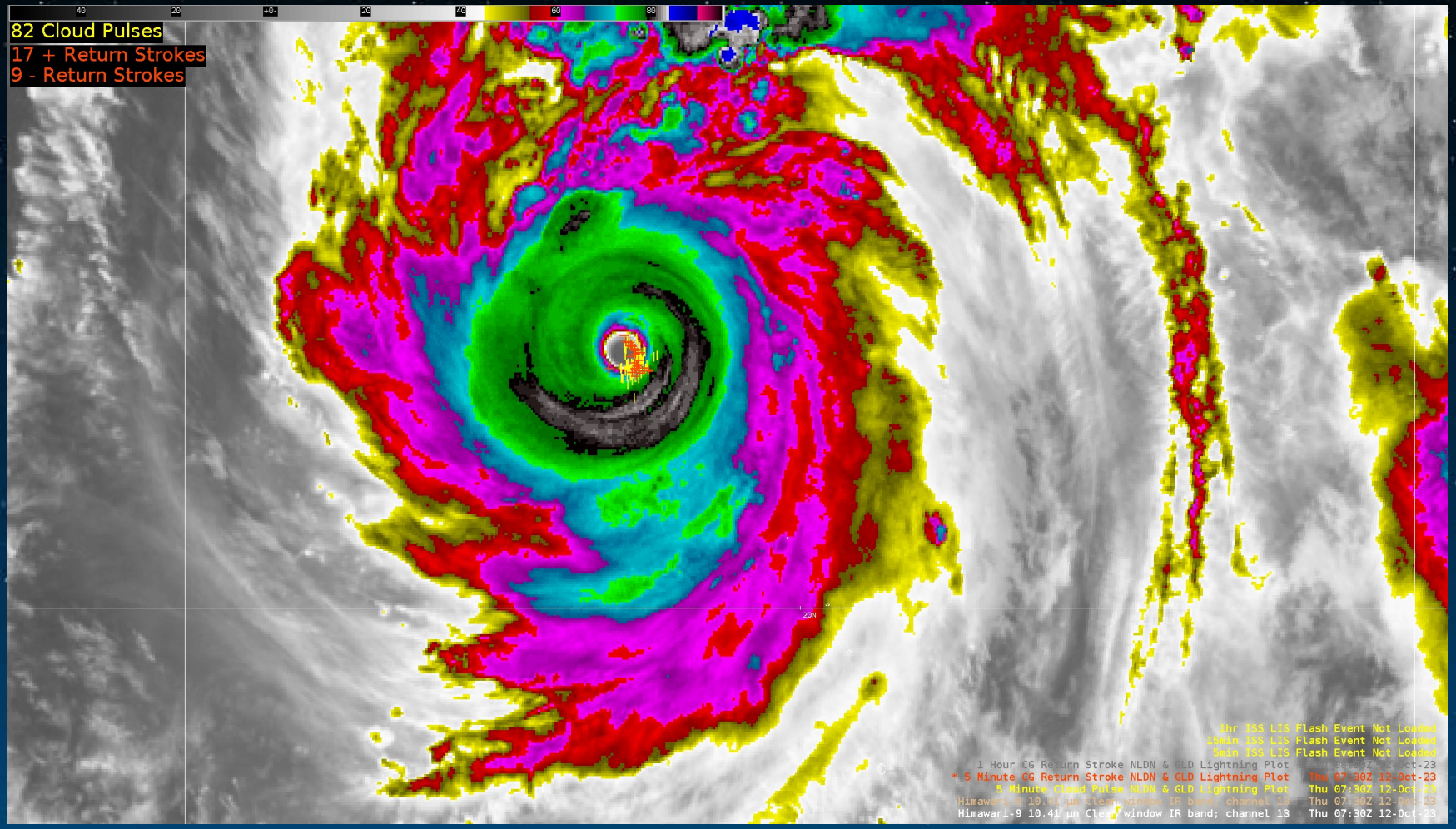
4 of 8, NLDN at 0720

NLDN/GLD360 Lightning in Bolaven Eyewall



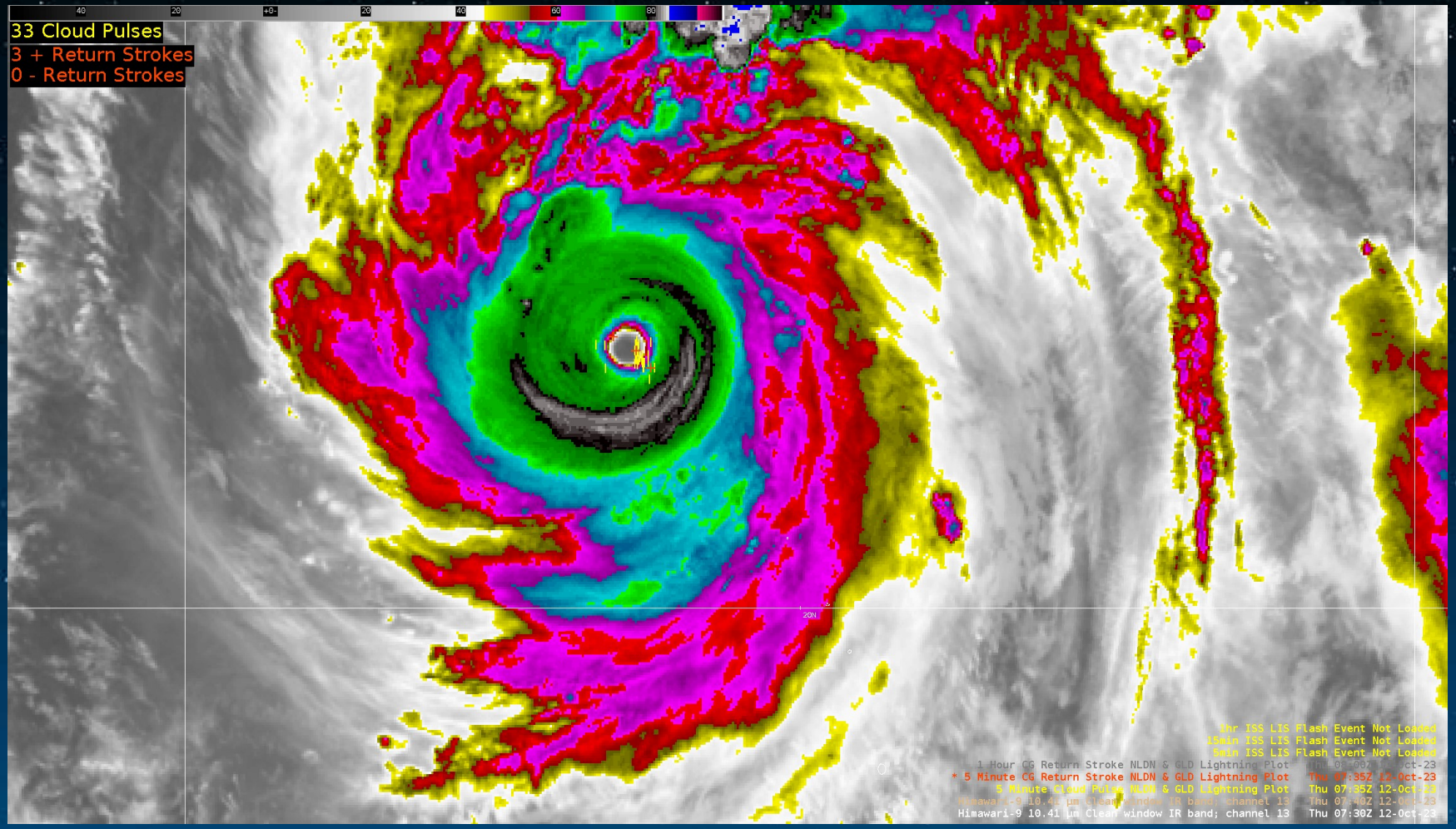
5 of 8, NLDN at 0725

NLDN/GLD360 Lightning in Bolaven Eyewall



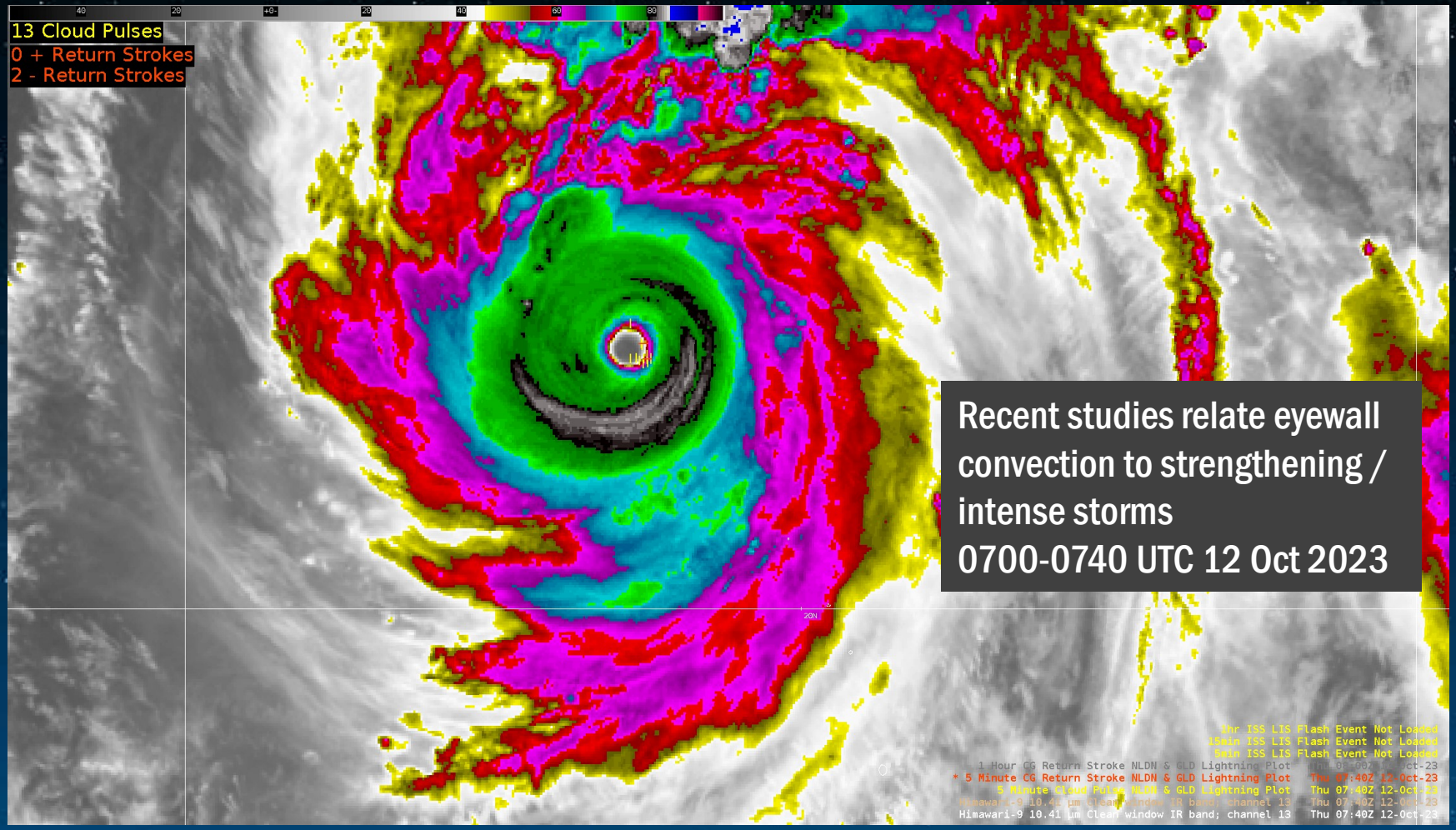
6 of 8, NLDN at 0730

NLDN/GLD360 Lightning in Bolaven Eyewall



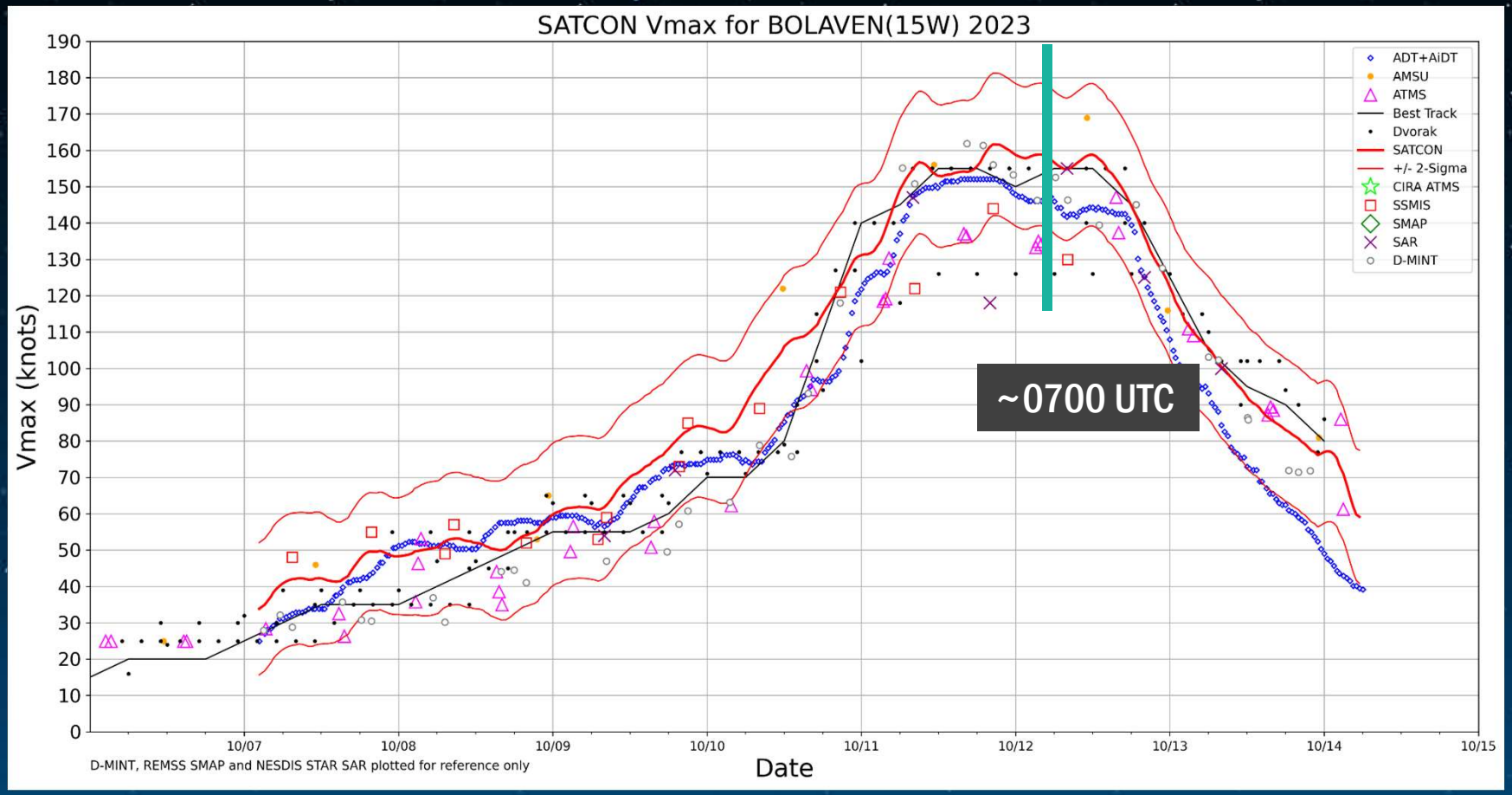
7 of 8, NLDN at 0735

NLDN/GLD360 Lightning in Bolaven Eyewall

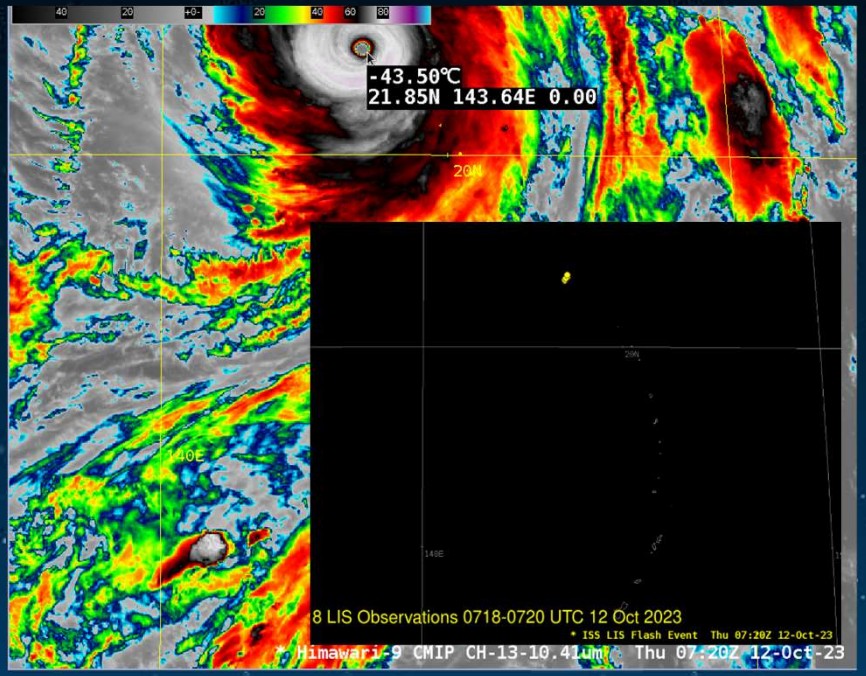


8 of 8, NLDN at 0740

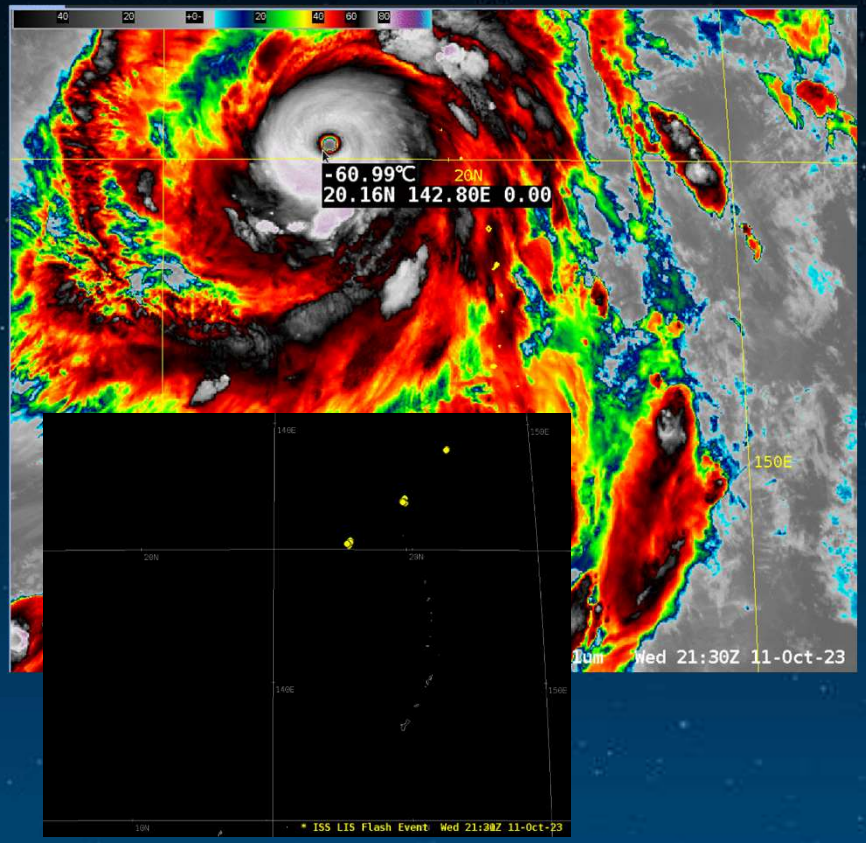
SATCON for Bolaven



LIS observations in Bolaven's Eyewall at the same time, and a bit earlier

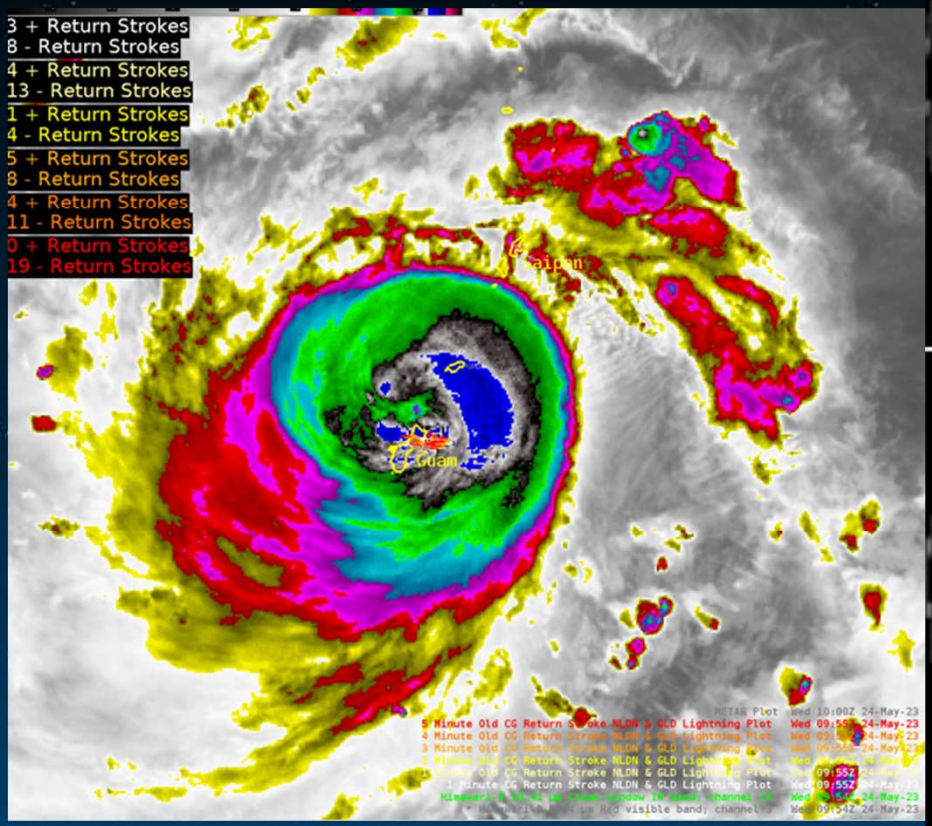


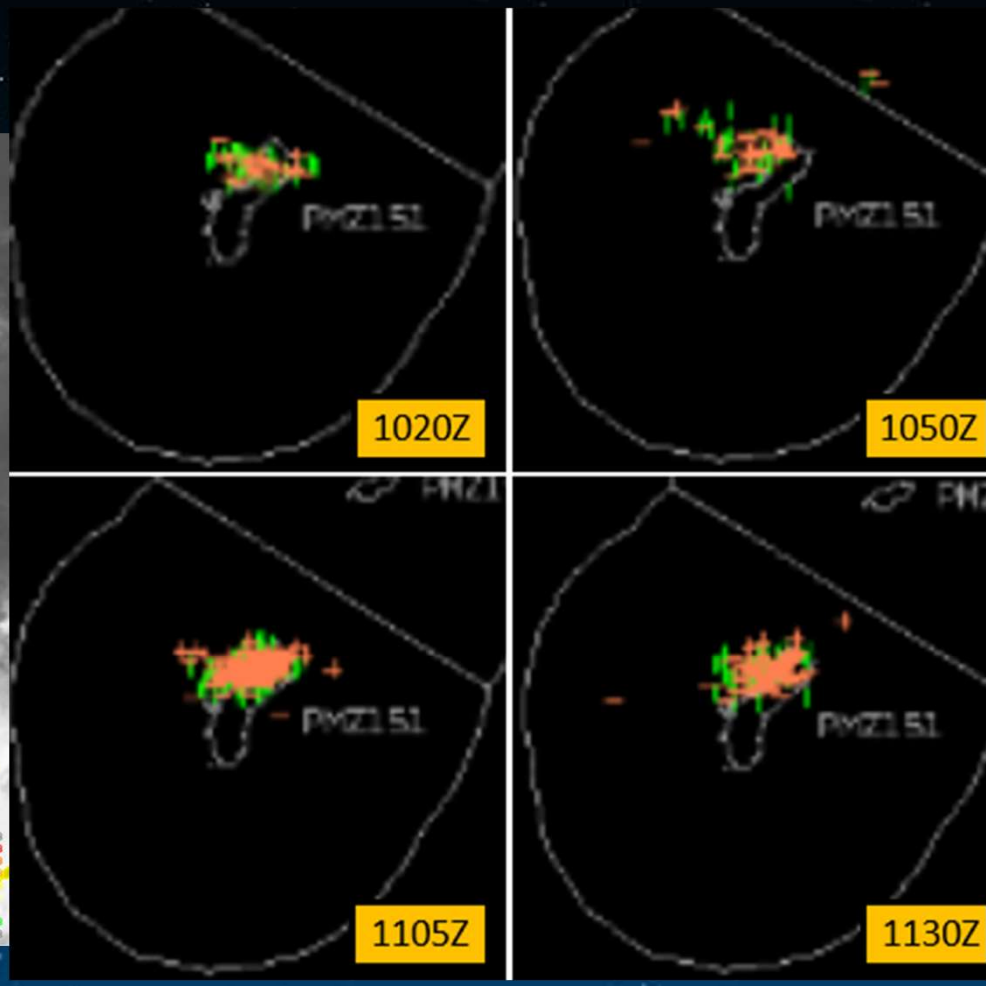
0720 UTC 12 October



2130 UTC 11 October

Mawar also showed extreme lightning behavior

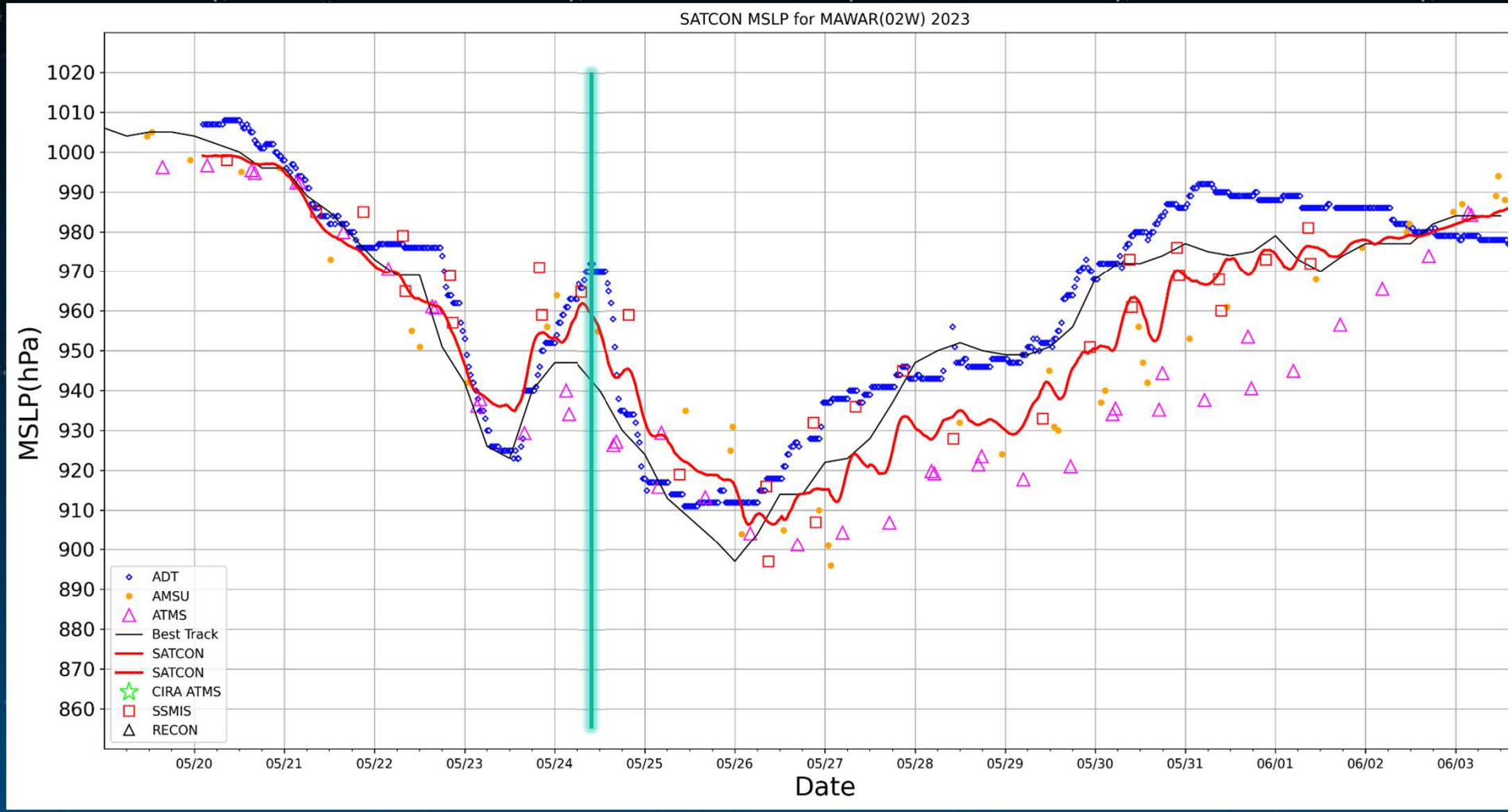




24 May 2023

LIS did not overfly Mawar on this day

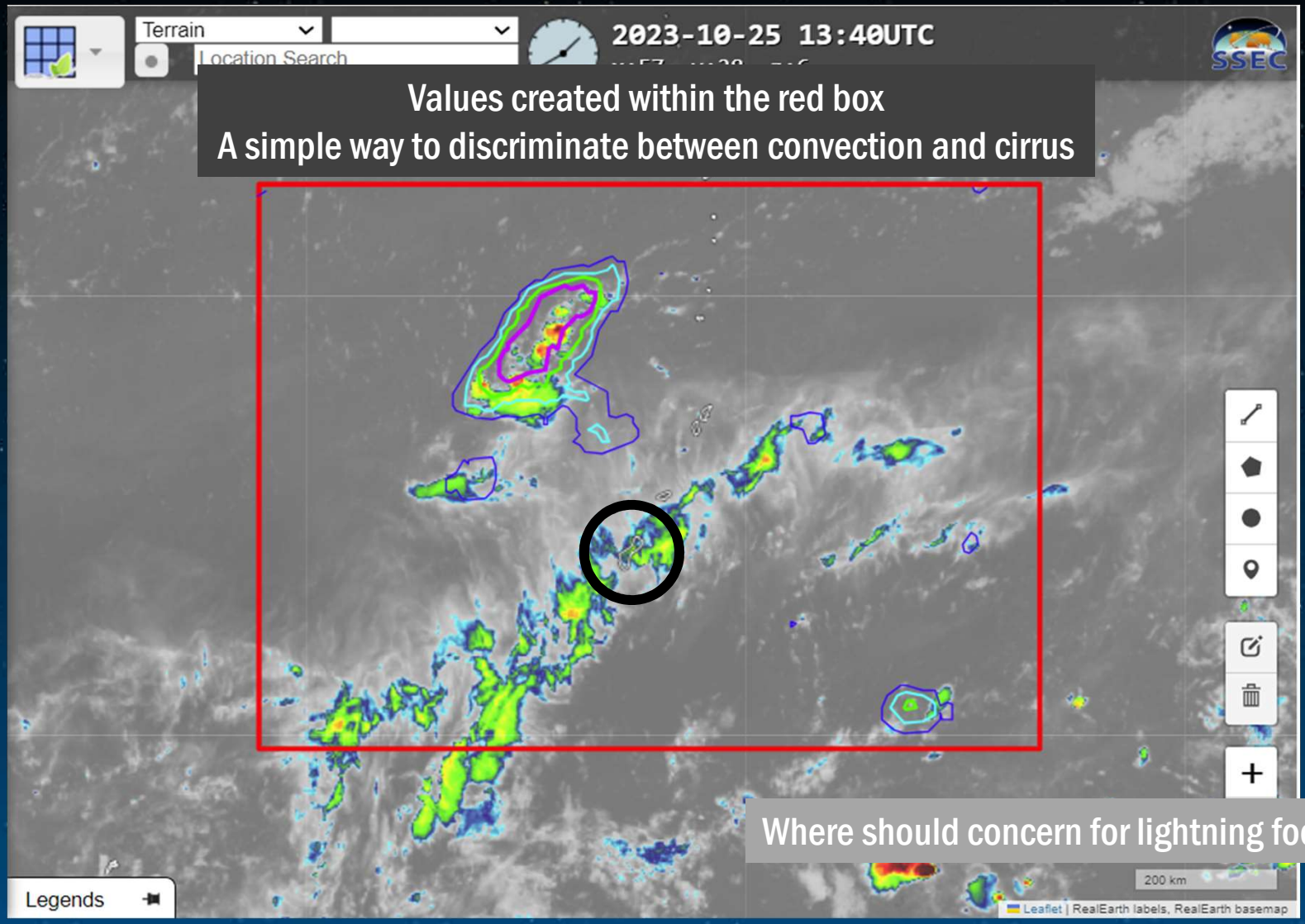
SATCON Pressure Trace with time, Mawar



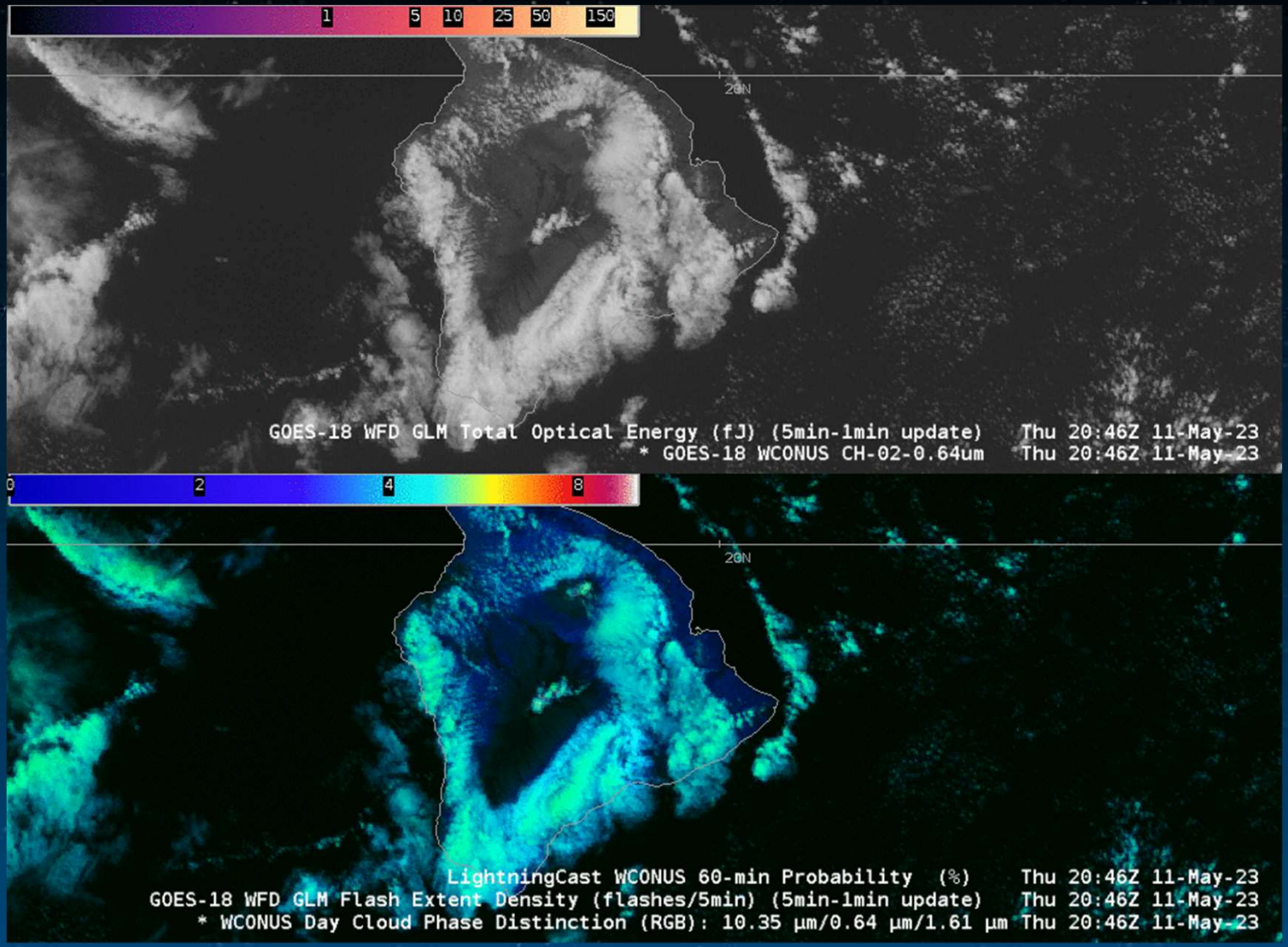
LightningCast Probabilities around Guam

- ML tool that relates ABI Bands 2 (0.64), 5 (1.61), 13 (10.33), 15 (12.3) to the likelihood that a GLM observation will occur in the next 60 minutes
  - Band 2, 5, 13: components of Day Cloud Phase Distinction RGB
  - Band 13, 15: Split Window Difference
- Use AHI data from Himawari-9
- Real Earth instance of the product; it's also input into the Guam AWIPS

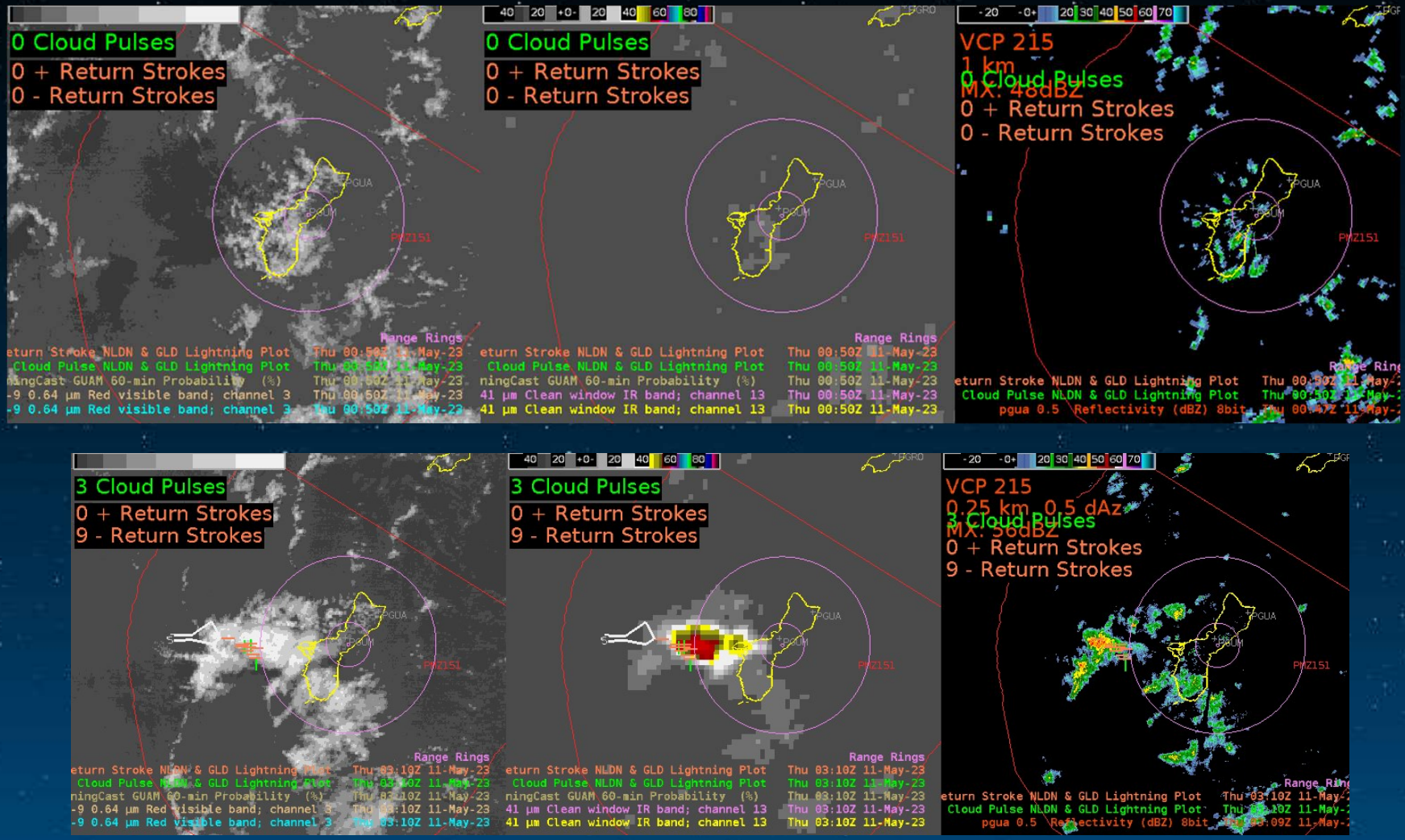
Example of LightningCast (a RealEarth instance)



Example over Hawai'I (11 May 2023)

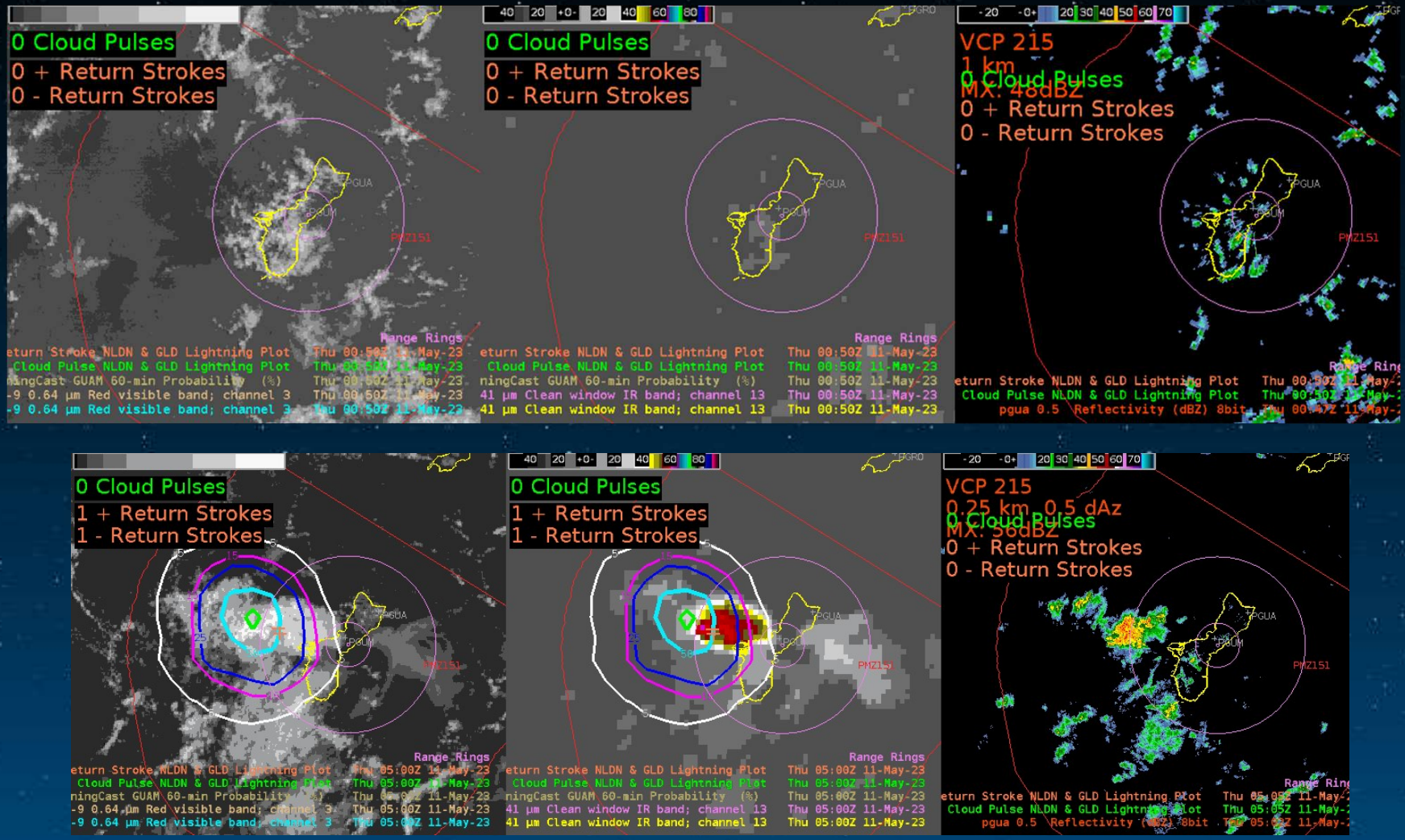


LightningCast increases, then there's lightning, then LightningCast decreases



11 May 2023, 0310 – lightning strikes where LightningCast is decreasing!

LightningCast increases, then there's lightning, then LightningCast decreases



11 May 2023 0500 – lightning strikes where LightningCast is a maximum!

Takeaway from 11 May 2023 Slides

- On the previous two slides – with the brief convection west of Guam, a forecaster would have to be more responsive to lower probabilities
- If there are multilayered clouds and widespread convection , the forecaster can focus on the higher probabilities.
- Ongoing use of the product will help a forecaster best understand how to use and interpret it as synoptic environments change.

Concluding thoughts

- LIS and Ground-based lightning detection overlap well
  - Sometimes LIS false positives occur, however
    - Can be sun glint, reflection off ISS solar panels, and defective detectors
  - Mis-navigated ground-based lightning detection is rare
- LightningCast Probabilities give useful information
  - Probabilities increase before lightning occurs, especially in regions of light winds.
  - Interpretation of the product might change as the synoptic situation changes

Contact Information

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