Questions & Answers Session A

Please type your questions in the Question Box. We will try our best to get to all your questions. If we don't, feel free to email Ameta Mehta (amita.v.mehta@nasa.gov) or Scott Rudlosky (scott.rudlosky@noaa.gov).

Question 1: At night, for a single lightning event, for a fraction of a second the entire area "lights up." Is the amount of light proportional to the energy released?
Answer 1: Yes, many other factors contribute to how bright the lightning appears, but stronger lightning will appear brighter with all other conditions the same.

Question 2: In the use-case of in-flight storm avoidance, are all the pilots making their own decisions in real-time, or are they following centralized predictions of where the storm is moving?
Answer 2: From what I understand, the pilots always make their own decisions, but they do fly predefined routes that consider the weather impacts. Often flight departures will be delayed to help avoid thunderstorms en route or at the destination.

Question 3: You stated that the GLM is an imager, not a detector. What work has been done on writing detectors that work on sequences of GLM images?
Answer 3: Researchers have looked at sequencing the GLM point-level data (events, groups, and flashes, producing the skeleton flash depictions with important metrics) as well as the optical imagery itself (i.e., gridded GLM products).

Question 4: I have a 400 km^2 study area that has been running for the last 4 years. How do I best find all GLM data with high flash density over the area? I'm trying to find the dates on which there was lightning over the study area.
Answer 4: The gridded products are likely the easiest to work with. They can be found here (https://search.earthdata.nasa.gov/search?q=glmgoesL3), although I am not sure if the archive has been completely backfilled.

Question 5: Is there any proven connection between lightning and specific rocks like granite?
Answer 5: We are not aware of any recent formal studies on connections between lightning and certain types of rock composition and if strikes occur more often on certain types of rocks.

Question 6: How "real-time" are these systems? For aviation and other applications, how long does it take to process, from detection to forecast?
Answer 6: From detection on GLM, it is nearly instantaneous (around 20 seconds or so). Combining it with other datasets and forecasting can add in latency. In the continental United States, there are gaps in coverage that can add latency as well. Some warnings are made ahead of another detection for safety measures.

Question 7: Is the thunderstorm intensity occurring more frequently in the tropical region or in the polar region?
Answer 7: It depends on the time scale. There are new detection systems that can detect lightning in polar regions, but it is hard to generalize frequency.

Question 8: What type of ground networks do you have in the U.S. to compare with GLM data/products? Do you have a network of observers at synoptic stations reporting the occurrence of storms?
Answer 8: In many cases such as at airports, there are weather monitors that note lightning strikes or severe weather, but in the majority of cases most of these observations are automated. Using both in conjunction with each other can help with forecasting. Lightning mapping arrays also help with smaller areas.

Question 9: What visualization tool do you use on pages 12 and 13? Generally could you recommend software to process and analyze flash data?
Answer 9: Python is used more frequently in our case versus other softwares and programming languages. On the slides, Blender was the software being used.

Question 10: How do you deal with the sparsing of the data from GLM electric drift movement? How does the polygon mixing help improve the model? They don't seem to be the same resolution. Is it vector based temporally? A reconstruction technique from multiple sources but how sparsing is dealt again?

Answer 10: If this is in reference to the GLM grid being non-uniform, there are some variations in the data, but that variation is accounted for in software.

Question 11: How often is the software running on the GLM satellite updated with new algorithms?
Answer 11: Early on, the update frequency was often (every 6 months). Now, the updates are larger, but less frequent (once per year). The software on the satellite is updated as well.

Question 12: Is a long strike the same as long as a continuing current strike?
Answer 12: Earlier in the slides, strikes that were covering long distances were shown, but there is a difference between that and a strike that has a continuing current.

Question 13: Is there any way to estimate/predict the intensity of cloud-to-ground given an observed cloud-to-cloud behavior currently being observed (on the ground).
Answer 13: Having intercloud observations helps to predict behavior of lightning and with cloud-to-ground observations.

Question 14: So (referring to Q11), can you treat GLM data series as a homogeneous -proper for climatic studies? How do you prepare data for these purposes?
Answer 14: As it stands, you cannot go back to the beginning of the GLM record and assume it will be homogeneous. Starting in 2019 to the present day, the data becomes more homogeneous. We are in the process of converting the old data into the new format.

Question 15: Is there a way to identify long continuing current strikes? I am interested in this regarding wildfire ignitions.
Answer 15: With ground-based networks, it is hard to observe. There are timed windows that allow for the prediction of continuing current.

Question 16: How can the electric field be captured with such resolution, is there exposure problems occuring with varying angles?
Answer 16: It is looking at the optical distribution for lightning. It will be more likely to be seen in a smaller pixel than a larger one, especially if it is a bright observation.

Question 17: Are there false alarms detected by the GLM (e.g., rocket launches)?
Answer 17: There are more false alarms than are wanted. However, there are good and bad false alarms as well. False alarms such as rocket launches can lead to false alarms, but are uncommon. There are filters such as sun glints that can lead to false alarms as well and we filter them out accordingly.

Question 18: Do the lenses have obturation control for occuring lightning or is it treated in software?
Answer 18: Both. In the lens and in software.

Question 19: How do aviation-specific weather apps assist pilots and aviation professionals in navigating thunderstorm hazards, avoiding turbulence, and making informed decisions about flight routes and schedules?
Answer 19: Aviation specific apps can be useful to pilots in the air. The planes having internet connectivity also helps pilots to stay connected and informed.

Question 20: Can the GLM image electric structures above the clouds, like sprites and elves?
Answer 20: Sprites and elves are too dim at the wavelengths we are looking at, but we can infer based on the data.

Question 21: In a lightning prone area, does installing lightning arresters/planting tall trees reduce the risk of human exposure?
Answer 21: In places where lightning safe structures exist, warnings and information help more. However, in places without lightning safe structures, using measures to create safe structures help.

Question 22: What accessibility features do weather apps offer to ensure that individuals with visual or hearing impairments can receive timely information and alerts about thunderstorms?
Answer 22: We cannot speak to the apps themselves, but some campaigns have been helping to make messaging about lightning more accessible to people with visual and hearing impairments.

Question 23: Has anyone tried sonification on lightning data?
Answer 23: There have been recent studies regarding sound and its correlation with lightning data.

Question 24: What is the wavelength used with GLM? Is it reacting with oxygen in the atmosphere?
Answer 24: GLM is at 777.4 nanometers.

Question 25: How frequently, we can have GLM images for a particular area?
Answer 25: 20 seconds (near continuous).

Questions & Answers Session B

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Question 1: Can take GLM data and upload it into a GIS software for analysis?
Answer 1: GIS software such as ArcGIS can be used, however coding languages such as Python can be used as well and simplifies the process. Blender is another software used for data visualization.

Question 2: What software can be used to process this type of images?
Answer 2: Refer to question 1.

Question 3: Can we use Jupyter notebook or another similar tool to manage the data?
Answer 3: You can!

Question 4: Are ground sensors better than GLM to detect lightning?
Answer 4: It depends on the application. Both datasets are complementary and are meant to be used in concert with each other. Ground-based data is good for measuring local and regional areas and GLM does a great job at measuring the whole picture.

Question 5: How can we validate the GLM data? Is there any other dataset?
Answer 5: There are smaller scale networks that provide more detailed information. Ground measurements help as well.

Question 6: Is upper atmospheric lightning ["jets"] being tracked in any way? Anything accessible to the public?
Answer 6: GLM does not see the upper atmospheric events, but can help classify that information. There is a Citizen Science effort at NASA that helps to identify those events. We will include a link to this as well. Social media and lightning photographers also help as well.
https://science.nasa.gov/science-research/earth-science/spritacular/

Question 7: What is the accuracy of ground-based network detected lightning strike position?
Answer 7: It depends on the network and where you are within the network.

Question 8: What is the maximum distance a lightning strike can move and touch the ground from a storm source region?
Answer 8: Hundreds of kilometers. The example of the strike in the presentation stretched over 800 km. If you can see and hear lightning and thunder, you are close enough to be stuck by it.

Question 9: Is it possible to mix radar, satellite and lightning data to identify meteorological systems?
Answer 9: There are tools that help with this. We will provide examples of this in the final document.

Question 10: Can lightning NOx emissions be derived from GLM data?
Answer 10: Ground based network data is more mature and the information has been around longer. There is active research in this topic.

Question 11: Can't those big lightning strikes electricity be re-used?
Answer 11: Unfortunately no. It is not possible to harness the energy of lightning strikes.

Question 12: Is there any relationship between lightning intensity and Cyclone/Thunderstorm strengthening/weakening?
Answer 12: Yes and that was a motivation to launch GLM. It is not exactly clean cut, but enough generalizations can be made to make correlations.

Question 13: Is there any relationship between coal-fired power plant emission and lightning intensification when a thunderstorm moves over it?
Answer 13: Researchers have shown a correlation between maritime shipping channels and lightning strikes. In terms of coal fired power plants, there is no direct research that we know of.

Question 14: Would geographical and other characteristics of the environment around the monitor/predicted location(s) such as terrain, temperature, humidity, certain emission concentration, etc., have any influence on the predicted lightning strike probability and their strength?
Answer 14: It has been documented. In the United States, lightning strikes are generally negative polarity. However, in certain parts of the US, such as the Great Plains region, up to 40 percent of lightning strikes are positive polarity and they are known as inverse polarity storms. Factors such as humidity also play a role as well.

Question 15: Is there any relationship between CCN and lightning polarity type?
Answer 15: There are studies that show correlations between Cloud Condensation Nuclei (CCN) and polarity.

Question 16: Lightning recorded by GLM produces X-rays?
Answer 16: GLM wouldn't observe X-rays, but there are some examples of a x-ray detection system being worked on by researchers. X-rays are part of a process called the lightning leader process.

Question 17: (Related to question 15) It was a wonderful answer and explanation. Could you share the additional cases you mentioned please?
Answer 17: If you look at distribution, you can find positive polarity storms in California near maritime ports. Lake Maracaibo in Venezuela is considered to be the lightning capital of the Western Hemisphere. It is in a tropical region in South America surrounded on three sides by mountains and one outlet. As a result of convergence and geography, lightning storms occur almost every night. Smoke can also change the polarity of a storm as well as with the example of the Okefenokee swamp fires in Northern Florida and Southern Georgia in the Southeastern United States.

Question 18: Lightning happens in the troposphere. How can it affect aircraft which fly in the stratosphere layer?

Answer 18: One of the reasons NOx is an important topic is due to the fact that NOx can emit ozone into the stratosphere. As a result, we are able to track and see how much ozone is being emitted from lightning. Turbulence in aircraft is an immediate effect of lightning.

Question 19: When studying the region near the Equator, does sun glint significantly affect the GLM data? If so, is there any way to work around it?
Answer 19: It does. A blooming filter helps to mitigate sun glint and eliminates most false alarms. Sometimes the sun glint appears as a speck or as a line. If there is an artifact in the data, it is most likely sun glint.