GOES-16 GLM Level 2 (Events, Groups, Flashes) Release, Beta Data Quality

July 5, 2017
Read-Me for Data Users

The GOES-R Peer/Stakeholder Product Validation Review (PS-PVR) for GLM L2 Beta Maturity was held on June 9, 2017. As a result of this review, the PS-PVR panel recommended that the GLM L2 data be included in GOES Rebroadcast (GRB) pending the operational release of upgraded Look Up Tables (LUTs) that address (but only partially mitigate) Instrument Navigation & Registration (INR) and noise issues. Implementation of the upgraded LUTs for operations occurred on June 29, 2017 at 20 UTC. Release of this data via GRB occurred July 5, 2017 at 15 UTC.

The GLM L2 product consists of geo-located and time-stamped *events, groups, and flashes*, with associated calibrated optical amplitudes (in units of Joules). Beta maturity, by definition, means that:

- Initial calibration applied (L1b);
- Rapid changes in product input tables / algorithms can be expected;
- Product quick looks and initial comparisons with ground truth data not adequate to determine product quality;
- Anomalies may be found in the product and the resolution strategy may not exist;
- Product is made available to users to gain familiarity with data formats and parameters (via GRB);
- Product has been minimally validated and may still contain significant errors; and
- Product is not optimized for operational use.

Beta users bear all responsibility for inspecting the data prior to use and for the manner in which the data are utilized. Persons desiring to use the GOES-16 GLM Beta-maturity L2 products for any reason, including but not limited to scientific and technical investigations, are encouraged to consult the GLM Calibration/Validation science team members for feasibility of the planned applications. Known issues being resolved include:

1. **False Events:** There are false events associated with (a) high energy radiation particles, aka "radiation dots", (b) blooming, created from glint and/or solar intrusion, and (c) duplicative dots, created from data processing mishandling. *Until a formal fix is applied, we recommend that the user remove single group flashes from the L2 data to help mitigate some of these noise sources.*
2. **Position Errors:** There are known position errors (some analyses show about 20 kilometer errors into the southwest direction). This issue could be due to one or more factors, such as erroneous INR LUTs, parallax (i.e., geolocation to Earth surface rather than to cloud-top), event overshoot, or erroneous lens distortion coefficients. However, these factors are still being investigated to determine the root cause(s) of position error.
3. **Timestamp:**
   a. TOF: The timestamp on events, groups, and flashes do not properly account for the Time-Of-Flight (TOF) of the photons from cloud-top to sensor; the distance from cloud-top to sensor in kilometers was incorrectly divided by the speed of light in meters/second. *Until a formal fix is applied, we recommend that the user apply their own TOF correction of about 125 ms [i.e., the actual TOF correction is estimated to range from 119 ms (nadir) to 131 ms (edge of FOV)].*
   b. The sequence in a datafile of event times (as well as group time, flash start time, and flash end time) are not in time order.

    c.   The scale factor for event times should be 1, not 2.

    d.   There exist erroneous time offset values for events, groups, and flashes.

4. **Lat/Lon of Events:** There exist erroneous lat/lon errors of events due to a conversion problem.

5. **Areas:** There are abnormally large group areas; and geolocation of groups show a peculiar "banding" structure. There are also flashes with negative flash areas.

6. **Unsigned Integer Read:** This could be the source of some of the errors in items 3d, 4, and 5 above. The classic model for NetCDF does not support unsigned integers larger than 8 bits. Many of the variables in GOES-16 data files are unsigned integers that are either 16-bits or 32-bits. We recommend using the following process to convert:

   - Retrieve the variable data.
   - If there is an attribute "_Unsigned" then cast the variable data to unsigned.

   This step must be completed before applying scale_factor and add_offset values to convert from scaled integer to science units. For example, when reading the NetCDF files, one has to MANUALLY read in the event lat/lon as an unsigned integer (using low level routines), and then manually take care of the scale and offset.

7. **Family Links:** There exists "childless" groups (i.e. groups with no events). There exist "childless" flashes (i.e. flashes with no groups). There exist "orphan" events (i.e. events with no parent group). There exist "orphan" groups (i.e. groups with no parent flash). There is a lack of proper links related to erroneous group or event counts. Finally, there are only upward links (event → group; group → flash) but no downward links.

8. *Arcs & Blobs:* Beginning in late August for the eclipse season, and near midnight, erroneous solar intrusion through the GLM lens system is expected to produce optical patterns (called "arcs" and "blobs").

9. Note: Users should also be aware that GLM background images (not technically part of the GLM L2 product) contain horizontal lines of enhanced amplitude at Real-Time Event Processor (RTEP) subarray boundaries due to instrument overshoot.