GOES-18 SEISS MPS-LO Level 1b (L1b) Data Release
Full Data Quality
December 6, 2023
Read-Me for Data Users

The GOES-R Peer Stakeholder - Product Validation Review (PS-PVR) for GOES-18 Space Environment In-Situ Suite (SEISS) Magnetospheric Particle Sensor - Low Energy (MPS-LO) L1b Full Maturity was held on December 6, 2023. As a result of this review, the PS-PVR panel chair declared that the GOES-18 SEISS MPS-LO L1b data are at Full Validation Maturity as of December 6, 2023.

MPS-LO consists of two electrostatic analyzers (ESAs) per particle species with microchannel plates (MCPs) as the detection elements. The ESAs apply an electric field between two curved surfaces allowing charged particles in a narrow energy range to reach the detector. The electric field is stepped rapidly through 15 fixed values, plus a return step, over 1 second to measure electrons and ions within 0.03 to 30 keV in 15 logarithmically spaced energy channels. The MPS-LO field of view is split into 14 angular zones, each approximately 15 degrees, spanning 180 degrees in the north-south plane. There are 2 pairs of overlapping zones centered at 7.5 and 22.5 degrees north and south of the zenith direction (spacecraft –Z direction), thus, there are 12 unique look directions. During each 1-second energy step cycle, counts are accumulated at each energy for 0.0615 s, and the complete energy-angle distribution of counts is reported for both species every second. The outputs of all the zones are registered simultaneously on a set of MCPs. The MCPs also include dark zones for measuring counts from penetrating radiation which are used by the ground processing algorithm to remove backgrounds from the illuminated zones. Since the background counts are measured independently, the background corrected (subtracted) count rates in the 1-second L1b data may contain some negative values (non-physical), obeying the statistics of the difference between two Poisson distributed measurements. Longer time averages may also contain some negative values for reasons described below. The pitch angle (between particle velocity and local magnetic field direction) associated with each zone can be calculated using the magnetic field vector measured by the GOES-18 magnetometer (GMAG). Pitch angles are not reported in the L1b data.

Full validation maturity, by definition, means:

- Validation, quality assurance, and anomaly resolution activities are ongoing;
- Incremental product improvements may still be occurring;
- Users are engaged and user feedback is assessed;
- Product performance for all products is defined and documented over a wide range of representative conditions via ongoing ground-truth and validation efforts;
- Products are operationally optimized, as necessary, considering mission parameters of cost and schedule, and technical competence as compared to user expectations;
- All known product anomalies are documented, and shared with the user community;
- Product is operational.

Users of the GOES-18 MPS-LO L1b data bear responsibility for inspecting the data and understanding the known caveats prior to use. Below is the list of caveats that have been identified and are under analysis. Solutions to anomalies are in development and testing:

1. No GOES-18 MPS-LO L1b data processed prior to declaration of Provisional Maturity (e.g., those available from CLASS) should be used. NCEI will reprocess and release the early mission data using Full Maturity algorithms and look-up tables.
2. Anomalously high backgrounds have resulted in negative background corrected (subtracted) fluxes in much of the L1b data reported up to time of writing of this document. Implementation of empirically determined zone-energy dependent background removal coefficients has alleviated some effects of this anomaly, but changing instrument characteristics since launch means that the background removal coefficients need periodic updating. There continues to be periods of negative fluxes, on average, in some zone-energy channels.
3. Interzonal crosstalk has been observed in energy-sweep-voltage dependent count rates in the electron background zones in on-orbit data. The geometric factors have been scaled such that the background subtraction performed in L1b processing provides a measure of correction for the crosstalk without loss of signal in the reported fluxes.
4. Post launch tests show evidence for significant error in absolute values of reported fluxes, e.g., significant differences between fluxes from overlapping zones, changing instrument characteristics since launch, and discrepancies in comparisons with other missions. One source of error in reported fluxes is gradual decline in response of the Micro Channel Plate (MCP) detectors since start of the mission. Some GOES-16 MPS-LO channels (powered on 2017-01-08) are reporting over an order of magnitude low. Similar decline is observed in GOES-18 MPS-LO. A correction is being developed for this, and a corrected GOES-18 MPS-LO dataset will be made available to the public in the future.
5. High background counts typically dominate over in-band counts in the lower ion energy channels resulting in a very low signal to noise ratio in the background corrected ion fluxes. The problem is worse, affecting energy channels up to tens of keV, when the source of backgrounds is high (e.g., when the radiation belts are elevated).
6. There are gaps in the L1b data.

Please refer to the GOES-R Series Product Definition and Users' Guide (PUG) https://www.goes-r.gov/users/docs/PUG-L1b-vol3.pdf for information on the Data Quality Flag (DQF) values and meanings (pg. 221). The DQFs provide the user with information on when to exercise caution due to instrumental effects like low signal/background, elevated uncertainties, and non-operational time periods.

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NCEI website for GOES-R Space Weather data (provides daily aggregations of MPS-LO L1b data):
https://www.ngdc.noaa.gov/stp/satellite/goes-r.html