GOES-17 SEISS EHIS Level 1b (L1b) Data Release
Provisional Data Quality
Read-Me for Data Users
May 28, 2019

The GOES-R Peer Stakeholder Product Validation Review (PS-PVR) for GOES-17 Space Environment In-Situ Suite (SEISS) Energetic Heavy Ion Sensor (EHIS) Level 1b (L1b) Provisional Maturity was held on May 21, 2019. As a result of this review, the PS-PVR panel recommended that the EHIS L1b data be promoted to Provisional Validation Maturity.

The L1b data product consists of 5-minute-cadence differential directional fluxes and associated systematic (instrumental) and statistical errors. Fluxes are produced for hydrogen (H) and helium (He); for the carbon-nitrogen-oxygen (CNO), neon-sulfur (Ne-S), and chlorine-nickel (Cl-Ni) mass groups; and for individual elements between beryllium and copper (Be-Cu) (but see below for a restriction on the beryllium and boron fluxes). EHIS has a single 60^{o} (full cone angle) field-of-view directed radially outward from the Earth (toward the zenith). The energy range is nominally 10-200 MeV/nucleon for hydrogen (protons) and helium (alpha particles), divided into five energy channels. The energy range increases with atomic number (Z) since the stopping power in silicon is the same for all species in each energy channel. Outside of solar energetic particle (SEP) events, EHIS observes galactic cosmic ray (GCR) fluxes.

The H and He fluxes are derived directly from coincidence rates (3-second cadence in the raw Level 0 data), as with SGPS, and can be averaged over longer periods to improve the counting statistics. In contrast, the heavy ion fluxes are derived using a maximum likelihood (ML) fit to a histogram of Z values determined on-orbit (1-minute cadence) using the angle-detecting inclined sensor (ADIS) system incorporated into the EHIS telescope (see Literature). While this ML fit is necessary for meeting requirements in the presence of very sparse heavy ion count rates, it limits the utility of the L1b data in post-processing. From the Ground Processing Algorithm Document for the GOES-R Space Environment In-Situ Suite (SEISS), Rev. F (p. 76): “EHIS data is accumulated over 3 second and 1 minute intervals. Data products for longer periods of time must be added together from the raw data and processed as shown below. Taking fluxes from five [or] 1-minute periods (particularly upper limits) and simply averaging them to obtain fluxes for a longer period, is not valid and EHIS reporting requirements will not be met.”

Moreover, when, in the L1b data, the lower one-sigma statistical error is equal to the mean value, only an upper limit exists (mean plus upper one-sigma statistical error). (In the L1b files, the mean fluxes are contained in the variable ‘BeCu5MinuteDifferentialFluxes‘, and the lower and upper statistical errors are contained in the variable ‘BeCu5MinuteDifferentialFluxStatErrorsBounds‘.) As a result, derivation of heavy ion fluxes for periods longer than 5 minutes (e.g., SEP event fluences, GCR fluxes averaged over a solar rotation period of 27 days) requires reprocessing from Level 0 raw data. This is a limitation that is independent of the maturity of the product.

Provisional validation means:

- Validation activities are ongoing and the general research community is now encouraged to participate.

- Severe algorithm anomalies are identified and under analysis. Solutions to anomalies are in development and testing.
- Incremental product improvements may still be occurring.
- Product performance has been demonstrated through analysis of galactic cosmic ray (GCR) observations.
- Product analysis is sufficient to establish product performance relative to expectations. (Performance Baseline)
- Documentation of product performance exists that includes recommended remediation strategies for all anomalies and weaknesses. Any algorithm changes associated with severe anomalies have been documented, implemented, and tested.
- Testing has been fully documented.
- Product is ready for operational use and for use in comprehensive cal/val activities and product optimization.

Users of the GOES-17 EHIS 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:

1. The primary caveat is that, as of the date of this Read-Me, GOES-17 EHIS has not yet observed a solar energetic particle (SEP) event. A SEP event is needed for the validation of all EHIS requirements. The 10 September 2017 SEP event revealed problems with the GOES-16 EHIS that had not been evident in GCR observations or in the prior, weaker SEP events in 2017.

2. Until GOES-17 EHIS observes a large SEP event, it should be assumed that it will exhibit the same temperature sensitivities in the hydrogen fluxes and deficiency in the helium count rates exhibited by the GOES-16 EHIS.

3. The L1b algorithm assumes that the histogram backgrounds are constant with atomic number (Z). Since this is in fact not the case in the on-orbit data, an alternative background formulation is under investigation.

4. The beryllium (Be) and boron (B) fluxes in the L1b product are replaced with fill values since such ions of solar origin are never observed. The counts in those bins are from backgrounds.

5. Outside of SEP events, EHIS observes GCR fluxes. Under these conditions, the L1b fluxes are generally too high, since the processing uses geometrical factors and energy bandwidths derived for SEP spectra. Such spectra deemphasize the contribution of the high-energy portions of the response functions, which dominate the instrument's response to GCR spectra.

6. As described above, the L1b heavy ion fluxes, in particular those that are upper limits, should not be time-averaged since this does not improve counting statistics.

Literature

Pre-launch SEISS overview:

Dichter, B. K., Galica, G. E., McGarity, J. O., Tsui, S., Golightly, M. J., Lopate, C., Connell, J. J. (2015). Specification, design and calibration of the space weather suite of instruments on the NOAA GOES-R program spacecraft. IEEE Transactions on Nuclear Science, 62(6), 2776–2783.

Angle-Detecting Inclined Sensor (ADIS) system:

Connell, J. J., Lopate, C., and McKibben, R. B. (2001). The angle detecting inclined sensors (ADIS) system: measuring particle angles of incidence without position sensing detectors. Nuclear Instruments and Methods in Physics Research A, 457, 220-229.

Connell, J. J., Lopate, C., McKibben, R. B., Enman, A. (2007). Accelerator test of an angle detecting inclined sensor (ADIS) prototype with beams of 48Ca and fragments. Nuclear Instruments and Methods in Physics Research A, 570, 399-413.

Connell, J. J., Lopate, C., McLaughlin, K. R. (2016). Accelerator test of an improved angle detecting inclined sensor (ADIS) prototype with beams of 78Kr and fragments. Nuclear Instruments and Methods in Physics Research A, 837, 11-15.

Contact for further information: OSPO User Services at SPSD.UserServices@noaa.gov

Users are strongly encouraged to contact the NCEI GOES-R SEISS team in the event they have questions or encounter difficulties with EHIS files. The NCEI website https://www.ngdc.noaa.gov/stp/satellite/goes-r.html provides additional information and access to SEISS L1b files https://doi.org/10.25921/9R33-CM27

NCEI contacts for specific information on the EHIS L1b data:

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