GOES-19 SEISS SGPS Level 1b (L1b) Data Release
Provisional Data Quality
December 6, 2024
Read-Me for Data Users

The GOES-R Peer Stakeholder - Product Validation Review (PS-PVR) for GOES-19 Space Environment In-Situ Suite (SEISS) Solar and Galactic Proton Sensor (SGPS) L1b Provisional Maturity was held on December 6, 2024. As a result of this review NOAA has confirmed that the SGPS L1b data are at Provisional Validation Maturity as of December 6, 2024.

There are two SGPS sensor units mounted on each GOES-R series spacecraft, facing in the spacecraft -X and +X directions. When the spacecraft is not in the yaw-flipped configuration SGPS-X faces west and SGPS+X faces east. Each SGPS unit has three solid-state (silicon detector) telescopes T1, T2, and T3 for measuring 1-25, 25-80, and 80-500 MeV protons, respectively. All three telescopes have the same look direction (i.e., +X or -X). T1 and T2 have 60^{o} (full cone angle) fields of view, and T3 has a 90^{o} field of view. Each unit measures 1-500 MeV proton fluxes in 13 logarithmically spaced differential channels (P1-P10) and >500 proton flux in a single integral channel (P11). The L1b data product is one-second cadence fluxes. The channels generally register counts above backgrounds only during solar energetic particle events, except for P11 which measures galactic cosmic rays in the absence of a solar particle event (SPE).

Provisional validation maturity, by definition, 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 a small number of independent SEP measurements;
- 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 calibration/validation activities and product optimization.

Users of the GOES-19 SGPS 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 are in development and testing.

1. No SGPS 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 Provisional Maturity algorithms and look-up tables.

2. GOES-19 SGPS P5 may be contaminated with electrons when radiation belt fluxes are elevated (TBD). The magnitude of the contamination with respect to solar proton fluxes during a SPE is small in other SGPS units.
3. There are gaps in L1b data.
4. SGPS P1-P9 differential channels were designed and calibrated to measure SPE spectra. Outside of SEP events, when SGPS observes galactic cosmic ray (GCR) protons, background fluxes reported from these channels are much higher than actual GCR fluxes.
5. On-orbit cross calibrations show that some channels were not well characterized by ground/beam calibrations. During the October-November 2024 SEP events, GOES-19 SGPS-X and +X P8C both appear to be reporting a factor of ~2 high. Some geometric factors may need adjustment (TBD).
6. There is no evidence of temperature dependence in GOES-19 SGPS channels, as seen in some channels in GOES-16 and -18 SGPS units.
7. GOES-19 SGPS P7 and P8C channels will be undergoing testing of a contamination removal circuit until April 2, 2025. The test results in occasional step changes of a factor of ~2 in the P7 and P8C channels.
8. In April 2024, updated SGPS P1-P5 geometric factors and energy bounds were provided by the SEISS instrument vendor with the recommendation that these revised calibration factors be applied to all SGPS units. The revised calibration parameters bring SGPS P1-P5 into better agreement with MPS-HI P8-P11 and GOES 13-15 Energetic Particle Sensor (EPS) P1-P3 channels. The original and revised ("corrected") calibration parameters are provided in Table 1 below.

Channel	Original			Corrected			G [cm²-sr] Uncertainty	Correction Factor
	E_L [MeV]	E_U [MeV]	G [cm2-sr]	E_L [MeV]	E_U [MeV]	G [cm²-sr]		
P1	1.02	1.86	0.11	0.92	1.80	0.16	0.019	0.656
P2A	1.90	2.30	0.11	1.80	2.20	0.16	0.019	0.688
P2B	2.31	2.34	0.11	2.20	3.20	0.16	0.019	0.708
P3	3.40	6.48	0.10	3.30	6.20	0.17	0.021	0.625
P4	5.84	11.0	0.11	6.30	11.7	0.17	0.021	0.618
P5	11.6	23.3	0.12	12.4	23.3	0.17	0.021	0.753

Table 1. SGPS P1-P5 original and corrected lower and upper channel energy bounds (E_L and E_U) and geometric factors (G). A multiplicative factor that can be applied to correct P1-P5 channel fluxes is provided in the rightmost column

A multiplicative factor that can be applied to correct P1-P5 channel fluxes is also provided in the rightmost column (i.e., correction factor = $[G*\Delta E]_{\text{Original}} / [G*\Delta E]_{\text{Corrected}}$, where $\Delta E=E_U-E_L$). The new calibration factors have not been applied to the SGPS operational L1b data, pending full analysis of the impact on integral fluxes used by the NOAA-SWPC for reporting Solar Particle Storm Scales. In the future, the Level-2 SGPS one- and five-minute averaged fluxes available from NCEI's website will be replaced with corrected data using the updated calibration factors. This note applies to all SGPS units.

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.

Comprehensive review of SGPS measurements:

Kress, B. T., Rodriguez, J. V., Boudouridis, A., Onsager, T. G., Dichter, B. K., Galica, G. E., & Tsui, S. (2021). Observations from NOAA's newest solar proton sensor. *Space Weather, 19*, e2021SW002750. https://doi.org/10.1029/2021SW002750

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