

GOES-17 and GOES-16 MAG Level 1b (L1b) Release

Full Data Quality

Updated: January 22, 2024

Read-Me for Data Users

The GOES-17 and GOES-16 Peer Stakeholder Product Validation Review (PS-PVR) for MAG L1b Full Validation Maturity was held on February 25, 2021. The result of this review was the PS-PVR panel chair recommending that the MAG L1b data for both GOES-17 and GOES-16 be declared Full Validation maturity.

The L1b data products derived from MAG are vector measurements of the geomagnetic field sampled at 10 Hz from the inboard and outboard magnetometers.

The GOES-17 and GOES-16 MAG Level 1b (L1b) Full maturity data products continue to be suitable for operational (note, this only applies to the GOES-16 outboard sensor) use but have documented known issues. Product performance has been demonstrated through analysis of a significant number of independent measurements obtained from select locations, periods, and comparisons to nearby spacecraft and magnetic field models. The product was calibrated, validated and optimized to the extent allowed within resources available. Users bear all responsibility for inspecting the data prior to use and for the manner in which the data are utilized.

In late 2019, the L1b GOES-17 and GOES-16 data sets released on the NCEI website (listed below) included correction for arcjet contamination. However, it is highly recommended that users use the arcjet flag described below to flag the periods contaminated by arcjet firings. For details on the arcjet contamination and correction algorithm see *Califf et al., (2019, 2020)*.

On March 14th, 2023, the magnetometer instrument on GOES-17 will enter storage mode. During this time, the magnetometer will be turned off and not producing operational or scientific datasets. In preparation for storage the magnetometer will be configured to only produce limited data products from February 27th - March 14th, 2023. Storage mode will continue until GOES-17 is decommissioned or should an operational GOES magnetometer become unusable.

The GOES-16 inboard magnetometer should not be used for scientific or operational purposes. There are issues on the inboard magnetometer that limit its reliability. For more information, see Loto'aniu et al. (2019). The outboard magnetometer should be used for operations, while the inboard sensor should be used with care for scientific analysis and we recommend that users contact NCEI before publishing with GOES-16 data.

Additionally, L2 products based on this scientific data set are also available at the NCEI website (listed below).

Full Validation means:

- Validation, Q&A, 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 operational optimized, as necessary, considering mission parameters of cost, schedule, and technical competence as compared to user expectations (Performance Baseline);
- All known product anomalies are documented and shared with the user community;
- The product is operational.

We recommend that persons using the GOES-17 and GOES-16 MAG Full Validation maturity L1b products for scientific and technical investigations, particularly model validation, model development, and plasma waves analysis, contact the responsible NOAA scientists before making definitive scientific or technical conclusions derived directly from the MAG data.

Cautions, known issues, and issues under work for resolution at Full maturity status:

1. The GOES-17 and GOES-16 inboard sensor (IB_* variables in the L1b files) suffers anomalous bias shifts and should not be used in science and technical investigations. We are working to understand the inboard sensor issues.
2. The outboard sensor (OB_* variables in the L1b files) can be used for science and technical investigations.
3. The L1b files generated after application of the arcjet correction in the GOES-R ground system contain magnetic field variables that have “uncorrected” or “corrected” added to the variables name. In addition, an arcjet flag was added to the data quality flag (DQF) variable that covers the period where arcjets are fired and contaminate the magnetic field observations. Hence, it is highly recommended that users use the arcjet flag data quality bit named `potentially_degraded_due_to_arcjet_firing_qf` to flag the periods contaminated by arcjet firings.
4. The `amb_mag_*` variables in the L1b files refer to the best observation of the geomagnetic field, which is currently set to the outboard sensor values due to issues with the inboard sensor. This variable should be the default magnetic field observation used by users for science and technical investigations.
5. The outboard sensor observations show slow diurnal and seasonal variations when compared to other GOES satellites and models. We are currently investigating this issue and some of these variations are likely due to outboard sensor thermal issues, while others may be due to issues with other GOES sensors and inaccuracies in magnetic field models. The diurnal bias variations are approximately +/- 1-2 nT, and the long-term variations are +/- 3 nT.
6. *Update: January 22, 2024:* Based on analysis of the yaw flips in March and September 2019 and comparison to GOES-15, it was determined that the GOES-17 outboard magnetometer zero levels were not invariant to the yaw flip and thus were incorrect. The errors were -0.25 and 1.82 nT in the P and N components. Revised zero levels were installed in the data processing February 22, 2021. See Rich et al., 2024 for details. Data prior to February 22, 2021 were not corrected.

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

NCEI contact for specific information on the MAG L1b data:

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Data inquiries can be directed to goesr.mag@noaa.gov

NCEI website for GOES-R Space Weather data: <https://www.ngdc.noaa.gov/stp/satellite/goes-r.html>

References:

Califf, S., Early, D., Grotenhuis, M., Loto'aniu, T. M., and Kronenwetter, J. (2020) Correcting the arcjet thruster disturbance in GOES-16 magnetometer data. *Space Weather*, 18, doi:10.1029/2019SW002347.

Califf, S., Loto'aniu, T. M., Early, D., and Grotenhuis, M. (2019) Arcjet Thruster Influence on Local Magnetic Field Measurements from a Geostationary Satellite, *Journal of Spacecraft and Rockets*, Vol. 57, No. 1, doi:10.2514/1.A34546

Loto'aniu, T.M., Redmon, R.J., Califf, S. *et al.* (2019) The GOES-16 Spacecraft Science Magnetometer. *Space Sci Rev* 215, 32. <https://doi.org/10.1007/s11214-019-0600-3>

Rich, F.J., Califf, S., Loto'aniu, T.M., Coakley, M., Krimchansky, A., Singer, H. (2024) Intersatellite Comparisons of GOES Magnetic Field Measurements, *Space Weather* (in press as of Jan 2024)