GOES-** Magnetometer Level-2 README

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Description

The products contained here are full-resolution magnetometer (MAG) observations for the GOES-8 through GOES-17 series of 10 spacecraft, covering a time span of more than 27 years (from 1995 to present). Future spacecraft will be added as they are launched and become operational. The three-axis stabilized satellites were also known as GOES-I-M (G8-G12), GOES-NOP (G13-G15), GOES-R (G16) and GOES-S (G17) prior to their launch.

The GOES MAG subsystem consists of fluxgate magnetometer instruments monitoring three orthogonal components of the geomagnetic field at geosynchronous orbit (L = 6.6) with high resolution (sampling rate) (G8-15: 2 Hz and G16-17: 10 Hz). GOES MAG supports the following mission objectives:

- Measures the magnitude and direction of Earth's ambient magnetic field in the geosynchronous equatorial orbit.
- Determines the general level of geomagnetic activity.
- Detects disturbances such as: geostationary magnetopause crossings, storm sudden commencements, substorms and ultra-low-frequency (ULF) waves.
- Maps the space environment that controls charged particle dynamics in the outer region of the magnetosphere.

The GOES MAG measurements are provided as B field vectors in the ECI (Earth-centered inertial), EPN (earthward, poleward, normal/eastward), GSE (geocentric solar ecliptic), GSM (geocentric solar magnetospheric), VDH (dipole aligned), and body reference frame coordinate systems.

Data Variable Descriptions

Total magnetic field, computed from EPN vector components [nT]
Magnetic field in EPN coordinates (x, y, z). E: earthward, P: perpendicular to the satellite orbital plane, N: ExP [nT] (eastward)
Magnetic field in Earth Centered Inertial coordinates (x, y, z) [nT]
Magnetic field in Geocentric Solar Ecliptic coordinates (x, y, z) [nT]
Magnetic field in Geocentric Solar Magnetospheric coordinates (x, y, z) [nT]
Magnetic field in VDH coordinates (x, y, z). V: anti-earthward, D: eastward, H: northward along dipole [nT]
Magnetic field in Body Reference Frame coordinates (spacecraft x=Roll, y=Pitch, z=Yaw). This is also the frame of the SEISS instrument [nT]
Data quality flag [0= good_quality]
G08-G15: [1= unspecified_degraded, 2= degraded_via_equitorial_approx, 65536=unspecified_bad, 2147483648= missing_data]
G16-G17: [1 = invalid_due_to_missing_L0_IB_and_OB_MAG_data_qf,
2 = degraded_due_to_IB_MAG_x-axis_potential_failure_or_off_state_or_IB_mag_potentially_in_maintenance_mode_qf,
4 = degraded_due_to_IB_MAG_y-axis_potential_failure_or_off_state_or_IB_mag_potentially_in_maintenance_mode_qf,
8 = degraded_due_to_IB_MAG_z-axis_potential_failure_or_off_state_or_IB_mag_potentially_in_maintenance_mode_qf,
16 = degraded_due_to_OB_MAG_x-axis_potential_failure_or_off_state_or_OB_mag_potentially_in_maintenance_mode_qf,
32 = degraded due to OB_MAG_y-axis potential failure or off state or OB_mag potentially in maintenance mode_qf,
64 = degraded due to OB_MAG_z-axis potential failure or off state or OB_mag potentially in maintenance mode_qf,
128 = degraded due to IB_MAG_x-axis magnetic field at saturation_qf,
256 = degraded due to IB_MAG_y-axis magnetic field at saturation_qf,
512 = degraded due to IB_MAG_z-axis magnetic field at saturation_qf,
1024 = degraded due to OB_MAG_x-axis magnetic field at saturation_qf,
2048 = degraded due to OB_MAG_y-axis magnetic field at saturation_qf,
4096 = degraded due to OB_MAG_z-axis magnetic field at saturation_qf,
8192 = degraded due to MAG calibration maneuver in progress_qf,
16384 = degraded due to potentially stale MAG engineering data_qf,
32768 = potentially degraded due to out of valid range IB_MAG_x-axis thermistor temperature_qf,
65536 = potentially degraded due to out of valid range IB_MAG_y-axis thermistor temperature_qf,
131072 = potentially degraded due to out of valid range IB_MAG_z-axis thermistor temperature_qf,
262144 = potentially degraded due to out of valid range OB_MAG_x-axis thermistor temperature_qf,
524288 = potentially degraded due to out of valid range OB_MAG_y-axis thermistor temperature_qf,
1048576 = potentially degraded due to out of valid range OB_MAG_z-axis thermistor temperature_qf,
2097152 = potentially degraded due to out of valid range IB_electronics_temperature_qf,
4194304 = potentially degraded due to out of valid range OB_electronics_temperature_qf,
8388608 = potentially degraded due to IB_MAG_in_shadow_qf,
16777216 = potentially degraded due to arcjet firing_qf

** Data Issues and other notes:**
- The GOES satellites have two magnetometers (inboard and outboard sensors) and the magnetic field data available for plotting are usually the outboard sensor values. The source netcdf files (accessed via CDAWeb or NOAA-NCEI, see links below) contain variables not available for plotting at CDAWeb including both inboard and outboard sensor (*_ib_* and *_ob_* variables, respectively) data, the sensor data in additional coordinate frames, a flag indicating which sensor the estimated magnetic field data represents and additional quality flags. Please refer to the metadata description of each variable present in the netcdf files for more details.
- The time coverage listed does not imply continuity of the data during the entire interval.
- Due to data processing issues for the high resolution GOES mag data:
  - B_total can sometimes be NaN for G14. In this case, the user can calculate it using the EPN available vector components.
  - B_BRF is not always available for G08-G15 (showing fill values).
  - B_VDH occasionally shows unrealistic outliers due to spikes in the spacecraft attitude data used for the coordinate transformation.
- The satellite position extracted from the netcdf file variable “orbit_llr_geo” might contain some errors, especially for the longitude values. The GOES ephemeris data was reprocessed by NOAA-NCEI (only in 1-min resolution) and can be accessed in the links below:

<table>
<thead>
<tr>
<th>GO8-G15</th>
<th><a href="https://satdat.ngdc.noaa.gov/sem/goes/data/sat_locations/">https://satdat.ngdc.noaa.gov/sem/goes/data/sat_locations/</a></th>
</tr>
</thead>
<tbody>
<tr>
<td>G16</td>
<td><a href="https://data.ngdc.noaa.gov/platfomrs/solar-space-observing-satellites/goes/goes16/l2/data/ephe-l2-orb1m/">https://data.ngdc.noaa.gov/platfomrs/solar-space-observing-satellites/goes/goes16/l2/data/ephe-l2-orb1m/</a></td>
</tr>
<tr>
<td>G17</td>
<td><a href="https://data.ngdc.noaa.gov/platforms/solar-space-observing-satellites/goes/goes17/l2/data/ephe-l2-orb1m/">https://data.ngdc.noaa.gov/platforms/solar-space-observing-satellites/goes/goes17/l2/data/ephe-l2-orb1m/</a></td>
</tr>
</tbody>
</table>
- Arcjet Contamination:
  - The GOES-R series satellites use hydrazine arcjet thrusters for periodic orbital maneuvers for station keeping. When the arcjets are fired the magnetometer measurements (both inboard and outboard sensors are contaminated by up to ~20 nT. This is significant
contamination relative to the typical 100 nT geomagnetic field magnitude at geostationary orbit. The arcjets fire once every 1 to 4 days and contamination can last ~90 minutes or less. When using the GOES-16 and GOES-17 magnetic field data, users are strongly encouraged to refer to the references below that describe and show examples of the arcjet signature in the magnetic field data.


- Arcjet flag: Arcjet firings can be identified in the “flag_meanings” attribute of the DQF variable defined as “potentially_degraded_due_to_arcjet_firing_qf”.
- Older versions of GOES magnetometer data files available at CDAWeb are identified by names that begin with Gx where x is the satellite number. These are:
  a. GOES 6 and 7, 1-min data in EPN coordinates
  b. GOES 7 power spectral density plots for selected intervals
  c. GOES 8, 9, 10, 11, and 12 magnetometer data with 1-min resolution in various coordinate systems (duplicated with the newer processed files discussed above).
  d. Selected intervals of GOES-10, -11, and -12 magnetometer data at 0.512 sec resolution. (duplicated with the newer processed files discussed above).

For accessing the original high-resolution G08-G17 data product files at NOAA-NCEI, please visit the links listed below:

<table>
<thead>
<tr>
<th>Time resolution</th>
<th>Data coverage</th>
<th>Links:</th>
</tr>
</thead>
<tbody>
<tr>
<td>G08 512 ms</td>
<td>95-01</td>
<td><a href="https://satdat.ngdc.noaa.gov/sem/goes/data/science/mag/goes08/magn-l2-hires">https://satdat.ngdc.noaa.gov/sem/goes/data/science/mag/goes08/magn-l2-hires</a></td>
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<tr>
<td>G09 512 ms</td>
<td>95-01</td>
<td><a href="https://satdat.ngdc.noaa.gov/sem/goes/data/science/mag/goes09/magn-l2-hires">https://satdat.ngdc.noaa.gov/sem/goes/data/science/mag/goes09/magn-l2-hires</a></td>
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<tr>
<td>G11 512 ms</td>
<td>00-10</td>
<td><a href="https://satdat.ngdc.noaa.gov/sem/goes/data/science/mag/goes11/magn-l2-hires">https://satdat.ngdc.noaa.gov/sem/goes/data/science/mag/goes11/magn-l2-hires</a></td>
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<tr>
<td>G12 512 ms</td>
<td>01-09</td>
<td><a href="https://satdat.ngdc.noaa.gov/sem/goes/data/science/mag/goes12/magn-l2-hires">https://satdat.ngdc.noaa.gov/sem/goes/data/science/mag/goes12/magn-l2-hires</a></td>
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<td>G13 512 ms</td>
<td>10-17</td>
<td><a href="https://satdat.ngdc.noaa.gov/sem/goes/data/science/mag/goes13/magn-l2-hires">https://satdat.ngdc.noaa.gov/sem/goes/data/science/mag/goes13/magn-l2-hires</a></td>
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<tr>
<td>G14 512 ms</td>
<td>12-17</td>
<td><a href="https://satdat.ngdc.noaa.gov/sem/goes/data/science/mag/goes14/magn-l2-hires">https://satdat.ngdc.noaa.gov/sem/goes/data/science/mag/goes14/magn-l2-hires</a></td>
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<tr>
<td>G15 512 ms</td>
<td>11-17</td>
<td><a href="https://satdat.ngdc.noaa.gov/sem/goes/data/science/mag/goes15/magn-l2-hires">https://satdat.ngdc.noaa.gov/sem/goes/data/science/mag/goes15/magn-l2-hires</a></td>
</tr>
<tr>
<td>G16 0.1 s</td>
<td>18-present</td>
<td><a href="https://data.ngdc.noaa.gov/platforms/solar-space-observing-satellites/goes/goes16/l2/data/magn-l2-hires">https://data.ngdc.noaa.gov/platforms/solar-space-observing-satellites/goes/goes16/l2/data/magn-l2-hires</a></td>
</tr>
<tr>
<td>G17 0.1 s</td>
<td>18-present</td>
<td><a href="https://data.ngdc.noaa.gov/platforms/solar-space-observing-satellites/goes/goes17/l2/data/magn-l2-hires">https://data.ngdc.noaa.gov/platforms/solar-space-observing-satellites/goes/goes17/l2/data/magn-l2-hires</a></td>
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