SET Operational Mg II c/w data: Information for Data Users

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The Mg II c/w (center-to-wing ratio) measurement has been an important input to solar irradiance models and is one of the best chromospheric time series available for describing solar FUV/ EUV irradiance variations from daily to solar cycle timescales. It is the basis for M10 index used in the JB2008 model. The Mg II c/w is a relative photometric measurement at 280 nm between the Mg II h and k lines. Because it is based on the ratio of the lines, and not to an absolute calibration, it is much less susceptible to instrument degradation. Continuous daily values are available from late 1978, covering five solar cycles. In many ways, compared to sunspots and the F10.7 2800 MHz data, it is a superior index to solar irradiance variability and space weather applications because it can accurately describe chromosphere variability on time scales ranging from a solar rotation (27 days) to the 11-year solar cycle, and, unlike F10.7, it describes the solar FUV variability that directly affects the Earth's lower thermosphere.

A detailed description of the Mg II c/w measurements can be found at:
https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2004SW000084.
Also see DeLand & Cebula, 1978: https://www.researchgate.net/publication/23885308_Composite_Mg_II_solar_activity_index_for_solar_cycles_21_and_22

The MgII c/w began with the SBUV instrument (Solar Backscatter UltraViolet) that was onboard the NOAA-9 to NOAA-19 polar-orbiting satellites since late 1978. After the failure of the NOAA-19 satellite 3 Sep 2017, SET acquired the Mg II c/w data from the GOME satellite (https://www.researchgate.net/publication/252096847_The_MG_II_solar_activity_proxy_indicator_derived_from_gome_and_sciamachy). In some instances, the LASP SORCE/SOLSTICE (https://lasp.colorado.edu/home/sorce/instruments/solstice/) data was employed in SET operations to address data gaps and inter-calibrations.

More recently, beginning 9 Mar 2022, SET began using the Mg II data acquired from the GOES-R(16) EUVS instrument (https://data.ngdc.noaa.gov/platforms/solar-space-observingsatellites/goes/goes16/l2/docs/GOES-R_EUVS_L2_Data_Readme.pdf). The current plan is to continue using the primary NOAA GOES satellite sources (e.g., the upcoming

GOES-18 satellite) as the primary source of Mg II because the GOES satellites are officially supported as a NOAA operational asset.

SET employs the daily Mg II c/w ratio in daily operations, in particular, in creating the M10 index used in the JB2008 thermospheric density model (see https://spacewx.com/current-data/, Solar irradiance and indices, and https://spacewx.com/jb2008/), and are provided by SET as a

courtesy to the space-weather community "As-Is" without implied warranty. The SET version of Mg II data are based on the original units from NIMBUS-7 and NOAA-9 data (as defined by Heath, Schlesinger, and Donnelly, circa 1978), using concurrent satellite measurements or proxies as different sources became available over the years. Thus, the absolute values of SET Mg II will differ from other satellite sources: but it is the relative variability that is relevant in operations, and a straight-forward linear regression can be used to inter-calibrate different Mg II sources.

Since the data provided by SET is designed to be consistent with JB2008 M10 thermospheric density operations and the SOLAR2000 irradiance specification tool, and because a time series of continuous historical and current daily data values are required by the JB2008 and SOLAR2000 operational models, a secondary source (e.g., GOME) or an interpolated or forecasted value is substituted until a GOES measurement is available A latency of 1-7 days is typical in NOAA GOES processing. Additionally, extreme outliers are removed and a 3-day smoothing filter is applied. As a result, the SET operational data will vary slightly day-to-day compared to prior data estimates. Nevertheless, the SET version of Mg II is also compared daily to other EUV/UV related data (e.g., Ly-a, JB2008 S10, F10.7, etc.) to ensure consistent relative variability.

Users of the SET near-real-time Mg II c/w data at: https://sol.spacenvironment.net/spacewx/data/mg2_atmos.dat.txt should be aware that the data are dynamically re-calibrated to meet JB2008 M10 thermospheric operations for estimating satellite drag, and do not reflect an absolute static calibration of historical measurements. Current or historical data are dynamically re-calibrated as updated primary and secondary sources become available, data anomalies are detected, or metadata needs to be updated.

Change Logs

9 Mar 2022

GOES-16 is now the primary source of Mg II data. The data are calibrated to the adjusted (to prior NOAA-19 data) GOME data dynamically and will continue to be until there is sufficient overlap to ensure coverage over a range of solar activity, at which point a fixed set of linear coefficients will be applied. GOME is now a secondary source when GOES data are delayed or

unavailable, and tertiary forecasted/interpolated are used otherwise. This is to ensure that current daily values are always available for near-real-time ingest by other space weather models.

21 Sep 2017

NOAA-19 Mg II data has suddenly gone offline Sep 3, 2017. The source of the problem is unknown at this point, but the SBUV instrument data suggests NOAA-19 MgII data has gone offline permanently. We have back-filled our operational MgII data with GOME data and will continue to use it until an alternate Mg II data source is implemented (possibly LASP or GOES-16).

27 Jan 2017

NOAA-19 data has been corrected. It was discovered that NOAA-19 data (after 1 Jun 2015) was under-estimated by 0.003. Historical data has been replaced. All future data will include the correction. There may still be issues with NOAA-19 MgII data (a low dynamic range). However, the background/minimum data is within 1-3% of former solar minima and is consistent with GOME Mg II data. Further investigation will be performed.

23 Sep 2015

We have been using GOME data since the last update. In June 2015, the NOAA-19 data came on-line. On September 23, new processing code using a Data State Matrix was implemented as a beta-level product. When verified, the NOAA-19 data will replace the GOME data as the primary source, and GOME will be the secondary.

13 Jun 2014

In Dec 2012, the SBUV instrument failed on NOAA-18, and SBUV data are no longer available from NOAA-18 (permanently). Within several weeks, the NOAA-16 data processing was reimplemented. Note that the SET issued Mg II data during that period used extrapolated estimates, and that introduced a large error (Dec 2012).

Then, on 9 Jun 2014, NOAA-16 suddenly failed, and has been decommissioned. Efforts are ongoing to implement the GOME MgII data.

13 Feb 2013

Normal Mg II data processing has been running for five weeks without incident; thus, we have resumed normal Mg II data operations, using the NOAA-16 SBUV instrument, and preliminary evaluation indicates less than a 5% error. Work continues.

22 Mar 2013

Normal Mg II data processing continues. A detailed comparison of the SOSTICE and NOAA-16 data was performed with respect to F10.7. Neither source indicated long-term instruments from 2006-2013, nor comparing SOLSTICE to NOAA-16 resulted in a 0.94 correlation coefficient. By simply applying a linear regression SOLSTICE data can be adjusted to NOAA-16 and is done so when NOAA-16 data are missing.

27 Dec 2012

On 12 Dec 2012 NOAA-18 had a sudden SBUV instrument failure, and Mg II is no longer available from NOAA-18. Since then, we have switched to NOAA-16. Currently, we are still calibrating the NOAA-16 data to NOAA-18, consequently the relative error may be on the order of 20%, but we expect to complete adjusting the data to historical Mg II baselines within 30 days.

13 Dec 2011

There have been several difficulties in determining an accurate Mg II c/w since February 2009. The SBUV diffuser plate on NOAA-17 increasingly was shadowed due to the spacecraft's attitude, due to its slow precession in its orbit. SET Mg II data operations substituted a combination of adjusted SOLSTICE and GOME data, but the data were not consistently accurate (to within the 5% level).

Recently, Matt DeLand at SSAI has graciously provided new processing algorithms for the NOAA-18 data, which has been performing very well. SET has integrated those new algorithms in its operations 13 Dec 2011. These data have been re-calibrated back to June 1, 2008. Prior to that, the data is unchanged from earlier versions. In the most recent version, NOAA-18 is the primary source, and when those measurements are missing, data from the SOLSTICE instrument are substituted in.

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