


S5P MPC VDAF Validation Web Article: Total Column of Ozone

Contributing authors

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Product definition

The following table contains a description of the S5P TROPOMI processor versions used in this report.

Processor Version	In operation from	In operation until
01.00.00	RPRO orbit 0354, 07-11-2017	RPRO orbit 2880, 04-05-2018

The data used in this report was obtained with the NRT processor. NRT products do not have a DOI.

Product requirements are described in the Sentinel-5 Precursor Calibration and Validation Plan for the Operational Phase source: ESA; ref: ESA-EOPG-CSCOP-PL-0073; issue: 1.0 date 2017-06-11, Sentinel-5P-Calibration-and-Validation-Plan.pdf

Validation results

Initial Sentinel-5p TROPOMI L2_O3 O_3 column data retrieved with the PDGS NRTI processor (v1.0.0) have been compared to reference measurements acquired by instruments contributing to WMO's Global Atmosphere Watch: (1) Brewer and (2) Dobson UV spectrophotometers (data collected from WOUDC), and (3) the NDACC network of zenith-sky DOAS UV-Visible spectrometers (especially SAOZ data collected from the CNRS LATMOS real time processing facility). All those preliminary reference data have been quality-controlled by BIRA-IASB's Multi-TASTE/CORR_2 system. Over the period tested (November 2017 up to 5 May 2018) and with respect to the reference data available at the time of this analysis, of the order of 20 to 100 co-locations have been identified at about 20 Brewer and Dobson sites and at 11 SAOZ sites, sampling many latitudes from the Arctic to the Antarctic.

Ground-based data comparisons with the S5P Validation Data Analysis Facility (VDAF) and with the Multi-TASTE expert validation system lead to the following preliminary conclusions:

- Qualitatively, at all of the 30 reference stations, short scale temporal variations in the ozone column as captured by ground-based instruments are reproduced very similarly by S5P. Figure 1 illustrates this at the station of Manchester. The overall good agreement is corroborated by Pearson correlation coefficients well above 0.9.
- Quantitatively, the bias between S5P and reference data at individual stations rarely exceeds 3%, as depicted in Figure 2. The median bias calculated over the entire ground-based network is of the order of +1%. This median bias falls well within the mission requirements (bias at most 3.5-5%).
- The 1σ spread of the bias (between S5P and reference data) around its median value rarely exceeds 3-4% for the comparisons with direct-sun instruments. Combining random errors in satellite and reference measurements with irreducible co-location mismatch effects, this value can be taken as a conservative upper limit of the random uncertainty on the S5P measurements.
- The analysis of potential dependence of the S5P bias and spread on key influence quantities, namely, the Solar Zenith Angle (SZA), Air Mass Factor (AMF) and cloud fraction of the S5P measurement, does not reveal any variation of the bias larger than 2% over the range of those influence quantities. The positive difference between S5P and GOME-2 data above cloudy scenes as identified by satellite-to-satellite comparisons (see below) has not been detected (yet) by ground-based comparisons, possibly due to the sparsity of the co-locations. The random noise of S5P data of about 3-4% increases up to 7% with increasing SZA (Figure 3).

Initial Sentinel-5p TROPOMI L2_O3 O_3 column data have also been compared to EUMETSAT AC-SAF GOME-2/MetOp-A and GOME-2/MetOp-B satellite data processed with the operational GDP 4.8 algorithm. Between 50˚S and 50˚N, the mean agreement between the different satellite data sets is within 1%. At higher latitudes - and thus higher SZA - the scatter increases up to 7%. Maps of the bias between S5P and the GOME-2 datasets reveal patterns that could be related to cloud cover, which can potentially be linked to the different overpass times (3.5 hours difference), although there is a systematically positive difference between S5P and GOME-2 total ozone values in these structures.

Overall, the quality of the initial L2_O3 PDGS NRTI v1.0.0 data product appears to comply with the S5P mission requirements.

Current conclusions are nevertheless based on the limited amount of reference measurements available at the time of this first analysis, and on the period covered by the initial S5P dataset (November 2017 to May 2018). The current conclusions need to be confirmed by a larger amount of co-locations, and extended over a full year of data, hence, a full cycle of key influence quantities, in order to enable detection and quantification of potential patterns, dependences, seasonal cycles and longer term features. For further details, the user is referred to the S5P MPC Validation Data Analysis Facility website at http://mpc-vdaf.tropomi.eu .

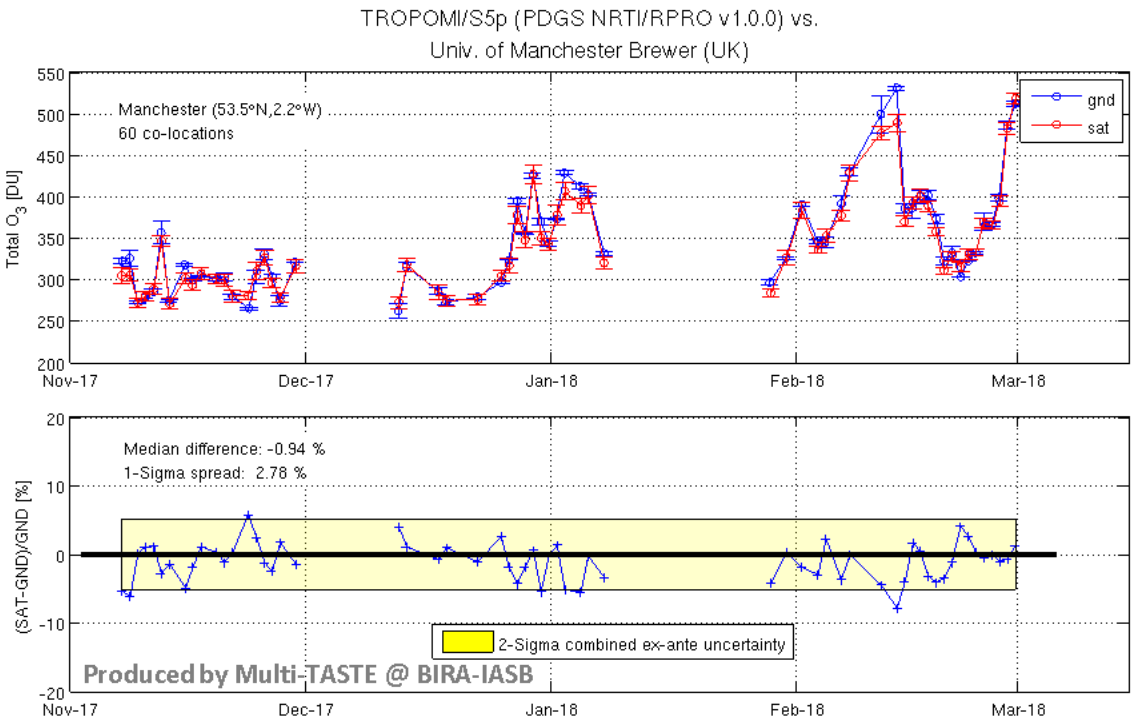

Figure 1: Comparison between S5P L2_O3 (PDGS NRTI processor v1.0.0, RPRO data set) and ground-based measurements obtained with the Brewer operated by the University of Manchester. Upper panel: Time series of co-located total ozone measurements from both instruments. Bottom panel: Relative differences, including some statistical properties. The shaded yellow area represents the (quadratically) combined measurement uncertainty.

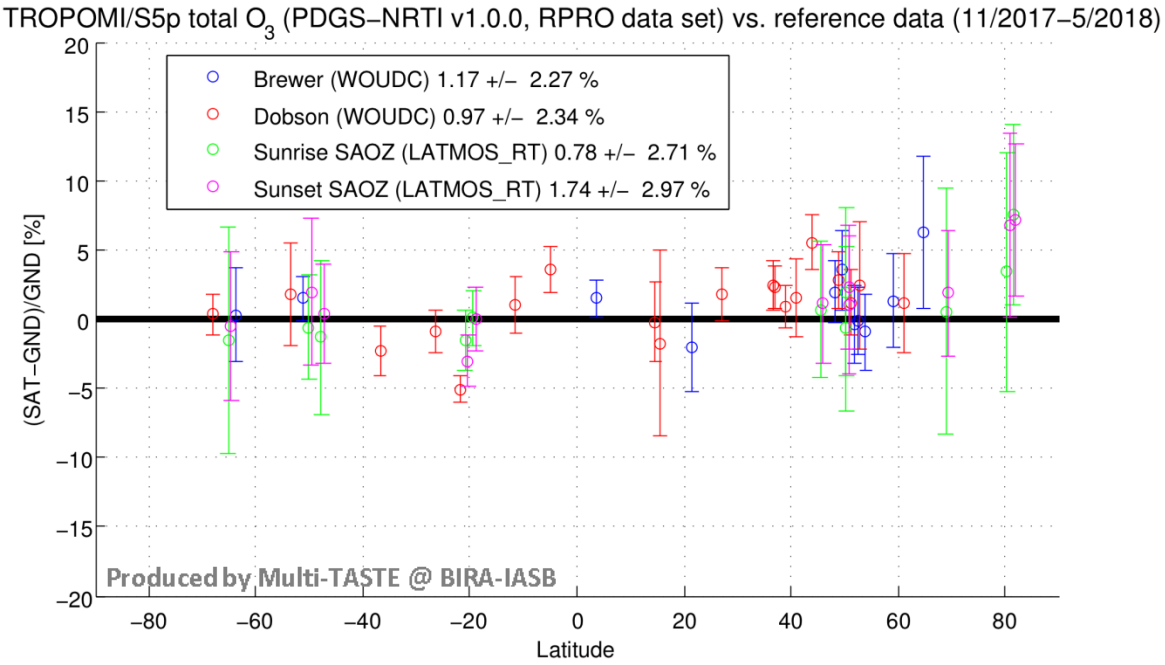

Figure 2: Meridian dependence of the median and spread (1 sigma) of the bias between S5P L2_O3 (PDGS NRTI processor v1.0.0, RPRO data set) and ground-based reference ozone column data, represented at individual stations from the Antarctic to the Arctic and per reference measurement type. The values in the legend correspond to the median and spread of all median differences. For clarity, sunrise and sunset SAOZ measurements have been offset by -0.5˚ and +0.5˚ in latitude.

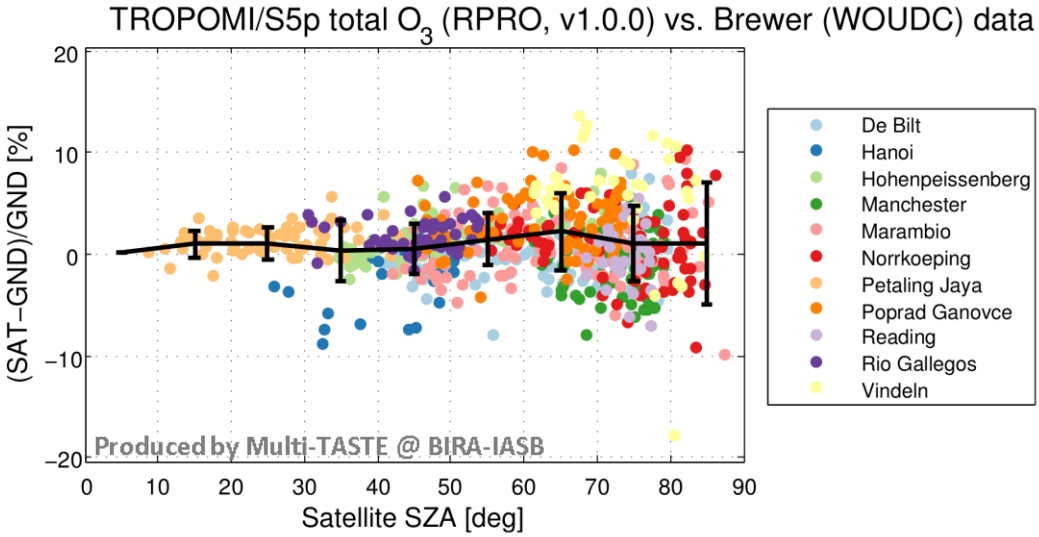

Figure 3: Solar Zenith Angle (SZA) dependence of the differences between S5P L2_O3 (PDGS NRTI processor v1.0.0, RPRO data set) and ground-based Brewer reference ozone column data. Black lines and markers represent the mean and standard deviation in 10˚ bins.

Acknowledgments

The Brewer, Dobson, and ZLS-DOAS data used in this work were obtained as part of WMO's Global Atmosphere Watch (GAW) and the Network for the Detection of Atmospheric Composition Change (NDACC). They are publicly available via the NDACC Data Host Facility (http://www.ndacc.org) and the World Ozone and Ultraviolet Data Centre (http://www.woudc.org). The authors acknowledge the dedication of the PIs and staff at the stations to acquire and maintain long-term ozone data records of high quality, as well as supporting projects like ESA's CEOS Intercalibration of Ground-Based Spectrometers and Lidars.

NRT SAOZ data were obtained through the CNRS-LATMOS SAOZ RT facility (http://saoz.obs.uvsq.fr/SAOZ-RT.html), maintained by Andrea Pazmino, Florence Goutail, and Jean-Pierre Pommereau.

The analysis made use of the HARP toolset, designed, developed and maintained by S&T (http://www.stcorp.nl).