Title:	Glyoxal tropospheric column retrievals from TROPOMI – multi-satellite intercomparison and ground-based validation
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Abstract:	We present the first global glyoxal (CHOCHO) tropospheric column product derived from the TROPOspheric Monitoring Instrument (TROPOMI) on board the Sentinel-5 Precursor satellite. Atmospheric glyoxal results from the oxidation of other non-methane volatile organic compounds (NMVOCs) and from direct emissions caused by combustion processes. Therefore, this product is a useful indicator of VOC emissions. It is generated with an improved version of the BIRA-IASB scientific retrieval algorithm relying on the differential optical absorption spectroscopy (DOAS) approach. Among the algorithmic updates, the DOAS fit now includes corrections to mitigate the impact of spectral misfits caused by scene brightness inhomogeneity and strong NO2 absorption. The product comes along with a full error characterization, which allows for providing random and systematic error estimates for every observation. Systematic errors are typically in the range of 1 ×1014–3 ×1014 molec. cm−2 (∼30 %–70 % in emission regimes) and originate mostly from a priori data uncertainties and spectral interferences with other absorbing species. The latter may be at the origin, at least partly, of an enhanced glyoxal signal over equatorial oceans, and further investigation is needed to mitigate them. Random errors are large (molec. cm−2) but can be reduced by averaging observations in space and/or time. Benefiting from a high signal-to-noise ratio and a large number of small-size observations, TROPOMI provides glyoxal tropospheric column fields with an unprecedented level of detail. Using the same retrieval algorithmic baseline, glyoxal column data sets are also generated from the Ozone Monitoring Instrument (OMI) on Aura and from the Global Ozone Monitoring Experiment-2 (GOME-2) on board Metop-A and Metop-B. Those four data sets are intercompared over large-scale regions worldwide and show a high level of consistency. The satellite glyoxal columns are also compared to glyoxal columns retrieved from ground-based Multi-AXis DOAS (MAX-DOAS) instruments at nine stations in Asia and Europe. In general, the satellite and MAX-DOAS instruments provide consistent glyoxal columns both in terms of absolute values and variability. Correlation coefficients between TROPOMI and MAX-DOAS glyoxal columns range between 0.61 and 0.87. The correlation is only poorer at one mid-latitude station, where satellite data appear to be biased low during wintertime. The mean absolute glyoxal columns from satellite and MAX-DOAS generally agree well for low/moderate columns with differences of less than 1×1014 molec. cm−2. A larger bias is identified at two sites where the MAX-DOAS columns are very large. Despite this systematic bias, the consistency of the satellite and MAX-DOAS glyoxal seasonal variability is high. How to cite. Lerot, C., Hendrick, F., Van Roozendael, M., Alvarado, L. M. A., Richter, A., De Smedt, I., Theys, N., Vlietinck, J., Yu, H., Van Gent, J., Stavrakou, T., Müller, J.-F., Valks, P., Loyola, D., Irie, H., Kumar, V., Wagner, T., Schreier, S. F., Sinha, V., Wang, T., Wang, P., and Retscher, C.: Glyoxal tropospheric column retrievals from TROPOMI – multi-satellite intercomparison and ground-based validation, Atmos. Meas. Tech., 14, 7775–7807, https://doi.org/10.5194/amt-14-7775-2021, 2021.
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