A multi-year global synergetic IASI-TROPOMI satellite product of tropospheric CH4

Kanwal Shahzadi[2,1], Matthias Schneider[1], Nga Ying Lo[1,2], Jörg Meyer[2], Frank Hase[1], Peter Braesicke[1], Tobias Borsdorff[3] and Mari Martinez Velarte[3]

*[1]**Karlsruhe Institute of Technology, Institute of Meteorology and Climate Research – Atmospheric Trace Gases and Remote Sensing.***
Hermann-von-Helmholtz-Platz 1, Building 435, 76344 Eggenstein-Leopoldshafen, Germany
Email:kanwal.shahzadi@kit.edu

*[2]**Karlsruhe Institute of Technology, Scientific Computing Center.***
Hermann-von-Helmholtz-Platz 1, Building 435, 76344 Eggenstein-Leopoldshafen, Germany

*[3]**SRON Netherlands Institute for Space Research.***
Niels Bohrweg 4, 2333 CA Leiden, Netherlands

Data products of atmospheric methane with improved vertical sensitivity in the lower troposphere are crucial for gaining a more comprehensive understanding of the impact of anthropogenic emissions. This study presents a methane data product derived from the synergetic combination of TROPOMI (Tropospheric Monitoring Instrument) total column and IASI (Infrared Atmospheric Sounding Interferometer) profiles, utilizing level 2 data spanning the period from 2018 to 2021. IASI enables high-quality retrievals in the upper troposphere-lower stratosphere, while TROPOMI observations excel in providing sensitivity to the total-column-averaged mixing ratio of CH4. The combined product retains the information from individual datasets and therefore enhances sensitivity to lower tropospheric signals while minimizing influence from upper tropospheric signals, which is not achievable by using IASI or TROPOMI data alone.

We present the method for optimally combining the IASI and TROPOMI level 2 data. Firstly, the products from the individual satellites are collocated in time and space (geomatching). Subsequently, the collocated data are optimally merged by fully considering the individual data characteristics (uncertainties and sensitivities) by the application of a Kalman filter. We show that the procedure is robust and computationally cheap, which allows the efficient combination of billions of IASI and TROPOMI observations and the combined product offers a good global coverage.

The combined product is validated by comparison to available reference datasets such as 14 globally distributed TCCON (Total Carbon Column Observing Network) stations, CH4 profile measurements made by 36 individual AirCore soundings, and tropospheric CH4 data derived from continuous ground-based in situ observations made at two nearby Global Atmospheric Watch (GAW) mountain stations. These comparisons confirm the theoretically predicted quality of the combined data product, particularly the increased quality of the tropospheric CH4 data.

Following the procedure outlined above, the resulting data product comprises partial-column-averaged CH4 below and above 6000 m a.s.l., accompanied by their averaging kernels and uncertainties. These data will be provided in netCDF files compliant with the CF metadata convention version 1.7, ensuring accessibility and interoperability for further research and applications.