The Retrieval of Atmospheric Trace Gases using Passive Solar Remote Sensing from Satellite and Aircraft Platforms: Progress and Challenges

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Abstract

GOME (ESA ERS-2 (1995-2011)) and SCIAMACHY (ESA Envisat (2002-2012)) began a new age of nadir viewing passive remote sensing instruments from space, aiming to deliver globally trace gas amounts and distributions. Follow-ons with progressively improving spatial resolution and signal to noise have resulted: the most recent being TROPOMI, on the Copernicus Sentinel-5 Precursor, EU-ESA-S5P (2017 to present). In addition, the Geostationary Environment Monitoring Spectrometer, GEMS, on the Korean Aerospace Research Institute GEO-KOMPSAT-2B satellite launched in 2020 into a Geostationary orbit, GEO. This evolution of passive remote sensing stimulated the development of aircraft-borne instruments at the University of Bremen e.g. the AIRMAP and the MAMAP family of instruments. The spectral resolution of the above instruments is sufficient to identify the electronic-vibrational-rotational-absorptions in the ultraviolet, visible, and near-infrared spectral regions of the upwelling radiance. Using differential optical absorption spectroscopy, DOAS, total column amounts of key trace gases (e.g. ozone, O3, nitrogen dioxide, NO2, bromine monoxide, BrO, chlorine dioxide OClO, iodine oxide, IO, formaldehyde, HCHO, glyoxal, CHO.CHO, and water vapour H2O) are retrieved. In addition, SCIAMACHY and TROPOMI observe in the shortwave-infrared. CO columns and the dry columns of methane, XCH4, and carbon dioxide, XCO2, are retrieved from SCIAMACHY measurements, and the inversion of TROPOMI radiances delivers CO columns and XCH4 at a much higher spatial resolution. The AIRMAP and MAMAP family of instruments have been developed to target absorptions respectively in the ultraviolet/visible and the near-infrared/shortwave-infrared.This presentation focuses on recent results addressing: i) the validation of TROPOMI and the estimation of urban emissions of NO2; ii) ozone measurements; iii) the validation of the GEMS data products; iii) the emissions of CH4 from TROPOMI and CH4 and CO2 from the new MAMAP 2D Light instrument. These developments will be put in the context of the evolving global observing system.

Early Career Scientist

NO, I am not an early career scientist.

IGAC Activities

CATCH: the Cryosphere and Atmospheric Chemistry, TOAR: Tropospheric Ozone Assessment Report