IRS2012-116
International Radiation Symposium 2012
Dahlem Cube, Berlin, Germany, 06 – 10 August 2012

Remote sensing of carbon dioxide and methane from space

A. Butz (1), I. Aben (2), A. Babenhauserheide (1), S. Basu (2), C. Dominguez-Tagle (1), C. Frankenberg (3), A. Galli (2), S. Guerlet (2), P. Hahne (1), O. Hasekamp (2), J. Landgraf (2), and D. Schepers (2)

(1) Karlsruhe Institute of Technology (KIT), Institute for Meteorology and Climate Research (IMK), Eggenstein-Leopoldshafen, Germany (andre.butz@kit.edu), (2) Netherlands Institute for Space Research (SRON), Utrecht, The Netherlands, (3) California Institute of Technology / Jet Propulsion Laboratory (JPL), Pasadena, CA, USA

Several current and future Earth-observing satellite sensors such as the Greenhouse Gases Observing Satellite (GOSAT), the Orbiting Carbon Observatory (OCO-2), and the Sentinel-5 Precursor (S5P) aim at monitoring the column-integrated concentrations of atmospheric greenhouses gases. Their observational strategy relies on recording spectra of sunlight backscattered by the Earth's surface and atmosphere in the shortwave-infrared (SWIR) spectral range. Rotational-vibrational absorption bands of the main target gases carbon dioxide and methane allow for deducing the respective gas concentrations with fairly uniform sensitivity throughout the atmospheric column. The overall goal is to establish a data record of atmospheric greenhouse gas abundances with good spatiotemporal coverage and sufficient accuracy to gain new insight into the biogeochemical processes that drive greenhouse gas fluxes at the Earth's surface.
Remote sensing of the column-integrated carbon dioxide (XCO_2) and methane (XCH_4) concentrations from space is challenging due to the high accuracy required to inform about the weak surface flux signals. In particular, scattering by aerosols and thin water and cirrus clouds is a source of error that could jeopardize the usefulness of the satellite measurements if lightpath modification due to such scattering is not taken into account appropriately. We have developed a methodology (RemoTeC) that aims at minimizing scattering-induced retrieval errors by simultaneously retrieving XCO_2, XCH_4, and scattering properties of the atmosphere from multiple spectral windows in the SWIR spectral range. Three retrieval parameters effectively describe the amount, the size, and the height distribution of atmospheric particles. These parameters then drive a radiative transfer model that models the atmospheric lightpath as accurately as possible. RemoTeC is sufficiently flexible to be applied to the currently orbiting GOSAT but also to future missions such as OCO-2, GOSAT-2, S5P, and other proposed missions such as CarbonSat.
Here, we focus on reporting the performance of the method for solar-backscatter spectra recorded by GOSAT which is in orbit since January 2009. Comparison of our retrievals to correlative ground-based measurements by the Total Carbon Column Observing Network (TCCON) shows that RemoTeC achieves a precision of better than 1% and accuracy of better than 0.5% for both, XCO_2 and XCH_4. In particular, we highlight the benefit of using a line-mixing spectroscopy model and show how the satellite spectra can be used to feedback information on spectroscopic inconsistencies. On the global scale, the RemoTeC-GOSAT retrievals reproduce the large scale concentration patterns such as seasonal cycles and hemispheric gradients. First attempts to use satellite-derived XCO_2 and XCH_4 for inverse modeling of the respective surface fluxes are promising.