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## Validation of the greenhouse gases observing satellite GOSAT using an ensemble of COCCON spectrometers

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Greenhouse gases (GHGs) play a crucial role with respect to global warming. Therefore, precise and accurate observations of anthropogenic GHGs, especially carbon dioxide (CO<sub>2</sub>) and methane (CH<sub>4</sub>), are of utmost importance for the estimation of their emission strengths, flux changes and long-term monitoring. Satellite observations are well suited for this task as they provide global coverage. However, like all measurements these need to be validated. The Total Carbon Column Observing Network (TCCON) performs ground-based observations of GHGs with reference precision using high-resolution Fourier Transform infrared (FTIR) spectrometers. TCCON data are of high accuracy as TCCON uses species dependent scaling factors derived from in-situ reference measurements to be calibrated to the World Meteorological Organization (WMO) reference scale. For several satellites measuring GHGs TCCON data are the main validation source.

To further improve the global coverage of FTIR spectrometers and complement TCCON especially in remote areas, the COllaborative Carbon Column Observing Network (COCCON) was established. Until now the focus of COCCON was on the quality control of EM27/SUN spectrometers and dedicated campaigns to estimate emission strengths of CO<sub>2</sub> and CH<sub>4</sub> from local and regional sources, e.g. from cities, fracking areas or mining sites.

Here we present a global validation of the Greenhouse Gases Observation Satellite GOSAT using multiple spectrometers from the COCCON network. The COCCON instruments are stationed in Finland, Germany, Greece, Japan, Namibia, Sweden and the USA. The sites span a range of different atmospheric and observing conditions, from subtropical to subpolar regions, including boreal forests and deserts, low and high albedo surfaces, polluted and clean areas. Overall, we find a good agreement between GOSAT and COCCON measurements.