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Arctic methane – First results of the junior research group ”Greenhouse gases in the Arctic”

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Abstract

Methane (CH4) is a globally well-mixed greenhouse gas and represents the second largest driver of anthropogenic climate change. It’s increase in concentration between pre-industrial times and today corresponds to an associated estimated increase in radiative forcing of +0.48 W/m^2 (compared to 2.82 W/m^2 for all well-mixed GHG (IPCC 2013)). About 50% of the world’s global soil carbon is concentrated in the Arctic representing a potential additional large source of CH4 (and CO2) emissions. While the measurement of methane concentration and its associated radiative forcing is of great interest to understand climate change in the Arctic, measurement of both quantities has proven difficult for different reasons. In this joint presentation we will present the work of the Junior Research Group ‚Greenhouse gases in the Arctic‘.

In the first part we present the progress in the analysis of satellite-based measurements of methane in the Arctic using the WFMD/S5P data product developed at the IUP Bremen. With the launch of the Sentinel-5 Precursor (S5P) mission, carrying the TROPOMI instrument, an unprecedented high spatio-temporal resolution of the column-averaged mole fraction of various gases was made possible, e.g., methane (XCH4). Especially in the northern high-latitude regions, where few ground stations and in-situ measurements are available, this data promises new ways of understanding the methane distribution and variation on large scales. In addition to the operational Copernicus S5P XCH4 data product developed by SRON, the scientific WFMD algorithm data product (WFMD product) was generated at the Institute of Environmental Physics at the University of Bremen. While direct validation proves difficult due to the limited amount of ground-based measurements, e.g., from TCCON and NDACC, evaluation of the data itself regarding potential biases seems promising. First results show large scale cloud contamination of the data and a possible local bias in Greenland which is introduced by the underlying elevation model.

In the second part we present first attempts to measure methane surface radiative forcing directly. Using far infrared emission spectra from the Vertex 80 instrument operated in Ny-Ålesund, Svalbard since 2019, we determine the radiative forcing by integrating the residual after removing all but the methane lines from the measured

spectrum. For this we use a radiative transfer model (SFIT4) with the full atmospheric state where only the methane profile is set to zero. Since water vapour has strong features in the relevant methane band, we determine the water vapour lines as accurately as possible via a trace gas retrieval.