



## **Vertical distribution of Arctic methane from ground-based FTS measurements**

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In this work, we studied the vertical distribution of atmospheric methane ( $\text{CH}_4$ ) measured in Sodankylä, Northern Finland. Sodankylä often lies beneath the middle or on the edge of the stratospheric polar vortex resulting considerable variability in the vertical profile of methane. The  $\text{CH}_4$  profiles were retrieved from the ground-based direct Sun FTS measurements using a method that utilizes a novel dimension reduction approach and Bayesian inference. The instrument belongs to Total Carbon Column Observing Network (TCCON), source for accurate and precise column-averaged abundance of several trace gases and the data are used for climatological studies and act as important reference for satellites such as OCO-2 and GOSAT. The new profile data set covers years from 2009 to the present day (from February to November) and altitudes 0-40 km. The retrieved FTS profiles were validated against the ACE satellite measurements and AirCore balloon measurements. The total columns derived from the profiles were compared to the official TCCON XCH<sub>4</sub> data. Finally, we analyzed the altitude-dependent time series of  $\text{CH}_4$  using a flexible method that allows smooth variations in the trend and seasonal cycle. These results provide valuable information on the  $\text{CH}_4$  vertical distribution at a high-latitude site, and thus have a direct connection to further investigations of methane fluxes in the Arctic. The profile retrieval method developed in this work was proven particularly successful in the challenging conditions of a strong polar vortex and is directly applicable to other trace gases (e.g.,  $\text{CO}_2$ ) and, ultimately, to space-based retrievals.