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Methane retrievals from GOSAT shortwave infrared measurements: Performance comparison of proxy and physics retrieval algorithms

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JAXA's Greenhouse gas Observing Satellite (GOSAT), launched in 2009, is the first operating satellite mission dedicated to measuring greenhouse gas abundances from space. Onboard GOSAT, the TANSO-FTS instrument acquires shortwave infrared spectra of sunlight backscattered by the Earth's surface and atmosphere. These spectra show absorption features of CH_4 that allow for retrieving it's atmospheric abundance with high sensitivity in the lower atmosphere. However, unknown light path modification introduced by scattering in the Earth's atmosphere is a major cause of uncertainty in these retrievals. Here we present a comparison between two conceptually different methods for determining methane total column mixing ratios from GOSAT shortwave infrared measurements. Both methods account differently for the effect of light scattering by aerosol and cirrus on the retrieved methane column. The so-called proxy method simultaneously retrieves CO_2 total column density which, in conjunction with prior knowledge on CO_2 is used as a proxy for the light path modification by scattering. In contrast, the physics method aims to account for atmospheric scattering by retrieving three effective parameters of an atmospheric scattering layer. Both retrieval approaches are validated on a 19 month data set using collocated ground based Fourier Transform measurements of methane at 12 stations of the TCCON network, showing very comparable performance: for the proxy retrieval we find station-dependent retrieval biases ranging from -0.312% to 0.333% with a standard deviation of 0.22% and a typical precision of 17 ppb. The physics shows biases between -0.836% and -0.081% with a standard deviation of 0.24% and a precision similar to the proxy method. To complement this validation we verified the retrievals with methane fields which were simulated by a global chemistry-transport model. This comparison identified shortcomings of both retrieval approaches causing biases of up to 1% total column on regional scales introduced by scattering over bright surfaces or *a priori* CO_2 fields. These shortcomings could not be identified by the validation with the existing ground based measurements due to its limited spatial coverage. To confirm these findings and to provide a satisfying validation of any algorithm for methane total column retrieval from space borne shortwave infrared measurements, it is to our opinion, essential to further expand the network of TCCON stations.