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Observations of tropospheric trace gases from GOSAT thermal infrared spectra

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Thermal And Near infrared Sensor for carbon Observation-Fourier Transform Spectrometer (TANSO-FTS), which is one of the sensors onboard the Greenhouse gases Observing SATellite (GOSAT), measures the sunlight backscattered by the Earth's surface and atmosphere as well as the thermal radiance emitted from the Earth. Atmospheric trace gases such as ozone (O_3), water vapor (H_2O and HDO), methanol (CH3OH) and ammonia (NH3) are derived from the thermal infrared spectral radiance recorded with the TANSO-FTS by an optimal estimation retrieval approach. TANSO-FTS total ozone columns are compared with Dobson spectrophotometer and Ozone Monitoring Instrument (OMI) data. The TANSO-FTS total ozone retrievals exhibit a positive bias of 3–4% with a root-mean-square difference of 2–6% compared to the Dobson and OMI measurements. We compare TANSO-FTS tropospheric ozone columns to those from ozonesonde data as well as from a three-dimensional chemical-climate model (MRI-CCM2). The TANSO-FTS data have high correlations with the ozonesonde data. The seasonal trends of the retrieved tropospheric ozone are consistent with those of the ozonesonde data. The spatial distribution of the tropospheric ozone from the TANSO-FTS and MRI-CCM2 shows good agreement, especially in the high-level tropospheric ozone regions. We also retrieve tropospheric H_2O and HDO profiles simultaneously, accounting for the cross correlations between the water isotopes. The joint retrieval results in precise estimation of the isotope ratio by partial cancellation of systematic errors common to both H_2O and HDO. The retrieved profiles and columns are compared with radiosonde, GPS, and ground-based high-resolution FTS data. The temporal and spatial variations of the precipitable water and the isotope ratio are consistent with those of the validation data. Finally, air pollutants such as CH3OH and NH3 are retrieved using the retrieved ozone and water vapor. We present the latitudinal and seasonal variations of CH3OH related to plant growth and biomass burning, and the high-level NH3 in the hot spot areas.