

Characteristics of Seasonal, Regional, and Vertical Variations in GHGs Concentrations Captured by High Spectral Resolution Observations of GOSAT/TANSO-FTS and GOSAT-2/TANSO-FTS-2

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Abstract

Greenhouse Gases Observing Satellite (GOSAT) and its successor, GOSAT-2, have been observing several greenhouse gases (GHGs) concentrations since 2009, by utilizing both short-wave and thermal infrared (TIR) bands of Thermal and Near Infrared Sensor for Carbon Observation-Fourier Transform Spectrometer (TANSO-FTS) and TANSO-FTS-2 on board GOSAT and GOSAT-2. We have retrieved CO₂, CH₄, H₂O, N₂O, and O₃ concentrations and temperature on 29 vertical layers from the TIR spectra by adopting a non-linear maximum a posteriori method with linear mapping. We conducted comprehensive comparisons of the retrieved GHGs concentrations with several aircraft observations to validate their quality. The comparisons generally showed a good agreement between TANSO-FTS-2 TIR and aircraft CO₂ vertical profiles to within about 0.5-1%, although we found some regional dependent biases that should be considered in the TIR CO₂ data analysis. TANSO-FTS-2 TIR CH₄ and N₂O vertical profiles also agreed well with coincident aircraft observations, which could provide a useful dataset of global CH₄ and N₂O distributions. While vertical GHGs distributions derived from TIR band of satellite-borne sensors are useful, their vertical resolution is in general lower than that of in-situ observations and therefore, it is required to refer to their averaging kernels, especially for nadir-viewing satellite-borne sensors, to assess how much GHGs concentrations in each layer from satellite observations reflect realistic and true variations in GHGs concentrations in that layer. From comparisons of seasonal variations in CO₂ concentrations based on TANSO-FTS TIR and aircraft data, we found that the TIR observations could capture seasonal CO₂ variations in the lower, middle, and upper tropospheres in mid- and high latitudes of the Northern Hemisphere, but in the Southern Hemisphere, where seasonal CO₂ variations are more complicated due to transport from the Northern Hemisphere, coarser vertical resolution of the TIR observations hinder reproducing intricate seasonal variations there.

Early Career Scientist

NO, I am not an early career scientist.

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