

Cloud detection algorithm using TIR spectra for improving gas retrievals from GOSAT data

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Thermal And Near-infrared Sensor for Observation (TANSO) onboard Greenhouse gases Observing SATellite (GOSAT) consists of Fourier Transform Spectrometer (FTS) and Cloud and Aerosol Imager (CAI). Greenhouse gas concentrations are retrieved from the shortwave infrared (SWIR) bands and the thermal infrared (TIR) for scenes judged to be cloud and aerosol free through the cloud screening procedure with CAI observations. However, CAI does not operate during nighttime although TIR data can be obtained. Moreover, it has no sensitivity for cloud and aerosol heights which must be measured to decrease the currently reported gas concentration biases. Therefore, we developed an algorithm to detect optically thin clouds and dust aerosols with their heights from TIR data. The algorithm used in this study was based on a cirrus detection technique called CO₂ slicing method, modified as described below. The weighting functions which represent sensitivity profiles were calculated at each channel in the TIR band of GOSAT. The channels were reconstructed as sets of several spectral channels for each height level based on the peak heights of the weighting functions. Subsequently, the channel combinations were optimized based on simulation studies for several temperature profile patterns for each latitude and temperature at 500 hPa. The observed data were analyzed using these optimized channels. Global tropospheric cloud amounts and cloud properties such as cloud top heights and optical thickness were validated using CALIPSO data.

Monthly mean cloud amounts from GOSAT data were compared with those from CALIPSO. Results show some differences of cloud amounts and heights between GOSAT and CALIPSO, which might be caused by surface temperature biases, the difference of sensitivity of sensors, the inverse layer, and marine stratocumulus clouds. However, the horizontal distributions of clouds derived using the slicing method resembled those obtained from CALIPSO and it was revealed that the slicing method algorithm has high sensitivity compared with TIR threshold cloud screening which is currently adopted as the cloud screening method for GOSAT data in nighttime. Cloud properties were also compared for coincident observation between GOSAT and CALIPSO and the results showed that the accuracy of cloud detection is improved drastically by the new approach presented in this study. Clouds with optical thickness less than 0.1 are detectable using this method. Based on these results, the slicing method algorithm developed for this study seems to be useful for cloud screening. It is expected to improve the accuracy of greenhouse gas observations.

Keywords: satellite remote sensing, greenhouse gas, cirrus