Carbon Dioxide Seasonal Cycle from GOSAT Retrievals and NIES Transport Model Simulations

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The distribution of atmospheric carbon dioxide (CO_2) was investigated using the National Institute for Environmental Studies (NIES) three-dimensional transport model (TM) and retrievals from the Greenhouse gases Observing SATellite (GOSAT).

The GOSAT satellite was launched on 23 January 2009 to monitor the global distributions of greenhouse gases (CO_2 and CH_4) from space. The satellite is in a sun-synchronous orbit with an equator crossing time of about 13:00 local time and an inclination angle of 98°. The satellite flies at an altitude of approximately 666 km, completes an orbit in about 100 min, and operates on a global basis with a 3-day repeat cycle. The design and functions of the instrument are described in detail by Kuze et al. (2009). Several retrieval algorithms have been developed by different research groups for routinely processing GOSAT observational data. In this study, we use the GOSAT Level 2 (L2) XCO_2 retrieval dataset (Yoshida et al., 2011); this GOSAT dataset was also used in the inversion model to yield optimized fluxes (Maksyutov et al., 2013).

Column-averaged dry air mole fractions of CO_2 (XCO_2) from the NIES TM for four flux combinations were analyzed. The NIES TM is designed to simulate natural and anthropogenic synoptic-scale variations in atmospheric constituents on diurnal, seasonal, and interannual timescales. The model uses a mass-conservative flux-form formulation that consists of a third-order van Leer advection scheme and a horizontal dry-air mass flux correction. The horizontal latitude–longitude grid is a reduced rectangular grid, with a spatial resolution of 2.5° × 2.5° near the equator (Belikov et al., 2011). The model is off-line and is driven by a dataset that consists of both Japanese 25-yr Reanalysis (JRA-25) and Japan Meteorological Agency Climate Data Assimilation System (JCDAS) data. The JRA-25/JCDAS data are available on Gaussian horizontal grid T106 with 40 hybrid σ–p levels every 6 hours. Thus, the model integration time step is also 6 hours.

To simulate XCO_2, the NIES TM was run from 1 January 2009 employing the initial global XCO_2 distribution derived from GLOBALVIEW-CO_2 (2011). Four cases with different source components of CO_2 were considered in this study. Two flux sets were optimized without GOSAT data and two others were optimized with GOSAT Level 2 retrieval data.

The results reveal the benefits of using NIES TM simulations and GOSAT data to study seasonal cycle of CO2.

References

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