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成田上空におけるCO2短周期変動の観測値と計算値の比較

Correlation between simulation and observation on the synoptic scale CO 2 variation over Narita in 2007

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Background: Atmospheric concentration of CO_2shows variability over a range of scales, from inter-annual and seasonal to synoptic and diurnal. The synoptic scale variability of CO_2concentration is influenced by various factors such as regional surface CO_2fluxes, the strength of vertical mixing, the thickness of the planetary boundary layer, and synoptic meteorological systems. Characteristic patterns of advective transport of $CO_2$from its source regions to monitoring sites depend on the evolution of the existing meteorological conditions. Despite of increasing interest in synoptic-scale variations of the atmospheric concentration of CO_2, there have been only limited studies mostly using surface-level data. In this study, we compared the synoptic-scale variation obtained by the aircraft observation and a model simulation to better understand the controlling factors of the variation.

Method: Observation data used in this study are obtained by frequent measurements of $CO_2$from commercial aircraft as a part of the Comprehensive Observation Network for Trace gases by AIrLiner project. Simulation was conducted by the NIES TM version 05 was driven by the reanalysis meteorological data from NCEP at 1°x 1°resolution. The model horizontal resolution was 1°x 1°and the vertical resolution was 47 sigma levels. The CO_2flux data for fossil-fuel emissions, terrestrial biosphere flux, and ocean flux are taken from the protocol for the TRANSCOM continuous data experiment. We also used the flux corrections based on the previous inversion result. For tagged simulation, tags were put on both fossil-fuel and terrestrial-biosphere flux from 4 regions (Japan, East Asia, East Russia, and Southeast Asia). Time series for 1 year (2007) is calculated following 4 years of spin-up. Observed and calculated CO_2mixing ratios over the grid including NRT are divided into 2 km altitudinal bins. Digital filtering and harmonic regression curve fitting techniques are applied to the data in each bin and the deviation from the fitting curves is derived. Correlation was calculated between daily deviations of net $CO_2$from observation and those from simulation for each season.

Results: The vertical profiles of correlation coefficient between deviations of $CO_2$from observation and those from simulation are calculated for 6 altitudinal bins (centered at 0.5, 1, 3, 5, 7, 9 km, respectively). The correlations between simulated and observed synoptic variations are statistically significant (the number of samples for each case was approximately 90) except for

some cases below 3km and a case for 9km in autumn. Correlation was the best in summer throughout the troposphere except in the boundary layer.
The simulation with tags put on tracers from 4 regions indicated a notable seasonal and altitudinal variation in the tracer transport over Narita. For the purpose of discussion, we can divide the vertical SD distribution into 2 layers.
In the bottom layer (<3km), the predominant tracer contributing the deviation over Narita is fossil fuel flux from Japan through the year. The correlation between observation and simulation was not high (R=0.2-0.5) in the bottom layer, reflecting the difficulty in simulating the fine-scale transport from the local flux, with the limited resolution of flux distribution and transport of the model.
In the top layer (>3km), influence from sources in Japan decreases rapidly with altitude and fluxes from East Asia contribute the most in the free troposphere over Narita. The better correlation in the top layer indicates that the model can reproduce the continental-scale transport. Seasonal/ vertical difference in contribution factor to the correlation will be further discussed.