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TITLE: Evaluation of the GOSAT observations of the atmospheric CO_2 seasonal cycle in the northern high latitudes

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ABSTRACT BODY: Cold high latitude terrestrial areas (north of 55 deg. N) of the North Eurasia and North America are already experiencing impacts of the climate change in late 20th - early 21st century and are expected to be affected more in the 21st. Quantifying the carbon cycle change and climate feedback of the terrestrial ecosystems has been identified as an important subject of climate change research. Atmospheric CO_2 observations serve as a convenient monitor of the space and time-integrated seasonal change of the surface sources and sinks where the terrestrial biosphere dominates over oceanic and fossil fuel signals. The free tropospheric observations of the vertical profiles with aircraft are especially useful for quantification of local fluxes contribution by comparison of the PBL observations to the free tropospheric background. Analysis of the existing observations summarized in the Globalview-CO_2 dataset reveals the air mass contrast between mid-latitude (35-45N) and high-latitude (north of 55N) sites. While the seasonal amplitude of CO_2 in mid troposphere (500 mbar) is below 10 ppm in mid latitudes it increases to 15 ppm in high latitudes. There is also evidence the larger mid-tropospheric high latitude CO_2 seasonal cycle amplitude is difficult to simulate with the global tracer transport model which are otherwise successful in simulating the seasonal cycle near surface and in mid-latitudes. Only few airborne and ground based FTS sites are presently available for monitoring the high-latitude CO_2 in free-troposphere which calls for enhancements in the observation coverage. On the other hand, the GOSAT satellite CO_2 observations for more than 2 years are now available, that cover the high latitude areas in summer, with practically no data in winter due to very low solar zenith angle. In our report we evaluate recently improved column average CO_2 (XCO_2) retrievals from GOSAT at high and mid latitudes by comparison with global three-dimensional CO_2 climatology derived by correcting transport model ensemble simulation with observed (Globalview) CO_2 seasonal cycle. The retrievals with both full-physics (GOSAT SWIR Level 2 product versions 1.xx) and PPDF-DOAS algorithms are considered. The observations by GOSAT show that latitudinal distribution of the magnitude of the summertime decrease in XCO_2 as reproduced well by GOSAT. The GOSAT SWIR temporal coverage varies from 5 months at 60N to 3 months at 70N, but it matches well with a period of the terrestrial biospheric activity. Level 2 product shows about 2 ppm stronger amplitude while PPDF-DOAS algorithm amplitude matches the climatology within the uncertainty range. These results suggest usefulness of the GOSAT observations for quantification of the northern hemisphere high latitude tropospheric CO_2 variability, where only a few samples per month are taken with airborne observations.

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INDEX TERMS: [0394] ATMOSPHERIC COMPOSITION AND STRUCTURE / Instruments and techniques, [0428] BIOGEOSCIENCES / Carbon cycling, [3360] ATMOSPHERIC PROCESSES / Remote sensing.