Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

MIS003-P02 Room:Convention Hall Time:May 26 10:30-13:00

Evaluation of West Siberian wetland CH4 emission in inverse modeling

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West Siberia contains the largest wetland area in the world with large peat deposits and the wetland area is equivalent to 27% of total area of West Siberia. Recently, Glagolev et al. (2010) published the CH4 emission data from West Siberian wetlands at 0.5 deg resolution, using in situ measurements for each bioclimatic zone and a detailed wetland classification. Annual mean CH4 flux from West Siberian wetlands was calculated to be 3.2 Tg/yr in the updated version of Glagloev et al. (2010) (called Bc7) with strong wetland CH4 flux concentrated in Southern taiga. While a double magnitude of wetland CH4 flux estimated in Bc7 inventory was calculated in GISS inventory of Fung et al. (1991) with strong wetland CH4 flux in Northern and Middle taiga. In GISS inventory, wetland CH4 flux was estimated by emission seasons and emission rates calculated based on the climatology of monthly surface air temperature and precipitation with the global distribution of the simplified five wetland types published in Matthews and Fung (1987).

In this study, we estimate CH4 flux through inverse modeling for West Siberian wetlands with two different bottom-up inventories. Two airborne observations in West Siberia are used in verification for the inversed fluxes: at Surgut over wetlands in Northern taiga and at Novosibirsk near wetlands in Subtaiga. In forward simulations, the individual monthly CH4 surface sources for each region are emitted for a single month then discontinued for the remainder of the 6-year simulation to consider the response of atmospheric CH4, using interannually repeating OH and winds for the analysis year. The NIES transport model (Maksyutov and Inoue, 2000) simulates a total of 288 tracers for CH4, representing a combination of 12 land regions and 12 months for two source categories.

Annual mean CH4 flux of West Siberian wetlands is estimated to be 2.9 Tg/yr and 2.6 Tg/yr in inversions using GISS and Bc7 inventories, respectively. The inversed wetland flux well constrained is good agreement with the wetland flux in Bc7 inventory, but a large difference of the inversed flux to the wetland flux in GISS inventory. The inversed flux estimated using GISS inventory is only 45.0% of the prior flux with large decrease in June-August and it indicates the overestimated wetland flux in GISS inventory. As compared with the overestimated CH4 concentrations in forward simulations with GISS inventory, the mismatch between observed and predicted CH4 concentrations in inversion using GISS inventory is reduced with the decreased wetland flux by data constraint, but still higher CH4 concentrations at Surgut than observations. Larger mismatch between observed and predicted CH4 concentrations at Surgut is shown in inversion using GISS inventory than that for Bc7 inventory, while CH4 concentrations closer to observations at Novosibirsk are predicted in inversion using GISS inventory. These results suggest that GISS inventory includes the overestimated wetland CH4 flux in Northern and Middle taiga, implying that Bc7 inventory is more reasonable in the spatial distribution of West Siberian wetland CH4 flux with stronger CH4 flux from wetlands over Southern taiga than that for Northern and Middle taiga.

Keywords: Wetland methane emission, West Siberia, Inverse modeling