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Recent variation of West Siberian wetland CH4 fluxes estimated from atmospheric CH4

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The world's largest extent of wetlands occurs in West Siberia, where wetlands account for 27% of the area of West Siberia (Peregon et al. 2009). The vast wetlands emit methane (CH4) to the air and the magnitude depends highly on soil temperature and the water table. A large increase of atmospheric CH4 was observed globally in 2007 and Siberian wetland emission enhanced by high temperature was mentioned as one of main contributor to the increase at northern high-latitudes (Dlugokencky et al. 2009; Bloom et al. 2010). This study shows the year-to-year variation of CH4 emissions from West Siberian wetlands estimated from atmospheric CH4 observed by a tower network (JR-STATION: Japan-Russia Siberian Tall Tower Inland Observation Network) and aircraft over Siberia, using inverse model of atmospheric CH4 transport based on a fixed-lag Kalman smoother. We also use flask sampling and continuous measurement data of atmospheric CH4 archived at WDCGG (World Data Centre for Greenhouse Gases) in flux estimates. Interannually varying CH4 emissions are used to calculate CH4 transport with NIES transport model including chemical sink rates developed in TransCom-CH4 project (Patra et al. 2011): wetland and rice paddy emissions and soil sinks simulated with a process-based biogeochemical model (VISIT), biomass burning emissions of GFED v3.1, anthropogenic emissions of EDGAR v4.2, and interannually repeating termite emissions of GISS.

Annual mean of Siberian wetland CH4 flux was estimated to be 6.9 +/- 1.1 Tg/yr in 2006-2010 and high wetland flux was concentrated between (57.5N, 65.0E) and (67.5N, 90.0E) in West Siberia (called WL area), occupying 57% (3.9 +/- 0.2 Tg/yr) of the estimated Siberian wetland flux. The annual mean of WL area was very close to that for VISIT emission (3.8 Tg/yr), but a larger year-to-year variation was estimated in wetland flux of WL area (0.8 Tg/yr). A higher wetland flux of WL area was estimated in 2007 and 2008, but lower in 2006 and 2010. The enhanced wetland fluxes in 2007 and 2008 coincided with higher surface air temperature of NCEP/NCAR and greater precipitation of GPCP than those means in 1991-2010 over WL area and explained high CH4 concentration observed in May-Sep 2007 and 2008 at Demyanskoe and Karasevoe near extensive wetlands in WL area. The year-to-year variation of observed CH4 concentration was well reproduced with inverse model-estimated fluxes, showing high positive correlation between observed and predicted CH4 concentrations ($r = 0.85$ and 0.98 at Demyanskoe and Karasevoe, respectively). In WL area, we found a high positive correlation of annual mean of inverse model-estimated wetland flux with annual mean surface air temperature ($r = 0.89$) and liquid water equivalent thickness of GRACE ($r = 0.92$), but relatively low correlation ($r = 0.37$) for precipitation.

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