Estimations of natural methane fluxes taking into account the wetland area dynamics

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The natural emission of methane is estimated at 35-50% of the total, the main natural source is wetlands. It is not only the largest source of methane, but also the most volatile on an inter-annual scale. There are concerns that methane emissions from wet ecosystems can grow significantly with climate warming and the inclusion of feedbacks between the climate and the methane cycle.

The annual-mean surface air temperature is expected to increase by 3–5 °C in Siberian region by the end of the 21st century. The largest increase of precipitation rate is expected in winter for all river basins especially in the northeastern part of Eurasia. It can result in changes in the thermal and hydrological regime of soil.

Methane emissions from wetlands were calculated using the model, which takes into account the soil temperature and moisture content and the amount of carbon substrate in soil for the methane production (Denisov et al. 2015). It has been complemented with wetland area calculation scheme based on TOPMODEL (Beven et al., 1979). Main thermophysical characteristics of high latitude soils are obtained using a numerical scheme of heat and moisture transfer in the atmosphere-underlying surface-soil accounting for dynamics of frozen and thaw layers boundaries with water phase changes (Arzhanov et al. 2008, Arzhanov et al. 2012).

An ensemble of 45 realizations of the multi-year data of meteorological variables at the land surface, calculated by the ECHAM5 for different initial and identical boundary conditions for a 34-year period (from 1.01.1979 to 31.12.2012) was specified as space-distributed input data. The initial conditions (the state of the atmosphere for January 1, 1979) were specified as instantaneous atmospheric conditions at various 12 hour intervals in December 1978.

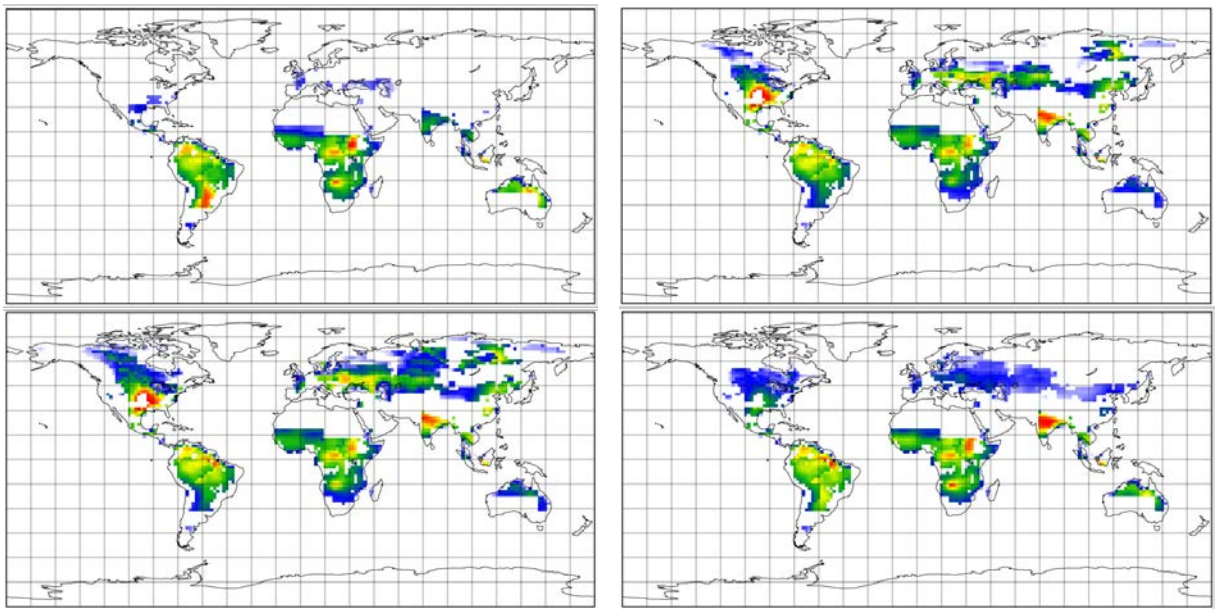

Fig.1 Global methane emissions for January, June, August and October

The ensemble average of annual emissions from Western Siberia over the estimated period equals to 3.8 TgCH4 (uncertainty index is 10%). The highest methane flux estimations (more than 2 TgCH4) were obtained for August-September (Fig. 1). The trend of emissions is about 0.02 TgCH4/yr. Total annual emissions in individual years may differ by a factor of more than 3 between different realizations of the model. For individual months, the uncertainty index of emission mean values is 7-35%, and it is minimal for months with maximal emissions. It is concluded that the uncertainty of methane emission mean values due to climatic noise decreases with the growth of the averaging time interval. The uncertainty of the estimates for the emission mean values on the monthly scale has a pronounced seasonal variability. The uncertainty index of the standard deviation estimates for both annual and monthly emission values is 25-26% and has negligible seasonal variability.

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