Sensitivity of methane emissions from wetlands to atmospheric impact in permafrost-covered regions

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Model of methane emissions from wetlands [1] is implemented to the dynamic model of thermo- and hydrological processes in soil [2]. Simulations with the combined model are performed for the 21st century forced by atmospheric impact from the ensemble of climate models: ECHAM5/MPI-OM, CCCMA-CGCM3, GISS-AOM, IPSL-CM4, and INM CM3.

Simulations are analyzed for the region 65-70°N, 150-160°E in Eastern Siberia. Simulated thaw depths for that region rise by 0.4 m during the 21st century (Fig.1a). On average, simulated methane emissions E_{CH4} for that region increase from 1000 $mgCH_4/m^2/yr$ for the early 21st century to 2000 $mgCH_4/m^2/yr$ to the end of the century (Fig.1b). According to observational estimates [3], E_{CH4} equals to 250 $mgCH_4/m^2/yr$ for that region. In the climate model of intermediate complexity of the A.M. Obukhov Institute of Atmospheric Physics RAS (IAP RAS CM), methane emissions for the analyzed region increase from 120 to 930 $mgCH_4/m^2/yr$ during the 21st century [4]. Estimations of methane emissions obtained for ensemble of models show notable scatter, intermodal differences may be as large as 6000 $mgCH_4/m^2$.

To assess the sensitivity of combined model to input parameters a set of average parameters was constructed for selected site (65°N, 155°E). Simulations of methane emissions are performed for this site with climate forcing from the ensemble of models along with mean model forcing (Fig. 2). Also multiple simulations were made with the input from this “mean” model, when one of input variables is replaced with the same variable from one of the climate models (Table 1). It appears that the combined soil-methane emission model is most sensitive to the temperature at the surface.

This work was supported by the Russian Foundation for Basic Research, by the programs of the Russian Academy of Sciences, and by the Russian President scientific grant.

References

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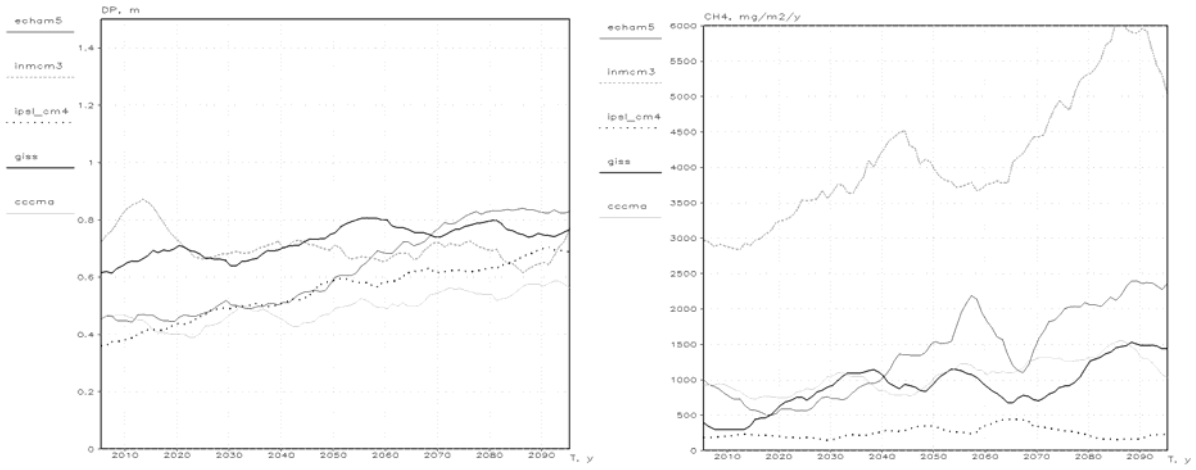

a) b)

Figure 1: Thaw depths (a) and methane emissions (b) for the Eastern Siberia region (10-year moving average).

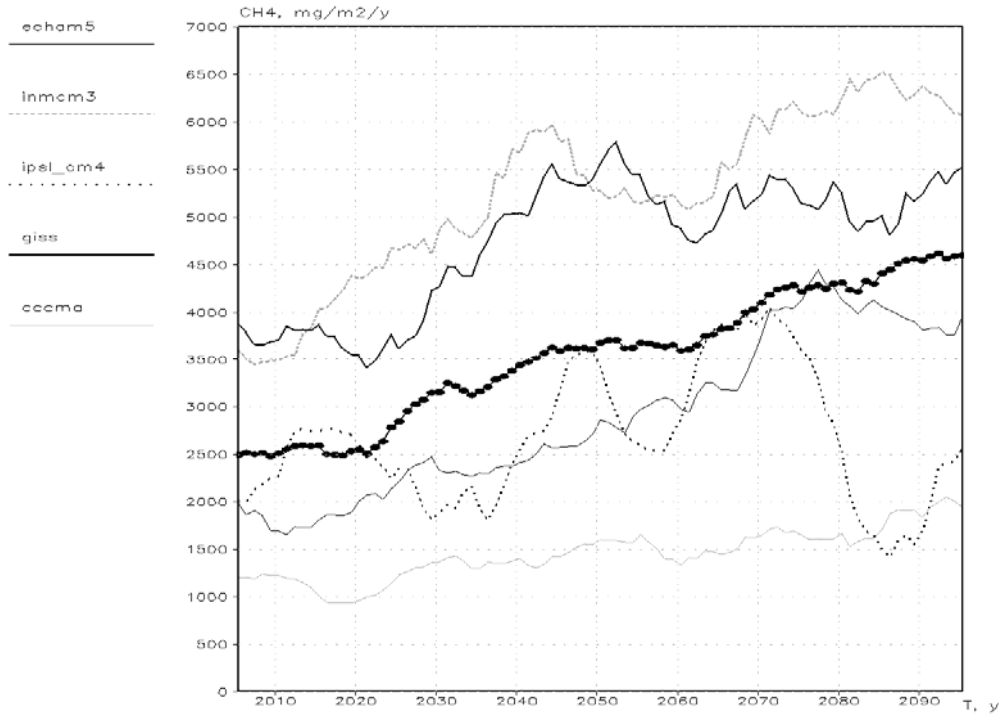

Figure 2: Methane emissions (10-year moving average) for the selected site (line with marks for “mean” model).

	CCCMA-CGCM3	ECHAM5/MPI-OM	GISS-AOM	INM CM3	IPSL-CM4
Cloudiness	0.7	0.7	0.3	0.5	-5.3
Precipitation	0.4	0.8	-0.4	-0.3	1.9
Humidity	0.6	0.4	1.0	0.5	-5.6
Shortwave radiation	0.4	0.0	0.4	0.1	-0.2
Temperature	28.4	36.2	18.1	29.8	-18.7

Table 1: Ratio of difference between average emissions of methane over 100 years (in %) to difference between the input from the “mean” model and from one of the climatic models (in %).