Выводы.

Развитие сети инструментального климатического мониторинга наземных экосистем в условиях разных биоклиматических зонах позволяет оценить общие и локальные закономерности климатических условий в районе исследований. Достоверность и высокая периодичность регистрации инструментальных данных для всех измерительных систем позволит использовать, получаемые результаты в ходе комплексного анализа процессов газообмена, в экосистемах среднетаежной подзоны приенисейской Сибири, как на региональном, так и на локальном уроне.

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METHANE EMISSION FROM KHANTY-MANSIYSK AND SURGUT LANDFILLS

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Municipal solid waste (MSW) landfills are important anthropogenic sources of CH_4, important greenhouse gas. Since organic matter decomposition in solid waste lasts for decades, landfills emit methane over a long period. It is predicted, that from 2005 to 2030 methane emission from MSW landfills will increase at 21% (EPA, 2011).

The goal of the research was to study methane fluxes at two MSW landfills in Khanty-Mansiysk Autonomous region (KMAO), West Siberia. Because methane fluxes at landfills are of highly heterogeneous (Czepiel et al., 1996; Bogner et al., 1997), micrometeorological method based on inverse modelling was used for estimating CH_4 emission.

KMAO occupies the area of 53.48 Mha or 3% of Russia; landfill area in KMAO is 441.7 ha. In August 2015, five series of the methane flux measurements were made: three series at the landfill near Surgut city (S1 – two series, S2) and two series (KM1, KM2) at the landfill near Khanty-Mansiysk city. Methane fluxes were calculated using inverse modelling method as it was described at (Glagolev and Sabrekov, 2012). However, horizontal diffusion and convection were considered besides the vertical component of turbulent transport and non-steady state concentration term. Turbulent diffusion coefficient and horizontal component of wind speed were calculated as in (Zilitinkevich, 1970) using universal functions from (Högström, 1996) corrected for stable stratification according to (Handorf et al., 1999). Horizontal turbulent diffusion coefficient was calculated within the framework of «calculating viscosity» by Phedorenko (1994). In addition, weights were not used for different time intervals. Geometry of studied area was taken from Google Earth high-resolution images. Algorithm written on Fortran90 was used for solution of direct and inverse problem; finite difference method (implicit upwind scheme) with a split in different directions with further using of tridiagonal adjustment algorithm (Phedorenko, 1994). For conservativeness of differencing scheme its coefficients was specified as by Kalitkin (1978). Searching of minimal sum of squared residuals for difference between observed and predicted methane concentration was performed using gradient descent algorithm (Khimmelblau et al., 1973).

Meteotower consisted of a pole with three thermologgers at 1.6, 3.2 and 5.9 m height (nine thermologgers in total) and gas sampling pipes at 2.3 and 5.9 m height under the soil surface. Wind speed of 1 Hz frequency was measured by ultrasonic anemometer WindSonic Option 1 ("Gill Instruments", UK) at 2.2 m height. Received data were averaged for 5 min intervals. Gas was sampled every 15-30 min.

Measured methane flux values ranged from 0.3 to 5.8 $gCH_4/m^2/h$. The highest emission of 5.8±0.3 $mgCH_4/m^2/h$ was obtained at the polygon KM2 that was currently used for waste disposal and was not covered by a soil layer. Slightly lower fluxes were measured at the large closed polygon S2 that was covered by 30 cm soil layer and had the size of about 280 x 100 x 30 m. Middle emissions were observed at the polygon S1 that was covered by soil layer and had the size of 400 x 150 x 30 m. Besides, the polygon was equipped by aeration pipes (1 pipe for 500 m^2) and vegetated; these factors intensified methane oxidation decreasing methane emission. Lowest fluxes of 0.3±0.1 $mgCH_4/m^2/h$ was found at the closed polygon «KM1» that was covered by soil, vegetation and had the smallest size of about 80 x 40 x 5 m.

Overall, received fluxes were orders of magnitude higher than observed in taiga wetlands, the main natural methane source in West Siberia (Glagolev et al., 2011). Data upscaling gave the regional methane flux of 0.1 $MtCH_4/yr$ from all KMAO landfills, which accounts for 10% of total emission from middle taiga wetlands.