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An integrated approach for estimation of methane emissions from wetlands and lakes in high latitude regions

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In recent years, there has been increasing evidence of significant alteration in the extent of lakes and wetlands in high latitude regions due in part to thawing permafrost, as well as other changes governing surface and subsurface hydrology. Methane is a 23 times more efficient greenhouse gas than carbon dioxide; changes in surface water extent, and the associated subsurface anaerobic conditions, are important controls on methane emissions in high latitude regions. Methane emissions from wetlands vary substantially in both time and space, and are influenced by plant growth, soil organic matter decomposition, methanogenesis, and methane oxidation controlled by soil temperature, water table level and net primary productivity (NPP). The understanding of spatial and temporal heterogeneity of surface saturation, thermal regime and carbon substrate in northern Eurasian wetlands from point measurements are limited. In order to better estimate the magnitude and variability of methane emissions from northern lakes and wetlands, we present an integrated assessment approach based on remote sensing image classification, land surface modeling and process-based ecosystem modeling. Wetlands classifications based on L-band JERS-1 SAR (100m) and ALOS PALSAR (~30m) are used together with topographic information to parameterize a lake and wetland algorithm in the Variable Infiltration Capacity (VIC) land surface model at 25 km resolution. The enhanced VIC algorithm allows subsurface moisture exchange between surface water and wetlands and includes a sub-grid parameterization of water table position within the wetland area using a generalized topographic index. Average methane emissions are simulated by using the Walter and Heimann methane emission model based on temporally and spatially varying soil temperature, net primary productivity and water table generated from the modified VIC model. Our five preliminary study areas include the Z. Dvina, Upper Volga, Yeloguy, Syum, and Chaya river basins. The temporally-variable inundation extent simulated by the VIC model is compared to 25 km resolution inundation products developed from combined QuikSCAT, AMSR-E and MODIS data sets covering the time period from 2002 onward. The seasonal variation in methane emissions associated with sub-grid variability in water table extent is explored between 1948 and 2006.

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