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Modeling methane emissions from Arctic lakes under warming conditions

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To investigate the response of methane emissions from arctic lakes, a process-based climate-sensitive lake methane model is developed. The processes of methane production, oxidation and transport are modeled within a one-dimensional water and sediment column. Dynamics of point-source ebullition seeps are explicitly modeled. The model was calibrated and verified using observational data in the region. The model was further used to estimate the lake methane emissions from the Arctic from 2002 to 2004. We estimate that the total amount of methane emissions is 24.9 Tg CH_4 yr^{-1}, which is consistent with a recent estimation of 24$\pm$10 Tg CH_4 yr^{-1} and two-fold of methane emissions from natural wetlands in the north of 60 ^{o}N. The methane emission rate of lakes spatially varies over high latitudes from 170.5 mg CH_4 m^{-2} day^{-1} in northern Siberia to only 10.1 mg CH_4 m^{-2} day^{-1} in northern Europe. A projection assuming 2-7.5^{o}C warming and 15-25% expansion of lake coverage shows that the total amount of methane emitted from Arctic lakes will increase to 29.8-35.6 Tg CH_4 yr^{-1}.