Evaluation of two process-based models used to estimate global CH4 emissions from natural wetlands

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Reliable models are required to estimate global wetland CH4 emissions. This study aimed to test two process-based models, CH4MOD\textsubscript{wetland} and TEM, against the CH4 flux measurements of marsh, swamps, peatland and coastal wetland sites across the world; specifically, model accuracy and generality were evaluated for different wetland types and in different continents, and then the global CH4 emissions from 2000 to 2010 were estimated. Both models showed similar high correlations with the observed seasonal CH4 emissions, and the regression of the observed versus computed total seasonal CH4 emissions resulted in R\textsuperscript{2} values of 0.78 and 0.72 by CH4MOD\textsubscript{wetland} and TEM, respectively. The CH4MOD\textsubscript{wetland} predicted more accurately in marsh, peatland and coastal wetlands, with model efficiency (EF) values of 0.22, 0.55 and 0.72, respectively; however, the model showed poor performance in swamps (EF<0). The TEM model predicted better in peatland and swamp, with EF values of 0.77 and 0.71, respectively, but it could not accurately simulate the marsh and coastal wetland (EF<0). There was a good correlation between the simulated CH4 fluxes and the observed values on most continents. However, CH4MOD\textsubscript{wetland} showed no correlation with the observed values in South America and Africa. TEM showed no correlation with the observations in Europe. The global CH4 emissions for the period 2000–2010 were estimated to be 105.31±2.72 Tg yr\textsuperscript{-1} by CH4MOD\textsubscript{wetland} and 134.31±0.84 Tg yr\textsuperscript{-1} by TEM. Both models simulated a similar spatial distribution of CH4 emissions across the world and among continents. Marsh contributes 36%–39% to global CH4 emissions. Lakes and rivers and swamp are the second and third contributors, respectively. Other wetland types account for only approximately 20% of global emissions. Based on the models’ generality, if we use the more accurate model to estimate each continent/wetland type, we obtain a new assessment of 116.99–124.74 Tg yr\textsuperscript{-1} for the global CH4 emissions for the period 2000–2010.