(1) CH4MOD – a process-based model for simulation of CH_4 emissions from natural/ managed wetlands

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(3) Available modes for the model runs: Operational

(4) Components & processes: Atmosphere, Biosphere & Physical, Chemical, Biological
-> linking to impact assessment

(5) Brief model description

CH4MOD was developed to predict methane fluxes from rice paddy soils. The model associated this process with rice growth, organic C depletion and environmental factors (Huang et al., 1998; 2004). The model's input parameters included the rice grain yield, the soil sand percentage, the amount of organic amendment, the water management pattern, and the daily air temperature. The outputs are the daily and annual rates of CH_4 production and emissions. The model was validated against a total of 94 field observations that covered the main rice cultivation regions from northern (Beijing, 40º30'N, 116º25'E) to southern (Guangzhou, 23º08'N, 113º20'E) China and from eastern (Hangzhou, 30º19'N, 120º12'E) to southwestern (Tuzu, 29º40'N, 103º50'E) China. This model can reasonably simulate CH_4 flux from irrigated rice fields (Huang et al., 2004). The CH4MODwetland (Li et al., 2010) describes the processes of CH_4 production, oxidation and transportation. It was modified from CH4MOD, which was used to simulate CH_4 emissions from rice paddies (Huang et al., 1998), after attentively considering the differences between rice paddies and natural wetlands. The wetland plants will not be harvested as in rice paddies. So, the decomposition of plant litter is part of the methanogenic substrates for methanogens. In addition, there is thick sod layer which contains great amounts of organic matter that can supply the substrates to methanogens. Moreover, in natural wetlands, the variation of soil redox potential is controlled by the natural variation in water table depth. And finally, the effect of salinity on CH_4 emissions is also considered in the coastal wetlands. We adopted the linear relationship between salinity and log-transformed CH_4 (Poffenbarger et al. 2011) to describe the influence of salinity on CH_4 emissions (Li et al., 2016a). In this model, the CH_4 production was determined by the methanogenic substrates as well as the environmental factors. The methanogenic substrates come from three sources: the root exudate, plant litter and organic soil matter. The environmental factors include the soil temperature, soil redox potential and soil texture. The model includes a sub module for simulating plant growth. The plant phenology data (date of germination, date of achieving maximum biomass and date of death) were determined by the accumulated temperature. CH_4 is emitted from the soil to the atmosphere via plant transportation, ebullition and diffusion. CH_4 oxidation occurs during the plant transportation and diffusion processes. The model inputs include the environmental data (daily air or soil temperature, the daily water depth and the daily soil salinity for the coastal wetlands), soil data (soil sand fraction, soil organic matter and soil bulk density) and data related with the plant (e.g., NPP). The model outputs estimated daily CH_4 emissions. Additional details on the CH4MODwetland model have been described in previous studies (Li et al., 2010., 2012). This model has been used to simulate CH_4 emissions from Chinese wetlands (Li et al., 2015; 2017) as well as Finland peatlands (Li et al., 2016b).

Key references:

Huang Y, Zhang W, Zheng X, Li J, and Yu Y, 2004. Modeling methane emission from rice paddies with various agricultural practices. Journal of Geophysical Research 109: D08113.

Li T, Huang Y, Zhang W, Song C, 2010. CH4MODwetland: A biogeophysical model for simulating methane emissions from natural wetlands. Ecological Modelling 221: 666–680.

Li T, Huang Y, Zhang W, Yu Y, 2012. Methane emissions associated with the conversion of marshland to cropland and climate change on the Sanjiang Plain of northeast China from 1950 to 2100. Biogeosciences 9: 5199-5215.

Li, T., Zhang W., Zhang Q., Lu Y., Wang G, Niu Z, Raivonen M, Vesala T. 2015. Impacts of climate and reclamation on temporal variations in CH_4 emissions from different wetlands in China: from 1950 to 2010. Biogeosciences 12: 6853-6868.

Li T, Raivonen M, Alekseychik P, Aurela M, Lohila A, Zheng X, Zhang Q, Wang G, Mammarella I, Rinne J, Yu L, Xie B, Vesala T, Zhang W, 2016. Importance of vegetation classes in modeling CH_4 emissions from boreal and subarctic wetlands in Finland. Science of the Total Environment 572: 1111-1122.

Li T, Xie B, Wang G, Zhang W, Zhang Q, Vesala T, Raivonen M, 2016. Field-scale simulation of methane emissions from coastal wetlands in China using an improved version of CH4MODwetland. Science of the Total Environment 559: 256-267.

Li T, Zhang Q, Cheng Z, Wang G, Lu Y, Zhang W, 2017. Performance of CH4MOD wetland for the case study of different regions of natural Chinese wetland. Journal of Environmental Sciences 57: 356-369.

Li T, Li H, Zhang Q, Ma Z, Yu L, Lu Y, et al. (2019): Prediction of CH4 emissions from potential natural wetlands on the Tibetan Plateau during the 21st century. Science of The Total Environment 2019; 657: 498-508.