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Modelling methane ebullition from sub-tropical peat reveals the importance of pore structure

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Methane (CH4) is a greenhouse gas with a global warming potential much greater than carbon dioxide, and one of the major sources of naturally occurring CH4 are peatlands. Large amounts of CH4 can be transported from peat to the atmosphere through bubbles (ebullition). Sources of CH4 from tropical/subtropical peats may have an important role in mediating the Earth's climate and predicting present and future bubble emissions from these peat soils is necessary. Numerical modeling offers the possibility to quantitatively investigate ebullition, and much progress has been made in predicting bubble dynamics using modeling approaches with various levels of physical rigour and process complexity. Here in this study we present a simple model that is able to reproduce the process of CH4 bubble loss from peat. The model includes a spatially-explicit representation of the peat pore structure and replicates bubble accumulation, storage, and release within peat. In this study the model of ebullition was setup to replicate field scale datasets collected using hydrogeophysical methods describing observed CH4 accumulation and ebullition from subtropical peat soils in the Florida Everglades, USA. This study demonstrates: 1) the predictive potential of numerical modelling to describe biogenic gas dynamics in peat soils; 2) the importance of combining modelling with "real" datasets; and 3) the importance of peat structure as a control for gas storage and subsequent ebullition.