The influence of temperature-dependent methanogenesis on basin-scale methane emissions from the western Black Sea

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In our study, we use a large-scale 3D basin model of the western Black Sea to quantify the amounts and rates of biogenic and thermogenic methane fluxes within the sediments as well as the seafloor methane emissions. The model construction is based on over one hundred interpreted seismic horizons repopulated with more than forty sedimentary layers of complex lithological and facies distribution. The deepest and the oldest central part of the basin (98 Ma) is located at the depth of about seventeen kilometres. Well known organic-rich Oligocene-Early Miocene Maykopian facies provide high petroleum potential to form thermogenic methane. However, our results show that due to mostly premature state of these Maykopian source rocks, the majority of methane generated in the Black Sea basin manifests its clear biogenic origin. To investigate in detail the potential variability of generated biogenic methane amounts, we have performed multiple numerical simulations using various temperature-dependent kinetic rates of organic matter degradation. Precisely, we tested numerous temperature limits of microbial methanogenesis ranging from 40 to 120 deg. C. On a basin-scale, it lead to significant differences in methane generation, migration and capture in a form of natural gas hydrate deposits. Our results highlight the importance of spatio-temporal temperature changes on microbial communities and their abilities to produce light hydrocarbon components throughout the basin history.