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Response of subsea permafrost and associated methane hydrates to Pleistocene glacial cycles

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Climate warming may lead to the degradation of the subsea permafrost developed during Pleistocene glaciations and release methane from the hydrates, which are stored in this permafrost. In the present paper the one–dimensional single–point simulations with a model for thermal state of subsea sediments driven by the forcing constructed from the ice core data are performed. The model was forced by idealised forcing constructed from changes in sea level and temperature of high latitudes constructed from the Vostok ice core data.
We found that the time scale of the response of heat penetration in the within the subsea sediments and, thus, of the response of the shelf permafrost to imposed temperature changes at the ocean–sediment interface is about 10–20 kyr. The obtained time scale of temperature signal propagation in the sediments is longer than the present interglacial, the Holocene. It supports the view that the present–day changes in the thermal state of the subsea sediments may be related to the adjustments to the last glacial cycle termination rather than to the contemporary, century–scale climate warming, at least at large depth within the sediments.
The timings of shelf exposure during oceanic regressions and flooding during transgressions are important for representation of sediment thermal state and hydrates stability zone (HSZ). These timings should depend on the contemporary shelf depth. During glacial cycles temperature at the top of sediments is a major driver of HSZ vertical boundaries change for any shelf depth. The pressure exerted by oceanic water becomes also important for shelf depth more than 50 m. Thus, even the existence of HSZ and its disappearance might not be easily tied to oceanic transgressions and regressions.