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Arctic greenhouse-gas storage and release modulated by late-glacial ice sheet fluctuations

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The subglacial footprint of the Barents Sea Ice sheet which advanced across northern Eurasia from 26 to 22 ka BP had a major impact on the underlying gas hydrate stability zone (GHSZ) leading to storage of methane and other hydrocarbons. With the onset of deglaciation, these hydrocarbon rich hydrates dissociated, releasing potent greenhouse gas into the ocean and possibly atmosphere over a period of thousands of years. We present a wide-range of observational data acquired from offshore western Svalbard and the Barents Sea to robustly constrain a coupled model of the subglacial evolution of gas hydrate reservoirs during and after the Last Glacial Maximum (LGM). Our results indicate that even under minimum ice thickness reconstructions, an extensive, ∼500-meter thick GHSZ existed beneath the ice sheet in our study area offshore of western Svalbard (Portnov et al., 2016). An offshore corridor of methane release did though also persist throughout maximum ice conditions on the upper continental margin. Throughout the LGM a marine ice sheet directly comparable to those of Greenland and Antarctica today inundated the continental margin offshore of western Svalbard and the vast shelf areas of the Barents Sea. However, with climatic amelioration the Barents Sea ice sheet experienced a 4ka period of dynamic retreat with concurrent flooding of the shelf by rising sea levels, which provided a high magnitude perturbation to the substrate pressure and temperature domains. By analogy, the future response of Polar ice sheets is an emerging concern as their ongoing thinning and retreat will likewise perturb the present day subglacial GHSZ leading to potential widespread gas hydrate destabilisation and release.

Portnov, Alexey, et al. “Ice-sheet-driven methane storage and release in the Arctic”, Nature Comm. DOI: 10.1038/ncomms10314. (2016).