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The impact of increased sedimentation rates associated with the decay of the Fennoscandian ice-sheet on gas hydrate stability and focused fluid flow at the Nyegga pockmark field, offshore mid-Norway

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Climatic changes since the Last Glacial Maximum (LGM) have affected the stability of gas hydrate systems on glaciated margins by sea-level changes, bottom water temperature changes, isostatic uplift or subsidence and variability in sedimentation rates. While subsidence and sea-level rise stabilize gas hydrate deposits, bottom water temperature warming, uplift and enhanced sedimentation have the opposite effect. The response of gas hydrate systems to post-glaciation warming is therefore a complex phenomenon and highly depends on the timing and magnitude of each of these processes. While the impact of bottom water warming on the dissociation of gas hydrates have been addressed in numerous studies, the potential of methane release due to basal gas hydrate dissociation during periods of warming has received less attention. Here, we present results from numerical simulations which show that rapid sedimentation associated with the decay of the Fennoscandian ice-sheet was capable of causing significant basal gas hydrate dissociation. The modeling is constrained by a high-resolution three-dimensional sedimentation rate reconstruction of the Nyegga pockmark field, offshore mid-Norway, obtained by integrating chrono-stratigraphic information derived from sediments cores and a seismo-stratigraphic framework. The model run covers the period between 28,000 and 15,000 calendar years before present and predict that the maximum sedimentation rate-related gas hydrate dissociation coincides temporally and spatially with enhanced focused fluid flow activity in the study area. Basal gas hydrate dissociation due to rapid sedimentation may have occurred as well in other glaciated continental margins after the LGM and may have caused the release of significant amounts of methane to the hydrosphere and atmosphere. The major post glaciation deposition centers are the location of some of the largest known submarine slide complexes. The release of free gas due to basal gas hydrate dissociation has the potential to destabilize the continental slopes by focused fluid migration and the transfer of overpressure.