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Constraining the global distribution and amount of methane hydrates in marine sediments

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In the past decades several estimates of the global inventory of gas hydrate have been published, ranging over several orders of magnitude and thus, the total amount of methane stored in gas hydrates is still poorly constrained. Here, we present new global estimates by applying a recently published transfer function that calculates the amount of gas hydrate from methane produced in situ through organic matter degradation (Marquardt et al., 2010). The transfer function was derived from a large set of systematic runs of a numerical diagenetic model (Wallmann et al., 2006) covering a wide range of environmental conditions that are typical for continental margins. As a result, the transfer function could be reduced to two independent variables: the accumulation rate of particulate organic carbon and the thickness of the gas hydrate stability zone (GHSZ). We tested various approaches to calculate both parameters on the global scale. The global grids used include seafloor bathymetry, TOC input, organic carbon rain rate, bottom water temperature, geothermal gradient estimated from heat flow, sediment thickness, and age of the oceanic crust. The results obtained lead to the conclusion that only minor amounts of gas hydrates (15 Gt of C) are formed by in situ methane production within the GHSZ. Since it is known that a significant amount of methane is transported into the GHSZ from below, an extended function considering fluid flow was developed applying the same transport-reaction model. The resulting global distribution map estimates a total inventory of gas hydrate ranging from 3,500 to 16,500 Gt of C. Our calculations are slightly higher than previously published results (e.g. Archer et al., 2009) and also suggest that less than 1 % of the global gas hydrate budget forms from an autochthonous source of methane. The results presented here suggest that where gas does not migrate into the GHSZ only negligible concentrations of gas hydrate accumulate.

References

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