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Monitoring of temporally and spatially transient bubble release and the spatial extrapolation of methane fluxes: Use of hydroacoustic methods in the Black Sea

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Particularly free gas fluxes at seeps are transient in time and space, triggered by external forces (wind, tides) as well as internal properties, e.g. gas reservoir sizes or gas supply from deeper sediment horizons. In 2003 and 2004, multibeam and single beam surveys and the deployment of the hydroacoustic lander system GasQuant were carried out in an active seep area west of the Crimea Peninsula within the CRIMEA project. Multibeam data (bathymetry and backscatter mapping) and single beam data (bubble seep localization) were used for mapping the seep distribution and for determining the relation of seeps/m2 and backscatter values. Backscatter data are used to quantify the amount of active seeps in the entire mapped area based on the full coverage backscatter maps derived from the multibeam survey. Flux measurements using the submersible JAGO yielded very accurate single spot fluxes but do not provide information about the temporal variability of bubble release. To analyse this, the GasQuant lander was deployed. The data gained show that by far the majority of bubble releasing seeps is only active for less than 10% of the time. Distinct release patterns could be observed, varying from frequent and periodic releases to sporadic and periodic, to erratic or single bursts. These patterns are sometimes related to the filling and emptying of small gas reservoirs, e.g. underneath bacteria mats or carbonate slabs triggering periodic bubble release on a minute basis). Tidal cycles were not observed as the Black Sea does not have prominent sea level changes ($<$ 20cm). Using the average bubble release activity (only 12% of the time) together with the directly

measured fluxes (0.24 to 0.63 mmol/s), the total number of seeps in the study area (2709), and correcting this flux with the mean activity measured by GasQuant results in a methane flux of 14043 mol/d (224kg of C). To estimate the maximum amount of methane that could be transported to the sea surface, we applied a bubble dissolution model (McGinnes at al., JGR 2006). Based on the initial bubble size distribution (mean 6.5mm in diameter) we can estimate that only 1% of the ascending methane will reach the sea surface (140 mol/d or 2.24kg of C). This flux is in very good agreement with geochemically measured sea surface fluxes by Schmale et al. (GRL 2005). However, compared to other methane sources as e.g. sheep, each of which burps out about 20g of methane per day, the studied seep site, which has been classified as highly active, is negligible as a methane source compared to e.g. the about 40,000,000 sheep that discharge methane in New Zealand alone.