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Influence of submerged peat deposits on methane production in shallow coastal regions by submarine groundwater discharge - controlled carbon release

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Through frequent inundation, erosion and solution processes, sea level rise, which is considered to be one of the main impacts of climate change, alters areal extensions of coastal peatlands. Coastline retreat shifts adjacent ecosystems and results in the submergence of terrestrial, organic carbon rich peat sediments in the sea. The coastal peatland Heiligensee and Hütelmoor near Rostock-Warnemünde is a very unique ecosystem due to its strong connection with the Baltic Sea. Using sediment cores and shallow geo-acoustic surveys, we found Holocene peat deposits (Corg of 37-53%, ^{14}C-dated to 6725 $\pm$ 87 cal yr BP) to continue more than 90 m (areal extend: 0.16-0.2 km^2) offshore from the recent peatland (Kreuzburg et al., 2018, doi: 10.3389/feart.2018.00103). The location of outcropping peat deposits coincides with temperature, salinity and bottom water methane anomalies (CH_4 = 42.4 $\pm$ 12.9 nmol L^{-1}) most likely originating from submarine groundwater discharge.
Motivated by these findings in the field, we investigated the release of peat-derived dissolved organic carbon (DOC) and biogeochemical processes that govern carbon transformations by a 50-day column experiment, simulating alternating episodes of brackish water (S $\sim$16) intrusion and seepage of anoxic, low-saline groundwater. Results imply that discharge of low-saline groundwater through the peat soils significantly increased the release of DOC, with the source confirmed by ^{13}CDOC signatures of -26.9 to -27.7 ‰Ẇe further observed that the concentrations of DOC correlate positively with dissolved inorganic carbon (DIC), suggesting rapid organic matter mineralization. In contrast, oxygenated brackish water intrusions show a contrary effect with decreasing DOC and DIC concentrations in the pore water and significantly lower CH_4 and CO_2 emissions. These, to date unmonitored dynamics, reveal a potential source of CO_2 and CH_4 from coastal sediments with submerged peat, and show that the production and release of carbon is significantly dependent on the flow regime and on the sediment characteristics.