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Importance of intertidal sediment processes and porewater exchange on the water column biogeochemistry in a pristine mangrove creek (Ras Dege, Tanzania)

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We conducted tidal sampling in a tidal creek (Ras Dege, Tanzania) to document the variations in a suite of creek water column characteristics and to determine the relative influence of tidal and biological driving forces. Since the creek has no upstream freshwater inputs, highest salinity was observed at low tide, due to evaporation effects and porewater seepage. Total suspended matter (TSM) and particulate organic carbon (POC) showed distinct maxima at periods of highest water flow, indicating that erosion of surface sediments and/or resuspension of bottom sediments were an important source of particulate material. Dissolved organic carbon (DOC), in contrast, followed the tidal variations and was highest at low tide. Stable isotope data of POC and DOC exhibit large variations in both pools, and followed tidal variations. Although the variation of $\delta^{13}C_{DOC}$ (-23.8 to -13.8 per mil) was higher than that of $\delta^{13}C_{POC}$ (-26.2 to -20.5 per mil) due to the different end-member pool sizes, the $\delta^{13}C$ signatures of both pools differed only slightly at low tide, but up to 9 per mil at high tide. Thus, at low tide both DOC and POC originated from mangrove production. At high tide, on the other hand, the DOC pool had signatures consistent with a high contribution of seagrass-derived material, whereas the POC pool was dominated by marine phytoplankton. Daily variations in CH_4, and partial pressure of CO_2(pCO_2) were similarly

governed by tidal influence and were up to 7- and 10-fold higher at low tide, which stresses the importance of exchange of porewater and diffusive fluxes to the water column. Furthermore, this illustrates that constraining an ecosystem-level budget of these greenhouse gases in tidal systems requires a careful appraisal of tidal variations. When assuming that the high dissolved inorganic carbon (DIC) levels in the upper parts of the creek (i.e. at low tide) are due to inputs from mineralization, δ^{13}C data on DIC indicate that the source of the mineralized organic matter has a signature of -22.4 per mil, which shows that imported POC and DOC from the marine environment contributes strongly to overall mineralization within the mangrove system. Our data show a striking example of how biogeochemical processes in the intertidal zone appear to be prominent drivers of element concentrations and isotope signatures in the water column, and how pathways of dissolved and particulate matter exchange are fundamentally different. The estimated export of DIC through porewater exchange appears considerably larger than for DOC, suggesting that if this mechanism is indeed a major driver of solute exchange, benthic mineralization and subsequent export as DIC could represent a very significant and previously unaccounted fate of mangrove-derived C. Budgeting efforts should therefore pay attention to understanding the mechanisms and quantification of different pathways of exchange within and between both zones.