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Upscaling small-scale spatial and temporal changes in microphytobenthos biomass for large-scale primary production estimates

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Abstract

Estuaries are productive and highly diverse ecosystems. Primary production of microphytobenthos (MPB), microalgae that form dense biofilms in the top layers of intertidal sediments, contributes greatly to this productivity and as such, sustains whole coastal food webs.

Surprisingly, relatively little is known about the magnitude of microphytobenthos productivity at the ecosystem scale. This is mainly due to difficulties in monitoring MPB in dynamic and often inaccessible tidal environments. The last decades, remote sensing has emerged as an important tool for upscaling field biomass measurements, with the Normalized Differential Vegetation Index (NDVI) commonly used as a proxy of MPB biomass. However, linking images to primary production remains challenging.

Modeling MPB productivity from surface biomass requires precise knowledge about the vertical distribution of the MPB in the upper, illuminated layers of the sediment (photic zone). This vertical distribution can vary greatly between MPB communities and sediment types. To date however, information about the vertical biomass distribution cannot be obtained from remote sensing images.

We aim to develop a calculation tool incorporating the vertical biomass distribution of different MPB communities into benthic primary production estimations. To this end, we developed a novel, rapid, high-resolution measuring technique based on hyperspectral imaging to visualize both the top surface and the vertical NDVI profiles of MPB biofilm in intertidal sediment. The technique was used to study vertical profiles of two MPB communities in the Scheldt estuary: one euglenid dominated and one diatom dominated biofilm. The results were then implemented in a primary production model to study the effect of differences in vertical profiles on primary production estimates.

Using hyperspectral imaging enables resolving MPB biomass distribution much more rapidly than currently used techniques based on core sectioning and pigment analyses. Furthermore, model simulation show that differences in vertical biomass profile can greatly influence MPB primary production.

Keywords

Primary production, Microphytobenthos, Remote sensing, Modelling