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Novel developments in benthic modelling to address scientific and policy challenges

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Understanding the role of benthic systems in supporting, regulating and providing marine ecosystem services requires better understanding of their functioning and their response and resilience to stressors. Novel observational methods for the investigation of dynamics of benthic-pelagic coupling in shelf seas are being developed and new data is being collected. Therefore there is an increasing demand for robust representation of benthic processes in marine biogeochemical and ecosystem models, which would improve our understanding of whole systems and benthic-pelagic coupling, rather than act as mere closure terms for pelagic models. However, for several decades development of benthic models has lagged behind their pelagic counterparts.

To address contemporary scientific, policy and societal challenges, the biogeochemical and ecological model ERSEM (European Regional Seas Ecosystem Model), including its benthic sub-model, was recently recoded in a scalable and modular format adopting the approach of FABM (Framework for Aquatic Biogeochemical Models). Within the Shelf Sea Biogeochemistry research programme, a series of additional processes have been included, such as a sedimentary carbonate system, a resuspendable fluff layer, and the simulation of advective sediments. It was shown that the inclusion of these processes changes the dynamics of benthic-pelagic fluxes as well as modifying the benthic food web. Comparison of model results with in-situ data demonstrated a general improvement of model performance and highlighted the importance of the benthic system in overall ecosystem dynamics. As an example, our simulations have shown that inclusion of a resuspendable fluff layer facilitates regeneration of inorganic nutrients in the water column due to degradation of resuspended organic material by pelagic bacteria. Moreover, the composition of fluff was found to be important for trophic interactions, and therefore indirectly affects benthic community composition. Where the fluff layer contributed significantly to benthic DOC content, a large biomass of aerobic bacteria could be sustained, which in turn became available for consumption by benthic fauna dwelling near the sediment surface, whose biomass increased.

The complexity of model response confirmed the necessity of a multidisciplinary approach to model development, whereby the modelling process can inform the experimental and observational community regarding data and process study requirements, which are in turn necessary to improve model performance.