Quantifying benthic-pelagic coupling in the changing Arctic Barents Sea

F.S. FREITAS[1,2]*, J. WARD[1,2], M.A. STEVENSON[3], G.D. ABBOTT[3], S.F. HENLEY[4], J.C. FAUST[5], A.C. TESSIN[5], M. SOLAN[6], C. MÄRZ[5], K. HENDRY[1], S. ARNDT[2]

[1]University of Bristol, Bristol, BS8 1RJ, UK (*correspondence: felipe.salesdefreitas@bristol.ac.uk)
[2]Université Libre de Bruxelles, Brussels, Avenue Franklin Roosevelt 50, CP160/02 1050, Belgium
[3]Newcastle University, Newcastle upon Tyne, NE1 7RU, UK
[4]University of Edinburgh, Edinburgh, EH9 3FE, UK
[5]University of Leeds, Leeds, LS2 9JT, UK
[6]University of Southampton, Southampton, SO17 1BJ, UK

Organic matter (OM) cycling in marine sediments plays a key role connecting benthic and pelagic carbon and nutrient cycles over a range of time scales. However, we currently lack a mechanistic understanding of the processes governing carbon cycling and nutrient fluxes. The Barents Sea is subjected to large spatial and temporal variability in sea ice cover, which regulates OM dynamics. A systematic understanding of OM cycling in marine sediments is crucial to improve our ability to forecast changes associated with sea ice cover fluctuations and the impacts for the Arctic Ocean. Our aims are to investigate the benthic-pelagic coupling across the polar front and winter sea ice gradient in the Barents Sea and to quantify OM reactivity and degradation dynamics using an integrated data-model approach.

We employ the Biogeochemical Reaction Network Simulator (BRNS) to reconstruct and quantify benthic remineralisation along a 30°E S–N transect (74°N – 81°N). The model is constrained by sediment profiles of TOC and total Mn and Fe, as well as porewater measurements of NO_3, NH_4, PO_4, Mn^{2+}, and Fe^{2+} from five benthic stations sampled during a summer cruise in 2017. Our model results show that, compared to the northern ice-covered region, benthic OM remineralisation is more accentuated in the southern seasonal ice-free area of the Barents Sea, which experiences higher fluxes of labile OM to the seafloor. OM degradation pathways are dictated by OM reactivity and availability of terminal electron acceptors, as well as local benthic biological mixing. Those processes also impact Mn and Fe recycling rates along the S–N transect. Our results help to disentangle the mechanisms driving OM dynamics in Arctic sediments. This allows us to develop improved predictions of OM cycling, crucial for understanding the impacts of changes in sea ice cover experienced by the Barents Sea and other Arctic environments undergoing similar changes in ice dynamics.