Exploring the Impacts of Glacier Melting Upon Marine Ecosystems

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Abstract: Coastal waters around the globe receive an important nutrient and carbon subsidy from riverine dissolved and particulate load which helps support marine productivity. Included in this are the many large river systems fed by glacier snow and ice melt and which feature upon most continents. The physical impacts of glacial meltwater discharge on the oceans are becoming better studied, driven by a need to predict future sea level rise and future water supply for human settlements. However, the biological dimension of this freshwater export is poorly understood. A growing body of data demonstrate that glacial runoff and icebergs likely act as "fertilisers" for marine ecosystems, being rich in highly bioavailable dissolved organic matter[1], macro- and micro-nutrients, such as iron, phosphorus, nitrogen and silicon[2-5]. The high suspended particulate matter load of glacial runoff is likely to have a dual effect, adding further nutrients but creating light limiting conditions for plankton close to the shore. These impacts on downstream ecosystems are likely to intensify as glacial melt fluxes rise.

This seminar explores the relationship between glacial riverine discharge and coastal marine productivity, drawing upon field data from large glacier systems in the Polar Regions to constrain the nutrient content of glacial runoff. It goes on to present new results from global biogeochemical models which indicate the sensitivity of marine productivity to this glacial nutrient subsidy. These data demonstrate that glaciers and ice caps are vibrant ecosystems where active biogeochemical cycling results in the export of vital nutrient and organic carbon to downstream ecosystems. In an era of global climate change, and enhanced glacial runoff, it is likely that these land-ocean biogeochemical support systems will alter as glacial freshwater (and nutrient) fluxes respond to rising glacier melt rates[5].

Background: Jemma Wadham is a Professor in Glaciology at the Bristol Glaciology Centre, University of Bristol. Her current research falls into three themes: 1) Determining the role of riverine systems and wetlands in regulating global and regional biogeochemical cycles, 2) Understanding water, sediment and solute transport through large riverine catchments and their associated downstream impacts and 3) Challenging Engineering: Development and validation of in situ sensing technologies and autonomous platforms for the survey of extreme aquatic ecosystems. To date, these themes have been applied largely to Polar and Alpine environments and she has led over 25 field expeditions to these regions over her career, with most recent work on the Greenland Ice Sheet. She has been actively involved in the organisation of science in Antarctica via SCAR: The Scientific Committee on Antarctic Research.

Some pictures below: Captions (top left) – Jemma Wadham on fieldwork in the McMurdo Dry Valleys, Antarctica (supported by Antarctica New Zealand), (top right) – Jemma Wadham, (bottom) glacial meltwater streams tracking the margin of the Greenland Ice Sheet

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References:

Bhatia, M.P., Kujawinski, E.B., Das, S.B., Breier, C.F., Henderson, P.B. and Charette, M.A. (2013) Greenland meltwater as a significant and potentially bioavailable source of iron to the ocean. Nature Geoscience 6, 274-278.

Hawkings, J., Wadham, J.L., Tranter, M., Raiswell, R., Benning, L.G., Statham, P.J., Tedstone, A. and Nienow, P. (2014) Ice sheets as a significant source of highly reactive nanoparticulate iron to the oceans. Nature Communications 5, doi:10.1038/ncomms4929.

Hawkings, J.R., Wadham, J.L., Tranter, M., Lawson, E., Sole, A., Cowton, T., Tedstone, A.J., Bartholomew, I., Nienow, P., Chandler, D. and Telling, J. (2015) The effect of warming climate on nutrient and solute export from the Greenland Ice Sheet. Geochemical Perspectives Letters 1, 94-104.

Hood, E., Battin, T.J., Fellman, J., O'Neel, S. and Spencer, R.G.M. (2015) Storage and release of organic carbon from glaciers and ice sheets. Nature Geoscience 8, 91-96.

Raiswell, R., Benning, L.G., Tranter, M. and Tulaczyk, S. (2008) Bioavailable iron in the Southern Ocean: the significance of the iceberg conveyor belt. Geochemical Transactions 9, doi:10.1186/1467-4866-1189-1187.