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Physical, biogeochemical and ecological impacts of giant icebergs: a multidisciplinary study of iceberg A68 near South Georgia, Southern Ocean

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Giant icebergs can greatly impact the mass, freshwater and nutrient budgets of the ocean. They can deposit large amounts of freshwater at great distances from their origins, impacting upper-ocean stratification and mixing, and they can be important vectors for micronutrient delivery with impacts on primary production and carbon drawdown. Their impacts on advection, productivity and blocking of flows can be critical for zooplankton and regional ecosystem functioning, with consequences for higher trophic levels and local fisheries. Their breakouts from ice shelves create new opportunities for biological colonisation and carbon sinks and their collisions with the seabed (iceberg scour) can shape local and regional benthic biodiversity patterns and influence carbon sequestration.

In 2017, the A68 iceberg (around 6000 km^2) calved from the Larsen C Ice Shelf on the Antarctic Peninsula. It subsequently moved eastward and northward, crossing the Scotia Sea to move, virtually intact, to within 300 km of the island of South Georgia (SG) in late 2020. This caused concern, following the impact of a previous iceberg, A38, on the SG ecosystem in 2003-2004. Further, given the advances in observing technology since the time of the previous iceberg, it afforded an unparalleled opportunity to study in detail the impacts of giant bergs on the ocean physical, biogeochemical and biological systems.

Diverse datasets were collected in response to this event. A research cruise on RRS James Cook was mobilised, to study the iceberg as it approached SG and fragmented into multiple smaller pieces. These measurements included physical parameters (including oxygen isotopes to inform on freshwater sources), dissolved inorganic nutrients, biosilica concentration, and composition of the phytoplankton community to inform bloom dynamics and primary production by the input of terrigenous material. Ocean gliders, deployed from the ship, surveyed the largest iceberg fragment in extremely close proximity and followed this for the remainder of its life, deconvolving the iceberg influence from frontal dynamics and assisting in understanding meltwater influence.

Concurrently, Earth Observation (EO) techniques were employed including Sentinel-1 SAR imagery, Planet Labs very high-resolution optical imagery, MODIS Aqua and Terra imagery and satellite radar and laser altimetry. A sediment trap deployed on a mooring downstream of SG will be utilised to investigate the carbon export from the cruise period to that of the previous 10 years while enhanced observations on higher predator colonies will compare their foraging paths and breeding performance to those of previous years.

This presentation will discuss preliminary findings from the study of A68, including EO-derived quantifications of changing iceberg morphology, ice loss from fragmentation and basal melting, and the significance of fractures in dictating collapse fissures. Physical oceanographic data from the ship and gliders are used to determine the impact on water column stability, mixing and circulation on a range of scales. Biogeochemical and biological data reveal the impact of interacting processes on phytoplankton community biomass and species composition. Ecosystem implications and future directions of investigation will be outlined.