National Oceanography Centre

British Antarctic Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

Variability in circulation and exchange in a sub-Antarctic island fjord

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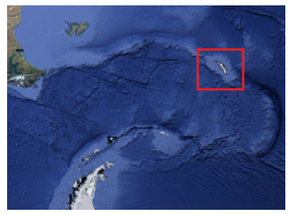
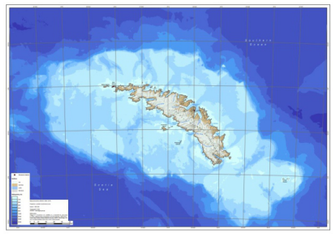


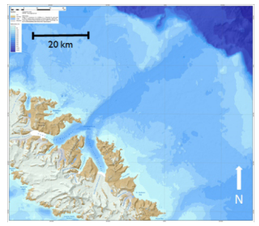
South Georgia (SG) is and island in the Southern Ocean (SO) lying South of the Polar Front (PF). SG lies in the path of the Antarctic Circumpolar Current (ACC) and in a belt of strong westerly winds.

SG is crescent shaped, ~170 km long, mountainous and heavily glaciated. The island is ideally located for investigating variations in high-latitude fjord circualtion in a changing climate.

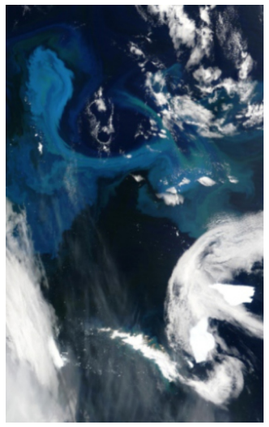


The shelf surrounding the island is traversed by deep, glacially eroded canyons. Cumberland Bay (CB) on the NE coast is the largest fjord.

This project aims to use the NEMO 4 modelling framework to determine the drivers of variability in circulation and exchange in CB, and use the results to investigate three further objectives, detailed below.



1. Iron contribution from CB to phytoplankton blooms.

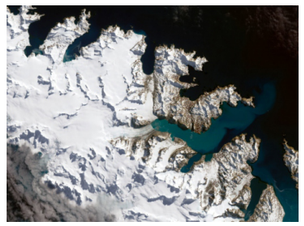


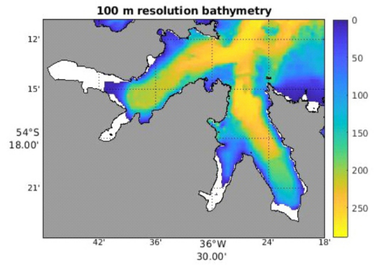
To the northwest of SG is one of the largest phytoplankton blooms in the SO.

Iron to support these blooms is advected from island sources, such as shelf sediments and glacial melt.

Glacial flour plumes emerging from the coast of SG are potentially a significant source of iron controlling the extent of the blooms.

2. Coupled ice-ocean interactions within CB.





100 m resolution bathymetric data of Cumberland Bay (Hogg et al. 2016) reveals deep sill near mouth of East Bay. Markedly different behaviour of glaciers terminating in East and West Bay over last century.

This could be due to subglacial forced circulation interacting with sill depth or differential effect of local winds.

3. Transport and retention of fish larvae and krill.

Strong interannual variability in krill abundance at SG which are transported by the Southern ACC Front.

Krill availability has major knock-on effect on the food web.

Mackerel Icefish commercial stock has reduced significantly in recent years.

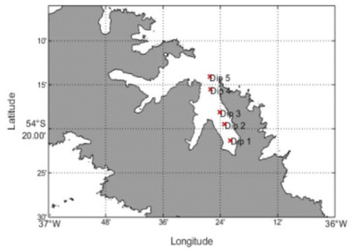
Successful management of the fisheries requires detailed knowledge of the circulation patterns and retention mechanisms around SG and CB.

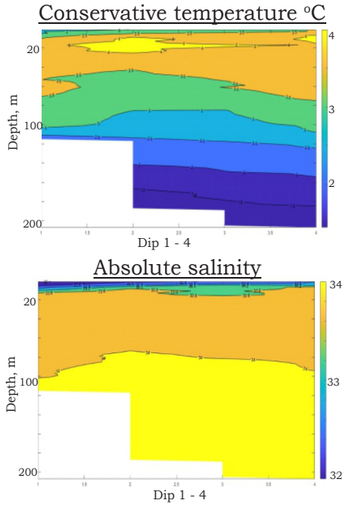
Data - Cumberland East Bay

Conductivity-Temperature-Depth (CTD) data collected from CB in collaboration with SAERI.

CTD data taken on the 20th March 2020 from the SG Pharos. Actual data at 1, 2, 3, and 4, interpolated between.

(Dip 5 planned but not taken.)





Model development

200 m resolution model currently being developed in NEMO-4.0.4 to simulate years 2000-2012.

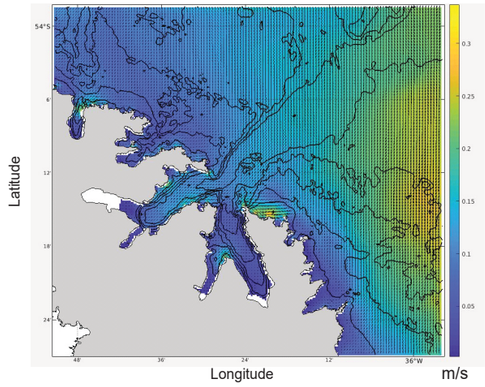
Surface Boundary: ERA5 reanalysis dataset.

Freshwater: Subglacial plume representation and surface run-off from glaciers at the head of the bays .

Open Boundaries: 3 km regional model (Young et al. 2016) with 2D, 3D and tidal forcing.

Passive tracers will be used to find pathways of iron, and simulated flows will drive an IBM to investigate the transport of fish larvae and krill.

Example model output: averaged horizontal velocites at the surdface



Young et al. (2016) High-resolution ocean modelling of the South Georgia and South Orkney Islands regions, WG-EMM-16/15. CAMLR Working Group on Ecosystem Monitoring and Management. Report of the XXXV Scientific Committee, Bologna, Italy.

Hogg, O. T., Huvenne, V. A. I., Griffiths, H. J., Dorschel, B., & Linse, K. (2016). Landscape mapping at sub- Antarctic South Georgia provides a protocol for underpinning large- scale marine protected areas. Nature Publishing Group, March, 115. https://doi.org/10.1038/srep33163