Investigating Antarctic krill connectivity

Assessing the effect of environmental and biological conditions on Antarctic krill large scale connectivity facilitated by ocean currents.

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In Short

• Investigate the large scale connectivity of Antarctic krill via ocean currents throughout the Southern Ocean, with special focus on the Lazarev Sea.

• Find regions from where existing populations can supply the Lazarev Sea krill population.

• Investigate how environment and biological parameters such as temperature and food availability influence the survival of krill during such a long-distance transport.

Motivation

Antarctic krill, *Euphausia superba*, is a key component of the Antarctic marine food web that plays a fundamental role in the transfer of energy between the lower and the upper trophic levels. It has been found capable of grazing as much as 55% of the net primary production and many of the top predator populations are dependent on krill as a food source, such as whales, seals, seabirds, penguins and fish. In addition, it is a growing, globally important fisheries resource.

Many marine populations, such as Antarctic krill or other zooplankton and fish stocks, are structured by their physical environment. As a result, the spatial relationships between physical and biological processes are potentially key to understanding their distribution and abundance. Dispersal occurs mostly during early life through advection by ocean currents, when young individuals are not yet capable of active movement. Older life stages exhibit behavior and active movement and can therefore often move on different spatial scales. Larval dispersal by ocean currents and connectivity between different oceanic regions have been identified as crucial factors for structuring marine populations as well as for designing networks of Marine Protected Areas (MPAs), or even understanding the spread of marine pests.

Transport and connectivity of Antarctic krill between regions spatially far apart have been demonstrated for the western Antarctic Peninsula and South Georgia regions [1],[2], with krill spawned at the Antarctic Peninsula and the Weddell Sea supplying the South Georgia krill population. Separate, observational studies in the Lazarev Sea concluded that this region does not support a single self-maintaining population, but represents a complex transition zone of stocks with different origins, which was hypothesized to maybe stem from the Scotia Sea and the Cosmonaut Sea (Fig. 1). It is this hypothesis that this proposed project is going to investigate.

Aim

The aim of this study is to quantify the connectivity of Antarctic krill living in different regions in the Southern Ocean large distances apart and how both environmental (temperature, currents) and also bi-
ological factors (food concentration) can impact this connectivity. To achieve this, we want to 1) investigate the impact of the horizontal model resolution on the representation of filaments, fronts and eddies, 2) find out from which regions krill populations can supply input to the Lazarev Sea krill population, and 3) investigate how environment and biological parameters influence the survival of krill during such a long-distance transport.

Methods

For the work proposed here we apply the high-resolution, circumpolar hydrodynamic Finite-Element Sea ice Ocean Model (FESOM) coupled to the Regulated Ecosystem Model 2 (REcoM2) (Fig. 1). Currently this model system runs well with the BOLD grid (or HR grid) [5]. However, the relatively low horizontal resolution on the continental shelf and shelf break was identified as a potential weakness of the model configuration with respect to the representation of mesoscale eddies, as they are very important features for krill retention and accumulation of food such as phytoplankton and copepods.

In an attempt to overcome this issue and improve the representation of mesoscale frontal processes we aim to decrease the horizontal model resolution in the region between 20°W to 40°E, the larger Lazarev Sea region (Fig. 1). We will conduct a suit of tuning experiments to adjust sub-gridscale parameterizations to the new, finer resolution in both FESOM and REcoM2. These simulations are important as previous moves to higher resolution grids gave rise to problems in the ecosystem model. We will then evaluate the tuning experiments by comparing them with high-resolution synoptic observations and use the best-performing configuration to perform a 50-year model run. This reference run will then provide the basis for Lagrangian particle simulations with an individual-based model of krill that utilize the FESOM-REcoM2 output in form of environmental conditions (temperature, salinity and currents) as well as biological conditions (nutrient, phytoplankton and zooplankton distribution and abundance) to investigate how these factors impact connectivity of Antarctic krill.

More Information


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