Turbulence in the sea ice impacted Southern Ocean and its implications for primary production and carbon export

The seasonally sea ice covered Southern Ocean is globally important for the distribution of heat, freshwater, carbon and nutrients. Turbulent processes in the upper ocean of this region mediate the exchange and mixing of water properties between the upwelling warm, carbon-rich deep water and the sea ice influenced surface layer, setting the properties of the water that enters the global overturning circulation. Uncertainty in the interpretation of observed variability and predictions of the ocean's response to a warmer climate is perpetuated by sparse observations at the relevant spatial and temporal scales. This thesis looks at observing and understanding centimeter to kilometer scale turbulence and its implications for primary production by algae. We achieve this using gliders that are able to collect data in the ocean at high resolution in both space and time for sustained periods. There are three main findings. First, we find that sea ice melt enhances kilometer scale horizontal changes in salinity and temperature. However, sea ice melt also increases the stability of the surface mixed layer, preventing the vertical transport of heat and freshwater between the ocean interior and surface ocean in the regions where sea ice melts. Second, centimeter scale mixing of heat into the subsurface winter water drives the seasonal warming of this layer, mediating the subsurface transformation of the warm and salty deep waters into Antarctic intermediate waters. And third, we find that algal growth increases in relation to the amount of sea ice growth because sea ice growth during winter can drive the entrainment of limiting nutrients and minerals from the deep ocean reservoir. This results in increased carbon export to the mesopelagic.

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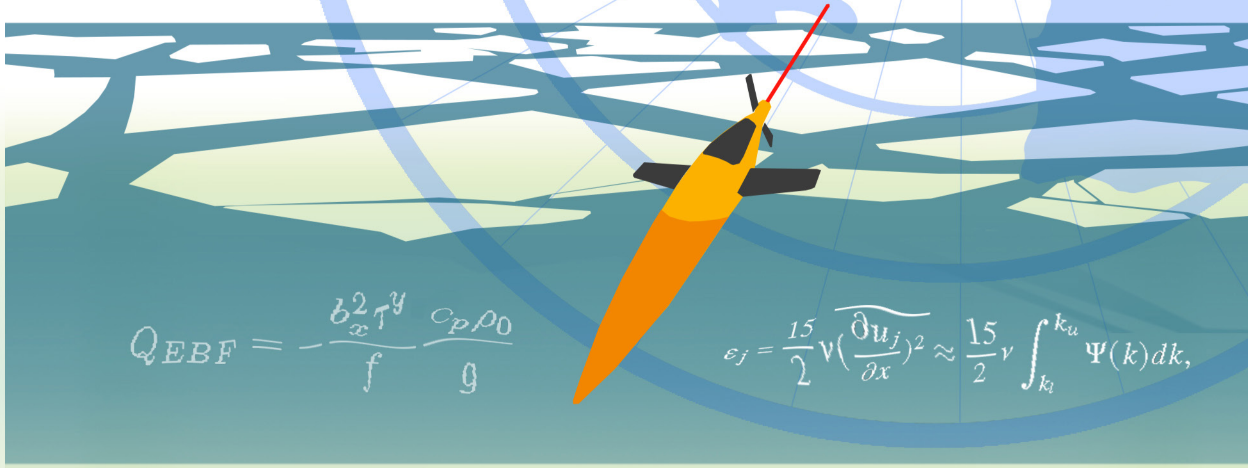

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