Physical forcing of marine ecosystems in the vicinity of the Prince Edward Islands

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The Southern Ocean forms a major component within the global ocean and climate system and is a critical link in earth system processes [1,2]. Its ecosystems affect global biogeochemical cycles, sustain globally important marine biodiversity and will be important in maintaining food security by supporting fisheries [3], key resources under increasing international pressure [4]. The region is also recognised as key to understanding and perhaps mitigating global climate change [5]. Somewhat alarming therefore is the rapid rate of environmental change being experienced by the region with resultant impacts to ecosystems and food webs.

Understanding the impacts of a changing physical environment on biological systems is a key question in marine ecology. The effects of the physical environment on Antarctic marine biological systems and species are well documented [6]. Nevertheless, while impacts of physical change on species have been recorded, linking ecosystem changes to physical ones remains difficult [7]. Ecosystem models allow computational exploration of disruptions on ecosystems that would otherwise be impossible experimentally. Such approaches are crucial in the Antarctic where the development of observing systems capable of explaining the causes of marine ecosystem changes and impacts of these changes on species and communities remains a challenge [7]. However, globally, much research to date has focussed on species-specific research. Therefore a great emphasis has been placed on the need for the development of modelling strategies that cut across traditional disciplinary clusters to span all levels of the biotic system, from end to end [8]. Building end-to-end models of ecosystems from the physics to top predators constitutes a way forward in this regard by creating a platform to better understand and predict changes in marine ecosystems under effects of environmental change. While integrated whole ecosystem views of the Southern Ocean from nutrients through primary producers and consumers to top predators are starting to emerge, models integrating physics and biology are lacking.

Therefore, in this study, we use physical oceanographic data to drive biological ecosystem models of the sub-Antarctic Prince Edward Islands. Physical oceanographic processes are of considerable importance to the marine ecosystem in the vicinity of these islands [e.g. 9] and therefore changes to these processes are predicted to have significant impacts on species and communities.