



Impact of Icebergs on Net Primary Productivity in the Southern Ocean

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Productivity in the Southern Ocean (SO) is iron-limited, and supply of iron dissolved from aeolian dust is believed to be the main source from outside the marine environment. However, recent studies show that icebergs could provide comparable amount of bioavailable iron to the SO as aeolian dust. In addition, small scale areal studies suggest increased concentrations of chlorophyll, krill, and seabirds surrounding icebergs. Based on previous research, this study aims to examine whether iceberg occurrence has a significant impact on marine productivity at the scale of the SO, using remote sensing data of iceberg occurrences and ocean net primary productivity (NPP) covering the period 2002-2014. The impacts of both large and small icebergs are examined in four major ecological zones of the SO: the continental shelf zone (CSZ), the seasonal ice zone (SIZ), the permanent open ocean zone (POOZ) and the polar front zone (PFZ). We found that both large and small icebergs have an observable positive impact on NPP, but their impacts vary in different zones. Small icebergs on average increase NPP in most iron deficient zones: by 21% for the SIZ, 16% for the POOZ, and 12% for the PFZ, but have relatively small effect in the CSZ where iron is supplied from melt water and sediment input from the continent. Large icebergs on average increase the NPP by about 10%. Their impacts are stronger at higher latitudes, where they are more concentrated. From 1992-2014, there is a significant increasing trend for both small and large icebergs. The increase was most rapid in the early 2000s, and has levelled off since then. As the climate continues to warm, the Antarctic Ice Sheet is expected to experience increased mass loss as a whole, which could lead to more icebergs in the region. Based on our study, this could result in higher level of NPP in the SO as a whole, providing a negative feedback for global warming.