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Quantifying the island mass effect for the marine carbon cycle at the Crozet Plateau in the southern Indian Ocean

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Phytoplankton growth is low in large parts of the Southern Ocean. High marine productivity is encountered in frontal systems and downstream of land and shallow topography, as shown by satellite observations of sea surface chlorophyll. In two CROZEX cruises we quantified the impact of such algal blooms on dissolved inorganic carbon (DIC) chemistry at the Crozet Plateau in the southern Indian Ocean. The cruises were in austral spring and summer 2004-2005. Extensive algal blooms far north and north (downstream) of the plateau reduced the fugacity of CO_2 (fCO_2) in surface water by up to 70 μatm and decreased the DIC content by up to 60 μmol kg^1. The algal blooms created an important sink for atmospheric CO_2. Waters south (upstream) of the plateau generally had surface chlorophyll concentrations below 0.5 mg m^{-3} with locally higher values up to 0.7 mg m^3. Significant algal CO_2 uptake decreased fCO_2 by 13 μatm and DIC by 15 μmol kg^{-1}. It changed the waters south of the plateau from a small source for atmospheric CO_2 to a small sink. A north-south gradient was observed in the timing of DIC uptake from November to January: Algal blooms had almost reduced DIC to its lowest level in Mid-November far north of the plateau, while DIC uptake only started in November south of the plateau. The total DIC deficit in the upper 120 m ranged from 4 mmol m^2 far north of the plateau to almost 2 mmol m^2 south of the plateau in January, suggesting that that the waters south of the plateau had a higher integrated marine productivity than evident from satellite observations of sea surface chlorophyll.