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The impact of Southern Ocean bathymetry on the ocean circulation and the overlying atmosphere

Agatha De Boer, David Hutchinson, Fabien Roquet, Louise Sime, and Natalie Burls
Stockholm University, Bert Bolin Centre for Climate Research, Department of Geoscience, Stockholm, Sweden
(agatha.deboer@geo.su.se)

Southern Ocean bathymetry constrains the path of the Antarctic Circumpolar Current (ACC), but the bathymetric influence on the coupled ocean-atmosphere system is poorly understood. Here, we investigate this impact by respectively flattening large topographic barriers around the Kerguelen Plateau, Campbell Plateau, Mid-Atlantic Ridge, and Drake Passage in four simulations in a coupled climate model. The barriers impact both the barotropic and baroclinic forcing of the ACC, which increases by between 3% and 14% when barriers are removed individually and by 56% when all barriers are removed simultaneously. The removal of Kerguelen Plateau bathymetry increases convection south of the plateau and the removal of Drake Passage bathymetry reduces convection upstream in the Ross Sea, affecting the deep overturning cell. When the barriers are removed, zonal flattening of the currents leads to SST anomalies upstream and downstream of their locations. These SST anomalies strongly correlate to precipitation in the overlying atmosphere, with correlation coefficients ranging between r=0.92 and r=0.97 in the four experiments. Windspeed anomalies are also positively correlated to SST anomalies in some locations but other forcing factors obscure this correlation in general. The meridional variability in the wind stress curl contours over the Mid-Atlantic Ridge, the Kerguelen Plateau and the Campbell Plateau disappears when these barriers are removed, confirming the impact of bathymetry on overlying winds. However, bathymetry-induced wind changes are too small to affect the overall wave-3 asymmetry in the Southern Hemisphere Westerlies. Removal of Southern Hemisphere orography is also inconsequential to the wave-3 pattern, suggestion a remote control.