EFFECT OF THE DRAKE PASSAGE THROUGHFLOW ON GLOBAL CLIMATE

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The role of the Southern Ocean in global climate is examined using three simulations with a coupled model employing geometries different only at the location of Drake Passage (DP). We examine the results of three main experiments: (1) a simulation with Drake Passage closed, (2) an experiment with DP at a shallow (690 m) depth and (3) a realistic Drake Passage experiment. Our climate with DP closed is characterised by warmer Southern Hemisphere surface air temperature (SAT), little Antarctic ice, and no North Atlantic Deep Water (NADW) overturn. On opening the DP to a shallow depth of 690 m we find an increase in Antarctic sea-ice and a cooling of the Southern Hemisphere, but still no North Atlantic overturn. On fully opening the DP we find a mostly similar Southern Hemisphere climate to DP at 690 m, but the model now simulates NADW formation and a warming in the Northern Hemisphere. This suggests the North Atlantic thermohaline circulation depends not only on the existence of a DP throughflow, but also on the depth of the sills in the Southern Ocean. The closed DP experiment exhibits a large amount of deepwater formation (56 Sv) in the Southern Hemisphere; this reduces to 38 Sv for the shallow DP case, and 13 Sv when DP is at 2148 m, its modern day depth. NADW formation is shut down in both DP closed and shallow experiments, which accounts for the warming in the Northern Hemisphere observed when the DP is opened. Our experimental results support paleoclimatic evidence of rapid cooling of the Southern Ocean region soon after the isolation of Antarctica.