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Antarctic Circumpolar Current Biases in a hierarchy of HadGEM3-GC3.1 Models

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The Southern Ocean is a crucial part of the global ocean circulation. The unique bathymetry and lack of meridional boundary in conjunction with an equator to pole temperature gradient and strong westerly winds results in an eastward flowing Antarctic Circumpolar Current (ACC). The ACC is the strongest ocean current in the world (173.3 ± 10.7Sv), vital in transporting heat, carbon and nutrients between the major ocean basins.

Using prototype UK CMIP6 (HadGEM3-GC3.1) simulations at 1°, 1/4° and 1/12° spatial resolutions we illustrate the strong resolution dependence of the strength of the ACC through the Drake Passage. All three model resolutions exhibit a weak ACC compared to observations. The 1/4° and 1/12° models show a significant weakening over the first 50 years, stabilizing at 60Sv and 120Sv respectively.

We analyse the source of the weaker volume transport by decomposing the ACC transport into components arising due to northern and southern boundary density profiles (relative to the bottom density), Ekman transport and depth-independent flow. We attribute the weaker ACC in the 1/4° model to a lightening of the southern density profile and the formation of a reverse flow along the coast of Antarctica.

Our decomposition highlights the significant contribution to the ACC's volume transport and variability made by both northern and southern density profiles, as well as the depth-independent component of the flow.