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Ocean-only FAFMIP: Understanding Regional Patterns of Ocean Heat Content and Dynamic Sea Level Change

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A rise in global mean sea level is a robust feature of projected anthropogenic climate change using state-of-the-art atmosphere-ocean general circulation models (AOGCMs). However, there is considerable disagreement over the more policy-relevant regional patterns of sea level rise. The Flux-Anomaly-Forced Model Intercomparison Project (FAFMIP) aims to improve our understanding of the mechanisms controlling regional and dynamic sea level change. In FAFMIP, identical air-sea buoyancy and momentum flux perturbations are applied to an ensemble of different AOGCMs, to sample the uncertainty associated with model structure and physical processes. Our novel implementation applies FAFMIP perturbations to an ensemble of OGCMs. This framework enables an estimate of the unknown atmosphere-ocean feedbacks, by comparing the coupled and ocean-only response to surface flux perturbations.

Comparing the response to idealised FAFMIP forcing with more realistic, increasing CO2 forcing, much of the spread in regional sea level projections for the North Atlantic and Southern Ocean arises from ocean model structural differences. Ocean-only simulations indicate that only a small proportion of this spread is due to differences in the atmosphere-ocean feedback. Novel tendency diagnostics indicate the relative effect of resolved advection, parametrised eddies, and dianeutral mixing on regional and dynamic sea level change. This study helps to reduce uncertainty in regional sea level projections by refining our estimates of atmosphere-ocean feedbacks and developing our understanding of the physical processes controlling sea level change.