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The impact of biases in the tropical South Pacific and near the Agulhas Current on the large-scale Southern Hemisphere circulation

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A common model bias in comprehensive climate models used in climate assessments such as the Coupled Model Intercomparison Project is a double inter-tropical convergence, with excessive precipitation in the tropical eastern South Pacific. In addition, the current generation of climate models cannot adequately resolve the dynamics of the Agulhas Current, and in particular the relative fraction of the Current that leaks into the Atlantic as opposed to retroreflecting back into the Indian Ocean. The intermodel spread in the magnitude of the double ITCZ bias is significantly correlated with the strength and phasing of SH stationary waves in the CMIP archive, with models with a smaller bias generally showing more realistic stationary waves. An intermediate complexity moist General Circulation Model is used to demonstrate the causality of this connection: by fluxing heat out of the tropical South Pacific Ocean, we can capture the responses seen in CMIP5 models. Finally, the same intermediate complexity moist General Circulation Model is used to demonstrate that an overly diffuse Agulhas leads to an equatorward shift of the Southern Hemisphere jet by more than 3degrees, and indeed an overly equatorward Southern Hemisphere jet is a common model bias in most CMIP5 models.