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The transient response of the Southern Ocean to stratospheric ozone depletion

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Recent studies have suggested that the response of the Southern Ocean to stratospheric ozone depletion is non-monotonic in time; consisting of an initial cooling followed by a long-term warming. This result may be significant for the attribution of observed Southern Ocean temperature and sea ice trends, but the time scale and magnitude of the response is poorly constrained, with a wide spread among climate models. Furthermore, a long-lived initial cooling period has only been observed in a model with idealized geometry and lacking an explicit representation of ozone. In this study we calculate the transient response of the Southern Ocean to a step-change in ozone in a comprehensive coupled climate model, GFDL ESM2Mc. The Southern Ocean responds to ozone depletion with an initial cooling, lasting 25 years, followed by a warming. We extend previous studies to investigate the dependence of the response on the ozone forcing as well as the regional pattern of this response. The response of the Southern Ocean relative to natural variability is shown to be largely independent of the initial state. However, the magnitude of this response is much less than that of natural variability found in the model, which limits its influence and detectability.