Supplementary Material

1 SUPPLEMENTARY FIGURES

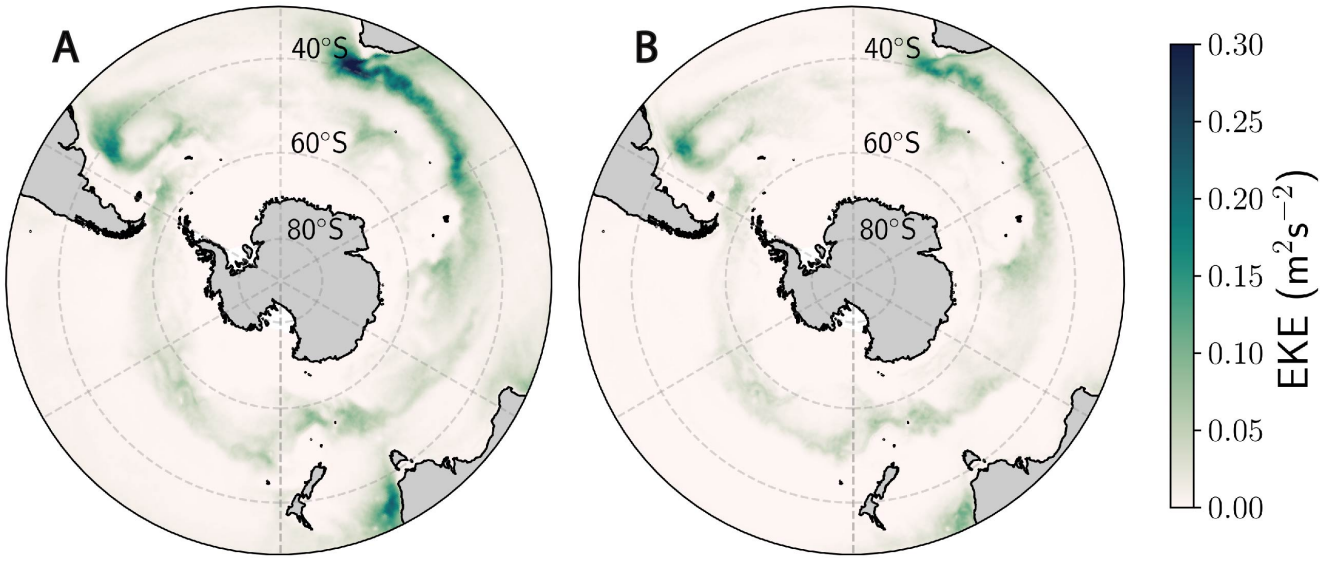

Figure S1. Eddy kinetic energy **A**) calculated from satellite altimetry observations over the period 1993-2019, and **B**) from the ACCESS-OM2-01 model with 1990-91 repeat year forcing over the 10 year period of analysis. From both datasets the EKE=$\frac{1}{2}(u'^2 + v'^2)$ is calculated from the geostrophic velocities obtained from sea surface height.

We provide further evidence that ACCESS-OM2-01 reproduces realistic Southern Ocean upwelling by comparing its eddy kinetic energy field to that of observations. Global satellite altimetry data, combined from multiple satellite missions, is available from 1993. The satellite data is produced by Ssalto/Duacs and distributed by AVISO+, with support from CNES (https://www.aviso.altimetry.fr/en/data/products/sea-surface-height-products/global/gridded-sea-level-heights-and-derived-variables.html). The eddy kinetic energy obtained from satellite data (Fig. S1A) are compared with the ACCESS-OM2-01 model used in this study (Fig. S1B). The satellite observations do not cover the 1990-91 time period used for the repeat year forcing, but the interannually forced version of ACCESS-OM2-01 for years 1993-2018 has a nearly identical distribution (not shown) to Fig. S1B. The similarity suggests differences are due to the model rather than atmospheric forcing. The satellite eddy kinetic energy has a similar spatial distribution to the model, though with a slightly larger magnitude, explained by the real ocean containing smaller scale variations than the 0.1° model resolves. The similarity suggests that the eddy kinetic energy distribution in the model is realistic.