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A geometric interpretation of vertical structure and eddy-mean flow interaction in the Southern Ocean

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The interaction between mean flow and mesoscale eddies is important for the large-scale ocean circulation. Here we exploit a geometric approach taken in past studies of Reynolds stresses and stability of barotropic jets, and examine the vertical structure of eddy energy and eddy buoyancy fluxes in combination through a geometric ellipse representation. We show that the geometry relates to eddy interfacial form stress and stability of baroclinic mean flow. The ellipse geometry in the Southern Ocean is diagnosed in a forced eddy-resolving general circulation model with realistic basin geometry and bottom topography. We find that the effective ellipse eccentricity, a measure of interaction strength, is depth-insensitive in the interior ocean, and that the eddy interfacial form stress compares well with the baroclinic conversion term. We discuss how these results are relevant to a recently developed eddy parameterization framework, which formulates the closure problem in terms of the ellipse geometry.