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Automated detection of Lagrangian eddies and coherent transport of heat and salinity in the Agulhas leakage

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Haller and Beron-Vera(2013) have recently introduced a new objective method to detect coherent Lagrangian eddies in turbulence. They find that closed null-geodesics of a generalized Green-Lagrange strain tensor act as coherent Lagrangian eddy boundaries, showing near-zero and uniform material stretching. We make use of this method to develop an automated detection procedure for coherent Lagrangian eddies in large-scale ocean data. We apply our results to a recent 3D general circulation model, the Southern Ocean State Estimate (SOSE), with focus on the South Atlantic Ocean and the inter-ocean exchange between the Indian and Atlantic ocean. We detect a large number of coherent Lagrangian eddies and present statistics of their properties. The largest and most circular eddy boundaries represent Lagrangian Agulhas rings. Circular regions inside these rings with higher temperature and salinity than the surrounding waters can be explained by the coherent eddy boundaries that enclose and isolate the eddy interiors. We compare eddy boundaries at different depths with eddy boundaries obtained from geostrophic velocities derived from the model's sea surface height (SSH). The transport of mass, heat and salinity enclosed by coherent eddies through a section in the Cape basin is quantified and compared to the non-coherent transport by the background flow.