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Spatio-temporal characteristics of Agulhas leakage: a model inter-comparison study

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Abstract

Investigating the variability of Agulhas leakage, the volume transport of water from the Indian Ocean to the South Atlantic Ocean, is highly relevant due to its potential contribution to the Atlantic Meridional Overturning Circulation as well as the global circulation of heat and salt and hence global climate. Quantifying Agulhas leakage is challenging due to the non-linear nature of this process; current observations are insufficient to estimate its variability and ocean models all have biases in this region, even at high resolution . An Eulerian threshold integration method is developed to examine the mechanisms of Agulhas leakage variability in six ocean model simulations of varying resolution. This intercomparison, based on the circulation and thermohaline structure at the Good Hope line, a transect to the south west of the southern tip of Africa , is used to identify features that are robust regardless of the model used and takes into account the thermohaline biases of each model. When determined by a passive tracer method, 60 % of the magnitude of Agulhas leakage is captured and more than 80 % of its temporal fluctuations, suggesting that the method is appropriate for investigating the variability of Agulhas leakage. In all simulations but one, the major driver of variability is associated with mesoscale features passing through the section. High resolution (<1/10°) hindcast models agree on the temporal (2–4 cycles per year) and spatial (300–500 km) scales of these features corresponding to observed Agulhas Rings. Coarser resolution models (<1/4°) reproduce similar time scale of variability of Agulhas leakage in spite of their difficulties in representing the Agulhas rings properties. A coarser resolution climate model (2°) does not resolve the spatio-temporal mechanism of variability of Agulhas leakage. Hence it is expected to underestimate the contribution of Agulhas Current System to climate variability.