Abstract View

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Asymptotic Analysis of the Agulhas and Brazil Current Systems

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ABSTRACT

An asymptotic analysis is carried out of a linear and a nonlinear transport model of the large-scale wind-driven ocean circulation in the subtropical region of the Atlantic and Indian Oceans. The complicated geometry with a continent that terminates in mid-ocean is reflected in both models into the Atlantic Ocean through free boundary layers. It is shown that inertia must be incorporated to be able to produce a significant retroflection of the Agulhas Current south of Africa. In such a model the transport of the Return Agulhas Current becomes large when the wind stress curl decreases substantially over the north–south scale of an inertial boundary layer region around South Africa. The reason is that the overshooting Agulhas Current can then “unload” more of its transport eastward into the Sverdrup regime. The remainder of the transport bends westward into the free boundary layer. Wind stress curls calculated from the observed wind field over the Indian Ocean show such a rapid decrease. Thus the existence of a stagnation point near South Africa is shown to be a consequence of the large-scale conditions especially over the Indian Ocean part of the domain. The length scale that results from a formal asymptotic analysis for the distance of that retroflection point to the southern tip of the peninsula and the associated transport of the Return Agulhas Current agree with values from observations. Without the fast latitudinal variation of the wind stress curl the transport of the Brazil Current would he of the same order as that in the Agulhas. Almost the full Agulhas Current would then flow around South Africa and proceed as a westward jet into the Atlantic Ocean.