Abstract View

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A Model of the Inertial Recirculation Driven by Potential Vorticity Anomalies

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ABSTRACT

Some essential features of a recirculating inertial gyre (the “recirculation”) can be analyzed with a very simple, analytically tractable model. In wind-driven eddy-resolving general circulation models the recirculation appears as a strong sub-basin-scale inertial flow with homogeneous potential vorticity. The constant value of potential vorticity decreases with increasing forcing/dissipation ratio while the size and the strength of the recirculating gyre increases. In the subtropical gyre the recirculating gyre might be driven by anomalous values of low potential vorticity carried northward by the western boundary current. We have modeled this process using a barotropic model and prescribing the values of potential vorticity at the edge of the gyre. Our model gyre is contained in a rectangular box in an attempt to simplify the geometry as much as possible and to isolate the processes occurring in the recirculating region.

With weak diffusion the prescribed boundary forcing induces a flow with constant potential vorticity. We show how to calculate the homogenized value of potential vorticity in the interior without explicitly solving for the flow. We also numerically solve our model and so obtain explicit solutions. Two distinct cases arise: 1) For strong boundary forcing the gyre fills the whole box. Therefore the homogenized value of potential vorticity can be determined but the extent of the recirculation is prescribed. 2) For weak boundary forcing the recirculation fills only part of the basin and the size of the gyre must be determined as well as the homogenized value of potential vorticity within it. The latter case is the most relevant to the wind-driven, numerical experiments, because in these calculations the recirculating flow is confined to a sub-basin-scale region. Also in this case the homogenized value of potential vorticity decreases with increasing forcing, while the size and the strength of the gyre increase.

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