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Symmetric (inertial) instability in cross-equatorial western boundary currents

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The upper limb of the Atlantic Meridional Overturning Circulation draws waters with negative potential vorticity from the southern hemisphere into the northern hemisphere. The North Brazil Current is one of the cross-equatorial pathways in which this occurs. It is known that upon crossing the equator fluid parcels within this current must modify their potential vorticity, to render them stable to symmetric (inertial) instability and to merge smoothly with the ocean interior.

A hierarchy of models predict the excitement of inertial instability in cross-equatorial flows dynamically similar to the North Brazil Current. A linear stability analysis of a barotropic flow is able to predict the structure and growth rate of the instability. A two-dimensional numerical model verifies these predictions and shows how the instability is able to stabilise unstable potential vorticity configurations. A simplified three-dimensional model demonstrates how large anti-cyclonic rings spun up at the equator entrain waters with negative PV, before the rings themselves become inertially unstable. The high-resolution, observationally constrained, MITgcm LLC4320 model is probed for signs of this instability process.