Abstract View

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Stable Jet Modes: A Special Case of Eddy and Mean Flow Interaction

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ABSTRACT

The quasi-geostrophic, small-amplitude free modes of oscillation are examined for a midlatitude ocean basin with mean currents. Attention is restricted to a particular class of mean currents which are solutions of nonlinear, inviscid and unforced equations and whose free modes are all stable ones. Among the free modes are ones confined to the narrow regions where the mean jets are strongest. These modes, dubbed “jet modes”, have the following properties: 1) their phase speed is in the direction of and of the order of magnitude of the mean jet maximum velocity; 2) they are vertically in phase and upper-layer intensified when the mean jet is upper-layer intensified in phase and the thermocline is shallow; 3) they have a broader horizontal scale in the deep water than in the thermocline; 4) they have horizontal critical layers whose local balance is a nonlinear rather than a frictional one; 5) their Doppler-shifted frequencies are proportional to a mean potential vorticity gradient dominated by the horizontal curvature of the, mean jet; 6) and their mean energy and potential vorticity flux divergences are small or—in the particular geometry of a channel—zero. It is argued that many of these features should characterize the transience of narrow jets in general, especially those features relating to the spatial structure of the modes. (The stability and dispersion relation characteristics should be more peculiar to the type of jet present.)