Abstract View

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Radiating Instabilities of Thin Baroclinic Jets

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ABSTRACT

The linear stability of thin, quasi-geostrophic, two-layer zonal jets on the β-plane is considered. The meridional structure of the jets is approximated in such a way as to allow an exact dispersion relation to be found. Necessary conditions for instability and energy integrals are extended to these piece-wise continuous profiles. The linearly unstable modes which arise can be related directly to instabilities arising from the vertical and horizontal shear. It is found empirically that the necessary conditions for instability are sufficient for the cases considered. Attention is focused on unstable modes that penetrate far into the locally stable ocean interior and which are found when conditions allow the jet instability phase speeds to overlap the far-field. free-wave phase speeds. These radiating instabilities exist in addition to more unstable waves which are trapped within a few deformation radii of the jet. The growth rates of the radiating instabilities depend strongly on the size of the overlap of instability and free-wave phase speeds. The extreme cases of this are westward jets which have vigorously growing, radiating instabilities and purely eastward jets which do not radiate at all. Radiating instabilities are divided into two types: a subset of the jets' main unstable waves near marginal stability and instabilities which appear to be destabilized free waves of the interior ocean. It is suggested that the fully developed field of instabilities of a zonal current consists of the most unstable, trapped waves directly in the current with a shift to less unstable, radiating waves some distance from the current. A brief comparison of the model results with observations south of the Gulf Stream is made.