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On zonally symmetric equatorial waves trapped in the meridional-depth plane

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A feature of equatorial dynamics common to both the atmosphere and the ocean is the phenomenon of equatorially trapped waves. Here we employ three different simplified models of linear zonally symmetric monochromatic waves confined to a homogeneous or uniformly-stratified layer of fluid on the equatorial beta plane. The first one is the standard equation, which results from the hydrostatic and the traditional approximation, i.e. neglecting vertical acceleration and horizontal components of the Coriolis force. The second one is Stern's (1963) equation which keeps non-traditional terms but uses the hydrostatic assumption and considers the fluid to be homogeneous. Finally, a model for a uniformly-stratified fluid called the stratified Stern equation is discussed which neither uses the hydrostatic nor the traditional approximation.

A robust feature of all three models is the occurrence of wave attractors (i.e. limit cycles of the characteristic web). Unfortunately, only for the Stern equation we can pin down the meaning of wave attractors for the solution. The other models are not separable in terms of characteristics. To understand the role wave attractors play for more realistic nonseparable models of meridionally propagating equatorial waves a physical interpretation of the characteristics e.g. as rays of energy propagation is compelling.

The purpose of the paper is i) to draw attention to features coming from the hyperbolic nature of the (zonally symmetric) equatorial wave problem (wave attractors, degenerate spectra) and ii) to show that for the models under consideration characteristics correspond to energy rays (in a WKB sense).