TRANSMISSION OF EQUATORIAL WAVES THROUGH A STRAIT

A DISSERTATION SUBMITTED TO THE GRADUATE DIVISION OF THE UNIVERSITY OF HAWAI'I IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY

IN

OCEANOGRAPHY

MAY 2006

By
Theodore S. Durland

Dissertation Committee:

Bo Qiu, Chairperson
Eric Firing
Kevin Hamilton
Jay McCreary
Dennis Moore
Peter Müller

ABSTRACT

A mathematical procedure is developed for determining the response of zonal channels to forcing by large-scale basin waves, within the framework of the linear, inviscid, shallow-water equations on the equatorial β-plane. A meridional-mode-1 Rossby wave that is incident upon a western boundary pierced by a zonal, semi-infinite channel, excites predominantly the anti-Kelvin wave and the lowest two meridional-mode channel-Rossby waves, for channels within a broad range of latitudes (0–9°) and widths (30–600 km). When the channel is near the equator and less than about 300 km wide, the anti-Kelvin wave carries more than 99% of the channel energy flux. In addition, there is a frequency-dependent channel-width, below which all channel Rossby modes are evanescent, and all of the channel energy flux is carried by the Kelvin-like waves, regardless of latitude. At the semi-annual period, this cutoff width is about 100 km. Within the above range of latitudes and widths, the channel response to an incident basin Kelvin wave is virtually all channel Kelvin wave. A Kelvin-like wave within a narrow channel reflects from a channel mouth, generating predominantly an oppositely directed Kelvin-like wave that reduces the pressure signal and enhances the zonal-velocity signal at the channel mouth.

The dominance of the Kelvin-like waves within narrow channels leads to a simple formulation of transmission through a strait, based on the multiple-beam-interference phenomenon. The multiple reflections from the mouths of the strait reinforce the channel waves, under typical conditions of strait length and wave period. This effect increases as the strait width decreases, allowing for the enhanced transmission through very narrow straits that was noticed by previous researchers.