Long internal waves studies with applications to large-scale ocean transport and improvement of altimeter measurements

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Long internal waves (such as gravity, Rossby, and a variety of coastal waves) with wavelengths up to several thousand kilometers greatly affect altimeter measurements. They also play an important role in ocean energy budget, in the transport of tracers (e.g., heat, salt, CO_2) and in climate dynamics. Our research seeks to 1) improve ocean dynamics modeling by developing an experimentally justified and theoretically sound description of wave-induced phenomena; and 2) filter adverse effects of internal gravity waves out of altimeter measurements.

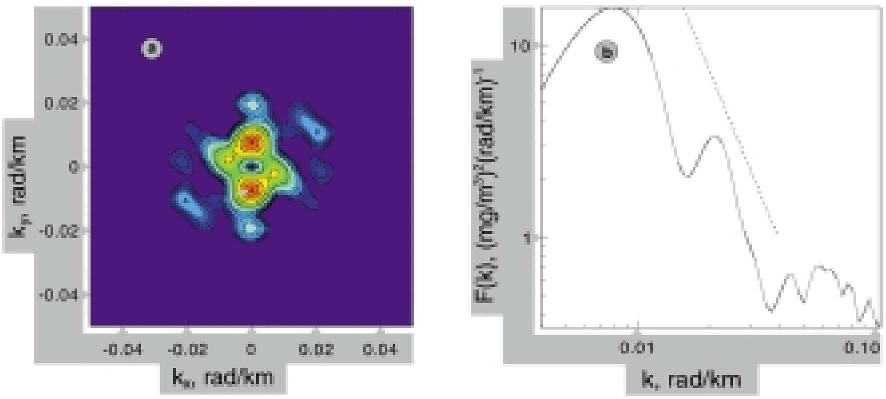

Figure 2: (a) Power spectra of chlorophyll-a concentration variations in a NW Pacific region characterized by relatively intense BIG waves [reproduced from a manuscript under review]: while the highest spectral peak (seen as red) corresponds to long Rossby waves, a set of smaller peaks (light blue) is due to semi-diurnal internal tides in this region. (b) The observed high rate of spectral roll off (the dotted line illustrates the k^{-3} power law) points to the dominance of BIG wave turbulence. [Glazman et al., 1999, Weichman et al., 1999].

Our research includes theoretical efforts, statistical analysis of satellite altimeter data and of ocean color images, and modeling. In figure 1, we illustrate characteristic amplitude of sea surface height variations, σ (cm), due to baroclinic inertia-gravity (BIG) waves. Particularly large values of σ are observed near strong ocean current regions, thus identifying current-wave interactions as a likely mechanism of energy transfer to BIG waves. Our plans include a study of these interactions on global scale, an investigation of long-term variability of the wave properties and their relationship to relevant factors of ocean dynamics. Our tracer transport study recently produced a rigorous theoretical description of the underlying mechanisms [Weichman et al., 1999, Weichman et al., 2000].
This description will serve as a basis for our planned efforts on predicting and modeling the BIG wave effects. In figure 2 we illustrate a spectrum of Chlorophyll-a variations in a 10° x 10° ocean region in the NW Pacific where BIG waves are well manifested in ocean dynamics. This spectrum confirms our theoretical predictions, and it displays a peak at the wavenumber scale corresponding to the semi-diurnal internal tides - a new phenomenon discovered for the first time by our analysis.

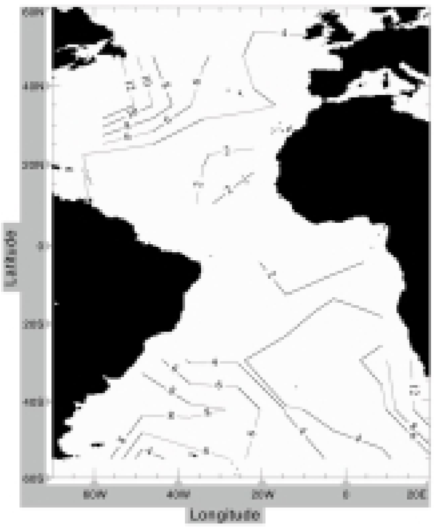

Figure 1: Characteristic amplitude (in centimetres) of the sea surface height variation component caused by long internal gravity waves [reproduced from Glazman et al., 1999].

References

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