Modeling and Analysis of Internal-tide Generation and Beam-like Onshore Propagation in the Vicinity of Shelfbreak Canyons

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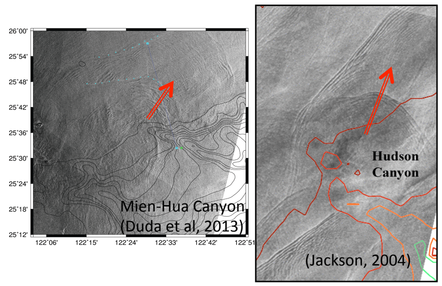
1. Nonlinear internal waves have been observe to radiate onto shelves to the right of northern hemisphere canyons:

Fig. 9 ➔ Could the asymmetrical internal-tide generation and onshore propagation lead to nonlinear internal waves occurring preferentially on one side of the shelfbreak canyons?



2. This behavior has been duplicated in ROMS model simulations:

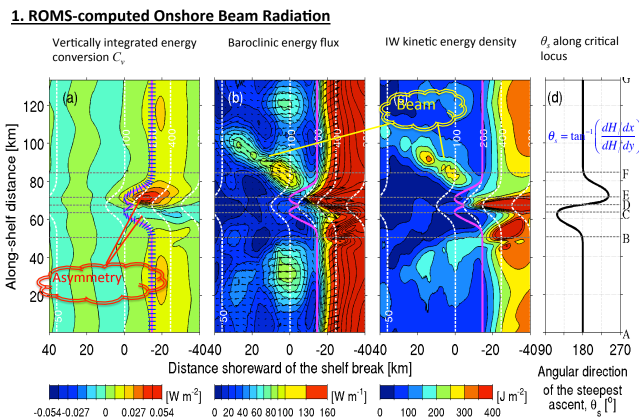


Fig. 3 ➔ Results from the ROMS control simulation showing asymmetrical (a) C_v and (b-c) beams of onshore internal wave energy radiation with the stronger beam on the side with higher C_v and starting from the canyon side flank (rather than its outer skirt).

3. A simple model of mode-1 internal tide generation at the locus along which the slope is critical successfully reproduces the internal-tide radiation pattern

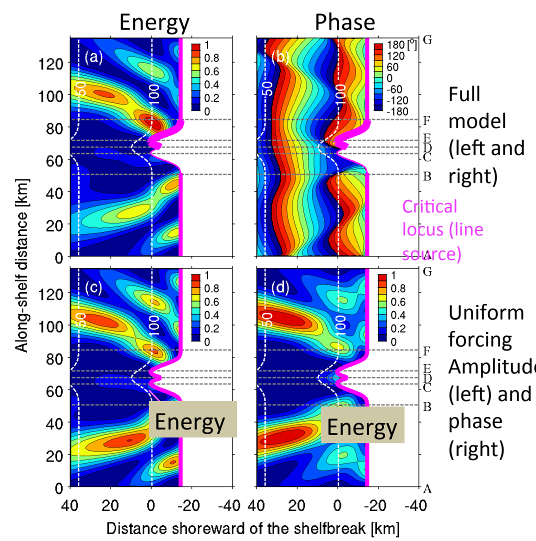
4. The essential element of the model is the variation of the forced-wave phase along the locus. The relative phases along the locus are linked to the phase of the tidal cycle when the barotropic tidal currents are directed upslope.

The barotropic tidal ellipses are uniform. The relative phase is controlled entirely by the bathymetry.

A secondary concern is the amplitude of the forcing along the locus. This is variable. Arguments are given for this being the result of a multiple-scattering process. That is,
the resultant internal tide is not caused by the action of the barotropic tide at each source locations, but by the combined action of the barotropic tide at each location plus internal tides that radiate in from the entire collection of source locations.

Fig. 5 ➔ Above: (a-b) the wave field from the semi-analytical calculation with sources along the critical locus of variable amplitude ($\hat{A}_{s1} \propto C_v$) and phases ($\phi_{s1} \approx \theta_s$). Below: wave field from (c) Run 2 (sources with uniform $\hat{A}_{s1}$ and variable ϕ_{s1}) and (d) Run 3 (sources with both $\hat{A}_{s1}$ and ϕ_{s1} uniform). Note that the isobath contours (white dashed lines) are merely for reference.

(a) shows an asymmetrical beam pattern similar to the ROMS simulated IW kinetic energy distribution on the shelf (Fig. 3c). The relative strength of the beams switches when uniform source amplitude is used (c); the beams become completely symmetrical when uniform source phase is used (d).



5. The model equations are given in the poster, and in a paper in press, JPO.

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Session 158: Measuring and modeling internal waves and the turbulence cascade: A tribute to David Tang [2014 AGU Ocean Sciences Meeting]

David Tang was extremely important in establishing the collaborative ocean research arrangement that is now in place between Taiwan and the United States. David worked to procure ships for ONR studies in the South China Sea for US/Taiwan collaborative studies in Spring 2000 and Spring 2001. The success of these projects, reported on in a collection of papers in the October 2004 issue of the IEEE Journal of Oceanic Engineering, has led to continued successful physical oceanographic collaboration between investigators in the two countries, and countless important findings. After 2001, Professor Tang continued to foster this relationship, as National Taiwan University professor and as a Program Manager, National Science Council.

NTU Professor T. Y. David Tang.
May 2001, ASIAEX project.

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