SEMIDIURNAL INTERNAL TIDE SIGNATURE ON TOPEX/POSEIDON DATA DURING COARE

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Semidiurnal baroclinic tides were observed by in situ data during the Enhanced Monitoring Phase of the Coupled Ocean-Atmosphere Response Experiment (COARE) (September 1992 - February 1993). The Tropical Atmosphere-Ocean (TAO) mooring at 2°S-156°E (1739 m depth), on the Ontong Java plateau, fitted with additional sensors to precisely measure the surface-to-bottom dynamic height directly beneath two TOPEX/POSEIDON crossovers [Picaut et al., 1995], has proved useful for describing the internal tides [Gourdeau et al., 1997].

Evidence of semidiurnal internal tides

The signature on sea level of the internal tides from the TAO mooring has a 2.3 cm standard deviation (Figure 1).

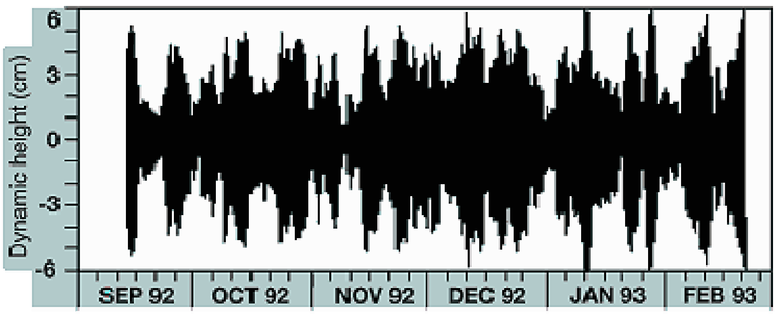

Figure 1
Time series of the semidiurnal surface to bottom dynamic height

Three dominant semidiurnal components, M2, S2 and N2, are detectable in this signal, M2 being the largest with a 2.3 cm amplitude against 0.8 cm for S2 and N2. M2 and S2 internal waves have different vertical structures: M2 resembles the first baroclinic mode while S2 resembles the second baroclinic mode. As suggested by Feng et al [1997], the internal tides propagate north eastward from a source determined to be 200-300 km south west of the mooring at a series of islands and shallow ridges located near the Kilinailau Trench (see Figure 1 in Gourdeau [1997]).

The internal wave signature on sea level is expected along the two TOPEX/POSEIDON tracks crossing over the mooring during the experiment (cycles 2-15), despite the weakness of the signal. Ray and Mitchum [1996] have also given evidence of surface manifestation of internal tides generated near Hawaii.

Knowing the probable direction of propagation of the baroclinic tides and the characteristic wavelengths for modes 1-2 (106 km and 55 km respectively), the theoretical apparent wavelengths along both ascending and descending satellite tracks can be calculated for each mode. On the descending track, the wavelength is 250 km (130 km) for mode 1 (mode 2) and on the ascending track, the wavelength is 117 km (61 km) for mode 1 (mode 2). The along track sea level anomaly spectra, averaged over the cycles 2-15, have notable peaks appearing at the suspected wavelengths [Gourdeau et al., 1997]. On the descending track, the 260 (130) km wavelength has a 5 (3) cm amplitude and on the ascending track the 117 (65) km wavelength has a 3 (1) cm amplitude for modes 1 and 2 respectively. Mode 1 is the major contribution to sea level as mode 1 is more significant than mode 2 in the upper 300 m.

A better tool for describing such heterogeneous signals is the "wavelet transform". This provides a three dimensional description of the signal, where its amplitude is given as a function of position and wavelength. The wavelet analysis was performed along both tracks for every 10-day TOPEX/POSEIDON cycle (2-15). Figure 2 shows the amplitudes averaged over all the cycles as a function of wavelength and latitude.

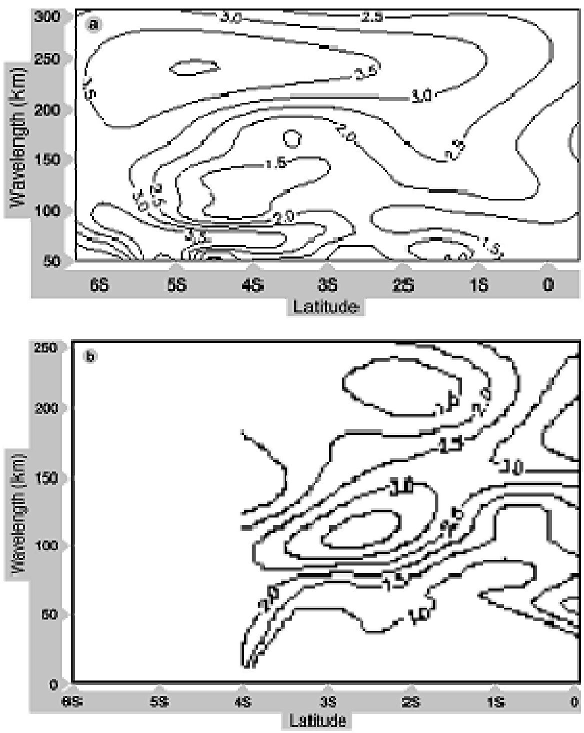

Figure 2
Mean amplitude (in cm) of along track sea level anomalies, function of wavelength, observed on ascending track (a) and descending track (b).

For the ascending track, the wavelet analysis clearly shows a signal for wavelengths in the 100-150 km range, between 3°S and 2°S with an amplitude reaching 4 cm, corresponding to the first baroclinic mode signal. For the descending track, a first baroclinic mode signal with a 250 km wavelength has a 4 cm amplitude and extended between 5°S and 3°S. It has a larger latitudinal extension, limited to the Ontong Java plateau, and it is further south than the corresponding signal of the ascending track. The mode 1 along-track signatures suggest both a north-eastward propagation of the baroclinic tides and their generation by a series of islands in line with the Kilinailau Trench or by the large sloping topography between the Kilinailau Trench and the Ontong Java Plateau, characterized by a 1000 km depth difference over 150 km (see Figure 1 in Gourdeau [1997]). In both cases, the orientation of the islands or of the 2000-3000 m topography is nearly parallel to the descending track, explaining why the along-track internal wave signature has a larger extension along the descending than the ascending track.

References :

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