Abstract View

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Measuring Dynamic Heights with Inverted Echo Sounders: Results from MODE

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ABSTRACT

Inverted Echo Sounders (IES) were deployed during MODE at seven ocean bottom stations to acoustically monitor depth variations of the main thermocline. The IES transmits pulses of 10 kHZ sound and records the time τ for the echo to return from the ocean surface; τ varies by a few milliseconds in response to vertical displacements of the temperature and salinity profiles in the water column. The acoustic travel time is inherently an integral measurement, which is insensitive to finestructure in the vertical but is dominantly influenced by vertical displacements which are coherent throughout the water column. Thus the IES performs as a natural "matched filter" for the most fundamental internal displacement mode. A perturbation analysis on the dynamic height (D), the total heat content (Q) and the acoustic travel time (τ) integrals shows that all three are dominated by displacements of the main thermocline. The proportionality is unique when a single mode of internal displacements is dominant.

Comparisons with MODE hydrographic data near each instrument show that the measured travel times may be rescaled into dynamic height (ΔD) records with an uncertainty of only ±1 dyn cm, which is comparable to the best of hydrographic measurements. Time series of τ show that internal waves on the main thermocline in this "mid-ocean" location have larger amplitude than is generally appreciated: ΔD can change by 2–3 dyn cm in 2–3 h, thereby aliasing a measurement taken at a single instant in time. Differences between the low-pass filtered IES dynamic height records from pairs of sites are compared, via the thermal wind relationship, with the observed current shear across the main thermocline, as determined from current meter and SOFAR float records; the agreement is good within the limitations imposed an estimating the current streamfunctions from a sparse network of current meters. Thus the IES records can be used to extend the mapping of the baroclinic velocity field.

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