Resonance of infragravity waves with ocean tides: Observations

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How and where the ocean tides dissipate the energy are longstanding questions whose answers would bear on consequences ranging from the history of the Moon to the climate changes. Historically, there are two principal mechanisms of the sink of tidal energy. One is the bottom friction in shallow seas and the other is topographic scattering of surface tides into internal waves in the open sea. Here we present evidence suggesting tidal dissipation by resonance with infragravity waves that occurs in deep oceans. The evidence comes from the records of broadband seismographs placed at deep seafloors, which are rich in signature of infragravity waves. We analyzed the vertical records of two long-term array observations, the 2003-2005 expeditions deploying 7 stations in the French Polynesia region and the 2005-2008 expeditions deploying 12 to 16 stations in the Philippine Sea and NW Pacific. We found that the low-pass filtered records in the tidal frequency band are coherent with the tilt component of the solid earth tide, suggesting that they register the tilt motion of sensor axis. The bandpass-filtered records at frequencies 13-50 mHz are, on the other hand, dominated by signal (noise?) of infragravity waves, which are strongly modulated by ocean tides with neap and spring tidal variations. We found that the tide-modulated wave groups tend to propagate in directions approximately conjugate to the cophase lines of the M2 tide (Matsumoto et al., 2000) with the apparent propagation speed of a cophase line. We also found that this apparent propagation speed almost coincides with the theoretical propagation speed of infragravity waves determined by water depth. Such coincidence suggests that free infragravity waves in deep oceans can be amplified by resonance with ocean tides upon phase-velocity matching.