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Variations in sea surface roughness induced by the 2004 Sumatra-Andaman tsunami

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Abstract. Observations of tsunamis away from shore are critically important for improving early warning systems and understanding of tsunami generation and propagation. Tsunamis are difficult to detect and measure in the open ocean because the wave amplitude there is much smaller than it is close to shore. Currently, tsunami observations in deep water rely on measurements of variations in the sea surface height or bottom pressure. Here we demonstrate that there exists a different observable, specifically, ocean surface roughness, which can be used to reveal tsunamis away from shore. The first detailed measurements of the tsunami effect on sea surface height and radar backscattering strength in the open ocean were obtained from satellite altimeters during passage of the 2004 Sumatra-Andaman tsunami. Through statistical analyses of satellite altimeter observations, we show that the Sumatra-Andaman tsunami effected distinct, detectable changes in sea surface roughness. The magnitude and spatial structure of the observed variations in radar backscattering strength are consistent with hydrodynamic models predicting variations in the near-surface wind across the tsunami wave front. Tsunami-induced changes in sea surface roughness can be potentially used for early tsunami detection by orbiting microwave radars and radiometers, which have broad surface coverage across the satellite ground track.

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