Exploring tectonic processes beneath the oceans using new seafloor observations.

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New data and analyses of seafloor temperature, pressure, and seismic observations have led to insights about transient slow slip events (SSEs) along subduction zone plate interfaces or faults in the overriding plate (Wallace et al., 2016; Suzuki et al., 2016; Araki et al., 2017; Muramoto et al., 2018), sediment gravity flows and turbidites generated by earthquake shaking (Johnson. et al., 2017), and the interplay between accretionary prism structure and seismic wave characteristics (Gomberg, 2018). This presentation focuses on SSEs and insights about the accuracy and uniqueness of vertical displacement estimates attributed to them, when derived from seafloor absolute pressure gage measurements. These insights come from seafloor pressures observed on a temporary sensor network deployed near an SSE (known from onshore GPS data) in the Hikurangi subduction zone of New Zealand (Wallace et al., 2016; Muramoto et al., 2018), in combination with co-located temperature measurements and simulated pressures and temperatures derived from a numerical ocean circulation model. Results show that vertical displacements may be estimated reliably when a few cm or larger, but that at least for these data, ocean water column pressure changes likely contributed significantly to estimates that were previously attributed to the SSE. When only pressure data are used, distinguishing between water column and SSE generated displacements requires assumptions about the spatial scales of changes in both, which cannot be tested without other types of data. Clear correlations between co-located temperature and pressure recordings suggested temperatures might enable such testing, serve as proxies for water column pressures, and eliminate the need for spatial scale assumptions. While this may be true elsewhere, for reasons that may be unique to the ocean circulation in the Hikurangi zone, the temperatures failed as useful proxies. Application of the same displacement estimation methods to numerically simulated ocean circulation-generated seafloor pressures and temperatures (i.e., with no SSE) resulted in displacement patterns that are very similar to those observed, leading to the conclusion that previous interpretations ascribing them entirely to SSE displacements need rethinking. We continue to explore approaches to improve the fidelity with which seafloor measurements reveal tectonic deformation, for Cascadia, Alaska and hopefully Japan; unlike the datasets from these other regions, the multi-year operation and dense station spacing of the DONET array mean its data hold special promise for significant advances.

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