U.S. WEST COAST RELATIVE SEA LEVELS FROM TIDE GAUGES

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Abstract

A series of articles by Aubrey and Emery have documented relative sea level changes in Japan, eastern Asia mainland, Australia, Scandinavia/Northern Europe, U.S. east coast, U.S. west coast, and South America. Concentrating on nteranmual variability in relative sea levels, these studies show the strong impact of tectonism and isostatic processes on relative sea-level records. With the short record lengths and nonunique sources of low-frequency relative sea-level changes (e.g., isostasy, eustasy, and tectonism), separation of the various contributions cannot be accomplished spectrally. When examining any geophysical time series, one must beware of the redness of the spectrum compared to the finite record length.

Examining secular changes in relative sea level along the U.S. west coast, we have identified strong tectonic signals. Tectonism exists not only on a coherent plate-wide scale (assuming a rigid plate approximation), but also on a sub-plate scale. In fact, differential tectonism between exotic or suspect geological terrain explains much of the spatial patterns of west coast tide-gauge data. Peltier's isostatic model appears not to explain the spatial pattern, implying glacio-isostatic adjustment is not the dominant contribution to the low-frequency signals. Eustatic effects cannot be identified unambiguously.

These studies suggest several major questions/observations with regard to relative sea-level studies:

(1) Spectral differentiation of relative sea-level effects is difficult due to similar time scales of eustasy, isostasy and tectonism. These time scales are long compared to record length.

(2) Model-fitting is difficult due to incomplete knowledge of the physics involved. For instance, isostatic adjustments are at best approximate over these short time scales. In addition, tectonic processes are only subjectively and qualitatively describable (e.g., suspect terrain, plate-scale motions, subduction).

(3) Tectonism and isostasy may mask long-term climate signals, given the short length of record.

(4) El Niño events stand out along Pacific stations, but represent only a small proportion of relative sea-level variance. Meteorological and oceanographic influences explain more of the higher frequency (0.1 - 0.5 cpy) variability.

(5) A sharp change in rate of relative sea-level rise has been identified in 1930-35 for Scandinavia, U.S. east coast, and U.S. west coast tide-gauge records. Similar changes have been described by Barnett (1984). What is the cause for this change? Is any part a response to climactic/atmospheric phenomena such as the Greenhouse effect?

(6) Studies of basin-wide and global coherence are required to resolve some of these questions, using sophisticated statistical analysis and model-fitting. How strong are sea-level teleconnections? What are the mechanisms for these teleconnections?