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Comprehensive Examination of Sea Level Variations over the Length and Breadth of the Red Sea and Adjacent Gulfs

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Shallow environments in the Red Sea, such as found over the crests of platform reefs, are highly sensitive to changes in water depth. To better understand the variations of water level over the Red Sea system, our study employed in situ sea level measurements and reanalysis wind data from the Red Sea and two adjacent Gulfs (i.e. Gulf of Aden and Gulf of Aqaba). The sea level variations were divided into three frequency bands: tidal (T<1.5 d), weather (1.5<T<30 d) and seasonal (T=1 yr) [where T is period]. The seasonal sea level signal makes the smallest contribution to the overall sea level variance. Over the full Red Sea and the Gulf of Aqaba, the seasonal signal is remarkably coherent, with nearly uniform phase and an amplitude of $\sim$ 0.15 m. By contrast, the seasonal sea level signal in the Gulf of Aden has an amplitude of only 0.08 m and is not in phase with the Red Sea seasonal sea level signal. The tidal signal is dominant at the northern and southern extremes of the Red Sea and in the adjacent gulfs. However, the weather-band signal dominates sea level variations in the central Red Sea. Correlation and EOF analyses reveal that 93.5 % of the weather-band sea level variance over the Red Sea is due a single mode of motion in which the sea level rises and falls coherently, with nearly uniform phase, over the full extent of the Red Sea and Gulf of Aqaba. This mode appears to be decoupled from sea level motions in the Gulf of Aden. Correlation analysis suggests that it is driven principally by the along-axis component of surface wind stress over the southern Red Sea.