Geophysical Research Abstracts
Vol. 18, EGU2016-11102, 2016
EGU General Assembly 2016

Dynamics of sea level variations in the coastal Red Sea

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Sea level variations in the central Red Sea coastal zone span a range of roughly 1.2 m. Though relatively small, these water level changes can significantly impact the environment over the shallow reef tops prevalent in the central Red Sea, altering the water depth by a factor or two or more. While considerable scientific work has been directed at tidal and seasonal variations of Red Sea water level, very little attention has been given to elevation changes in an 'intermediate' frequency band, with periods of 2-30 d, even though motions in this band account for roughly half of the sea level variance in central Red Sea. We examined the sea level signal in this band using AVISO sea level anomaly (SLA) data, COARDAS wind data and measurements from pressure sensors maintained for more than five years at a number of locations in Saudi Arabian coastal waters. Empirical orthogonal function analysis of the SLA data indicates that longer-period (10-30 d) sea level variations in the intermediate band are dominated by coherent motions in a single mode that extends over most of the Red Sea axis. Idealized model results indicate that this large-scale mode of sea level motion is principally due to variations in the large-scale gradient of the along-axis wind. Our analysis indicates that coastal sea level motions at shorter periods (2-10 d) are principally generated by a combination of direct forcing by the local wind stress and forcing associated with large-scale wind stress gradients. However, also contributing to coastal sea level variations in the intermediate frequency band are mesoscale eddies, which are prevalent throughout the Red Sea basin, have a sea level signal of 10's of cm and produce relatively small-scale (order 50 km) changes in coastal sea level.