Wind-Wave Climate Studies for the Indian Ocean

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ABSTRACT

The thesis provides a comprehensive overview on the wind-wave climate over the Indian Ocean region for the past two decades utilizing satellite altimeter data and wave model products. It also proposes a new method to extract perturbations in specific climate variables due to external factors. The study examines the trend in different wave parameters such as maximum significant wave height (MSWH), mean wave direction and period (MWD, MWP); swell mean wave direction and period, and peak wave period (PWP). To understand the inter-dependency between these parameters the study also investigated the spatiotemporal correlation between these parameters using directional statistics methods used for the first time in climate analysis. The Bay of Bengal and Arabian Sea located in the North Indian Ocean showed an increased MWSH activity as well changes in wave directional behavior in the past two decades. The highest MSWH variability occurred over the South Indian Ocean (SIO) region, a potential region of swell generation. The study also examines the swells generated from SIO basin and its influence over the North Indian Ocean region. The trend analysis for the Bay of Bengal region clearly deciphers the role and importance of swells in the overall wave field. These are evident in the circular correlation maps generated between MWD and swell MWD with the highest positive correlation observed over the Bay of Bengal. Based on MWD and PWP analysis, the effect of local wind direction and extreme waves from Southern Ocean impacts the Arabian Sea region. The EOF (Empirical Orthogonal Function) analysis on MSWH for the Southern Ocean clearly indicates a dipole pattern in EOF2 (EOF second mode) with a unique oscillatory pattern having both intra-seasonal and inter-seasonal variations. The study also investigated the degree of polarity and inclinations in the dipole pattern using radon transform an integral transform method whose inverse finds application in varied fields such as image reconstruction and line detection. It is a mapping technique from Cartesian rectangular coordinates to a polar coordinate system. Further, the study examined the application of low rank and sparse decomposition method on

two climate variables such as SST and wind speed. The analysis of sparse components show a decadal reversal pattern in maximum wind speed over the North Indian Ocean region and also analyzed the effect of strong 1997 El Nino on the SST variability over the Indian Ocean region.