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Sea Breezes over the Red Sea: Affect of topography and interaction with Desert Convective Boundary Layer

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Thermodynamic structure of sea-breeze, its interaction with coastal mountains, desert plateau and desert convective boundary layer have been investigated in the middle region of the Red Sea around 25°N, at the Western coast of Saudi Arabia. Sea and land breeze is a common meteorological phenomenon in most of the coastal regions around the world. Sea-Breeze effects the local meteorology and cause changes in wind speed, direction, cloud cover and sometimes precipitation. The occurrence of sea-breeze, its intensity and landward propagation are important for wind energy resource assessment, load forecasting for existing wind farms, air pollution, marine and aviation applications. The thermally induced mesoscale circulation of sea breeze modifies the desert Planetary Boundary Layer (PBL) by forming Convective Internal Boundary Layer (CIBL), and propagates inland as a density current. The leading edge of the denser marine air rapidly moves inland undercutting the hot and dry desert air mass. The warm air lifts up along the frontal boundary and if contains enough moisture a band of clouds is formed along the sea breeze front (SBF). This study focuses on the thermodynamic structure of sea-breeze as it propagates over coastal rocky mountain range of Al-Sarawat, east of the Red Sea coast, and the desert plateau across the mountain range. Additional effects of topographical gaps such as Tokar gap on the dynamics of sea-land breezes have also been discussed. Interaction of SBF with the desert convective boundary layer provide extra lifting that could further enhance the convective instability along the frontal boundary. This study provides a detailed analysis of the thermodynamics of interaction of the SBF and convective internal boundary layer over the desert. Observational data from a buoy and meteorological stations have been utilized while The Advanced Research WRF (ARW) modeling system has been employed in real and 2D idealized configuration.