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The interaction of the sea breezes with the boundary layer along the Red Sea coast and its effect on the dust transport

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Sea and land breezes are common meteorological phenomena in most coastal regions of the world. The thermally induced mesoscale circulation of sea breezes modifies the planetary boundary layer (PBL) by forming a convective internal boundary layer (CIBL), which can trap dust and other pollutants in the thin convective layer while the return flow can transport dust and pollutants from the land towards the sea. We used the Advanced Research WRF (ARW) modeling system to study the structure and dynamics of sea breezes in the middle region of the Red Sea (around 25°N) on the western coast of Saudi Arabia. Results showed the existence of two thermal circulations on both the western and eastern coasts of the Red Sea. The modeling results are consistent with observations from buoys and meteorological towers along the Saudi Arabian coast and suggest that the onset of the sea breeze in this area typically occurs at about 0800 Local Standard Time (LST). The sea breeze decays after 1700 LST, although the timing of the onset and decay could be affected by the sea-land thermal gradient, topography, the sea-land orientation and the direction and strength of the wind. The depth of the predicted inflow layer reaches one kilometer while the height of sea breeze head may reach three kilometers. The rocky mountain range of Al-Sarawat, along the Saudi coast line, restricts the inland propagation of the sea breeze and significantly affects the structure of the flow. We conducted a detailed process analysis of our simulation results to understand the sea breeze and PBL interaction and its effect on local meteorology and dust transport.