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Spatio-temporal variability of the thermodynamic characteristics of the marine atmospheric boundary layer (MABL) over the Indian and Southern Ocean (15°N to 70°S)

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The study deals with the thermodynamic characterization of marine atmospheric boundary layer (MABL) prevailing over regions of Indian Ocean and Indian Ocean sector of Southern Ocean from 29 high-resolution radiosondes launched during the International Indian Ocean Expedition (IIOE-2) and Southern Ocean Expedition (SOE-9). IIOE-2 was conducted during December 2015 onboard ORV Sagar Nidhi during which 11 radiosondes were launched, whereas SOE-9 was conducted during January-March 2017 onboard MV SA Agulhas which had 18 radiosonde ascents. These observations spanned latitudes from ~15°N to 70°S having crossed three major atmospheric circulation cells: Hadley cell, Ferrell cell and Polar cell. In addition, crucial atmospheric mesoscale phenomena such as inter-tropical convergence zone (ITCZ), sub-tropical jet (STJ) and polar jet (PJ) were encountered along with several oceanic fronts. Analysis of thermodynamic structure of MABL showed large variability in the formation of atmospheric sub-layers such as surface layer, mixed layer, cloud layer and trade wind inversion layer within MABL. MABL height varied spatially from tropics and mid-latitudes (12°N to 50°S) to polar latitudes (60°S to 68°S). Deep mixed layer were found over the tropics and mid-latitudes (~700 m) while shallow mixed layer was observed over the polar latitudes (~200 m). Deep mixed layer over the tropics were attributed to intense convective mixing while shallow mixed layer over polar regions was attributed to limited convective overturning associated with negative radiation balance at the surface. Convection was negligible over mid-latitudes (43°S to 55°S) where most of the atmospheric mixing were forced by frontal systems where lifting of air mass was mechanically driven by high speed winds rather than by convection. The enhanced convection over the tropics was confirmed from higher values of convective available potential energy (CAPE > 1000 J/kg) and large negative values of convective inhibition energy (CINE < -50 J/kg). Over the mid-latitude region (43°S to 50°S), enhanced advection and detrainment of convection was evident with maximum values of BRN shear (~65 knots) and lowest CAPE (~4 J/kg). Over polar latitudes (~60°S to 68°S), minimum CAPE (~17 J/kg) and low BRN shear (~5 knots) was noticed, which indicated presence of stable boundary layer conditions. A mesoscale phenomenon (i.e., ITCZ) was witnessed at ~5.92°S with highest CAPE ~2535.17 J/kg which signifies large convective instability resulting in strong convective updraft aiding thunderstorm activity and moderate precipitation over ITCZ. Analysis of conserved variables (CVA)

revealed formation of second mixed layer (SML) structure between 12^{o}N and 40^{o}S. However, south of 40^{o}S this structure ceases. The characteristics of SML structure and the plausible causes for its existence are also investigated.