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Probing the dynamical features of intense pre-monsoon and summer monsoon deep convective systems using ARIES Stratosphere Troposphere Radar (206.5 MHz) over the Central Himalayan region

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Deep convection is known to be critical for the transport of mass and momentum flux, heat and moisture throughout in the upper troposphere and lower stratosphere region. Hence it modifies the heat budget and general circulation in the atmosphere. Earlier studies have noted very strong instability in the atmosphere over Himalayan foothills, triggering occasional intense convection due to the orographic lifting of the low level moist flow. However due to the lack of observational network over this complex terrain, a comprehensive analysis of these events and their impacts have not been done.

Recently a Stratosphere Troposphere Radar (wind profiler) operating at VHF frequency of 206.5 MHz has been installed at a high altitude site Aryabhatta Research Institute of Observational Sciences (ARIES) (29.4^{o}N, 79.5^{o} E, 1790 m amsl) in Nainital located in Himalayan foothills, a meteorologically sensitive subtropical region. Using the capability of VHF radar of detecting echoes from both clear air and precipitation, intense deep convection systems were observed on May 5, 2020 and September 2, 2020. Both the events have been studied in details using the temporal and vertical evolution of radar parameters like total backscattered power and spectral width. Reanalysis data from MERRA-2 and cloud fraction data of IR and Water Vapour channels of INSAT 3D has also been used to investigate underlying synoptic features of the event. Here, it is suggested that deep convection of the pre-monsoon season was induced due to moisture carried by the western disturbance. While the event in monsoon season was due to the easterly moist flow from the Bay of Bengal. The moisture in the mid - troposphere coupled with the orographic lift led to vigorous updrafts and downdrafts of magnitude reaching up to 16 m/s. Updrafts found to be extending well beyond the tropopause into the lower stratosphere region. From the temporal evolution of vertical wind velocity obtained from ST Radar, a clear demarcation between updrafts and downdrafts region was established during the mature phase of the event due to veering of the wind from lower to upper troposphere which also led to the tilting of the updraft cores. During the event the exchange of the vertical flux of horizontal momentum between upper troposphere and lower stratosphere has also been estimated. A significant enhancement (2 – 3 times) in mean zonal ($u'w'$) and meridional component ($v'w'$) of momentum flux has been observed during convection as compared to quiet period. In the upper troposphere and lower

stratosphere region mean flux values even reached up to about 33 m^2 s^{-2}. We feel that this study will help in providing the crucial insights of the dynamical features of meso-scale convective phenomenon in the central Himalayan region for the first time.