



A Comprehensive Investigation of the Atmospheric Clouds and Boundary Layer using PRL's Indian Lidar Network (ILIN) Program: A Novel Perspective

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Atmospheric clouds are one of the vital components of the hydrological cycle and play important role on modulating Earth's radiation budget and also play an important role in the weather and climate of the earth-atmosphere system. Understanding of the vertical distribution of clouds, their properties, and temporal evolution are essential for understanding the origin and impact of clouds and their feedback on the above-mentioned processes and their parameterization in weather and climate models for improving forecast. Atmospheric Boundary Layer (ABL) characteristics lies in their direct and indirect influence on living beings and the environment and it work like packing volume of most of the pollutants. Understanding ABL characteristics, and ABL-clouds interactions along with pollutants is essential for improving weather forecasting, air quality management, climate modeling, and many more atmospheric processes. This study deals with the investigation of Cloud characteristics, ABL dynamics and pollutants using lidars operating under the Physical Research Laboratory's Indian Lidar Network (ILIN) Program over the Indian region. Ground-based observations using ceilometer lidar show a prominent diurnal variation of ABL, with summer boundary layer height (BLH) exceeding the winter BLH by 1-1.5 km. The substantial variation in surface fluxes during the two seasons drives these differences. During the onset of monsoon, the ABL is thicker compared to active monsoon. The seasonal variation of BLH is crucial for several environmental aspects. Further, we have investigated the role of dust storms on the Clouds and ABL over an urban location in Western India. The characteristics of cloud base height and modulations in the ABL over a hilly remote station in northeast India are also investigated. The accuracy of reanalysis datasets in representing the boundary layer over the Western-Indian region has been assessed using observations from ILIN. The reanalysis datasets show less than 1 km differences from the ground-based lidar observations. However, the performance of reanalysis in representing BLH has a seasonal dependency. Satellite observations overestimated the observed BLH. Therefore, it is essential to monitor the Clouds and ABL using ground-based instruments continuously covering different regions and seasons. A good network of ground-based lidar observations of clouds and ABL along with other atmospheric parameters provides ground-truth inputs for weather and climate models. This will further help in improving weather forecasting, air quality management, and climate predictions over the India region.