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Spatio-temporal variations of Planetary Boundary Layer characteristics over Indian subcontinent

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The Planetary Boundary Layer (PBL) characteristics play an important role in mixing, cloud formation and pollutant transport, but their diurnal, seasonal and inter-annual variations on a regional scale over the Indian subcontinent is not well-understood. Proper PBL characterization requires measurements with adequate spatial and temporal resolution, whereas methods using traditional radiosonde observations are limited in spatial and temporal coverage and observations are lacking over oceanic regions. Again, the available twice daily observations over the Indian region are in the local morning and evening hours (corresponding to 0000 and 1200 UTC), which completely excludes information on daytime and nocturnal boundary layer.

Atmospheric profiling with the satellite based Global Positioning System (GPS) Radio Occultation (RO) is a relatively new technique that provides air temperature and water vapor profiles with an almost uniform global coverage at sufficiently large vertical resolution (100 – 200 m in the troposphere to 1 km in the stratosphere). The RO technique utilizes the information on bending and time delay of GPS signals for the estimation of atmospheric refractivity and thus the air temperature and water vapor profiles. The GPS RO atmospheric profiles can fill in the temporal and spatial voids in radiosonde data and be used for the estimation of PBL parameters. The Indian subcontinent characterized by two monsoon regimes and several different climate zones with humid and arid regions, is an ideal test bed for evaluating the GPS RO data. However, evaluation and use of these datasets over the Indian subcontinent have been limited.

The present study focuses on the estimation of PBL height and other important boundary-layer parameters from GPS RO data and validating them by comparing with those derived from radiosonde measurements over different geographical locations on Indian subcontinent. The COSMIC (Constellation Observing System for Meteorology Ionosphere & Climate) RO atmospheric profiles over the Indian region during 2007-2009 are used for the analysis. The radiosonde data used are from two sources: (i) routine radiosonde observations conducted by India Meteorological Department over the Indian subcontinent and (ii) additional radiosonde observations conducted by the Indian Institute of Tropical Meteorology as a part of the Cloud Aerosol Interaction and Precipitation Enhancement Experiment (CAIPEEX) during the southwest monsoon season May-September, 2009. In order to extrapolate the information on a spatio-temporal scale, comparison of PBL parameters from the observational methods and high-resolution WRF model simulations over selected regions is also conducted. The variation in PBL characteristics over the Indian subcontinent are depicted using parameters calculated from observations and WRF model simulations.