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Planetary Boundary Layer variability over New Delhi, India, during EUCAARI project

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Atmospheric lidar measurements were carried out at Gual Pahari measurement station, approximately 20 km south of New Delhi in India throughout a year (from March 2008 to March 2009), under the framework of the EUCAARI (European Integrated project on Aerosol Cloud Climate and Air Quality Interactions) project. In Southern Asia, only a few measurements of aerosol vertical profiles have been carried out. However, observations in this polluted area are crucial to reveal information on local air quality. Planetary Boundary Layer (PBL) depth is a critical component in air pollution models, since it determines the pollutant mixing volume, which is a key parameter for the assessment of concentrations. The PBL top was continuously measured using a Raman lidar, PollyXT (POrtabLe Lidar sYstem eXTended). The PBL depths were retrieved from the 15 min averaged lidar backscatter signals at 1064 nm using the modified wavelet covariance transform (WCT) method. PBL depth was also derived from radiosonde data by utilizing the Bulk Richardson Number (BRN) method. Lidar results were compared to radiosondes, CALIOP (Cloud-Aerosol Lidar with Orthogonal Polarization) space-borne lidar level 2 aerosol layer product and ECMWF (European Center for Medium Weather Forecasts) model data. Lidar measurements were possible during 2081 out of 3578 total 15min daytime periods (from 4 h after sunrise to 1 h before sunset). Thus, the data coverage was, on average, 58% with respect to the total time. PBL depths could successfully be determined with the modified WCT method in 56% of the cases, with the remaining 44% of the cases to be attributed to low clouds, fog, and complex aerosol layer structures. Comparisons between lidar and radiosonde derived PBL tops revealed variation both during daytime (12:00 UTC, 17:30 IST) and night-time (00:00 UTC, 05:30 IST). About 24% of the daytime lidar PBL tops (46 cases) were within the $\pm$25% of those derived from the soundings. The slope of the linear fit was 0.56 (x-intercept forced to zero in all fittings), while the Pearson correlation coefficient was 0.22. Regarding the night-time (31 cases), 97% of the radiosonde acquired PBL depths were within the $\pm$25% of the lidar depths. The slope of the fit was equal to 1.24, while the Pearson correlation coefficient was 0.28. The variation could be attributed to the distance between the lidar station and the radiosonde site (Safdarjung Airport, 20 km from Gual Pahari), the detection of the residual layer (RL) top from lidar during night-time (25% of night-time cases) and the height resolution of the soundings. The statistical analysis, based on cases with sufficient data coverage (79 daytime periods), revealed significant variability in seasonal mean and maximum PBL depths. The mean and maximum PBL depths were, respectively, 677 m and 931 m in winter (December to March), 980 m and 1418 m in the pre-monsoon season (April to June), 857 m and 1094 m during the monsoon season (July to September). The daily growth rates were, on average, 151 m/hour in winter, 180 m/hour in the pre-monsoon season and 167 m/hour in the monsoon season.