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Assessment of the planetary boundary layer height by means of machine learning techniques using ceilometer signals

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It is well known that anthropogenic aerosols deteriorate air quality increasing public health risk. Therefore their characterization must be one of the main objectives in atmosphere studies, although the heterogeneous distribution of the aerosols in the atmosphere hampers it. Anthropogenic aerosols are mostly concentrated within the planetary boundary layer (PBL) that extends from the surface up to a variable height that usually coincides with the presence of a temperature inversion. The PBL height, then, is affected by the radiation emitted by the surface causing turbulence and evolving along the day and in this way limiting the vertical mixing of the air pollutants generated near the surface. Therefore, it can be assumed that the lower the PBL height, the higher the aerosol concentration from local sources. Lidars have demonstrated their capabilities to study the aerosol vertical distribution and their spatio-temporal evolution can provide very complete information on both aerosol spatial distribution and their characterization. Their wavelength dependence of the backscatter and extinction coefficients allows for a more detailed discrimination of aerosol types. On the other hand, ceilometers are capable of providing continuous aerosol vertical profiles with good spatial resolution and a large range, besides ceilometers operating at 1064nm can provide backscatter and extinction coefficients as Lidar instruments. The present work has been carried out in the Madrid metropolitan area located in the center of the Iberian Peninsula, which counts with a population of nearly 6 million inhabitants and a car fleet of almost 3 million vehicles. Its main objective is the assessment of the planetary boundary layer height by means of machine learning techniques using ceilometer signals and also its validation by using multiwavelength lidar measurements and radiosoundings. Typical techniques as the wavelet and the gradient methods are unable to detect the PBL in cases with presence of low clouds or residual layers. For that purpose, several profiles stored in the Madrid database, covering different synoptic situations as long-range transport of aerosols and clean-atmosphere situations are used. These profiles have been performed by the CHM15k Nimbus ceilometer deployed next to the MDR-CIEMAT ACTRIS station (40.4565ºN, 3.7257ºW, 663 m a.s.l.), equipped with a Lidar-Raman instrument (integrated in EARLINET-ACTRIS) and located in the Madrid North-West city outskirts.

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