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Observations of the atmospheric boundary layer height over Abu Dhabi, United Arab Emirates: Investigating boundary layer climatology in arid regions

Mohamed Al Marzooqi (1,2), Ghouse Basha (1,2), Taha B.M.J. Ouarda (1,2), Peter Armstrong (3,4), Annalisa Molini (1,2)

(1) iWATER, Institute Centre for Water Advanced Technology & Environmental Research, Masdar Institute of Science and Technology, PO Box 54224, Abu Dhabi, United Arab Emirates (amolini@masdar.ac.ae), (2) Department of Chemical and Environmental Engineering, Masdar Institute of Science and Technology, PO Box 54224, Abu Dhabi, United Arab Emirates, (3) iENERGY Institute Center for Energy, Masdar Institute of Science and Technology, PO Box 54224, Abu Dhabi, United Arab Emirates, (4) Department of Mechanical and Materials Engineering, Masdar Institute of Science and Technology, PO Box 54224, Abu Dhabi, United Arab Emirates

Strong sensible heat fluxes and deep turbulent mixing – together with marked dustiness and a low substrate water content – represent a characteristic signature in the boundary layer over hot deserts, resulting in “thicker” mixing layers and peculiar optical properties. Beside these main features however, desert ABLs present extremely complex local structures that have been scarcely addressed in the literature, and whose understanding is essential in modeling processes such as the transport of dust and pollutants, and turbulent fluxes of momentum, heat and water vapor in hyper-arid regions.
In this study, we analyze a continuous record of observations of the atmospheric boundary layer (ABL) height from a single lens LiDAR ceilometer operated at Masdar Institute Field Station (24.4oN, 54.6o E, Abu Dhabi, United Arab Emirates), starting March 2013. We compare different methods for the estimation of the ABL height from Ceilometer data such as, classic variance-, gradient-, log gradient- and second derivation-methods as well as recently developed techniques such as the Bayesian Method and Wavelet covariance transform. Our goal is to select the most suited technique for describing the climatology of the ABL in desert environments. Comparison of our results with radiosonde observations collected at the nearby airport of Abu Dhabi indicate that the WCT and the Bayesian method are the most suitable tools to accurately identify the ABL height in all weather conditions. These two methods are used for the definition of diurnal and seasonal climatologies of the boundary layer conditional to different atmospheric stability classes.