EMS Annual Meeting Abstracts
Vol. 7, EMS2010-170, 2010
10th EMS / 8th ECAC

High resolution climatology
- towards climate change services

Deriving boundary layer mixing height from LIDAR measurements using a Bayesian statistical inference method.

A. Riccio (1), L. Caporaso (2,3), F. Di Giuseppe (2), G. Bonafè (2), G. P. Gobbi (3), and A. Angelini (3)
(1) Dept. of Applied Science, University of Napoli "Parthenope", Napoli, Italy, (2) ARPA, SIMC, Bologna, Italy, (3) CNR-ISAC, Roma,Italy

The nowadays availability of low-cost commercial LIDAR/ceilometer, provides the opportunity to widely employ these active instruments to furnish continuous observation of the planetary boundary layer (PBL) evolution which could serve the scope of both air-quality model initialization and numerical weather prediction system evaluation. Their range-corrected signal is in fact proportional to the aerosol backscatter cross section, and therefore, in clear conditions, it allows to track the PBL evolution using aerosols as markers. The LIDAR signal is then processed to retrieve an estimate of the PBL mixing height. A standard approach uses the so called wavelet covariance transform (WCT) method which consists in the convolution of the vertical signal with a step function, which is able to detect local discontinuities in the backscatter profile. There are, nevertheless, several drawbacks which have to be considered when the WCT method is employed. Since water droplets may have a very large extinction and backscattering cross section, the presence of rain, clouds or fog decreases the returning signal causing interference and uncertainties in the mixing height retrievals. Moreover, if vertical mixing is scarce, aerosols remain suspended in a persistent residual layer which is detected even if it is not significantly connected to the actual mixing height. Finally, multiple layers are also cause of uncertainties.

In this work we present a novel methodology to infer the height of planetary boundary layers (PBLs) from LIDAR data which corrects the unrealistic fluctuations introduced by the WCT method. It implements the assimilation of WCT-PBL heights estimations into a Bayesian statistical inference procedure which includes a physical model for the boundary layer (bulk model) as the first guess hypothesis. A hierarchical Bayesian Markov chain Monte Carlo (MCMC) approach is then used to explore the posterior state space and calculate the data likelihood of previously assigned PBL heights. Finally the data likelihood is used to discriminate between realistic and unrealistic PBL heights and ‘regularize’ experimental values.

The new method is tested for several days of continuous measurements collected during the BASE:ALFA projects. It is shown that the new methodology allows for a realistic description of the PBL time evolution, as demonstrated by the comparison with independent data from the analysis of radiosounding profiles.