Geophysical Research Abstracts
Vol. 12, EGU2010-3208, 2010
EGU General Assembly 2010

Unattended automatic monitoring of boundary layer structures with cost effective lidar ceilometers

Christoph Münkel (1) and Reijo Roininen (2)

(1) Vaisala GmbH, Hamburg, Germany (christoph.muenkel@vaisala.com), (2) Vaisala Oyj, Helsinki, Finland (reijo.roininen@vaisala.com)

The vertical temperature and moisture distribution affect the layering of the atmospheric boundary layer and the existence of inversions within this layer or on the top of it. These layers have a strong influence on the development of episodes of high concentrations of air pollutants which might be harmful to people and ecosystems. The height of the mixing layer is defined as the height up to which due to the thermal structure of the boundary layer vertical dispersion by turbulent mixing of air pollutants takes place. Most of the aerosol particles in an atmospheric column are usually confined to atmospheric layers below this height, the knowledge on the mixing layer height can thus be employed to convert column-mean optical depths measured from satellites into near-surface air quality information.

Eye-safe lidar ceilometers are reliable tools for unattended boundary layer structure monitoring around the clock up to heights exceeding 2500 m. Comparison to temperature, humidity, and wind profiles reported by RASS, sodar, radio soundings, and weather mast in-situ sensors has confirmed their ability to detect convective or residual layers. In addition, ceilometers with a single lens optical design enable precise assessment of inversion layers and nocturnal stable layers below 200 m. This design has been chosen for the Vaisala Ceilometer CL31, the standard cloud height indicator for the Automated Surface Observing System of the US National Weather Service (NWS).

During a two years evaluation period, the NWS permanently collected backscatter profiles from at least three ceilometers at its test site in Sterling, VA. Based on these and on data from units running at the Vaisala test sites in Vantaa, Finland, and Hamburg, Germany, an automatic algorithm for online retrieval of aerosol layer heights within the boundary layer has been developed that covers not only ideal boundary layer diurnal evolution, but all situations involving clouds, fog, and precipitation. This algorithm is part of the Vaisala boundary layer reporting and analysis tool BL-VIEW.

The algorithm is based on the gradient method looking for gradient minima of the backscatter intensity to mark upper edges of aerosol layers. Main additional features of the novel automatic algorithm are a cloud, fog and precipitation filter designed to avoid false hits, a noise and range dependant averaging scheme, and a variable detection threshold. Examples covering a variety of meteorological situations in all seasons will be presented that demonstrate the quality of the algorithm and its application in the field of air quality forecasting.