Geophysical Research Abstracts
Vol. 14, EGU2012-13036, 2012
EGU General Assembly 2012

Turbulence measurements with lidar

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During COPS, for the first time, a combination of a high-resolution water-vapor differential absorption lidar (DIAL) and a rotational Raman lidar (RRL) for temperature measurements was operated. This was an excellent opportunity to investigate these systems with respect to their capability of monitoring turbulent exchange processes in the convective boundary layer (CBL).
For this purpose, an extensive analysis of measurements during COPS will be presented, mainly focusing on IOP11b. During this IOP, which was characterized by fair weather conditions within a high pressure ridge, a relatively shallow CBL developed over the northern Black Forest mountain range. Thiswas an excellent opportunity for studying vertical exchange processes in complex terrain.
The measurements are characterized with respect to noise and systematic errors. It is demonstrated that the DIAL measurements provide a unique SNR at resolutions of 1 s and 15 m vertically, respectively. This permits the profiling of turbulent moments of water-vapor up to the forth order. Similar analyses demonstrate that the RRL can also be applied for turbulent profiling in the CBL albeit - due to a lower SNR - up to the second order and with resolutions of 10s and 60 m, respectively.
In the CBL, the profiles of variances, skewness, and kurtosis show a structure with is in good agreement with turbulence theory and large eddy simulation.
These results make the combination of DIAL and RRL unique tools for studying land-surface-atmosphere exchange processes including the entrainment zone. Vertical profiling and scanning strategies are presented so that these systems can be used directly for studying turbulence models and the parameterization of turbulent transport processes in the CBL in mesoscale models.