Geophysical Research Abstracts
Vol. 17, EGU2015-5526, 2015
EGU General Assembly 2015

One year of Raman lidar observations of free tropospheric aerosol layers over South Africa

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Long-term studies of atmospheric aerosols over South Africa are limited. Moreover, in previous studies the optical properties of aerosols have been studied by means of sun photometers, in situ data and satellite observations. Thus there is a clear need for vertically resolved observations with advanced multiwavelength lidars. In this study we present one year Raman lidar data that have been performed over Highveld in South Africa. The data have been analysed in regard to free tropospheric aerosol layers and their contribution to the columnar aerosol optical depth (AOD).

A multi-wavelength Raman lidar PollyXT was operated remotely at Elandsfontein in South Africa about 150 km east of Johannesburg from December 2009 to January 2011. The range-resolved backscatter signal of elastic lidar contains information that can be used to derive the height of aerosol layers. The gradient method was applied to determine the bottom and top layer heights of the aerosols in the free troposphere (FT). Planetary boundary layer top heights were retrieved from the lidar backscatter signal at 1064 nm using the Wavelet Covariance Transform method.

The AOD in the boundary layer and the FT at 355 nm is estimated. The same seasonal pattern is observed for the AOD at 355 nm in the boundary layer and the FT, i.e. larger AOD values measured during late July, August, September and October in the boundary layer and the FT. The percentage contribution of free tropospheric AOD to the total AOD had large variations for the period investigated, with a mean value of 46%. The largest monthly contribution of 92% is observed in October. The period with increases in columnar, free tropospheric and boundary layer optical depths coincides with an increase in biomass burning activity in South Africa. Also the observed higher wind speeds could lead to an increase of biomass emissions from region further away from Elandsfontein.