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Spectral characterisation of mineralogical components of dust, HULIS and winter time aerosol using multi-wavelength photoacoustic spectrometer. A laboratory and a field study

Tibor Ajtai, Noémi Utry, Ágnes Filep, Dávid Tátrai, Zoltán Bozóki, and Gábor Szabó
Department of Optics and Quantum Electronics, University of Szeged, Hungary (zbozoki@physx.u-szeged.hu)

Aerosol can interact with solar radiation via scattering and absorption. The back scattering fraction of incoming solar irradiation has cooling effect, while the forward scattering redistributes electromagnetic energy into the atmosphere. The photon energy transformed into thermal energy via the light absorption, therefore the absorption process heating absorbing particles and also their surroundings While scattering can be measured fairly accurately, the assessment of the radiative effect of light absorption by aerosol can only be determined with limited accuracy, in part, because of the lack of reliable instrument for absorption measurement. The photoacoustic (PA) spectroscopy is the only method that can measure light absorption by aerosol in-situ (without sampling artifacts) with high sensitivity and temporal resolution, but not widespread in its application yet. Recently, multi-wavelength photoacoustic instruments including excitation at UVs have become available and open up a new perspective on in-situ investigation of light absorption by aerosol as well as its wavelength dependency.
In this study we present novel results of an in-situ study of aerosol light absorption measurement of re-dispersed mineralogical composition of dust such as illit, caolinite, quartz, rutile, limestone, hematite and HULIS aerosols using state-of-the-art multi-wavelength photoacoustic instrument (4λ-PAS). We experimentally demonstrated that the absorption feature of MAC (mass specific aerosol absorption) could be used as chemically selective parameter. We also demonstrated the results of an in-situ winter time ambient aerosol measurement. The hourly concentration of trace elements(i.e. K, Ca, Fe, and Si), gaseous pollutants (CO and NO_x), as well as the size distribution of ambient aerosol were also analyzed during the measurement campaign. The levoglucosan measurement was made to confirm that the daily fluctuation of ambient AAE (absorption Angstrom Exponent) governed by the changes in the relative strength between the traffic and residential heating emission. Finally, we demonstrated correlations between the AAE measured in different wavelength region and concurrently measured other aerosol variables such as size distribution, gas and trace element concentrations.

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