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Spectral Responses of the Laser Generated Coal Aerosol

Authors : Tibor Ajtai, Noémi Utry, Máté Pintér, Tomi Smausz, Zoltán Kónya, Béla Hopp, Gábor Szabó, Zoltán Bozóki

Abstract : Characterization of spectral responses of light absorbing carbonaceous particulate matter (LAC) is of great importance in both modelling its climate effect and interpreting remote sensing measurement data. The residential or domestic combustion of coal is one of the dominant LAC constituent. According to some related assessments the residential coal burning account for roughly half of anthropogenic BC emitted from fossil fuel burning. Despite of its significance in climate the comprehensive investigation of optical properties of residential coal aerosol is really limited in the literature. There are many reason of that starting from the difficulties associated with the controlled burning conditions of the fuel, through the lack of detailed supplementary proximate and ultimate chemical analysis enforced, the interpretation of the measured optical data, ending with many analytical and methodological difficulties regarding the in-situ measurement of coal aerosol spectral responses. Since the gas matrix of ambient can significantly mask the physicochemical characteristics of the generated coal aerosol the accurate and controlled generation of residential coal particulates is one of the most actual issues in this research area. Most of the laboratory imitation of residential coal combustion is simply based on coal burning in stove with ambient air support allowing one to measure only the apparent spectral feature of the particulates. However, the recently introduced methodology based on a laser ablation of solid coal target opens up novel possibilities to model the real combustion procedure under well controlled laboratory conditions and makes the investigation of the inherent optical properties also possible. Most of the methodology for spectral characterization of LAC is based on transmission measurement made of filter accumulated aerosol or deduced indirectly from parallel measurements of scattering and extinction coefficient using free floating sampling. In the former one the accuracy while in the latter one the sensitivity are liming the applicability of this approaches. Although the scientific community are at the common platform that aerosol-phase PhotoAcoustic Spectroscopy (PAS) is the only method for precise and accurate determination of light absorption by LAC, the PAS based instrumentation for spectral characterization of absorption has only been recently introduced. In this study, the investigation of the inherent, spectral features of laser generated and chemically characterized residential coal aerosols are demonstrated. The experimental set-up and its characteristic for residential coal aerosol generation are introduced here. The optical absorption and the scattering coefficients as well as their wavelength dependency are determined by our state-of-the-art multi wavelength PAS instrument (4λ-PAS) and multi wavelength cosinus sensor (Aurora 3000). The quantified wavelength dependency (AAE and SAE) are deduced from the measured data. Finally, some correlation between the proximate and ultimate chemical as well as the measured or deduced optical parameters are also revealed.

Keywords : absorption, scattering, residential coal, aerosol generation by laser ablation
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