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Photoacoustic measurements of photokinetics in single optically trapped aerosol droplets

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It is well established that interaction of light with atmospheric aerosols has a large impact on the Earth's climate. However, uncertainties in the magnitude of this impact remain large, due in part to broad distributions of aerosol size, composition, and chemical reactivity. In this context, photoacoustic spectroscopy is commonly used to measure light absorption by aerosols. Here, we present photoacoustic measurements of single, optically-trapped nanodroplets to reveal droplet size-depencies of photochemical and physical processes. Theoretical considerations have pointed to a size-dependence in the magnitude and phase of the photoacoustic response from aerosol droplets. This dependence is thought to originate from heat transfer processes that are slow compared to the acoustic excitation frequency. In the case of a model aerosol, our measurements of single particle absorption cross-section versus droplet size confirm these theoretical predictions. In a related study, using the same model aerosol, we also demonstrate a droplet size-dependence of photochemical reaction rates [1]. Within sub-micron sized particles, photolysis rates were observed to be an order of magnitude greater than those observed in larger droplets.

[1] J. W. Cremer, K. M. Thaler, C. Haisch, and R. Signorell. Photoacoustics of single laser-trapped nanodroplets for the direct observation of nanofocusing in aerosol photokinetics. Nat. Commun., 7:10941, 2016.