Optical Properties of Secondary Organic Aerosols

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Optical properties of secondary organic aerosols

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Optical Properties of Secondary Organic Aerosols

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Abstract

It is well known that the increased warming effect due to greenhouse gases is a major environmental concern. While the amount of solar radiation absorbed by greenhouse gases is known to a high certainty, the amount absorbed by secondary organic aerosols (SOA) is not. The experimental procedure used to measure the amount of radiation absorbed by SOA was optimized using fulvic acid. The optimized method was then used to measure how much radiation SOA absorb between ~200 and 800 nm. Using this data, mass absorption coefficient (MAC) values at 405 nm and imaginary refractive indexes (k) were calculated. These values will be used to help improve climate models developed at PNNL that currently do not take into account radiation absorbed by SOA.

Methods

SOA were created in the PNNL environmental chamber and collected on Teflon filters. The filters were sonicated in two solvents: water and methanol (MeOH). Using a syringe, the aqueous SOA samples were injected into a liquid flow capillary cell (100-cm path length) coupled with a UV/Vis light source. The light absorbed was measured by the high resolution UV/Vis spectrometer.

UV/Vis Calibration

Two calibration curves using fulvic acid in water or methanol were created to validate the UV/Vis procedure. Water and methanol were used to determine if SOA solubility was affected by different solvent systems. Stock solutions of fulvic acid in each solvent were created and then diluted to desired concentrations. The absorbance of light (between ~200 and 800 nm) by each solution was measured. The calculated MAC values matched the literature value¹ of 0.17 m²/g.

SOA Absorbance

The UV/Vis technique was optimized for use in two different solvent systems: water and methanol. After the procedure was verified, SOA particles were analyzed and found to absorb strongly between 280 and 400 nm. Furthermore, more oxidized SOA absorb slightly more radiation than less-oxidized SOA. It has been theorized that SOA absorb less strongly than fulvic acid. In one study it was found that SOA absorb radiation between 350 and 600 nm more strongly than fulvic acid. The research presented here is the impetus for future studies connecting SOA chemical composition and their light absorbing properties. The main goal of this work is to include SOA MAC values in climate models developed at PNNL.

Conclusion

Table 1. Stock solutions of fulvic acid (FA) in two solvents: water and methanol (MeOH).

Table 2. MAC values at 405 nm for the SOA particles shown in figures 4 and 5.

Reference


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