Scientists identify the chemical culprits responsible for smog trapping the sun's warmth

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Brown carbon in the atmosphere can have a substantial impact on climate, yet it is not clear how brown carbon's chemical composition influences its light-absorption properties. Scientists discovered a way to separate the light-absorbing organic compounds from other aerosol constituents and determine the optical properties and chemical composition of individual components of brown carbon.

Hanging over the world's major cities, a brown haze of smog traps the warmth from sun. Acting like a warming blanket, this haze has a substantial impact on the climate. However, the chemical complexity of the haze makes it hard to separate out the compounds that absorb the sunlight from the stew of other chemicals. Scientists at Pacific

Northwest National Laboratory and the University of California, Irvine identified the culprits—a set of molecules called brown carbon chromophores.

If you want to lower your cholesterol, you need to know what caused it to rise. The same logic applies to those studying the atmosphere. If scientists want to lower the amount of heat trapped over the world's largest cities, they need to know the roles of the different chemicals involved. This study, which combined advanced chemical separations and mass spectrometry methods, reveals the role of about 30 brown carbon chromophores and is crucial to understanding their transformations by atmospheric aging processes. And hence, the underlying chemistry of brown carbon.

In the end, a more detailed description of brown carbon chemistry will be of practical use in estimating the carbon's impact on the climate. This contribution to atmospheric science will help in mitigating aerosol emissions and their impact on the environment.

To determine the optical properties and chemical composition of individual brown carbon components, the team first made their own brown carbon. They did so by reacting methylglyoxal with ammonium sulfate both of which are plentiful in the atmosphere. They applied high-performance liquid chromatography coupled to a photodiode array detector and to electrospray ionization high-resolution mass spectrometry to separate brown carbon chromophores. This capability is at EMSL, a Department of Energy national scientific user facility.

The team found light absorption in the mixture could be accounted for by approximately 30 major chromophores-the part of the molecules responsible for its color. Nearly all of these 30 compounds contain nitrogen. The results suggest reduced-nitrogen organic compounds formed in reactions between certain carbon-based chemicals in the atmosphere (atmospheric carbonyls) and ammonia or the related nitrogen-containing amines are important light absorbers in brown carbon.

The team is doing further studies on brown carbon. Their work will inform computational models to assess energy choices and their influence on the climate.

More information: Peng Lin et al. Revealing Brown Carbon Chromophores Produced in Reactions of Methylglyoxal with Ammonium Sulfate, *Environmental Science & Technology* (2015). DOI: 10.1021/acs.est.5b03608

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