Understanding Brown Carbon

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SUSTAINABILITY

As an undergraduate at the California Institute of Technology, Faye McNeill studied the atmosphere for a very personal reason. “The air pollution there was bad,” she said. “I have asthma, so I’m always a little more aware of atmospheric composition just because of the way I feel.”

McNeill is particularly interested in how aerosols affect global climate. Because they are so small, gravity has little effect on aerosol particles and they can remain airborne for several days. Aerosols such as the sulfur compounds and ash emitted by Mount Pinatubo in the Phillipines pushed down global average temperatures for two to three years after it erupted in 1991.

Other aerosols can absorb incoming solar radiation or long-wave radiation reflected from Earth’s surface, resulting in a warming effect on climate. The range of direct and indirect, compounding and conflicting effects makes aerosols one of the biggest unsolved problems facing climate scientists.

Aerosols can also have a wide range of chemical compositions, which reflect their diverse origins. Recently, McNeill and her team have focused on understanding the sources and properties of light-absorbing organic material, or brown carbon, in atmospheric aerosols. Often a byproduct of the burning of biomass, it turns out that brown carbon can also form through complex reactions in airborne atmospheric particles.

Brown carbon also interacts very differently with the atmosphere and environment than its inorganic cousin black carbon, and its roles in atmospheric chemistry and climate are just beginning to be understood. For one thing, black carbon tends to absorb radiation across the visible spectrum, but brown carbon preferentially absorbs shorter wavelengths of light and thus can influence the formation of ground-level ozone—the “bad” kind that leads to McNeill’s asthma attacks.

McNeill is focused on the basic chemistry and physics behind the cloud-forming and light-absorbing characteristics of organic aerosols in the lab. She also works with other groups to integrate their piece of the climate puzzle into the big picture, including climate modelers who write the massive, computer-based simulations that attempt to predict how individual parts of the environment interact to govern Earth’s climate.

“A big part of what we do is to communicate the results of our work to modelers,” said McNeill. “The fundamental information we get in the lab will eventually find its way into better climate models.” And that is something that can help us all breathe a little easier.

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