Secondary Organic Aerosol Formation from Isoprene: Potential Impacts of Biosphere on Air Quality

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Abstract

Until recently, the formation of secondary organic aerosol (SOA) from the photooxidation of isoprene, the most abundant non-methane hydrocarbon emitted into the Earth's atmosphere from plants and trees, was considered insignificant owing to the high volatility of its known gas-phase oxidation products. The photochemical oxidation of isoprene in the presence of nitrogen oxides (NOx) was only thought to enhance ozone (O_3) levels in urban areas. Interestingly, in 1981 President Ronald Reagan said, "trees cause more air pollution than automobiles do." If that were true, is the answer to cut down all of the trees or was the President missing all of the facts on how air pollution forms?

During this seminar we will systematically examine SOA formation from isoprene photooxidation in order to demonstrate the current state of knowledge. To accomplish this goal, three important parameters are varied in smog chamber experiments, namely: (1) level of NOx; (2) aerosol acidity of pre-existing aerosol; and (3) relative humidity. Our research demonstrates the profound effect of each of these on SOA formation from isoprene and utilizes advanced mass spectrometry and chromatographic techniques in order to chemically characterize both the gas- and particle-phase constituents that form from isoprene oxidation. The photochemical oxidation of isoprene in the presence of anthropogenic pollutants, such as acidic aerosols produced from the oxidation of sulfur dioxide (SO_2) or the presence of NOx, is shown to cause formation of substantial levels of SOA and could be a critical source of "missing urban SOA" not included in current regional or global models. We observe chemical constituents in both our laboratory-generated isoprene SOA and in ambient aerosols collected from many locations around the U.S., demonstrating the atmospheric relevance of our smog experiments. Without the presence of anthropogenic pollutants, it now appears to be difficult to form SOA from isoprene in the atmosphere, and thus, trees do not appear to be the cause of poor air quality but, instead, anthropogenic activities.