Shedding light on the dark side of biomass burning pollution

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Oxidized organic aerosol is a major component of ambient particulate

matter, substantially impacting climate, human health and ecosystems. Oxidized aerosol from biomass burning is especially toxic, known to contain a large amount of mutagens that are known carcinogens. Inhaling biomass burning particles can also cause oxidative stress and a wide range of diseases such as heart attacks, strokes and asthma. Oxidized aerosol primarily forms from the atmospheric oxidation of volatile and semi-volatile compounds emitted by sources like biomass burning, resulting in products that readily form particulate matter. Every model in use today assumes that oxidized aerosol forms in the presence of sunlight, and that it requires days of atmospheric processing to reach the levels observed in the environment. Naturally, this implies that oxidized aerosol forms in the daytime and mostly during periods with plentiful sunshine, such as in summer.

However, considerable amounts of oxidized organic aerosol forms during the winter and in other periods of low photochemical activity worldwide, often during periods of intense biomass burning. Models underestimate oxidized aerosol levels by a factor of three to five. This unresolved mystery carries significant implications for public health and climate, given that biomass burning events are often associated with population exposure to very high particulate matter levels. This issue will become more important in the future, given the increase intensity, duration and frequency of wood burning (both domestic and wildfire) around the globe.

Research led by the teams of Prof. Athanasios Nenes and Spyros Pandis of the Center for Studies on Air Quality and Climate Change (C-STACC) of the Institute of Chemical Engineering Sciences at the Foundation for Research and Technology Hellas (ICE-HT/FORTH) seem to have discovered the reason for the underprediction of biomass. Their study was published in the journal *Proceedings of the National Academy of Sciences*.

The study shows that this unexplained source of oxidized secondary particulate matter is from nighttime oxidation of biomass burning emissions. Through a combination of laboratory measurements and field observations, emissions from biomass burning are rapidly oxidized overnight, and the aerosol generated is remarkably similar to that observed in wintertime urban environments. This newly discovered mechanism was then introduced to a state-of-the-art air quality model to show that nighttime oxidation of biomass burning emissions can substantially influence organic aerosol levels throughout the United States.

The study is broadly important for a number of reasons. First, it shows beyond doubt that sunlight is not required for rapidly generating significant amounts of oxidized aerosol, a finding that reshapes the understanding of how pollution from biomass burning is formed. Second, this mechanism can explain the paradoxically high levels of organic pollution in urban environments during wintertime haze episodes, such as in Europe and China. Finally, the work greatly elevates the role of biomass burning as a source of air pollution at night, in winter, and during other periods of low solar activity, when intense haze episodes often occur around the world.

More information: John K. Kodros el al., "Rapid dark aging of biomass burning as an overlooked source of oxidized organic aerosol," *PNAS* (2020). www.pnas.org/cgi/doi/10.1073/pnas.2010365117

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