Rapid nocturnal aging of biomass burning as an overlooked source of oxidized organic aerosol

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EGU 2020
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How important is nighttime (or low light) chemical processing of biomass burning emissions as source of oxidized OA?

- Highly oxidized organic aerosol (OOA) is commonly observed in urban areas, even in winter or under low-light conditions; however, models tend to under predict wintertime OOA concentrations.

- Residential biomass burning as a source of heat is becoming an increasingly dominant source of primary particle and gas-phase organic compounds.

- Is dark oxidation (via the NO$_3$ radical) of biomass burning emissions an overlooked source of OOA not accounted for in models?
In a series of environmental chamber experiments, we find biomass burning emissions exposed to NO$_2$ and O$_3$ do age rapidly without requiring sunlight.
The evolution of the OA in the laboratory experiments is consistent with ambient observations from a typical wintertime urban center heavily influenced by biomass burning emissions.

### a. Diurnal profiles of $O_3$ and NO from a field campaign in Patra, Greece (January 2020) showing nighttime availability of $O_3$.

### b. Diurnal profiles of OA oxygen-to-carbon (O:C) ratio and ratio of normalized OA mass at m/z 44 to m/z 60 measured by the HR-ToF-AMS during the same field campaign.
Model simulations that include dark oxidation of biomass burning emissions (via the NO$_3$ radical) show an increased conversion from fresh to aged OA.

(a) bbPOA

![Map showing percent change in biomass burning primary organic aerosol (bbPOA) in simulations with and without dark NO$_3$ oxidation of BB emissions.]

\textbf{a. Percent change in biomass burning primary organic aerosol (bbPOA) in simulations with and without dark NO$_3$ oxidation of BB emissions}

(b) bbOOA

![Map showing percent change in biomass burning oxidized organic aerosol (bbOOA) in simulations with and without dark NO$_3$ oxidation of BB emissions.]

\textbf{b. Percent change in biomass burning oxidized organic aerosol (bbOOA) in simulations with and without dark NO$_3$ oxidation of BB emissions}
Summary

• Fresh emissions from biomass burning exposed to NO$_2$ and O$_3$ rapidly form OOA in the laboratory over a few hours and without any sunlight.

• The resulting OOA chemical composition is consistent with the observed OOA in field studies in major urban areas.

• Model simulations that include this dark chemical processing suggest that over much of the United States greater than 75% of the OOA formed from fresh biomass burning emissions underwent nighttime aging processes.