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

John Kodros, Dimitris Papanastasiou, Marco Paglione, Mauro Masiol, Stefania Squizzato, Kalliopi Florou, Agata Kołodziejczyk, Ksakousti Skyllakou, Athanasios Nenes, and Spyros Pandis

FORTH C·STACC Center for the Study of Air Quality & Climate Change

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Contact: jkodros@iceht.forth.gr

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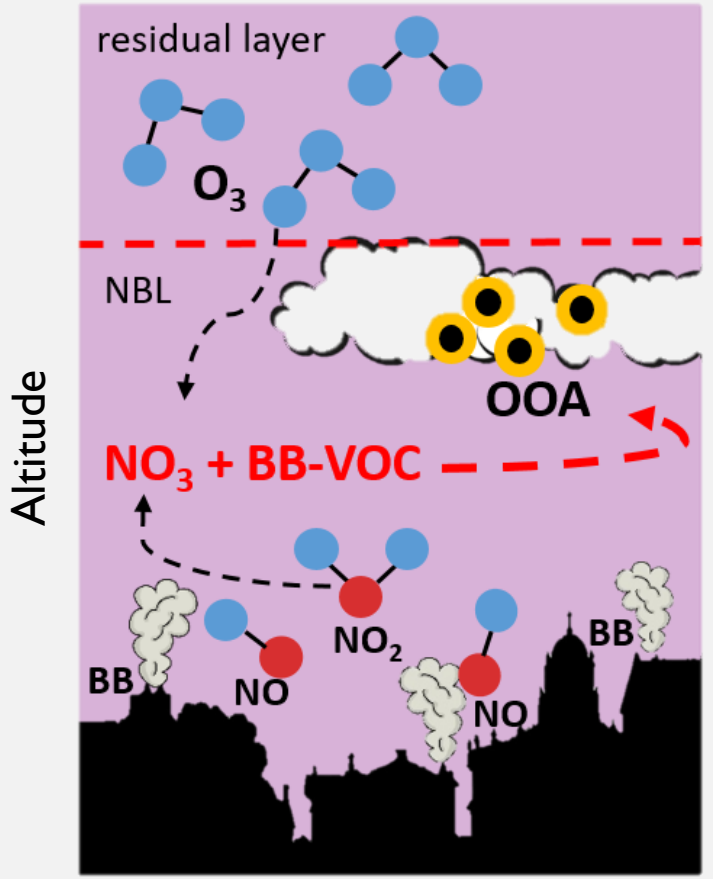
How important is nighttime (or low light) chemical processing of biomass burning emissions as source of oxidized OA?

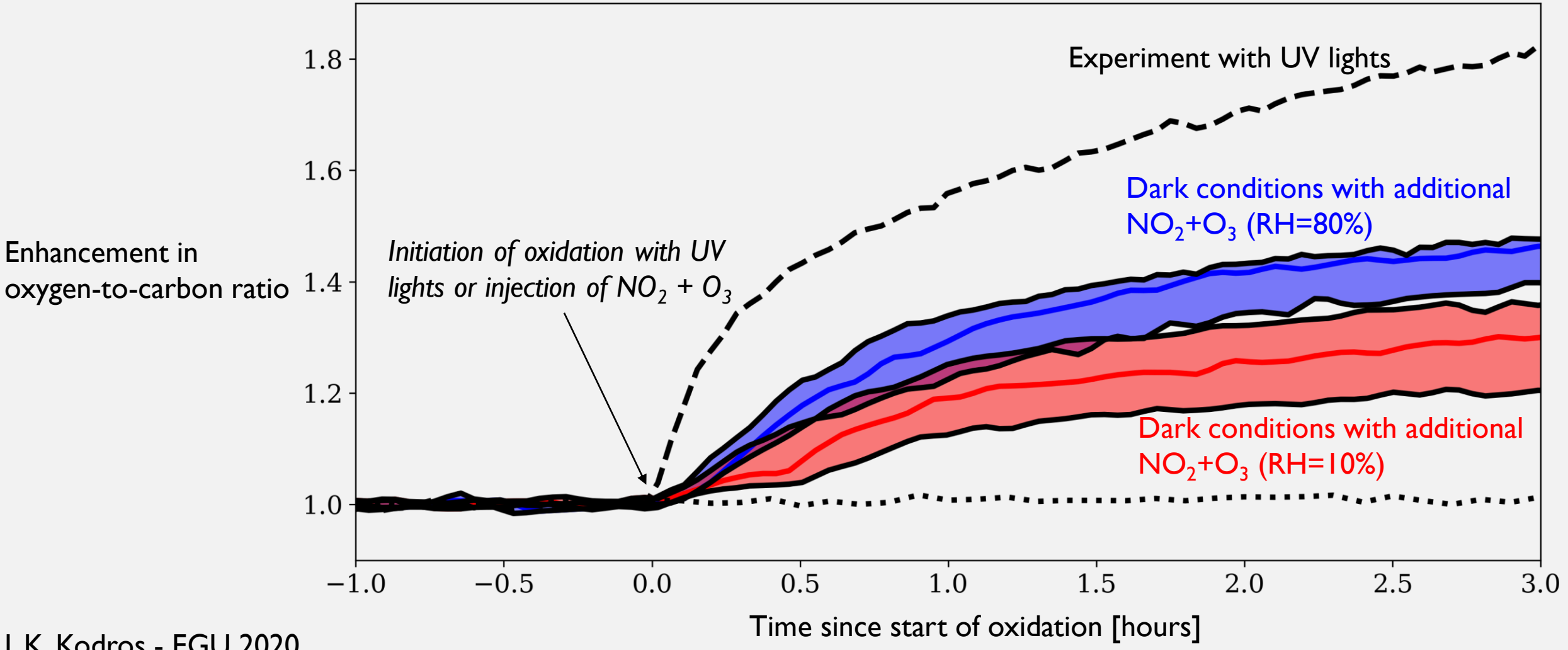
- Highly oxidized organic aerosol (OOA) is commonly observed in urban areas, even in winter or under low-light conditions; however, models tend to under predict wintertime OOA concentrations.

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

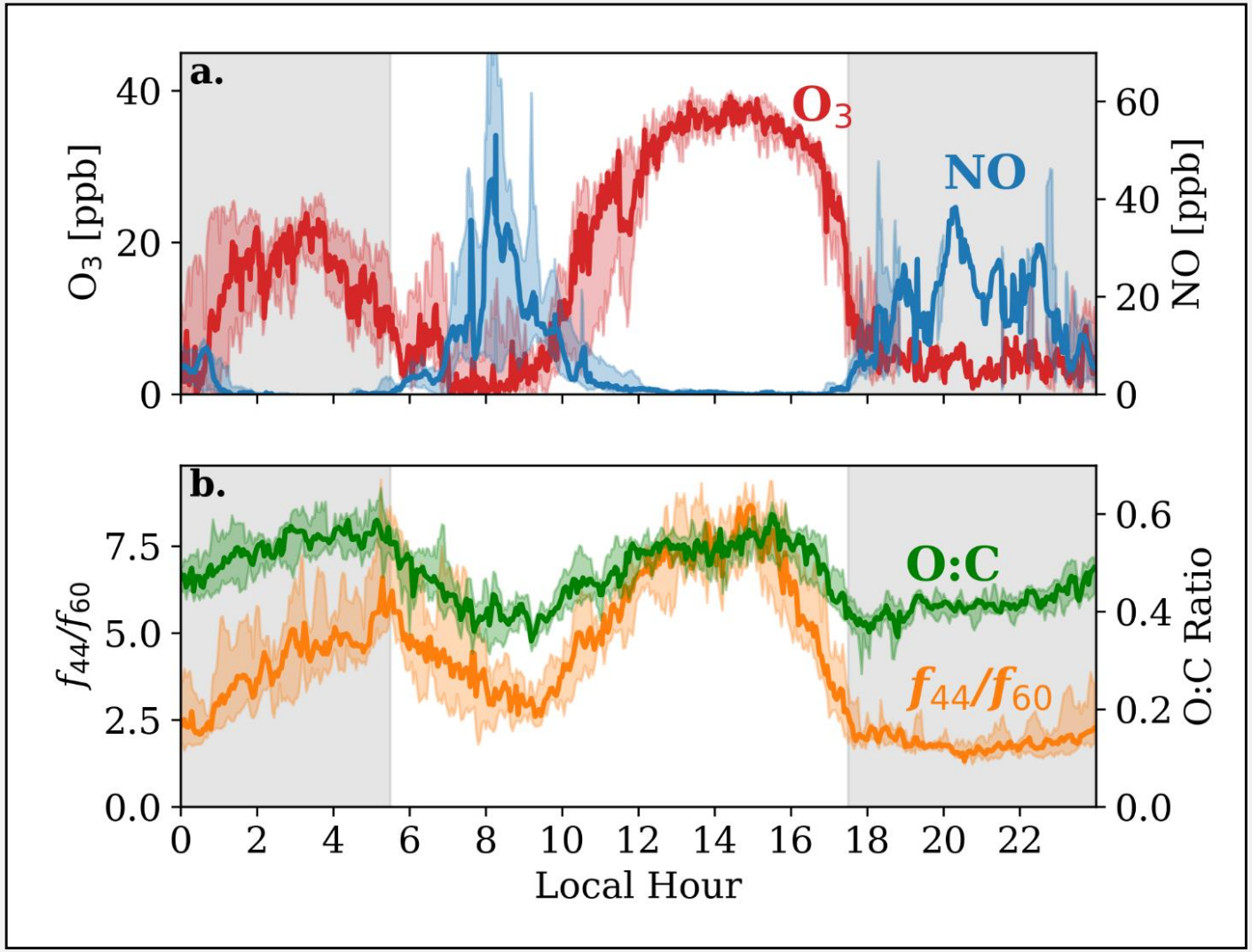
- Is dark oxidation (via the NO_3 radical) of biomass burning emissions an overlooked source of OOA not accounted for in models?



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.



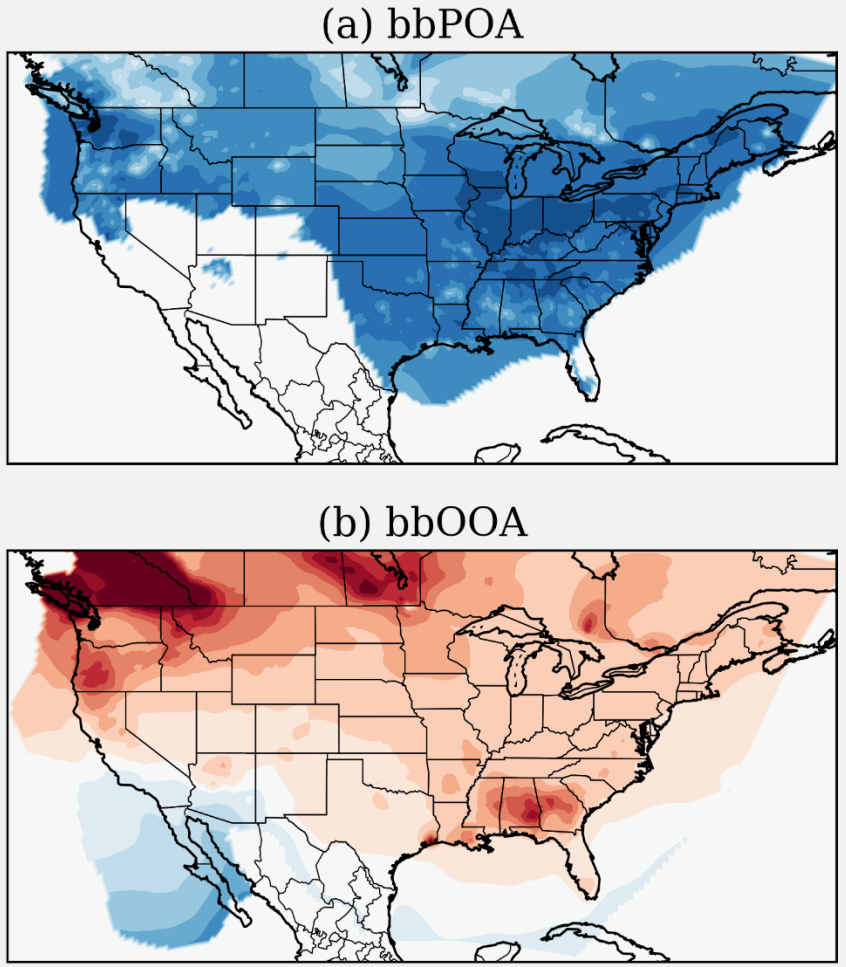
The evolution of the OA in the laboratory experiments is consistent with ambient observations from a typical wintertime urban center heavily influenced by biomass burning emissions.



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. *Percent change in biomass burning primary organic aerosol (bbPOA) in simulations with and without dark NO_3 oxidation of BB emissions*

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

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