Chemical & Molecular Composition, Optical Properties of African Biomass Burning Aerosols Laboratory and Ambient Measurements

https://www.ncat.edu/faculty-research/bililign/research-activities.php

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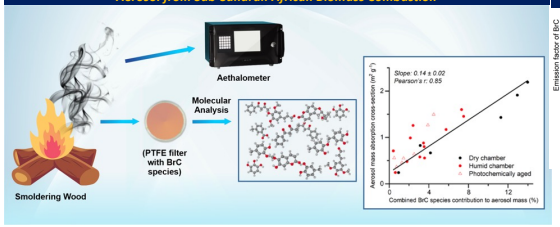
Research Focus

Research in our group uses several spectroscopic techniques for atmospheric applications: The focus is laboratory measurement of optical and physio-chemical properties of biomass burning (BB) aerosol derived from African biomass fuels. Laboratory studies at NCAT include

- Explore impact of RH, aging, burn condition, morphology fuel type and mixing state on optical properties (Collaboration with Los Alamos National Lab)
- Measure emission factors of pollutants from African BB sources
- *Quantifying the Light-Absorption Properties & Molecular Composition of Brown Carbon Aerosol from Sub-Saharan African Biomass Combustion (Collaboration with UNC-CH)*
- Determine the drivers of toxicity in BB emissions (Collaboration with UNC-CH)
- Model health impacts of biomass burning and trash burning in Africa (Collaboration with Colorado State University)
- Ambient filter sample collection for chemical analysis (Collaborators: Botswana International University of Science and Technology (BIUST), Kenyatta University (Kenya), Addis Ababa University (Ethiopia)
- Air Quality Management Capacity Building in East Africa (Collaborator: Columbia University)

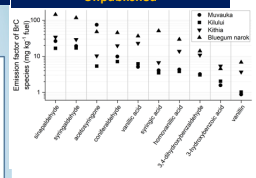
SOME –Recent Results

Quantifying the Light-Absorption Properties & Molecular Composition of Brown Carbon Aerosol from Sub-Saharan African Biomass Combustion



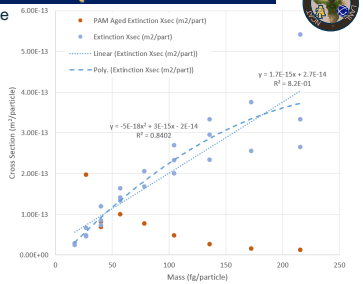
***Moschos V**, et al. Environ. Sci. Technol. 2024, 58, 9, 4268–4280,* https://doi.org/10.1021/acs.est.3c09378

Emission factors from Kenyan Fuels Unpublished



Size-dependent Optical Properties – Wild Olive

- Mass cross sections can be determined from the slope of linear fit
- However, polynomial fits are better for many fuels
  - Correcting for truncation angle effects could resolve this
- Scattering shows little fuel dependence; extinction shows greater variability
- For PAM aged aerosol, optical size decreases; composition may be size dependent



FACILITIES

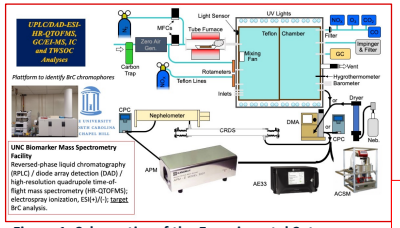
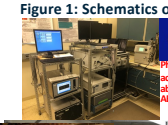


Figure 1: Schematics of the Experimental Setup



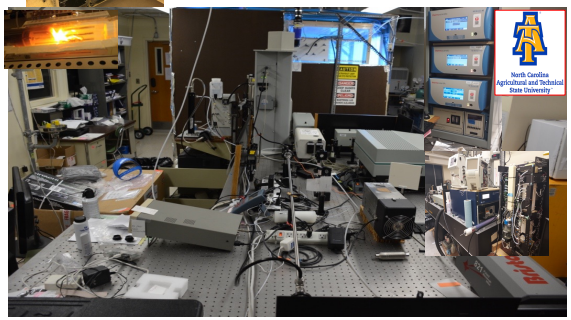
Photoacoustic spectroscopy for accurate Measurement of absorption and calibrations of AE33

Atmospheric aerosol sampling in Africa

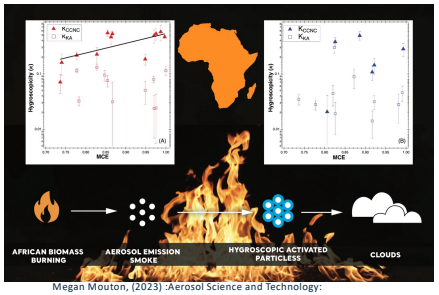
Atmospheric relevance evaluation of lab-generated BrC species

NC A&T indoor smog chamber

Smoldering combustion of African biomass fuels Dry or humidified chamber, rel. hum., RH, up to 70%)Primary and "control" (dark/photo-)aged emissions

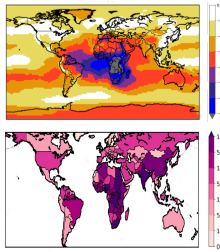


The hygroscopic properties of biomass burning aerosol from Eucalyptus and cow dung under different combustion conditions



Megan Mouton, (2023) :Aerosol Science and Technology: https://doi.org/10.1080/02786826.2023.2198587

The Effects of Trash, Residential Biofuel, and Open Biomass Burning Emissions on Local and Transported $PM_{2.5}$ and Its Attributed Mortality in Africa



CONCLUSIONS

-Largest impact from $PM_{2.5}$ emissions occurred in the region it is emitted

-Except for East Africa effects of transport $PM_{2.5}$ to Central Africa

-May be caused by the differences in geography and meteorology

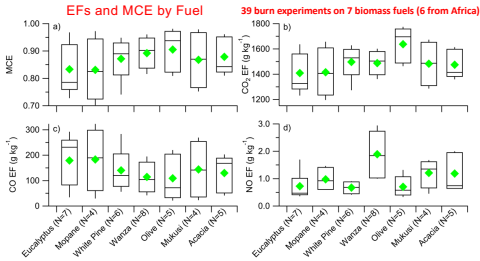
Attributed premature mortalities yr^{-1}

203,000 globally

167,000 in Africa (compared with Ebola only 11,000)Air pollution policies may need to focus on taking preventative measures to avoid exposure as much as focusing on emissions control policies from power, transport, and industry.

Determination of Emission Factors of Pollutants From Biomass Burning of African Fuels in Laboratory Measurements

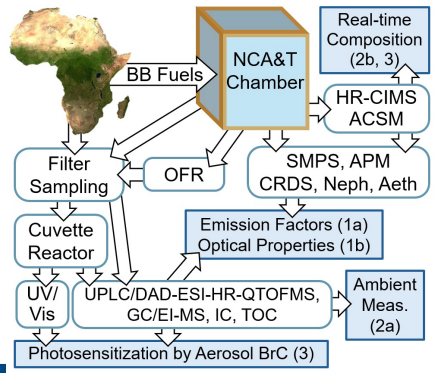
Gordon et al., 2023, GeoHealth https://doi.org/10.1029/2022GH000673



- Very little fuel type dependance for any species
- CO and CO_2 EFs show a stronger dependance on MCE
- CO EF (21.39 – 323.09 g/kg) is highly sensitive to MCE, much more than CO_2

Pokhrel et al, JGR-Atmosphere, 2021 https://doi.org/10.1029/2021JD034731

Current and Proposed Work



Collaborations

US

Europe

Africa

Acknowledgments -Funders