Detailed Characterization of Aqueous Aerosols in the Atmosphere

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Introduction

Background

- According to the World Health Organization (WHO), air pollution is responsible for the deaths of 7 million people annually(1).
- The Clean Air Act of 1963 set National Ambient Air Quality Standards (NAAQS) for six "criteria" pollutants.
- Air pollutants can be characterized and furthermore, human activities can be modified by applying sustainability principles.

Figure 1. Pillars of Sustainability

Objective

- This research aims at characterizing concentrations, sources, and impacts of atmospheric pollutants to devise proper mitigation strategies.
- It will focus on the formation of SOA through aqueous processes to address the bias seen in global aerosol models, where some masses are unaacounted for due to repartitioning.

Figure 2. Reversible processes.

Aerosols

- Aerosols are liquid or solid particles in the atmosphere that have detrimental effects on humans as well as the environment.
- $PM_{2.5}$ are fine particles that have a diameter of 2.5 micrometers or less (Figure 3).
- Organic aerosols have two source types:
  - **Primary**- Emitted directly into atmosphere
  - **Secondary**- Formed in the atmosphere

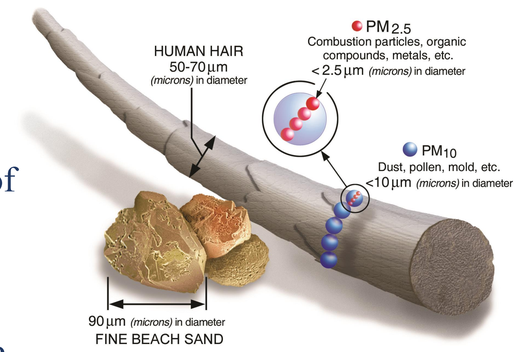

Figure 3. PM Size Comparison

Partitioning of Aerosols

SOA is formed through reactions in the atmosphere from two pathways (Figure 4):
1.Gaseous- gas undergoes absorption and partitions into particle phase(3)
2.Aqueous- gas undergoes dissolution and partitions into particle phase(4)

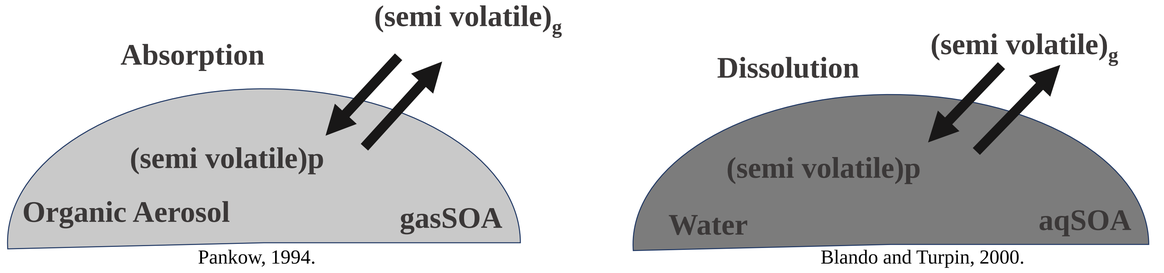

Figure 4. Partitioning of secondary organic aerosols

Methodology

Study Location

- **Study Location:**
  - Daytona Beach (Figure 5).
- **Air Quality Data:**
  - $PM_{2.5}$ concentrations from Florida Department of Environmental Protection (FLDEP).
- **Study Period:**
  - Summer (May-August) 2018, 2019, and 2020.

Figure 5. Site location on Florida State map.

Environmental Enclosure

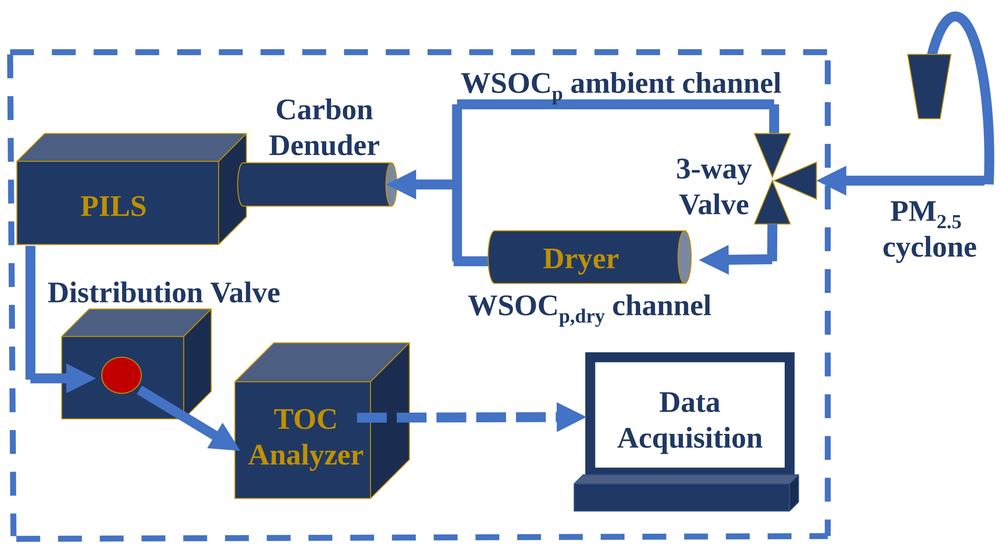

Figure 6. Environmental Enclosure Setup.

Particle Channels

- Water-soluble organic carbon will be measured in the particle phase ($WSOC_p$).
- To investigate the effect of drying on SOA, the $WSOC_p$ measurement will be alternated through an ambient channel and a "dried" channel ($WSOC_{p,dry}$) (Figure 6).
- $WSOC_p$ concentrations will be measured using a Particle Into-Liquid Sampler (PILS) accompanied with a TOC Analyzer (Figure 7).

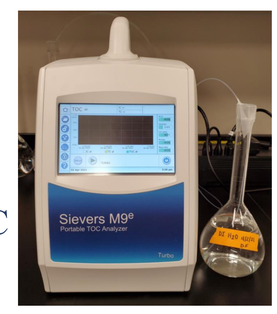

Figure 7. TOC Analyzer used in this study.

Results

$PM_{2.5}$ Data

- Recent studies show significant discrepancy between how organic aerosols may form in nature and the approach commonly used in global aerosol models to study the effects of organic aerosols on climate change(2).
- The EPA's outdoor air quality data tool and NAAQs will serve to characterize the bias seen within $PM_{2.5}$ measurements (Figure 8).

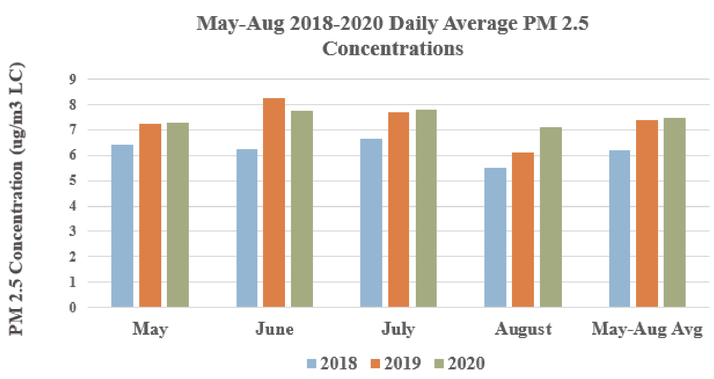

Figure 8. EPA Particulate Matter concentrations.

TOC Analyzer Calibration

- CO_2 from the total carbon and inorganic carbon concentrations within a given sample are measured by conductivity readings

TOC= TC - IC

- Before using the TOC for analysis, the factory-set calibration must be validated to ensure efficient readings.
- Sucrose concentrations were used to validate this calibration (Figure 9).

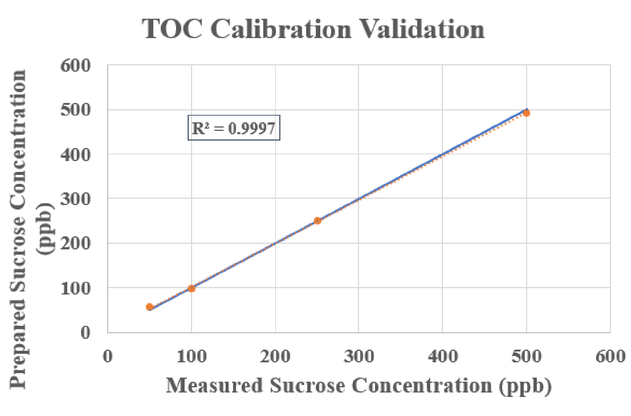

Figure 9. TOC analyzer validation process.

Future Work

- Characterize the impact of emission sources unique to Daytona Beach (i.e., the airport and Speedway).

Acknowledgments

- I would like to thank the FLDEP for providing air quality data to the public.

References

[1]World Health Organization (WHO): Air Pollution, 2018
[2]Marwa M. H. El-Sayed , at al.: The Effects of Isoprene and Nox on Secondary Organic Aerosols Formed through Reversible and Irreversible Uptake to Aerosol Water", Atmos. Chem. Phys. Discuss., 2017
[3]Pankow, Atmos. Environ. 1994
[4]Blando,and Turpin : "Secondary Organic Aerosol Formation in Cloud and Fog Droplets", 2000