



# Investigating the Significance of Organic Water Towards Atmospheric Aerosol Liquid Water Content in Florida

Megan E. Neumann<sup>1</sup>, Marwa M.H. El-Sayed<sup>2</sup>, Shannon L. Capps<sup>3</sup>

<sup>1</sup> Department of Applied Aviation Sciences, Embry-Riddle Aeronautical University

<sup>2</sup> Department of Civil Engineering, Embry-Riddle Aeronautical University

<sup>3</sup> Department of Civil, Architectural, and Environmental Engineering, Drexel University



## Background

- Aerosol liquid water content (ALWC) is ubiquitous in the atmosphere, i.e., it is an important component of the atmosphere as it is widely present.<sup>1</sup>
- Atmospheric liquid water is affected by relative humidity (RH), as well as inorganic and organic aerosol concentrations and composition, both inorganic and organic matter.<sup>2</sup>
- ALWC can affect the quantity and chemical composition of organic aerosols.<sup>3</sup>
- Although the organic contribution to ALWC concentrations has been neglected in some studies, evidence of the significant contribution of organic to ALWC has been reported.<sup>4</sup>
- At present, the contribution of organic versus inorganic aerosols towards the ALWC is uncertain; reports can vary between 8% and 52% organic contribution.<sup>4</sup>
- The contribution of water associated with organic and inorganic aerosol can differ due to geographic location, concentrations of pollutants and their sources, in addition to the time of year (season)<sup>5</sup>.

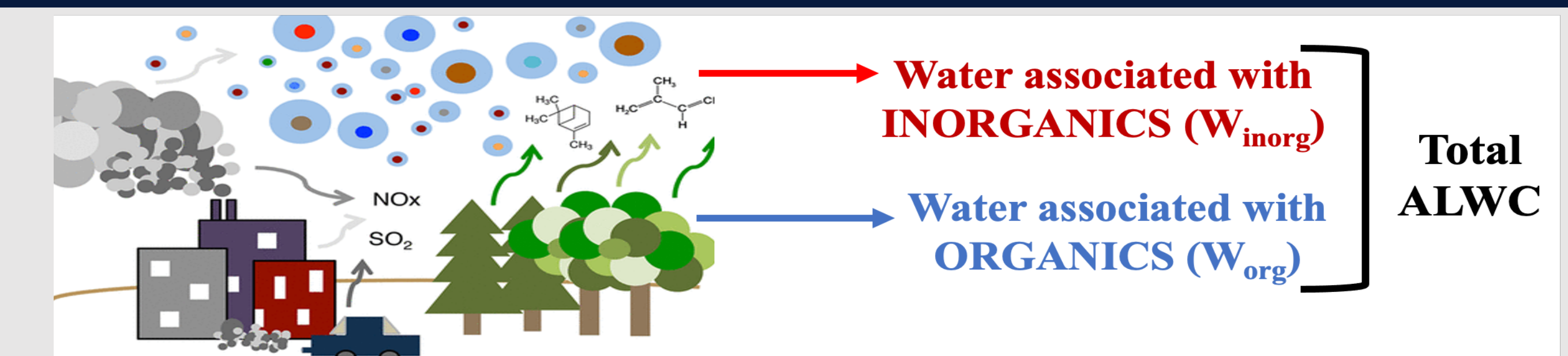


Figure 1: Schematic representing the contribution of organic and inorganic aerosol concentrations to the ALWC concentrations in the atmosphere. (adapted from <sup>1</sup>)

## Objective

### The goal of this study is to:

- Determine the contribution of organic aerosol to the concentration of ALWC.
- Analyze organic and inorganic contributions to ALWC across multiple seasons and under contrasting environmental conditions in Florida.

### Motivation

- Provide data to be used to improve the accuracy of ALWC modeling.
- Determine differences in organic ALWC contribution based on changes in location, population density, and other factors.
- Determine the temporal resolution of organic and inorganic ALWC.

## Methodology

**Inorganic water ( $W_{inorg}$ ):** ISORROPIAv2.1 aerosol thermodynamic equilibrium model<sup>6</sup>.  
 $W_{inorg} = f(\text{inorganic concentrations, temperature, and relative humidity})$

**Organic water ( $W_{org}$ ):** Based on assumptions based on the kappa-Kohler theory<sup>7</sup>.

$$W_{org} = \left\{ \frac{m_{org}}{\rho_w * \rho_{org}} \right\} * \left\{ \frac{k_{org}}{(1/RH) - 1} \right\}$$

where  $m_{org}$  is the measured organic mass concentration,  $\rho_w$  is water density,  $\rho_{org}$  is the organic density,  $k_{org}$  is the average kappa value of organics

**Total ALWC:** The sum of organic and inorganic concentrations.

$$\text{Total ALWC} = W_{inorg} + W_{org}$$

## Seasonal Variations in ALWC

- ALWC concentrations are the highest in the wintertime in Florida, opposite to trends observed in Baltimore<sup>3</sup>.
- Spring has the lowest ALWC concentrations in Florida.
- Daniela Banu is coastal and rural in nature compared to the other sites, hence the lower  $W_{org}$  contributions to ALWC concentrations.

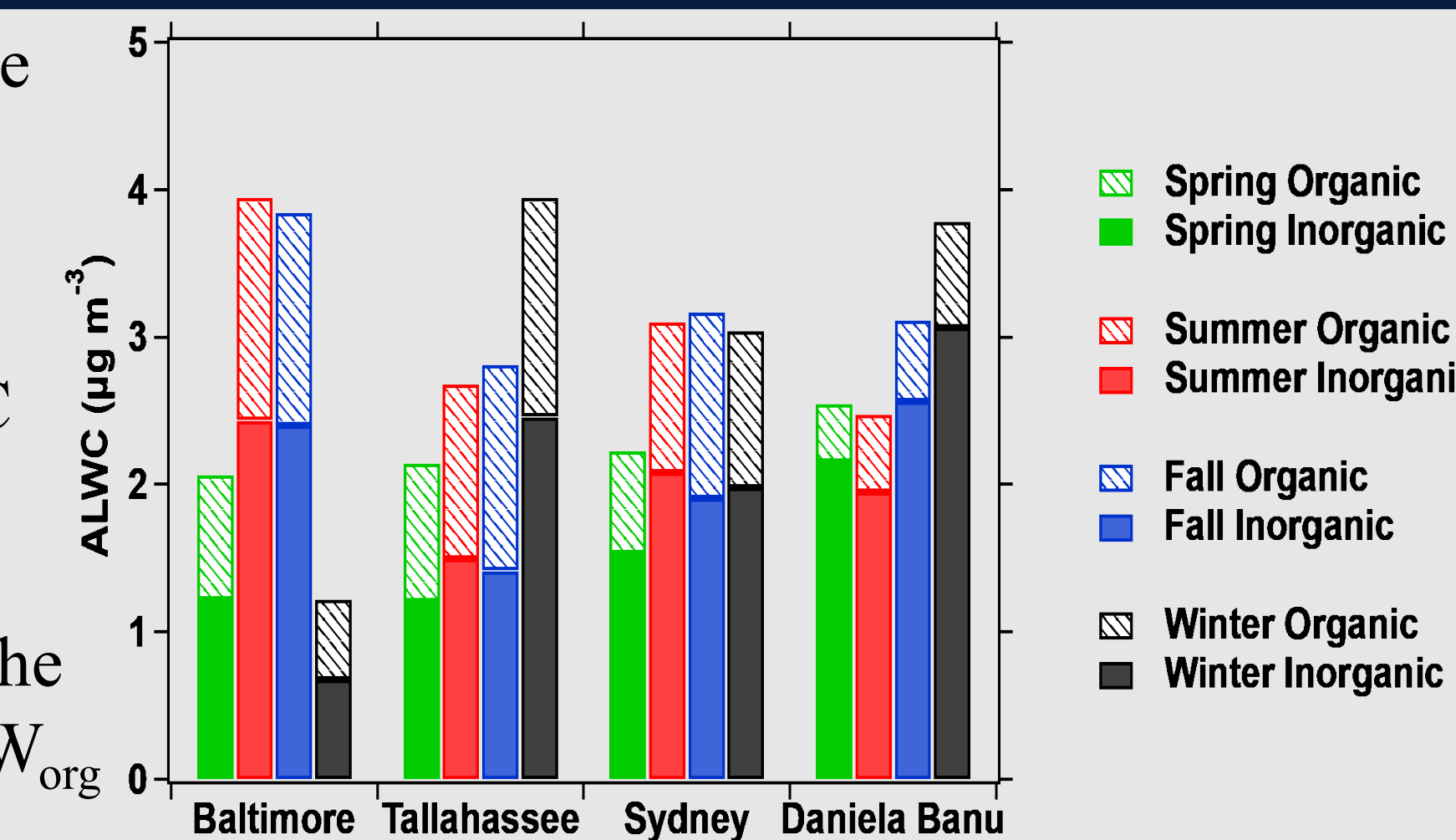


Figure 4: Annual median concentrations of ALWC at three Florida cities compared to Baltimore<sup>5</sup>.

## Study Location

Three sites governed by the IMPROVE network were investigated. These sites represent the Northern, Central, and Southern regions of Florida (Fig. 2).

### 1. Tallahassee Community College (Tallahassee)

- Pop. Density: 1809.3 persons/mile<sup>2</sup>
- Urban/suburban

### 2. Sydney (Dover)

- 1255.67 persons/mile<sup>2</sup>
- Suburban/rural
- Near Tampa

### 3. Daniela BANU NCORE (Davie)

- Pop. Density: 3028.9 persons/mile<sup>2</sup>
- Suburban
- Suburb of Ft Lauderdale



Figure 2: A map of the sites in Florida used in this study.

## Data

- Speciated organic and inorganic PM<sub>2.5</sub> concentrations were acquired from the Florida Department of Environmental Protection<sup>8</sup>.
- Gaseous ammonia and nitric acid concentrations were provided by EPA's CASTNET network.
- Specific meteorological data (Temperature and Relative Humidity) were acquired from Weather Underground<sup>9</sup>.

## Contributions of $W_{org}$ toward ALWC

- Tallahassee**
  - ALWC concentrations did not vary over time.
  - Comparable  $W_{inorg}$  and  $W_{org}$  contributions towards the total ALWC concentrations.
- Sydney**
  - ALWC concentrations increased by about 2  $\mu\text{g m}^{-3}$  over the 5 years perhaps due to its proximity to the increasingly populated urban city of Tampa.
  - $W_{org}$  contributions towards ALWC concentrations increased from 30% to more than 40% in 5 years.
- Daniela Banu**
  - No clear temporal variation in ALWC concentrations.
  - $W_{org}$  contributions towards ALWC concentrations were generally less than 20% except for 2021.

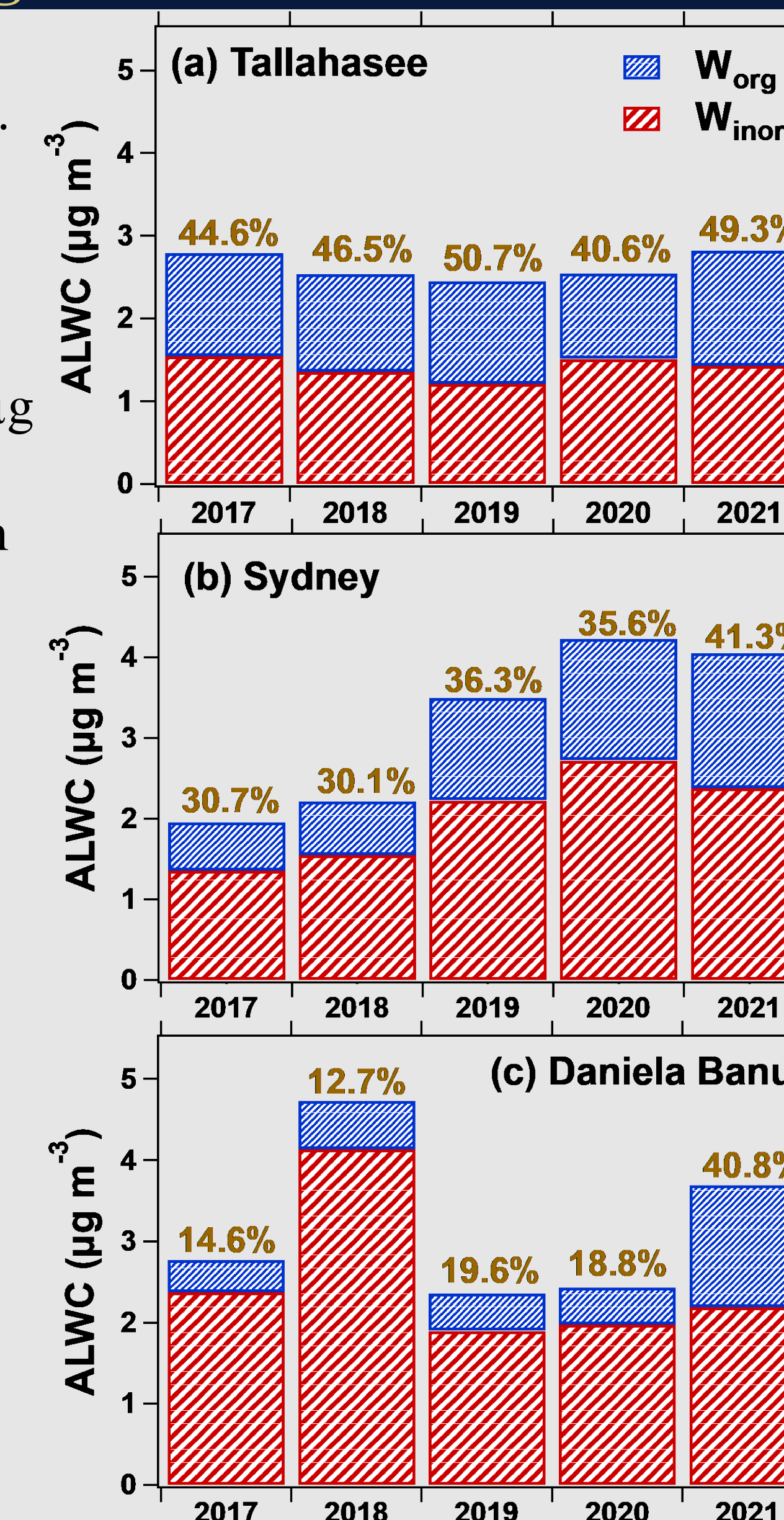


Figure 3: Seasonal median concentrations of  $W_{org}$  and  $W_{inorg}$  at (a) Tallahassee, (b) Sydney, and (c) Daniela Banu. Percentages represent  $W_{org}$  contributions.

## Conclusions

- Organic water is a significant contributor to ALWC concentrations in Florida.
- The highest contribution of  $W_{org}$  is in north Florida followed by the central and southern regions of the state.
- The contribution of organic water does not change as a function of season in Florida.

## Future Work

- This study will be extended to include other states/locations with implications for the accurate representation of ALWC in models.
- Sensitivity analyses will be conducted to test the sensitivity of each of these concentrations to the sum of the aerosol and gaseous concentrations.

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- Tallahassee
- Sydney
- Daniela Banu

