Sea Breeze Interactions with Aerosol content and Transport in the Coastal Houston Region

== Github Data Analysis Brief ==

1 Dataset

The primary data for this project was obtained from the main Atmospheric Radiation Measurement (ARM) facility in La Porte in Houston, TX (designated as ARM site AMF1) as part fo the Tracing Aerosol Convection Interactions Experiment (TRACER) in 2022. Due to data availability and the time constraints of the semester, only data from June and July 2022 were analyzed as a part of this project. This brief is a companion document to the git hub repository: https://github.com/IMedina-WxMech/TRACER_Data_Analysis

2 Methodology

The following two sections cover a brief methodology that each coding file is being used to address.

2.1 Sea Breeze Passage Identification

To correlate aerosol content with sea breeze (SB) passage, we first need to quantify when sea breeze passage is. For this we identify a wind shift, typically from west or southwest (coast parallel) to east-southeast (coast perpendicular). The coastline near the measurement site is oriented from southwest to northeast. From this, we expect sea breeze to be associated with directional shift that results in a decrease in degrees.

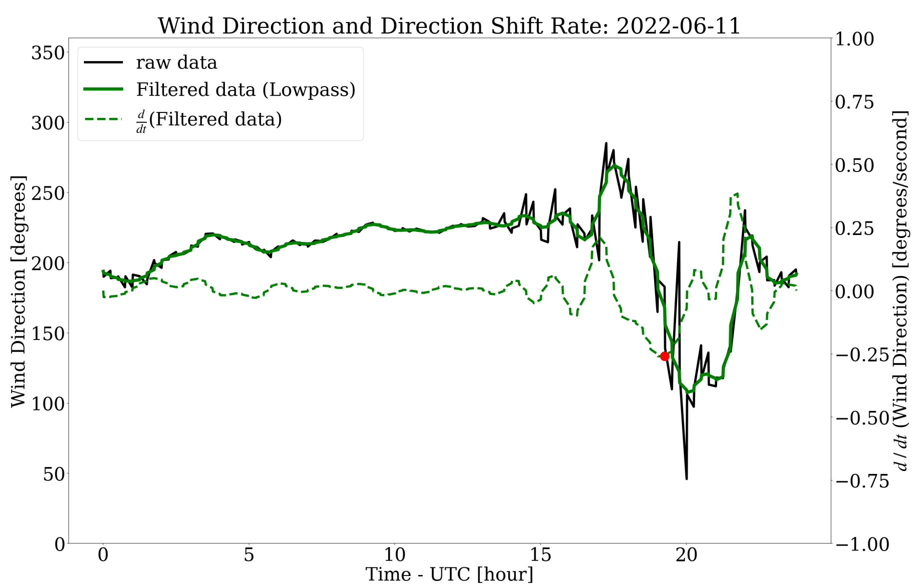

Figure 1: *Raw (black) and low-pass filtered (solid green) wind direction data returned from scanning lidar at ARM-AMF1. The first derivative in time (dashed green) also has its minimum marked with a red dot.*

In addition, we need to correlate this with an increase in water vapor. For this we follow the same process of taking the first derivative, instead finding its maximum.

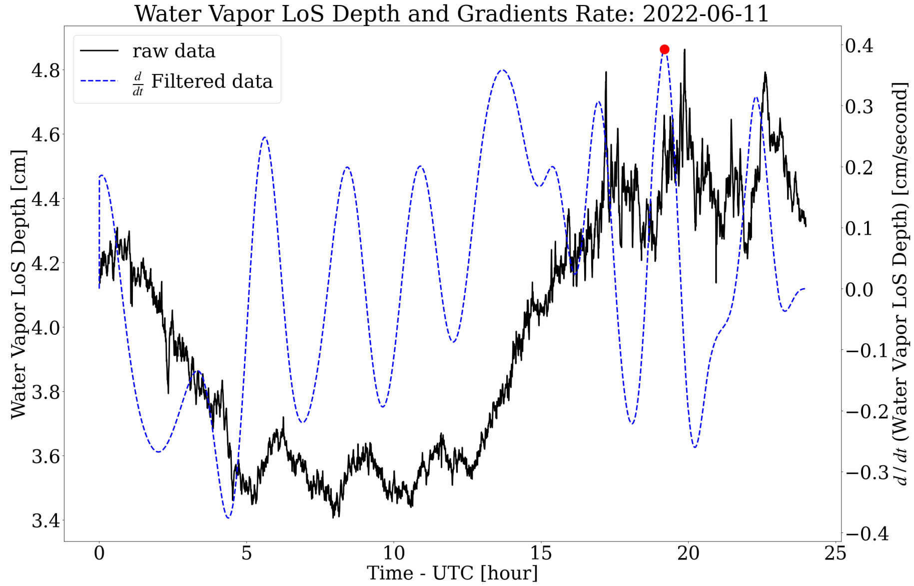

Figure 2: *Raw (black) and low-pass filtered (solid blue) Water Vapor line of sight (LoS) depth data returned from microwave radiometer at ARM-AMF1. The first derivative in time (dashed blue) also has its maximum marked with a red dot.*

2.2 Aerosol Content Correlation

Once the days of interest are identified, we will breakdown aerosol concentrations before dawn, before SB passage, and after SB passage. Here we do not need to graph everything and read all data in, so we can simplify the identification of SB passage time. For this, we obtain the time associated with the above identifiers, average it (as it should be very close), and use that as the time for SB passage. From here we will average the aerosol concentration data for hours before sunrise, before SB passage and after SB passage. This data can then be saved to separate arrays based on classification (see preliminary results).

We can then begin to correlate aerosol increases due to SB passage and recirculation events from consecutive passage days (comparing overall day to day averages before Sb passage). We can also compare hourly averages to determine how close to SB passage aerosol concentrations begin to increase. For the baseline cases, we will use either the average SB passage time, if not largely different across the data availability domain, or the time of SB passage from the nearest day with an SB passage to the baseline day for the 'after SB passage' data separation. This will allow us to separate aerosol changes that are due to SB passage and those that may occur diurnally at a similar time to SB passage.

For this we will save time averaged data for our window of concern (pre-dawn, pre-SB, post-SB or hourly or other) and the standard error for this period. This can then be plotted in a bar graph with error bars similar to other studies.

3 Preliminary Results

The results thus far will be broken down into three main classifications. The first of which are our baseline cases, or those that do not experience SB passage. The second are isolated SB cases, or those that do not have SB either the day before. To bolster this set, we will also use the first day of a consecutive period. Finally, we also look at cases with multiple consecutive days of SB passage to investigate recirculation. The dates for each are as follows:

4 Baseline days: 6/13, 6/14, 6/15, 7/20
3 Singular SB days: 6/11, 6/17, 6/23, 7/3, 7/16
2 Consecutive SB periods: 7/3-8, 7/16-18

3.1 Example Figures

Below is are example figures for aerosol content for a SB passage case. and bar plots of average concentrations with error bars from our observed cases. These plots are still a work in progress and needs tweaking for better visualization.

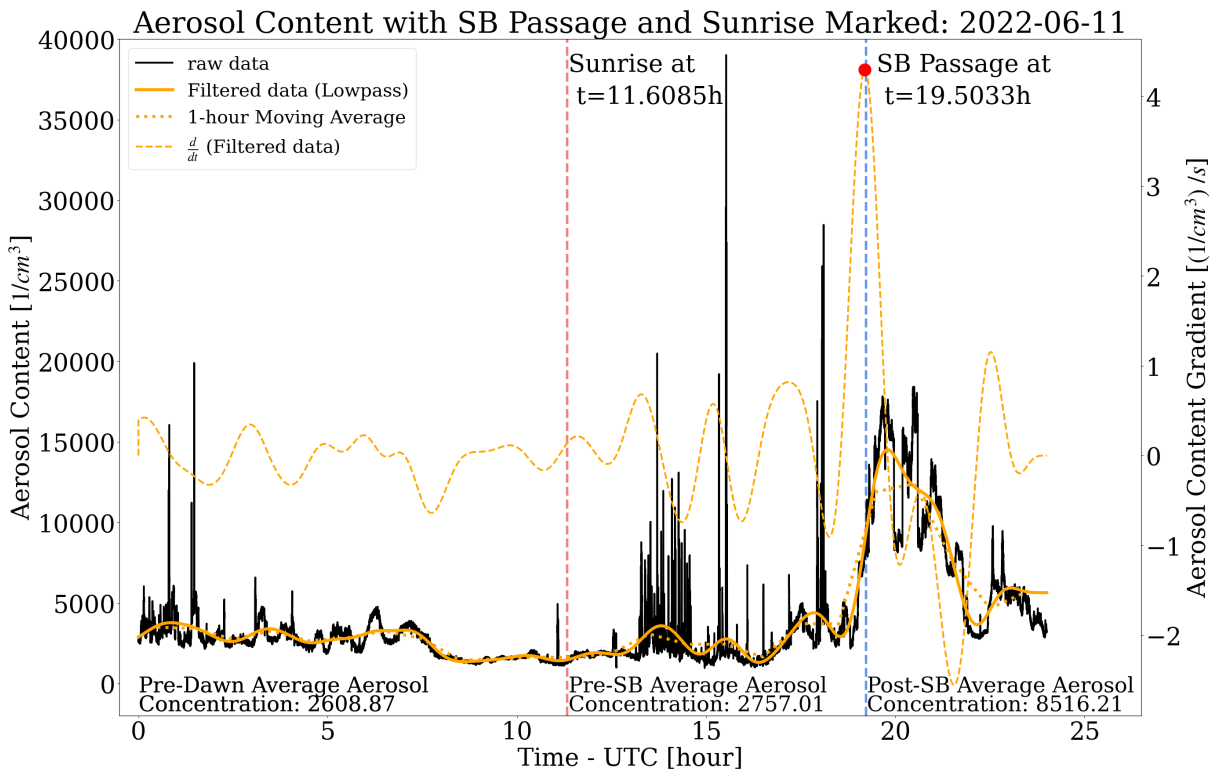

Figure 3: *Raw (black) and low-pass filtered (solid orange) aerosol content data returned from scanning lidar at ARM-AMF1. The first derivative in time (dashed orange) also has its maximum marked with a red dot. Here sunrise is noted and marked with a red dashed line, and SB passage is noted and marked with a blue dashed line.*

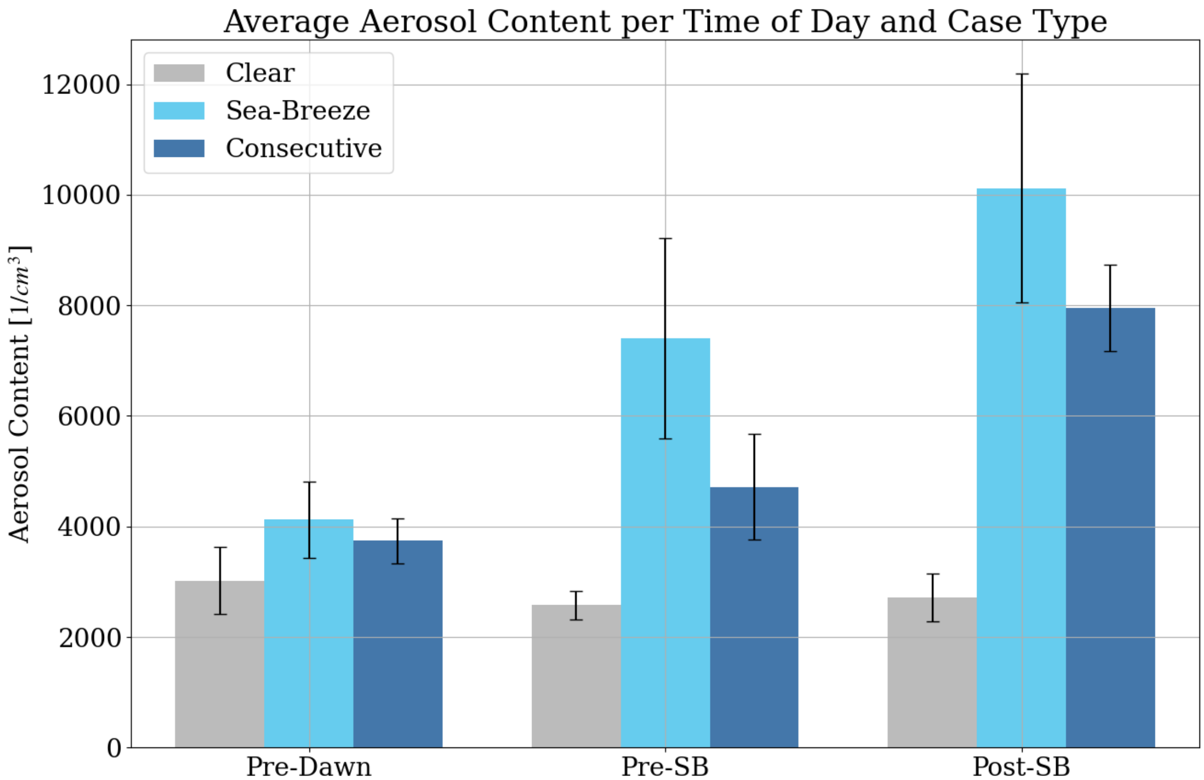

Figure 4: *Aerosol content based on time of day and case classification. Here the grey are clear cases, light blue are single SB cases, and dark blue are the consecutive SB cases. Standard error is also plotted for each bar in black.*

Hourly plots are still to come for further analysis.