

AERONET Science and Application Exchange 2024  
September 17-19, 2024, College Park, MD, USA

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**AERONET Science and Application Exchange**

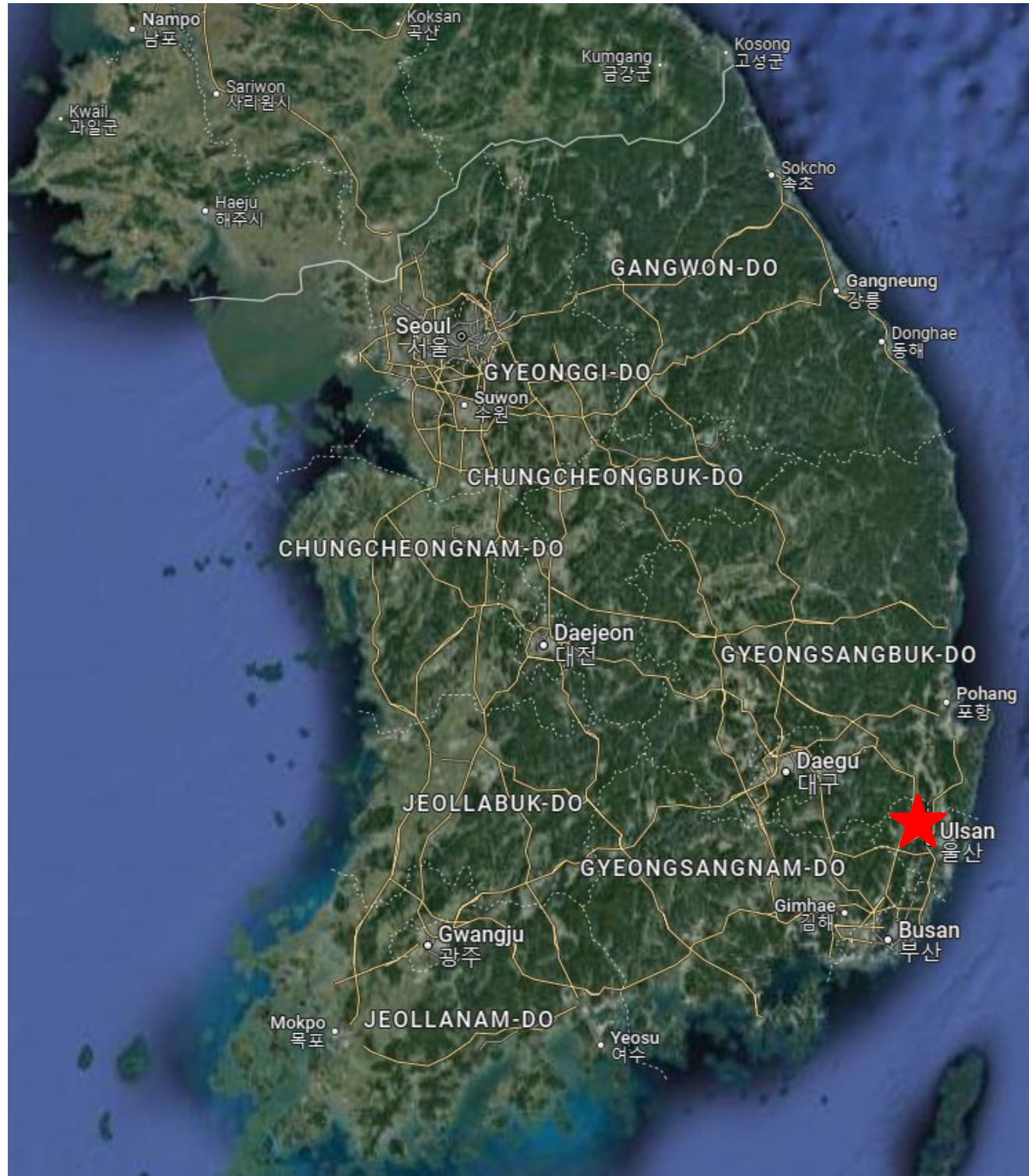
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# Relationship of Aerosol Optical and Chemical Properties from synergetic use of SPARTAN and AERONET observations

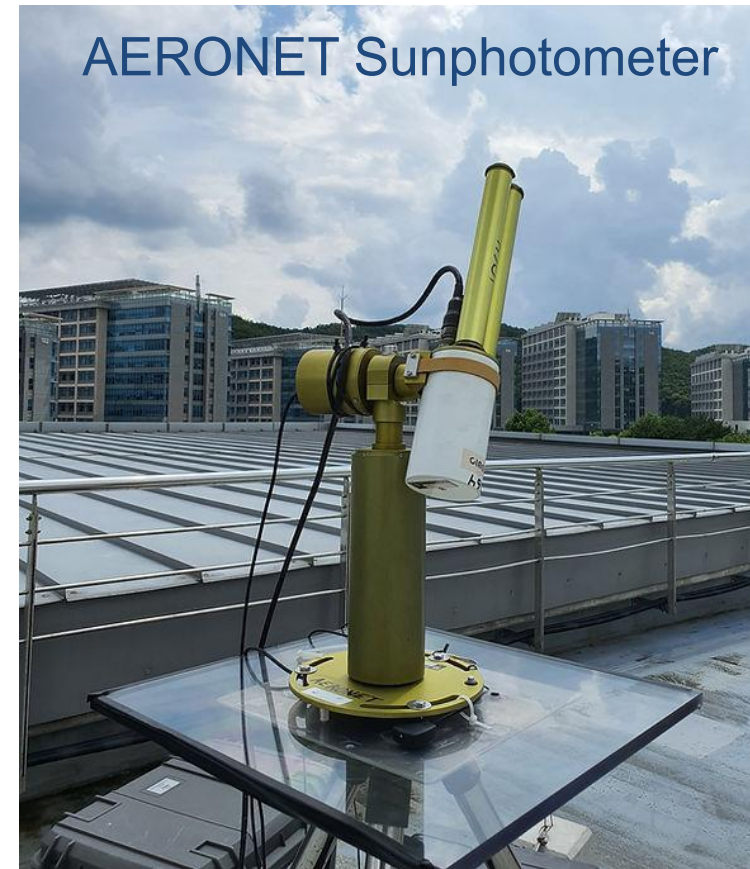
**Sang Seo Park, Sujin Eom (UNIST)  
Jhoon Kim (Yonsei University)**



## Ground Observation Site in Ulsan



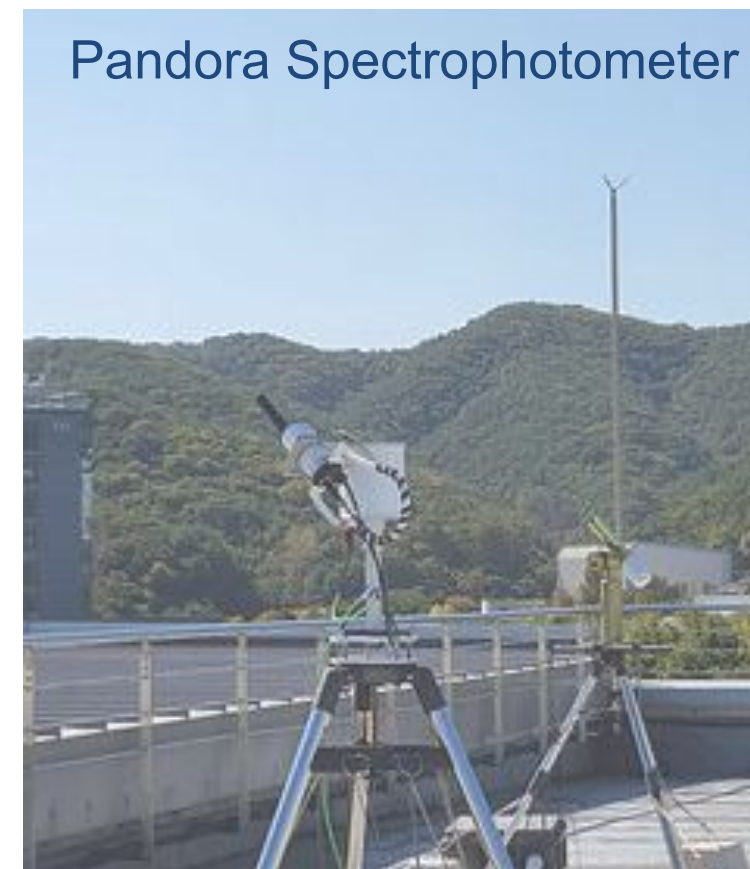
UNIST, South Korea



AERONET Sunphotometer



SPARTAN



Pandora Spectrophotometer



Ozonesonde  
(Field Campaign)

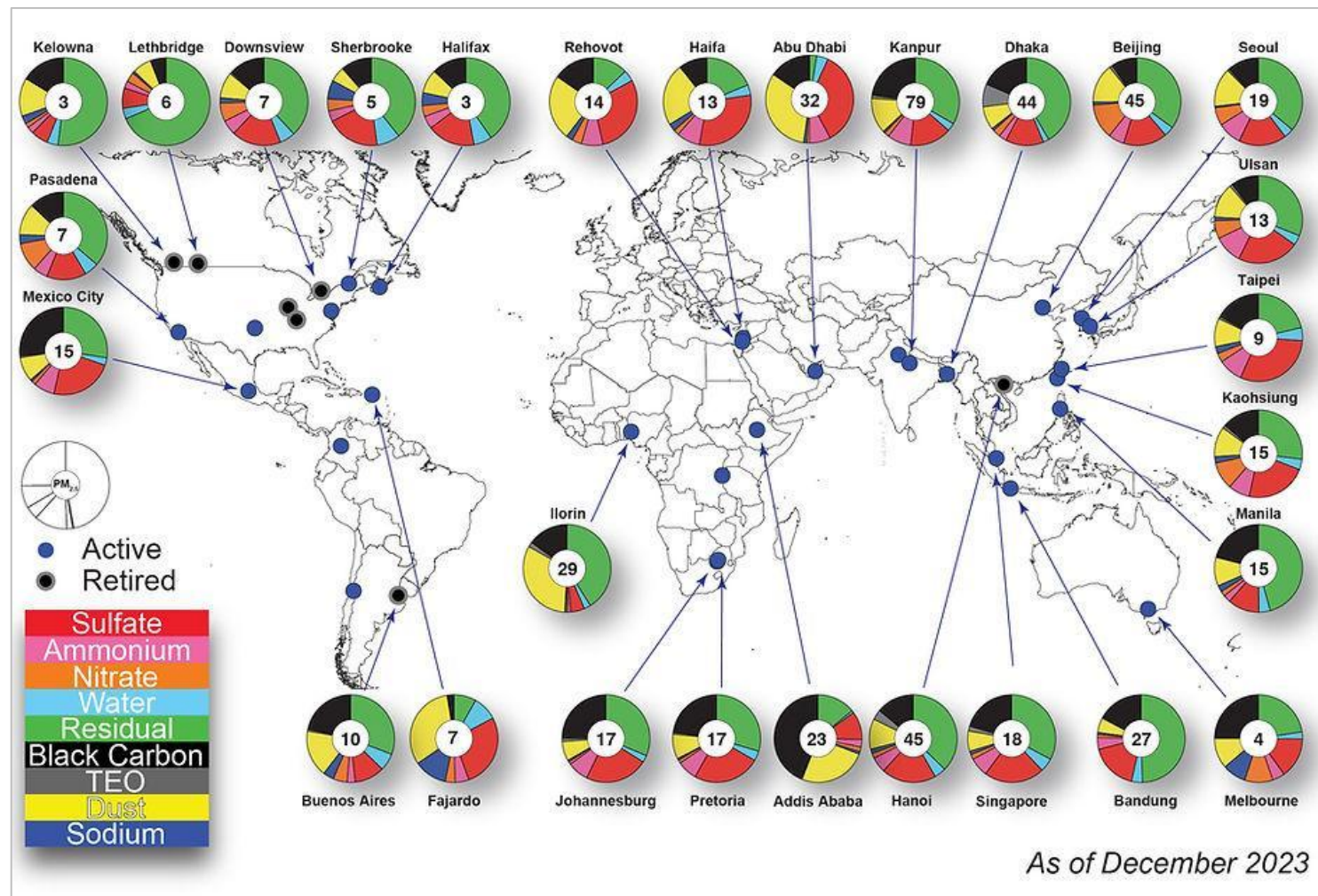


# Introduction

## SPARTAN Instrument

- Measure fine particulate concentrations & evaluate the estimation of PM<sub>2.5</sub> by satellite remote sensing.
- In-situ instruments (Sampling station and Nephelometer).
- Mass concentration of chemical information from laboratory (in U.S.).

Eom et al. (2023)



Worldwide SPARTAN sites



Seoul (Yonsei Univ., Prof. Jhoon Kim)

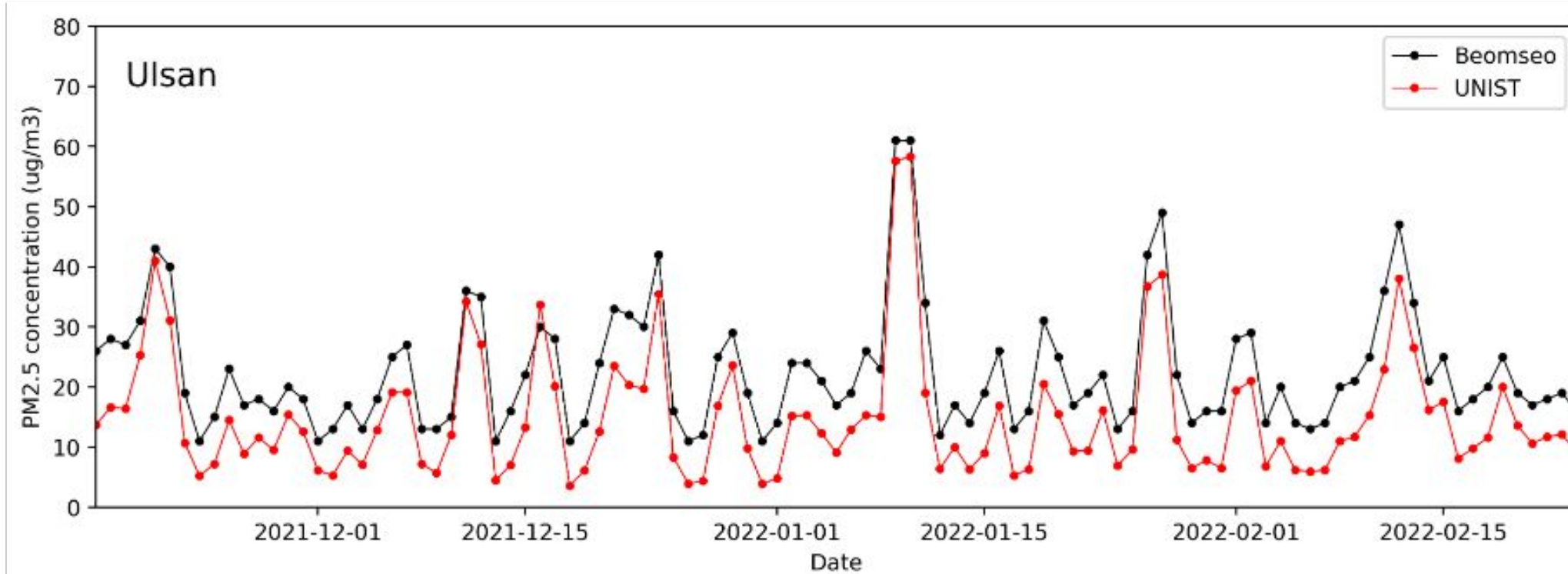
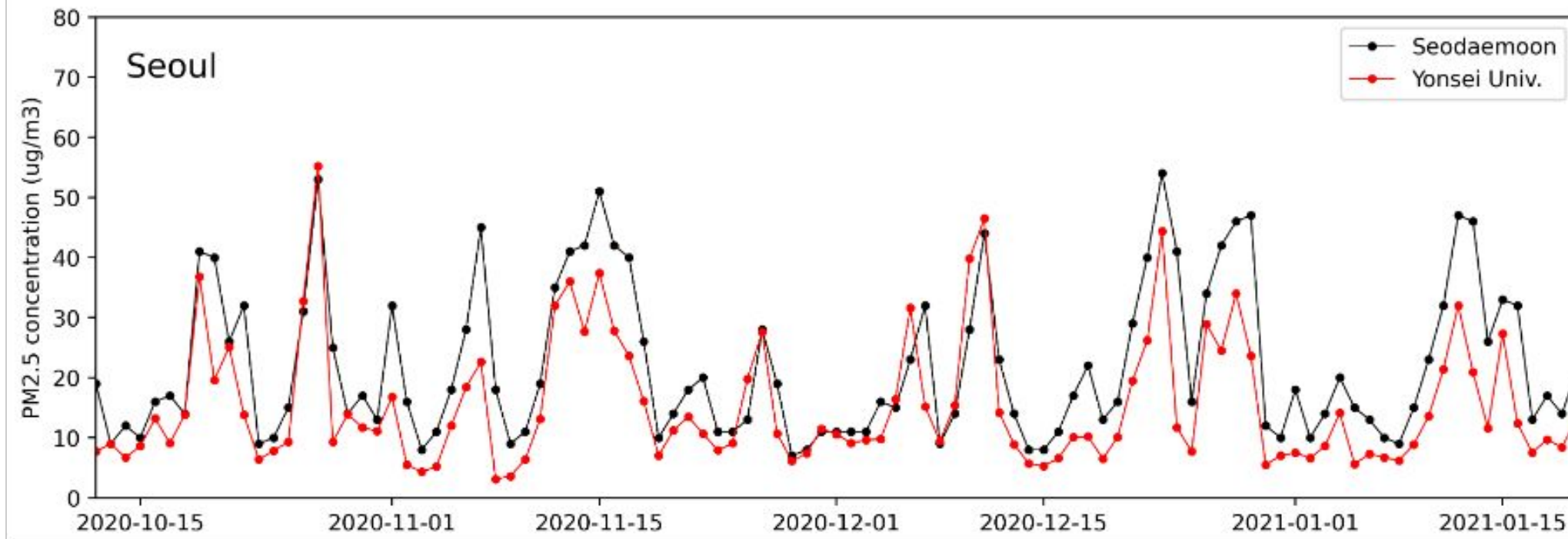


Ulsan (UNIST)

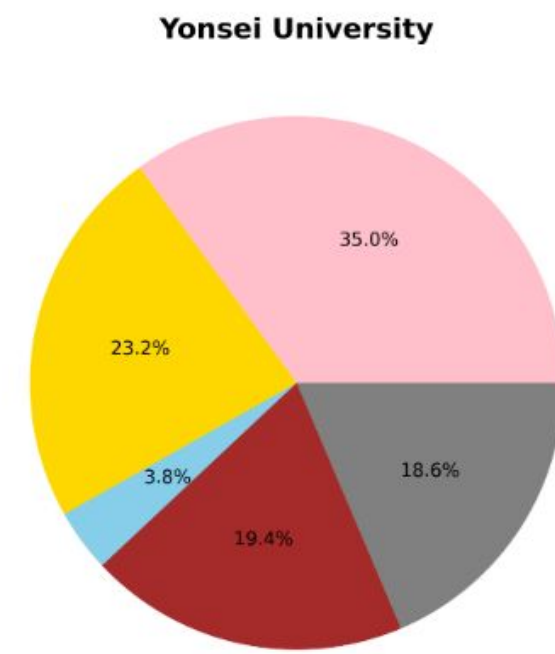


# Introduction

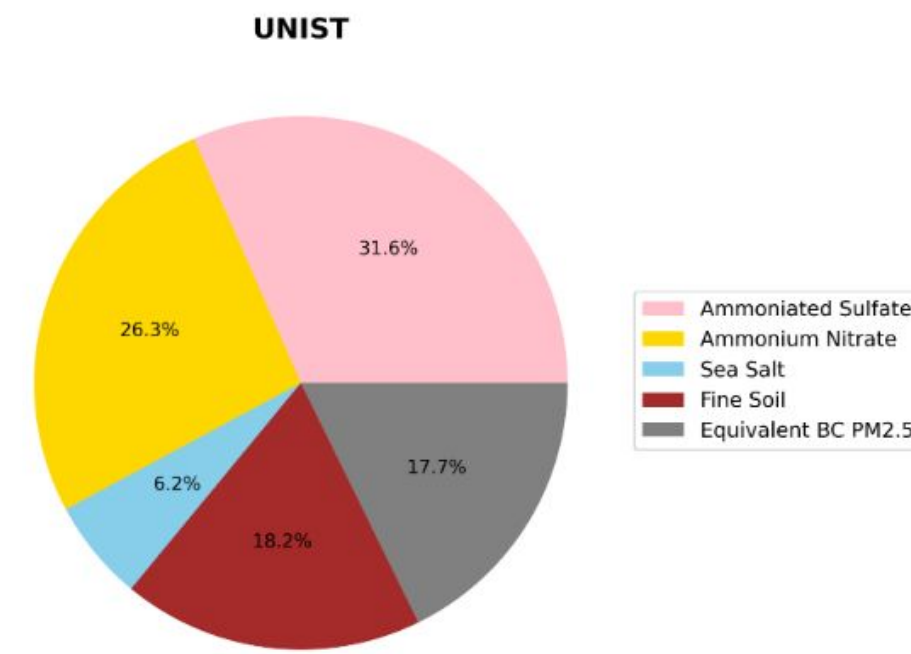
## SPARTAN Instrument



Day <sup>↕</sup>	PM <sub>2.5</sub> <sup>↕</sup>	PM <sub>10</sub> <sup>↕</sup>
1 <sup>↕</sup>	9:00 – 12:00 <sup>↕</sup>	12:00 - 12:30 <sup>↕</sup>
2 <sup>↕</sup>	12:00 – 15:00 <sup>↕</sup>	15:00 – 15:30 <sup>↕</sup>
3 <sup>↕</sup>	15:00 – 18:00 <sup>↕</sup>	18:00 - 18:30 <sup>↕</sup>
4 <sup>↕</sup>	18:00 – 21:00 <sup>↕</sup>	21:00 – 21:30 <sup>↕</sup>
5 <sup>↕</sup>	21:00 – 0:00 <sup>↕</sup>	↕
6 <sup>↕</sup>	↕	0:00 – 0:30 <sup>↕</sup>
7 <sup>↕</sup>	0:00 – 3:00 <sup>↕</sup>	3:00 – 3:30 <sup>↕</sup>
8 <sup>↕</sup>	3:00 – 6:00 <sup>↕</sup>	6:00 – 6:30 <sup>↕</sup>
9 <sup>↕</sup>	6:00 - 9:00 <sup>↕</sup>	9:00 – 9:30 <sup>↕</sup>



2019-05-02 ~ 2021-11-16  
Filter : 6

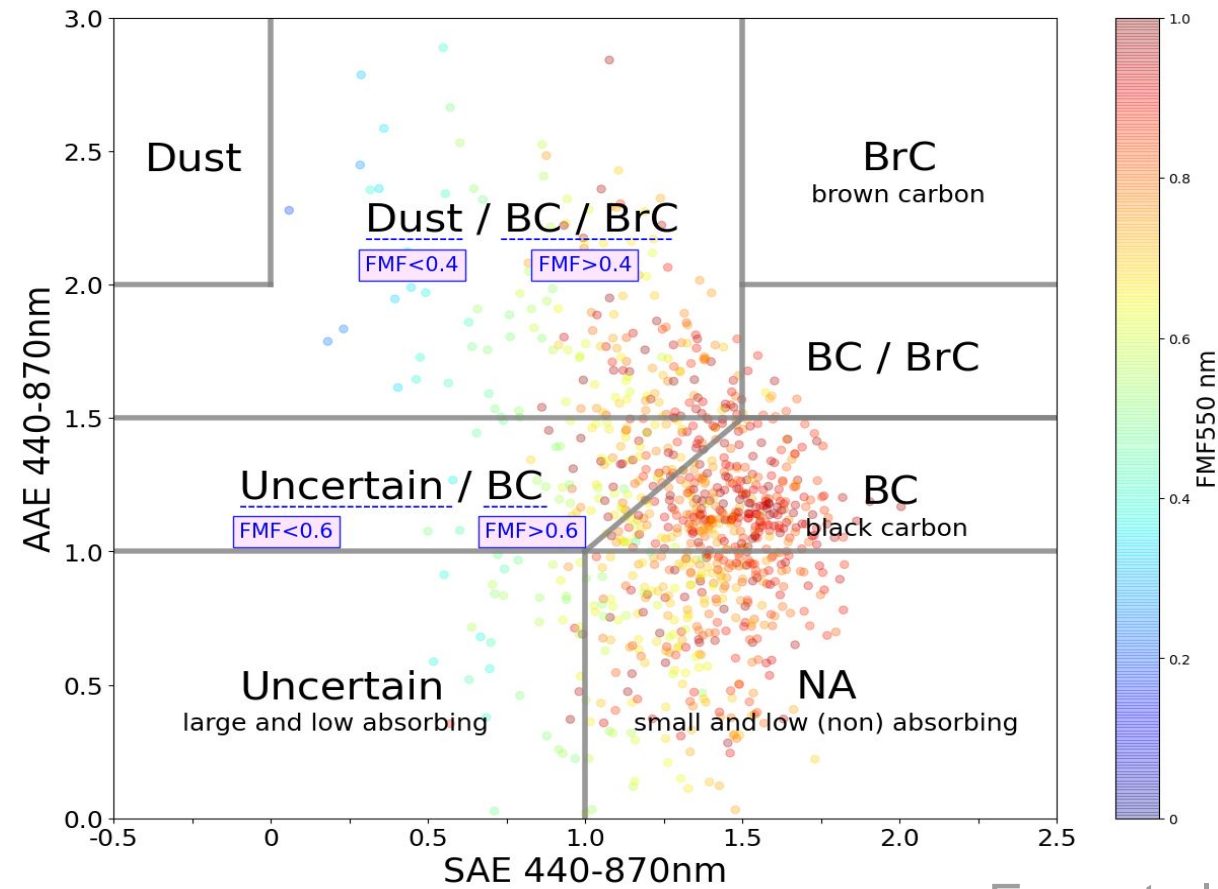


2021-10-28 ~ 2021-12-12  
Filter: 1

Eom et al. (2023)

# Purpose & Method

## Optical Property □ Identify Chemical Information?

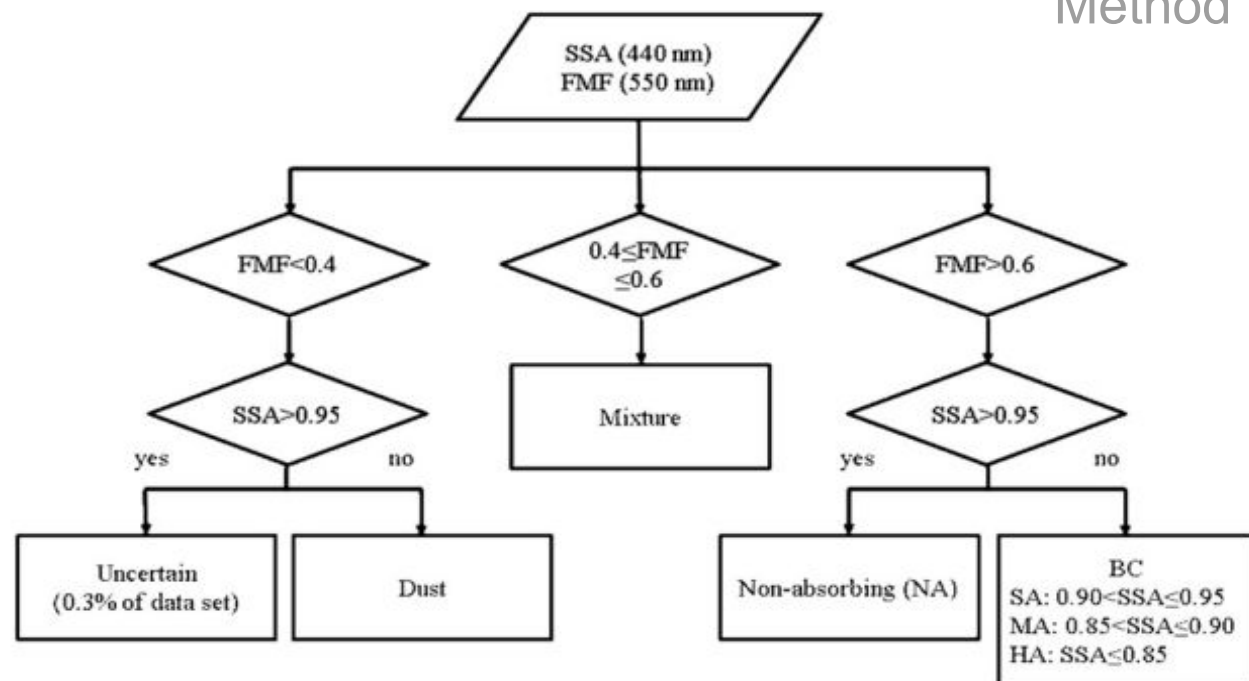


Eom et al. (2022)  
Method from Cappa et al. (2016)

Relationship of Aerosol type determination algorithm and aerosol chemical composition.



Need to find the direct linkage of relationship between optical and chemical composition.



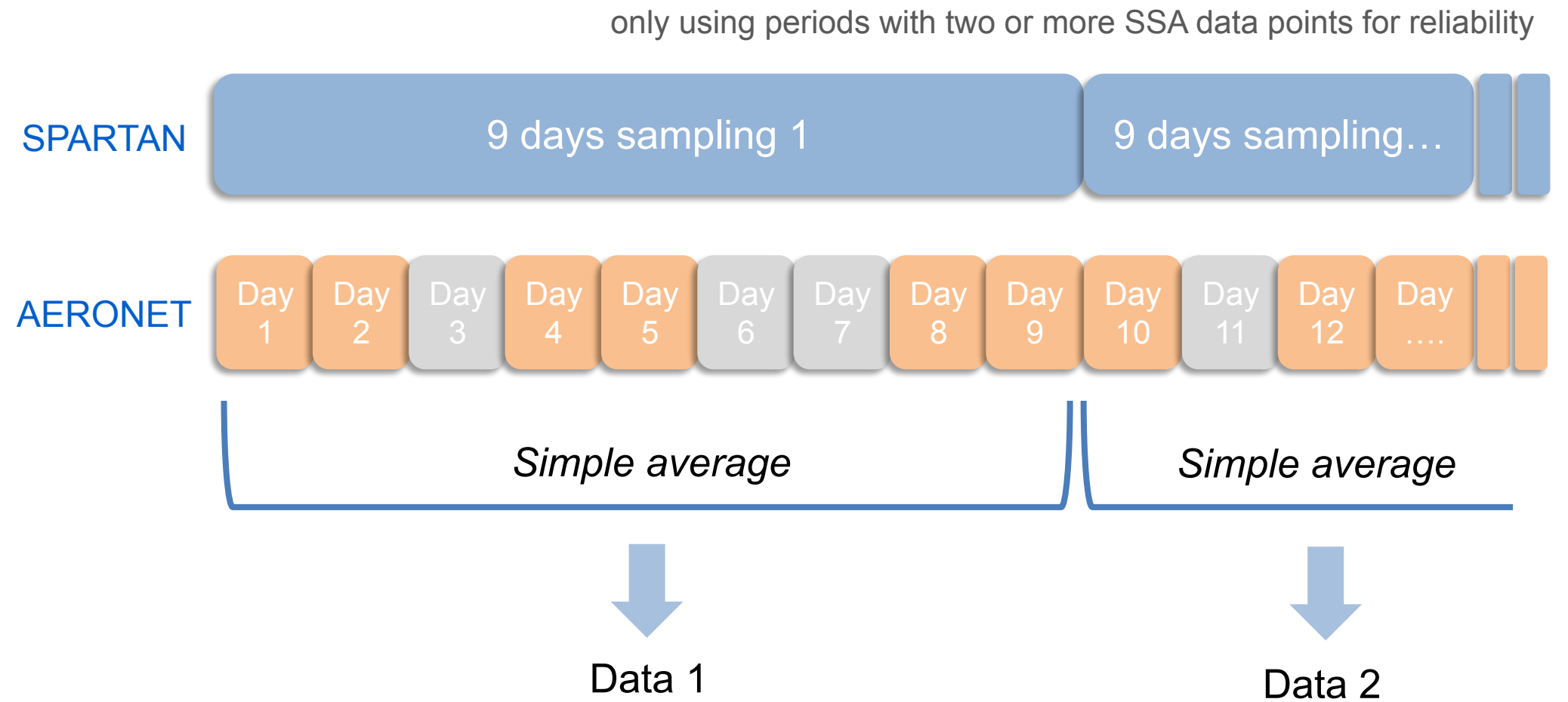
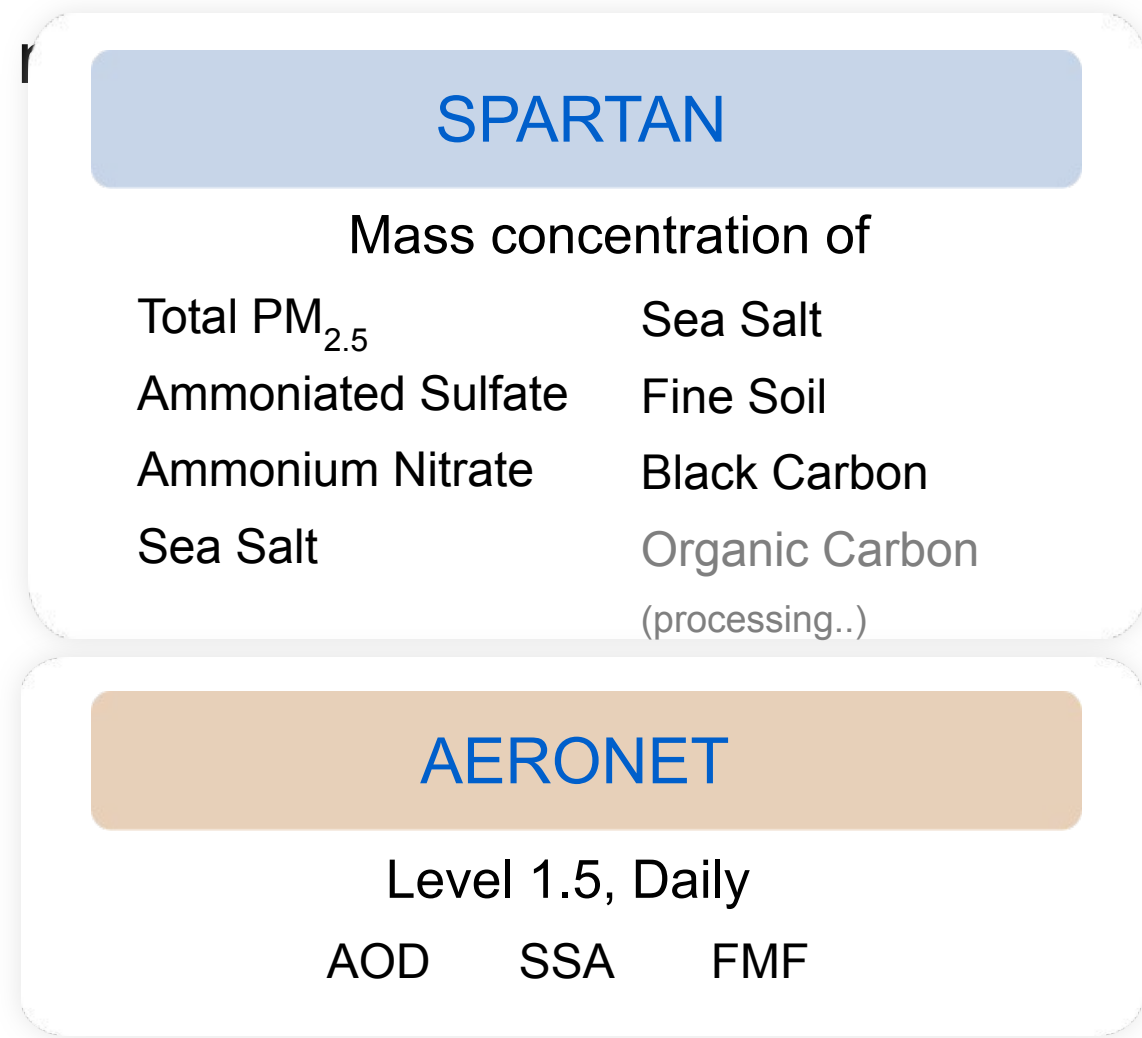
Lee et al. (2010)



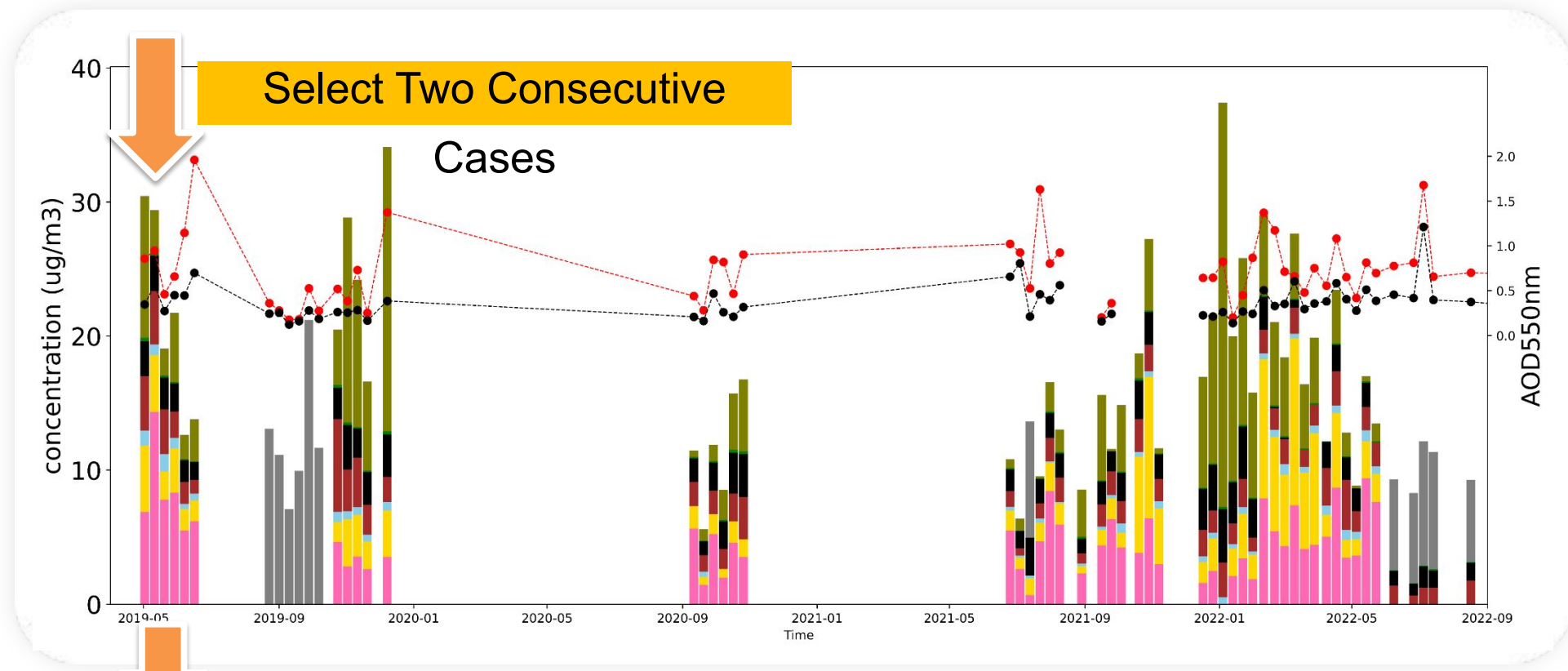
# Purpose & Method

## Data Collocation Method

- Our goal is to identify that chemical properties influence optical properties in real atmosphere.
- SPARTAN enables us to compare filter-based data with optical data at the same location.
- We used AERONET level 1.5 daily data to maximize data collection.
- AERONET data were averaged for each SPARTAN sampling period, generating one data point every

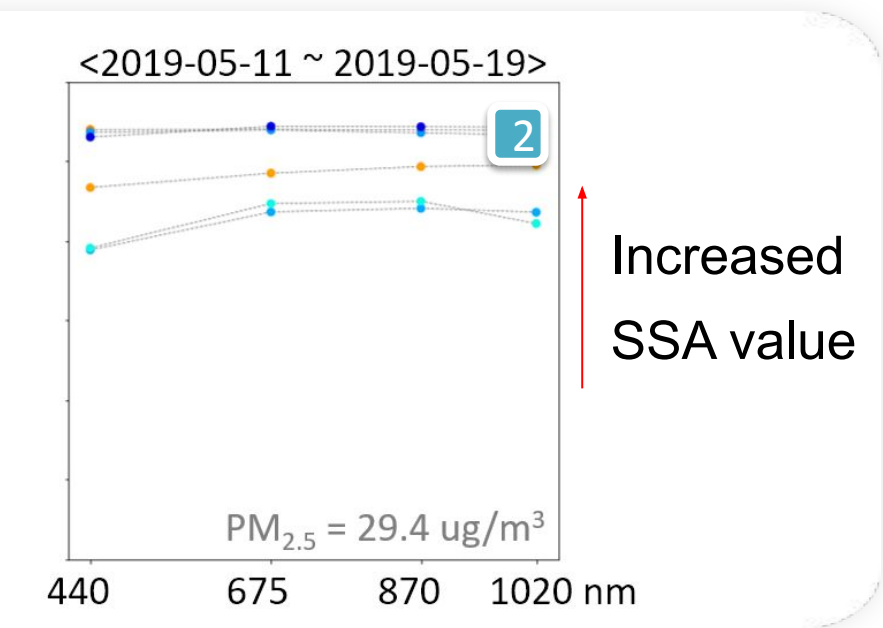
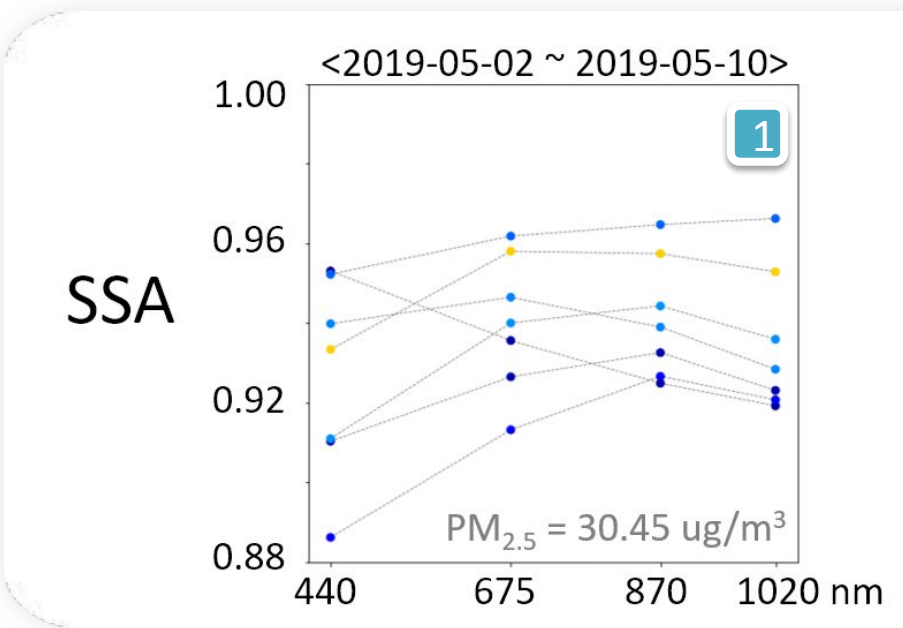
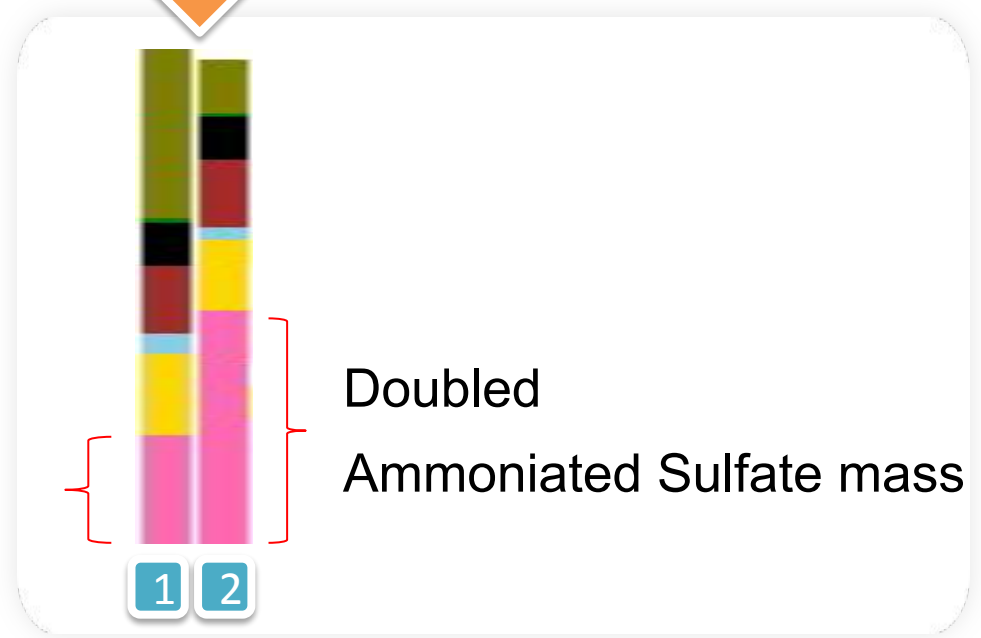


# Time Series of SPARTAN Data (Seoul)

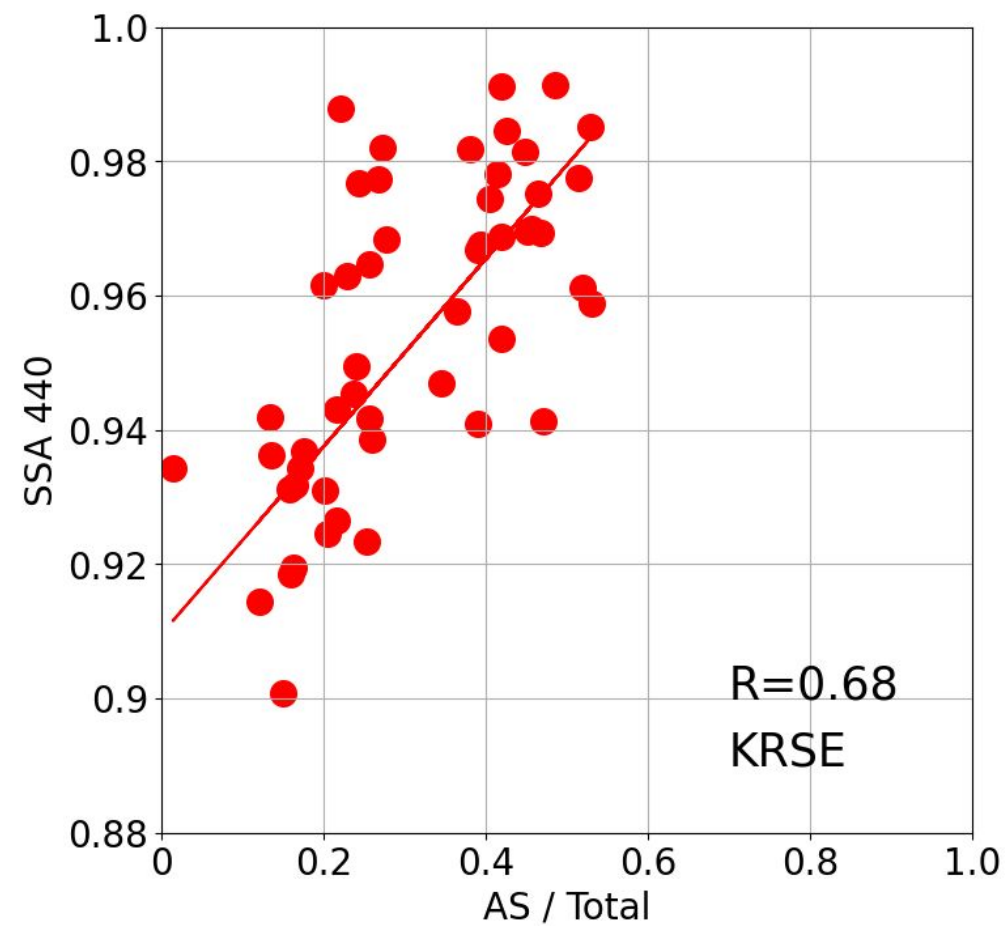


- Mass of Ammoniated Sulfate increased with SSA value increasing.
- Ammoniated Sulfate (AS) exists almost as a white substance in the atmosphere, it has scattering properties.

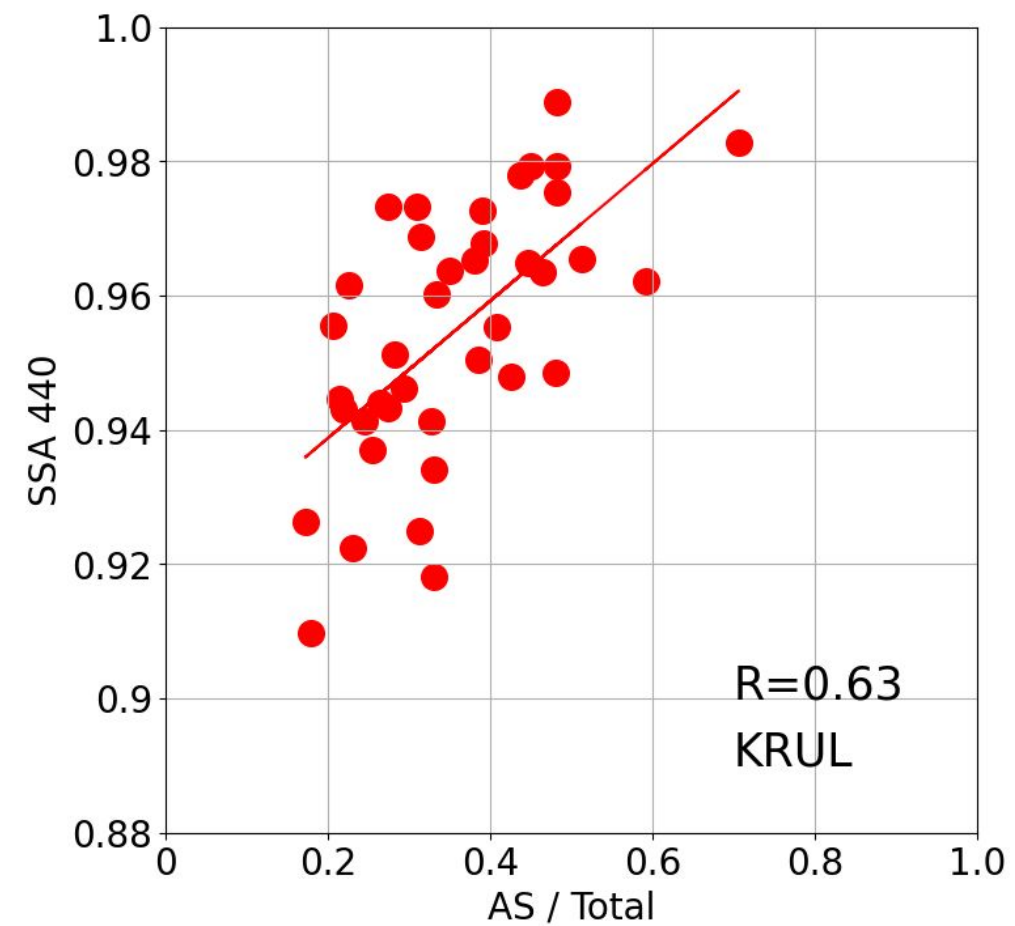
**Hypothesis:**  
*The increase in the proportion of AS in PM leads to an increase in SSA.*



# Relationship between SSA and AS Ratio



Seoul, Korea



Ulsan, Korea

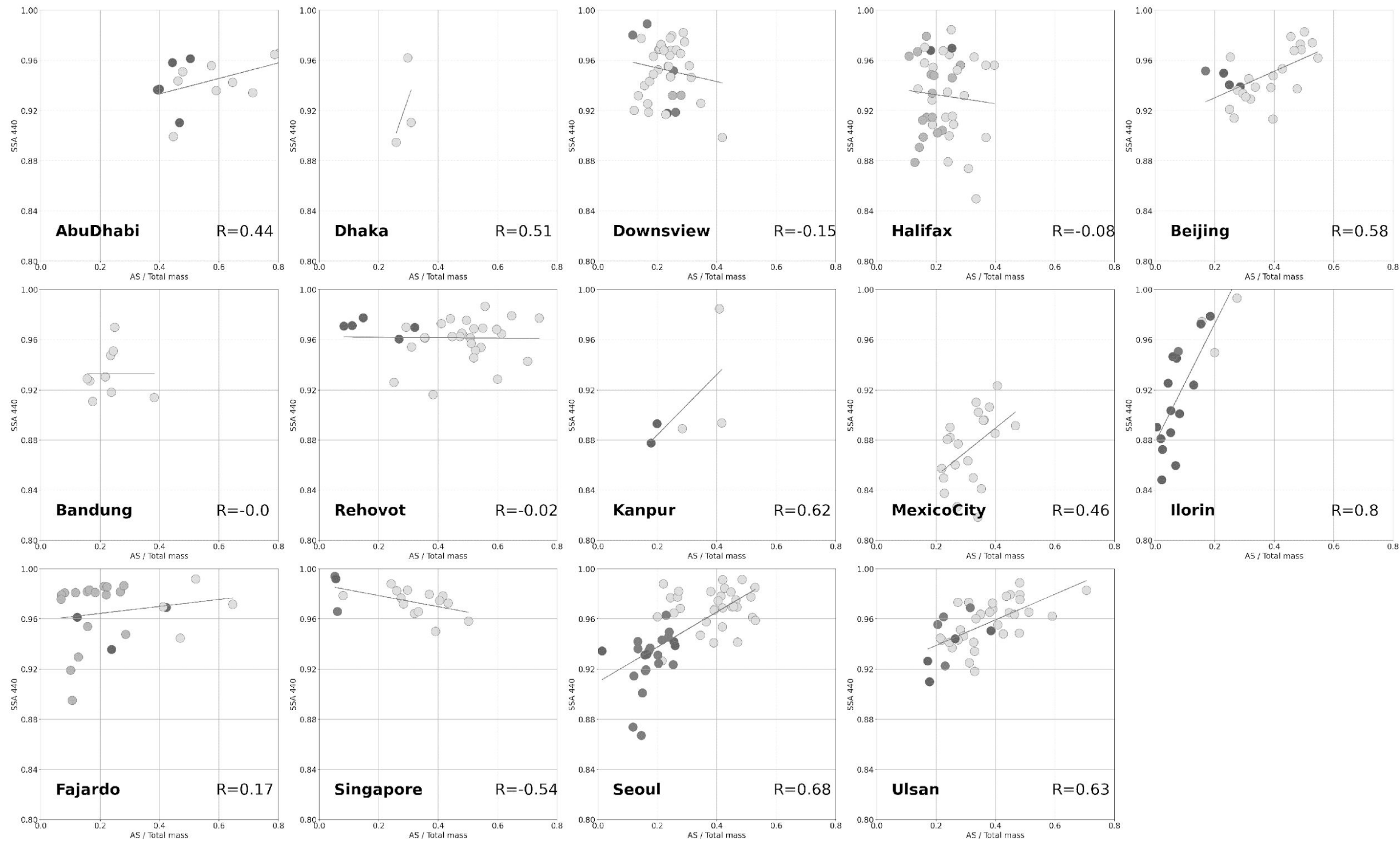
X axis : Ammoniated Sulfate / Total PM2.5  
Y axis : SSA value at 440nm

- Mass information from SPARTAN
- Optical information from AERONET

- Relatively high correlation value (0.6~0.7) at both sites
- Does this mean the hypothesis is correct?



# Relationship between SSA and AS Ratio



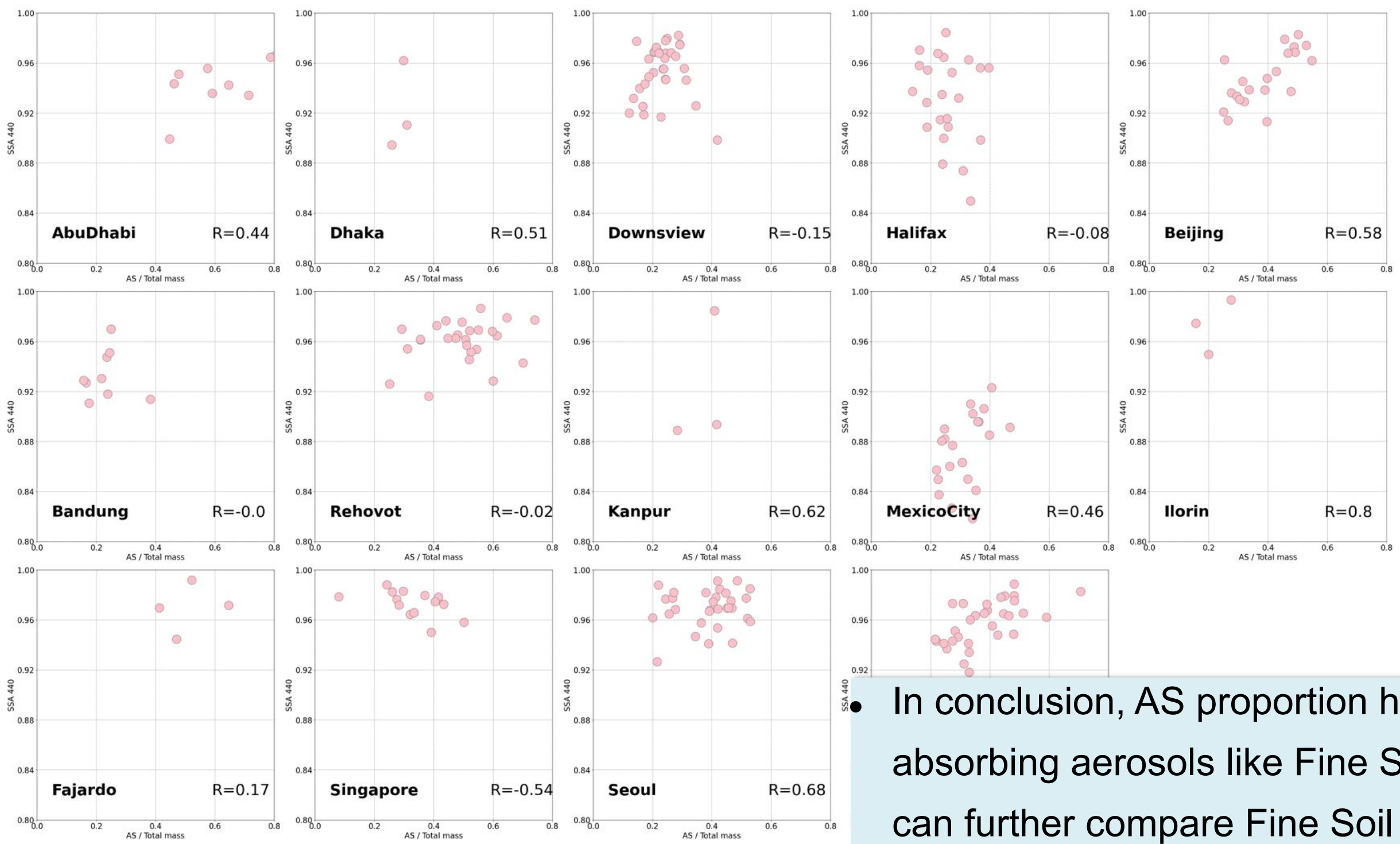
**Hypothesis:**  
The increase in the proportion of AS in PM leads to an increase in SSA.



# Relationship between SSA and AS Ratio

**Color : Dominant Chemical Composition**

	AmSulf
	AmNit
	Sea Salt
	Fine Soil
	BC

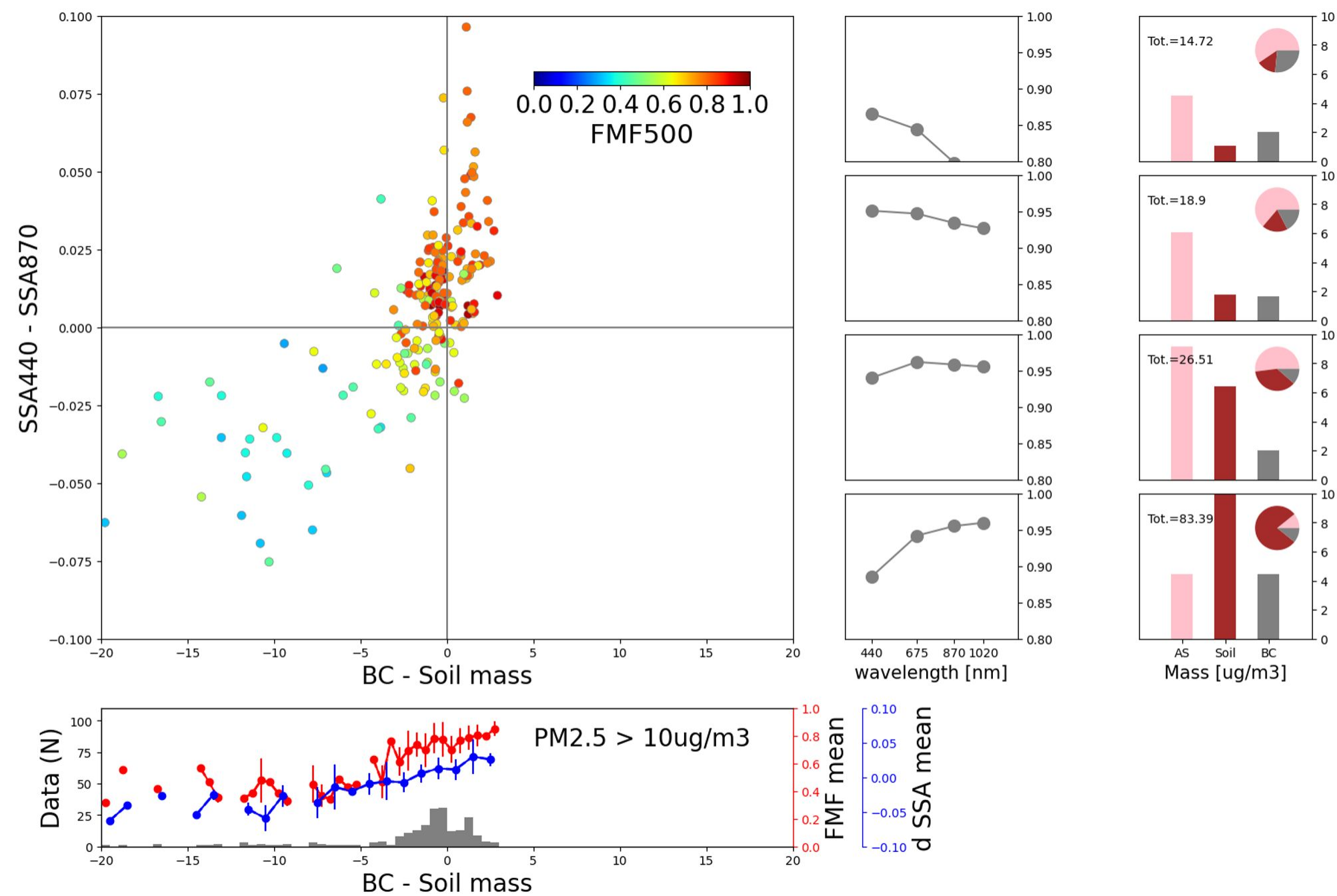


- The color of each point represents the dominant chemical component by mass for each sampling data.
- The data with the highest AS mass (pink points) shows no clear correlation.
- In some sites, as AS decreases and other components increase, SSA

• In conclusion, AS proportion had no consistent effect on SSA, while absorbing aerosols like Fine Soil (brown points) had a greater impact. We can further compare Fine Soil and BC to assess their influence on SSA.



# Optical Property change by BC and Fine Soil Mass

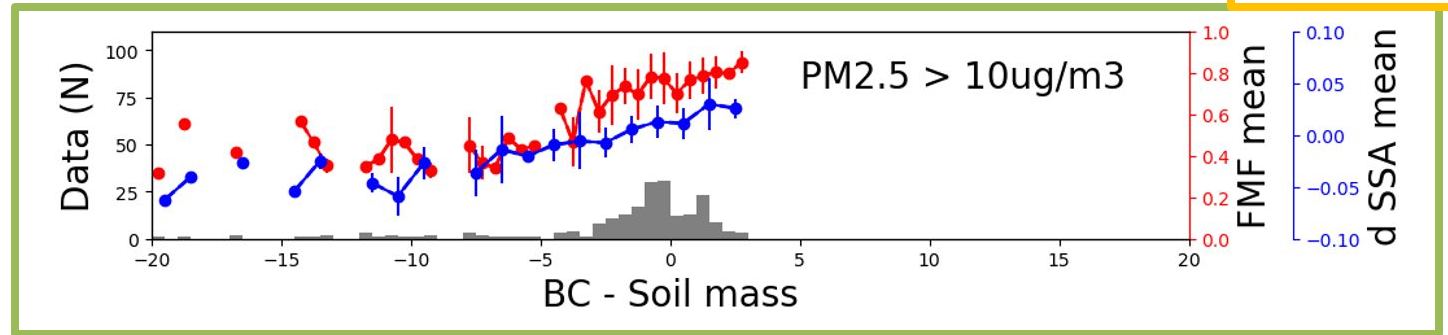
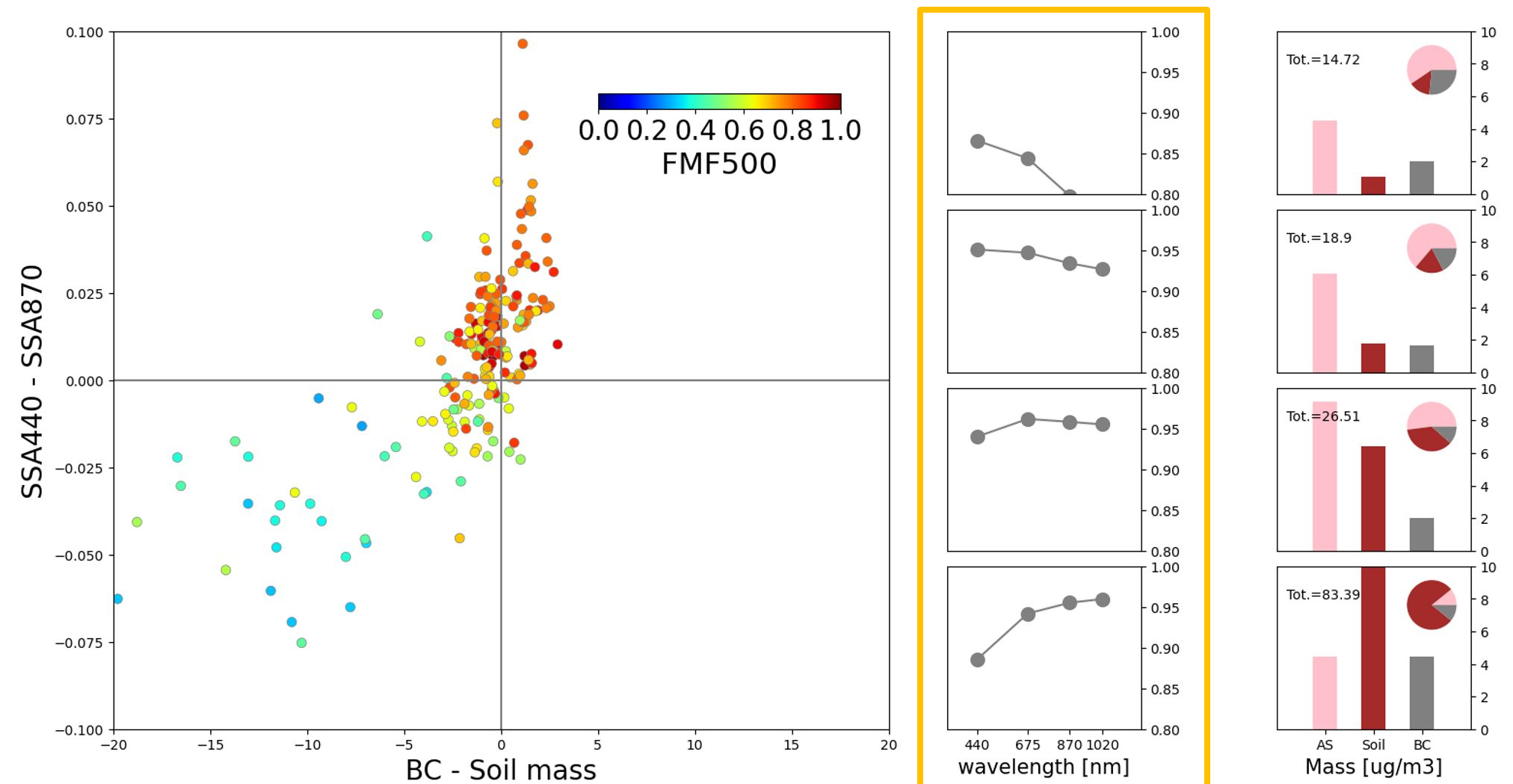


- We compared BC and Fine Soil mass differences using the full dataset.
- According to previous studies, a near-zero SSA delta (440nm-870nm) suggests BC dominance, while values above 0.05 indicate Dust dominance.

[\(Eck et al., 2010\)](#)



# Optical Property change by BC and Fine Soil Mass



- In regions with high Fine Soil, the SSA delta turns negative, and FMF decreases as larger particles increase.

- Simultaneously, SSA at shorter wavelengths also decreases effectively with increasing Fine Soil mass.

□ This shows clear changes in size and scattering properties due to absorbing aerosols



- **AS and SSA Correlation:** AS proportion did not consistently affect SSA, indicating it doesn't significantly impact optical properties across sites.
- **Fine Soil and BC Impact:** Absorbing aerosols like Fine Soil and BC showed a stronger influence on SSA compared to AS. Regions with more Dust showed a negative SSA delta, with BC and Dust dominance affecting particle size and scattering.
- **Aerosol Properties Conclusion:** Overall, Fine Soil and BC, not AS, are the key factors impacting optical properties like SSA and scattering in this study.



- ❖ This study confirmed the link between chemical and optical properties using a new in-situ instrument.
- ❖ Absorbing aerosols showed a clear match with optical properties, even with 9-day average data.
- ❖ Future research will explore the impact of non-absorbing aerosols.



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# Thank You!

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