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Analyzing uncertainties in a geophysical approach to estimate surface PM_{2.5} from satellite AOD

Xiaomeng Jin and Arlene M. Fiore
Columbia University/LDEO

HAQAST4 Meeting, UW-Madison

Kevin Civerolo and Mike Ku (NYSDEC)

Tabassam Insaf (NYSDOH)

Patrick Kinney (Boston University)

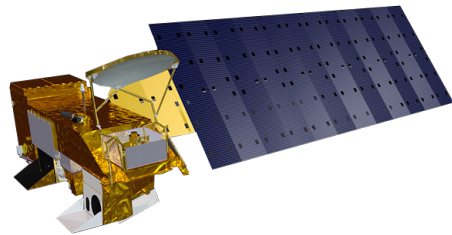
Marianthi-Anna Kioumourtzoglou and Mike He (Columbia Mailman School of Public Health)

Gabriele Curci (University of L'Aquila, Italy)

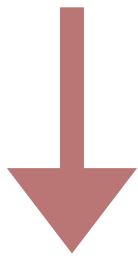
Alexei Lyapustin and Yujie Wang (NASA GSFC)

Randall Martin and Aaron van Donkelaar (University of Dalhousie, Canada)

Using satellite observations of AOD and models to infer PM_{2.5} distributions over Northeast USA



**Satellite
observations**



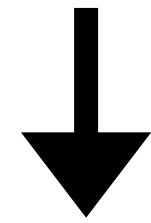
**MAIAC Aerosol
Optical Depth
(AOD)**



**CMAQ SIP Model (2011)
from NYSDEC**



**Ground-based
observations**



**Fine Particulate
Matter (PM_{2.5})**

$$\text{AOD}_{\text{satellite}} \times \frac{\text{PM}_{2.5_CMAQ}}{\text{AOD}_{CMAQ}} = \text{PM}_{2.5_satellite}$$



Aerosol Optical Properties

FlexAOD

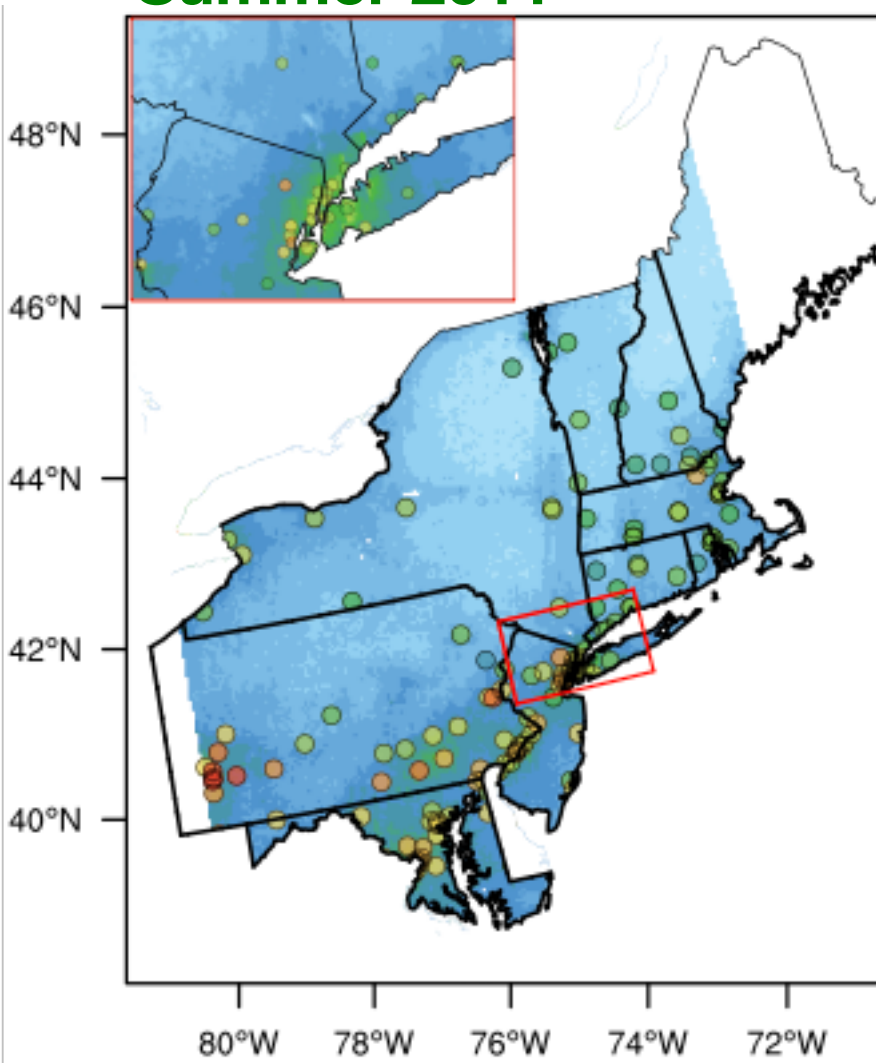


**Modeled 3D Aerosol
Distribution**

Satellite-derived PM_{2.5} is closer to observations than CMAQ

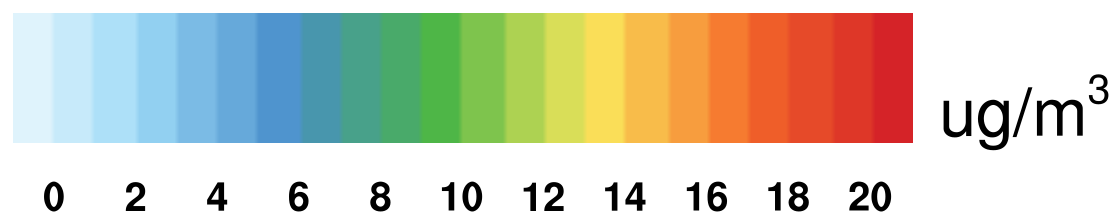
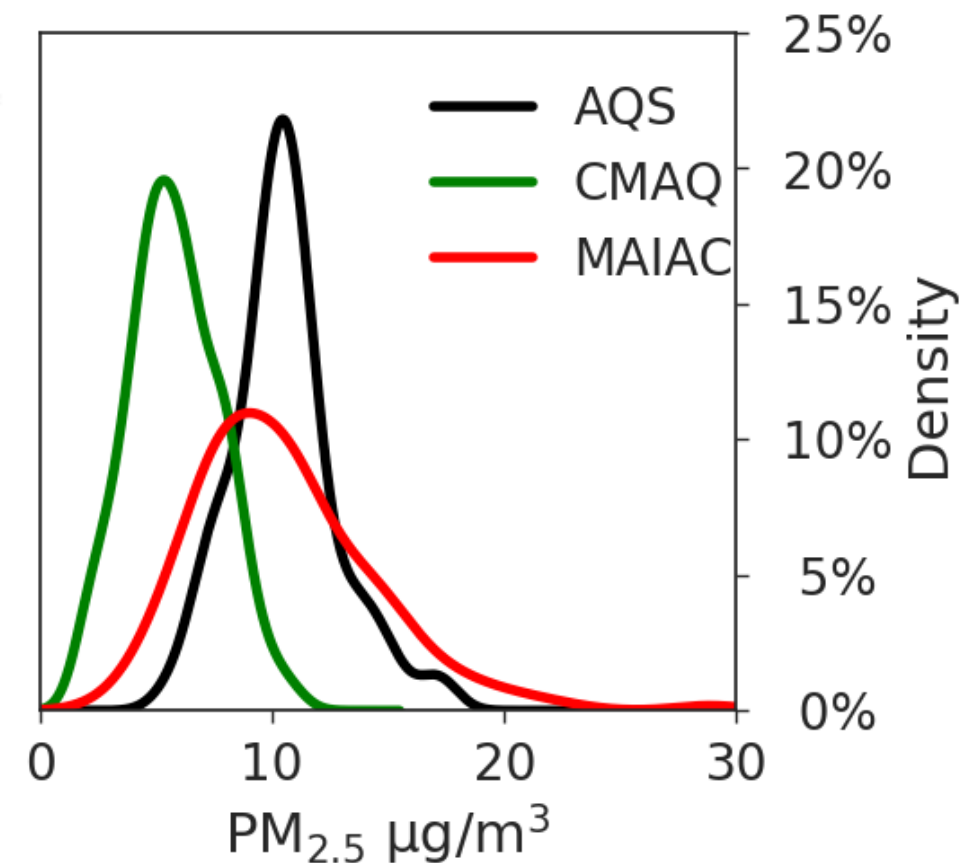
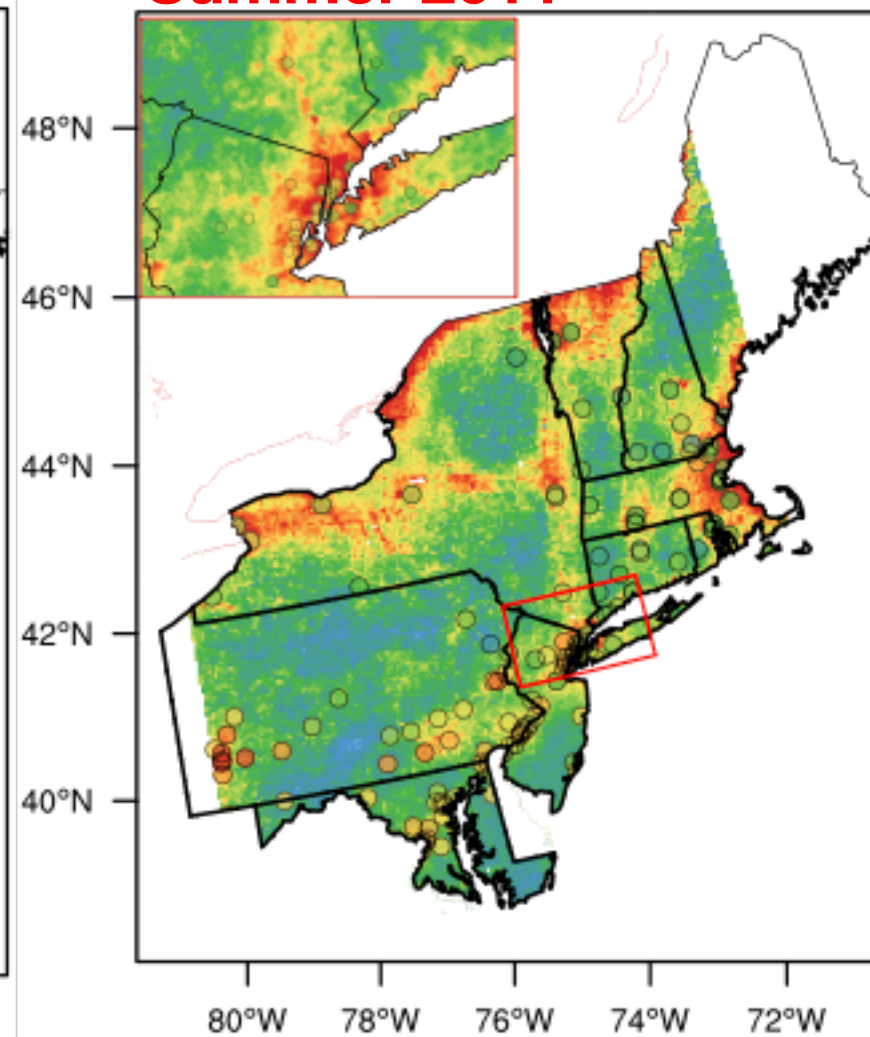
CMAQ PM_{2.5} (12 km)

Summer 2011



Satellite-derived PM_{2.5} (1 km)

Summer 2011



Using multi-platform *in situ* observations to assess the uncertainties associated with satellite derived PM_{2.5}

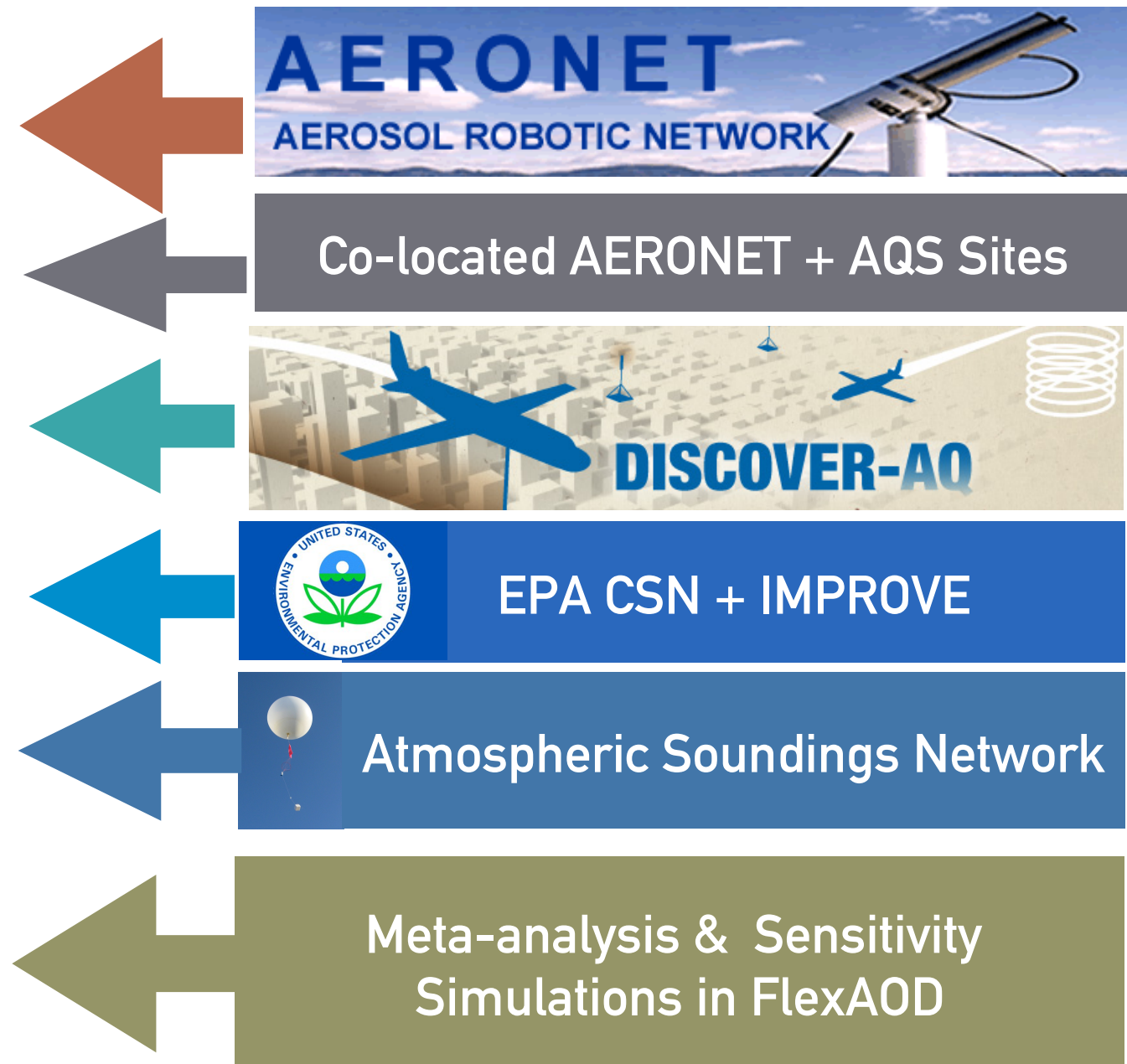
$$\text{AOD}_{\text{satellite}} \times \frac{\text{PM}_{2.5_CMAQ}}{\text{AOD}_{CMAQ}} = \text{PM}_{2.5_satellite}$$

➤ AOD_{satellite}

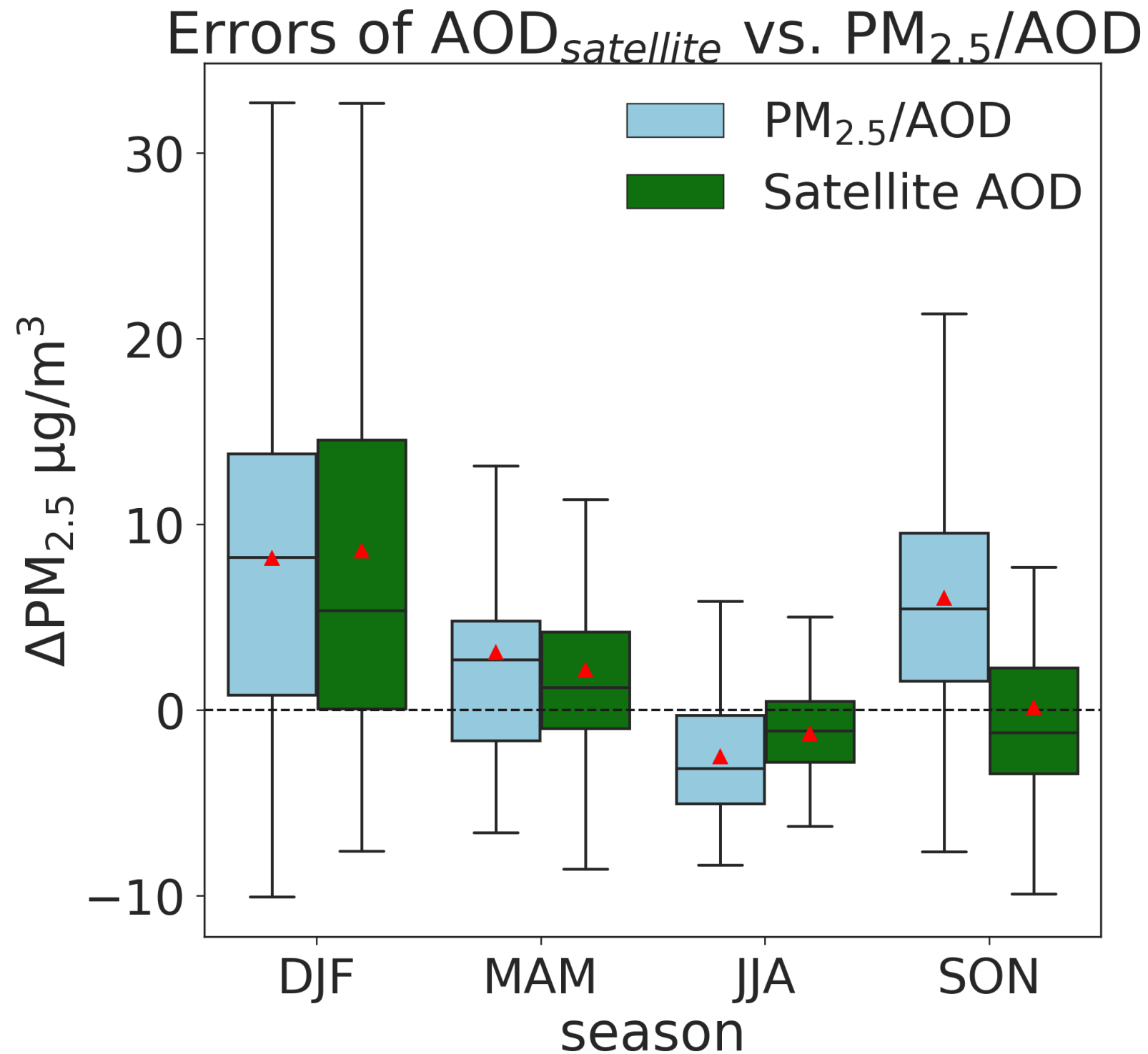
- Measurements uncertainty.
- Invalid observations due to cloud/snow.

➤ PM_{2.5}-AOD Relationship

- Aerosol column mass
- Aerosol vertical distribution
- Aerosol speciation
- Modeled meteorology (relative humidity)
- Size distribution
- Hygroscopic growth factor
- Refractive index
- Aerosol density



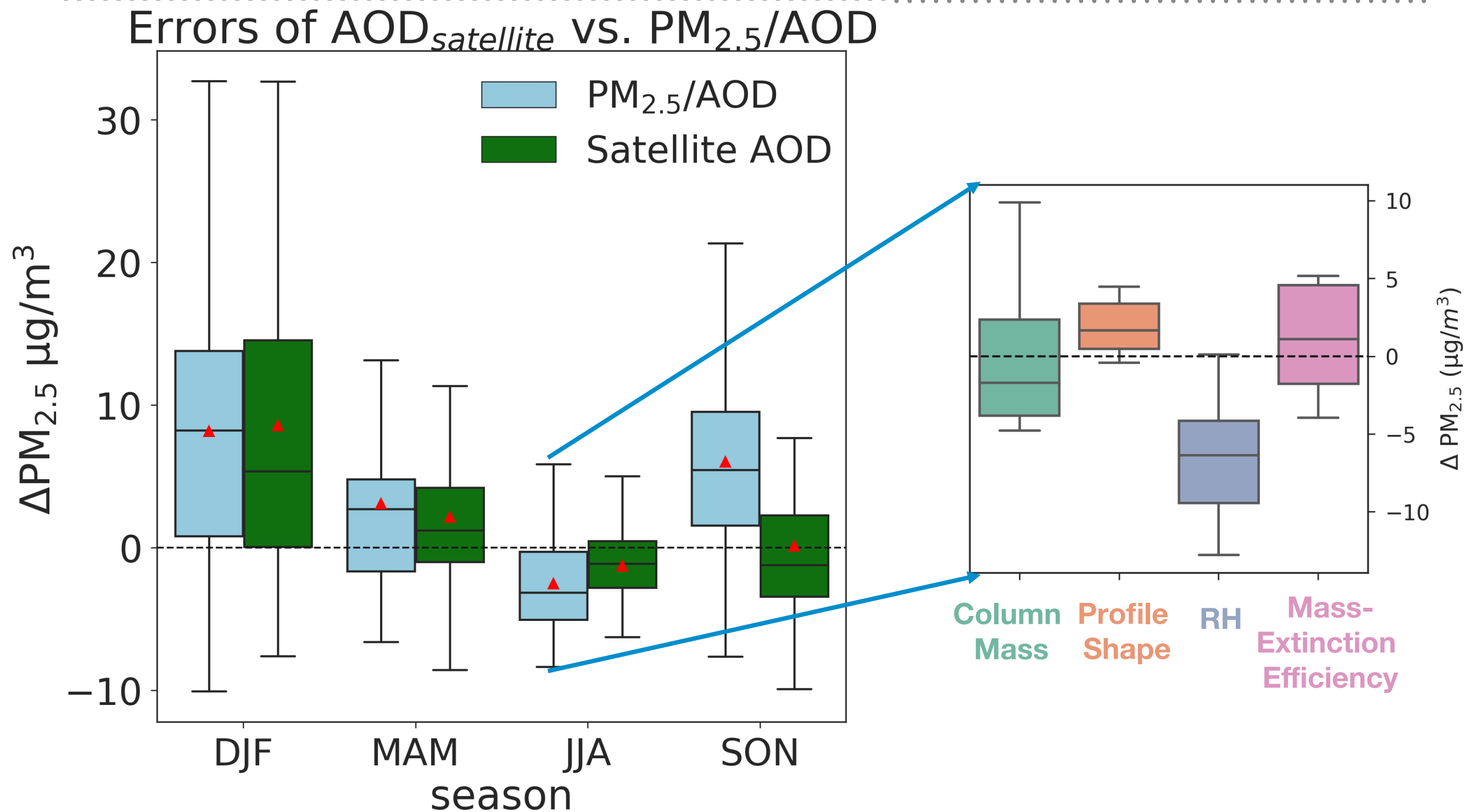
Modeled PM_{2.5}/AOD contributes larger uncertainty than satellite observations



Evaluated at 11 paired AQS-AERONET sites over Northeast US

Jin *et al.*, in prep

Factors lead to uncertainties in modeled PM_{2.5}/AOD

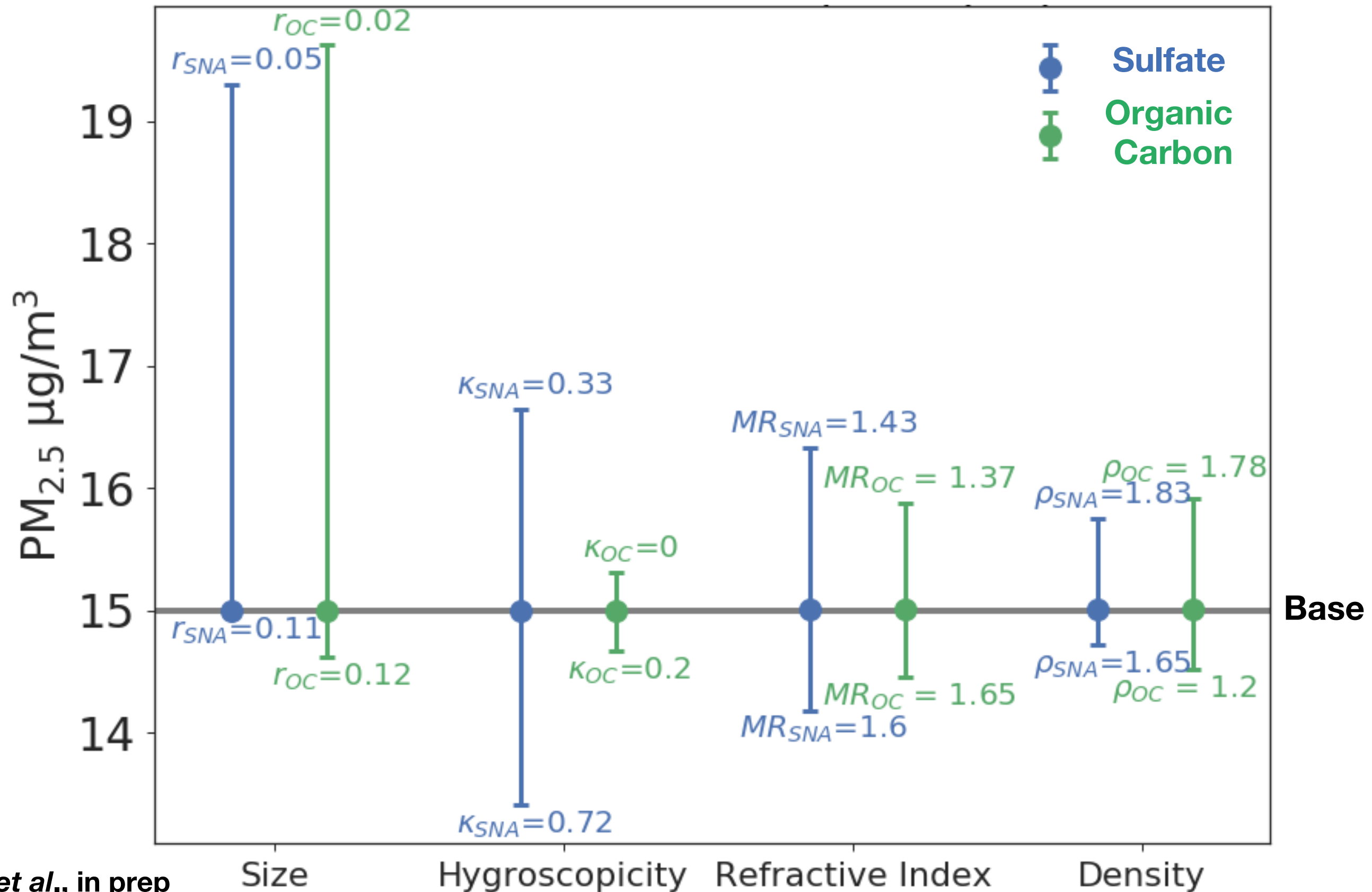


Evaluated at 11 paired AQS-AERONET sites over Northeast US

Jin *et al.*, in prep



Satellite-derived PM_{2.5} is sensitive to the parameterization of aerosol optical properties



Take-aways

- Multi-platform *in situ* measurements are valuable for quantifying the uncertainties of satellite-derived PM_{2.5}.
- Model simulated PM_{2.5}-AOD contributes larger uncertainty than satellite observations.
- Satellite-derived PM_{2.5} is sensitive to parameterized optical properties, with aerosol size distribution the largest source of uncertainty.
- Uncertainties to be considered in health analysis.