Temperature-dependent model biases in summertime $PM_{2.5}$ composition in the Eastern U.S.

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Acknowledgements + Scope

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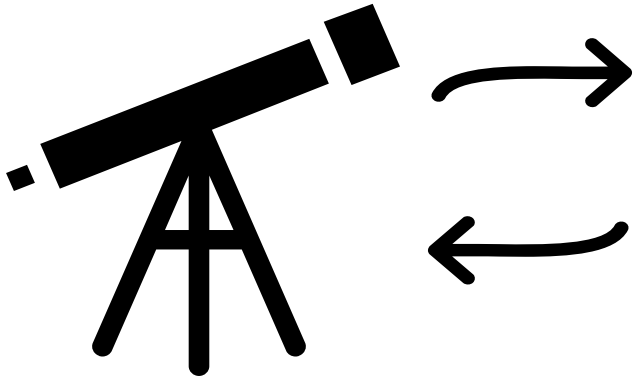


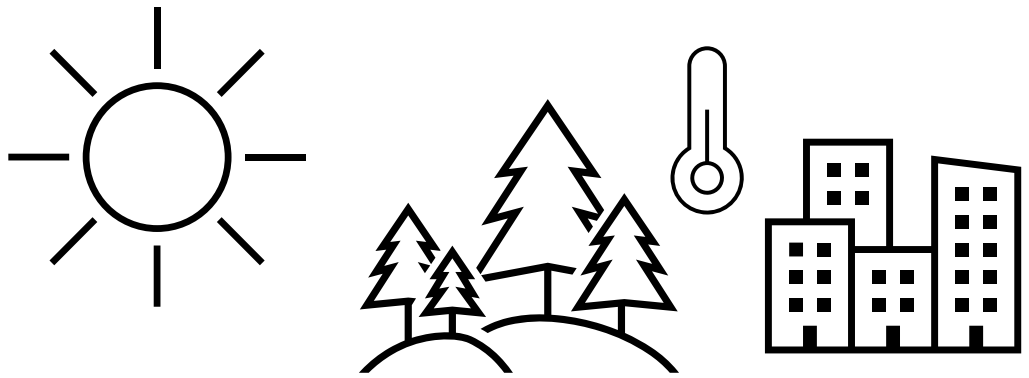
EPA Air Quality System (AQS)

CMAQ v5.4 CRACMM v1.0

Motivation

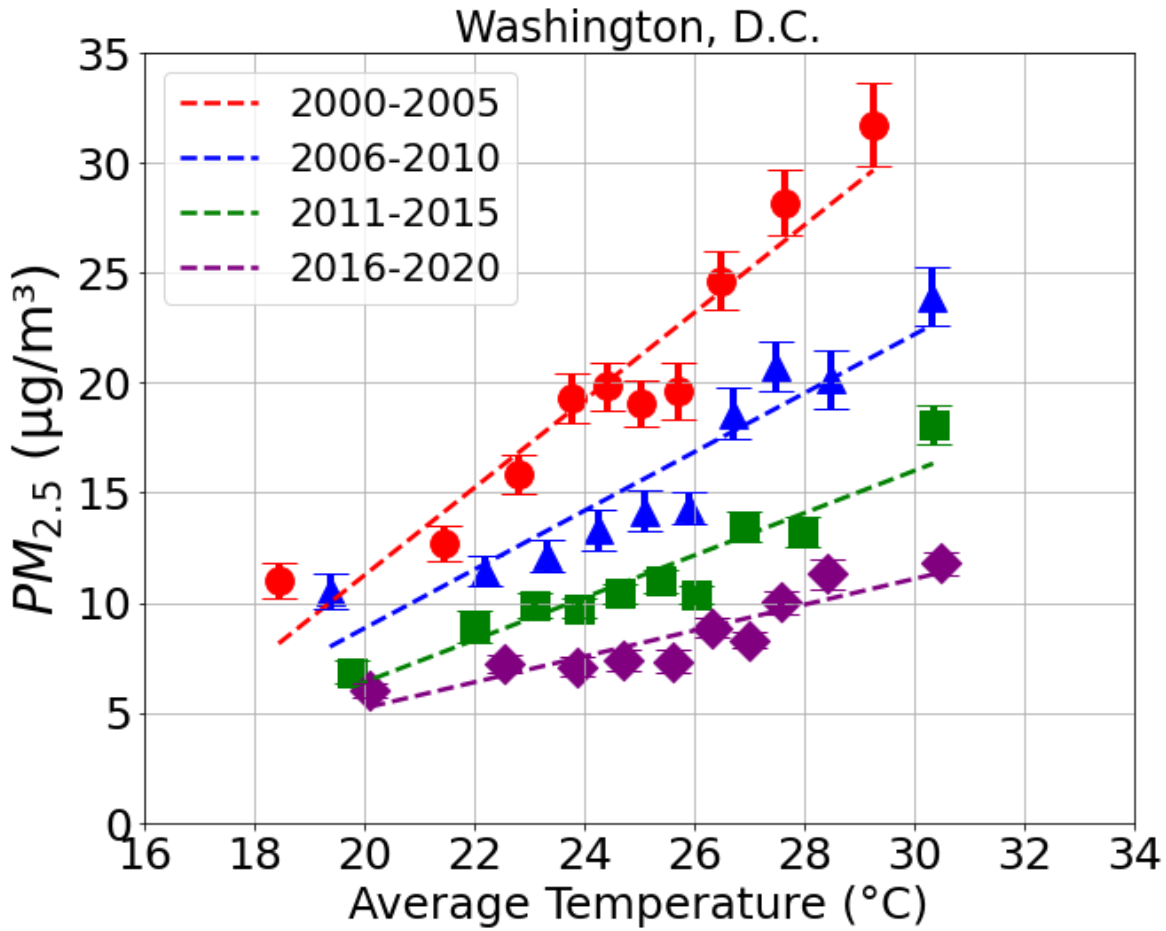
- Understanding drivers of summertime $PM_{2.5}$ in the U.S.

- What aerosol components are associated with high concentration events, through which processes are they formed, and to what extent are they controllable?



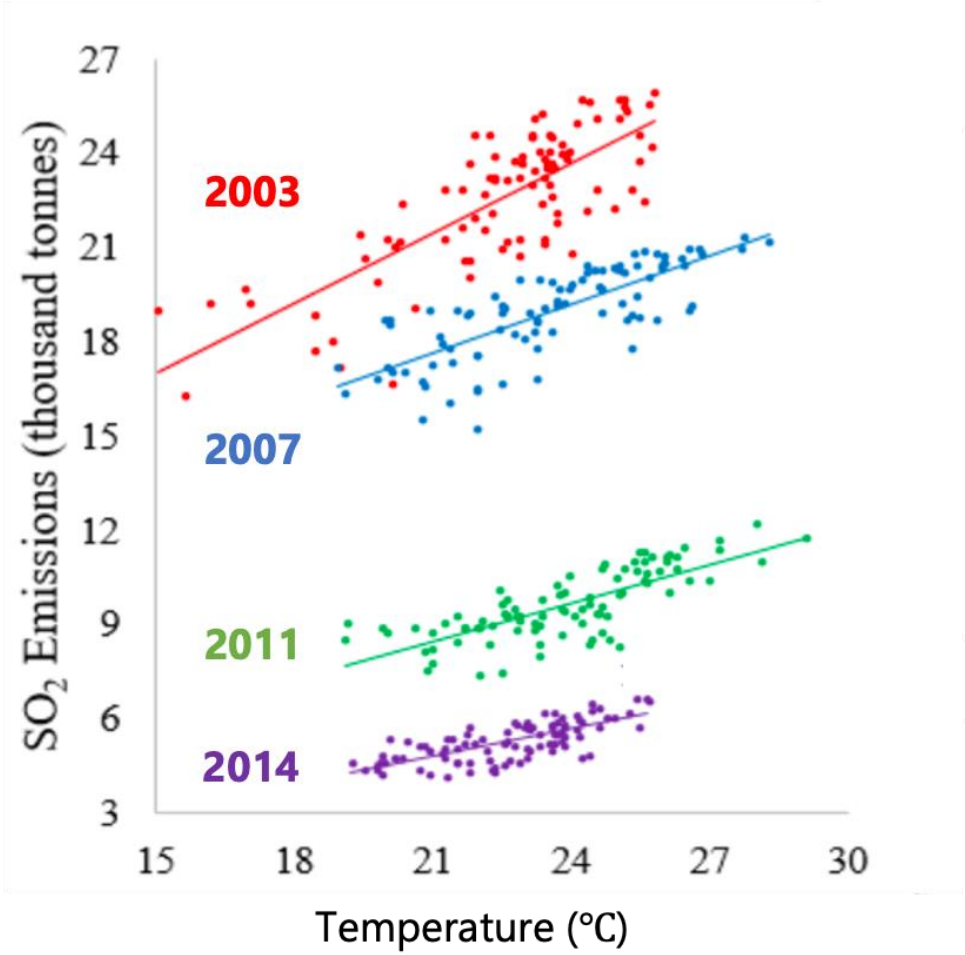
Temperature as a control for $PM_{2.5}$

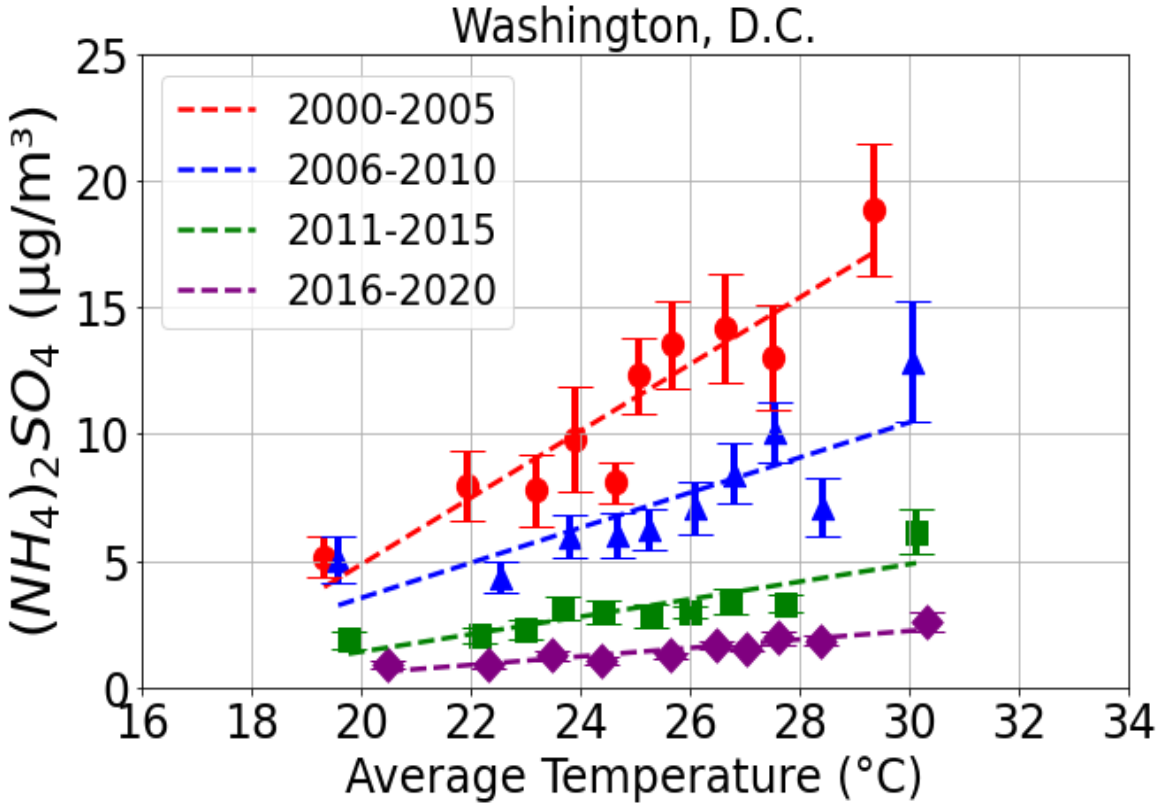
- In the Eastern U.S, we see a robust summertime $PM_{2.5}$ –T relationship with a prominent decadal evolution



(Vannucci and Cohen, 2022) ACS E&S

SO_4^{2-} aerosols emerge as the culprit:





(Abel et al. 2017) ES&T

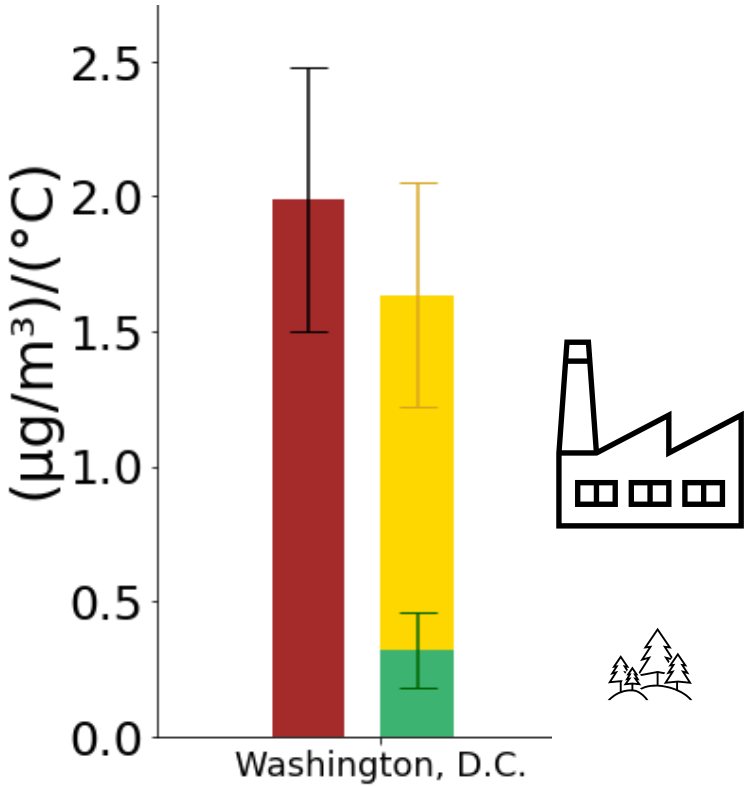
(Vannucci and Cohen, 2022) ACS E&S

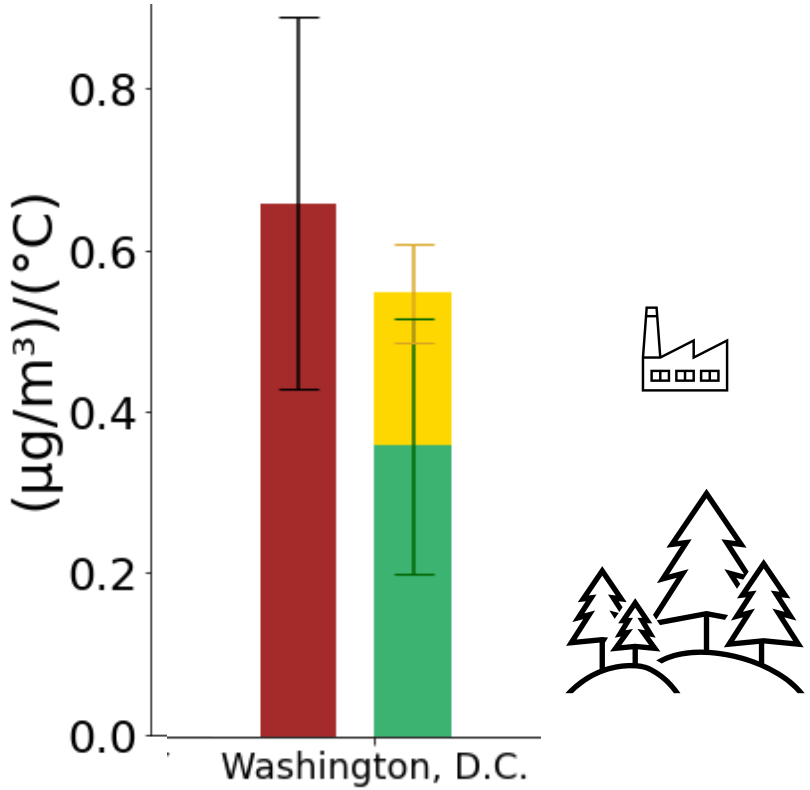
Reduced contributions from SO_2 leave organics in charge, so how do we continue to tackle this fraction?

Slope of:

- : $PM_{2.5}$ vs T
- : $(NH_4)_2SO_4$ vs T
- : OA vs T

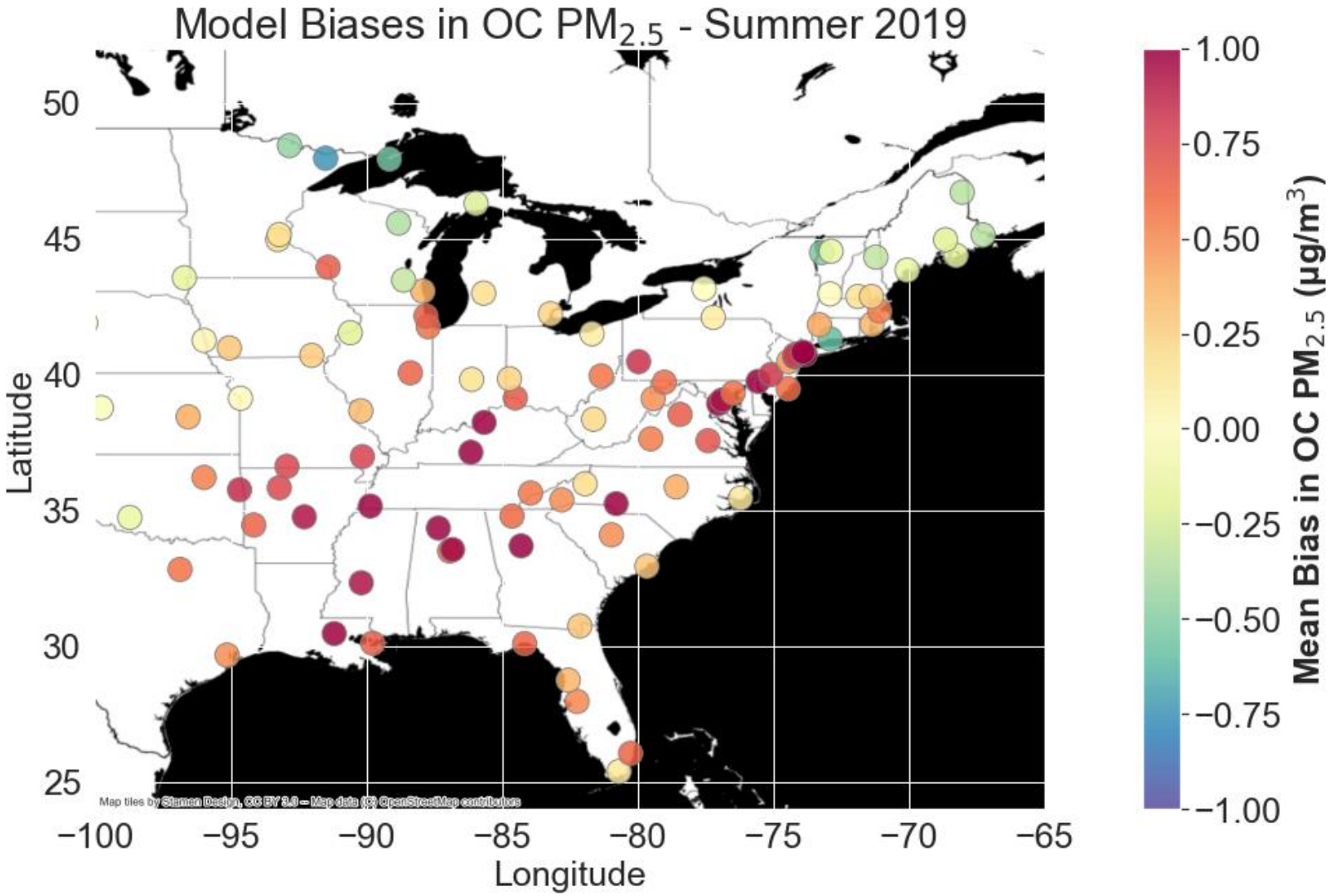
2000-2005 → 2016-2020



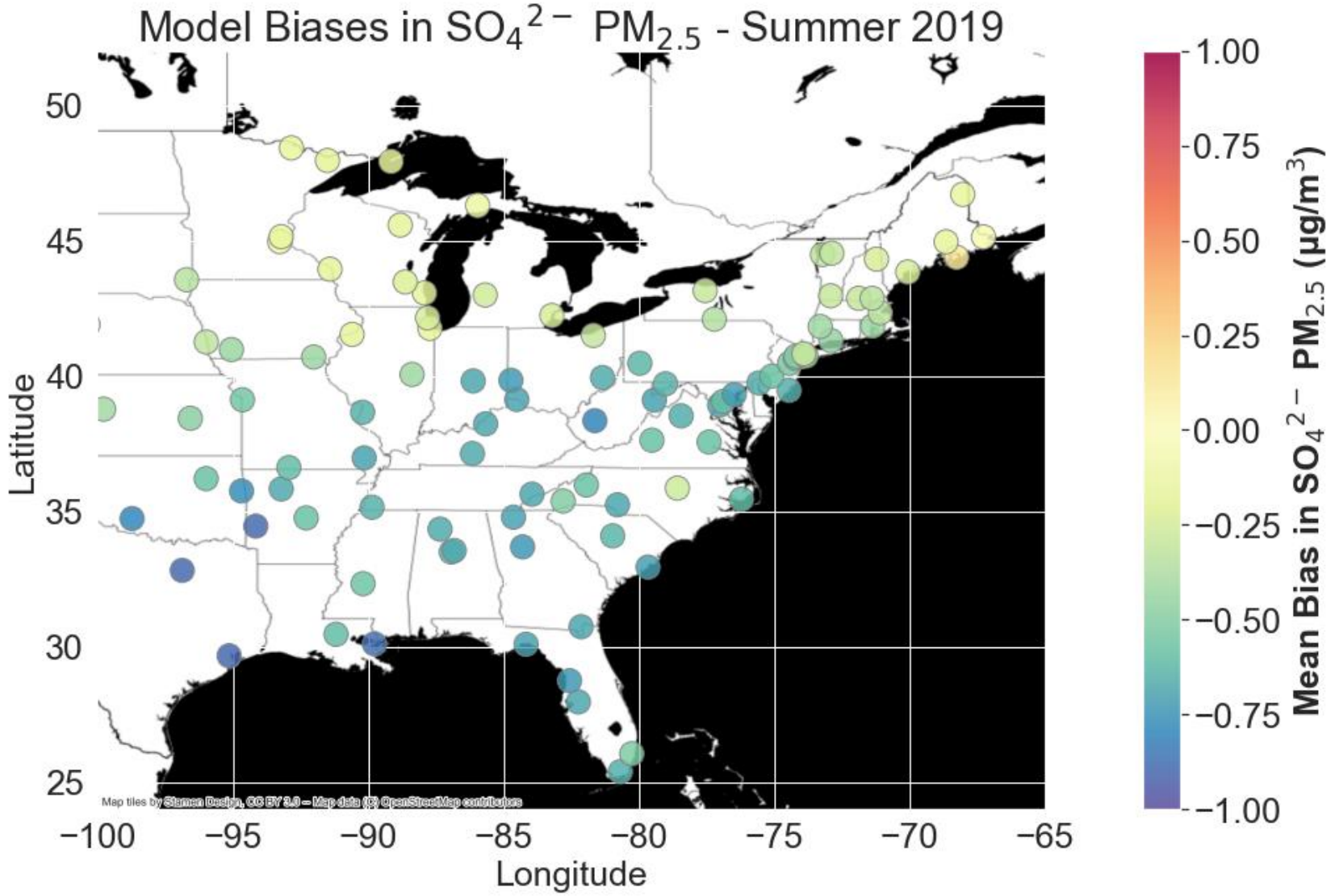


(Vannucci and Cohen, 2022) ACS E&S

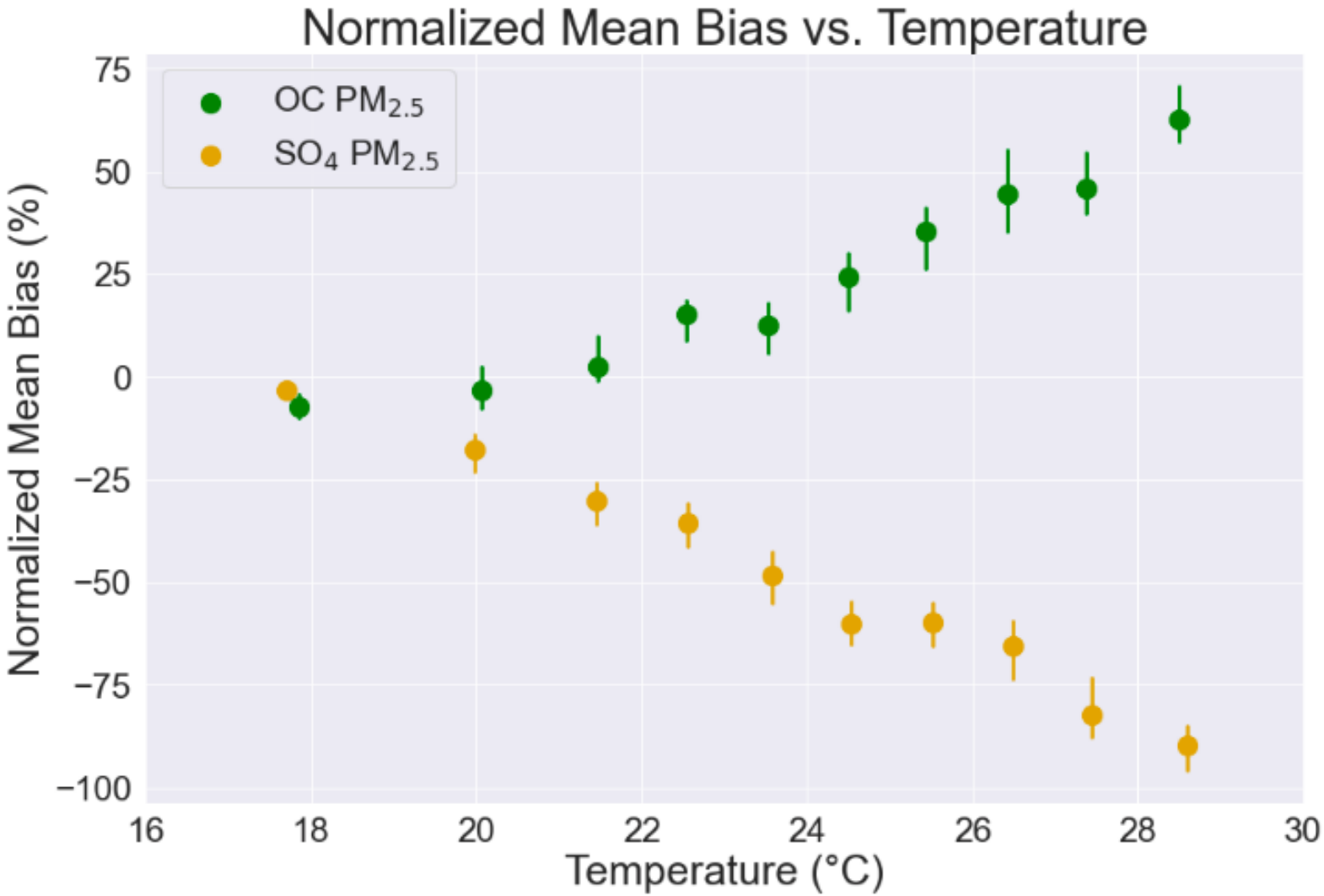
In model predictions, we find widespread overestimations in OC concentrations in the Eastern U.S.



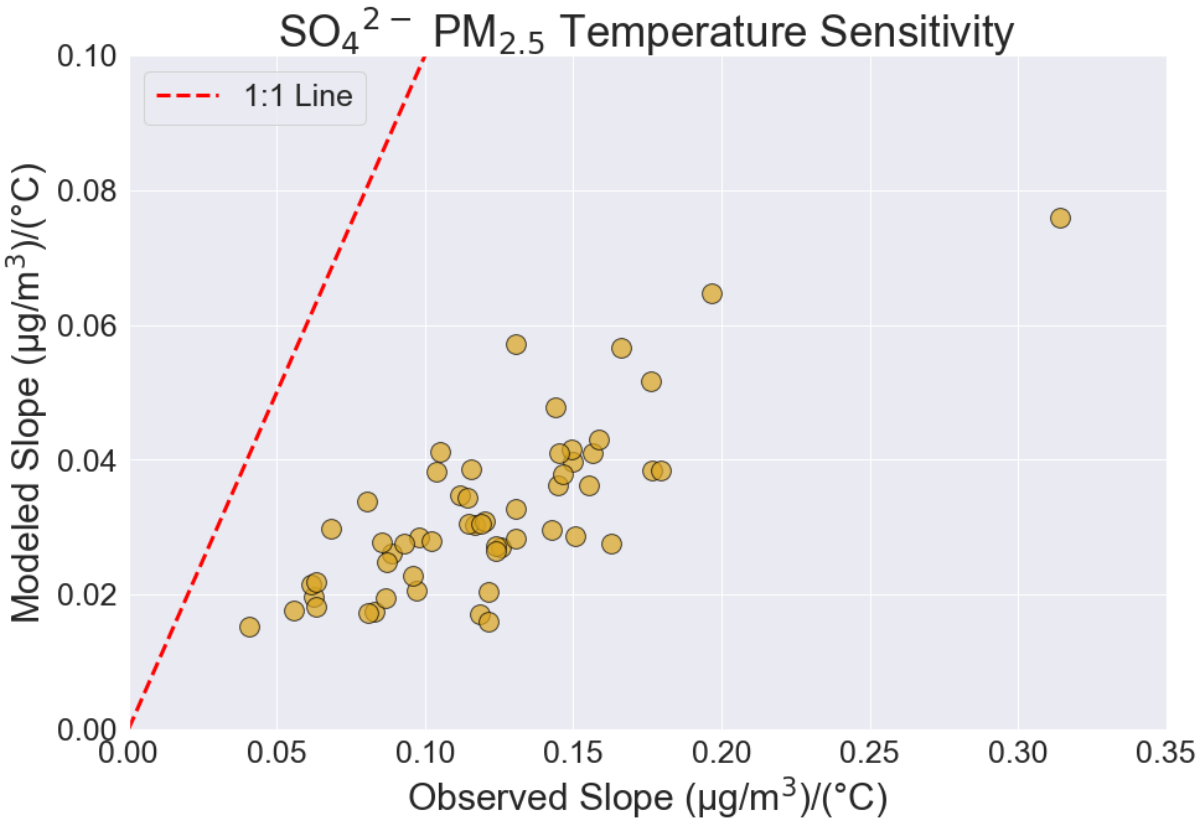
Simultaneously, we see widespread underestimations in modeled SO_4^{2-} aerosols:

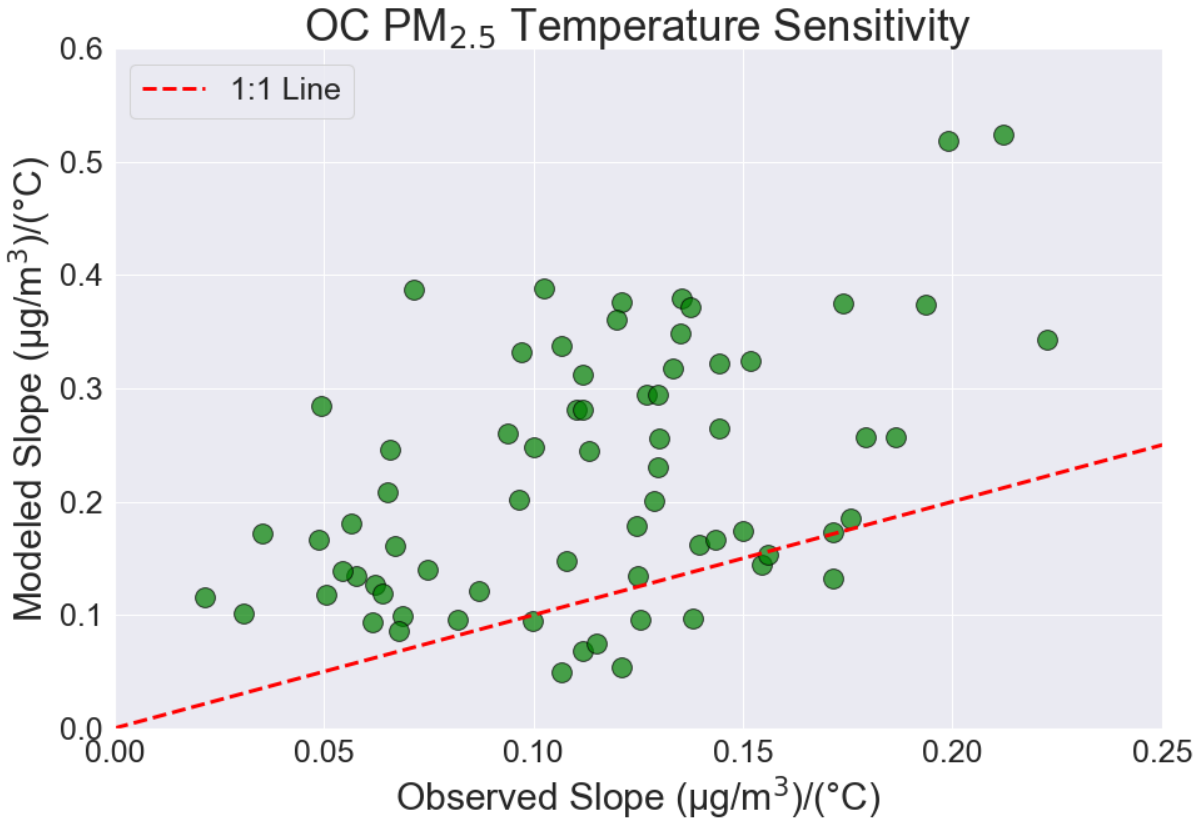


Predictions correct at low T, biases grow divergently at higher T

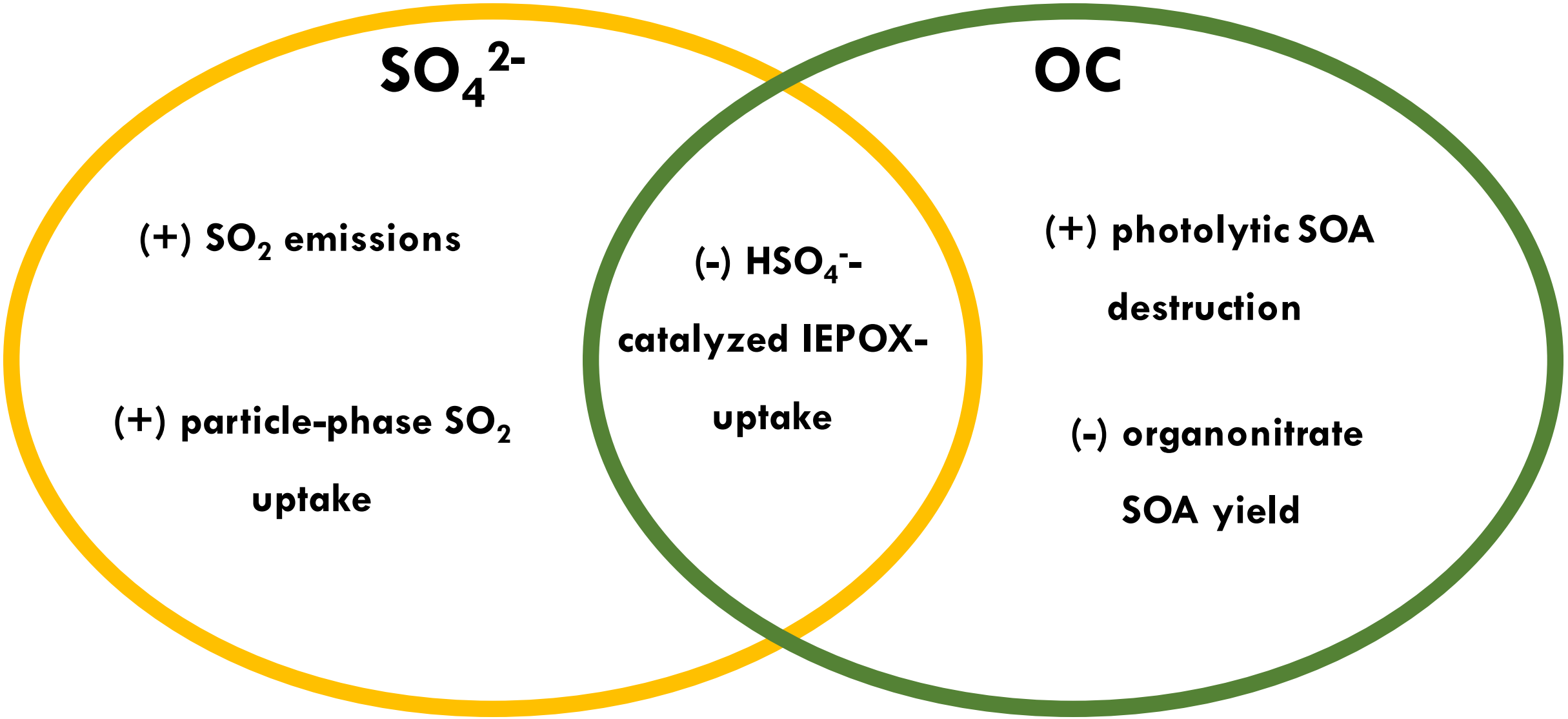


Site-wise discrepancies show persistent patterns, need to devise model interventions to address biases:





Model interventions probed in this study:



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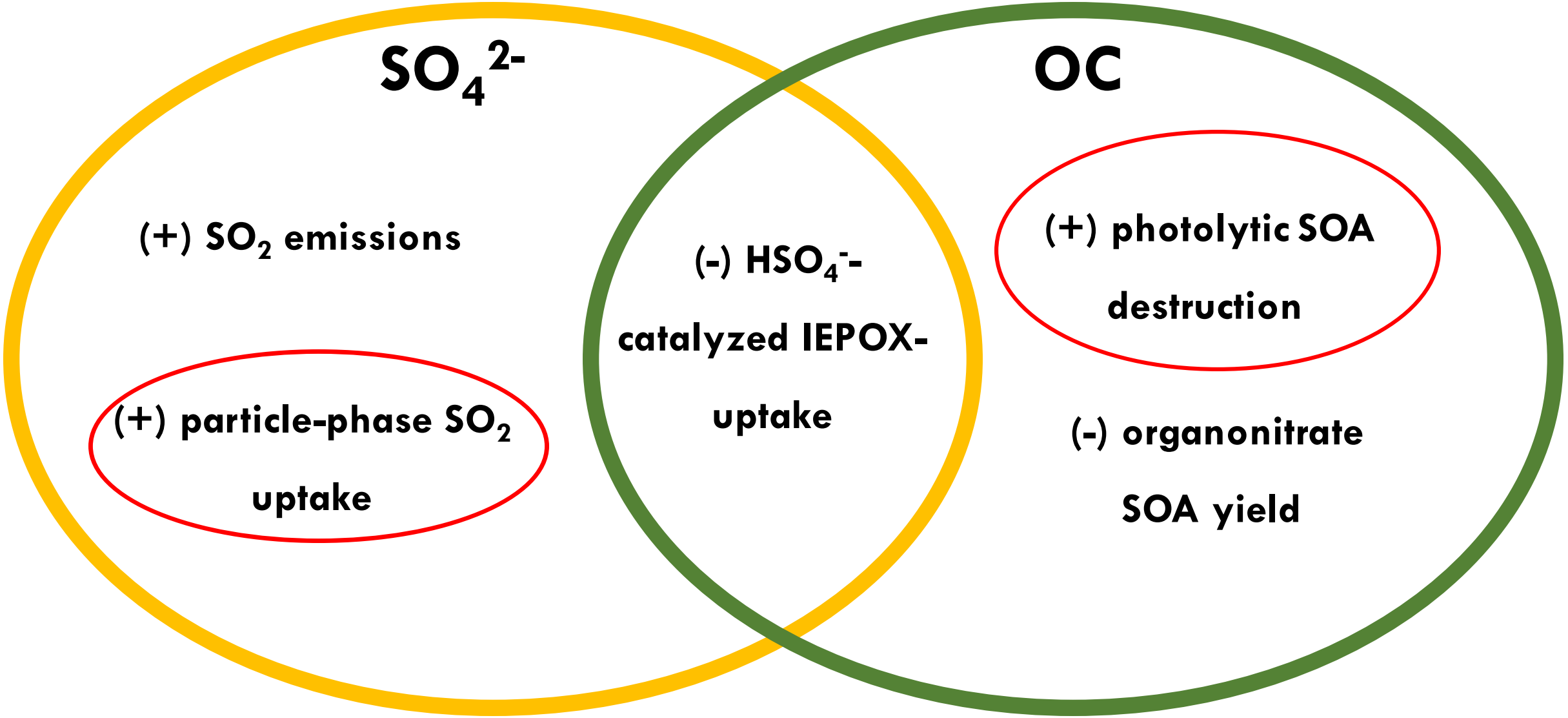
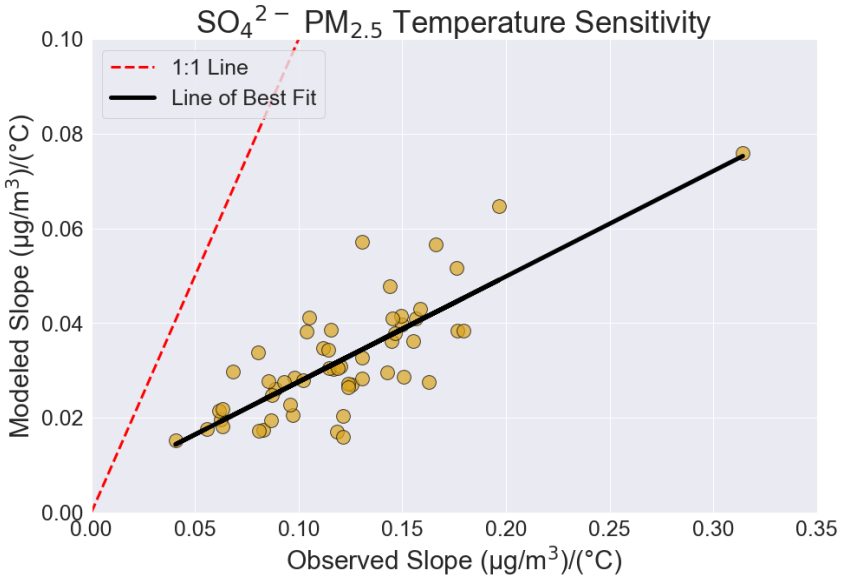
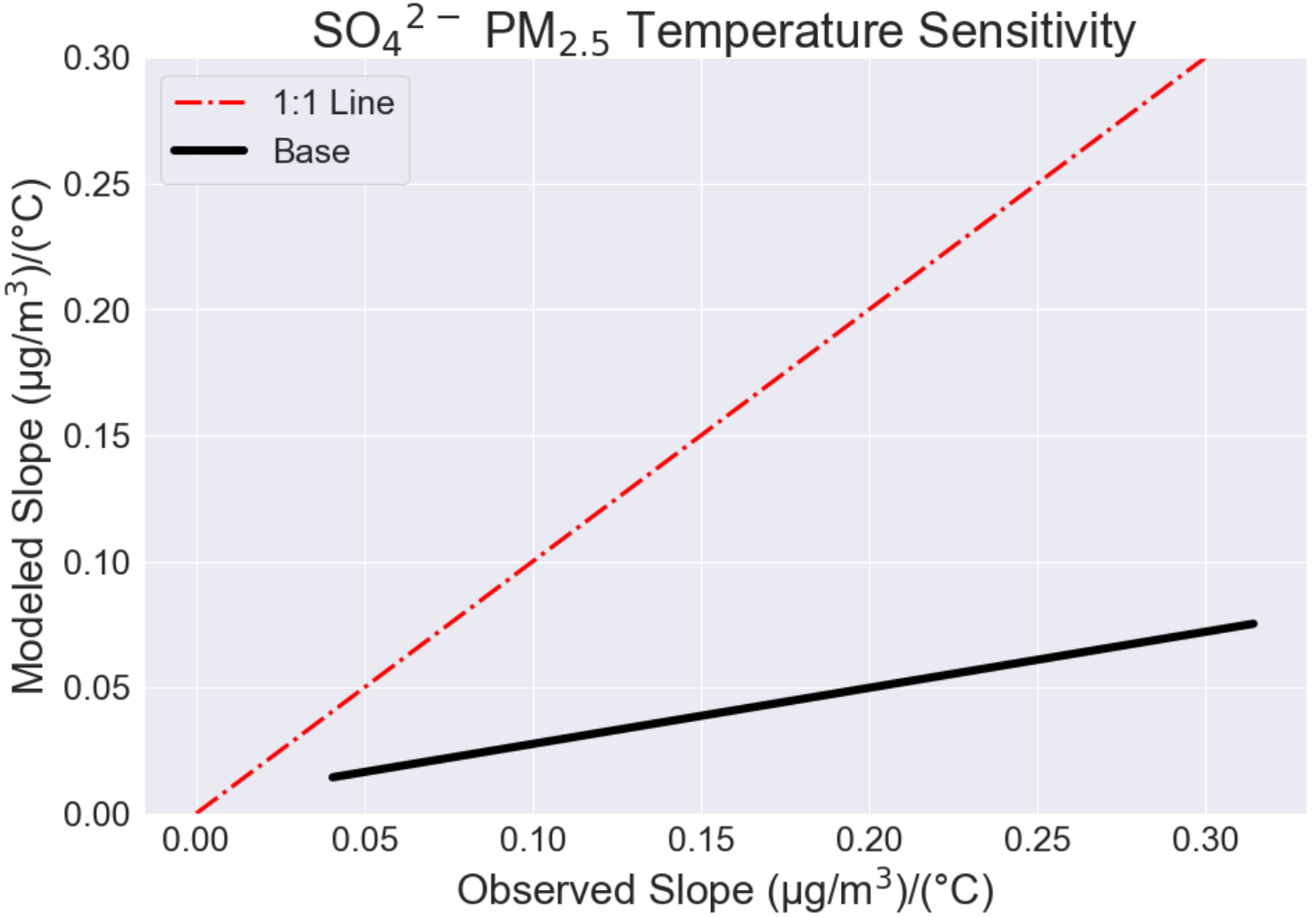


Revisiting modeled vs. observed site-wise temperature sensitivities shows impact in correcting trends





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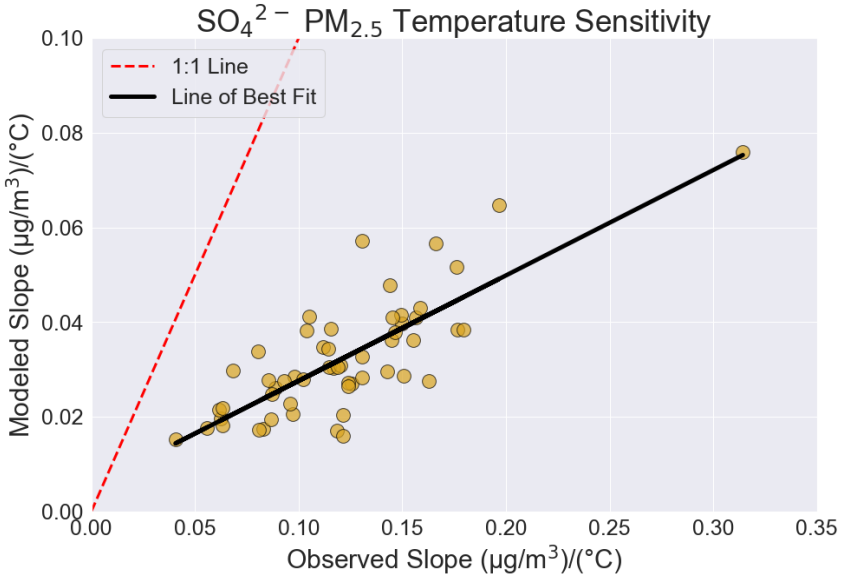
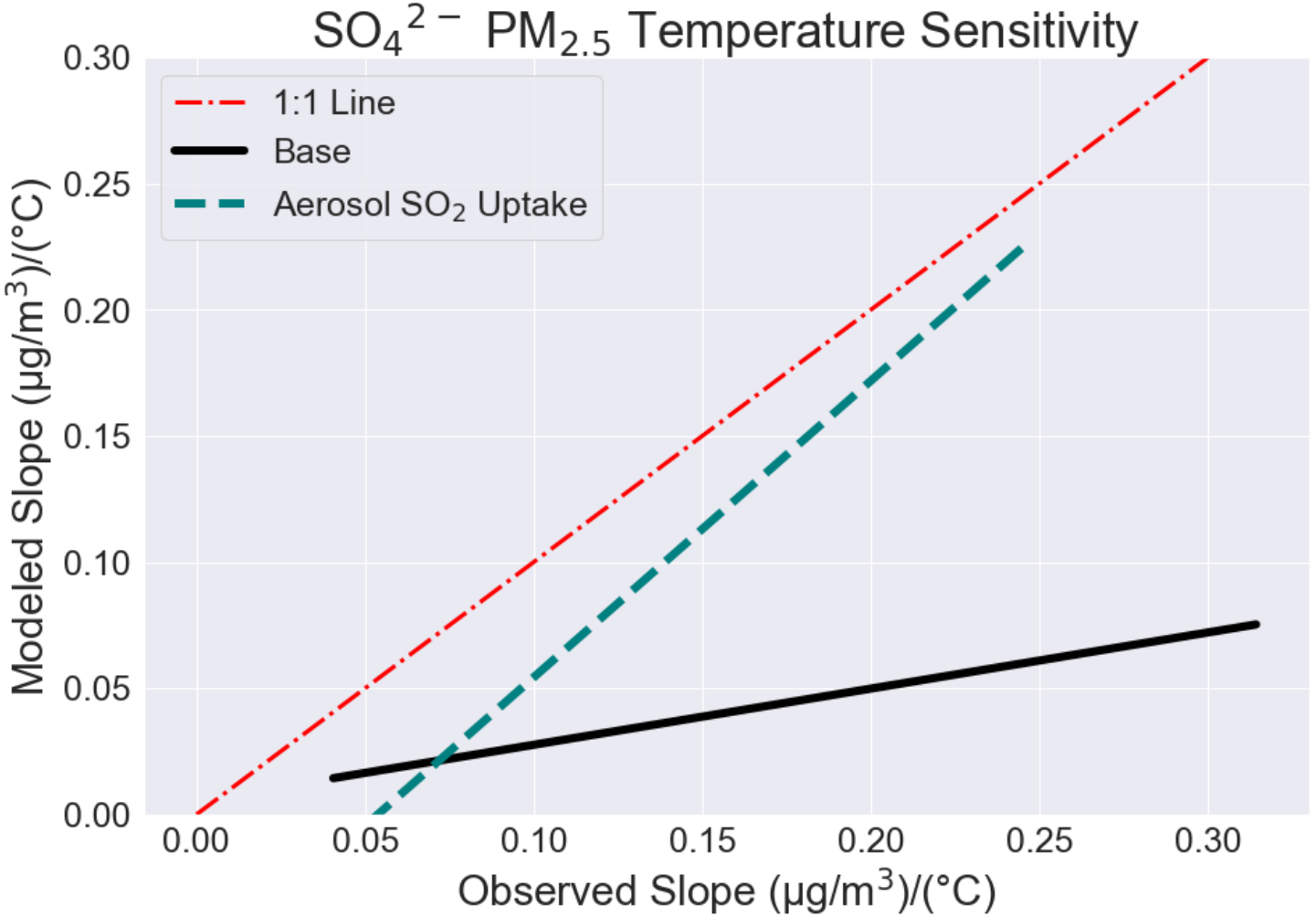
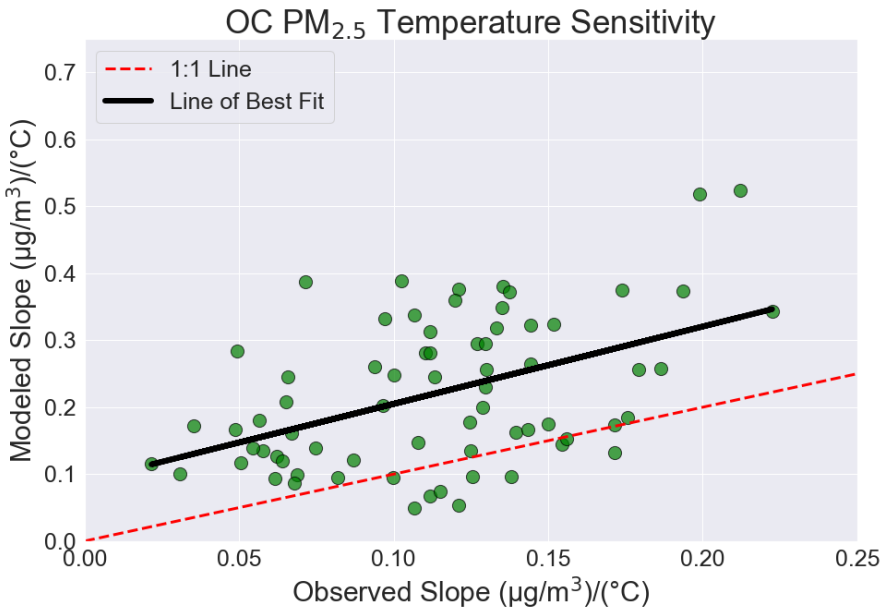
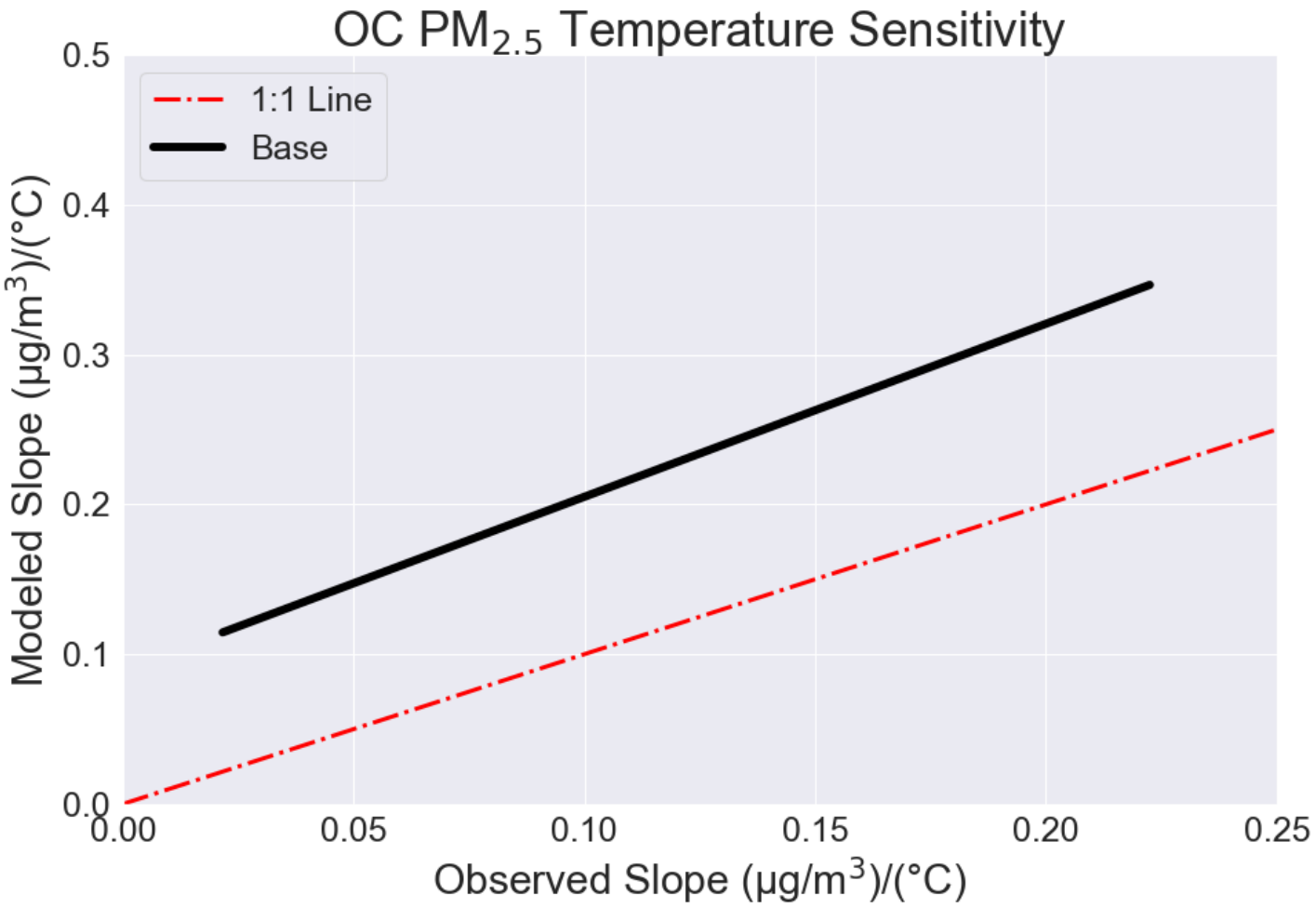




Feedback from SO_4 on OC production sheds light on how the two systems are linked





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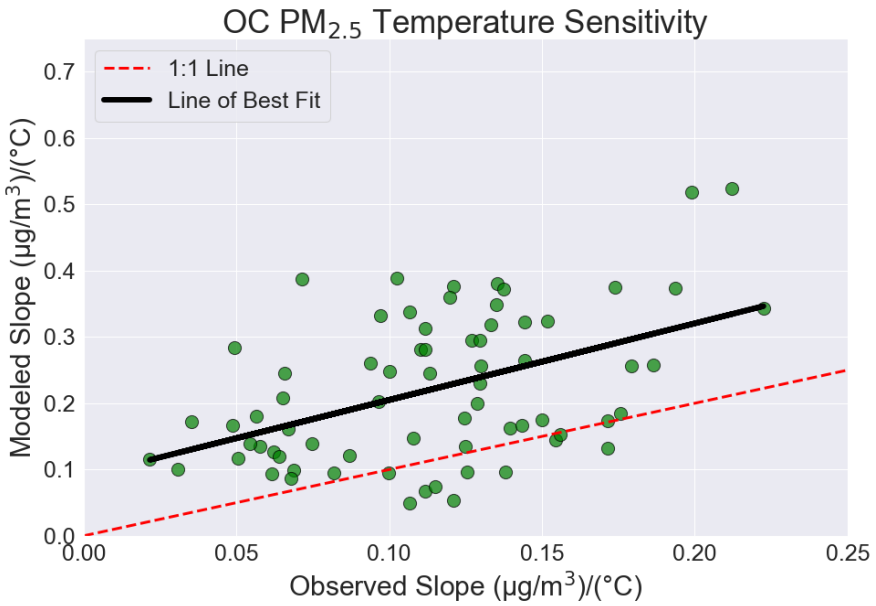

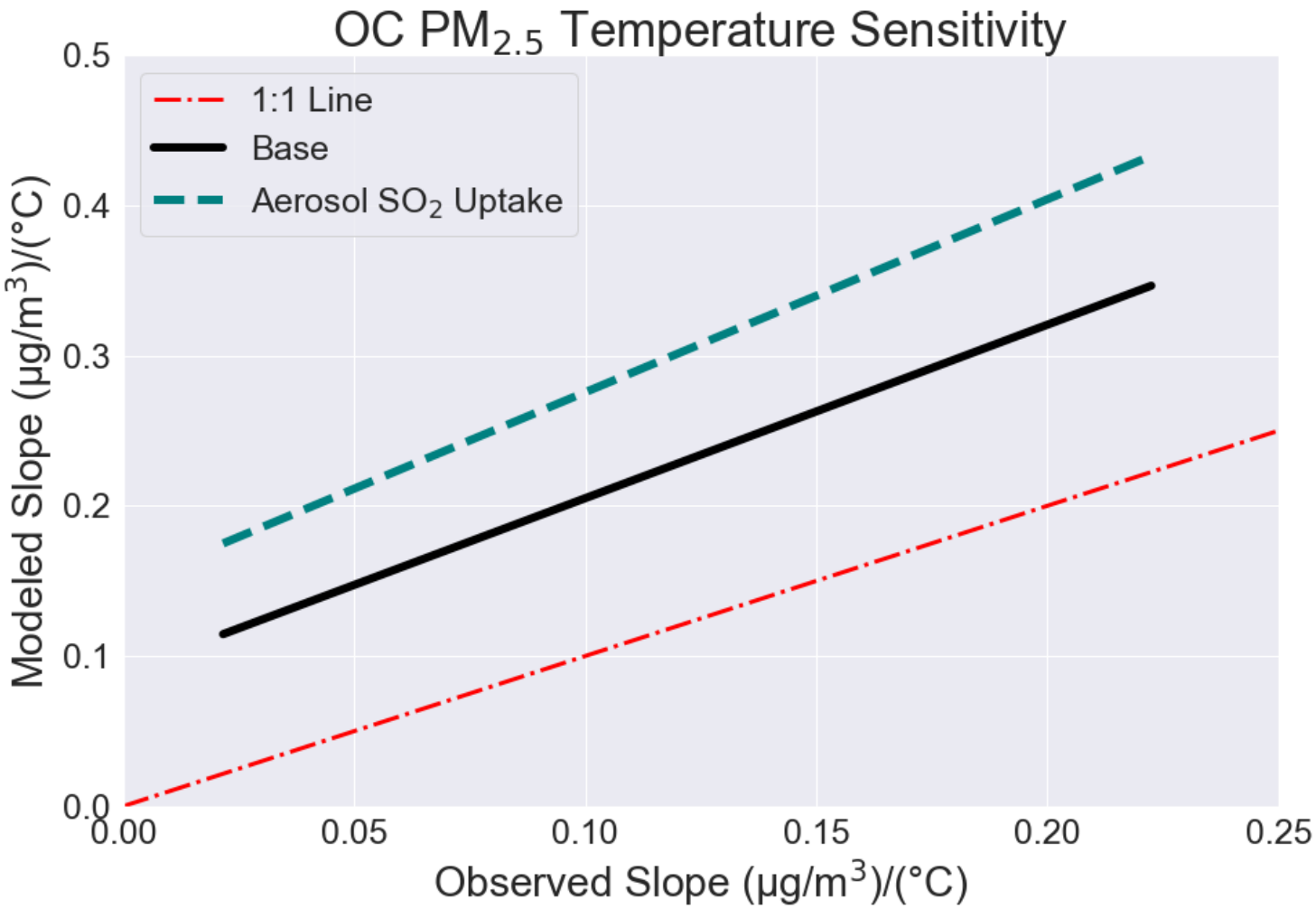

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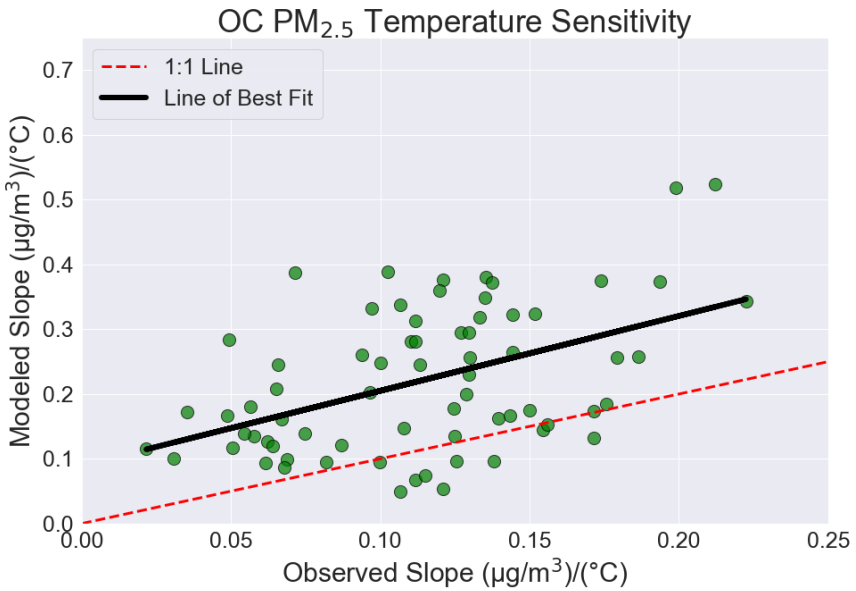

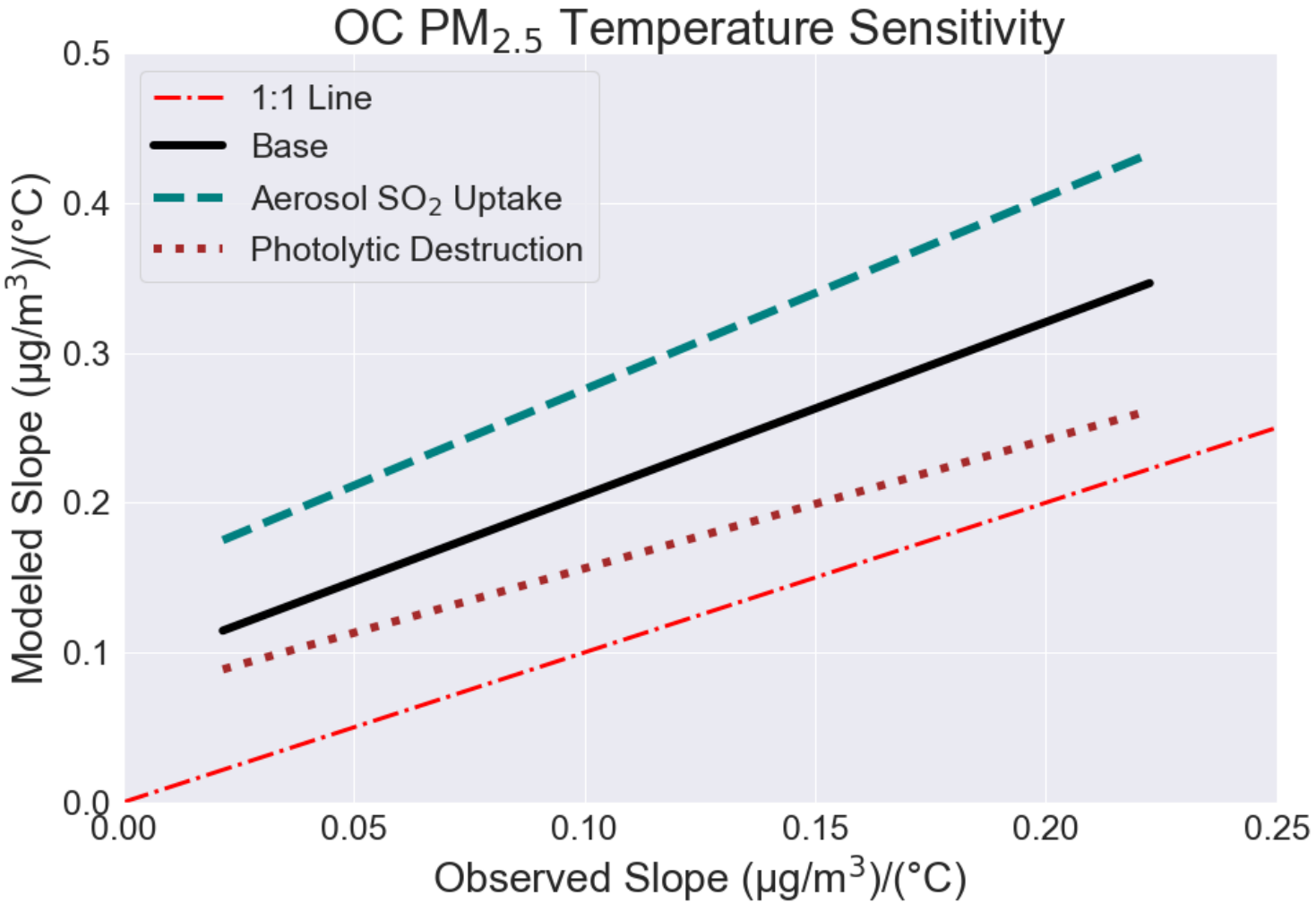

Conclusions

- Coupling of OC-SO_4^{2-} systems necessitates synergistic interventions

- A combination of model interventions can address temperature-dependent biases in both components simultaneously

- Achieving adequate model representation of these components and their response to temperature will be critical to better predict $PM_{2.5}$ and develop effective control strategies, now, and in a warmer future