

Olivia G. Norman (onorman@mit.edu) and Colette L. Heald

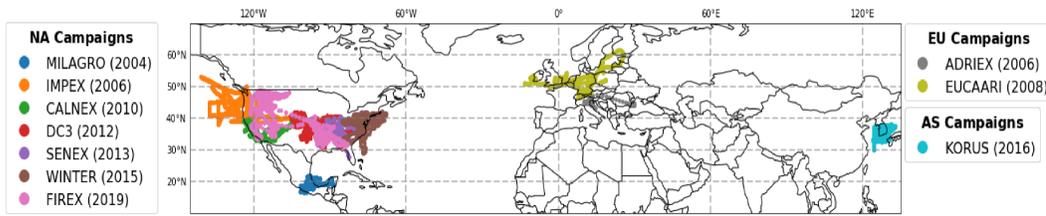
## Motivation

- Secondary inorganic aerosols (sulfate, nitrate, ammonium; hereafter SNA) are predominant components of  $PM_{2.5}$  and have both indirect and direct radiative effects
- To determine the impact of these aerosols on air quality and climate, models need to capture the emissions, chemical transformations, and deposition relevant to these aerosols

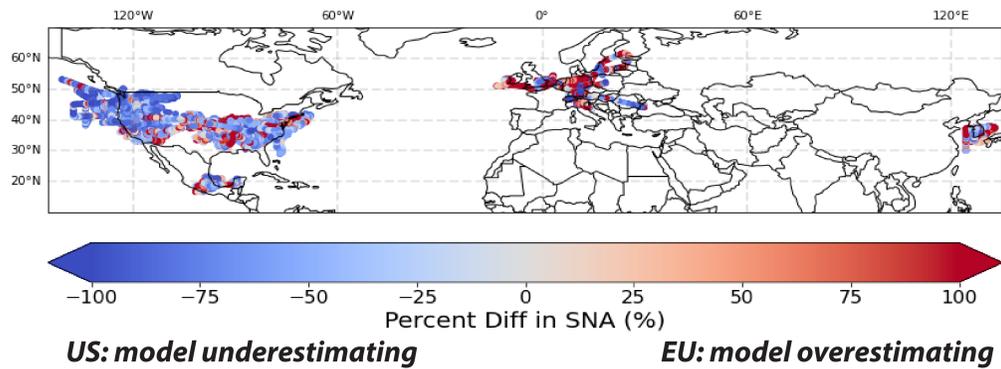
How well does GEOS-Chem do at this?

## Introduction

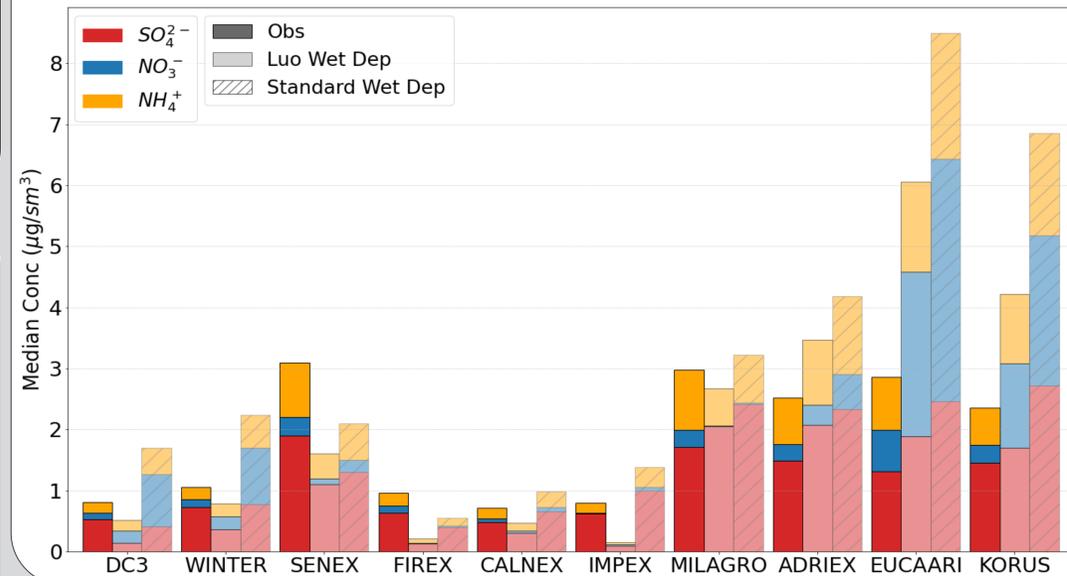
- Compare observations of SNA and their precursors from 10 aircraft campaigns to model (GEOSChem v13.3.4, with complex SOA)
- All observations of sulfate, nitrate, and ammonium are made using an AMS, with most made in regions that are primarily anthropogenically influenced
- Luo et al. (2020) wet dep scheme is compared to the standard (std) wet dep scheme
- Campaign v model analysis is supplemented with a comparison to surface station data



## Model v Observations: Total SNA



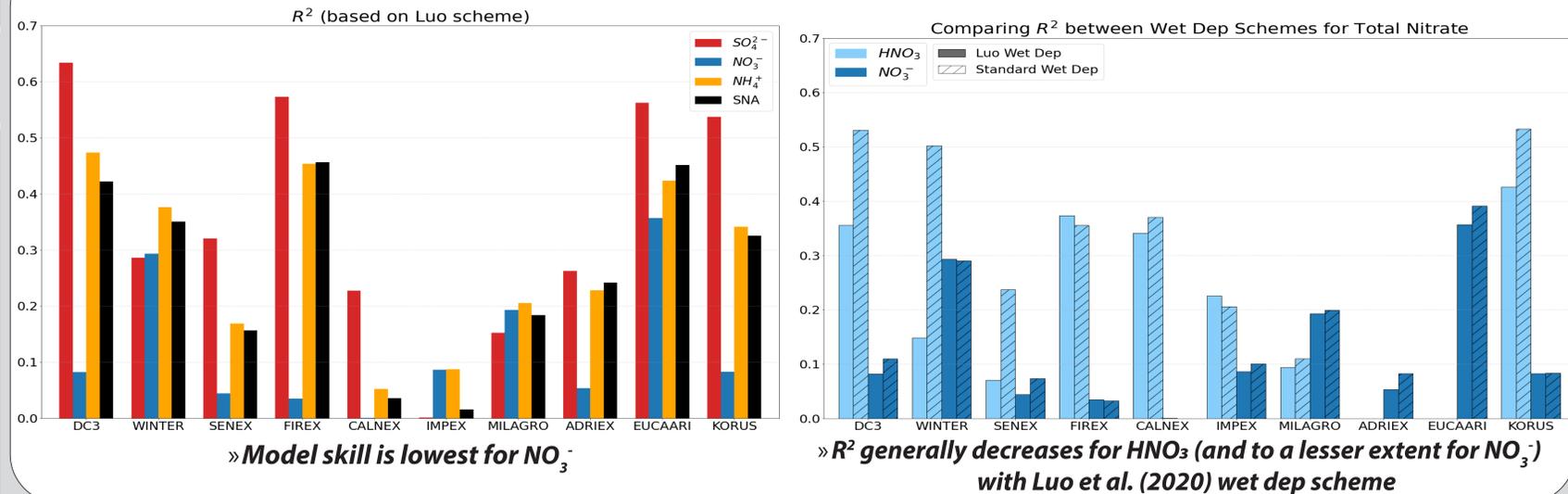
## Model v Observations: Speciated SNA



### Main takeaways:

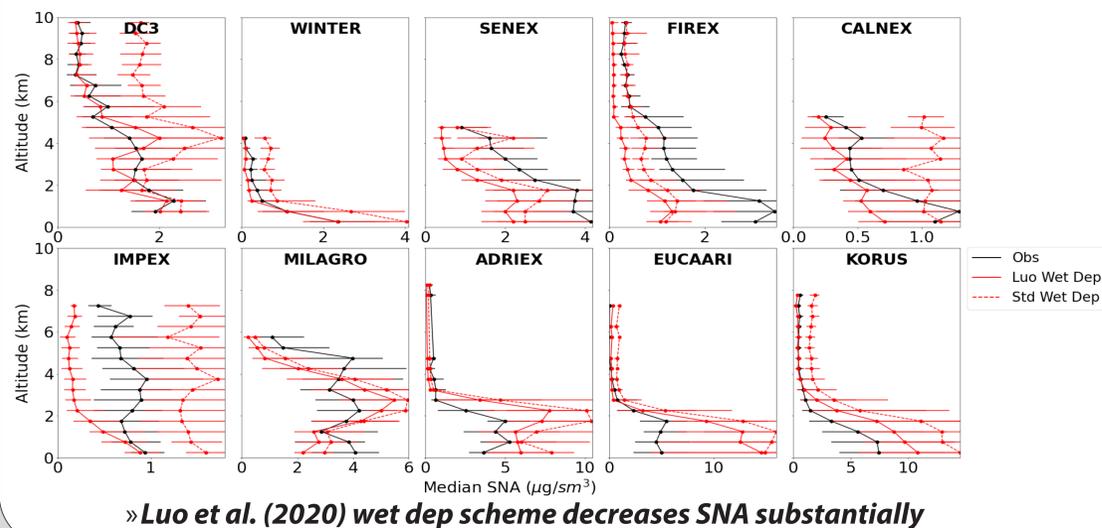
- Regional trends:
  - EU: overestimate in all species
  - US: underestimate in sulfate for all; nitrate and ammonium bias vary across campaigns
- Wet dep scheme performance:
  - Generally, Luo et al. (2020) wet dep scheme performs better for campaigns that have a larger fraction of  $NO_3^-$  (e.g. DC3, EU campaigns)
  - Some campaigns have a larger, more negative bias with the Luo et al. (2020) scheme (mainly attributable to loss of sulfate)

## R<sup>2</sup> as a Metric for Model Skill



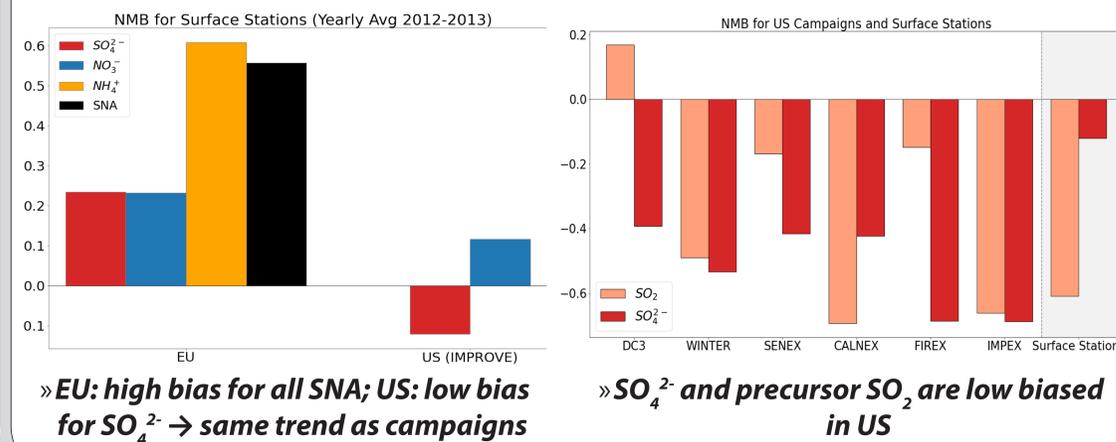
» Model skill is lowest for  $NO_3^-$

» R<sup>2</sup> generally decreases for  $HNO_3$  (and to a lesser extent for  $NO_3^-$ ) with Luo et al. (2020) wet dep scheme



» Luo et al. (2020) wet dep scheme decreases SNA substantially

## Consistent with Surface Observations?



» EU: high bias for all SNA; US: low bias for  $SO_4^{2-}$  → same trend as campaigns

»  $SO_4^{2-}$  and precursor  $SO_2$  are low biased in US

## Conclusions

- Model skill:** varies for SNA (best for  $SO_4^{2-}$ , worst for  $NO_3^-$ )
- Regional trends:** EU overestimates all SNA species. US underestimates total SNA and sulfate (which could be associated with emissions).
- Which wet dep scheme?:** Luo et al. (2020) significantly reduces SNA. This sometimes worsens model skill (higher bias and lower R<sup>2</sup>).
- Next steps:** explore effect of SNA bias on AOD