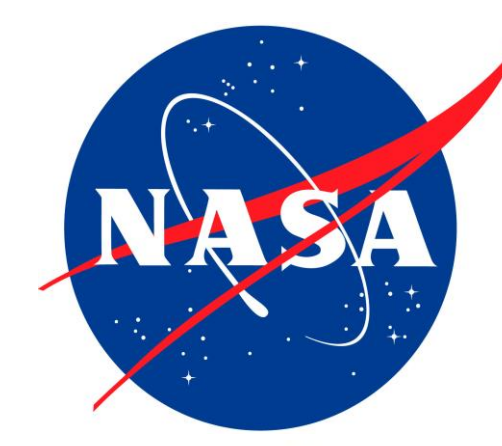




Improving aerosol representation in NU-WRF in support of MICS-Asia and ACAM activities



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Background

- **Model Inter-Comparison Study for Asia (MICS-Asia)**
 - Established in 1998 to investigate air quality over East and Southeast Asia - its origin, transport, and impacts;
 - Evolved from focusing on transport and deposition of sulfur initially, to model intercomparison of particulate matter and ozone and their climate effects in Phase III. Phase IV is under way;
 - Engaging scientists from 12 countries and regions;
 - Including both global and regional chemical transport models using same anthropogenic emissions (MIX inventory) but different chemical mechanism and physical parameterization
- **Atmospheric Composition and the Asian Monsoon (ACAM)** (<https://www.sparc-climate.org/activities/Asian-monsoon>)
 - Established in early 2010s to explore research themes connecting atmospheric composition and Asian monsoon dynamics;
 - Focusing on emissions and air quality, aerosols and clouds, convection and chemistry, and UTLS responses to Asian Monsoon;
 - Co-sponsored by SPARC and IGAC; co-chaired by Hans Schlager (DLR, Germany) and Mian Chin (GSFC, USA)
- **NASA Unified Weather & Research Forecasting (NU-WRF) model**
 - Participating in and contributing to both MICS-Asia and ACAM;
 - Employing GOCART aerosol module – simple, effective, and computationally efficient;
 - Lacking in mechanism to account for nitrate aerosols;
 - Especially problematic over Asia where nitrate is a major component of aerosols;
 - Demonstrated in MICS-Asia study: underestimate of PM2.5 constantly

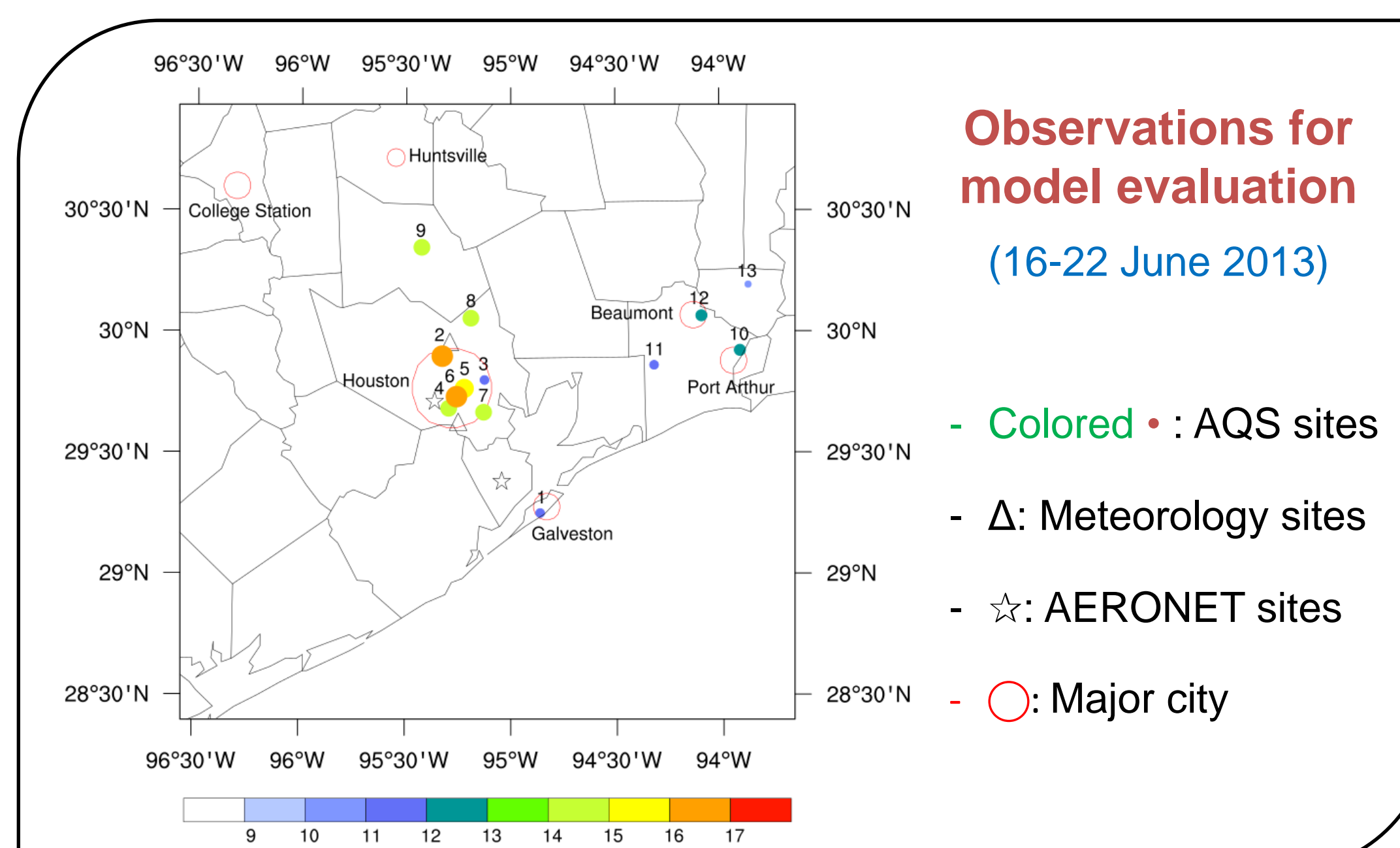
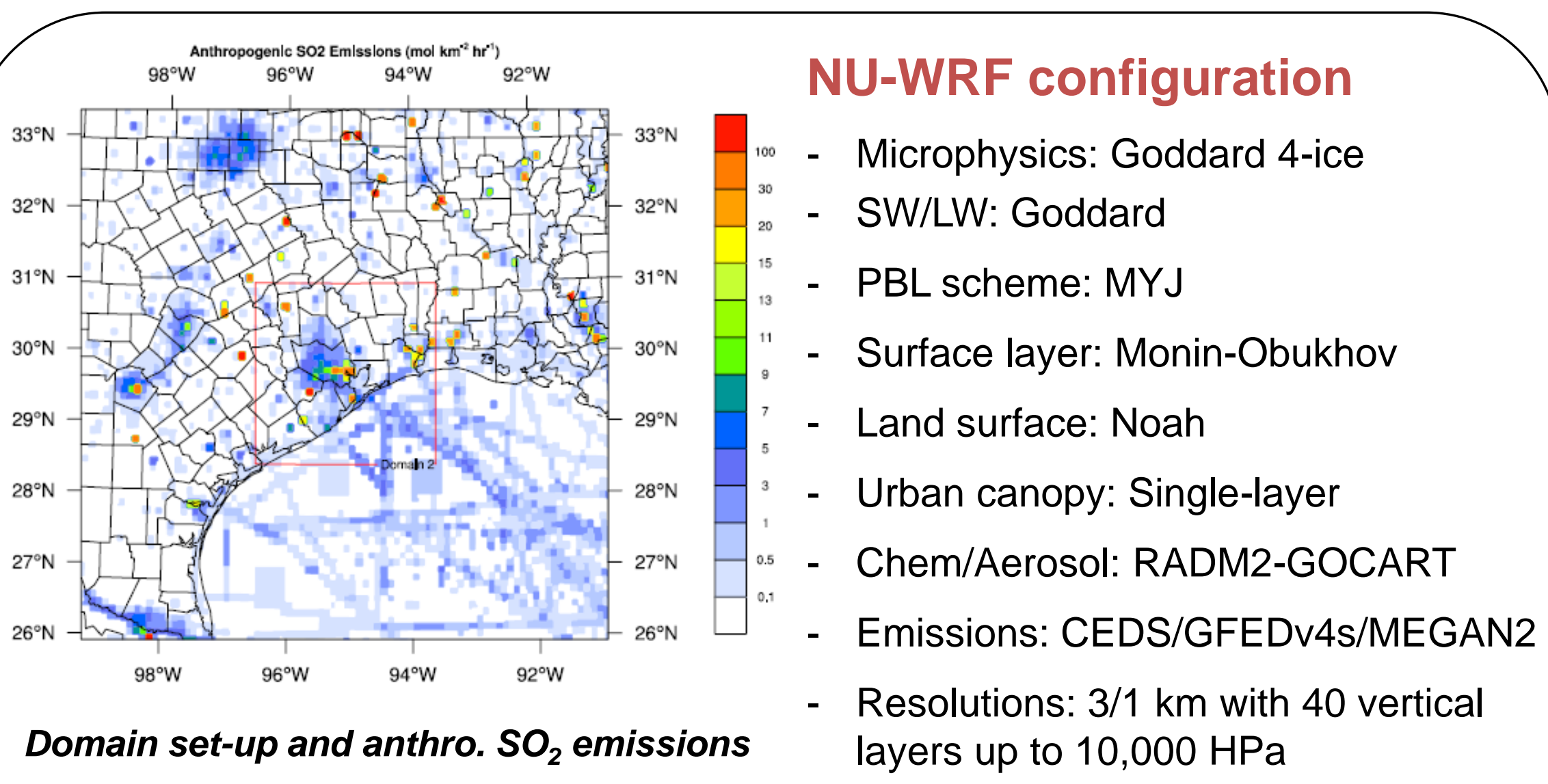
GOCART improvements in NU-WRF

- **Add CO chemistry**
 - $CO + OH \rightarrow \text{product}$
 - $CH_4 + OH \rightarrow CO + \text{other products}$
- **Update Secondary Organic Aerosol (SOA) parameterization**
 - $AVOC(g) = 0.069 \times A_EMIS_{CO}$
 - $BBVOC(g) = 0.013 \times BB_EMIS_{CO}$
 - $AVOC \text{ or } BBVOC + OH \rightarrow SOA + \text{other products}$
AVOC/BBVOC: anthropogenic/biomass burning VOC emissions scaled with the respective CO emissions
- **Implement nitrate aerosol scheme**
 - solve for $SO_4/NH_3/H_2O$ system based on equilibrium thermodynamics
 - nitrate heterogeneous reaction at the presence of dust and seasalt
 $HNO_3 \xrightarrow[\text{dust/seasalt}]{k} NO_3(\text{an}1\sim3) + \text{other products}$ (nitrate in 3 size bins)
 - dry deposition and vertical mixing (reconcile original NU-WRF and GEOS-5 schemes)
 - settling process (reconcile original NU-WRF and GEOS-5 schemes)
 - wet deposition (large scale or microphysics wet scavenging and convective or cumulus wet scavenging)

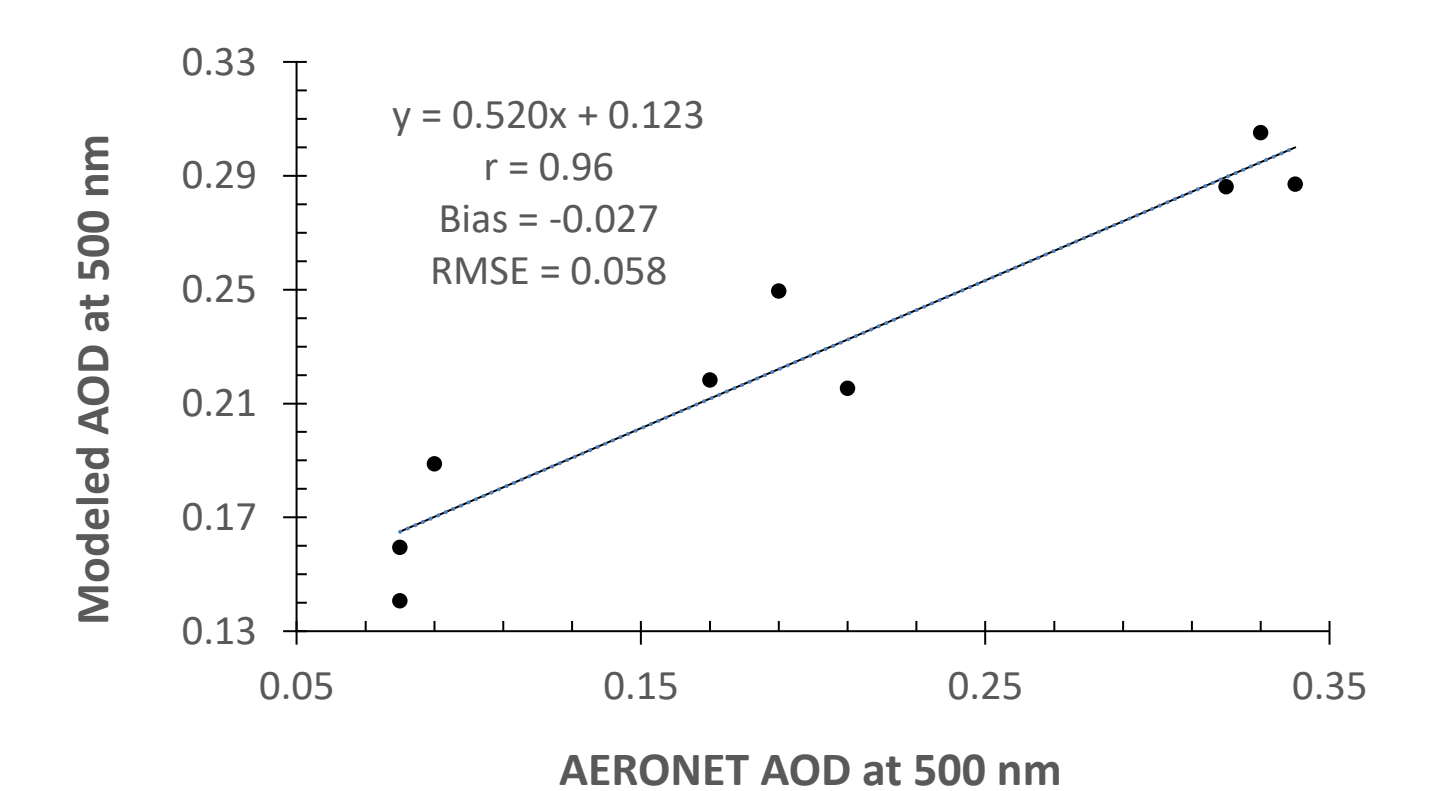
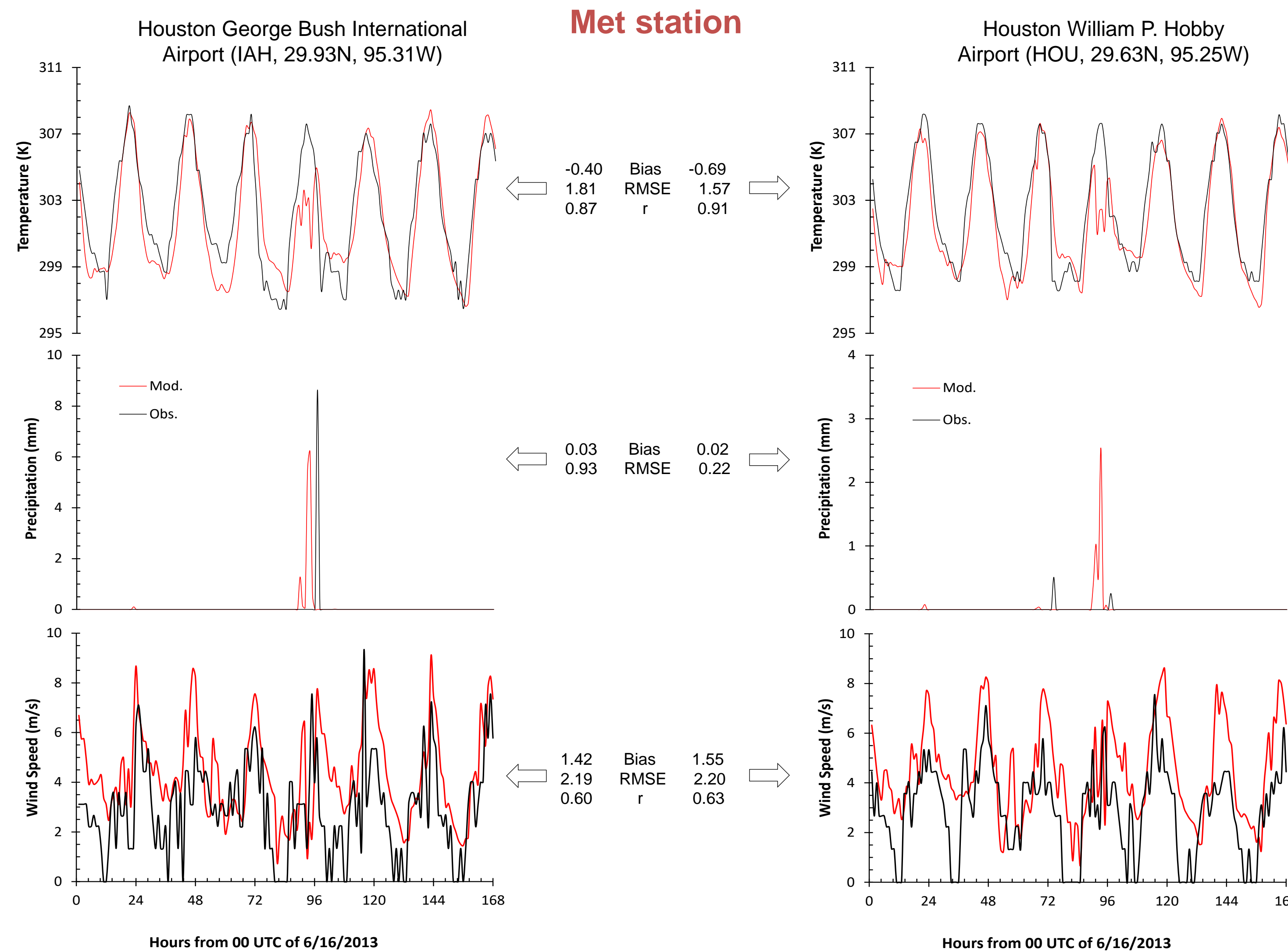
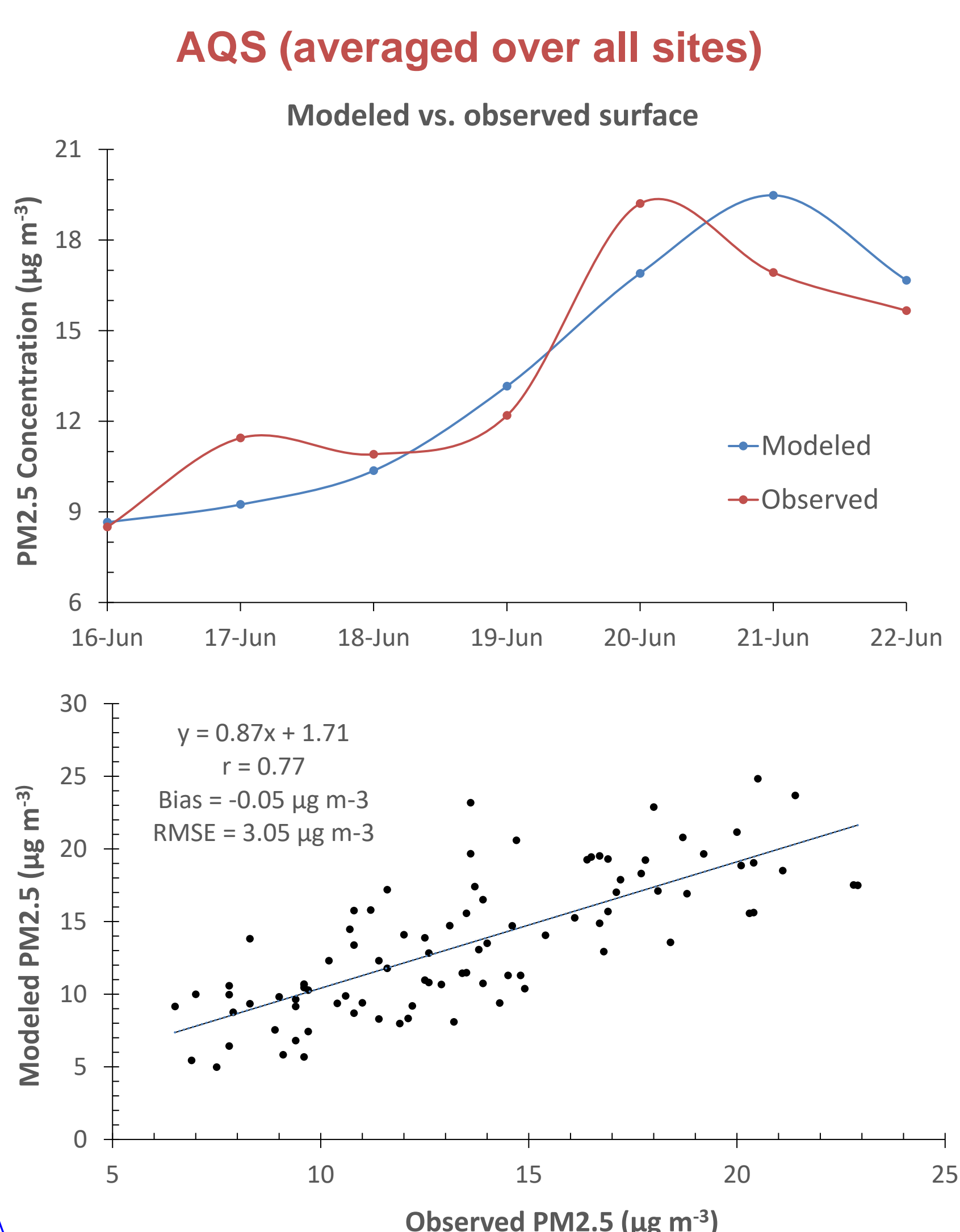
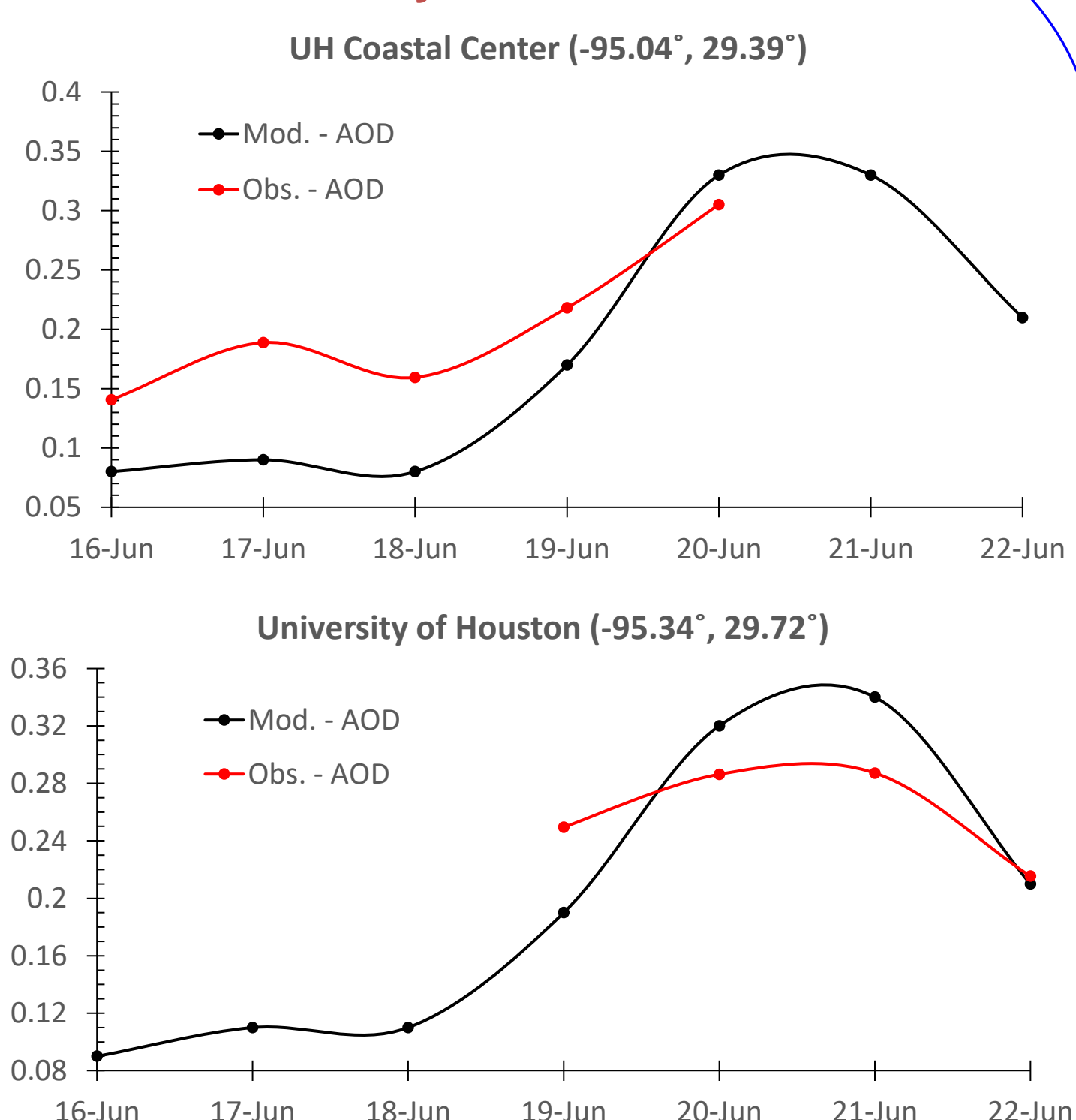
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Model evaluation - Houston case



AERONET – daily mean AOD at 500 nm



Take-home Message

- In support of MICS-Asia and ACAM, NU-WRF's aerosol module has been improved to 1) parameterize SOA, and 2) account for nitrate, consistent with the one implemented in GEOS-5
- Application of the modified NU-WRF to the Houston metropolitan areas demonstrates the good model skill in reproducing the observed meteorology and aerosol spatiotemporal distributions (PM2.5 and AOD)