Interactions of Asian monsoon and regional air quality – Synergy between MICS-Asia and ACAM

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What is MICS-Asia

- **Model Inter-Comparison Study for Asia**
- **Phase I (1998 – 2000)**

  - long-range transport and deposition of sulfur
- **Phase II (2002 – 2008)**

  - consider more species, e.g., S, N, O_3, aerosols…
- **Phase III (2010 – 2019)**

  - identify model uncertainties/improvements

  - develop reliable anthropogenic emission inventory

  - evaluate aerosol-weather-climate interactions
- **Phase IV (2020 ~ ?)**

Who contributes to MICS-Asia

- > 20 institutes from 12 countries and regions
- 14 CTM – 13 regional and 1 global –in Phase III

What are goals of ACAM

- **Emissions and air quality in the Asian monsoon region**
- **Aerosols, clouds, and their interactions with the Asian Monsoon**
- **Impact of monsoon convection on chemistry**
- **UTLS response to the Asian monsoon**

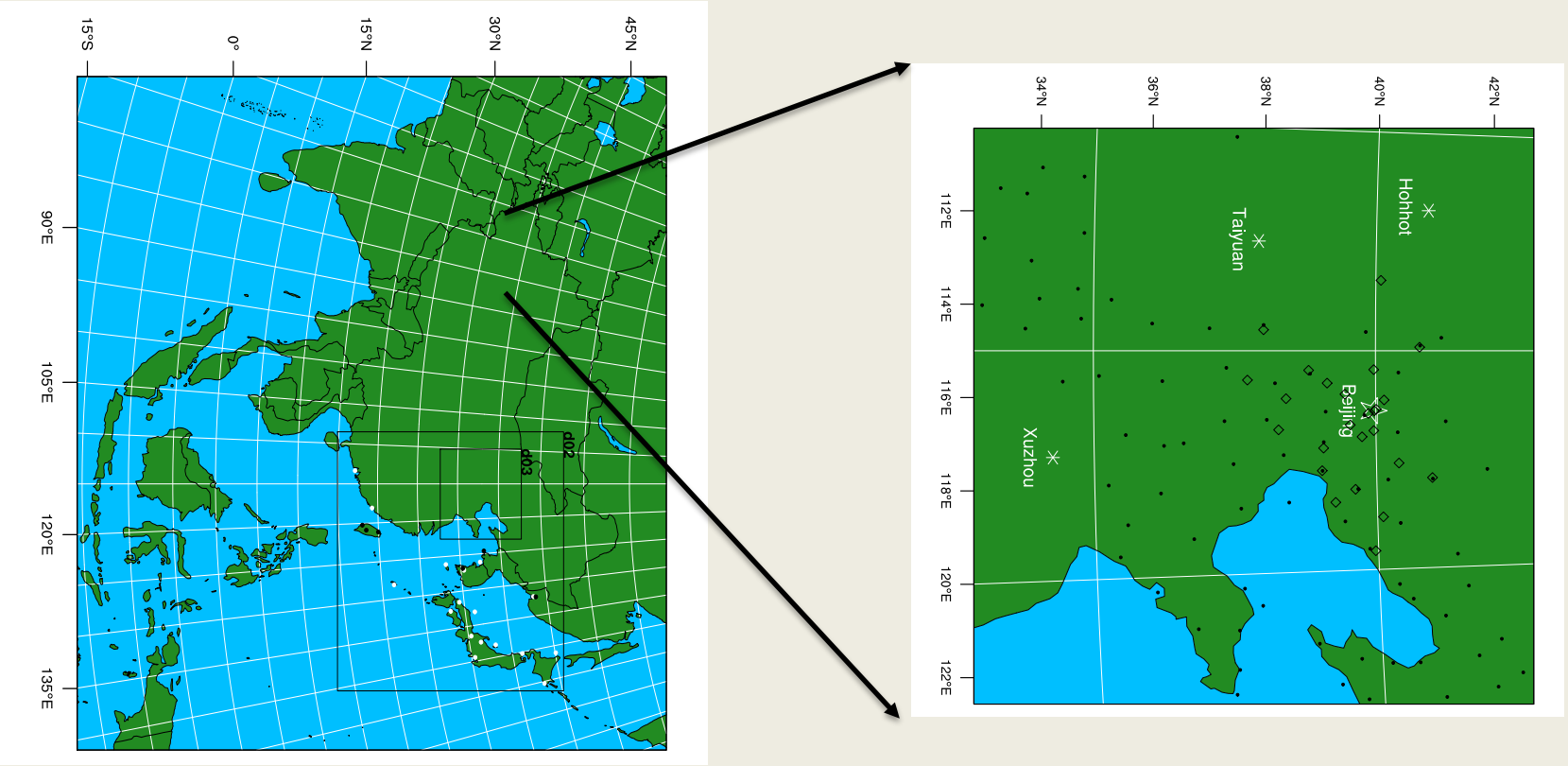
- Quoted from http://www.ukm.my/acam/

Quite overlaps between goals of MICS-Asia and ACAM

Science questions:

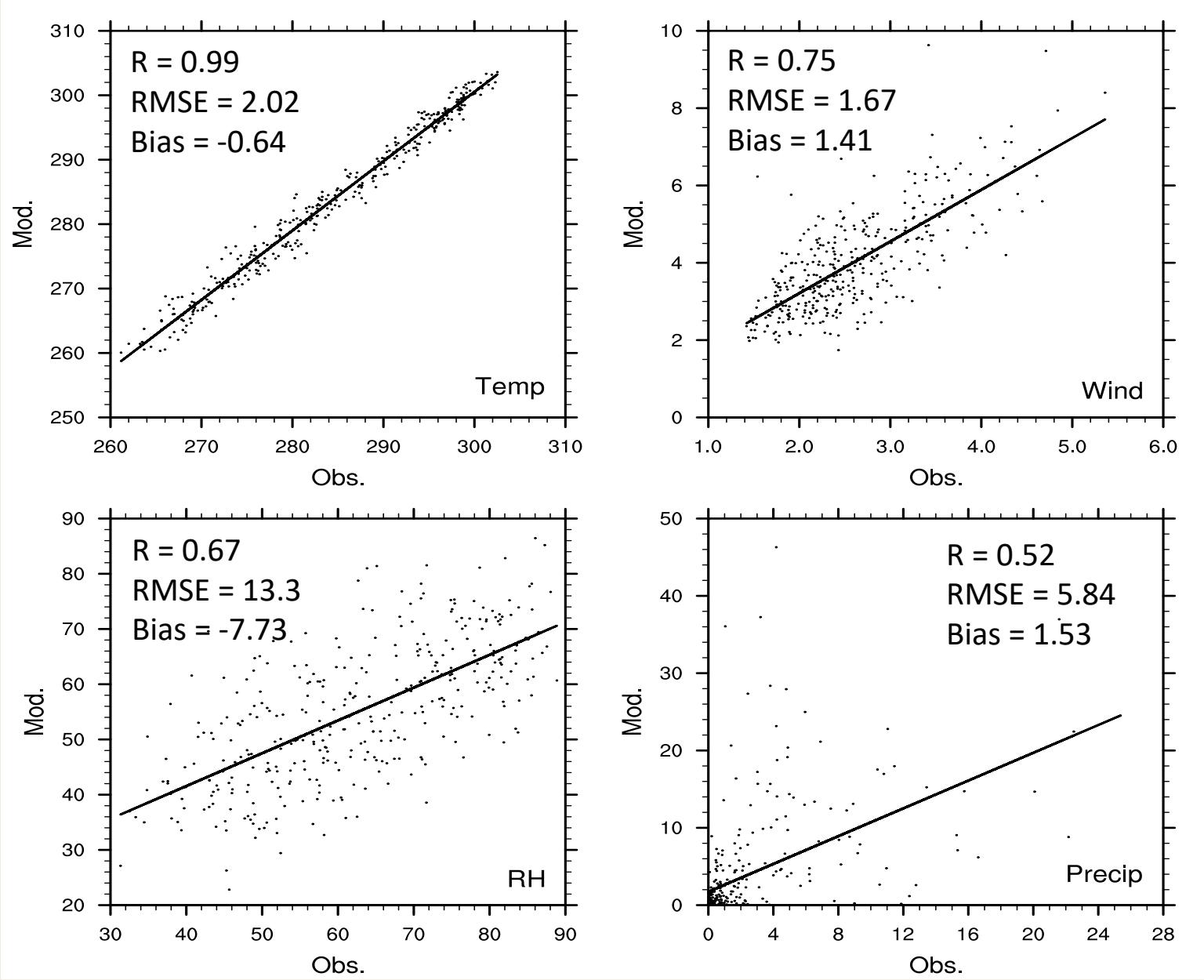
- How do pollution and dust aerosols regulate the circulation and rainfall via scattering and absorbing solar radiation, changing the atmospheric heating rates, and modifying the cloud properties?
- How do these meteorology changes feedback to regional air quality?

Regional model NU-WRF experiments

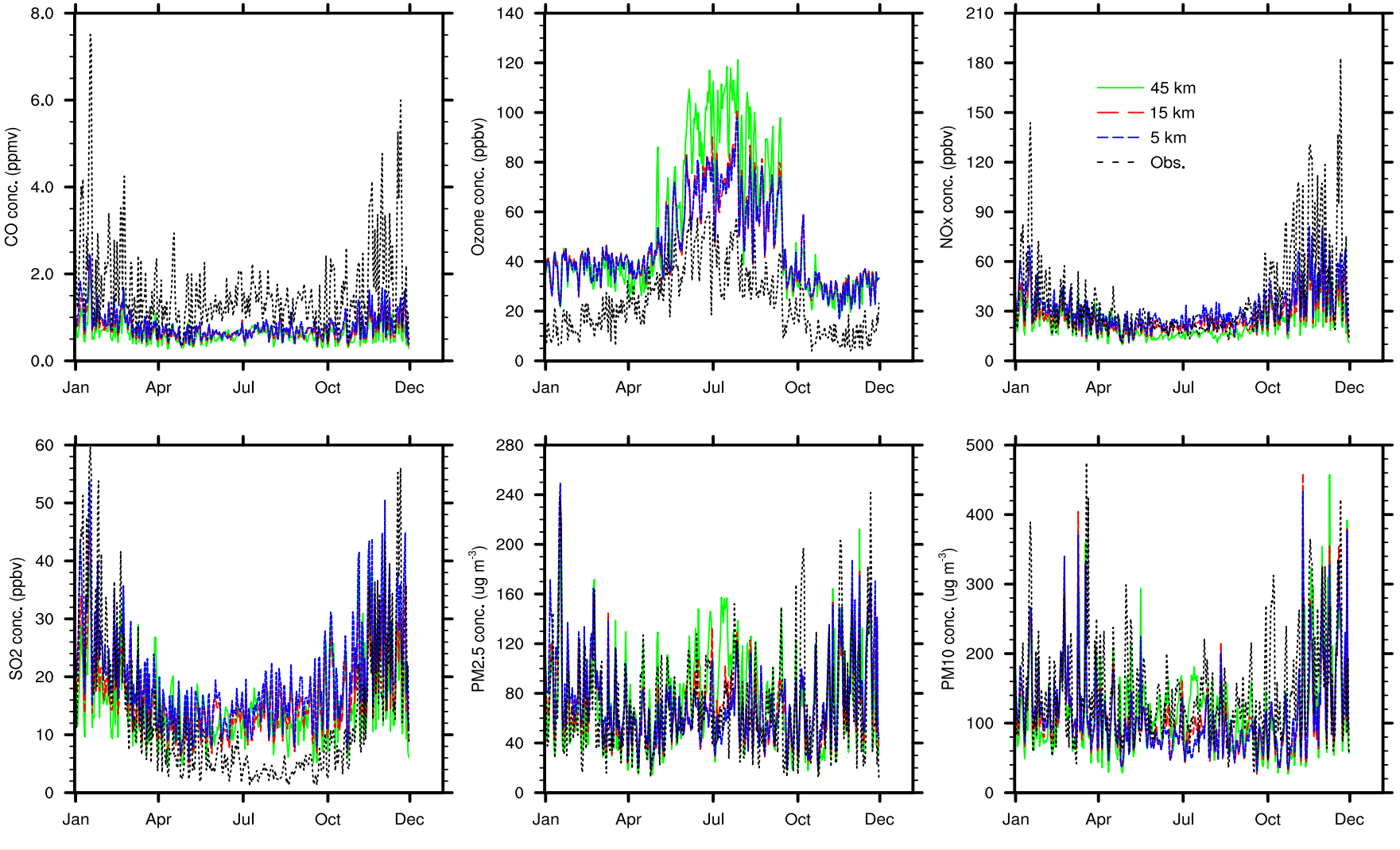


- Domains 1~3 follow MICS-Asia with 45-, 15-, and 5-km horizontal resolution for year 2010
- White dots (EANET sites), black dots (AERONET sites)
- In d03 (North China Plain), diamonds for CERN air quality monitoring sites; black dots for CMA meteorological stations

Comparison with daily mean meteorology from CMA



Comparison with daily mean air quality from CERN



Overestimate of O_3 and PM2.5 but underestimate of CO and NOx

Sensitivity Experiments

Experiment	Feedback(s) included
None	No aerosol-microphysics-radiation interactions
AM	Aerosol-microphysics interaction only
AR	Aerosol-radiation interaction only
AMR	Aerosol-microphysics-radiation interactions

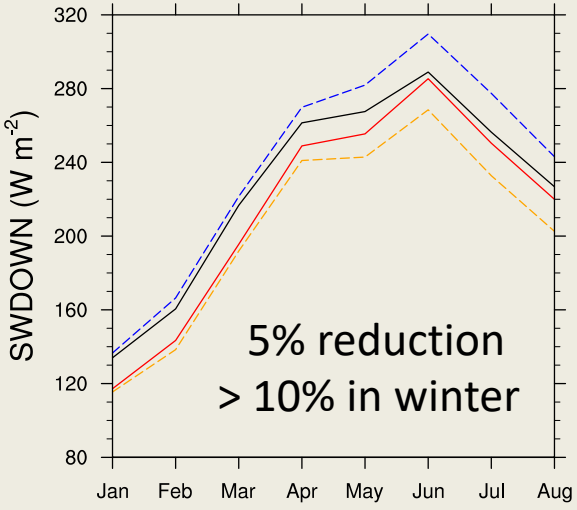
AM effect = AM – None

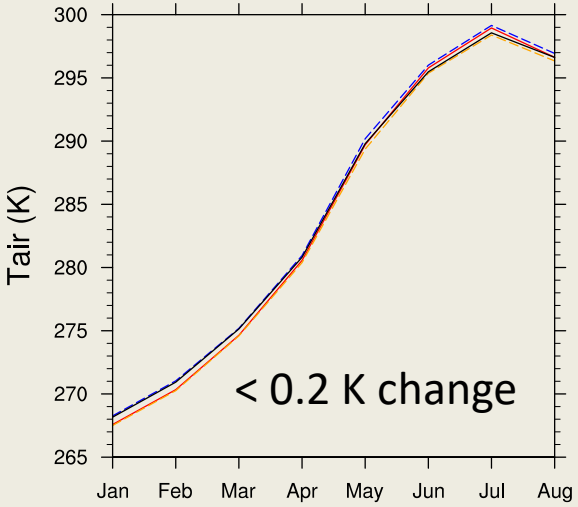
AR effect = AR – None

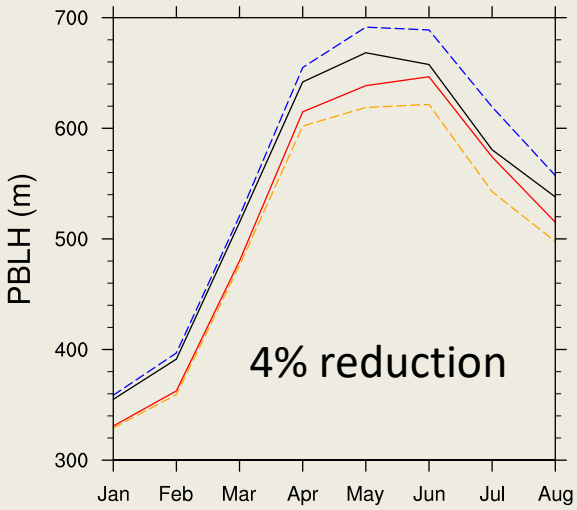
AMR effect = AMR – None

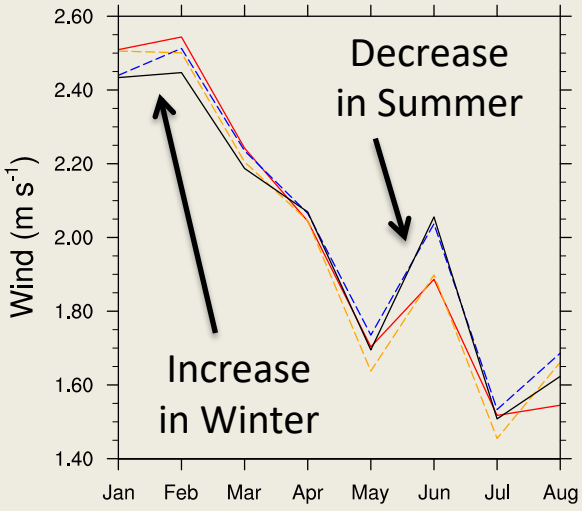
AMR effect ≠ AM effect + AR effect

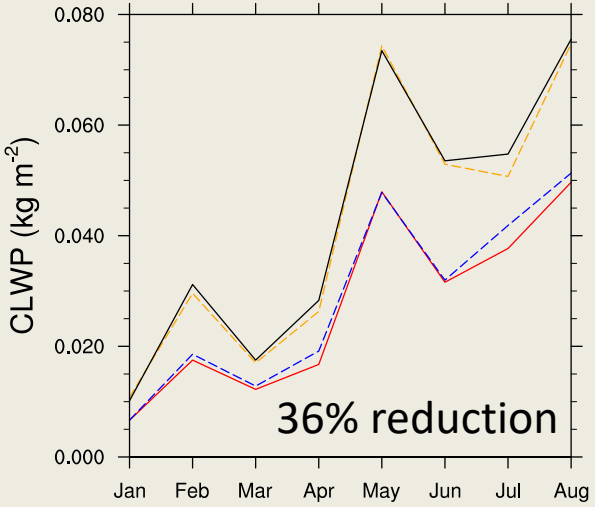
Impact of aerosols on key meteorology

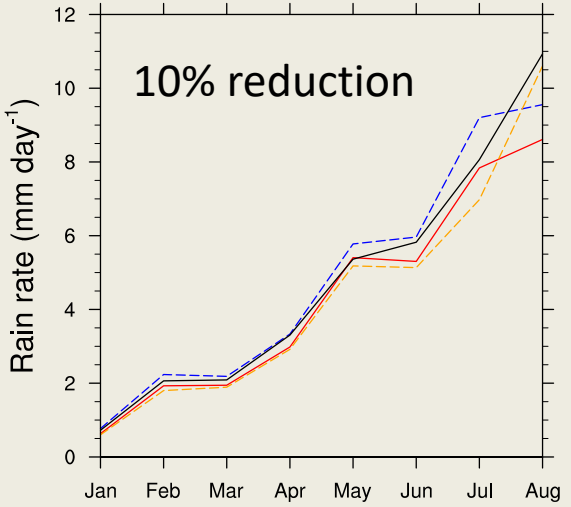






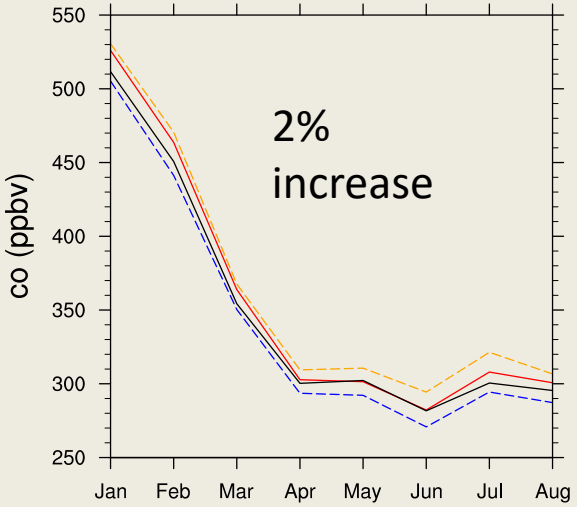


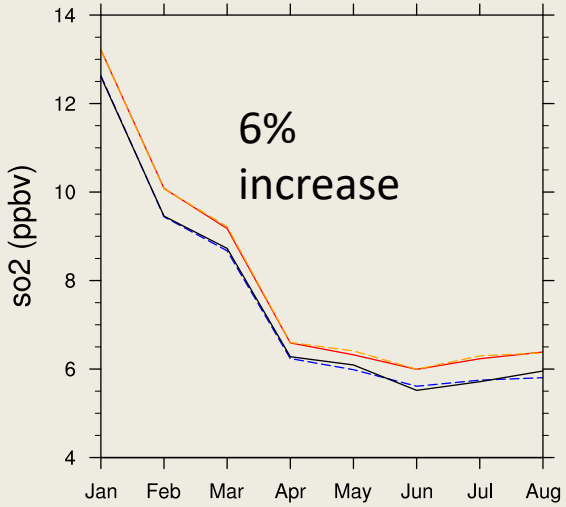


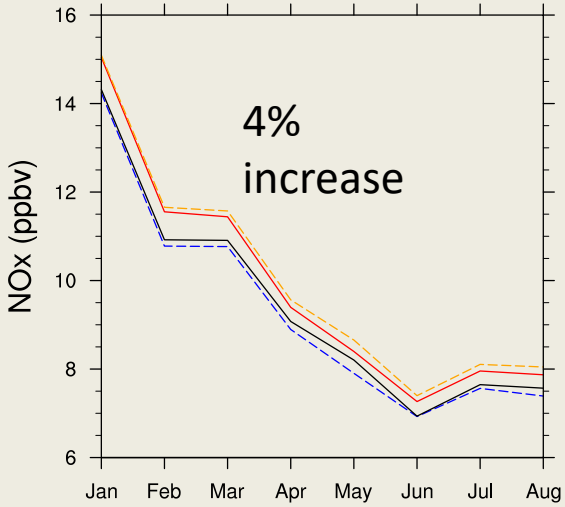


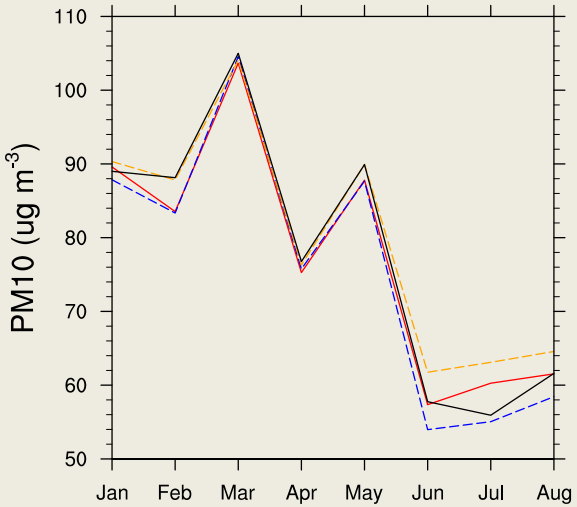
Monthly average from d03 (Red = AMR on; Blue = aerosol-mircophysics interaction (AM) on; Orange = aerosol-radiation interaction (AR) on; Black = no AMR)

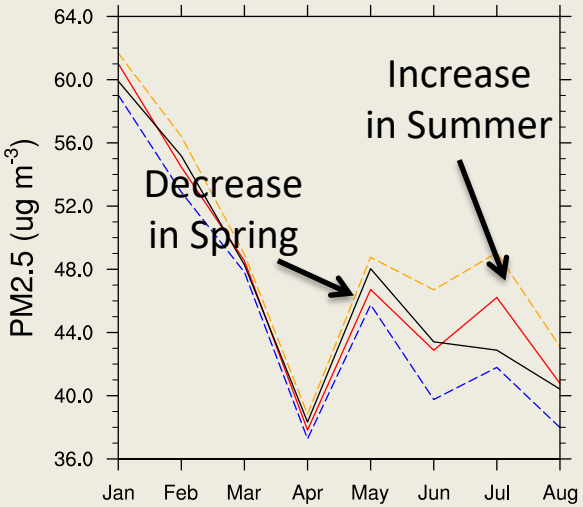
Impact of aerosols on regional air quality

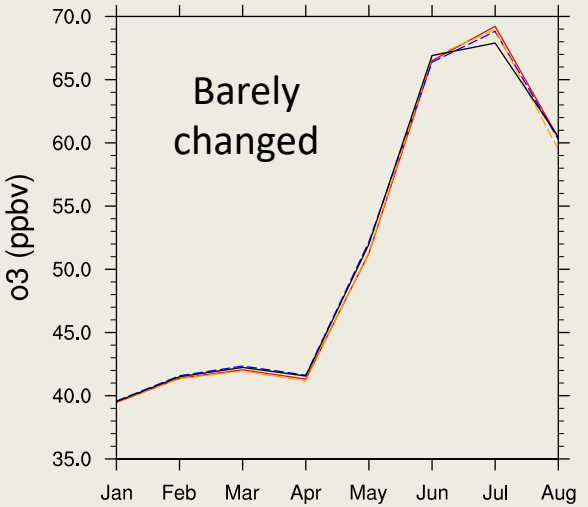












Summary

- Modeling of 2010 air quality over eastern Asia shows NU-WRF having sufficient skill in simulating daily to monthly aerosols and trace gases as compared to the available from ground- and space- measurements.
- Aerosol-microphysics-radiation interactions have sizeable impacts on local meteorology, e.g., SW radiation, temp., wind, cloud, PBLH, and precipitation
- Increase primary pollutant (i.e. CO, NOx, SO_2) conc. mainly due to reduced PBLH
- Slightly change PM2.5 in winter, reduce it in spring, and increase it summer, related to precipitation?
- Impact on ozone is minimum largely due to the contradicting meteorological conditions induced by aerosols

Synergy between MICS-Asia and ACAM

- Common goals between two programs (AMRI, air quality, emissions, radiative forcing, etc.)
- Both programs rely on data and modeling
- Promote data sharing
- Coordinate modeling activities beneficial to both communities
- Prepare for geo-satellite composition observing era over the region, i.e., GEMS
- More?