#680

Interactions between Asian air pollution and monsoon system – A multi-scale modeling study

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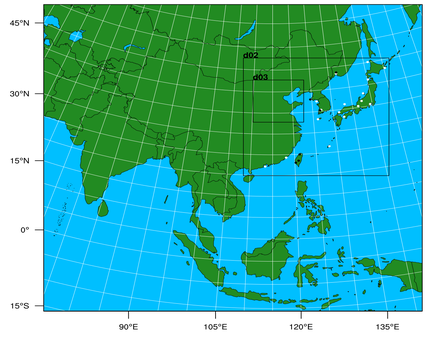
- Heavy air pollution plagues many Asian cities.
- Emissions aside, monsoon system plays a role in air quality.
- Monsoon regulates precipitation and hydrological cycle.
- High concentrations of aerosols characterizing Asian air pollution affect monsoon system through complex aerosol-cloud-radiation interactions (ACR).
- This multi-scale modeling study utilizing the Goddard Earth Observing System Model, Version 5 (GEOS-5) and NASA Unified Weather Research and Forecasting Model (NU-WRF) to better understand the linkage between Asian monsoon and regional air quality funded by NASA's ACMAP.
- This presentation will focus on one of three objectives of the proposed study, i.e., ***how pollution and dust aerosols in Asia affect the monsoon circulation and rainfall via scattering and absorption of solar radiation, changing the atmospheric heating rates, and modifying the cloud properties, based on NU-WRF simulations of the weak monsoon year of 2010.***



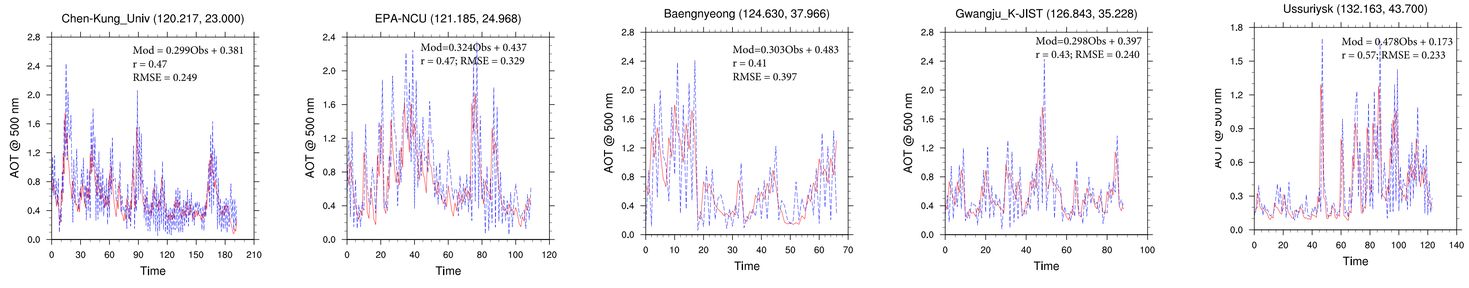
Domain set-up

- 3 nested domains with horizontal resolutions at 45, 15 and 5 km
- Terrain following 60 vertical layers up to 20 hPa
- Black dots for AERONET sites; White dots for EANET sites

Key input data

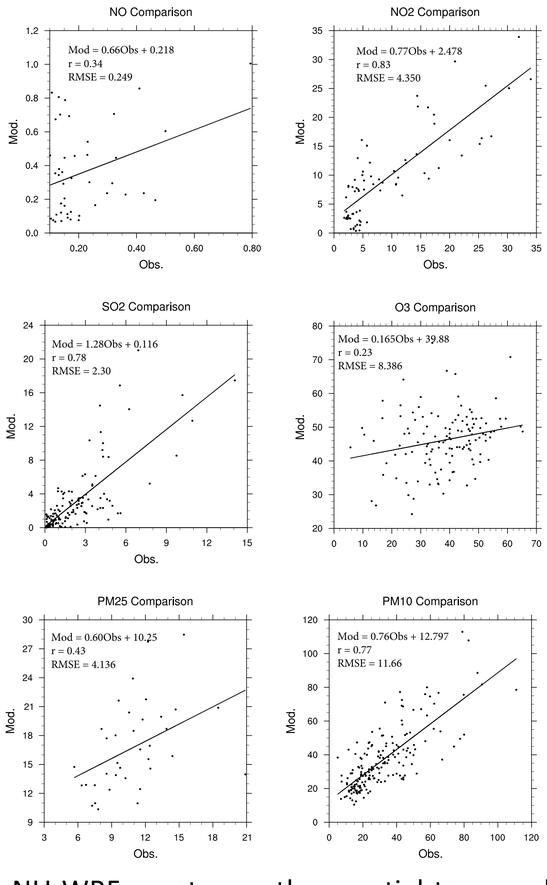
- Meteorology LBC: MERRA-2
- Anthropogenic Emissions: MICS-Asia
- Biogenic emissions: MEGAN2
- Chemical LBC: GOCART/MOZART
- Wild fire emissions: GFEDv3
- Dust/seasalt emissions: GOCART

Modeled 2010 daily AOD vs. AERONET (Red = obs. ; Blue = mod.)



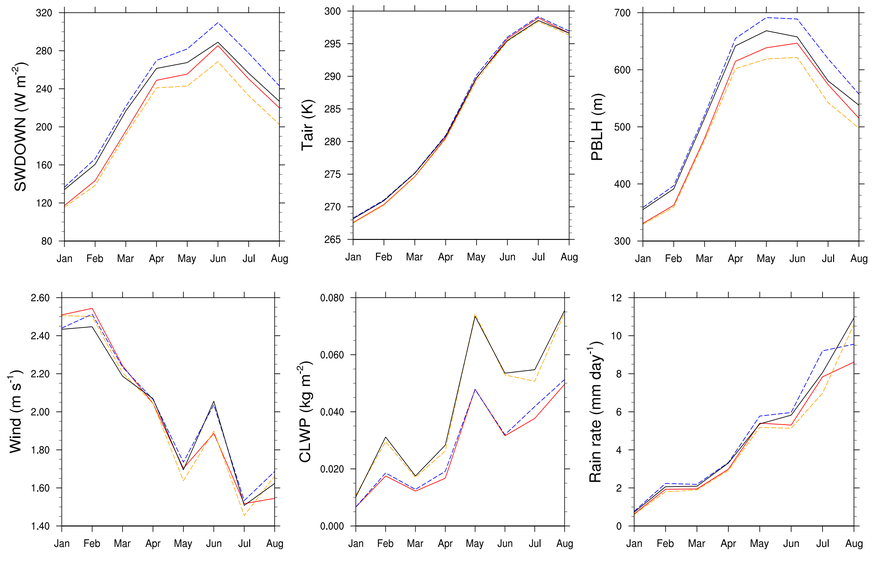
NU-WRF captures the daily AOD variation well but occasionally over/under-estimate the extreme high/low values

Modeled monthly air quality vs. EANET

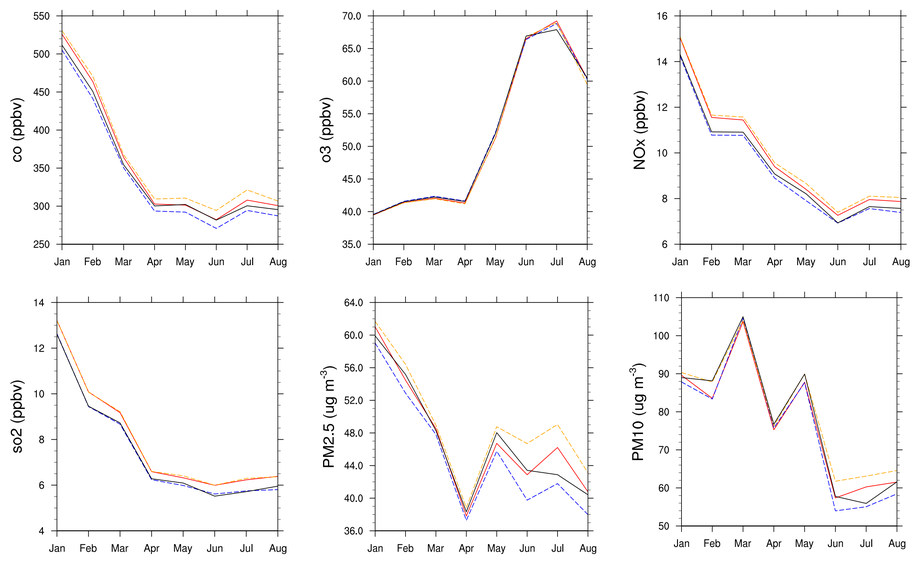


NU-WRF captures the spatial-temporal distributions of air quality but simulates primary pollutants better than secondary pollutants (O_3 and PM2.5)

Aerosol impact on meteorology



Meteorology feedback to air quality



Monthly average from d03 (Red = ACR on; Blue = aerosol-cloud interaction (AC) on; Orange = aerosol-radiation interaction (AR) on; Black = no ACR)

Comments

1) Reduce average surface shortwave radiation by ca. 5% largely due to AR and its synergy with AC with largest reduction (> 10%) in winter
2) Slightly reduce surface air temperature by less than 0.2 K
3) Reduce PBLH by ca. 4% mainly due to AR and its synergy with AC
4) Increase surface wind in winter but decrease it in summer
5) Reduce cloud liquid water path (CLWP) by ca. 36% mainly through AC
6) Reduce average precipitation by ca. 10% with larger (> 20%) reduction in summer
7) Increase average surface CO (ca. 2%), NOx (ca. 4%), and SO_2 (ca. 6%) in response to reduced PBLH
8) Impact on O_3 is minimum largely due to the contradicting meteorological effects caused by aerosols
9) Slightly change PM in winter, reduce it in spring, and increase it in summer

Future effort

2010 is a relatively weak monsoon year. How about the aerosol feedback in a relatively strong monsoon (thus different dynamics) year?