



WRF-GC: online two-way coupling of WRF and GEOS-Chem for regional atmospheric chemistry modeling

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For more information see: <http://wrf.geos-chem.org>

Overview of a new online coupled air quality model: WRF-GC



WRF

- Powerful and flexible grid system at resolutions 1km to 100km
- Hindcast and forecast capabilities, driven by NCEP, EC, etc
- Massively parallel architectures

GEOS-Chem

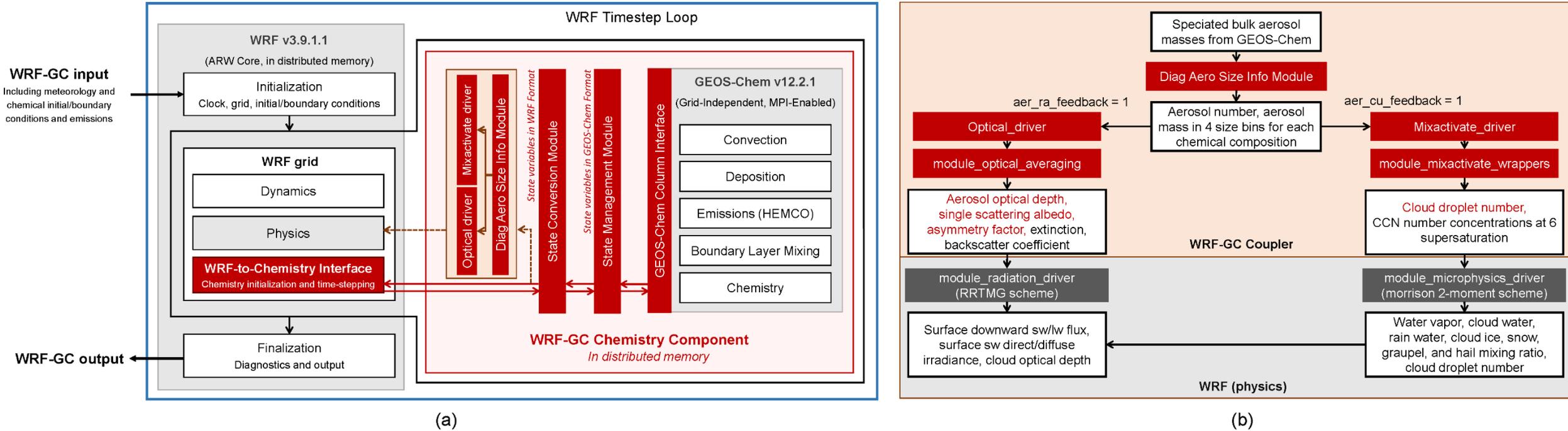
- State-of-the-science, well-documented, traceable, benchmarked, GSCT-supported chemical module

WRF-GC

- WRF-GC uses unmodified copies of WRF and GEOS-Chem from their respective sources.
- The Coupler is separate from both parent models and allows future versions of either one of the parent models to be integrated into WRF-GC.

Architecture of WRF-GC two-way coupled system

WRF-GC Model (v1.1, two-way)

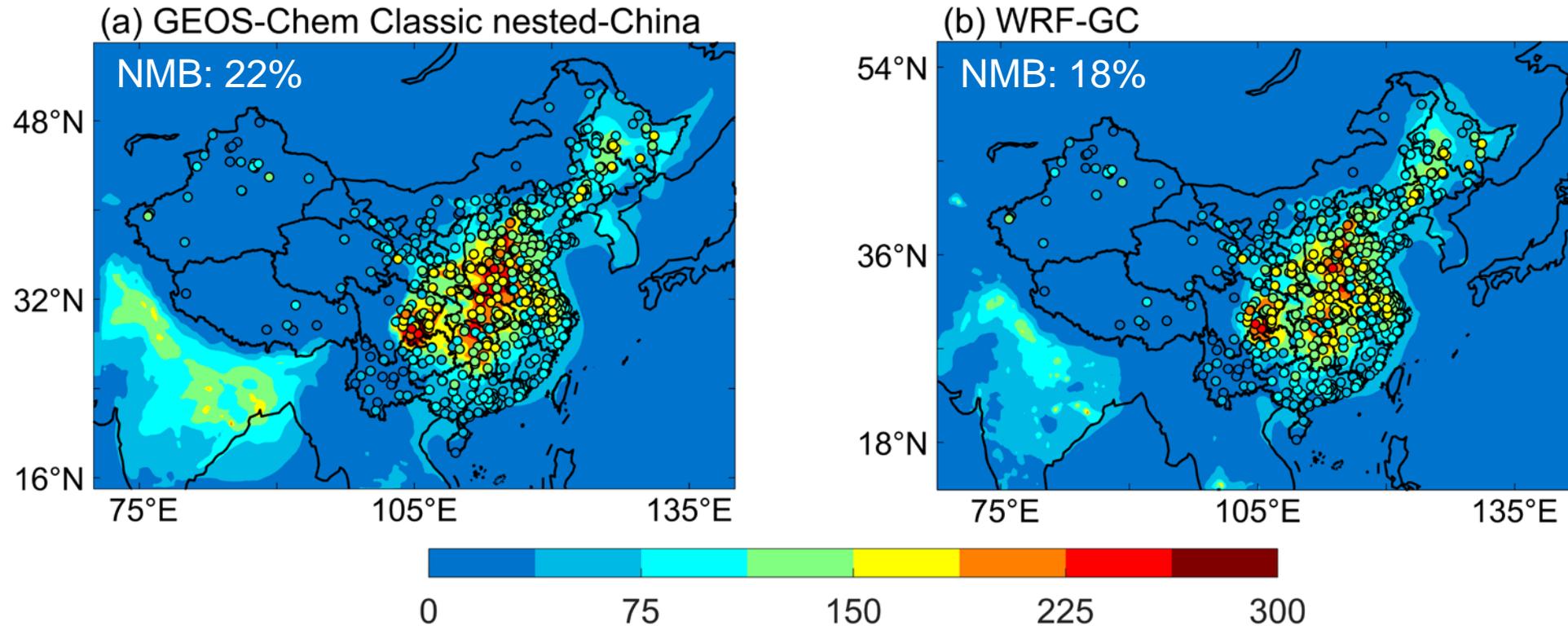


- (a) Architectural overview of the WRF-GC model (v1.1, two-way). The WRF-GC Coupler (all parts shown in red) includes interfaces to the two parent models, state conversion module, state management modules, and the two-way coupling modules (shown in orange). The parent models (shown in grey) are standard codes without any modifications.
- (b) Flow diagram of the aerosol-radiation and aerosol-cloud interactions in two-way coupled WRF-GC model.

(Feng et al., in preparation)

Evaluation of WRF-GC performance of PM_{2.5} over China

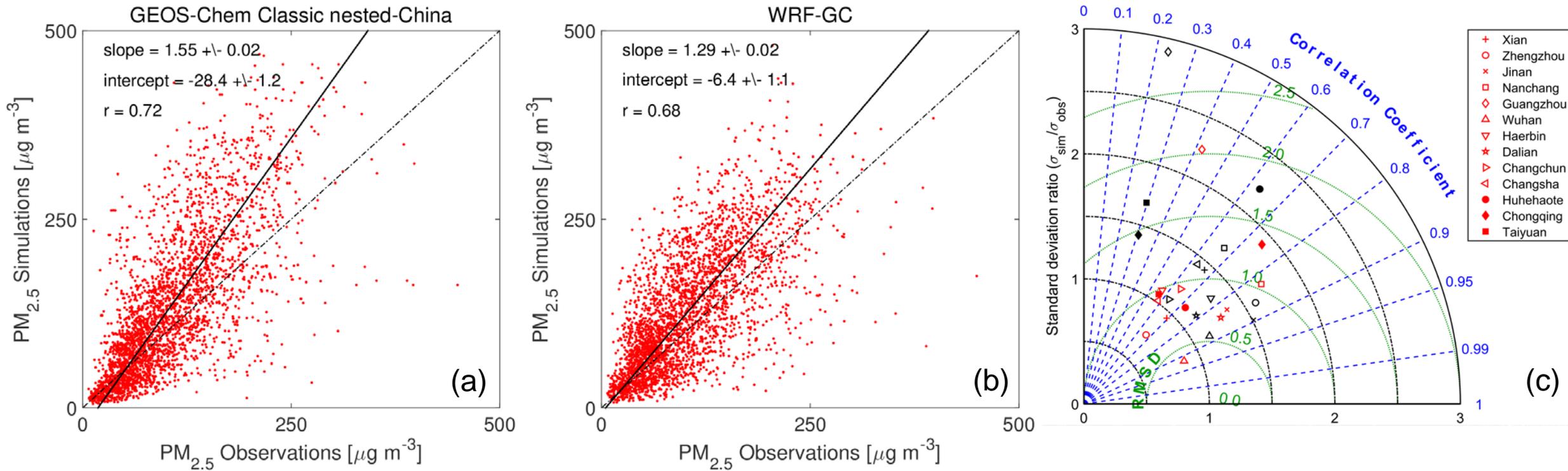
6-Day Time-averaged PM_{2.5} concentrations [$\mu\text{g m}^{-3}$]



- One-way coupled WRF-GC (WRF v3.9.1.1/GEOS-Chem v12.2.1)
- Simulation period: 2015-01-18 00:00 to 2015-01-28 00:00 (first 4 days initialized model)
- Spatial resolution: 27km (WRF-GC); GEOS-Chem Classic nested-China ($0.25^\circ \times 0.3125^\circ$)
- Chemical initial and boundary conditions: GEOS-Chem $2^\circ \times 2.5^\circ$ global simulation

(Lin et al., 2019, GMDD)

WRF-GC well reproduced the spatiotemporal distribution of PM_{2.5}

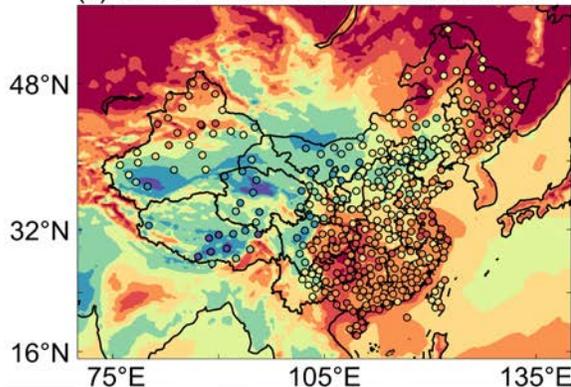


- Scatter plots of observed and simulated **daily mean PM_{2.5} concentrations** during Jan 22 to 27, 2015 at 507 surface sites over Eastern China for (a) the GEOS-Chem Classic nested-China simulation and (b) the WRF-GC nudged simulation.
- Taylor diagrams of **hourly PM_{2.5} concentrations** during Jan 22 to 27, 2015 from the GEOS-Chem Classic nested-China simulation (black symbols) and the WRF-GC simulation (red symbols) for (c) 13 major Chinese cities.

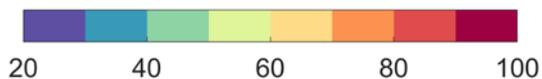
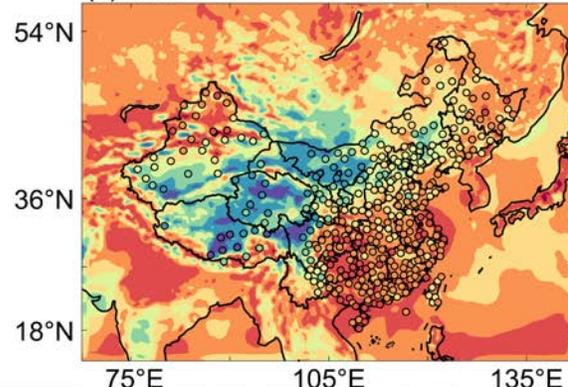
Representation of regional pollution meteorology

6-Day Time-averaged Surface Relative Humidity [%]

(c) GEOS-Chem Classic nested-China

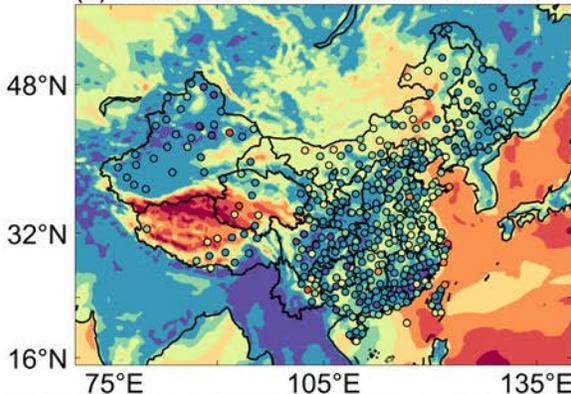


(d) WRF-GC

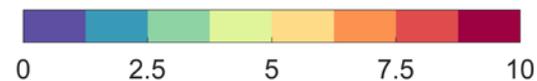
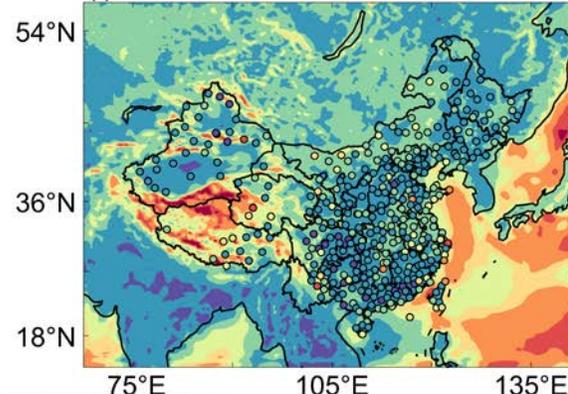


6-Day Time-averaged Wind Speed at 10m [m s^{-1}]

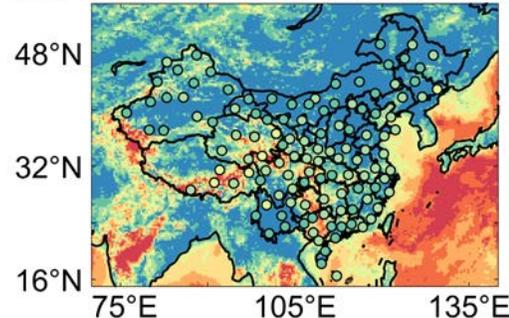
(e) GEOS-Chem Classic nested-China



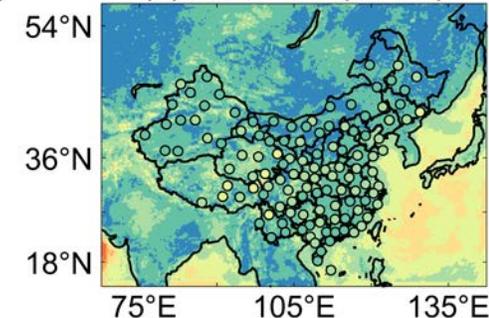
(f) WRF-GC



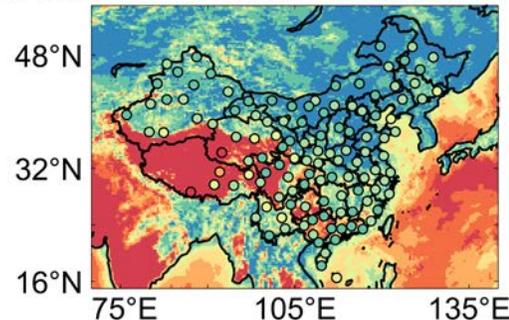
(a) GEOS-Chem Classic nested-China (08 LT)



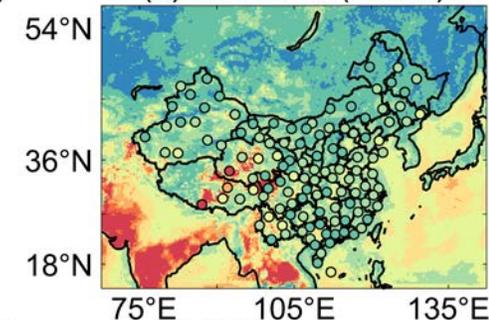
(b) WRF-GC (08 LT)



(c) GEOS-Chem Classic nested-China (20 LT)

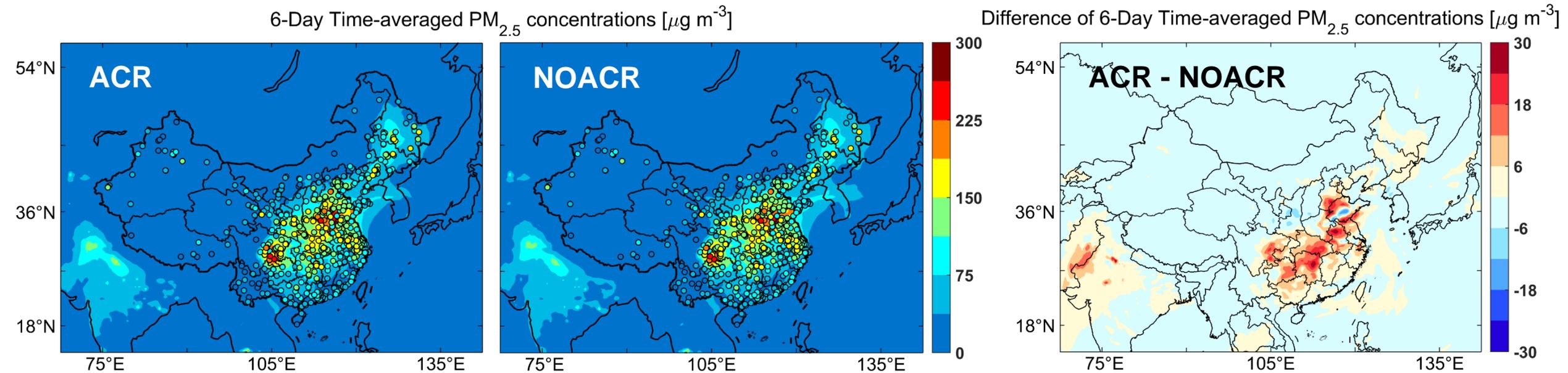


(d) WRF-GC (20 LT)



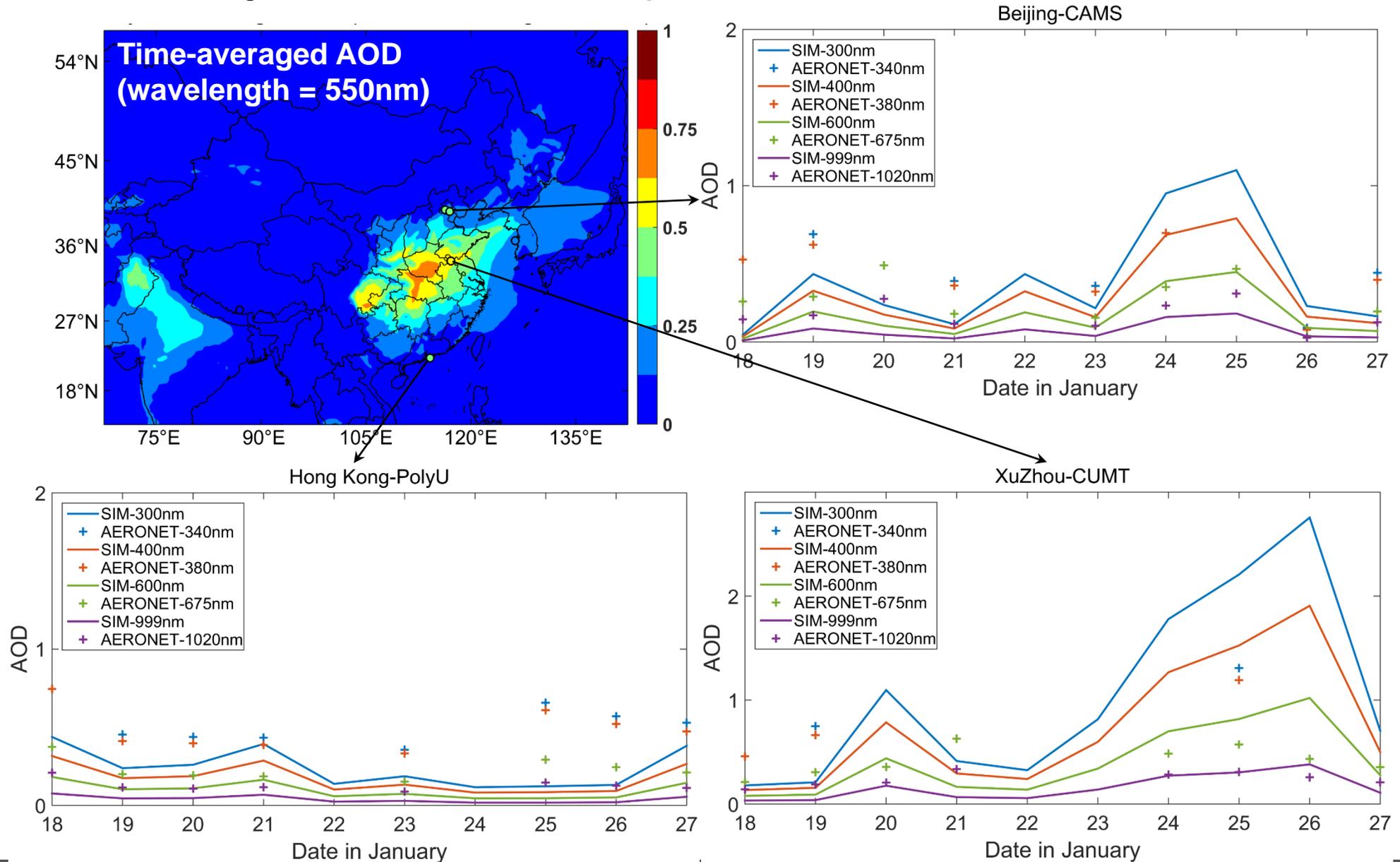
WRF-GC simulation nudged with meteorological observations was able to better represent the regional meteorology, such as the RH, WS10M, and PBLH in comparison with those from GEOS-FP dataset.

Impacts of aerosol-cloud-radiation interactions (ACR) on PM_{2.5} over China



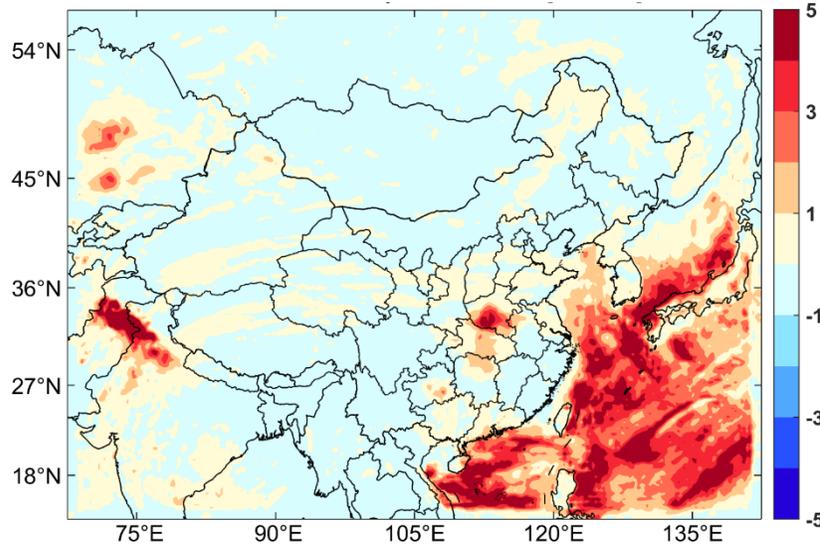
- Two-way coupled WRF-GC (WRF v3.9.1.1/GEOS-Chem v12.2.1)
- Simulation period: 2015-01-18 00:00 to 2015-01-28 00:00 (first 4 days initialized model)
- Spatial resolution: 27km (WRF-GC); GEOS-Chem Classic nested-China ($0.25^\circ \times 0.3125^\circ$)
- Chemical initial and boundary conditions: GEOS-Chem $2^\circ \times 2.5^\circ$ global simulation

Simulated AOD by WRF-GC in comparison with AERONET dataset

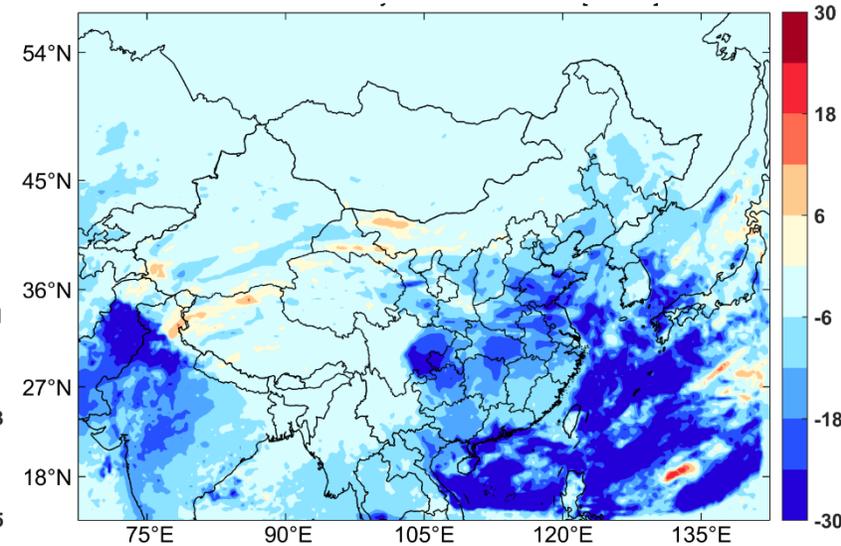


Impacts of aerosol-cloud-radiation interactions (ACR) on meteorology

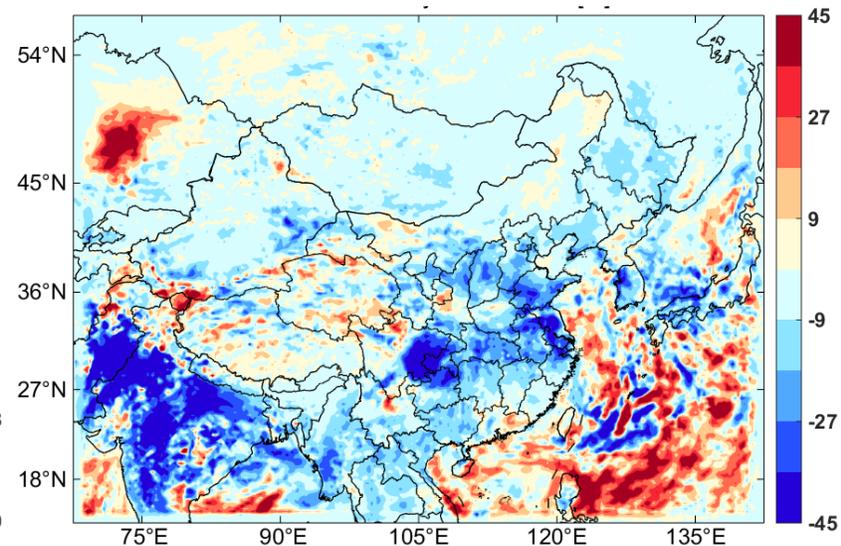
Cloud optical depth [unitless]
ACR - NOACR



Downward surface solar radiation [W m^{-2}]
ACR - NOACR



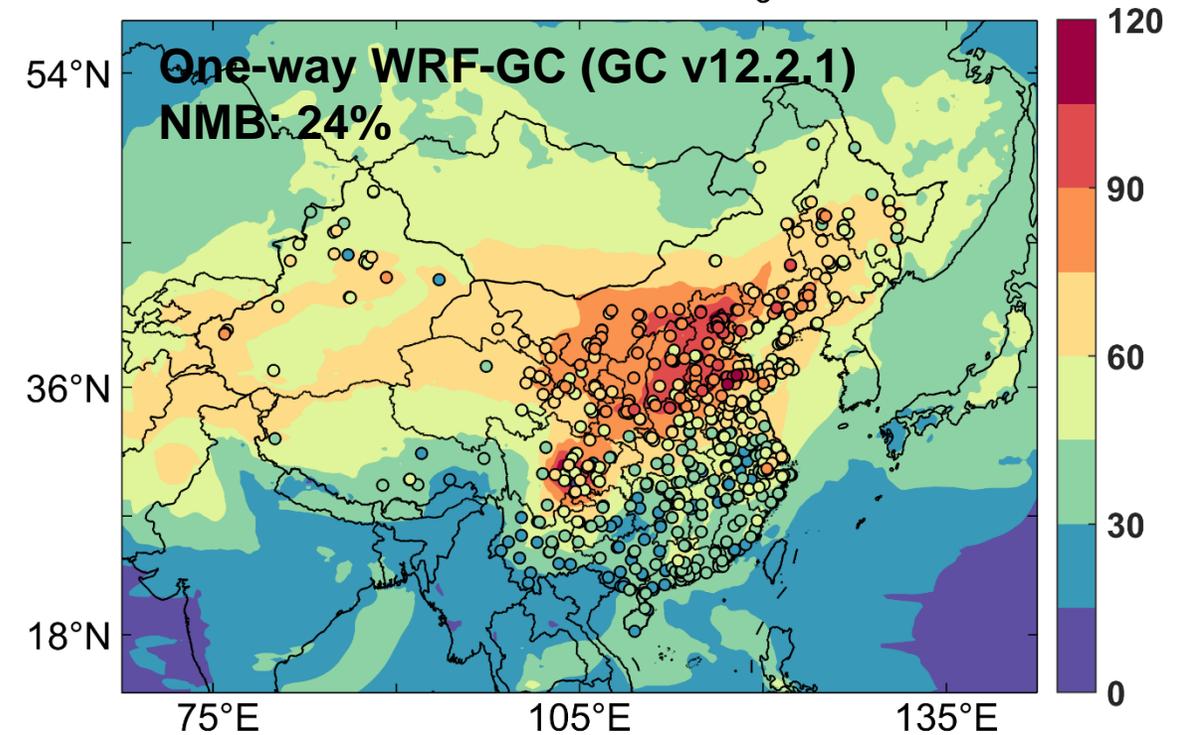
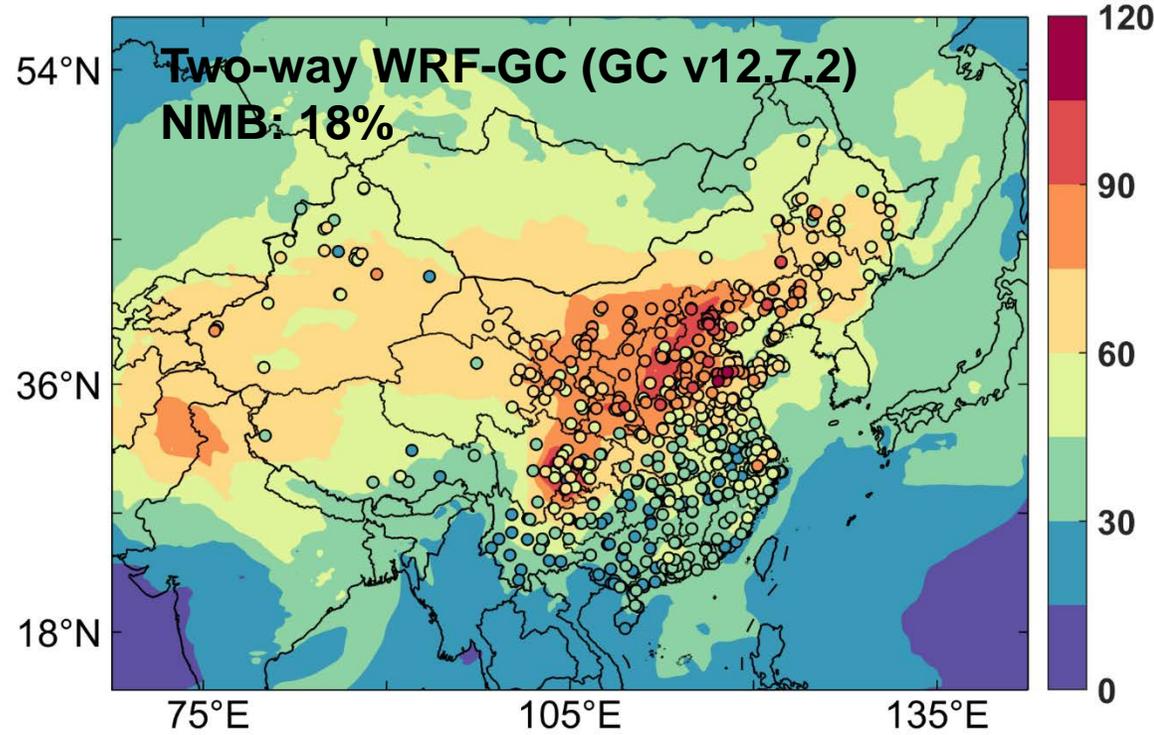
PBLH [m]
ACR - NOACR



- Two-way coupled WRF-GC (WRF v3.9.1.1/GEOS-Chem v12.2.1)
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Evaluation of WRF-GC performance of summer ozone over China

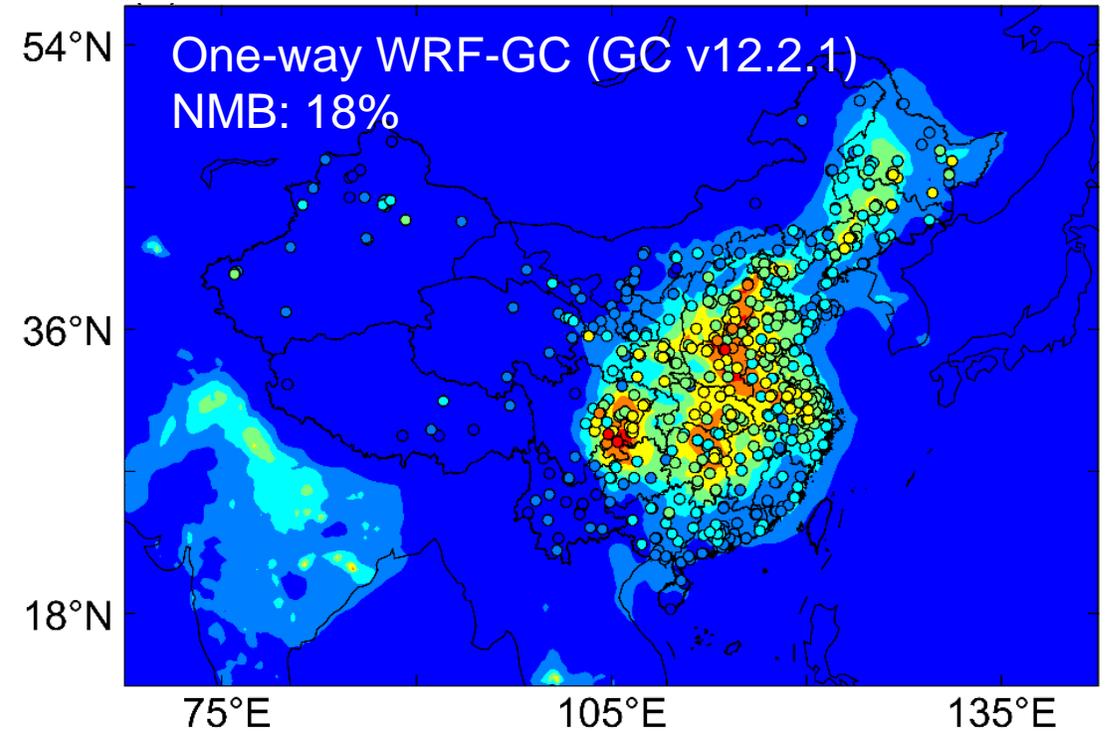
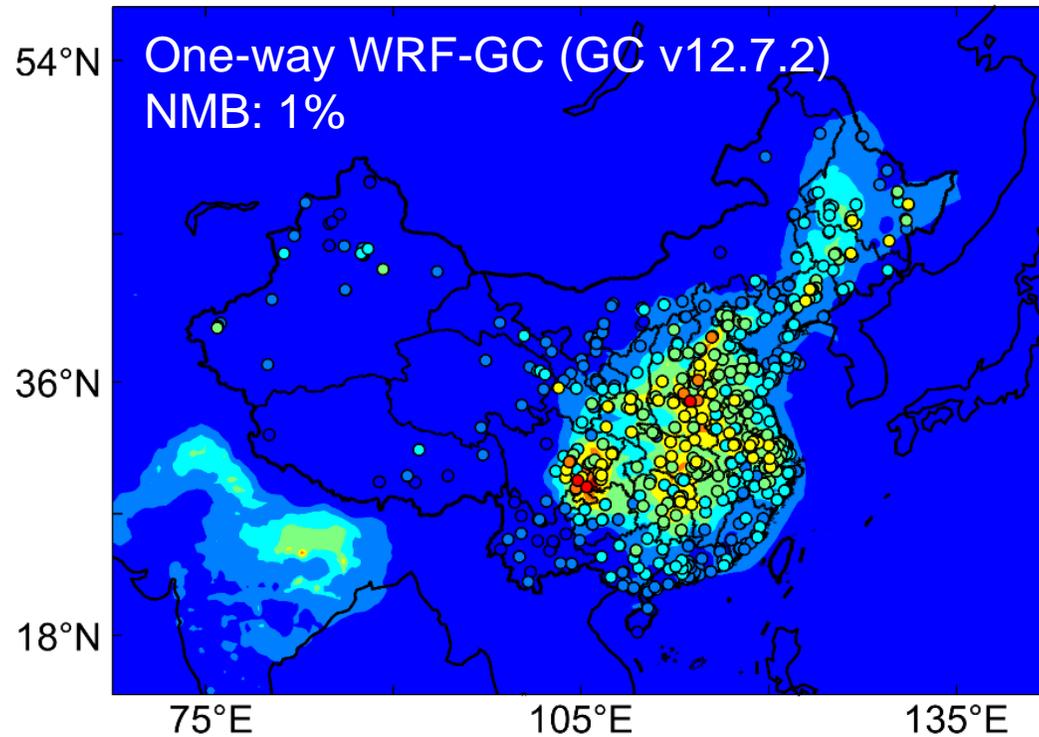
7-Day Time-averaged (13:00-17:00 LT) O₃ concentrations [ppbv]



- Simulation period: 2016-06-27 00:00 to 2016-07-08 00:00 (first 4 days initialized model)
- Spatial resolution: 27km
- Chemical initial and boundary conditions: GEOS-Chem 2° × 2.5° global simulation
- Meteorology nudging: off

Improvement of simulated PM_{2.5} due to updates of the dry deposition (HNO₃)

6-Day Time-averaged PM_{2.5} concentrations [$\mu\text{g m}^{-3}$]



- Simulation period: 2015-01-18 00:00 to 2015-01-28 00:00 (first 4 days initialized model)
- Spatial resolution: 27km (WRF-GC); GEOS-Chem Classic nested-China ($0.25^\circ \times 0.3125^\circ$)
- Chemical initial and boundary conditions: GEOS-Chem $2^\circ \times 2.5^\circ$ global simulation
- Meteorology nudging: on

WRF-GC is open-source and freely available

- WRF-GC Homepage: <http://wrf.geos-chem.org>



The screenshot shows the homepage of the WRF-GC project. The header features the text 'Atmospheric Chemistry & Climate @ SUSTech' and '大气化学与气候 @ 南方科技大学' in a blue gradient. Below the header is a navigation menu with links for 'Home', 'People', 'Research', 'Publications', 'Courses', 'WRF-GC model', and 'Real-time AQ Simulations'. The main content area displays 'WRF-GC' in large blue letters. To the right, there is a 'Tools' section with links for 'What links here', 'Related changes', 'Special pages', 'Printable version', and 'Permanent link'. Below the 'WRF-GC' title, there is a 'Contents [hide]' section with a list of links: '1 Introduction', '2 Getting started', '3 The 9th International GEOS-Chem Meeting (IGC9)', and '4 Contact us'.

- *More information on one-way WRF-GC model: <https://www.geosci-model-dev-discuss.net/gmd-2019-333/gmd-2019-333.pdf>*

Contact us

If you are interested in downloading WRF-GC and giving it a spin, please send us an email (fuzm@sustech.edu.cn) and tell us your name, affiliation, and intended general application. We will add you to a mailing list and keep you updated on new version releases.

