# WRF-Chem simulations of aerosol impacts on summer monsoon precipitation over China


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## 1. Motivation

- ❑ East Asia is one of the most heavily polluted regions in the world. Many previous studies have shown that East Asian monsoon precipitation is affected by aerosols, but contradictory results exist.
- ❑ In this study, the WRF-Chem model is used to examine the aerosol impacts on precipitation over China during the East Asian summer monsoon (EASM).

## 2. Model configuration and experiment design

- ❑ Time period: Apr. 1 to Aug. 5, 2007
- ❑ Horizontal resolution: 36 km
- ❑ Initial and boundary conditions: ERA-Interim (meteorology) and MOZART (chemistry)
- ❑ Physics:
  - ➢ Morrison 2-moment microphysics
  - ➢ New Grell cumulus
  - ➢ RRTMG longwave scheme
  - ➢ Goddard shortwave scheme
- ❑ Chemistry:
  - ➢ RADM2 chemistry and MADE/SORGAM aerosols
  - ➢ Anthropogenic emissions: RETRO and EDGAR
  - ➢ Biomass emissions: GFEDV2-8days
  - ➢ Biogenic emission: Guenther scheme
  - ➢ Dust emission: MADE/SORGAM scheme
  - ➢ wet scavenging, vertical turbulent mixing and cloud chemistry
  - ➢ Feedback from aerosols to radiation
- ❑ Experiments:
  - ➢ CTRL: the control run
  - ➢ CLEAN: without aerosol emissions
  - ➢ NORD: without aerosol impacts on radiation


## Acknowledgements

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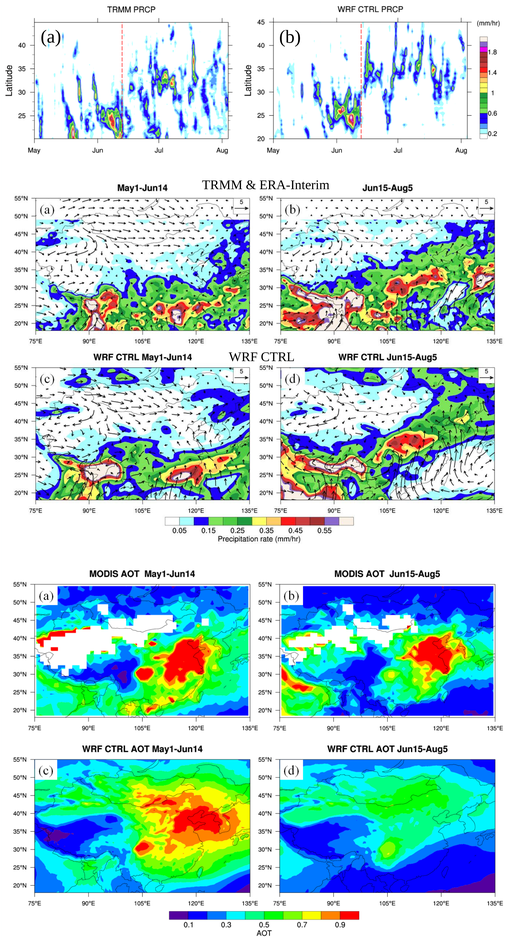
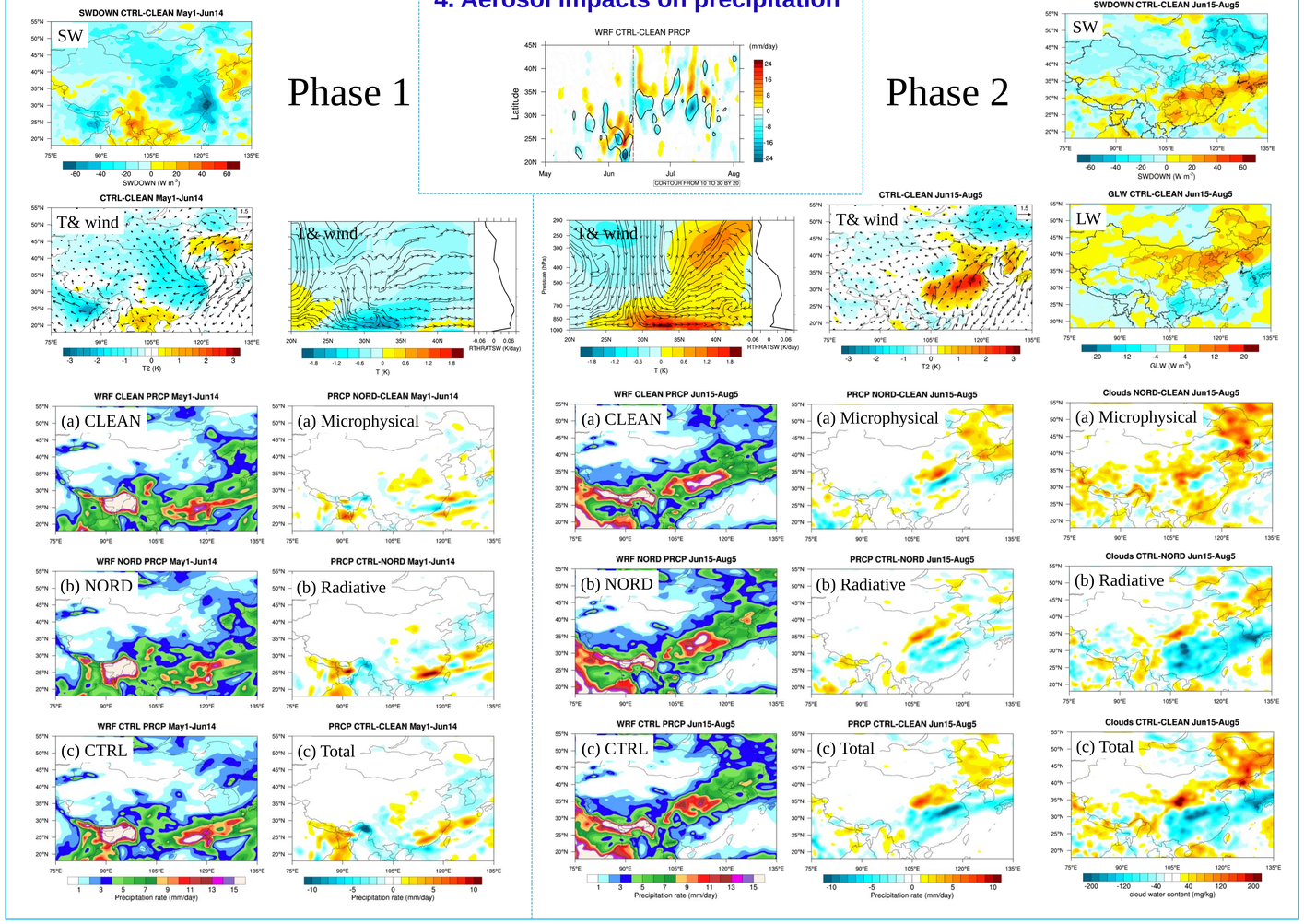
## 3. Model evaluation

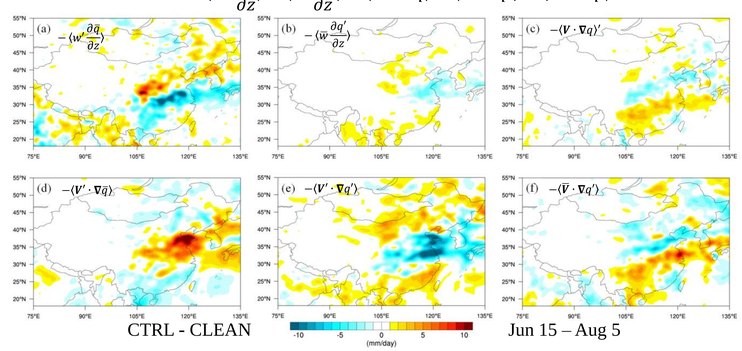



## 4. Aerosol impacts on precipitation



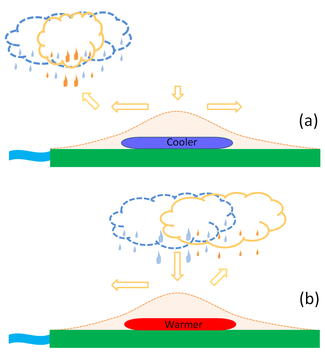

## 5. Moisture budget

$$P' \approx E' - \langle w' \frac{\partial \bar{q}}{\partial z} \rangle - \langle \bar{w} \frac{\partial q'}{\partial z} \rangle - \langle \boldsymbol{V}' \cdot \nabla \bar{q} \rangle - \langle \bar{\boldsymbol{V}} \cdot \nabla q' \rangle - \langle \boldsymbol{V}' \cdot \nabla q' \rangle$$




CTRL - CLEAN  Jun 15 – Aug 5

## 6. Summary




- ❑ In the first phase of the EASM, monsoonal rain band is located to the south of high aerosol areas. The cooling of the surface by aerosol radiative effects induces an anti-cyclonic circulation in northern China, inhibiting the northward migration of rain band and causing a precipitation change reminiscent of "northern drought and southern flood". The aerosol microphysical effect tends to broaden the precipitation region and weaken the meridional asymmetry.
- ❑ In the second phase of the EASM, the precipitation band jumps to high aerosol areas. The warming of atmosphere by absorbing aerosols causes a reduction of local cloudiness and induces ascent to the north and descent to the south, leading to a precipitation change resembling "northern flood and southern drought". The aerosol microphysical effect strengthens such a meridional asymmetry.
- ❑ Our study highlights that aerosol effects on EASM precipitation depend on the relative locations of aerosols and monsoonal clouds. Non-local dynamic feedback triggered by aerosol radiative cooling dominates the first phase of EASM, while changes in cloud radiative forcing mediated by atmospheric warming of absorbing aerosols is the primary driver in the second phase.