Responses of surface ozone air quality to anthropogenic nitrogen deposition

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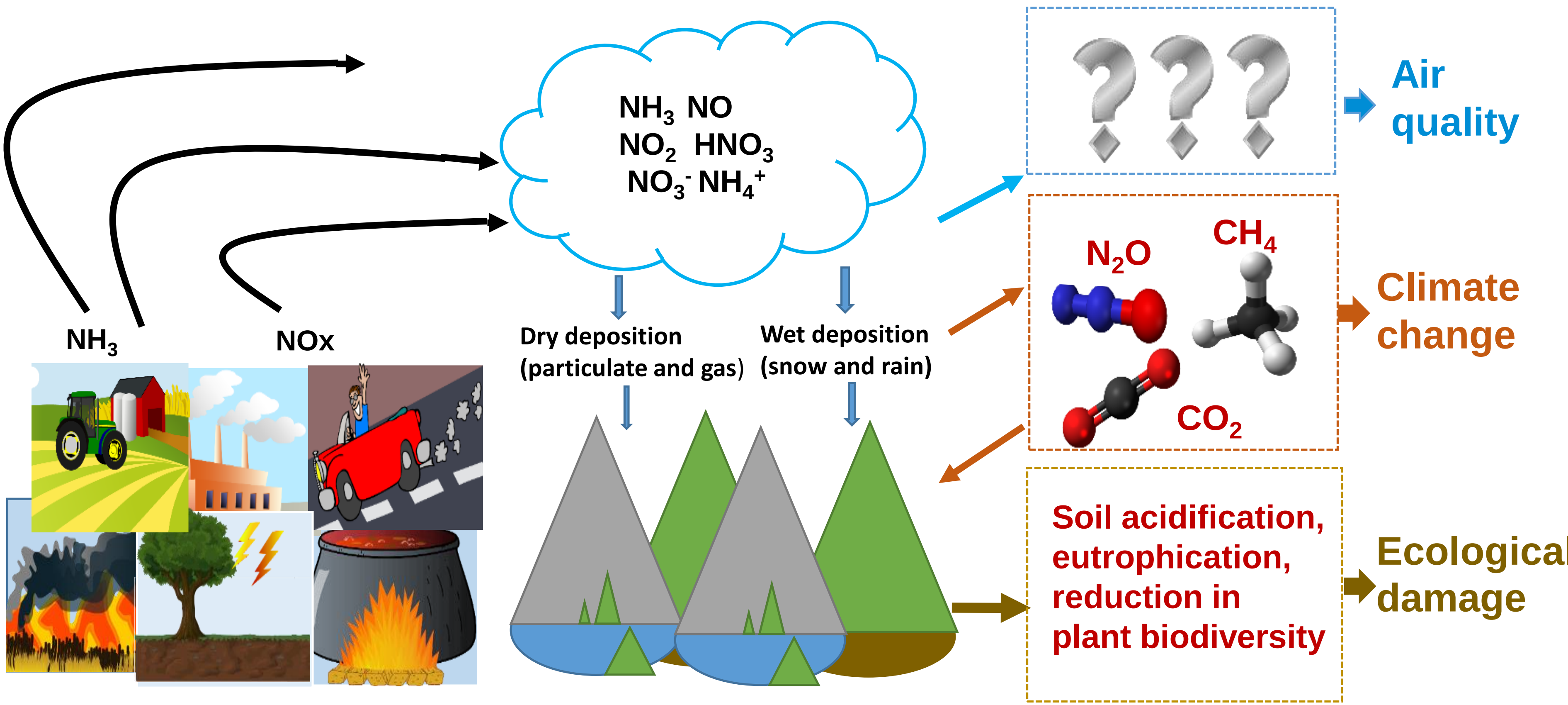
Key massages:

The impacts of anthropogenic nitrogen deposition on surface ozone are important at regional scales.

The complexity of biosphere-atmosphere interactions can have important implications for future air quality prediction.

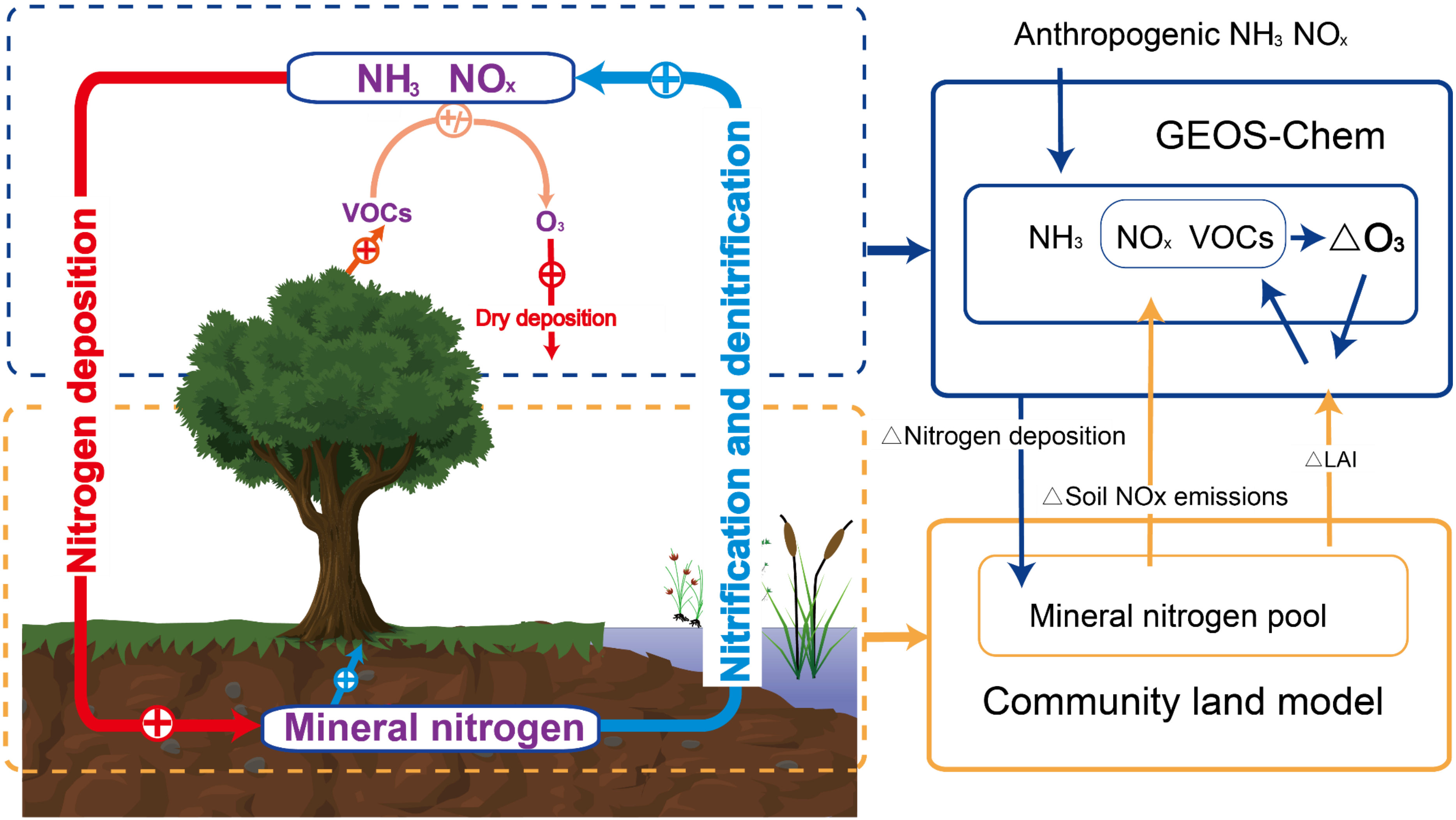
Zhao, Y., Zhang, L., Tai, A. P. K., Chen, Y., and Pan, Y.: Responses of surface ozone air quality to anthropogenic nitrogen deposition in the Northern Hemisphere, Atmos. Chem. Phys. Discuss., doi:10.5194/acp-2017-242, in review, 2017.

Increasing inputs of reactive nitrogen from the atmosphere can lead to complex environmental and climate consequences



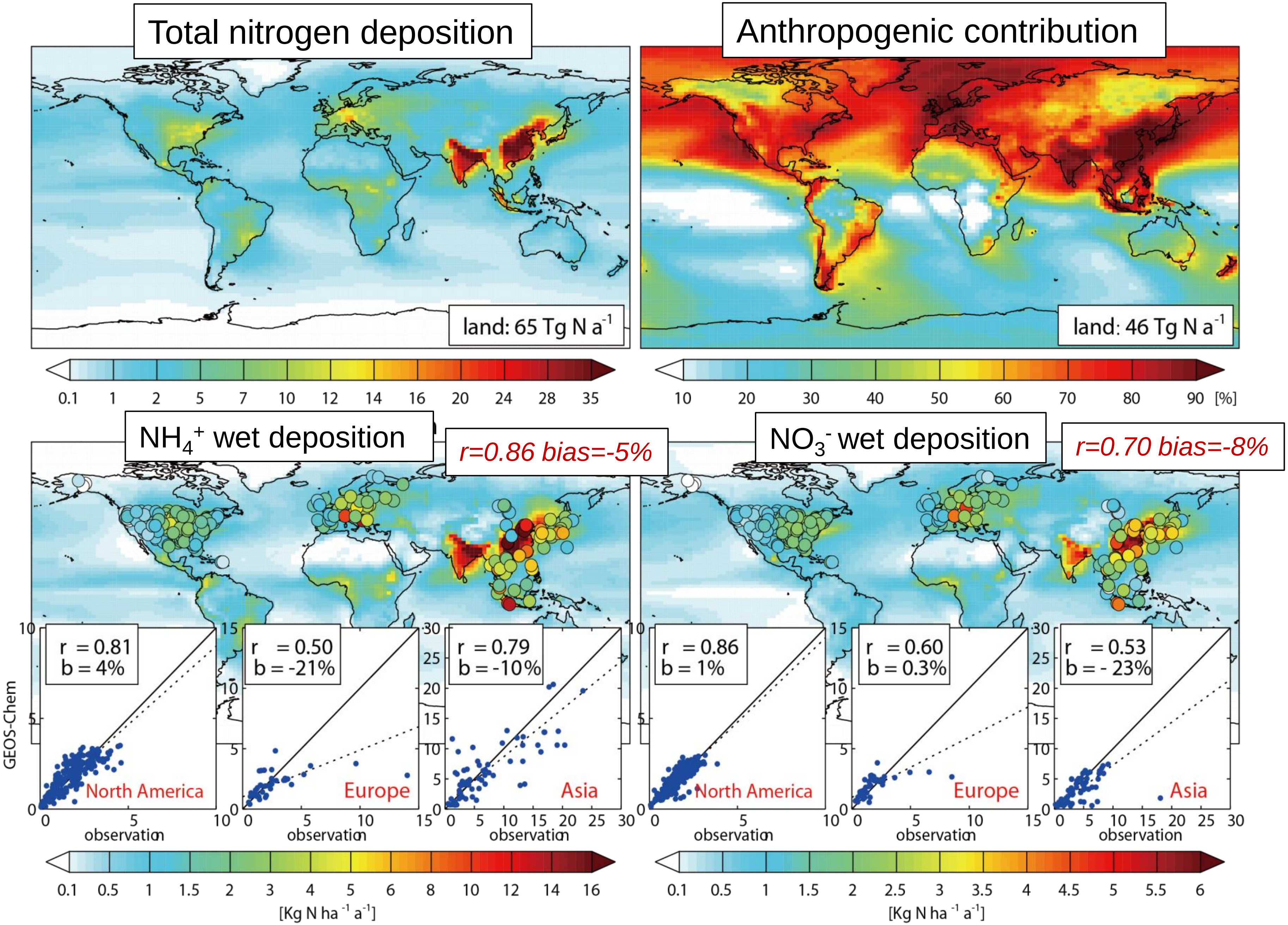
We focus on how human-induced nitrogen deposition may affect surface ozone air quality through land-atmosphere interactions.

Surface ozone air quality response to enhanced nitrogen deposition through land-atmosphere exchanges

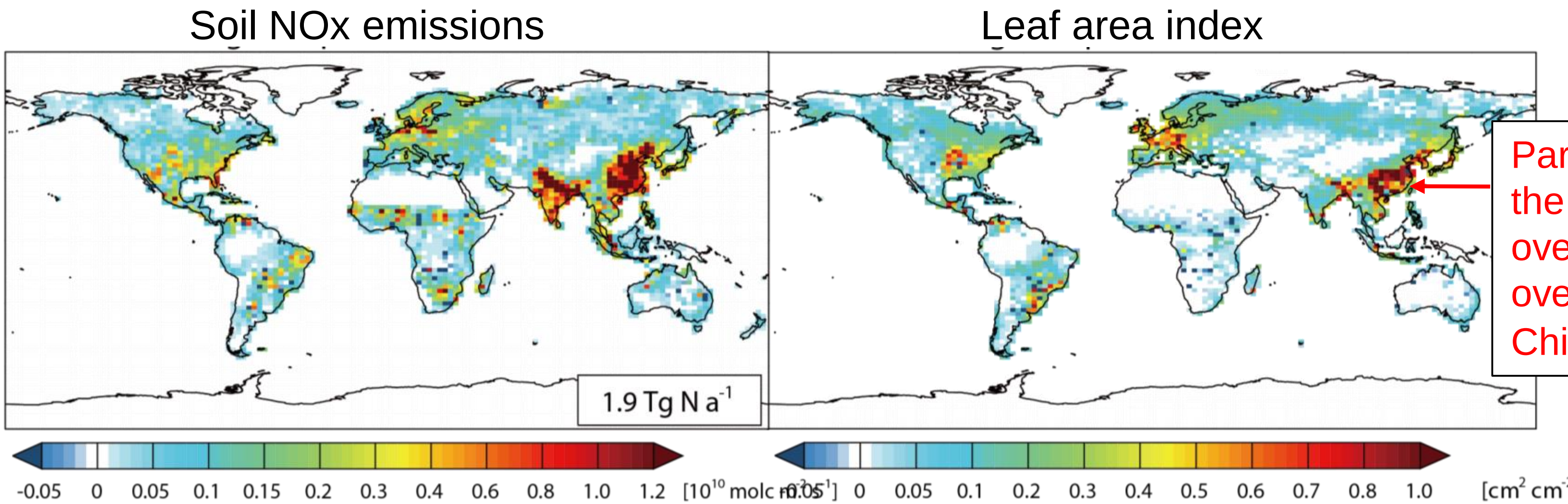


We build this asynchronously coupled system of GEOS-Chem and CLM to investigate the influences of nitrogen deposition on surface ozone from the individual processes and the overall effects.

GEOS-Chem simulated atmospheric nitrogen deposition

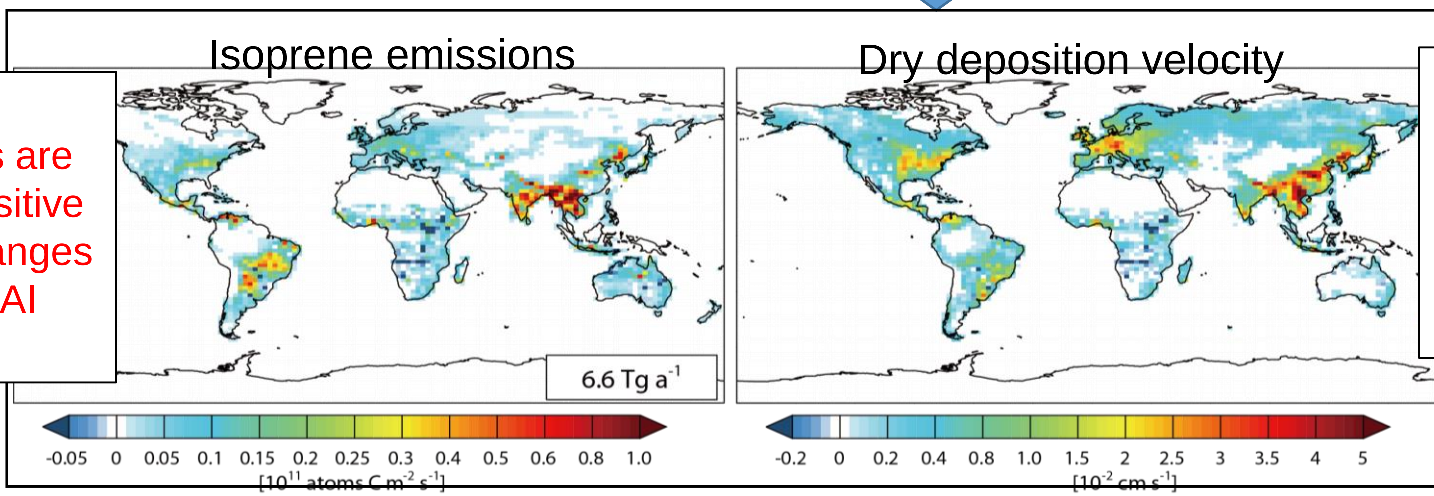


Impact of anthropogenic nitrogen deposition on land properties



Partly reflect the LAI overestimation over Southeast China in CLM.

Subsequent responses of LAI changes

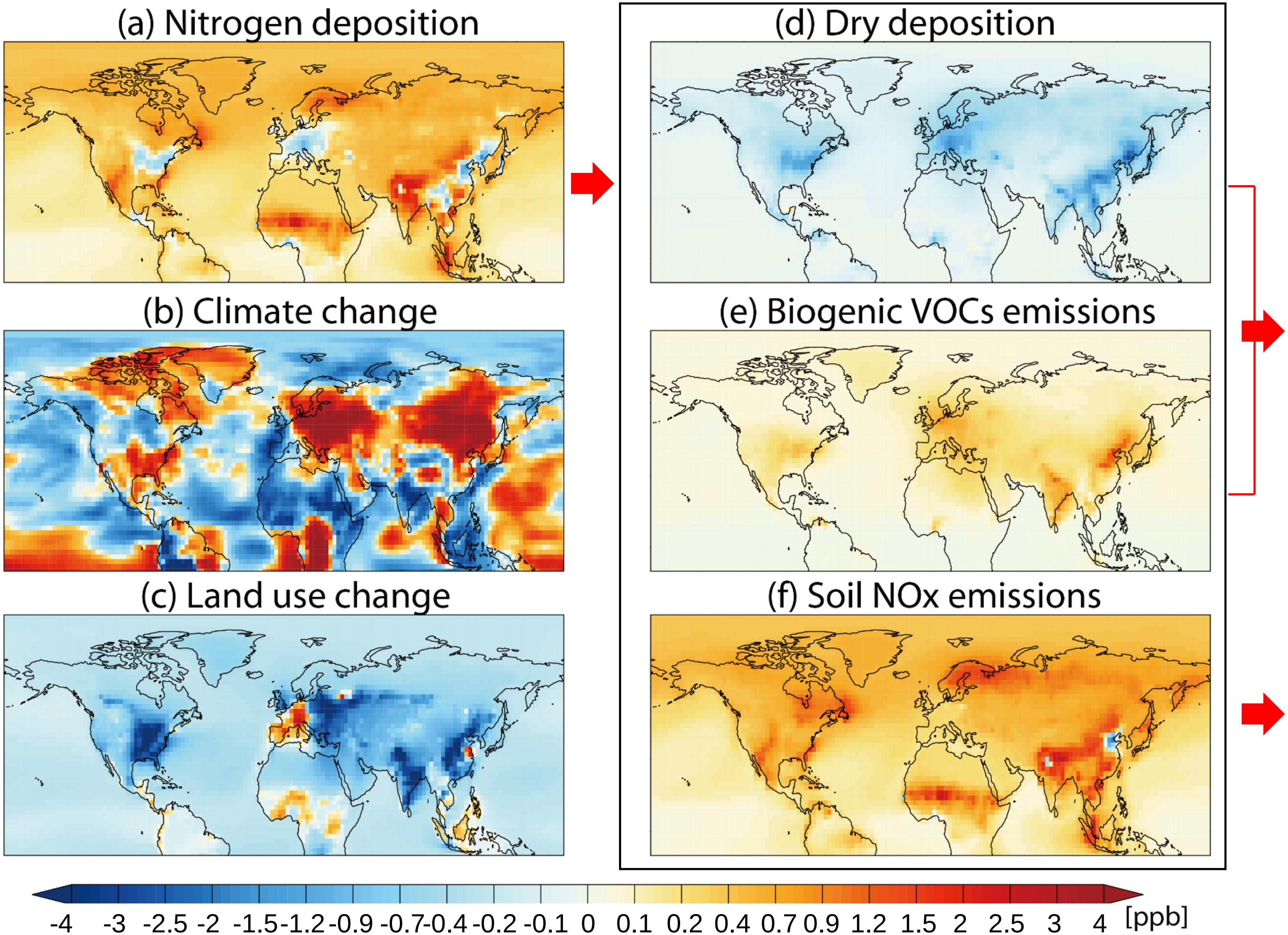


Isoprene emissions are more sensitive to LAI changes at lower LAI area.

The dry deposition velocity tends to increase with increasing LAI.

Biogenic emissions and ozone dry deposition show different sensitivity to LAI changes.

Responses of surface ozone pollution in June-July-August



Surface ozone changes due to increased dry deposition loss and biogenic VOC emissions are largely offset.

Enhanced soil NO_x emissions increases the surface ozone concentration over the globe except for NO_x saturated areas.

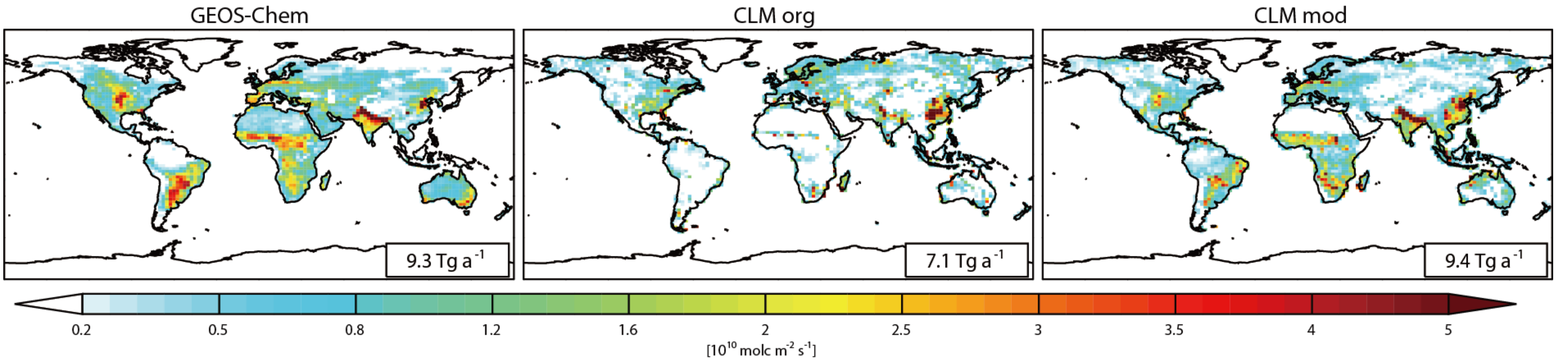
- The influences of anthropogenic nitrogen deposition may largely offset the surface ozone reduction due to historical land use change.
- Large uncertainties exist in this interaction since the estimated surface ozone responses rely heavily on the parameterizations of surface-atmosphere exchange processes.

Back-up slides

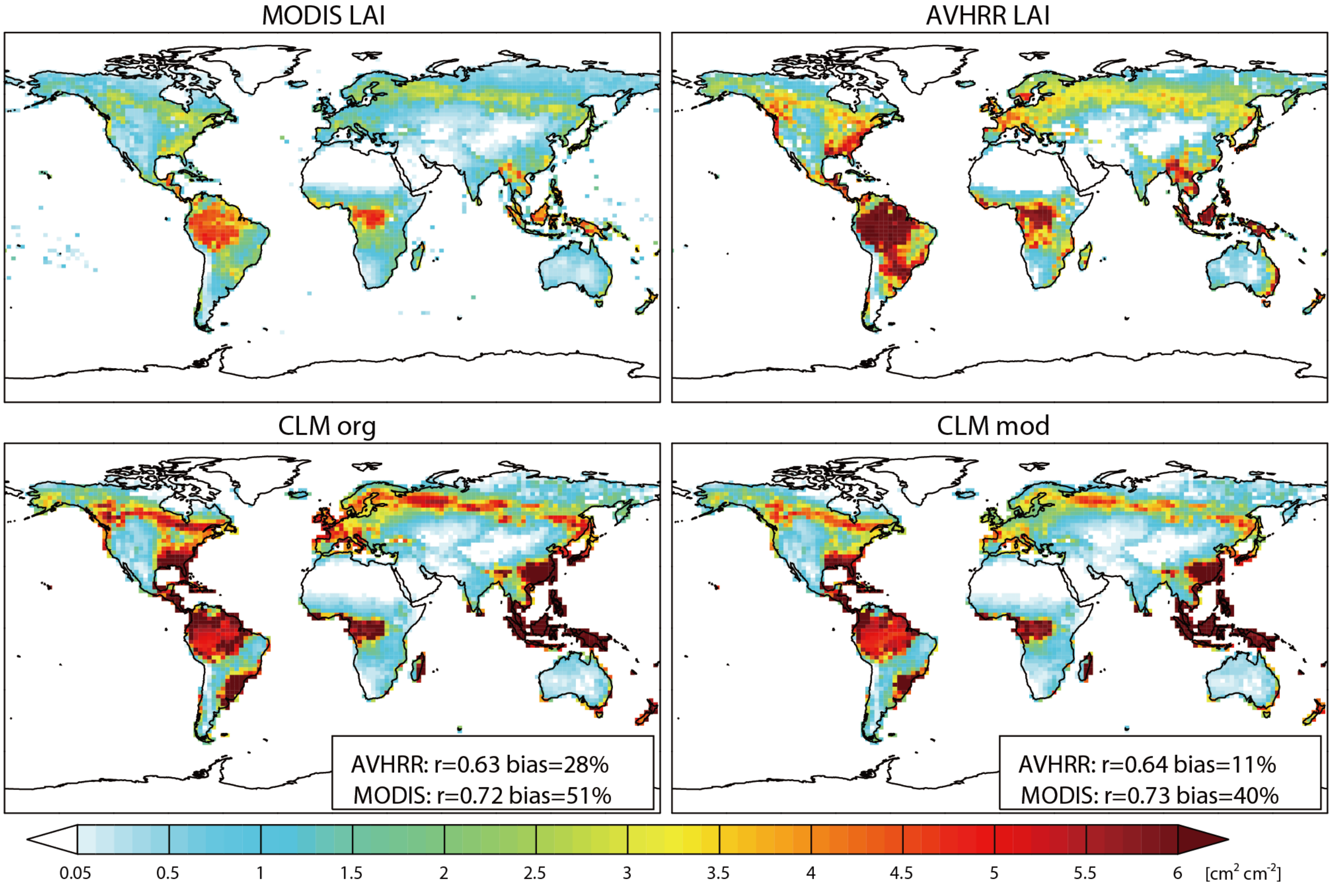
Modifications implemented to the CLMv4.5 model

1. Implement a process-based parameterization of soil NO_x emissions based on NO_x and N_2O emission ratios as described by Parton et al. (2001).
2. Add a process-based NH_3 volatilization parameterization in CLM following Xu and Prentice (2008) to avoid extremely high soil nitrogen content over desert areas.
3. Consider factors (soil inorganic nitrogen concentration, the fine root mass, and soil temperature) that limit plant nitrogen uptake capacity .

Soil NOx emissions from GEOS-Chem, original CLM and modified CLM



Compare LAI simulated by original CLM model and modified model with MODIS and AVHRR observations



The CLM LAI overestimation leads to the largest uncertainty over Southeast China