Constraints on aerosol sources using GEOS-Chem adjoint and MODIS radiances, and evaluation with OMI and MISR data

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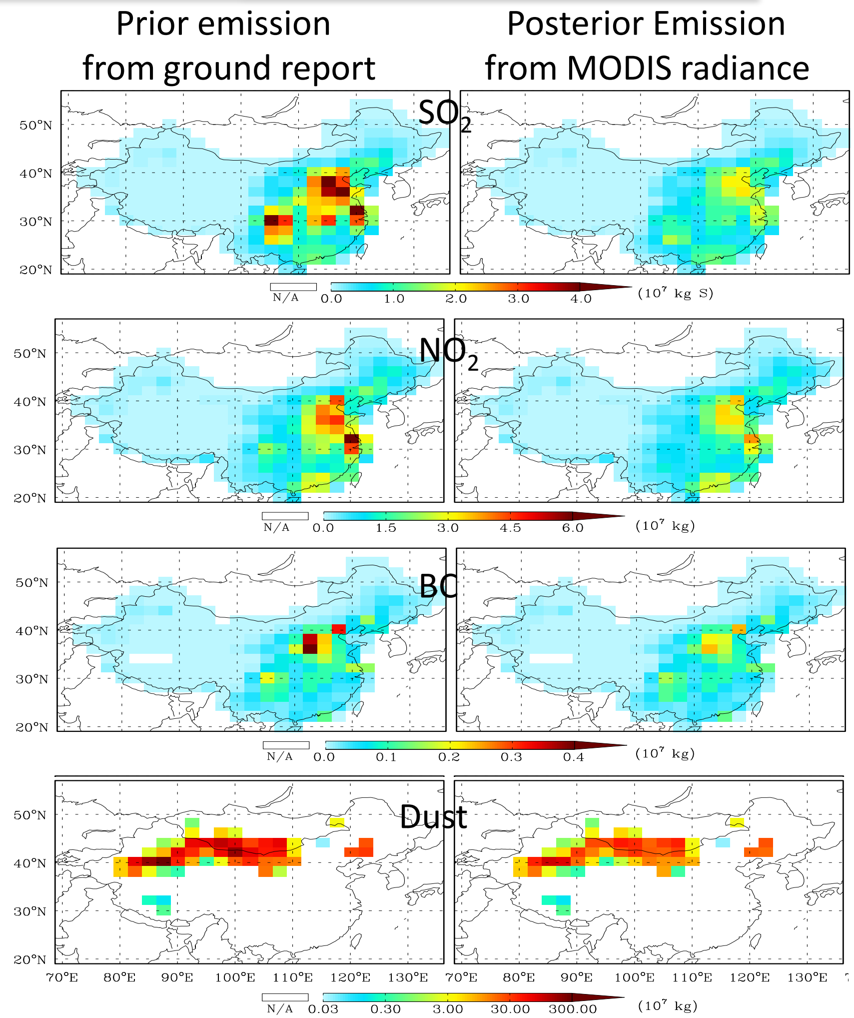
- Visible radiances and aerosol optical depth measured by satellites are generally thought to contain information of aerosol emissions.
- Derivation of aerosol sources from AOD is challenging because AOD, as a parameter, contains little information on aerosol composition, and the relationship between AOD and aerosol sources are non-linear.
- However, advantages of using AOD to constrain aerosol emission are also obvious as AOD is a columnar parameter and thus is a better indicator than surface measurements to reflect the strength of emission.
- We developed, for the first time, a numerical framework that combines GEOS-Chem adjoint technique, linearized radiative transfer model, and multi-sensor data from EOS to invert aerosol emissions from satellite-measured radiance.
- The implication of this work is that we can estimate the aerosol anthropogenic and natural emissions in high temporal (daily to monthly) from the space with a time lag of days to 1 month, which highly contrasts with the current bottom-up approach that often give *annual* estimate of emission with a time lag of 2-3 years.



The prior (ground-based, left column), and posterior (or MODIS-based, right column) aerosol emissions over China for the period of April 2008 for emissions of SO_2, NO2, BC, and dust. Note the prior emission is from the available 2006 inventory. The results show a decrease of emission in China between 2006 and 2008, likely reflecting the efforts of cutting emission for Olympics Games.

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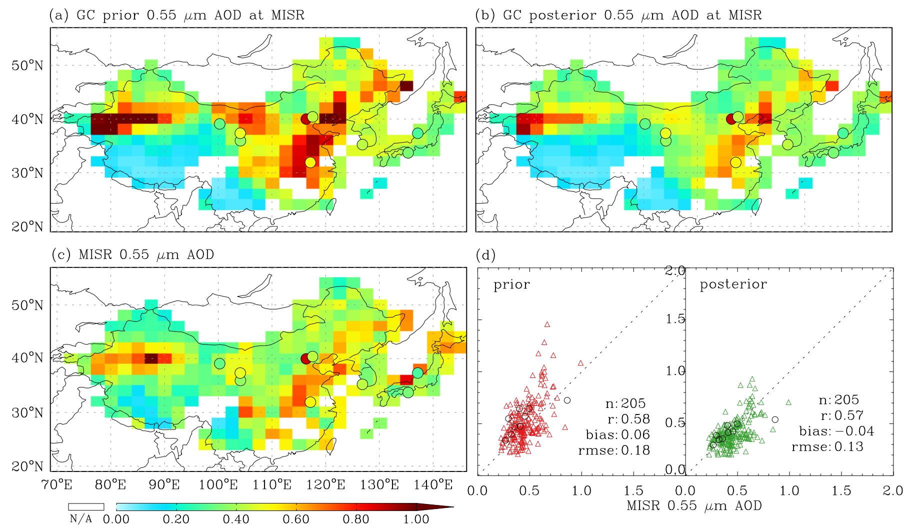
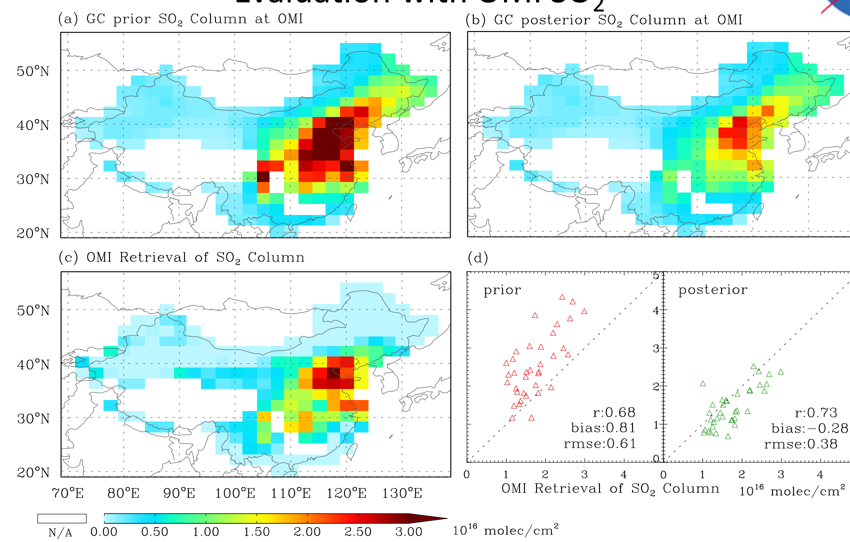
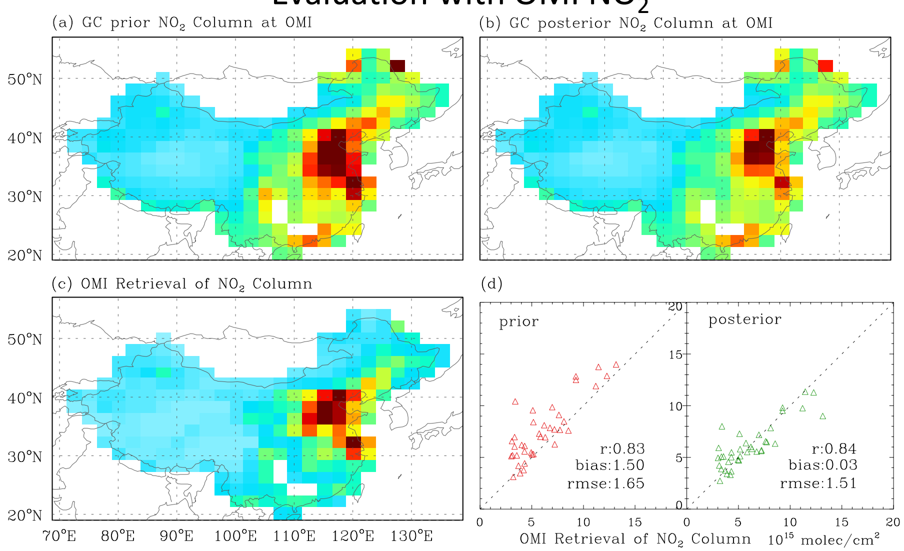
Evaluation with MISR AOD



Evaluation with OMI SO_2



Evaluation with OMI NO_2



Both ground-based (prior) emission and MODIS-based (posterior) aerosol sources are used in the GEOS-Chem model to simulate atmospheric aerosol optical depth (AOD), and columnar amount of SO_2, and NO_2. Independent evaluations with MISR AOD, OMI SO_2 and NO_2 product show that the MODIS-based aerosol sources (posterior) increase the GEOS-chem model performance.

Each subset consists of 4 panels. For each subset, panel (a) and (c) show the GEOS-Chem simulated results with prior and posterior emissions respectively; panel (b) shows independent measurements (e.g., from MISR or OMI); panel (d) show the inter-comparison of measurements with their counterparts simulated by GEOS-Chem using prior (scatter plot with red symbols) and posterior emissions (scatter plot with green symbols).