Variability of AOD over North China during haze and non-haze events based on satellite retrieval and GEOS-Chem model

Libao Chai[1], Yuxuan Wang[1] ,QianQian Zhang[1],Yuanyu Xie[1]

[1]Ministry of Education Key Laboratory for Earth System Modeling, Center for Earth System Science, Institute for Global Change Studies, Tsinghua University, Beijing, 100084, China

1. Introduction

AOD (Aerosol Optical Depth) is an optical indicant of atmosphere and it is concerned with the concentration of particles, the extinction coefficient of aerosols, size distribution of aerosols and the humidity of air, etc.

This study focus on the daily variation of AOD and use both satellite and model to investigate how good model simulates AOD during the haze and non-haze period.

2. Model description and setting

A nested-grid standard simulation of GEOS-Chem model version v9-01-01 over East China domain with horizontal resolution of 0.5 degree latitude x 0.667 degree longitude.

3. Monthly mean AOD comparation between model and satellite

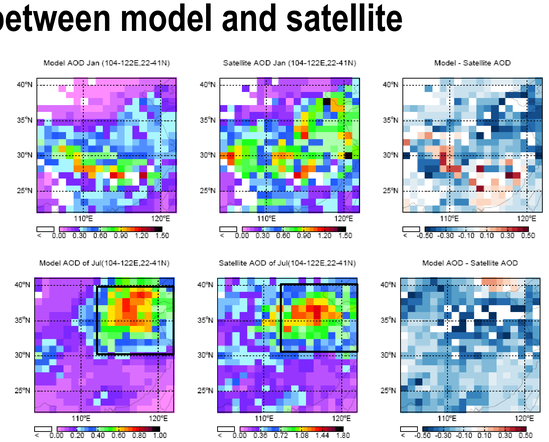

Figure 1: Monthly mean AOD spatial distribution of Model in January(top left) and July(bottom left),2012. Monthly mean AOD of MODIS satellite in January(top middle) and July(bottom middle). Model AOD minus Satellite AOD of Jan(top right) and Jul(bottom right). All of the AOD is in the domain of 104~122E, 22~41N. Notice that the color bar of satellite monthly mean AOD of July is 0~1.8, while model AOD is 0~1.0

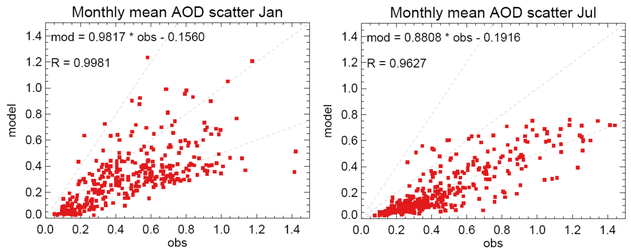

Figure 2: Scatter plots of simulated vesus observed monthly mean AOD over the domain of 104~122E, 22~41N.

The model can well capture high value zone in north China and the spatial distribution of monthly mean AOD. But there is a system under-estimate especially for summer.

4. AOD daily time series of model and satellite of North China

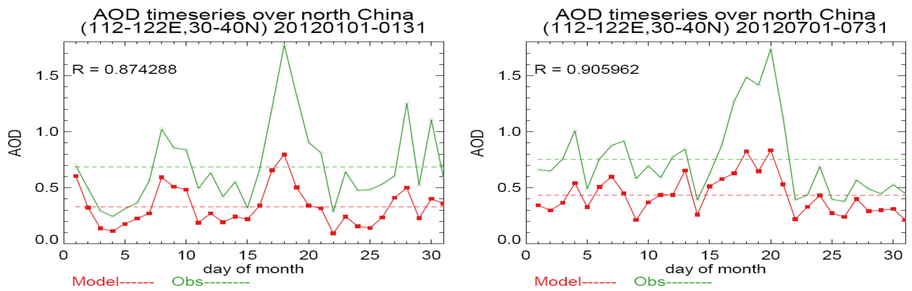

Figure 3: Observed and simulated daily time series over north China domain (112-122E, 30-40N).

- The model can well capture the daily time series of AOD, with a great underestimation over north China.
- The model results are regrided from 0.5degree latitude x 0.667 degree longitude to 1degree x 1degree to fit MODIS L3 data. Because there is not enough MODIS data for each grid to have value, model data is cast off when MODIS data is unknown at a certain grid.

5. Angstrom Exponent comparason

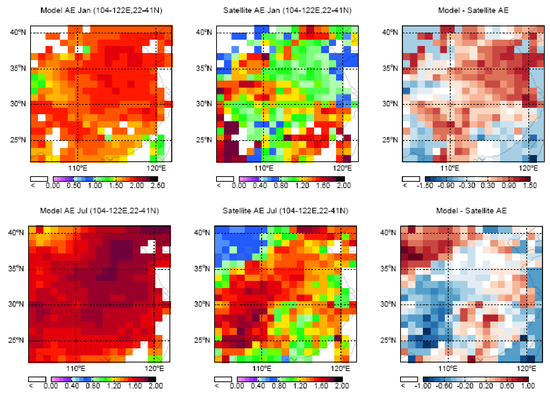

Figure 4: Monthly mean Angstrom Exponent spatial distribution of Model in January(top left) and July(bottom left),2012. Monthly mean Angstrom Exponent of MODIS satellite in January(top middle) and July(bottom middle). Model Angstrom Exponent minus Satellite Angstrom Exponent of Jan(top right) and Jul(bottom right). All of the Angstrom Exponent is in the domain of 104~122E, 22~41N.

- Angstrom exponent is calculated from AOD at 470nm and 660nm.
- High value of angstrom exponent means that the particles tend to be finer, while lower value of angstrom exponent means that the particles tend to be coarser.
- The model has a week capability in reproducing the angstrom exponent both in winter and summer.
- Model angstrom exponent is much larger overall, which means that simulated aerosols are smaller than observed aerosols, although simulated AOD and observed AOD are in good correlation.

5. Haze and non-Haze comparison

- Haze event (Jan 1, Jan 28, Jul 4 and Jul 20) and non-haze event (Jan 4, Jan 25, Jul 2 and Jul 23) are compared.

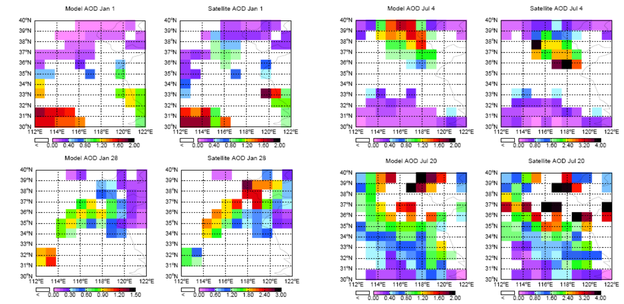

Figure 5: Model and observed AOD during haze period over north China domain (112-122E, 30-40N)

- Model AOD is lower than observed AOD during haze period.
- Model can catch the high value during haze period.

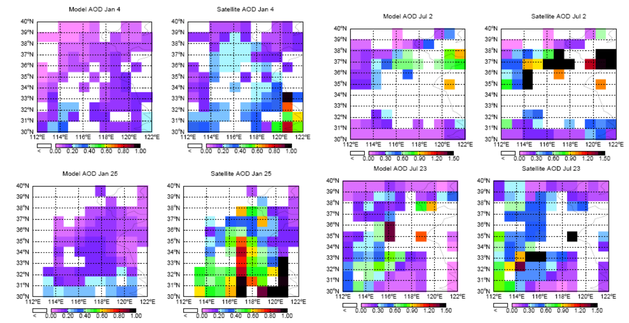

Figure 6: Model and observed AOD during non-haze period over north China domain (112-122E, 30-40N

- Model AOD is much lower than observed AOD during non-haze period.
- Model has a poor performance in reproducing the AOD during non-haze period.

6. Summary

- The model performs well in reproducing the monthly mean spatial distribution of AOD, but doesn't have a good result of angstrom exponent.
- Monthly mean model AOD is systematically lower than observed AOD.
- Model can also capture the daily variation AOD in north China, but the value is much lower than observed AOD.
- Model performs well during haze period, but in non-haze period, model can't simulate the spatial distribution of AOD

References

[1] Aaron et al, EHP, 2010
[2] Drury et al, JGR, 2008

CENTER FOR EARTH SYSTEM SCIENCE
清华大学地球系统科学研究中心