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Using MODIS AQUA Collection 5 data to Constrain GISS ModelE Aerosol Climatology - Preliminary Results

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Abstract

A physically based aerosol climatology is essential to address the questions of global climate changes. The previous comparisons of the GISS ModelE aerosol with satellite and ground-based measurements [Liu et al., 2006] show that the agreement in the distributions of global optical depth between GCM aerosols and satellite data is qualitatively reasonable. However the Angstrom exponent of the GCM aerosol is clearly biased low compared to satellite data, implying that the GCM aerosol sizes are overestimated. Consequently, the aerosol size distributions specified in the latest ModelE aerosol fields provided by Koch [2006, personal communications] are reduced. In this study we compare the newly available MODIS AQUA Collection 5 Level 3 quality assured monthly averaged data available from July 2002 to July 2006 with both the old that we used in Liu et al. [2006] and the new aerosol fields [Koch, 2006, personal communication]. Compared to MODIS AQUA Collection 4 data, the aerosol optical depth distributions are improved, particularly over land. The Angstrom exponent values are significantly smaller both over land and over ocean. We also present in the study preliminary results of the improved GCM aerosol climatology using the MODIS AQUA Collection 5 retrievals as constraints.

Results and Analyses

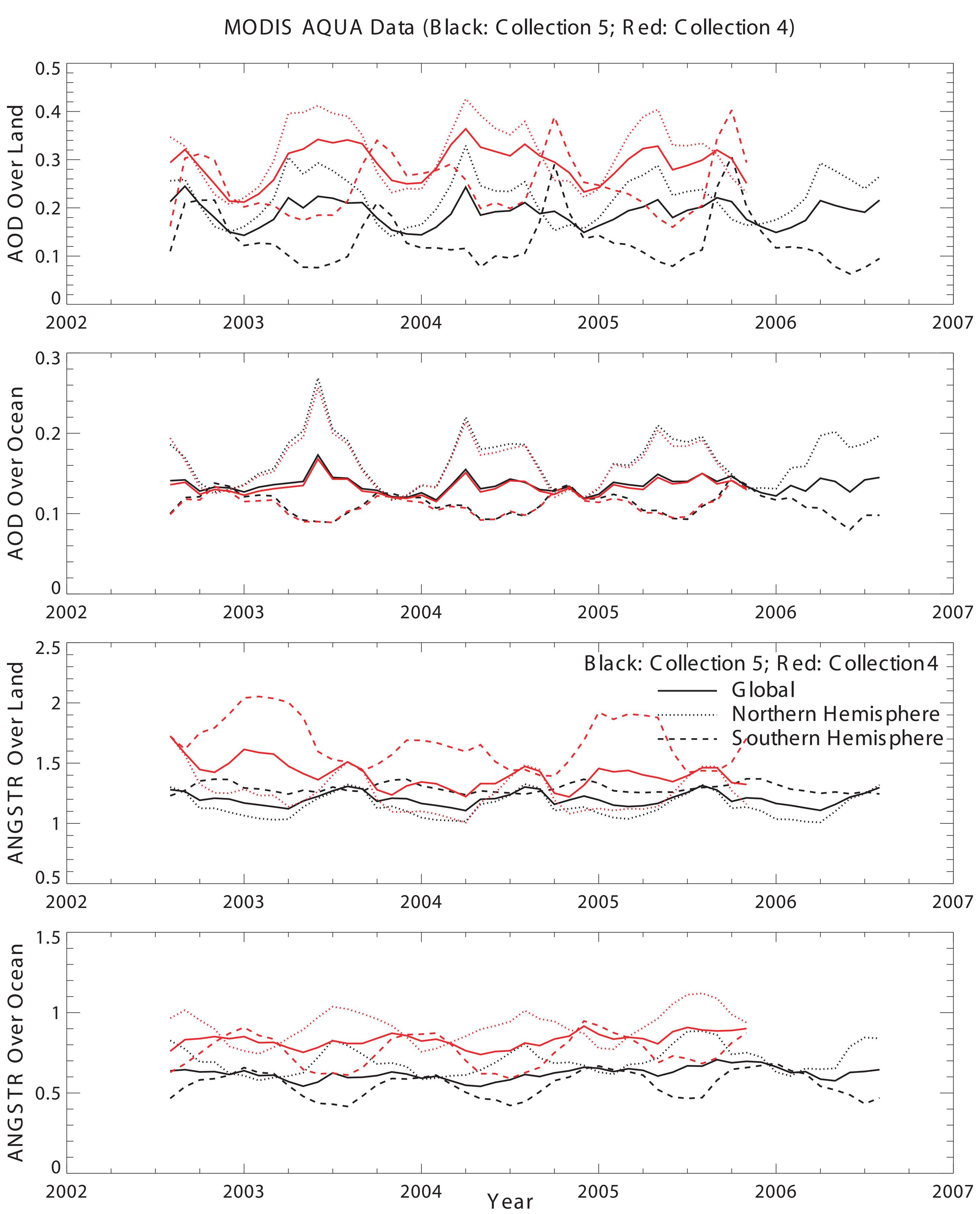

Figure 1. Time series of the global mean values of the aerosol optical depth (top two panels) and Angstrom exponent (bottom two panels) for MODIS AQUA Collection 5 (black curves) and Collection 4 (red curves) data.

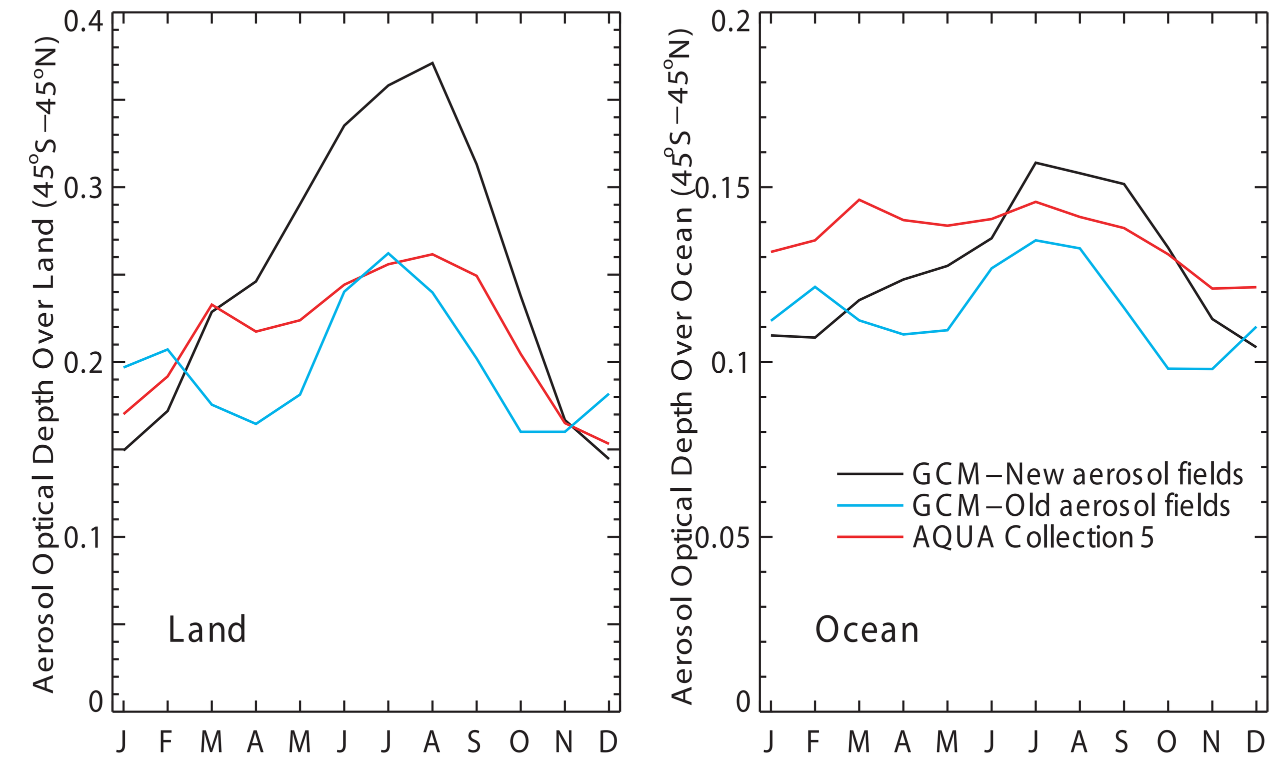

Figure 2. Seasonal dependence of area weighted overall monthly mean aerosol optical depth from different data sources. Data over land (left panel) and over ocean (right panel) have been constrained between the 45 degree south and north latitudinal band.

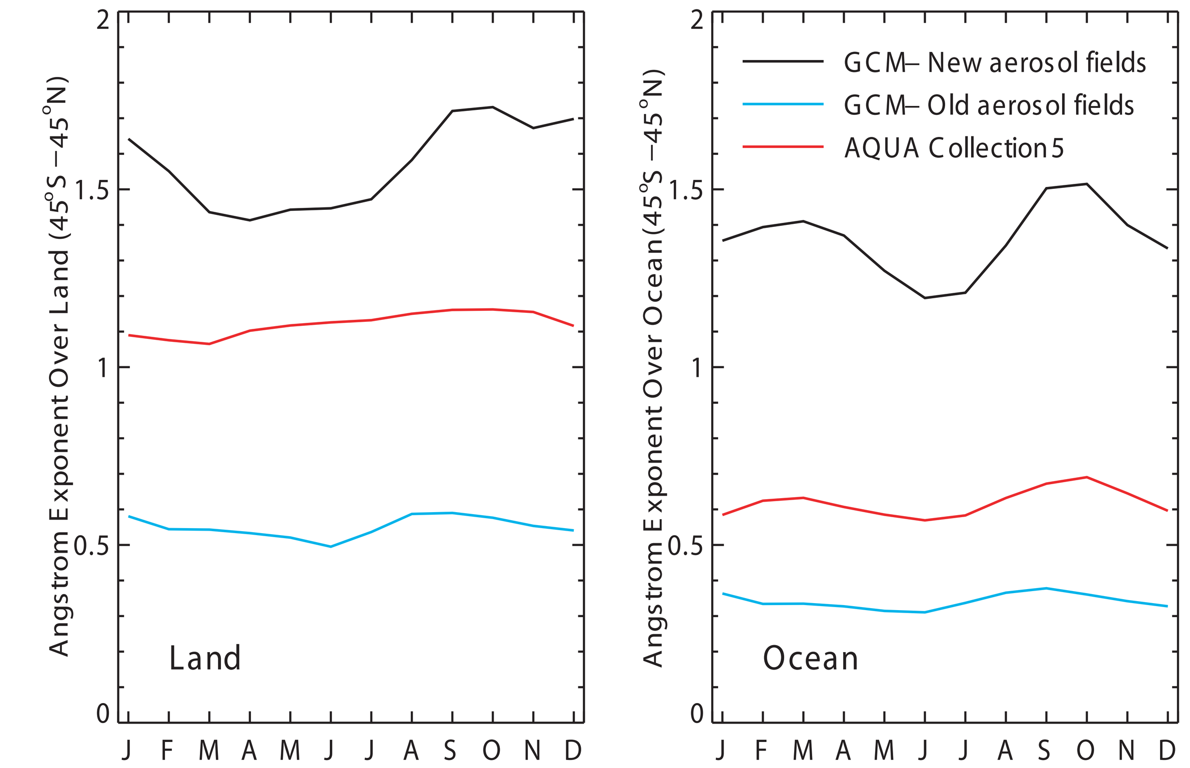

Figure 3. Same as Fig. 2, but the averaged data are for the Angstrom exponent.

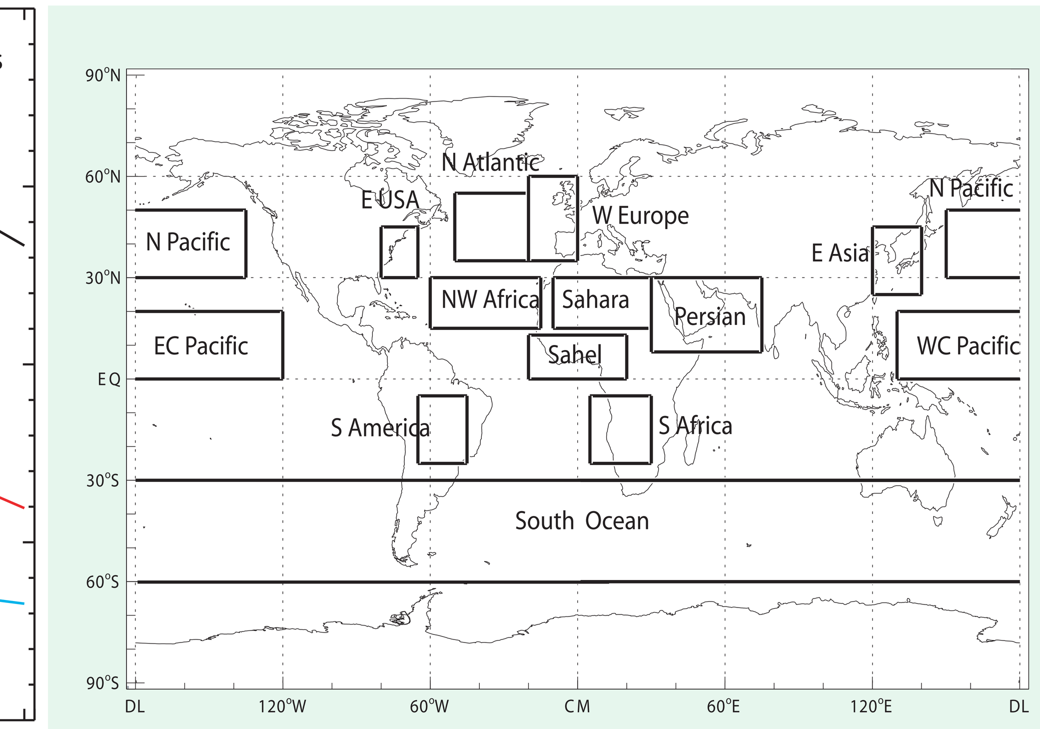

Figure 4. Regions selected for comparison of GCM aerosol climatology with MODIS AQUA data.

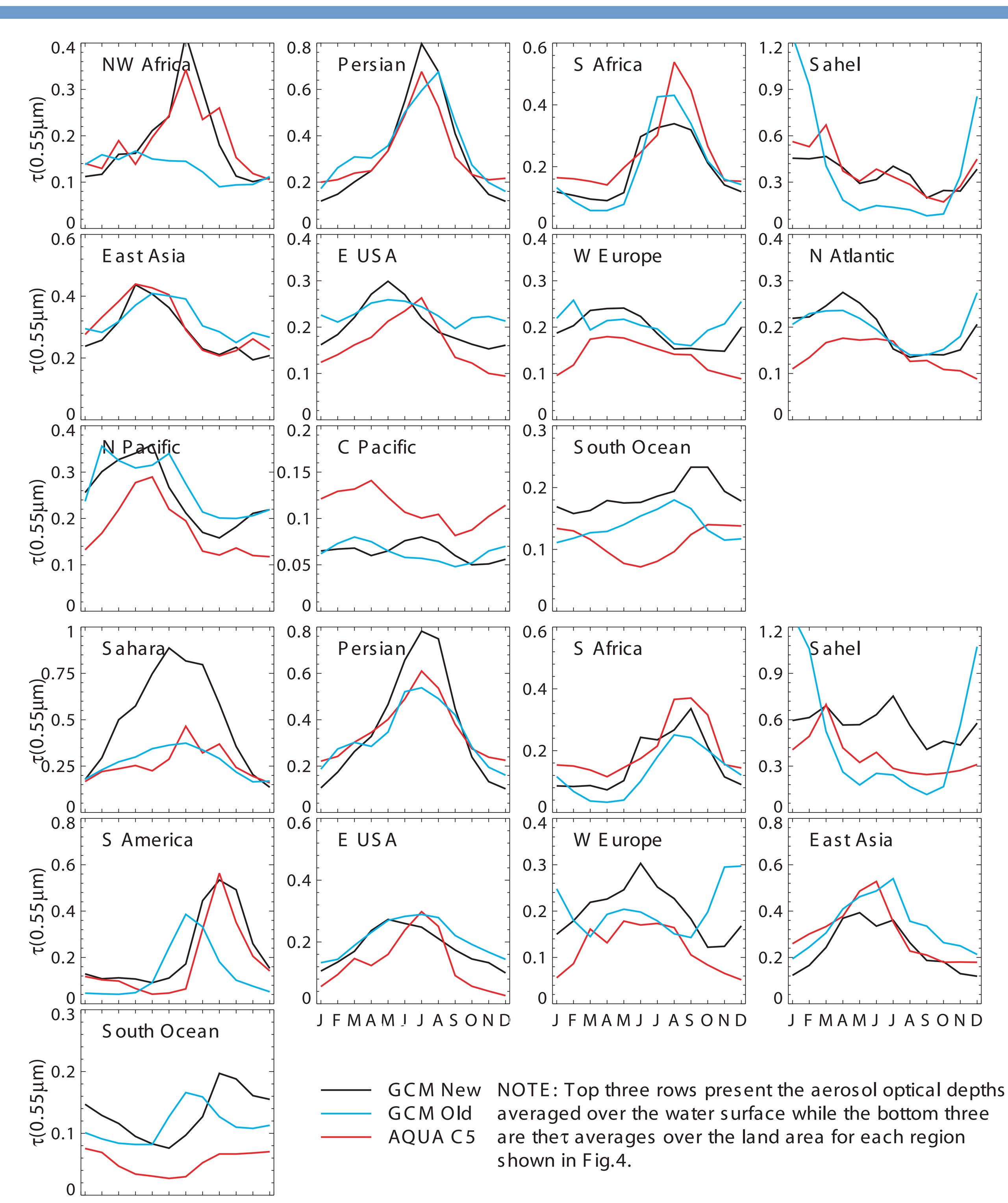

Figure 5. Regional analysis of overall monthly mean aerosol optical depth averaged over the various aerosol regimes shown in Fig.4. Averages are computed over water surfaces (top three rows) and land areas (bottom three rows) if the designated area contains both land and water masses.

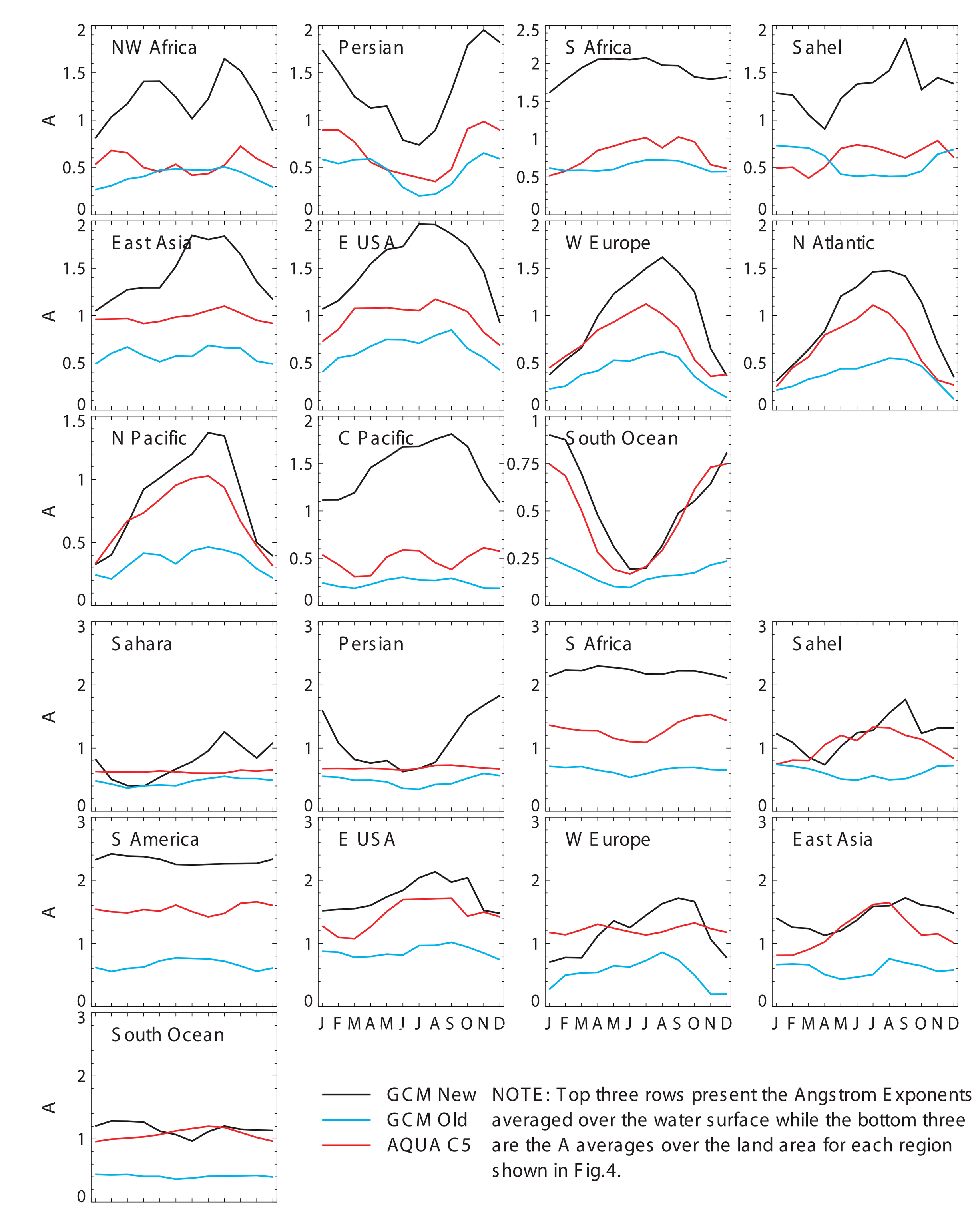

Figure 6. As in Fig. 5, but for seasonal dependence of overall monthly mean Angstrom exponent at different places shown in Fig.4.

Conclusions and Discussions

The GISS ModelE [Schmidt et al., 2006] aerosol optical depth reasonably agree with the newly released MODIS AQUA Collection 005 data, but the Angstrom Exponent is clearly biased low, implying that the aerosol size specified in the GCM are overestimated.

The new aerosol climatology [Koch, 2006] shows some improvements, particularly in terms of the seasonality of aerosol optical depth. But the Angstrom exponent is now too large. Increasing organic carbon size would be appropriate to start with since the bias is greatest in biomass burning regions like South Africa, South America and Sahel.

We present preliminary results of the improved aerosol optical depth distributions using the newly available MODIS AQUA Collection 5 data as constraints.

References

Schmidt, G. A., (2006), Present-day atmospheric simulations using GISS ModelE: comparison to in-situ, satellite, and reanalysis data, J. Climate, 19, 153-192, doi: 10.1175/JCLI3612.1.

Liu, L., A. A. Lacis, B. E. Carlson, M. I. Mishchenko, and B. Cairns (2006), Assessing GISS ModelE aerosol climatology using satellite and ground-based measurements: A comparison study, J. Geophys. Res., in press.

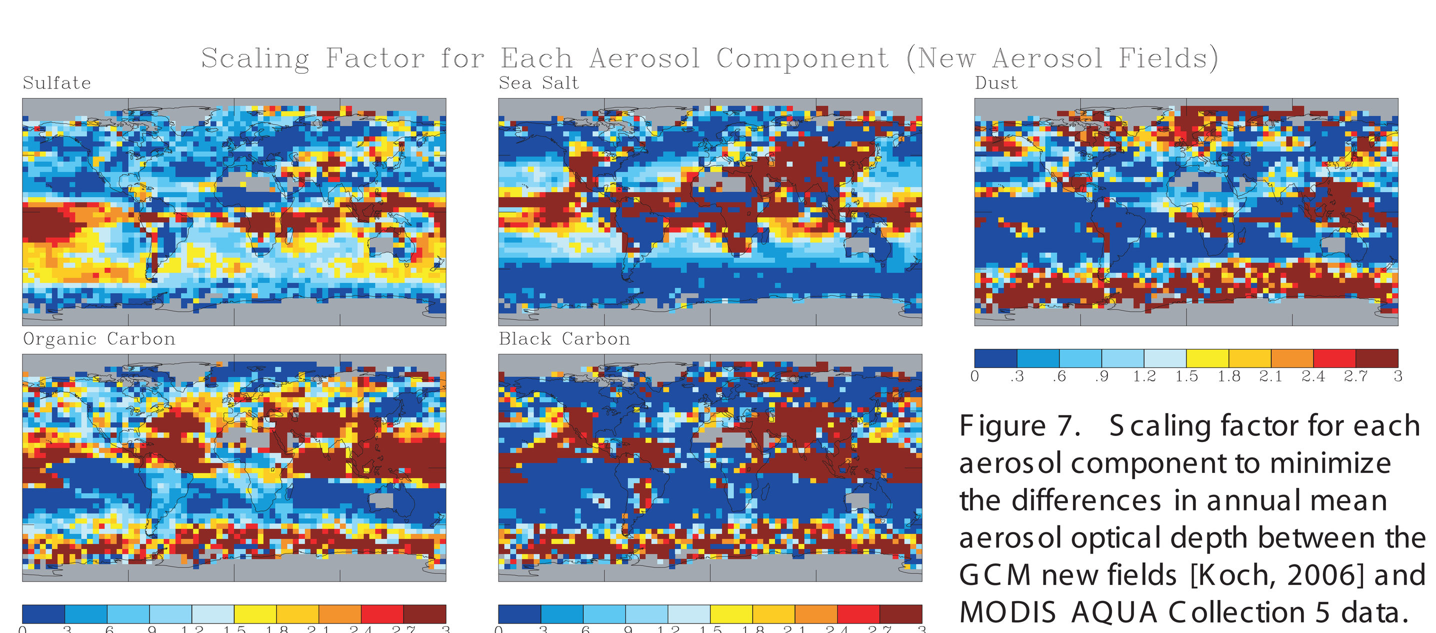

Figure 7. Scaling factor for each aerosol component to minimize the differences in annual mean aerosol optical depth between the GCM new fields [Koch, 2006] and MODIS AQUA Collection 5 data.

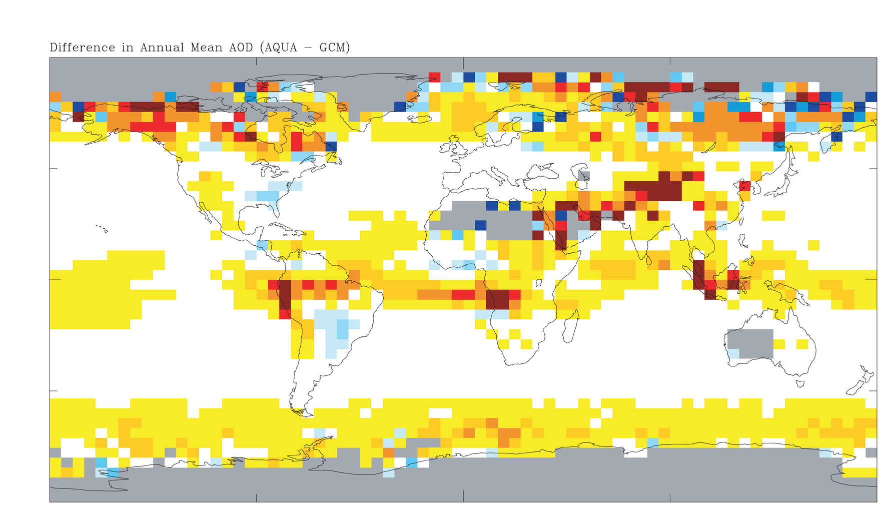

Figure 8. Differences in annual mean aerosol optical depth between MODIS Aqua Collection 5 data and the fitted GCM aerosol distribution. The global area weighted mean is 0.0056.

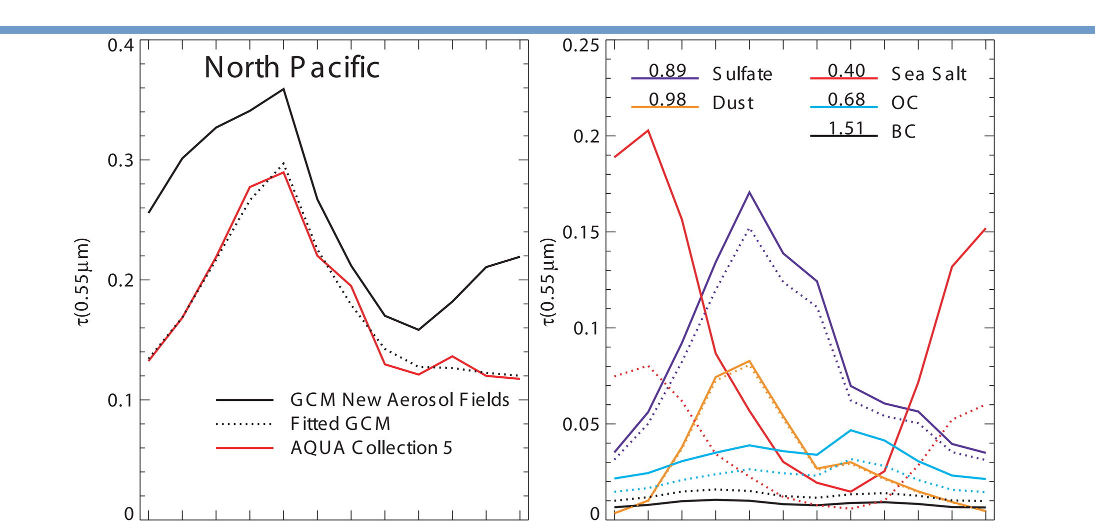

Figure 9. Seasonal dependence of overall monthly mean aerosol optical depth (left panel) and the relative contributions of each principle aerosol component considered in the GCM [Koch, 2006] to the total AOD (right panel) over North Pacific shown in Fig.4. The dotted curves present the relative contributions (times the scaling factors) of each principle aerosol species to the fitted GCM aerosol.