Understanding top-of-atmosphere flux bias in the AeroCom Phase III models: a clear-sky perspective

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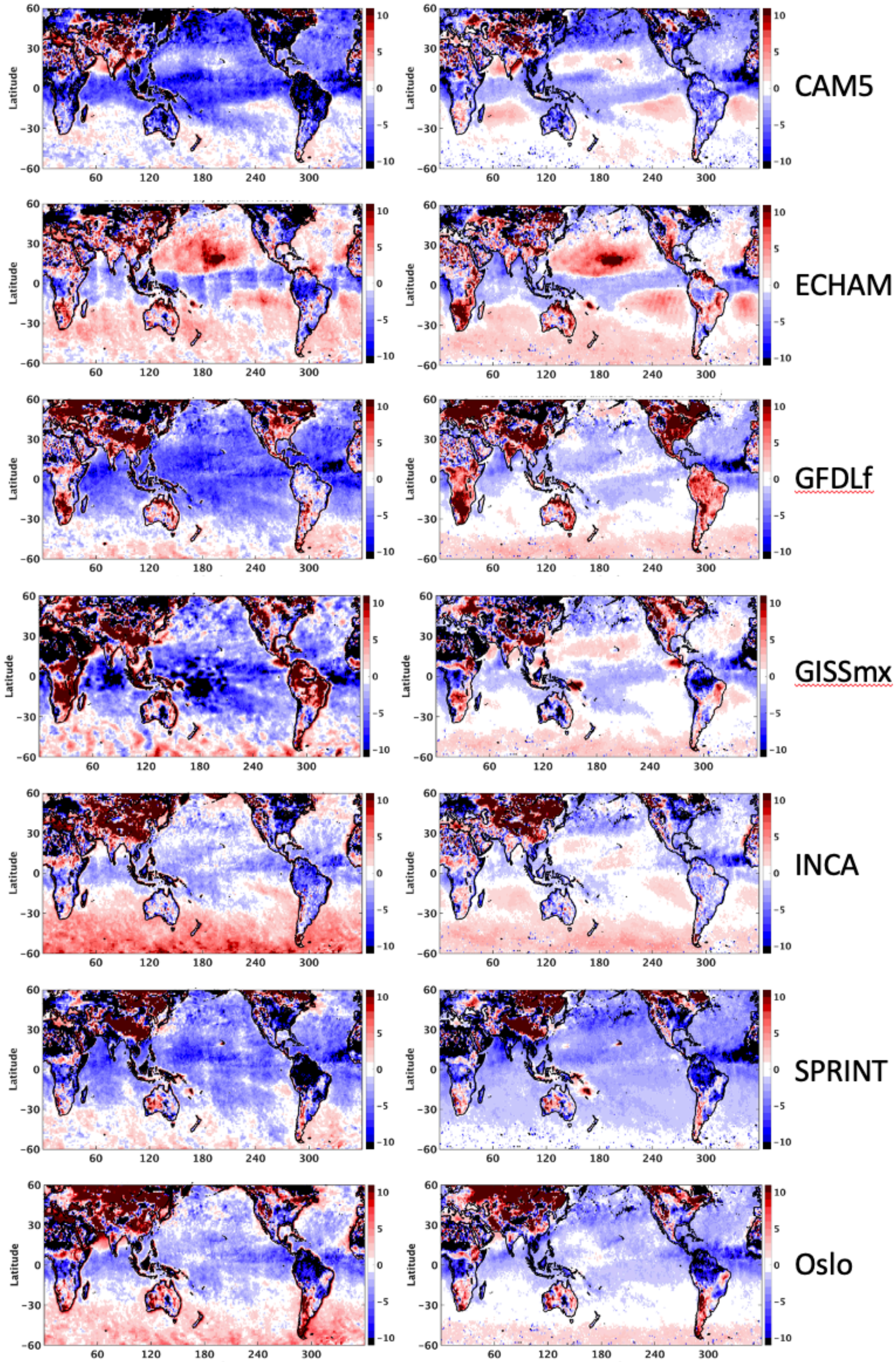
Abstract

Biases in aerosol optical depths (AOD) and land surface albedos in the AeroCom models are manifested in the top-of-atmosphere (TOA) clear-sky reflected shortwave (SW) fluxes. Biases in the SW fluxes from AeroCom models are quantitatively related to biases in AOD and land surface albedo by using their radiative kernels. Over ocean, AOD contributes about 25% to the 60°S-60°N mean SW flux bias for the multi-model mean (MMM) result. Over land, AOD and land surface albedo contribute about 40% and 30%, respectively, to the 60°S-60°N mean SW flux bias for the MMM result. Furthermore, the spatial patterns of the SW flux biases derived from the radiative kernels are very similar to those between models and CERES observation, with the correlation coefficient of 0.6 over ocean and 0.76 over land for MMM using data of 2010. Satellite data used in this evaluation are derived independently from each other, consistencies in their bias patterns when compared with model simulations suggest that these patterns are robust. This highlights the importance of evaluating related variables in a synergistic manner to provide an unambiguous assessment of the models, as results from single parameter assessments are often confounded by measurement uncertainty. We also compare the AOD trend from three models with the observation-based counterpart. These models reproduce all notable trends in AOD (i.e. decreasing trend over eastern United States and increasing trend over India) except the decreasing trend over eastern China and the adjacent oceanic regions due to limitations in the emission dataset.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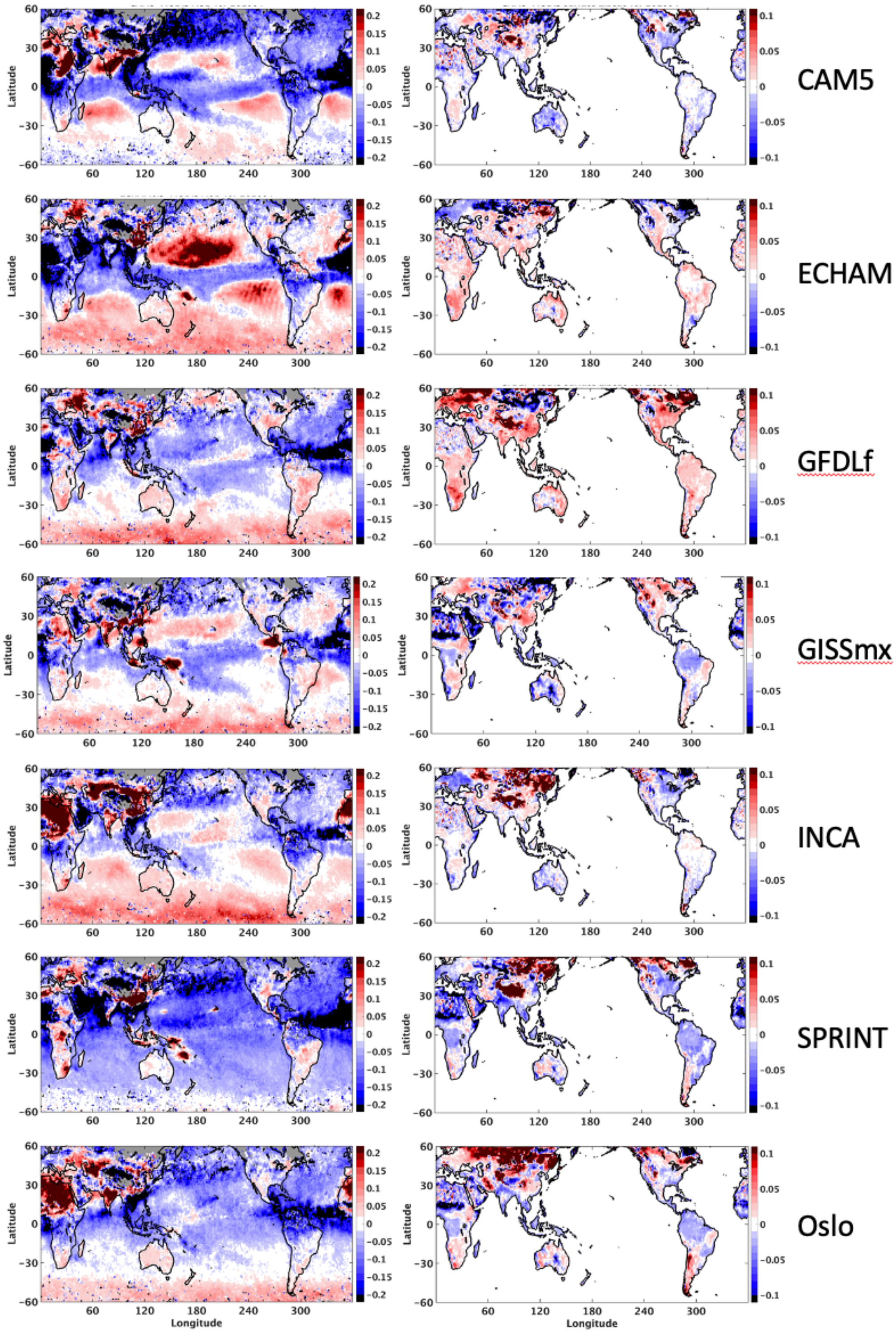
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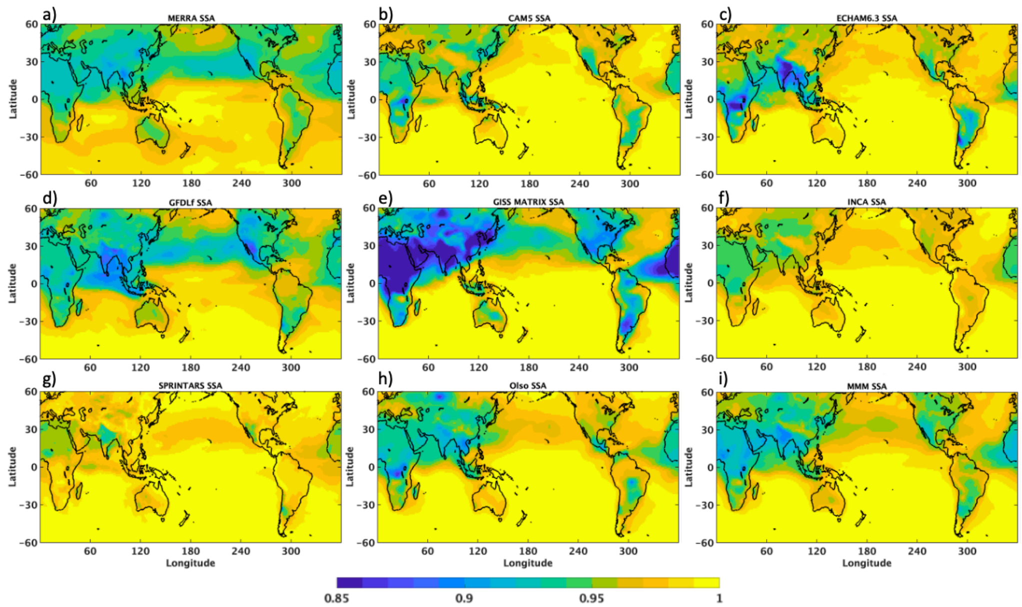
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c) ECHAM6.3 SSA
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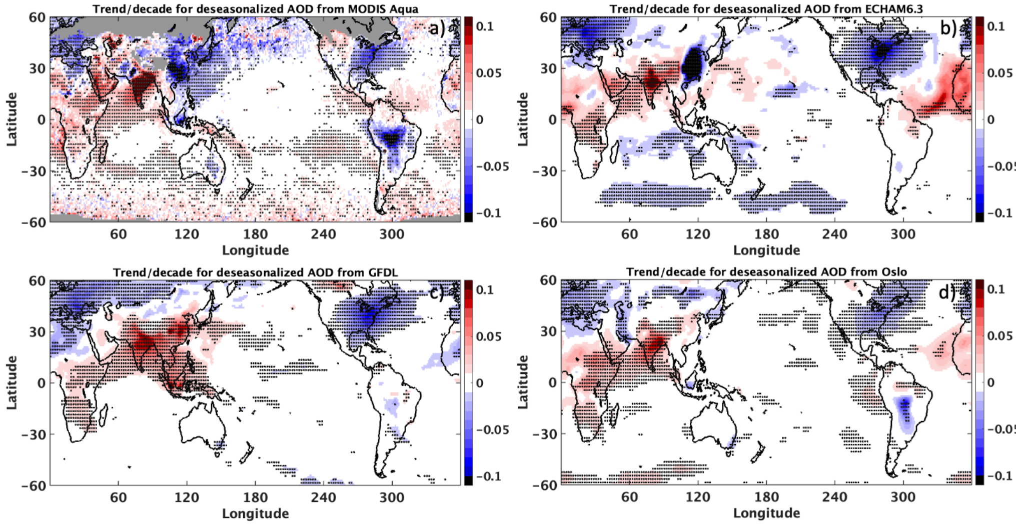

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$$\mathrm{DARE} = F(0;\ \ldots) - F(\mathrm{AOD};\ \ldots) \quad (3)$$

[illegible]

$$\Delta\mathrm{DARE} = \Delta F(0;\ \ldots) - \Delta F(\mathrm{AOD};\ \ldots) \quad (4)$$

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$$\Delta\mathrm{DARE} = \Delta F(\ldots) - \Delta F(\mathrm{AOD};\ \ldots) \quad (5)$$

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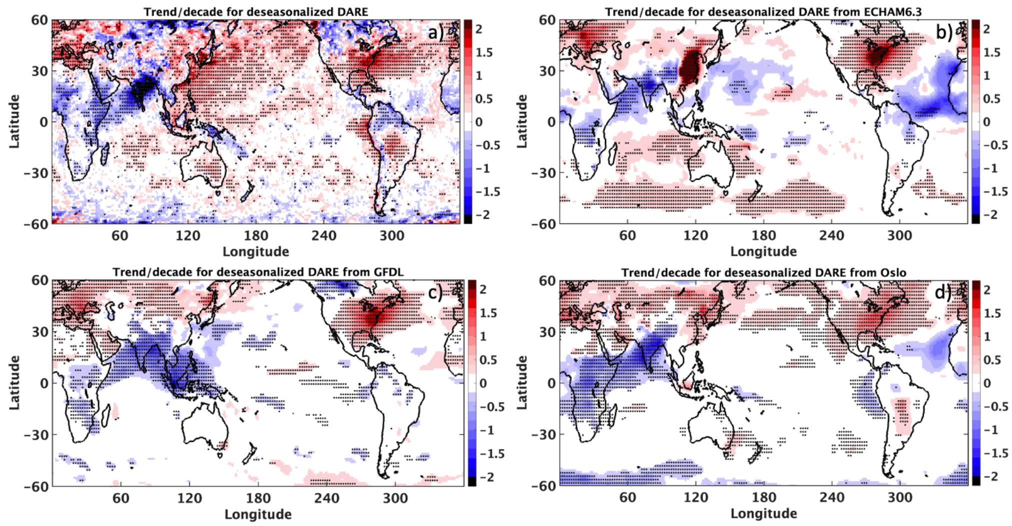

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Figure 13.

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A

[illegible] 1. [illegible]

erences therein. The aerosol optical properties in OsloCTM3 are described in Myhre et al. (2007) with some recent updates, where the BC mass absorption coe cient (MAC) is following the formula in Zanatta et al. (2016) and a weak absorption implemented for OA (Lund et al., 2018).

Appendix B

Figure B1 shows the regional AOD biases of the AeroCom models relative to MISR retrievals (left panels) and the regional SW ux biases due to AOD biases (relative to MISR retrievals) and land surface albedo biases (relative to MODIS retrievals) calculated from their radiative kernels (right panels) for April 2010. Many of the regional AOD bias patterns shown here are very similar to the AOD biases shown in Figure 9. The SW ux biases calculated from the radiative kernels using MISR AODs also resemble those shown in Figure 8. However, the biases over the tropical oceans are much muted when MISR AOD is used. The correlation coe cients between F and F_{AOD} + F range from 0.79 to 0.94 over land, which is very similar to those derived when MODIS AOD is used. The correlation coe cients between F and F_{AOD} range from 0.26 to 0.63 over ocean, not as high as when MODIS AOD is used. The reduced correlation over ocean is partly due to retrieval di erences between MODIS and MISR, but largely due to MISR sampling issue as evident in the stripping features of the AOD bias plots.

Acknowledgments

All AeroCom simulations are available at the Norwegian Meteorological Institute. The CERES EBAF Ed4.1 data were obtained from https://ceres.larc.nasa.gov/data/. MODIS 495 MYD08_M3_0_6_1 550 nm AOD Dark Target+Deep Blue Combined data were obtained from the Giovanni online data system, developed and maintained by the NASA GES DISC. The V6 MODIS Bidirectional Re ectance Distribution Func- tion (BRDF)/albedo products (MCD43C1) were obtained from the Land Processes Distributed Active Archive Center (LP DACC) through https://lpdaac.usgs.gov/products/mcd43c1v006/.

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Figure B1.

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