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Evaluation of a relationship between aerosols and surface downward shortwave flux through an integrative analysis of modeling and observation

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Although aerosols have great impacts on Surface Downward Shortwave Flux (SDSF), the relationship between aerosol loading and SDSF in global models has not yet been adequately investigated. In this study, we attempt to investigate the effects of aerosol optical thickness (AOT) and single scattering albedo (SSA) on SDSF through an integrative analysis of modeling and observation. At first, we compared the results obtained by a global aerosol model, SPRINTARS, with in-situ measurements, AERONET and BSRN. And then we estimated the impacts of AOT and SSA on SDSF through an offline radiative transfer model, Rstar. Through this study, we found that the difference in SDSF between SPRINTARS and BSRN is much larger over heavy aerosol regions than those over regions. Using the Rstar radiative transfer model, we demonstrated that the AOT difference usually has the strongest impact on the SDSF difference and the SSA difference has a moderate impact over heavy aerosol loading regions, whereas the effect of water vapor can be ignored. Finally, we generated a contour plot to demonstrate the relationships between AOT-SSA-SDSF. For example, at low AOT (e.g., 0.15), the 20 Wm-2 changes in SDSF are required to make more than 0.2 changes of SSA, whereas at high AOT (e.g., 0.85), the same changes in SDSF are required to have only 0.05 changes of SSA.