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The role of aerosol absorption in solar dimming over East Asia and its implications for regional climate

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Surface-based observations have identified statistically significant trends in clear-sky surface solar radiation (SSR) over South and East Asia since the 1960s. The trends are generally negative, indicating a reduction in clear-sky SSR or a "dimming." The dimming is strongly driven by aerosol emissions over the region, but little work has been done to quantify the particular aerosol mechanisms that produce the trend or the contribution to the surface values from aerosol absorption within the atmospheric column. The redistribution of shortwave radiation that these aerosol effects imply has the potential to significantly impact regional circulation and precipitation. We conduct experiments over East Asia in two generations of the Geophysical Fluid Dynamics Laboratory's Atmospheric General Circulation Model, AM2.1 and AM3, in order to analyze the characteristics of the SSR trends that the models produce and to understand the particular aerosol mechanisms responsible. AM2.1 and AM3 have significantly different aerosol treatments, including differences in aerosol mixing and interactivity with model meteorology. We use the models' standalone radiation module to analyze how various aerosol characteristics in the two models (such as aerosol mixing state, hygroscopicity, and seasonal distribution) contribute to the trends produced. We find that the two models produce similar trends in clear-sky SSR, comparable to the observed trend, but via significantly different aerosol mechanisms with different regional climate implications. Both models' dimming trends, however, are strongly driven by increased aerosol absorption since 1960. The implications of this redistribution of solar heating between the surface and atmosphere for Asia's regional climate will be discussed.