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An update on brightening and dimming in the United States

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Brightening and dimming of solar irradiance at Earth's surface is a multidecadal phenomenon that occurs globally. Generally, over the past century, there have been two brightening periods (1920s to 1950s, 1980s to the early 2000s) and one dimming period (1950s to mid-1980s). Exceptions are the evolving industrial regions of India and parts of China that have only experienced dimming owing to aerosol effects. The two most recent dimming and brightening periods in Europe were attributed to both aerosol and cloud variability. In the U.S., especially since the 1990s, the systematic variation of cloud cover has been the dominant influence on brightening and dimming.

From 1996 through 2011 downwelling surface solar irradiance over the U.S. increased by $+6.6 \text{ Wm}^{-2}/\text{decade}$ in an environment of decreasing cloud cover and decreasing aerosol optical depth (AOD) [Augustine and Dutton 2013]. Results presented here extend the brightening/dimming trend for the U.S. through 2018 and show that brightening continued for only one more year after 2011. Following 2012, solar irradiance at the surface abruptly retreated to the long-term mean ($\pm 1 \text{ Wm}^{-2}$) and stabilized at that level through 2017. In 2018 there was a slight decrease of solar irradiance at the surface resulting in a slight dimming trend of $-1.7 \text{ Wm}^{-2}/\text{decade}$ from 2013 through 2018. During that period AOD continued to decrease but mean cloud cover increased by about 1%, thus cloud variability continued to be the dominant influence on brightening/dimming in the U.S.

It has been shown that the direct effect of aerosols cannot account for the magnitudes of observed trends of surface solar irradiance over the U.S. [Augustine and Dutton 2013]. Here, we show that the second indirect effect of aerosols is consistent with the magnitudes of cloud and AOD reduction from 1996 through 2011. However, over the latest 6-year period analyzed, trends in cloud cover and AOD are not consistent with the stabilization (or small reduction) of solar irradiance at the surface with respect to both the direct and second indirect effect of aerosols. Therefore, systematic changes in circulation and weather must be considered to explain the observed variability, especially with regard to clouds. In this presentation we present evidence for a mechanism that could possibly have been a major contributor to brightening and dimming in the U.S. and western Europe over the past century.

Augustine, J. A., and E. G. Dutton (2013), Variability of the surface radiation budget over the United States from 1996 through 2011 from high-quality measurements, *J. Geophys. Res.*, 118,

doi:10.1029/2012JD018551.