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Solar Dimming and Brightening: Recent Developments in China

Martin Wild¹, Matthias Schwarz¹, Yawen Wang², Su Yang³, Bart Sweerts¹, Doris Folini¹, and Jörg Trentmann⁴

¹ETH Zurich, Institute for Atmospheric and Climate Science, Zurich, Switzerland (martin.wild@env.ethz.ch)

²School of Atmospheric Sciences, Sun Yat-Sen University, Zhuhai, China

³National Meteorological Information Centre, China Meteorological Administration, Beijing, China

⁴German Weather Service, Offenbach, Germany

There is growing evidence that the amount of solar radiation at the Earth's surface is not stable over time but undergoes substantial multidecadal variations. Particularly, a decrease in surface solar radiation has been noted from the 1950s to the 1980s at widespread observation sites, a phenomenon popularly known as "global (solar) dimming", followed by a partial recovery known as "brightening". An interesting hotspot in this context is China, where surface solar radiation (SSR) underwent particularly large changes over the past decades.

Here we discuss our latest studies, which shed new light on the magnitude, causes and implications of this phenomenon in China. The focus is on recent developments, which indicate, that after decades of decline in surface solar radiation, some recovery can be noted since the mid-2000s in the SSR records observed by the Chinese Meteorological Agency. This recovery is not seen in satellite derived records, which assume a constant aerosol climatology in their retrieval algorithm, suggesting the necessity for a decrease in aerosol to reconcile the diverging trends (Wang et al., 2019). This is independently supported by an analysis of SSR trends specifically in the cloud-free atmosphere, which show a turn into increase since around 2006, also suggesting a reduction of aerosol over China in recent years (Yang et al., 2019).

In a further study, the combination of the Chinese SSR observations with collocated space-based measurements of the net solar exchanges at the Top of Atmosphere from CERES enabled the determination of changes in solar absorption within the atmospheric column as a residual over recent decades. The results suggest that the recent brightening in China is predominately caused by a weakening of the solar absorption within the atmosphere. This indicates that a reduction of particularly the absorbing aerosol must have taken place in recent years (Schwarz et al., 2020).

In summary, all these studies provide independent evidence that air pollution mitigation efforts in China have successfully induced a trend reversal in the amount of solar radiation reaching the Earth's surface, with some recovery in recent years after decades of dimming.

We further estimated that, if such a recovery could persist and air pollution levels could eventually be reduced down to the pristine 1960s levels in China, this would have major benefits for Chinese

photovoltaic (PV) solar power production, which could be enhanced by as much as 13 %. With the PV capacity currently installed in China, and as projected for the year 2030, this would correspond to a yearly economic benefit of 2 and 6 billion US dollars, respectively, assuming current electricity prices (Sweerts et al., 2019).

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