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New aspects on global dimming and brightening

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Surface-based radiation observations suggest that surface solar radiation, after decades of dimming, reversed into a brightening since the mid 1980s at widespread locations. As potential explanation for these variations, both changes in clouds and aerosol from air pollution have been put forward. An analysis of synop and satellite-based cloud data over Europe suggests, that changes in cloud amount cannot explain the distinct reversal from solar dimming to brightening seen over Europe. This further points to anthropogenic air pollution and associated direct/indirect aerosol effect as a key explanation for the dimming to brightening transition.

To investigate the impact of these solar variations on global warming, trends in diurnal temperature ranges over global land surfaces are analyzed. They show, after decades of decline, a distinct tendency to level off since the mid 1980s. This suggests that daytime solar dimming did no longer counteract nighttime thermal warming since the 1980s, thereby no longer diminishing the diurnal temperature range. This implies that global dimming was no longer effective in masking greenhouse warming after the mid 1980s. With the fade of solar dimming, the uncovered greenhouse effect started to reveal its full dimension, as manifested in a rapid temperature rise (+0.38°C/decade over land since mid-1980s). Recent solar brightening cannot supersede the greenhouse effect as main cause of global warming, since land temperatures increased by 0.8°C from 1960 to 2000, even though recent solar brightening did not fully outweigh prior solar dimming within this period.

New GCM modelling studies with sophisticated interactive treatment of aerosol and their emission histories suggest a distinct latitudinal dependence of dimming and brightening. While most of the extratropics show a reversal from dimming to brightening during the 1980s in these model simulations, dimming is simulated to continue up to the present day in many low latitude areas. This is favoured by a transition from

increasing to decreasing sulfur and black carbon emissions in industrialized countries since the 1980s, which are mostly situated in the extratropics. The developing countries, on the other hand, more located in low latitudes, show a continuing increase in aerosol emissions, contributing to the continuing dimming in these areas. There are not enough direct observations in the tropics to strictly verify this latitudinal dependence of solar dimming and brightening. However, the available observations are not in conflict with this hypothesis. Also, the levelling off of the diurnal temperature range in the mid 1980s after decades of decrease is more evident in the extratropics than in the tropics, supporting a more distinct change in surface solar forcing in mid and higher than in low latitudes.

Related references:

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