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20^{th} Century reduction in surface solar irradiance in IPCC climate simulations

A. Romanou (1) and **B. Liepert** (2)

(1) Department of Applied Physics and Mathematics, Columbia University, New York, USA,
(2) Lamont-Doherty Earth Observatory, Columbia University, New York, USA

Local observations of inter-decadal variations in solar irradiance reaching the surface have focused attention on possible anthropogenic causes. Here we present diagnostics from 20th century simulations using nine state-of-the-art coupled ocean-atmosphere models and demonstrate that a long-term reduction in this flux is a robust result: all climate simulations show decreases in global mean downward surface solar radiation between 1 and 4 W/m^2 ("global dimming") concurrent with global mean temperature increases between 0.4 and 0.7 ^{o}C. Sensitivity experiments attribute this 20th century dimming primarily to the increased anthropogenic aerosol direct and cloud-aerosol indirect effects. Global dimming is compensated by reduced upward surface net fluxes (longwave, latent and sensible) since the warmer atmosphere due to GHGs, water vapor, and absorbing aerosols) increase the downward longwave faster than the upward longwave radiation, leading to net heating and positive surface energy imbalance over the 20th century. For the 1984-2000 period individual model simulations agree with overlapping satellite observations when they show similarly timed tropical variability. Hence we conclude, that recently reported brightening in surface solar radiation appear to be predominantly due to variability of the atmosphere-ocean system whereas the 20th century global dimming trends are attributed to anthropogenic forcings.