Further Comment on "A Perspective on Global Warming, Dimming, and Brightening"

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In a recent *Eos* Forum article, *Stanhill* [2007] suggested that there is an unexplained inconsistency between "global dimming" and global warming. This contention is mistaken.

Stanhill's argument is based on select local observations that show reductions in the surface shortwave downwelling radiation (SWD) from the 1950s to the 1980s of about 20 watts per square meter (W/m^2) [*Stanhill and Cohen*, 2005]. Stanhill errs in equating these surface flux changes (the "dimming") with the radiative forcing from anthropogenic greenhouse gases (currently about 2.6 W/m^2). Radiative forcing is defined at the tropopause (not the surface) specifically to provide a good prediction for eventual model responses. Changes in aerosols and clouds result in large changes in SWD, but they do not translate into similarly large changes in tropopause forcing since the aerosols and clouds absorb energy in addition to reflect it.

This is most clearly demonstrated in the Coupled Model Intercomparison Project phase 3 (CMIP3) suite of twentieth-century simulations (http://www-pcmdi.llnl.gov/ipcc/about_ipcc.php) that indicate a global dimming of 1–4 W/m^2 over the entire twentieth century (Figure 1), associated predominantly with aerosol effects [*Romanou et al.*, 2007]. Simultaneously, all CMIP3 simulations show global warming of 0.4°–0.7°C. The combined effect of aerosols and greenhouse gases at the tropopause is dominated by longwave changes, even while the aerosols cause surface dimming.

We also question the representativeness of Stanhill's selected stations for determining a global trend. For instance, a satellite-derived estimate of surface fluxes (International Satellite Cloud Climatology Project [*Zhang et al.*, 2004]) shows a small globally averaged increase in the SWD of 0.04 W/m^2 per year from 1984 to 2000, but there is significant spatial inhomogeneity. Using select station locations gives a much larger trend of 0.5 W/m^2 per year (in agreement with other analyses), but it is not representative of large areas of SWD reductions (namely, the Arctic, South and East Asia, and sub-Saharan Africa).

Understanding anthropogenic climate change depends on multiple lines of evidence and a variety of observations. "Global dimming" is an integral part of that evidence, not a contradiction to it.

References

Romanou, A., B. Liepert, G. A. Schmidt, W. B. Rossow, R. A. Ruedy, and Y. Zhang (2007), 20th-century changes in surface solar irradiance in simulations and observations, *Geophys. Res. Lett.*, *34*, L05713, doi:10.1029/2006GL028356.

Stanhill, G. (2007), A perspective on global warming, dimming, and brightening, *Eos Trans. AGU*, *88*(5), 58.

Stanhill, G., and S. Cohen (2005), Solar radiation changes in the United States during the 20th century: Evidence from sunshine duration measurements, *J. Clim.*, *18*, 1503–1512.

Zhang, Y.-C., W. B. Rossow, A. A. Lacis, V. Oinas, and M. I. Mishchenko (2004), Calculation of radiative fluxes from the surface to top of atmosphere based on ISCCP and other global data sets: Refinements of the radiative transfer model and the input data, *J. Geophys. Res.*, *109*, D19105, doi:10.1029/2003JD004457.

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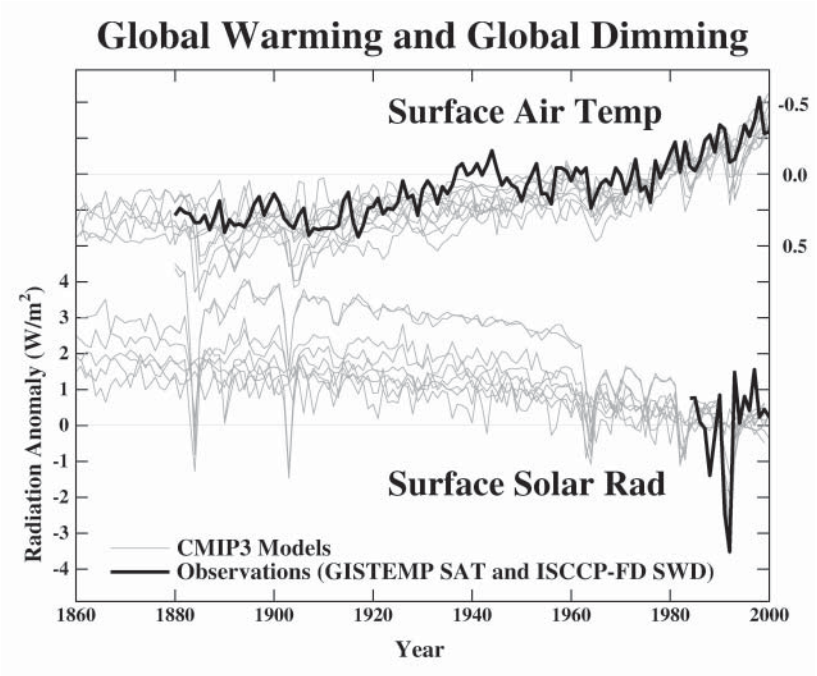

Fig. 1. The global surface air temperature (SAT) and surface shortwave radiation (SWD) anomalies for nine models (ensemble means) and observations. Anomalies are with respect to 1950–1999 for SAT and 1984–1999 for SWD.