



## Is global dimming and brightening limited to urban areas?

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Efforts have been put into place for decades around the world to understand the surface energy budget of the Earth. One of the pillars of such activities is the Global Energy Balance Archive (GEBA) project (Ohmura and Lang 1989), which established a database for the measurements of Surface Solar Radiation (SSR) and other parameters around the world. A major finding from the GEBA project is "global dimming and brightening" (Ohmura and Lang 1989; Wild 2009), which refers originally to the secular trend of SSR on the decadal time scale in Europe that had declined till around 1980s and then has been rising ever since. Secular trends have also been found elsewhere in the world, but the strength and the direction of the trend differ across regions (Ohmura 2009; Skeie et al. 2011; Wild et al. 2005).

As a number of observations are made in or close to urban areas, speculations have arisen that the observed SSR trends may be influenced by local atmospheric pollution (with the direct aerosol effects being predominant (Kvalevåg and Myhre 2007)) and also by enhanced cloud cover over urban areas (Shepherd 2005). Thus, this raises a question: to what extent the observed global dimming and brightening is limited to urban areas. To date, only a few studies address this problem including a statistical study based on population data (Alpert et al. 2005) and model studies inspecting SSR trends (e.g. Dwyer et al. 2010; Skeie et al. 2011). Answers are, however, inconclusive and remain debated.

We investigate whether the observed global dimming and brightening is a large scale phenomenon or limited to urban areas by using the following two complementary approaches:

1) We focus on a set of selected 14 stations in Japan that yield various high quality measurements since 1961 with three of them being least influenced by urbanization (based on expert elicitation). We look into seasonal time-series of SSR, cloud amount, and sunshine duration (Source: Japanese Meteorological Agency) as well as zenith transmittance and maximum transmittance (A. Ohmura, personal communication, 26 February 2012) separately for the pristine (i.e. least influenced by urbanization) and polluted stations.

2) We deal with several hundreds of stations in Europe, Japan, and China compiled by the GEBA project and look into the SSR data since 1960. To infer the temporal development of the urbanization level at each measurement site, we use the following two datasets: i) the high resolution gridded emission data (0.5 degree) provided by the Emissions Database for Global Atmospheric Research (EDGAR) (Source: European Commission, Joint Research Centre / Netherlands Environmental Assessment Agency), and ii) the population data (0.08 degree) obtained from the History Database of the Global Environment (HYDE) (Klein Goldewijk et al. 2010). To these data, we apply a selection of distance weighting functions to account for the spatial extent of urbanization surrounding each site (Folini et al. 2009).

Our preliminary results obtained from these two approaches do not support the claim that the global dimming and brightening is limited to urban areas.

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