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Recent Global Dimming and Brightening and its causes from a satellite perspective

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Solar radiation reaching the Earth's surface is particularly important for life on our planet and plays a major role for the Earth's energy budget and climate. The surface solar radiation (SSR) apart from long-temporal scale variations has been also shown to have undergone decadal variations that are documented on a regional or global scale since the middle of 20th century. After a dimming (decrease) through the 1980s and a subsequent brightening (increase) in the 1990s there are indications of a renewed dimming in the first decade of 2000. Although suggestions have been made, there is still no consensus on the causes of Global Dimming and Brightening (GDB), with clouds and aerosols being suggested as the most important factors,especially as to the GDB global distribution. The rapid progress of satellite observations over the last three decades, ensuring the retrieval of various atmospheric and surface parameters, enables a global view of the phenomenon and the identification of its causes, which are both critical for better understanding GDB and its role for recent climate change.

The present work is a model- and satellite- based study of GDB from 1984 to 2009 on global scale is attempted using a detailed spectral radiation transfer model (RTM) and satellite and NCEP/NCAR reanalysis input data. The model takes into account the physical parameters that drive SSR through scattering and absorption, namely clouds, aerosols, water vapor and other trace gases, as well as surface reflectance. However, due to limitations in the availability, homogeneity, continuity and complete temporal coverage of model input data, the study is performed forthree different cases. In the first case, GDB is computed with the RTM over the period 1984-2009 using temporally varying ISCCP cloud properties and GADS (Global Aerosol Data Set) climatological aerosol properties, namely aerosol optical thickness (AOT), single scattering albedo (SSA) and asymmetry parameter (AP). In the second case, GDB is determined for the sub-period 2000-2009 using the same data as with the first case, whereas in the third case GDB is computed for 2000-2009 but using temporally varying aerosol properties from MODIS. The inter-comparison of GDB from the three case studies aims to shed light on the identification of the possible causes of the phenomenon, attempting to conclude whether or not clouds or aerosols are responsible and to what spatial and temporal extent. In all cases the model fluxes are evaluated through comparisons against reference BSRN (Baseline Surface Radiation Network) data.

Preliminary results for the third case study, i.e. 2001-2009 using MODIS aerosol data, indicate apatchy global picture of GDB, yet with an overall dimming in the Northern Hemisphere (NH) equal to -2.3 W/m̂2, and a stronger dimming of -4.15 W/m̂2 in the Southern Hemisphere (SH), thus suggesting an inter-hemispherical GDB difference. According to our analysis, clouds seem to be the most important cause of dimming in both hemispheres. Specifically, mid-level cloud cover, which increased by 7.4% in NH and 9.5% in SH, and cloud optical thickness for low, middle and high clouds, which increased by 5% in NH and 10-15% in SH depending on cloud type, appear to explain the post-2000 GDB and its inter-hemispherical differences.