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A comprehensive study on the causes of Global Dimming and Brightening using a radiative transfer model and satellite and reanalysis input data

Michael Stamatis[1], Nikolaos Hatzianastassiou[1], Marios Bruno Korras Carraca[1,2], Christos Matsoukas[3], Martin Wild[4], and Ilias Vardavas[5]

[1]University of Ioannina, Department of Physics, Neochoropoulon, Ioannina, Greece (mixstam1453@gmail.com)
[2]Institute for Astronomy, Astrophysics, Space Applications and Remote Sensing, National Observatory of Athens, 11810 Athens, Greece
[3]Department of Environment, University of the Aegean, 81100 Mytilene, Greece
[4]Institute for Atmospheric and Climate Science, ETH Zurich, 8092 Zurich, Switzerland
[5]Department of Physics, University of Crete, 71003 Heraklion, Greece

Global Dimming and Brightening (GDB), which refers to the decrease/increase of incoming total solar radiation at the Earth's surface (or surface solar radiation, SSR) due to natural or anthropogenic composition changes of the Earth's atmosphere, plays an important role in the Earth's climate. According to the literature, the main drivers of the phenomenon are aerosols and clouds, contributing to GDB to different degrees depending on the world region and time period. This study aims, using a detailed spectral radiation transfer model (RTM), to identify and quantify the causes of GDB worldwide on a climatological scale. Specifically, it intends to determine their contribution to GDB as well as their spatio-temporal variability, performing detailed analyses on a monthly basis and a spatial latitude/longitude resolution of 0.5°x0.625°, all over the globe and for the 35-year period 1984-2018. The RTM required input data, such as those for cloud and aerosol optical properties, are taken from a synergy of satellite and reanalysis databases, namely the EUMETSAT's CLARA-A2 and the NASA's ISCCP-H and MERRA-2. Model runs, which are the main/base runs, are performed at the aforementioned spatial and temporal resolution and coverage to accurately calculate solar fluxes and GDB. The contribution of clouds (cloud amount-CA and cloud optical thickness-COT of low, middle, high and total clouds), aerosol optical properties (aerosol optical depth-AOD, single scattering albedo-SSA and asymmetry parameter-AP), water vapor and ozone to GDB during the 35-year period 1984-2018 are calculated through RTM computations in which each parameter is kept 'frozen' at its initial conditions, namely the first year of the study period (namely 1984). Then, the contribution of a parameter P to the overall GDB is estimated from the difference between the GDB of the main RTM run, with all parameters being activated, and the GDB of the run with 'frozen' P parameter. In addition to the overall 35-year investigation, the study is also conducted on a decadal time scale, as well as on global, hemispherical, regional, and land/ocean spatial scales, in order to investigate the contribution of each parameter to GDB in more detail.