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From global dimming to brightening?

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The amount of solar radiation reaching the surface of the earth strongly depends on the composition of the atmosphere. On direct irradiance the presence of clouds and aerosols has even stronger effects than on global irradiance. Long-term irradiance measurements therefore can be a good indicator of changes in the atmosphere. Several studies found a decrease of global irradiance reaching the surface during the last decades, often called "global dimming". Results presented here are time-series of up to 20 years of direct normal irradiance and global horizontal irradiance at the surface derived from satellite data.

Time-series of spectrally integrated direct and global irradiance are calculated with libRadtran (library for Radiative transfer) using the fast two-stream approximation and a 32-band correlated-k parameterization. This approach allows using physical input parameters best describing the actual composition of the atmosphere. The calculated time-series are based as far as possible on observational data, which represents our best knowledge of the true state of the atmosphere. Cloud properties are taken from the International Satellite Cloud Climatology Project (ISCCP) D input data set, which covers the 18-year period from July 1983 to June 2001 with a temporal resolution of 3 hours and a spatial resolution of 280 km by 280 km. Aerosols are based on the results of the Global Aerosol Climatology Project (GACP) merged with the temporally highly variable stratospheric aerosol content caused by volcanic eruptions from an additional data set. Water vapour data is provided by a combination of TOVS and SAGE-II data, ozone from the results of the Total Ozone Mapping Sensor (TOMS).

The results are validated with two years of high resolution Meteosat-derived direct irradiance and extended towards a 20 year times-series for several regions. The presented satellite derived observations also fit well to long-term ground measurements of

direct and global irradiance. In addition, an inter- comparison of the satellite-derived results is made with solar irradiance values supplied by reanalysis data of the ECMWF (European Centre for Medium-Range Weather Forecasts) and the NCEP/NCAR (National Centers for Environmental Prediction / National Center for Atmospheric Research) global atmospheric models.

Results show a very strong year-to-year variability in direct irradiance which can sometimes exceed 20%, whereas yearly averages of global irradiance vary only about 7%. Time-series over 20 years indicate significant and strong increases up to 4 W/mˆ(2) per year in direct irradiance. An exception is observed for Australia, where a decrease in the order of -1 W/mˆ(2) per year is noticed. Compared to direct radiation changes in global radiation are mostly about a factor of five smaller and less significant. When extending the time-series up to 56 years by the reanalysis data, the derived trends loose intensity and significance. Reasons for the observed strong trends are not yet fully understood but mainly seem to be due to changes in cloud occurrence. Other than the "global dimming", which was found mainly for the period 1960-1990, results rather seem to indicate a "brightening" during the past 20 years.