Changes in solar radiation in Estonia during the last half-century

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Solar radiation is the primary energy source for physical processes and phenomena in the atmosphere. Changes in radiative transfer conditions in the atmosphere may lead to changes in weather and in climate. However, long-term changes observed in solar radiation have so far been studied rather poorly.

The aim of present study was to analyse the changes in solar radiation in Estonia during the past half-century. For this purpose the measurement data from Tartu-Tõravere Meteorological Station (58^o16'N, 26^o28'E, 70 m a.s.l.) during the period from 1955 to 2005 have been used. Since the station is situated in a rural area, where remarkable sources of anthropogenic air pollution are missing, the described changes should be treated as typical radiation background in Estonia. Two different periods have become evident in analysed time series. During the first period, from the 1955 to the beginning of the 1990s, statistically significant decrease has been found in records of annual totals of global and direct solar radiation, whereat the absolute values of their decrease were close, 230 and 250 MJm^{-2}, accordingly, during 1955-1992. Such a decrease was most likely caused by the growth of low cloudiness, as well as by the significant decline of the transparency of cloud-free atmosphere observed in Estonia in these years. Increase in atmospheric aerosol burden was characteristic for these years. At the same time, no significant trend in diffuse radiation was found in this period. A transition from decrease to increase in solar radiation has been found in the late 1980s - early 1990s. This reversal can be related to changes in cloudiness and atmospheric transparency. Observed decline in low cloudiness was most likely a result of possible changes in location of air pressure systems and cyclone trajectories. Significant decrease of aerosol content in the atmosphere was caused by more effective clean-air regulations as well as by the decline in the Eastern European economy in the late 1980s. At present the aerosol optical thickness is comparable with its value in Estonia in the 1930s.Unlike solar radiation, no breakpoint was found in the time series of atmospheric long-wave radiation. During the period 1961-2000 it continuously increased, although the increase became restrained at the end of 1990s. This indicates that different factors cause the described changes in solar and infrared radiation.