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Long-Term Changes in Solar Shortwave Irradiance Due to Different Atmospheric Factors According to Measurements and Reconstruction Model in Northern Eurasia †

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Abstract: The temporal variability of solar shortwave radiation (SSR) has been assessed over northern Eurasia (40°–80° N; 10° W–180° E) by using an SSR reconstruction model since the middle of the 20th century. The reconstruction model estimates the year-to-year SSR variability as a sum of variations in SSR due to changes in aerosol, effective cloud amount and cloud optical thickness, which are the most effective factors affecting SSR. The retrievals of year-to-year SSR variations according to different factors were tested against long-term measurements in the Moscow State University Meteorological Observatory from 1968–2016. The reconstructed changes show a good agreement with measurements with determination factor $R^2 = 0.8$. The analysis of SSR trends since 1979 has detected a significant growth of 2.5% per decade, which may be explained by its increase due to the change in cloud amount (+2.4% per decade) and aerosol optical thickness (+0.4% per decade). The trend due to cloud optical thickness was statistically insignificant. Using the SSR reconstruction model, we obtained the long-term SSR variability due to different factors for the territory of northern Eurasia. The increasing SSR trends have been detected on most sites since 1979. The long-term SSR variability over northern Eurasia is effectively explained by changes in cloud amount and, in addition, by changes in aerosol loading over the polluted regions. The retrievals of the SSR variations showed a good agreement with the changes in global radiance measurements from the World Radiation Data Center (WRDC) archive. The work was supported by RFBR grant number 18-05-00700.

Keywords: solar shortwave radiation; trends; cloudiness; aerosols; reconstruction model; northern Eurasia

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Data Availability Statement: This study is supported by multiple datasets, which are openly available. Global radiance measurements from the World Radiation Data Center can be found here: http://wrdc.mgo.rssi.ru/. The cloud amount datasets are available from Integrated Surface Database by NOAA NCEI at https://www.ncdc.noaa.gov/isd. The aerosol optical thickness datasets are openly available from the MODIS Collection 6.1. at 10.5067/MODIS/MOD08_M3.061.