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Multi-annual changes in columnar aerosol optical thickness in Estonia

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Besides cloudiness, atmospheric transparency may remarkably affect radiation conditions on the ground. The time series of the Bouguer atmospheric transparency coefficient, calculated from broadband solar radiation measurements in Tartu (1932-1938) and at the Tartu-Tõravere Meteorological Station (since 1950), shows a continuous increase of atmospheric turbidity up to the middle of the 1980s. During the recent decades the atmosphere has clarified noticeably. These long-term changes are mainly connected to changes in the aerosol content of the atmosphere. Spectral measurements by an automatic Sun photometer began at Tõravere in 2002. In order to estimate spectral aerosol optical thickness at 550 nm (AOT550) from broadband solar radiation measurements retrospectively during a longer period, the method elaborated in Moscow University (Tarasova & Yarkho, 1991) has been used. The correlation between the AOT550, estimated both by the model and by the Sun photometer at Tõravere in 2002-03 (405 cases), was relatively high, R = 0.99. Long-term courses of spectral and broadband aerosol optical thicknesses were similar. Spectral aerosol optical thickness mostly exceeded the respective broadband value. The changes in AOT550 were more rapid in comparison with BAOT. This apparently points to the changes not only in the content, but also in the properties of dominating aerosol in Estonia during 1950-2006. According to the measurements by the Sun photometer, the spectral aerosol optical thickness at 500 nm in 75% of cases did not exceed 0.2 at Tõravere during 2002-2004. Scattering was prevailing in solar radiation extinction. For fine aerosol (0.05-0.6 μm), the scattering of radiation contributed to about 80-90% of extinction in spring and summer months, but about 40-50% in autumn. For coarse aerosol (0.6-15 μm), the role of scattering was about 70 and 50%, accordingly.