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Effect of the October 2003 solar proton event on stratospheric NO₂ over Europe derived from results of NO₂ ground-based measurements

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We analyze data of ground-based spectrometric measurements of the stratospheric column NO₂ contents (SC NO₂) at mid-latitude stations of Zvenigorod (55.7°N, 36.7°E) and Harestua (60.2°N, 10.8°E), and high-latitude stations of Sodankyla (67.4°N, 26.6°E) and Kiruna (67.8°N, 20.4°E). The stations are the part of the Network for the Detection of Atmospheric Composition Change (NDACC), and the data of the measurements are publicly available at the NDACC web site (<http://ndacc.org>). Episodes of a significant increase in the SC NO₂ in late October-early November 2003 were detected over the four stations. The observed NO₂ increase was associated with the transport of stratospheric air from the polar stratosphere region where a significant increase in the NO_x concentration had occurred in the end of October due to the strong solar proton event. The amplitude of the observed SC NO₂ increase at the high-latitude stations was about 80 percent relative to the mean SC NO₂ contents peculiar to the end of October and diminished with decreasing latitude to about 40 percent. The method of NO₂ observations at the Zvenigorod station make it possible retrieving NO₂ vertical profiles. Analysis of the NO₂ vertical profiles corresponding to the day of the largest increase in the column NO₂ content over Zvenigorod station and to days before and after it showed the growth of NO₂ concentration above 30 km related to the air transport from the polar stratosphere. The NO₂ concentration in the upper stratosphere over Zvenigorod in the end of October increased by about 50 percent, and one third of this increase may be related to the effect of the October proton event.