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The interaction of ozone and nitrogen dioxide in the stratosphere of East Antarctica

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At the Russian Antarctic station “Progress” (S69º23′, E76º23′) simultaneous measurements of trace gases using the MARS-B (Multi-Axis Recorder of Spectra) instrument and PION-UV spectro-radiometer for the time period from 05.01.2014 to 28.02.2014 have been performed. Both instruments were located outdoors. The aim of the measurements was to retrieve the vertical distribution of ozone and nitrogen dioxide in the atmosphere and to study their variability during the period of measurements.
The MARS-B instrument, developed at the National Ozone Monitoring Research and Education Centre of the Belarusian State University (NOMREC BSU), successfully passed the procedure of international inter-comparison campaign MAD-CAT 2013 in Mainz, Germany. The instrument is able to record the spectra of scattered sunlight at different elevation angles within a maximum aperture of 1.3º. 12 elevation angles have been used in this study, including the zenith direction. Approximately 7000 spectra per day were registered in the range of 403-486 nm, which were then processed by DOAS technique aiming to retrieve differential slant columns of ozone, nitrogen dioxide and oxygen dimer. Furthermore, total nitrogen dioxide column values have been retrieved employing the Libradtran radiative transfer model.
The PION-UV spectro-radiometer, also developed at NOMREC BSU, is able to record the spectra of scattered sunlight from the hemisphere in the range of 280-430 nm. The registered spectra have been used to retrieve the total ozone column values employing the Stamnes method.
In this study observational data from both instruments is presented and analyzed. Furthermore, by ombining analysis of this data with model simulations it is shown that decreases in nitrogen dioxide content in the upper atmosphere can be associated with increases in total ozone column values and rising of the ozone layer upper boundary. Finally, the time delay between changes in nitrogen dioxide and ozone values is calculated from the observed time series, demonstrating that changes in nitrogen dioxide content cause subsequent changes in the ozone layer. Attempt to explain this phenomenon as influence upper atmosphere on ozone layer is under discussed.