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Atmospheric remote-sensing reference data: Temperature-dependent absorption cross section spectra of ozone in the 235 - 795 nm range obtained with GOME-2 spectrometers

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The GOME-2 instrument is a scanning double spectrometer measuring the extraterrestrial solar irradiance and the up –welling earthshine in nadir viewing geometry. It covers the range from 235 to 795 nm. Using absorption spectroscopy it is to determine total column densities of O_3 and NO_2 and vertical profiles of O_3. Three identical GOME-2 spectrometers were commissioned for the MetOp satellite series to provide long term coverage of 15 years starting with MetOp-A launched in October 2006. Together with the observational data from GOME and SCIAMACHY more than two and a half decades of global O_3 and NO_2 data will be covered providing the basis for long term trend analysis. A pre-requisite to this are high quality absorption cross section spectra for the target gases with a clear need for consistency between all instruments involved.

In this context laboratory cross section spectra for O_3 and NO_2 at temperatures 203K, 223K, 243K, 273K, and 293K were measured on-ground and under representative in-flight conditions with all three GOME-2 flight models (2003, 2004). The instrument's full observational range from 235 to 795nm was covered. The measurements are motivated by the fact that using instrument specific cross section spectra in the analysis of atmospheric observational data automatically corrects effects of the implicitly contained instrument's characteristic function. An accurate knowledge of the instrument's function is not necessary. The measurements were performed with a mo-

bile absorption spectroscopy set-up "CATGAS" (Calibration Apparatus for Trace Gas Absorption Spectroscopy), which had been dedicatedly designed for this purpose. It had been used previously in 1994 and 1998 for the same purpose with the GOME and SCIAMACHY flight instruments, respectively. For the recent GOME-2 measurements of O_3 reported here, between 10 to 20 different combinations of optical path length and O_3 concentrations were used per temperature to cover the range of 7 orders of magnitude, over which the ozone cross section varies within the observational range. A special focus was on the Huggins bands and on simultaneous measurement of the Huggins and Chappuis bands to enable their intercalibration. A least squares based algorithm was developed, which improves the determination of spectra over the full range of cross sections from the experimental data. The algorithm enables the optimal use of available measurement data and at the same time optimises the obtained spectrum in the least squares sense. Based on normalisation to unit integrated absorption of electronic bands the relative temperature dependence of the ozone spectrum was determined and found to be in very good agreement with previous determinations. The spectra were placed on an absolute scale of absorption cross section by scaling to literature data in a least squares approach. Again good agreement with other data was found.

Enabled by the extensive amount of experimental data evidence was found for a continuous background absorption, which occurs dominantly at high concentrations of ozone and which clearly not belongs to O_3. Our observations suggest that it is likely to have its origin in an interaction between O_3 and molecular layers of water on windows and mirrors. This finding could provide further insight to understand discrepancies between different cross section spectra data sets available in literature. The algorithm used for the determination of our cross section spectra corrects the observed effect.

A first application of our cross section spectra to GOME-2 observational data for retrieval of O_3 and of minor trace gases such as glyoxal and formaldehyde will be shown.