On Attenuation of Solar Radiation Within Atmospheric Microwindows of the N_2O Band 1170 cm^{-1} from Winter Ground-Based Measurements

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Introduction

As is known, ground-based measurements of transmittance of solar radiation within the atmospheric window ν = 750 - 1250 cm^{-1} were carried out basically at spectral resolution $\delta\nu \approx 1 \div 10$ cm^{-1} in warm seasons with significant thickness W_z (cm) of precipitated layer of vertical column water vapor. It is difficult to estimate from those measurements the N_2O contribution to absorption of the radiation within spectral microwindows from the band ν = 1120 - 1200 cm^{-1}, because of non-insignificant selective absorption by water vapor at these conditions. In winter conditions, the spectral structure of N_2O absorption band 1170 cm^{-1} from spectral interval ν = 1120 - 1200 cm^{-1} is exhibited quite distinctly. In this work, the results of estimation of N_2O transmission functions are presented for spectral intervals of microwindows from the N_2O absorption band 1170 cm^{-1} at $W_z \leq 0.5$ cm and surface temperatures $t \leq 0^\circ$ C.

Data from Measurements

The initial data are spectra of the solar radiation I_ν, which were registered by spectrophotometer UR-20 in a range ν = 750 - 1250 cm^{-1} with $\delta\nu \approx 5$ cm^{-1} at different air masses M. Measurements of I_ν were done from January 28 through February 27, 1972, and on March 8 and 9, 1999, at Zvenigorod Scientific Station of the Institute of Atmospheric Physics (200 m above sea level). From these data, the transmission function P_{N2O} was estimated within the microwindows from the spectral band ν = 1120 – 1200 cm^{-1} taking into account the water vapor contribution to the absorption of solar radiation at known W_z (A. Kh. Shukurov 1999, K. A. Shukurov et al. 1998). W_z was determined using dependence of change in depth of the minimum of HDO absorption band 2724 cm^{-1} on thickness of precipitated water vapor layer along the beam direction $W = W_z \times M$ (Shukurov and Shukurov 1998). For P_{N2O} estimation, there were used about a hundred spectra I_ν obtained in 1972 (M = 3 - 12) and ten spectra I_ν obtained in 1999 (M = 2 - 4). Temperatures during the measurements changed from -25° C to -5° C, W_z from 0.1 cm to 0.5 cm.

Results

Using the data from these measurements, the transmittance curve $P_{N2O}(M)$ as function of M was obtained for different microwindows at M = 2 - 12. Deviations of distinct P_{N2O} values from the function $P_{N2O}(M)$ are within limits $\Delta P \approx \pm 0.02$. Results of estimation of mean P_{N2O} values for spectral intervals of microwindows with the centers at $\nu \approx 1143, 1158, 1170, 1194$ cm^{-1} and M = 2, 4, …, 12 are presented in Table 1. Note that P_{N2O} ($\nu \approx 1181$ cm^{-1}) ≈ P_{N2O} ($\nu \approx 1158$ cm^{-1}).

Table 1. Transmittance P_{N2O} as functions of air mass M.

N	ν = 1143 cm^{-1}	ν = 1158 cm^{-1}	ν = 1170 cm^{-1}	ν = 1194 cm^{-1}
2	0.97	0.90	0.93	0.95
4	0.95	0.82	0.89	0.92
6	0.93	0.77	0.86	0.90
8	0.91	0.72	0.84	0.88
10	0.89	0.69	0.82	0.86
12	0.88	0.65	0.80	0.84

Summary

Because atmospheric N_2O content is nearly constant, the transmittance values given in Table 1, as well as their dependence on air mass, can be used to account for the N_2O contribution to absorption of solar radiation when studying characteristics of atmospheric window ν = 750 - 1250 cm^{-1}.

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References

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