On Attenuation of Solar Radiation Within Atmospheric Microwindows of the N$_2$O 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 $\nu = 750 - 1250$ 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$_2$O contribution to absorption of the radiation within spectral microwindows from the band $\nu = 1120 - 1200$ cm$^{-1}$, because of non-insignificant selective absorption by water vapor at these conditions. In winter conditions, the spectral structure of N$_2$O absorption band 1170 cm$^{-1}$ from spectral interval $\nu = 1120 - 1200$ cm$^{-1}$ is exhibited quite distinctly. In this work, the results of estimation of N$_2$O transmission functions are presented for spectral intervals of microwindows from the N$_2$O 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 $I_\nu$, which were registered by spectrophotometer UR-20 in a range $\nu = 750 - 1250$ cm$^{-1}$ with $\delta \nu \approx 5$ cm$^{-1}$ at different air masses $M$. Measurements of $I_\nu$ 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 $P_{N_2O}$ was estimated within the microwindows from the spectral band $\nu = 1120 - 1200$ 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 $P_{N_2O}$ estimation, there were used about a hundred spectra $I_\nu$ obtained in 1972 ($M = 3 - 12$) and ten spectra $I_\nu$ obtained in 1999 ($M = 2 - 4$). Temperatures during the measurements changed from -25$^\circ$ C to -5$^\circ$ C, $W_z$ from 0.1 cm to 0.5 cm.
Results

Using the data from these measurements, the transmittance curve $P_{N_2O}(M)$ as function of $M$ was obtained for different microwindows at $M = 2 - 12$. Deviations of distinct $P_{N_2O}$ values from the function $P_{N_2O}(M)$ are within limits $\Delta P \approx \pm 0.02$. Results of estimation of mean $P_{N_2O}$ values for spectral intervals of microwindows with the centers at $\nu \approx 1143, 1158, 1170, 1194$ cm$^{-1}$ and $M = 2, 4, \ldots, 12$ are presented in Table 1. Note that $P_{N_2O}(\nu \approx 1181$ cm$^{-1}) \approx P_{N_2O}(\nu \approx 1158$ cm$^{-1})$.

<table>
<thead>
<tr>
<th>$N$</th>
<th>$\nu = 1143$ cm$^{-1}$</th>
<th>$\nu = 1158$ cm$^{-1}$</th>
<th>$\nu = 1170$ cm$^{-1}$</th>
<th>$\nu = 1194$ cm$^{-1}$</th>
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<td>0.93</td>
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<td>0.88</td>
<td>0.65</td>
<td>0.80</td>
<td>0.84</td>
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</tbody>
</table>

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 $\nu = 750 - 1250$ cm$^{-1}$.

Acknowledgments

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References

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