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0.1 Kinetics of electronically-vibrationlly excited $O_2(a^1\Delta_g$, v) and $O_2(b^1\Sigma_g$, v) in the Earth middle atmosphere. Retrieval of the ozone concentration altitude profile from the intensities of emissions at 1.27 μm and 762 nm.

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The subject of the study is creating a model of kinetics of electronically-vibrationally excited products of the O_3 and O_2 photolysis in the middle atmosphere.

A careful analysis of the latest theoretical and laboratory data revealed insufficiency of the simple scheme of the model of the O_3 and O_2 photolysis which did not take into account vibrational kinetics. That is why the traditional kinetics of electronically excited products of the $O_3$and O_2 photolysis was supplemented by processes of energy exchange between electronically-vibrationally excited metastable molecules of singlet oxygen molecules $O_2(a^1\Delta_g$, v), $O_2(b^1\Sigma_g$, v), atomic oxygen at the first excited level $O(^1D)$ and molecules of oxygen in the ground electronic state $O_2(X^3\Sigma_g$, v). In the framework of the study, the model of electronic-vibrational kinetics of the excited products of the O_3 photolysis in the Hartley-Huggins and Chappuis bands and the O_2 photolysis in the continuum of Schumann-Runge was developed. In the model the all known processes of energy transfer between electronically-vibrationally excited levels of the O_2 molecule in the two singlet electronic states ($a^1\Delta_g$ and $b^1\Sigma_g$) and in the fundamental state ($X^3\Sigma_g$) and also electronically excited state of the atomic oxygen $O(^1D)$ were taken into account. The kinetic balance equations were considered for 45 levels: 3 electronically-vibrationally excited levels $O_2(b^1\Sigma_g$, v$\leq$2), 6 levels $O_2(a^1\Delta_g$,v$\leq$5), 35 levels $O_2(X\,^3\Sigma_g$, v $\leq$35) and level $O(^1D)$. More than 100 reactions were used. The new model gave the opportunity for solution of different problems:

1. The calculation of the altitude profiles of the concentrations of the molecules $O_2(a^1\Delta_g$, v=0-5), $O_2(b^1\Sigma_g$, v=0-2) and $O_2(X\ ^3\Sigma_g$, v =1- 35) in the middle atmosphere for the arbitrary Solar zenith angles.

2. Correspondingly the altitude profiles of volume emission rates in the electronic-vibrational bands $O_2(a^1\Delta_g$, v' $\rightarrow X^3\Sigma_g$, v") at 1.06, 1.27 μm and others, and also in the bands $O_2(b^1\Sigma_g$, v'$\rightarrow X^3\Sigma_g$, v") at 762, 689, 629 nm and others were calculated in the middle atmosphere. The values of the volume emission rate at 1.27 μm and 762 nm calculated in the framework of our model for the conditions of the experiment, where these two emissions were simultaneously observed, coincide very closely with the measured ones.

3. In principle, retrieval of the $[O_3]$ from measured intensities of any abovementioned emission is possible. We discuss the solution of the inverse problem of the $[O_3]$ determination from the simultaneously measured intensities of the 762 nm and 1.27 μm emissions. The retrieved from the both emissions $[O_3]$ altitude profiles correspond to each other.