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Applications of advanced model of O_2 and O_3 photolysis in the mesosphere and lower thermosphere

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In the YM2011 model of excited products of O_3 and O_2 photolysis in the MLT of the Earth the processes of energy transfer among electronically-vibrationally excited singlet levels O_2(b1 SIGMA, v=0–2), O_2(a1Δ, v=0–5), vibrationally excited levels O_2(X3 SIGMA, v=1–35) of the O_2 molecules in the ground electronic state, and also excited atomic oxygen O(1D) were considered. For these excited levels the corresponding system of 45 kinetic balance equations was solved. Besides the O_3 photolysis in Hartley spectral band, we also considered the photolysis in the Chappuis, Huggins, and Wulf spectral bands in the interval of 200−900 nm and the photolysis of O_2 in Schumann–Runge continuum and Lyman-alpha line H atom, as well as resonant absorption of solar radiation in 629, 688 and 762 nm bands by O_2.

Based on YM2011 model we have solved several applied tasks. We proposed and justified the methods of retrieving the atomic oxygen and ozone vertical distributions from the observation of emissions of the excited oxygen molecules and O(1D) atom. In other words, we propose to retrieve the [O(3P)] and [O_3] using the proxies. We have tested 5 excited components, namely O_2(b1 SIGMA, v=0, 1, 2), O_2(a1Δ, v=0) and O(1D) as the proxies of [O_3] and [O(3P)] in the MLT region. The sensitivity study and uncertainty analysis enable us to conclude that the optimal proxies for [O(3P)] retrieval are emissions from O_2(b1 SIGMA, v=2) and O_2(b1 SIGMA, v=0) in the altitude range 90 – 140 km and for [O_3] retrieval – emissions from O_2(b1 SIGMA, v=1) and O_2(a1Δ, v=0) at 50 – 98 km.

YM2011 model enables us to calculate altitude profiles O_2(X3 SIGMA, v) concentrations for different vibrational levels up to v = 35. In particular, the altitude and latitudinal distributions of O_2(X3 SIGMA, v=1) molecules have been used for the accurate calculation of the H_2O(010) state population as it was done for [H_2O] retrievals from the SABER/TIMED satellite broadband measurements in the 6.3 μm H_2O band.