

Estimation of uncertainties of the results of $[O(^3P)]$, $[O_3]$ and $[CO_2]$ retrievals in the mesosphere according to the YM2011 model by two approaches: sensitivity study and Monte Carlo method

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The model of kinetics of excited products of O_3 and O_2 photolysis, YM2011, is designed to calculate of the concentrations of electronical-vibrationally excited components $O_2(b1\Sigma g+, v)$, $O_2(a1\Delta g, v)$, and, also, to retrieve of the $[O(^3P)]$, $[O_3]$ and $[CO_2]$ in the mesosphere and lower thermosphere (MLT) region. In forward problem for all the excited components considered, we have obtained analytical solutions for the stationary equations system. In inverse problem we have obtained several analytical solutions at certain height ranges using emissions from these excited molecules as individual proxy for each of the target component, $[O(^3P)]$, $[O_3]$ and $[CO_2]$.

To estimate the accuracy of solving direct and inverse problems, we have performed a sensitivity analysis of both problems to all the parameters of the YM2011 model: rate constants, quantum yields of reaction products, rates of photodissociation, kinetic temperature, concentrations of atmospheric gases, etc. [1]. To determine the uncertainties of the calculated values of the target functions, we used the sensitivity coefficients and the errors of the parameters, with only experimentally measured values. Alternative investigation of the uncertainties of the target function values, we were carried out by Monte Carlo method, using experimentally measured error values for the standard deviations of each parameter. Both approaches showed close results, although the differences can reach tens of percent in some ranges of heights. The funding of the study was provided by RFBR, grant N 17-05-00532-a.

1. Yankovsky V. A., Martyshenko K. V., Manuilova R. O., Feofilov A. G., "Oxygen dayglow emissions as proxies for atomic oxygen and ozone in the mesosphere and lower thermosphere," Journal of Molecular Spectroscopy, 327, 209-231 doi:10.1016/j.jms.2016. (2016).