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# Model of Daytime Oxygen Emissions in the Mesopause Region and Above: New Results

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Atmospheric emissions of atomic and molecular oxygen have been observed since the middle of the 19th century. In the last decades, it has been shown that emissions of excited oxygen atom $O(^1D)$ and molecular oxygen in electronically-vibrationally excited states $O_2(b^1\Sigma^+_g, v)$ and $O_2(a^1\Delta_g, v)$ are related by a unified photochemical mechanism in the mesosphere and lower thermosphere (MLT). The current study is performed in the framework of the state-of-the-art model of ozone and molecular oxygen photodissociation in the daytime MLT. In particular, the study includes a detailed description of the formation mechanism for excited oxygen components in the daytime MLT and presents the comparison of widely used photochemical models. The study also demonstrates new results such as i) new suggestions about possible products of collisional reactions of electronically-vibrationally excited oxygen molecules with atomic oxygen and ii) new estimates of $O_2(b^1\Sigma^+_g, v = 0 – 10)$ radiative lifetimes which are necessary for solving inverse problems in the lower thermosphere. Moreover, special attention is given to the Barth's mechanism in order to demonstrate that its contribution to $O_2(b^1\Sigma^+_g, v)$ and $O_2(a^1\Delta_g, v)$ populations is neglectable in daytime conditions regardless of fitting coefficients. In addition, possible applications of the daytime oxygen emissions are presented, e.g., the altitude profiles $O(^3P)$, $O_3$ and $CO_2$ can be retrieved by solving inverse photochemical problems where emissions from electronically vibrationally excited states of $O_2$ are used as proxies. The funding of V.Y., R.M. and I.M. was partly provided by the Russian Fund for Basic Research (grant RFBR No. 20-05-00450).