Geophysical Research Abstracts
Vol. 20, EGU2018-8319, 2018
EGU General Assembly 2018

Daytime photochemical equilibrium of OH, HO_2, and O_3 at the altitudes of the mesosphere: Implication for HO_2 retrieval from MLS/Aura data

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The prominent feature of the Earth photochemical systems is a number of chemical components with very short photochemical lifetimes. So one could consider them to be in the instantaneous equilibrium. The balance of sources and sinks of the components is represented by algebraic equations, which have to be correctly extracted from full photochemical model describing processes in the altitude region of interests. One could use it to determine poorly measured atmospheric species utilizing other components' observations, to estimate reaction rates, which are known with a significant uncertainty, and to estimate other atmospheric characteristics.
In this work we consider simultaneous photochemical equilibrium of daytime OH, HO_2, and O_3 at the altitudes of the mesosphere. We derive, basing on the concept of basic dynamical models of atmospheric photochemical systems [1], a simplified algebraic equation that relates local concentrations of these components in the 50-100 km altitude region. The parameters of the equation are air temperature, air concentration, local zenith angle, and reaction's rates. In order to estimate the accuracy of the equation we have performed one-year simulation of the mesosphere and lower thermosphere using a 3D chemical-transport model. The simulation shows that the discrepancy between the calculated evolution of the components and the equilibrium value given by the equation does not exceed 3-4% in the full range of altitudes independent of season or latitude.
We have developed the technique suggested in [2,3] for statistical retrieval of HO_2 distributions from simultaneous satellite measurements of OH, O_3, temperature, and air density. It assumes the above-mentioned equilibrium equation is fulfilled and takes into account satellite measurement error. The work shows first results of the technique application to MLS/Aura data [4] and compares them with HO_2 offline retrieval from the MLS data [5].
This work was supported by the Russian Science Foundation (contract No. 15–17–10024).

1. Feigin A.M., Konovalov I.B., Molkov Y.I. (1998) Toward an understanding of the nonlinear nature of atmospheric photochemistry: Essential dynamic model of the mesospheric photochemical system. J. Geophys. Res., v. 103, p. 25447-25460.
2. M.Yu. Kulikov, A.M. Feigin, G.R. Sonnemann (2009) Retrieval of water vapor profile in the mesosphere from satellite ozone and hydroxyl measurements by the basic dynamic model of mesospheric photochemical system. Atmospheric Chemistry and Physics, v.9, n.21, 8199–8210.
3. Kulikov, M. Yu., Nechaev, A. A., Belikovich, M. V., Ermakova, T. S., and Feigin, A. M. (2017). Technical Note: Evaluation of simultaneous measurements of mesospheric OH, HO_2, and O_3 under photochemical equilibrium assumption: Statistical approach. Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2017-738.
4. https://mls.jpl.nasa.gov/
5. Millán, L., Wang, S., Livesey, N., Kinnison, D., Sagawa, H., and Kasai, Y.: Stratospheric and mesospheric HO_2 observations from the Aura Microwave Limb Sounder, Atmos. Chem. Phys., 15, 2889-2902, 2015.