



## Relaxation of vibrational levels H<sub>2</sub>O (002, 101, 200): effect of new rate constants on the H<sub>2</sub>O vibrational level populations and ro-vibrational spectra in the mesosphere and lower thermosphere

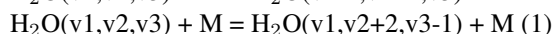
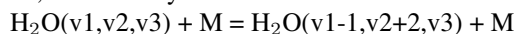
Rada Manuilova (1), Artem Feofilov (2), Alexander Kutepov (3), and Valentine Yankovsky (1)

(1) Saint-Petersburg State University, Atmospheric Physics, Petrodvorets, St. Petersburg, Russian Federation (nansey@yandex.ru, 7(812) 428 72 40), (2) Ecole Polytechnique, Dynamic Meteorology Laboratory, France, (3) The Catholic University of America, Washington, USA

In this work, we investigate the sensitivity of the H<sub>2</sub>O vibrational level populations and ro-vibrational spectra in the mesosphere and lower thermosphere (MLT) to new values of rate constants for the collision-induced transitions from the upper vibrational levels of H<sub>2</sub>O molecule. This study contributes to the development of the H<sub>2</sub>O non-equilibrium radiation model used for water vapor altitude distribution retrieval from the MLT radiation measurements.

Our model accounts for 13 excited vibrational states up to energies 7445 cm<sup>-1</sup> (the upper levels are 002, 101, 200) [Feofilov et al., 2009]. The model takes into account 54 vibrational-translational (V-T) and vibrational-vibrational (V-V) energy exchange processes at collisions of H<sub>2</sub>O with N<sub>2</sub>, O<sub>2</sub> and O. The 32 ro-vibrational transitions forming 1.4, 1.9, 2.7, 3.2, 4.7 and 6.3 μm water vapor radiation bands are considered.

Currently, the rate constants of intermolecular transitions between vibrational levels at collisions with N<sub>2</sub> and O<sub>2</sub> are known only for the transitions (010-000) and (001,100-020). In our model of H<sub>2</sub>O vibrational level kinetics [Feofilov et al., 2009], we assumed that for all collisional transitions, at which the bending mode quantum number, v<sub>2</sub>, increases by 2:



the rate constants are equal to that of the process H<sub>2</sub>O(001, 100) + M = H<sub>2</sub>O(020) + M.

Based on the analysis of currently available experimental and theoretical data, we have updated *k*, the rate constant of transitions (002, 101)→021 and (101, 200)→120, and estimated the effect of a new rate on the H<sub>2</sub>O vibrational levels populations and limb radiation spectra. The "upper limit" of the effect was estimated using the same rate constant *k* for all processes of type (1), excluding process (001, 100)→020.

The H<sub>2</sub>O vibrational levels populations and limb radiation spectra were calculated using the ALI-ARMS non-LTE code [Kutepov et al. 1998; Feofilov and Kutepov, 2012] for characteristic atmospheric conditions and compared with the populations and spectra obtained for "regular" rate constants used in [Feofilov et al., 2009].

### References

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