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Vertical Distribution of Vibrationally Excited Hydroxyl

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Knowledge about the vertical distribution of the vibrationally excited states of hydroxyl (OH*) is important for the interpretation of airglow measurements with respect to dynamical processes in the mesopause region. We derive an approximate analytical expression for the distribution of OH* that highlights the dependence on atomic oxygen and temperature. In addition, we use an advanced numerical model for the formation and relaxation of OH* and investigate the distributions of the different vibrationally exited states of OH*. For the production of OH*, the model includes the reaction of atomic hydrogen with ozone, as well as the reaction of atomic oxygen with hydroperoxy radicals. As loss processes we include 1) deactivation by atomic oxygen, molecular oxygen, and molecular nitrogen, 2) spontaneous emission, and 3) loss due to chemical reaction with atomic oxygen. All these processes take the dependence on the vibrational number into account. The quenching by molecular and atomic oxygen is parameterized by a multi-quantum relaxation scheme. This diagnostic model for OH* has been implemented as part of a chemistry-transport model that is driven by the dynamics simulated with the KMCM (Kühlungsborn Mechanistic general Circulation Model). Numerical results confirm that emission from excited states with higher vibrational number is weaker and emanates from higher altitudes. In addition we find that the OH*-peak altitudes depend significantly on season and latitude. This behavior is mainly controlled by the corresponding variations of atomic oxygen and temperature, as is also confirmed by the aforementioned approximate theory.