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Resonant Vibrational Excitation and STEVE

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The term Strong Thermal Emission Velocity Enhancement (STEVE) refers to a distinct form of continuum optical emission, an east-west oriented ribbon of mauve light in the near-midnight sky at sub-auroral latitudes. The mechanisms underlying the formation of STEVE are presently unresolved. Using laboratory measurements and the published events of STEVE in the literature (e.g., MacDonald et al., 2018; Gallardo-Lacourt et al., 2018), we investigate the resonant vibrational excitation (RVE) of nitrogen (N2) via the 2⊠g resonance by low-energy (1-5 eV) electron impact, and the dependence of its effectiveness on the plasma conditions (density, composition, and temperature) in the E- and lower F-region. Under the prevailing conditions in the region of Sub-Auroral Ion Drift (SAID), the RVE is found to constitute the dominant underlying mechanism for STEVE, in that it rapidly increases the N2 population above the first ten vibrational levels (v > 11), which leads to the subsequent formation of N2O via radiative attachment, and visible continuum emission. We present a kinetic-photochemical model to describe the dynamic evolution of the vibrational distribution of N2 and the resulting chemical reactions. We present simulation results from our model showing the orders-of-magnitude increase in the N2(v>11) population within ⊠10 minutes of substorm expansion onset and the peak brightness of ⊠5-10 kilo-Raleigh (kR) in the E-region (at ⊠135 km altitude). We discuss our model predictions in the context of the statistical characteristics of observed STEVE events.

Keyword-1

Aurora

Keyword-2

Ionosphere

Keyword-3

STEVE

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