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Sprite-induced excited-state reactions studied by means of a coupled ion-neutral chemical model

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As a result of certain chemical reactions, charged-particle precipitation, and sometimes also lightning-induced transient luminous events (TLEs, such as red sprites), many middle-atmospheric constituents, e.g., N₂, N₂⁺, O₂ and O, are partially excited. Their excited states may radiate, be quenched or take part in chemical reactions. The rates of reactions involving one or more components in an excited state can be orders of magnitude different from those of constituents in their ground state.

In this study we incorporate reactions of electronically and vibrationally excited molecular nitrogen and oxygen in the coupled ion-neutral Sodankylä Ion Chemistry (SIC) model, with special emphasis on their role in transient luminous events. Spectroscopical studies of TLEs published in the literature provide excitation rates of the most important states of these major constituents. This allows us to estimate the important in the energy balance of the atmosphere.