N_2 DISSOCIATION IN THE MESOSPHERE DUE TO SECONDARY ELECTRONS DURING A SOLAR PROTON EVENT: THE EFFECT ON ATOMIC NITROGEN AND NITRIC OXIDE

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Solar proton events have an effect on the middle atmospheric odd nitrogen chemistry. During a solar proton event high energy protons enter Earth's middle atmosphere where they ionize ambient gas. Ionization leads to production of atomic nitrogen, and further to production of nitric oxide, through ion chemistry. In addition, ionization processes produce secondary electrons that, if possessing 9.76 eV or more energy, dissociate N_2 providing an additional source of atomic nitrogen.

We have calculated mesospheric N_2 dissociation rate due to secondary electrons during a solar proton event. Further, we have studied the effect on atomic nitrogen and nitric oxide at altitudes between 50 and 90 km. It was found that N_2 is efficiently dissociated in the lower mesosphere by secondary electrons, with rates up to 10^3 cm^{-3} s^{-1} at 50 km. Thus, secondary electrons significantly add to odd nitrogen production. As a result of N_2 dissociation, atomic nitrogen is greatly enhanced in both N(^{4}S) and N(^{2}D) states by 259% and 1220% maximum increases at 50 km, respectively. This further leads to a maximum increase of 16.5% in NO concentration at 61 km via chemical reactions.

In our study a Monte Carlo model was used to calculate the total ionization rate and secondary electrons flux due to precipitating protons. These where then used as input to a detailed ion and neutral chemistry model and a steady-state solution was calculated for two cases: With and without N_2 dissociation due to secondary electrons.