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Sunset transition effects in the D-region ionosphere

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The solar proton event of October, 1989 and especially the sunset of October 23 is examined in this study of negative ion chemistry which combines measurements of nitric oxide, electron density, and cosmic radio noise absorption with ion and neutral chemistry modelling. Model results show that the negative charge transition from electrons to negative ions during the sunset occurs at altitudes below 80 km and is dependent on both ultraviolet and visible solar radiation. The ultraviolet effect is mostly due to rapid changes of atomic oxygen and $O_2(^1\Delta_g)$, while the decrease of NO_3^- photodetachment plays a minor role. The effect driven by visible wavelengths is due to changes in photodissociation of CO_3^- and subsequent electron photodetachment from O^-, and at higher altitudes also due to decrease in photodetachment of O_2^-. The relative sizes of the ultraviolet and visible effects vary with altitude, the visible effects increasing in importance at higher altitudes, and are also controlled by the nitric oxide concentration. These modelling results are in good agreement with EISCAT incoherent scatter radar and Kilpisjärvi riometer measurements.