High-energy protons emitted from the Sun during coronal mass ejections infrequently cause so-called solar proton events (SPEs) in the polar regions (at magnetic latitudes higher than about 60 degrees). Large SPEs, such as the Halloween 2003 storm, can dramatically increase ionisation rates in the middle atmosphere. As a result of subsequent chains of ion chemical reactions, substantial amounts of odd hydrogen (HOx = H + OH + HO2) and odd nitrogen (NOx = N + NO + NO2) species are produced. Increases in HOx and NOx concentrations lead to decrease of ozone (O3) in the mesosphere and upper stratosphere through the well-known catalytic reaction cycles. During the last ten years, observations in polar night regions by satellite instruments have clearly shown that also other minor constituents, such as nitric acid (HNO3), are produced in significant amounts during SPEs. In this paper, we present the complex chemistry scheme of the D region ionosphere and discuss the reaction pathways leading to hydroxyl (OH) and HNO3 production. Further, we give a general description of the Sodankylä Ion and Neutral Chemistry (SIC) model which is a powerful tool especially designed for studies of ionosphere-atmosphere interaction. Finally, we compare the Microwave Limb Sounder (MLS) data with the SIC results and summarise our recent work on the enhancements of OH and HNO3 during the January 2005 and December 2006 SPEs. We point out the importance of polar vortex dynamics in understanding the HNO3 behaviour and discuss the similarities and differences between the observations and the model.