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Precipitating Radiation Belt Electrons and Mesospheric Odd Hydrogen

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The significance of the atmospheric effects related to energetic electron precipitation (EEP) from the radiation belts is not well understood. It is known that EEP causes ionization which leads to, e.g., odd hydrogen production from water vapour. Odd hydrogen catalytically destroys mesospheric ozone which could lead to changes in UV absorption, temperature, and dynamics with possible connections to ground-level climate. However, the assessment of this process and its importance is not straight forward, partly because there are uncertainties related to the current satellite-based electron count rate observations and their usability in atmospheric modelling. Here we use observations of electron count rates (ECR) measured in the radiation belt by the Medium Energy Proton and Electron Detector (MEPED/POES) and hydroxyl (OH) mixing ratios from the Microwave Limb Sounder (MLS/Aura) to show that EEP is significantly affecting mesospheric odd hydrogen at the magnetic latitudes connected to the outer radiation belt. For example, in March 2005 and April 2006, when high ECR are observed, our results indicate that EEP causes factor-of-two OH increases at 71-78 km altitude and can explain 56-87% of OH variability. On a longer term, analysing the whole MLS OH data set extending from 2004 to 2009 (65 months), we find that 35% of the time there is a clear correlation between ECR and OH in the mesosphere. No significant EEP effect is seen in stratospheric OH. In order to understand the usability of ECR observations in atmospheric modelling, we use the 1-D Sodankylä Ion and Neutral Chemistry model to study the connection between ECR, EEP, and OH.