Precipitation of high-energy particles at high latitudes and impact on middle atmosphere

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When trying to understand the role of precipitating high-energy particles in variations of atmospheric properties, we are still facing the fact that accurate measurements throughout the chain from the origin of the particles, their acceleration and interactions in the magnetosphere-ionosphere system down to details of final atmospheric effects are limited. Similarily models mostly cover only specific regions and a consistent holistic model is not available. However, recent individual studies have shown for example evidence of energetic electron precipitation causing statistically significant decrease of upper stratospheric and mesospheric ozone during extended periods of time. Indeed, we need to include energertic electron precipitation as a process in general atmospheric circulation models, if we want to understand our atmosphere as a whole. Here we first review shortly the impact of energetic particles in atmosphere in general, and present the current status of knowledge in chemical variations of atmosphere caused by these particles, including galactic cosmic rays, solar protons and electrons of magnetospheric origin. The effects are both direct and indirect by first generating chemically active minor constituents of the atmosphere, such as odd nitrogen and odd hydrogen, which in turn can affect atmospheric ozone via catalytic reactions either directly in-situ, or after transport in atmosphere to lower altitudes and lower laitudes. Then we discuss recent advance in studying the effects of high-energy electron precipitation in atmosphere. In order to assses the role of precipitating particles in atmospheric variations one needs new measurements which characterize more accurately the energy and flux, as well as spatial and temporal variations of the energetic electron precipitation, both at high and subauroral latitudes, such as given for example by the Japanese ERG satellite mission, so that combined studies using advanced ground-based and satellite measurements together with theoretical modeling would be possible.

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