Excess ionization in mesosphere caused by relativistic electron precipitation

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Interest to understand variations in the relativistic electron population in radiation belts of the Earth has recently increased substantially. Several international projects are directed towards improving modelling of the radiation belts, aiming to address related space weather phenomena. Dedicated satellite missions, such as the Van Allen probes and the Japanese ERG satellite, are both flying and in preparation. In 2013 Dartmouth College with collaborators launched 20 stratospheric balloons to circumpolar flights in Antarctic for detection of relativistic electron precipitation (REP) into the atmosphere, and the group is planning for another set of 20 balloons in 2014. Their measurement is using Bremsstrahlung X-rays generated by REP. Despite of the above mentioned efforts, the chemical effect on neutral atmosphere due to the excess ionization at upper stratospheric and mesospheric altitudes by REP remains poorly quantified. The reason is missing continuous measurement capability in the atmosphere on one hand, and the difficulty of pitch-angle resolved measurements of the precipitating electron population at the equator level by satellites with low inclination.

Incoherent scatter provides a good measurement capability of ionization in the lower ionosphere, although with current radars the time resolution and altitude range demands are not optimally met. We re-analyse in detail one detection of relativistic electron precipitation by the EISCAT VHF radar on 15 September 1994 at 13:10 UT using the Sodankylä Ion Chemistry model, determining the flux and energy of the precipitating electrons. Comparison with recent publications on statistical properties of REP, based on satellite and VLF propagation experiments is then used to estimate the efficiency of both EISCAT VHF and the EISCAT_3D radars in quantifying the role of REP in the middle and upper atmosphere. Based on these estimates recommendations of possible EISCAT_3D experiments is made.

Mesosphere and D-region phenomena – including MST science, meteors, dusty plasma and sudden stratospheric warming.