LONG TERM DETERMINATION OF VARIATIONS IN ENERGETIC ELECTRON PRECIPITATION INTO THE ATMOSPHERE USING AARDDVARK

C. J. Rodger[1], J. J. Neal[1], M. A. Clilverd[2], andT. Raita[3]*

[1] Department of Physics, University of Otago, P.O. Box 56, Dunedin, New Zealand (crodger@physics.otago.ac.nz; neaja608@student.otago.ac.nz)

[2] British Antarctic Survey, Cambridge, United Kingdom (macl@bas.ac.uk)

[3] Sodankylä Geophysical Observatory, University of Oulu, Sodankylä, Finland (tero.raita@sgo.fi)

Abstract

Energetic electron precipitation can be monitored by their affect on the propagation of very low frequency (VLF) radio waves. EEP induced ionization produces changes in received amplitude and phase of the VLF waves as they propagate through the Earth-ionosphere waveguide. The Antarctic-Arctic Radiation-belt Dynamic Deposition VLF Atmospheric Research Konsortia (AARDDVARK) network of receivers (http://www.physics.otago.ac.nz/space/AARDDVARK_homepage.htm) observes VLF radio signals from high-power narrow-band communication transmitters from multiple nations with the goal of understanding and detecting EEP along many different paths. In this presentation we will focus on a near-continuous 8-year database of AARDDVARK ionospheric observations and extract EEP flux magnitudes.

Background Information

Earth is surrounded by regions of magnetospherically trapped high energy particles, known as the inner and outer radiation belts. Complex physical mechanisms of acceleration, transport and loss of electrons, influenced by geomagnetic storms, result in large changes to the flux of relativistic elections within the radiation belts. The loss mechanism for the outer radiation belt electron population results in energetic electron precipitation (EEP) into the atmosphere over $3>L>7$. These electrons can cause significant changes to ionization levels in the upper atmosphere, atmospheric chemistry and ozone concentrations, and potentially couple to climate variability.

Energetic electron precipitation can be monitored by their affect on the propagation of very low frequency (VLF) radio waves. EEP induced ionization produces changes in received amplitude and phase of the VLF waves as they propagate through the Earth-ionosphere waveguide. The Antarctic-Arctic Radiation-belt Dynamic Deposition VLF Atmospheric Research Konsortia (AARDDVARK) [1] network of receivers (http://www.physics.otago.ac.nz/space/AARDDVARK_homepage.htm) observes VLF radio signals from high-power narrow-band communication transmitters from multiple nations with the goal of understanding and detecting EEP along many different paths.

In this study we analyze data from an AARDDVARK receiver in Sodankylä, Finland, and concentrate on the signal from the US transmitter with call sign NAA located in Culter, Maine. We use data from 2004 till the end of 2012 to determine long time period EEP into the atmosphere along this path which spans $3<L<8$, i.e., under where outer radiation belt processes occur. We aim to recheck the quite day curves (QDC) and EEP fluxes produced in [2] with the longer dataset and produce QDC for more MLT sectors. We will use these to estimate the electron fluxes into the atmosphere and attempt to validate these with other measurements of EEP and geomagnetic indices.

With our new AARDDVARK EEP database we will test the link between plasma wave occurrence and EEP fluxes. In particular, we will contrast the occurrence of lower-band chorus (reported by the DEMETER spacecraft) with the EEP flux magnitudes. We will also examine the link between geomagnetic indices and EEP flux magnitudes,

978-1-4673-5225-3/14/$31.00 ©2014 Crown

References

1. Clilverd, M. A., et al. (2009), Remote sensing space weather events: the AARDDVARK network, *Space Weather*, 7, S04001, doi:10.1029/2008SW000412, 2009.

2. Clilverd, M. A., et al. (2010), Ground-based estimates of outer radiation belt energetic electron precipitation fluxes into the atmosphere, *J. Geophys. Res.*, 115, A12304, doi:10.1029/2010JA015638.