TESTING AIMOS IONIZATION RATES IN THE MIDDLE ATMOSPHERE: COMPARISON WITH GROUND BASED RADIO WAVE OBSERVATIONS OF THE IONOSPHERE

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Abstract

There is growing interest in coupling energetic particle precipitation (EPP) into Chemistry-Climate Models. Experimental observations show that EPP from the radiation belts during geomagnetic storms lead to significant ozone decreases in polar latitudes, and couple to polar surface air temperatures. Datasets of satellite-derived EPP-driven ionospheric ionization rates have been created. However, there are reasons to suspect the satellite EPP observations, and the ionization rates need to be tested against experimental reality. In this presentation we will contrast the ionization rates output by one model with experimental observations from ground-based observations, specifically VLF receivers and riometers.

Background Information

Significant progress has been made in the understanding of energetic particle precipitation (EPP) and its effects on the middle and upper atmosphere. Model simulations now include the chemical and energetic forcing from a broad range of energetic particles. One of the approaches for including such particle inputs has been through the output of the Atmospheric Ionization Module OSnabrück (AIMOS) model. AIMOS combines experimental observations from low-Earth orbiting and geostationary orbiting spacecraft with geomagnetic observations to provide 3-D numerical model of atmospheric ionization due to precipitating particles with high spatial resolution. Further details on the AIMOS model are available in the literature [3] and online [4].

Several existing studies have tested the AIMOS outputs to determine their validity. In particular, the AIMOS-determined ionization rates due to protons have been contrasted against neutral chemical changes in the polar regions during solar proton events. Additionally, incoherent scatter radar data indicates AIMOS-determined electron and proton ionization rates above ~100 km are reasonable. In this study we test the AIMOS-determined ionization rates in the mesosphere. We contrast the AIMOS outputs with experimental observations from ground-based observations, specifically VLF receivers and riometers.

Subionospherically propagating very low frequency (VLF) radio waves can be used to monitor electron precipitation through changes in the ionization rate at altitudes of 50-90 km. Here we use observations from 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). In contrast, riometers observe local EEP-produced changes occurring directly above the instrument. In this case the increased ionization number density in the D- and E-regions, due to EEP, results in the absorption of the HF "cosmic noise" passing through the ionosphere. We make use of observations from the IRIS riometer located at Kilpisjarvi, Finland. The AIMOS ionization rates are contrasted against to the VLF and riometers observations following the techniques reported by [2].

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