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Remote Sensing Space Weather Events Through Ionospheric Radio: The AARDDVARK Network

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The Antarctic-Arctic Radiation-belt (Dynamic) Deposition - VLF Atmospheric Research Konsortium (AARDDVARK) provides a network of continuous long-range observations of the lower-ionosphere, principally in the polar regions. The network of sensors detect changes in ionisation levels from ~30-90 km altitude, globally, continuously, and with high time resolution, with the goal of increasing the understanding of energy coupling between the Earth's atmosphere, Sun, and Space. We use the upper atmosphere as a gigantic energetic particle detector to observe and understand changing energy deposition from space weather events. AARDDVARK has contributed to the scientific understanding of a growing list of space weather science topics including solar proton events, solar flares, relativistic electron precipitation, the descent of NOx into the middle atmosphere, substorms, plasmaspheric hiss and EMIC-driven precipitation, CME's, and microbursts. Our recent work has focused strongly on measuring the flux magnitude of energetic electron precipitation from the radiation belts over long time periods. In this talk I will review previous ground based studies our team has undertaken to characterise some space weather impacts on the lower ionosphere. In particular, I will focus on solar protons events and solar flares.

A combination of observations from AARDDVARK and riometers have been used to test our modelling of solar proton event produced ionisation increases in the upper atmosphere and also the way geomagnetic rigidity screens solar protons from accessing mid- and low- geomagnetic latitudes. This is necessary for determining the impact of solar proton events upon the polar ionosphere, communication and navigation systems, and describing the coupling of solar proton events to the neutral chemistry of the polar atmosphere.

Mid-latitude AARDDVARK observations have been used to characterise solar flares, measuring both the solar X-flux and the change in the electron number density in the lower ionosphere. While a mature experimental technique, such observations can still lead to unexpected results. In particular, the subionospheric VLF observations led by Neil Thomson produced one of the few measurements of the great X45 solar flare of 4 November 2003, where the X-ray detectors on the GOES spacecraft saturated. However, the ionospheric D-region will not saturate, allowing a wider dynamic range than existing spaceborne instruments.

キーワード: space weather, solar flares, solar proton events, ionospheric remote sensing
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