Rocket-borne radio beacon experiment for electron density measurements in the ionosphere

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Abstract

In order to investigate the E and F-regions electrodynamics, a series of radar/rocket experiments were conducted in August-September, 2004, at Roi-Namur Is., Kwajalein Atoll (9.4° N, 167.5° E), as part of the NASA EQUIS II campaign. The ultimate object of these efforts was to improve the understanding of the electrodynamics associated with nighttime plasma density gradients near the magnetic equator. The rocket experiments consisted of instrumented payloads that included Langmuir probes and other instruments to measure de absolute plasma density. Separate rockets launched in conjunction with instrumented payloads released TMA trails in the upleg and downleg between roughly 90-250 Km that allowed observation of neutral winds and their velocity shears. These non-instrumented payloads also included a radio beacon experiment that provided an independent measurement of the plasma density and its variations.

Although beacon experiments have been done for a long-time, most of them are satellite-borne, so measurements of the E region and valley type are hard to do because of the mixing with F region heights. A simple technique for obtaining detailed information about the electron density structure along the entire trajectory is to use dual frequency beacons on rocket payloads and one or more receivers on the ground. The phase difference between the two received frequencies provides a measure of the total electron content along the line-of-sight between the receiving site and the vehicle at any given instant.

The focus of this paper is to describe the on-board and ground-based hardware used for the radio beacon experiment during the EQUIS II campaign. The resulting electron density profiles obtained from five TMA-beacon payloads launched during the campaign will also be presented. The rocket-borne radio beacon experiment consisted in adding a dual-frequency beacon transmitter to the available non-instrumented rockets of the campaign, in order to measure absolute density profiles at E region and Valley region heights. A relatively low frequency (around 38 MHz) and a higher frequency (~570 MHz) are used on board the rockets for transmission with an effective output power of 20 W. A ground-based receiver using two digital receivers was installed near the rocket range site at Roi-Namur Is. The radio beacon experiment, as well as the on-board transmitters and the receiving station were designed and developed at the Jicamarca Radio Observatory, in Lima, Peru. It has been called *PERSEUS* for *P*eruvian *E*lectron-densities *R*ocket *S*ounding *E*xperiment for *U*pper-atmosphere *S*tudies.