ROCKET BASED TOMOGRAPHY OF THE E-REGION

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Abstract:

Computerized ionospheric tomography (CIT) usually uses satellite radio beacons flying in low-earth-orbits over a linear array of ground receivers to scan the F-region. As an alternative, rocket borne beacons should be considered for tomographic applications. Ionospheric imaging using radio beacons on sounding rockets has several advantages over satellite-beacon tomography. First, the absolute value of TEC can be determined because the radio beacon signals are tracked (a) from launch, when the beacon is below the ionosphere, (b) through entrance into the ionospheric plasma, where the TEC increases as the rocket penetrates farther into the ionosphere, (c) on the down-leg as the beacon leaves the plasma layer, and (d) after reaching the neutral atmosphere below the ionosphere where the TEC is again zero. Consequently, there are two regions in the rocket flight when the beacon receiver system can be calibrated to determine the absolute TEC. Second, the measured TEC can be differentiated with respect to rocket altitude yield electron density at the rocket. Third, the received signals from sounding rockets are much stronger than those from satellites because of the reduced range and the availability stronger power sources for the short duration of the rocket flight. Finally, if a priori it is determined that the plasma resides in a thin region such as the E-layer; thin-layer tomography can be applied to give high resolution images of the plasma layer using as few as three receivers.
These ideas were tested during the SEEK2 Rocket Campaign in August 2002, when a Dual Band Beacon (DBB) transmitting to Ground Receivers provided unique data on E-Region electron densities. Information from two rocket beacons and four ground receivers yielded multiple samples of E-region horizontal and vertical variations. The radio beacon measurements were made at four sites (Uchinoura, Tarumizu, Tanegashima, Takazaki) in Japan for two rockets (S310-31 and S310-32) launched by the Institute of Space and Aeronautical Science (ISAS). Analysis was completed for four sets of beacon data to provide electron density images of sporadic-E layers. Signals from the two-frequency beacons on the SEEK2 rockets were processed to yield total electron content (TEC) data that was converted into electron density measurements. Wide variations in layer structures were detected. These included horizontal sporadic-E variations, vertical profiles of double, single, and weak layers. The radio beacon measurements were shown to be in agreement with the in situ SEEK2 sensors. The first tomographic image of a sporadic-E layer was produced from the data. The rocket beacon technique was shown to be an excellent tool to study sporadic-E layers because absolute TEC accuracy of 0.01 TEC Units can be easily obtained and, with proper receiver placement, electron density images can be

produced using computerized ionospheric tomography with better than 1 kilometer spatial resolution.