S-520-26号機による電離圏中の電場観測

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Electric field measurement in the ionosphere by S-520-26 sounding rocket

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S-520-26 sounding rocket experiment was carried out at Uchinoura Space Center (USC) in Japan at 5:51 JST on 12 January, 2012. The purpose of this experiment is the investigation of the bonding process between the atmospheres and the plasma in the thermosphere. S-520-26 sounding rocket reached to an altitude of about 300 km 278 seconds after a launch. The S-520-26 payload was equipped with a two set of orthogonal double probes to measure both DC and AC less than 200 Hz electric fields in the spin plane of the payload by using the double probe method. One of the probes is the inflatable tube structure antenna, called the ITA, with a length of 5 m (tip-to-tip). And ITA is very lightweight (12.5g per one boom). The ITA was the first successful use of an inflatable structure as a flight antenna. It extended and worked without any problems. Another one is the ribbon antenna with a length of 2 m (tip-to-tip). The electrodes of two double probe antennas were used to gather the potentials which were detected with high impedance pre-amplifiers using the floating (unbiased) double probe technique. The potential differences on the two main orthogonal axes were digitized on-board using 16-bit analog-digital converters, sampled at 800 samples/sec with low pass filters at cut-off frequency of 200 Hz.

As these measured electric fields are in the spacecraft frame, the large sine waves result from the payload rotation at the spin period. The largest contribution to the electric field measurements by double probes moving through the ionosphere at mid-latitudes is that due to the $\boldsymbol{v} \times \boldsymbol{B}$ fields created by their motion across the ambient magnetic field, where $\boldsymbol{v}$ is the rocket velocity in the Earth-fixed reference frame and $\boldsymbol{B}$ is the ambient magnetic field. The sum of the squares of the two components represents the magnitude of the DC electric field in the spin plane of the payload. These data reveal abrupt, large-scale variations which can immediately be attributed to changes in the geophysical electric field since the $\boldsymbol{v} \times \boldsymbol{B}$ fields are slowly varying. The sum of the squares data also reveals contributions at the spin frequency and its harmonics. These contributions result primarily from distortions of the waveforms in the raw data.

In this paper, we discuss the results of DC and AC less than 200 Hz electric fields in the ionosphere.