RADIO-FREQUENCY EXPERIMENTS WITH THE ENHANCED POLAR OUTFLOW PROBE SATELLITE PAYLOAD USING ITS RRI, GAP AND CERTO INSTRUMENTS

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ABSTRACT

The enhanced Polar Outflow Probe (e-POP) payload, to be launched in late 2007 on the Canadian CASSIOPE small satellite into a 325x1500-km orbit at 80° inclination, will include three radio instruments. RRI is a broadband digital ULF-HF receiver fed by four 3-m monopoles, measuring spontaneous waves and ground transmissions. Comprising five GPS receivers, GAP will be used in L1-L2 occultations for total-electron-content determination. CERTO will transmit CW simultaneously at 150, 400 and 1067 MHz to ground. Tomographic analysis of both GAP and CERTO data will permit reconstruction of ionospheric density distributions and support studies of ionospheric dynamics.

TEXT

The enhanced Polar Outflow Probe (e-POP) is a scientific payload to be launched in late 2007 on the Canadian CASSIOPE small satellite into a low-altitude, elliptical polar orbit with 80° inclination, 325 km perigee, and 1500 km apogee. The e-POP program comprises three interconnected components: the CASSIOPE component to investigate atmospheric and plasma flows and related wave-particle interaction processes in the topside ionosphere, coordinated ground-based observations and a theoretical assimilation component. The scientific objectives of e-POP are to quantify the micro-scale characteristics of plasma outflow and related micro- and meso-scale plasma processes in the polar ionosphere, explore the occurrence morphology of neutral escape in the upper atmosphere, and study the effects of auroral currents on plasma outflow and those of plasma microstructures on radio propagation. The e-POP science payload is a suite of 8 science instruments. These include three imaging plasma and neutral particle sensors, magnetometers, CCD cameras and three radio instruments. The imaging sensors will measure particle distributions and the magnetometers field-aligned currents on a time scale of 10 ms and a spatial scale of ~100 m. The CCD cameras will perform auroral imaging on a time scale of 100 ms.

This presentation focuses on the three e-POP radio instruments: the Radio Receiver Instrument (RRI), the dual-frequency GPS receiver system for Attitude, position and Profiling (GAP), and the beacon transmitter for Coherent Electromagnetic Radiation Tomography (CERTO). The RRI is a four-channel digital ULF-HF receiver fed by four 3-m monopoles. From 10 Hz to about 3 MHz, the RRI will measure the electric fields of spontaneous waves. Between about 1 kHz and 18 MHz, the receiver will measure the electric fields of waves created by ground transmitters, such as ionosondes, HF radars and ionospheric heaters. Scientific objectives relating to spontaneous radio emissions created by auroral processes, nonlinear plasma physics of the HF-modified ionosphere and imaging with signals from ground transmitters will be addressed.

GAP is composed of five GPS receivers each fed by an antenna through a low-noise amplifier. Its mission-support outputs are the position, velocity and attitude of the spacecraft and Universal Time. Scientifically, GAP will be used for radio occultation, in which the refraction and resulting relative phase delay of signals in both the L1 and L2 bands from a GPS satellite occulted by the limb ionosphere will provide large-scale (1000s of kilometers) information on how the total electron content responds to magnetospheric perturbations.

CERTO will emit CW simultaneously at 150, 400 and 1067 MHz from a mast on the spacecraft holding three half-wave

crossed dipoles, one for each frequency. The radiation will be received at coherent ground arrays of dedicated receivers, located at various places around the world. Tomographic analysis of the resulting data will permit reconstruction of the ionospheric density distribution and hence be a basis for studies of ionospheric dynamics.