Tropical Storm Sounding Rocket Campaign

Jason Bingham
Utah State University
4120 Old Main Hill
Logan, Utah 84322
jason.bingham@sdl.usu.edu

Timothy Campbell
Utah State University
4120 Old Main Hill
Logan, Utah 84322
timothy.campbell@sdl.usu.edu

Jessica Gregory
Utah State University
4120 Old Main Hill
Logan, Utah 84322
jessica.gregory@sdl.usu.edu

Mike Holt
Utah State University
4120 Old Main Hill
Logan, Utah 84322
michael.holt@sdl.usu.edu

Albert Hummel
Utah State University
4120 Old Main Hill
Logan, Utah 84322
achummel@cc.usu.edu

Wayne Sanderson
Space Dynamics Laboratory
1695 North Research ParkWay
North Logan, Utah 84341
wayne.sanderson@sdl.edu.edu

Dr. Charles Swenson
Utah State University
4120 Old Main Hill
Logan, Utah 84322
charles.swenson@usu.edu

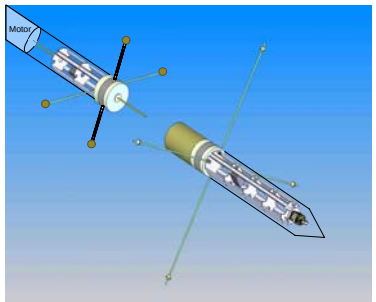
What is the Tropical Storm Campaign?

This fall USU science instruments will launch aboard a NASA sounding rocket from Wallops Island Virginia to measure characteristics of the Ionosphere (100 – 1000 km above the earth). Specifically scientists are studying the effect thunder storms have on the ionosphere.

Why Study the Ionosphere?

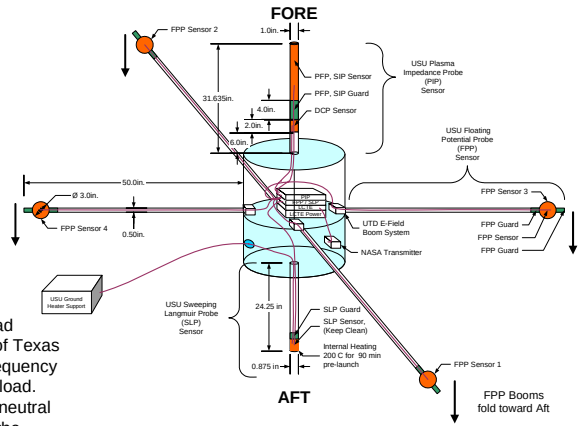
The ionosphere is a dynamic environment that affects both terrestrial and space communication. The reflective property of the ionosphere is used by international broadcasters, shipping companies, and the military for long range communication. Density structures in the ionosphere affect transionospheric communications by adding scintillations which are random variations in amplitude and phase to the signals. At latitudes near the earth's equator the density structures due to equatorial plasma bubbles cause such strong scintillations that satellite communications fail and systems such as GPS cannot be used. A better understanding of the ionosphere will improve systems that use or are affected by the ionosphere.

The Rocket Payload



The rocket's payload is divided into a main payload (foreground) and a sub payload. The University of Texas Dallas "HATI" Wind Instrument and "EFI"-Low Frequency E-field Instrument will be located on the main payload. These instruments will provide measurements of neutral winds and the quasi-DC electric fields present in the ionosphere. The sub payload contains the USU instrument suite.

USU Instrument Suite



There are five USU instruments, the Plasma Frequency Probe (PFP), the Sweeping Impedance Probe (SIP), the DC Langmuir probe (DCP), the Sweeping Langmuir Probe (SLP), and the Floating Potential Probe (FPP). These five instruments form a suite capable of making simultaneous measurements of electron density, electron-neutral collision frequency, electron and ion temperatures, vehicle floating potential, and electric field measurements. These five instruments are divided between two electronics boards. The first board is called the Plasma Impedance Probe (PIP) and contains the PFP, the SIP, and the DCP. The second is called the SLP/FPP board and houses those two instruments. Both boards are integrated to a Low Cost Telemetry Encoder (LCTE) designed and built by USU.

Low Cost Telemetry Encoder

LCTE performs data handling for the project. Sharing a common bus contained in the backplane connector, LCTE is able to obtain, organize, and encode data directly from the PIP and SLP/FPP science boards.

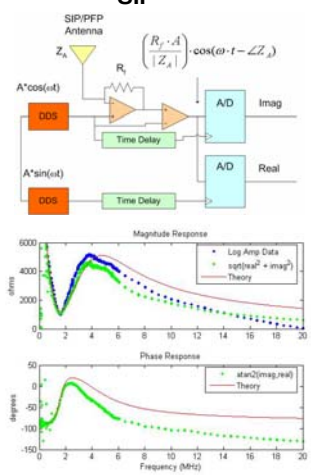
SLP/FPP Science Board

Applying a voltage to the plasma-immersed Lagmuir probe attracts or repels free electrons and ions. Current induced by the attraction is measured. Electron and ion density can then be derived from the measured currents. Using amplifiers with a very high input impedance and 18-bit A/D converters, the four floating potential probes measure the voltage potential of the plasma relative to the spacecraft payload. In the lab, resistive loads are attached to the Langmuir probe to create current flow, and a signal generator is used to apply a voltage to the floating potential probes. Using a LabVIEW interface, data are retrieved from the instruments and stored on a PC for calibration.

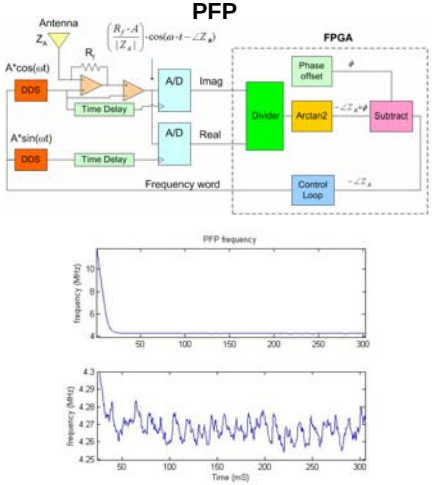
PIP Science Board

Two important instruments controlled by the the PIP board are the SIP and the PFP. Both techniques are based upon the analysis of the impedance profile of an electrically short antenna immersed in ionospheric plasma. The impedance of an antenna immersed in a plasma peaks as the antenna resonates with the characteristic frequencies of the plasma, as shown in the lower left figure. This figure is the impedance profile derived from the SIP instrument. The PFP tracks on the upper zero phase crossing called the upper hybrid frequency of the antenna's impedance. The track speed and frequency resolution is shown in the lower right figure.

SIP



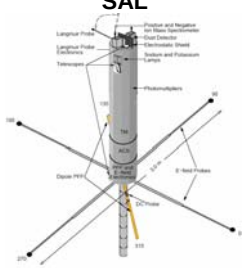
PFP



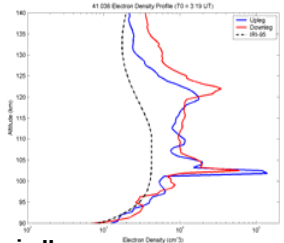
Recent Sounding Rocket Flights

Ionospheric measurement probes have been flown by USU on numerous ionospheric diagnostic sounding rockets and satellites since the early sixties. Recent flights have been The Sudden Atom Layer (SAL) payload launched February 20, 1998 from Puerto Rico, the E-Winds payloads launched July 1, 2003 from Wallops Island Virginia, and the Equis II payloads launched in August of 2004 from the Kwajalein Flight Facility in the South Pacific. The figure under the E-Winds heading shows a typical electron density profile of the ionosphere derived from one of the E-Winds payloads.

SAL



E-Winds



Equis II