The Tandem Instrumented CubeSats Experiment (TICE) in Low Earth Orbit for Continuous Occultation Observations of the Ionosphere

P.A. Bernhardt[1], Carl L. Siefring[1], Joe D. Huba[1], John Abrams[2], Scott Miller[2], Nestor Voronka[3]
[1]Plasma Physics Division, Naval Research Laboratory, Washington, DC 20375
[2]ARES Corporation, Torrance, CA 90502,
[3]Tethers Unlimited Inc., Bothell, WA 98011-8804

Ionospheric occultation involves a radio beacon transmitter on a satellite propagating a near line-of-sight signal to a receiver on another satellite with a ray path passing trough the ionosphere. Satellites in low-earth-orbit perform GPS occultations by sporadically recording the phase and amplitudes of L-Band signals from GPS satellites at a much higher altitude. The advantage of the GPS occultation technique is that there are a large number of GPS satellites available for the LEO satellite to observe the ionosphere and provide electron density profiles. These profiles represent a profile averaged over about 500 km in horizontal range along the occultation propagation path. The disadvantages of the GPS occultation technique are (1) the measurements are not continuous because they only use GPS satellites near the plane of the LEO satellite orbit near the horizon, (2) only L-Band observations are made limiting the radio frequency range of the scintillation information, and (3) the location of a disturbance along the propagation path is not known to better than ~200 km accuracy.

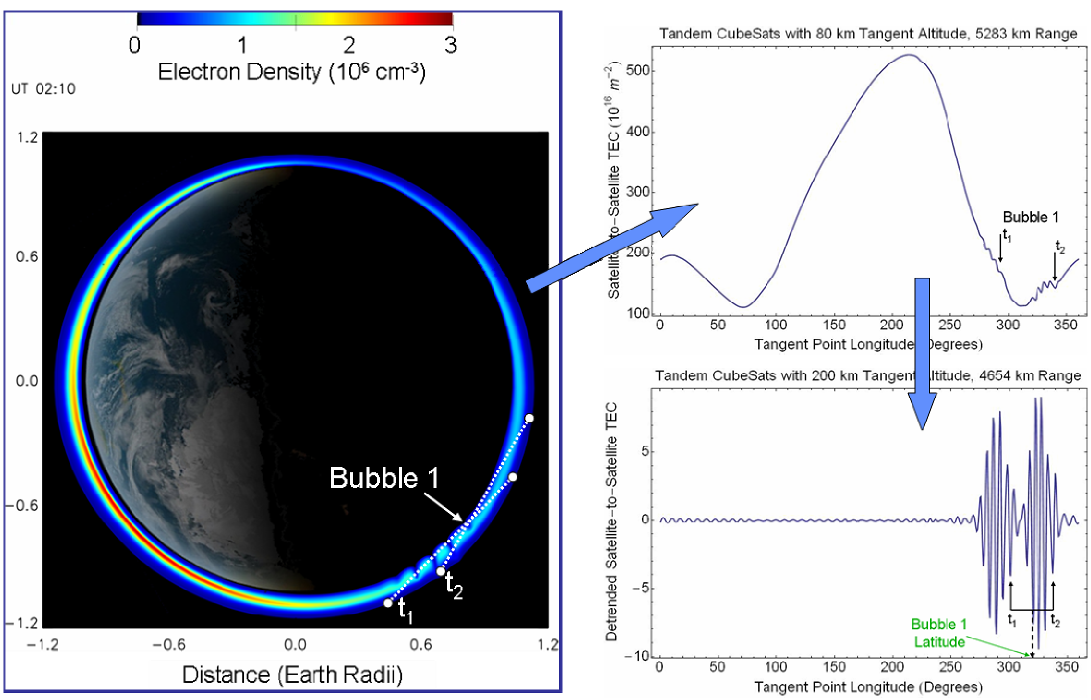

Figure 1. Localization of plasma bubbles with radio beacon propagation between CubeSats in low-earth-orbit.

978-1-4244-6051-9/11/$26.00

A new concept, called the Tandem Instrumented CubeSats Experiment (TICE), has been developed using a pair of CubeSats orbiting in tandem in a common orbit plane. With a ~4000 km range between the satellites, the propagation path will have constant tangent height around 80 km altitude well below the E- and F-layer ionospheres. The radio link between the transmitter CubeSat and receiver CubeSat will be continuous so that there will be no data gaps in the ionospheric measurements. Irregularities found in the orbit plane in the ionosphere are observed in two regions on either side of the path tangent point. The ionospheric irregularities will be triangulated from the tandem satellite observations to provide both location and scintillation strength. The space-based observations of the ionosphere will (1) determine the locations of plasma regions where radio propagation is affected and (2) collect data that supports physics and empirical models of the ionosphere. TICE will use UHF and L-Band transmissions to provide high accuracy total electron content (TEC) as well as radio scintillation data in each frequency band. Along with a radio beacon receiver or transmitter, each CubeSat will have a plasma probe to provide in situ measurements the electron density and density irregularities. The operations of the TICE satellite system has been simulated using plasma densities provided by the NRL SAMI3 model. The data from TICE can be directly assimilated into global ionospheric models.