Impact of Long Lived Artificial Ionization Clouds on VHF Scintillations

Paul A. Bernhardt[1], Carl L. Siefring[1], Stanley J. Briczinski[1]
Keith Akens[2], Mike Nurnberger[2]
[1]Plasma Physics Division, Naval Research Laboratory, Washington, DC 200375
[2]Spacecraft Engineering Dept., Naval Research Laboratory, Washington, DC

Three types of ionospheric disturbances produce scintillations in VHF and UHF transmissions from satellites. Natural irregularities, artificial field aligned irregularities and artificial ionization clouds all affect the amplitude and phase of radio wave propagating through the ionosphere. The measure these effects, VHF Beacon Transmissions at 253 MHz have provided high latitude scintillation monitoring from Gakona Alaska using the COMMX instrument on TACSat4. TACSat4 was constructed by the Naval Research Laboratory and was launched in September 2011 as an experimental communications satellite. Ground UHF transmissions are uplinked to TACSat4 using the 4 meter diameter antenna deployed to view the earth. These signals are coherently translated to other UHF frequency to be rebroadcast to the ground. Scintillation monitoring is achieved by taking the 401.25 MHz signals from ground DORIS beacons located in Cold Bay, Alaska; Yellowknife, Canada; Kauai, Hawaii; and Socorro Island, Mexico. These signals are translated to 253 MHz and broadcast with the 4 meter antenna pointed to the UHF receiver located at Gakona, Alaska. The satellite antenna gain is 18 dB in this UHF band and the transmitter power is 2 Watts. The satellite is in an elliptical orbit with an inclination of 63 degrees and a perigee of 12,000 km. Doppler frequency shifts allow separation of each uplink from the ground DORIS beacons. This new scintillation monitoring system has been used to detect natural and artificial field aligned irregularity effects on the amplitude and phase of UHF carriers where typical scintillation amplitudes are 2dB or less. Similar amplitudes were produced by propagating though artificial field aligned irregularities sustained by high power HF transmissions from the HAARP facility in Alaska. Using the HAARP transmitter tuned to electron gyro harmonics, TACSat4 was used to discover that artificial ionization clouds produce scintillations with as much as 16 dB and amplitude indices S4 greater than unity. This is the first demonstration of significant effects on radio scintillations using high power HF radio waves to disturb the ionosphere.