The Aguadilla Radio Array and Puerto Rico CubeSat

Brett Isham[(1)], Terence Bullett[(2)], Björn Gustavsson[(3)], Vasyl Belyey[(4)], Jan Bergman[(5)], Amilcar Rincon-Charris[(6)], Fredrik Bruhn[(7)], Peter Funk[(8)], Linda Krause[(9)], and Arturs Stramkals[(10)]

(1) Interamerican University of Puerto Rico, Bayamón, bisham@bayamon.inter.edu

(2) University of Colorado and NOAA, Boulder, terry.bullett@noaa.gov

(3) University of Tromsø, Norway, bjorn.gustavsson@uit.no

(4) Pinhole AS, Norway, vasyl.belyey@gmail.com

(5) Swedish Institute of Space Physics, Uppsala, jb@irfu.se

(6) Interamerican University of Puerto Rico, Bayamón, arincon@bayamon.inter.edu

(7) Mälardalen University, Sweden, fredrik.bruhn@mdh.se

(8) Mälardalen University, Sweden, peter.funk@mdh.se

(9) NASA Marshall Space Flight Center, linda.h.krause@nasa.gov

(10) Uppsala University, Sweden, arturs.stramkals@gmail.com

The ionosphere is a source of many natural radio emissions in the various low-frequency, medium-frequency, and high-frequency bands (0 to 30 MHz). In addition to natural radio emissions, artificial emissions can be stimulated using high-power radiowave ionospheric modification facilities, of which one is located at Arecibo Observatory in Puerto Rico. Two complementary projects are underway for the purpose of measuring stimulated radio emissions from the ionosphere above Arecibo.

One is the Aguadilla radio array, currently being installed at the Interamerican University Aguadilla Campus, located in northwestern Puerto Rico. The Aguadilla array is intended to measure 2 to 25 MHz radio images of the ionosphere, as well as to perform bistatic radar imaging of the ionosphere over Puerto Rico. The array will consist of 24 antenna elements, each of which is a single active (electromagnetically short) crossed electric dipole. Nineteen of these elements will be arranged within a roughly 200 by 300-meter area, in a semi-random pattern providing an optimal distribution of baseline vectors, with 6-meter minimum spacing to eliminate spacial aliasing. An additional five elements will be arranged in a ring around the central core, providing a roughly five times expanded region in u-v space for improved image resolution and quality. A relocatable six-element array is also being developed, in which each element consists of a single crossed pair of active electric dipoles and all associated electronics for phase-coherent radio measurements.

The second involves the GimmeRF radio instrument, designed for 0 to 30 MHz vector observation of the radio electric field, and planned for launch on the Puerto Rico CubeSat. By exploiting fast on-board computing and efficient artificial intelligence (AI) algorithms for analysis and data selection, the usage of the telemetry link can be optimized and value added to the mission. A second instrument on the CubeSat, CARLO, will measure ion irregularities, temperature, and turbulence.

Radio images produced by the Aguadilla array below the ionosphere can be directly compared with the radio data received by Puerto Rico CubeSat in-situ in the topside ionosphere, with the goal of better understanding the geometry and therefore the mechanisms of the radio emission processes. Using relocatable radio receivers and other HF arrays, similar measurements can be done at EISCAT, HAARP, and Sura.