URSI GASS 2021, Rome, Italy, 28 August - 4 September 2021

A Displaced Phase Center Antenna Configuration for Doppler Measurements Onboard a Spaceborne Weather Radar

Sergio Graniello*[(1)], Robert M. Beauchamp [(2)], Stephen L. Durden[(2)] and V. Chandrasekar[(1)]
(1) Colorado State University, Fort Collins, CO, e-mail: sdruiz@colostate.edu; chandra@colostate.edu
(2) Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA; email: robert.m.beauchamp@jpl.nasa.gov; stephen.l.durden@jpl.nasa.gov

Doppler measurements are essential in understanding the dynamic process of the atmosphere. While ground-based radars have been refined over the years to provide accurate measurements of the atmosphere, they are not available globally in locations such as oceans and high mountainous areas. Spaceborne weather radars offer a solution by observing precipitation from above. Due to this, research over the past several decades has developed techniques to more accurately measure Doppler velocity of clouds and precipitation using spaceborne weather radar systems.

Spaceborne weather radars have the unique challenge of high platform velocities relative to the precipitation they intend to observe. This motion results in a decorrelation of the echoes over successive pulses, leading to a degradation of the accuracy in Doppler velocity measurements. While advanced signal processing may help to lessen the effects, single antenna systems are still subject to velocity estimate biases due to reflectivity gradients within the footprint. Techniques have been suggested to help resolve this effect, such as increasing the size of the antenna, but the high platform velocity still results in large Doppler spectrum broadening, particularly in convective storms.

A displaced phase center antenna (DPCA) configuration is proposed to address this challenge. The main concept of DPCA is to use two along-track antennas for the radar; one leading and a following. By properly configuring the antennas to transmit and receive at certain locations in space, it is possible to mitigate the platform's velocity from the estimated Doppler moments of precipitation. The DPCA scheme results in a high correlation between concurrent transmit pulses. While DPCA has not been previously used in spaceborne weather radars, past work has shown the potential of use for Doppler measurements from space. This paper characterizes the performance of DPCA and the uncertainty of the Doppler velocity estimates. Additionally, we present a comprehensive comparison that illustrates the advantages that the DPCA method has with respect to a single antenna system.