11B.1 - A New Ka-Band Image PAR Concept for 4D-Volume Rapid Scan for Cloud Observations

Wednesday, January 15, 2020

3:00 PM - 3:15 PM

Boston Convention and Exhibition Center - 155 (1)

Abstract

Compared to longer, centimeter wavelength radars (S- to X- bands), millimeter (mm)-wavelength or cloud radars (Ka- to W- band) offer superior sensitivity to small cloud droplets and ice crystals, and provide high resolution radar sampling volumes while using small size antennas and improved signal-to-clutter and Rayleigh-to-Bragg scattering ratio. Analyses of dual-polarization and Doppler spectral data have enabled better discrimination of ice hydrometeor types. While vertically pointing, mm-wavelength radars have been used to obtain distributions of vertical velocities and turbulence in convective and stratiform clouds and the convective boundary layer. As a result, cloud radars are the primary instrument for cloud-scale studies and have contributed immensely to advance our scientific understanding of cloud and precipitation processes, dynamics, and turbulence. However, existing mm-wave radars rely on parabolic dish antennas and their narrow beamwidth results to very slow volumetric scan rates that severely limit our ability to track cloud volumes and fast cloud-scale processes.

To investigate candidate radar technologies to address this limitation, a trade study of different rapid-scan cloud radars has been undertaken. One result of this effort is the development of a concept called the Ka-band Rapid-scanning Volume Imaging Radar (KaRVIR). This new concept builds upon the emerging use of digital beamforming with weather radars, such as the Atmospheric Imaging Radar (AIR) and the C-band Polarimetric Atmospheric Imaging Radar (PAIR), to obtain vertically continuous, rapid-

scan radar observations of clouds. Another option is a Ka-band active electronically scanned array (AESA) architecture, which would permit an electronically steered beam with improved sensitivity and lower sidelobes compared to an imaging radar architecture. However, the cost of Ka-band AESAs is prohibitively expensive. Alternative designs could include millimeter-wavelength radars using frequency hopping to increase the number of independent samples and to increase radar rotation rates. However, such designs would still require numerous elevation angles to be scanned to completely observe cloud vertical structure without gaps.

This paper will present the results of the trade study and take a more detailed look at the concept of KaRVIR, the first ground-based millimeter-wavelength phased array radar for Earth system science. With unprecedented four-dimensional views from high-temporal resolution, volumetric imaging at Ka-band will enable transformative studies of clouds, precipitation, and boundary layer processes, and unleash innovative applied environmental research to study fire plumes and insect migration.

Co-Authors

S

Jorge Salazar-Cerreno (Presenter)

Univ. of Oklahoma
Norman, OK
USA

Norman, OK
USA

B

David Bodine

Univ. of Oklahoma
Norman, OK
USA

M

Jay McDaniel

Advanced Radar Research Center/Univ. of Oklahoma
Norman, OK
USA

H

C. R. Homeyer
Univ. of Oklahoma
Norman, OK
USA

P

R. D. Palmer
Univ. of Oklahoma
Norman, OK
USA

Y

M. Yeary
Univ. of Oklahoma
Norman, OK
USA

K

Pierre-Emmanuel Kirstetter
Univ. of Oklahoma
Norman, OK
USA

M

Greg M. McFarquhar
Cooperative Institute for Mesoscale Meteorological Studies
Norman, OK
USA

K

Jeffrey F. Kelly
Univ. of Oklahoma
Norman, OK
USA

I

Bradley M. Isom
PNNL
Richland, WA
USA

K

Pavlos Kollias
Stony Brook Univ.
Stony Brook, NY

USA

K

Matthew R. Kumjian

The Pennsylvania State Univ.
Univ. Park, PA
USA

T

Simone Tanelli

JPL/CalTech
Pasadena, CA
USA