Development of a Shared Mobile C-band Polarimetric Atmospheric Imaging Radar (PAIR)

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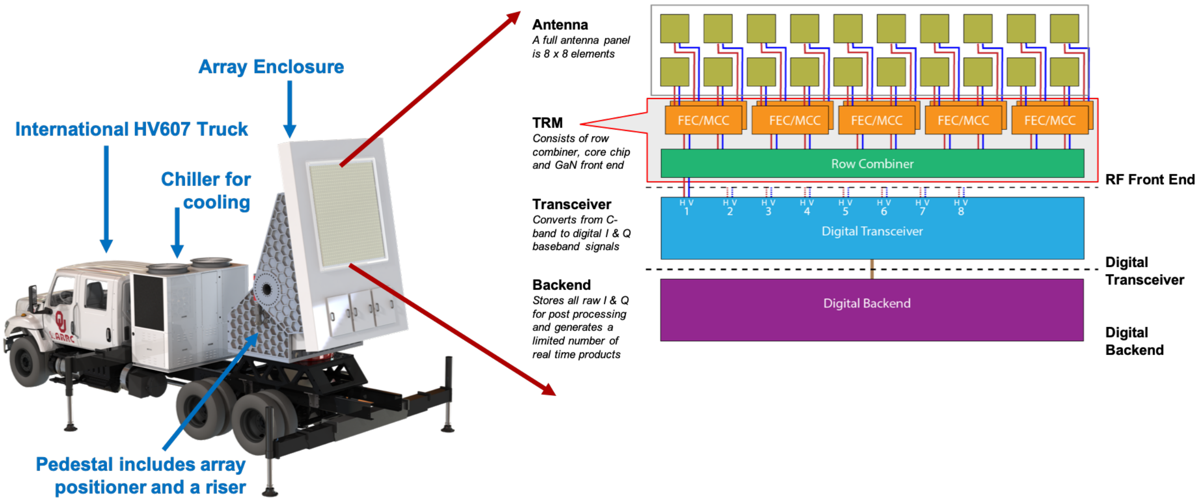
This paper presents the development of a mobile C-band polarimetric atmospheric imaging radar (PAIR), sponsored by the National Science Foundation. The architecture of the PAIR offers a unique flexibility of scanning capabilities and an unprecedentedly fast update time of polarimetric observations. Conventional weather radars, regardless of whether they are mechanically rotated or electronically scanned, use a pencil beam for both transmission and receiving. The update time of volumetric observations is the product of the dwell time and the number of beam positions. On the other hand, an imaging radar transmits a much wider beam and simultaneously produces multiple narrow receiving beams through digital beamforming (DBF), which leads to significant reduction of update time. Moreover, DBF allows radar beams to be shaped adaptively for better suppression of ground clutter, interference, etc., and provides improved weather observations. The idea of an imaging radar has been demonstrated and verified by the Atmospheric Imaging Radar (AIR), developed at the Advanced Radar Research Center (ARRC), the University of Oklahoma, which is an X-band mobile radar with single polarization. The development of PAIR leverages on the lessons learned from the development and deployment of the AIR and other radar systems at the ARRC, and improves reliability, maintainability, ease-of-use, safety and fast deployment in the field, etc.

In this presentation, the design concept and capability of the PAIR will be first introduced. PAIR is capable of both DBF as well as pencil beam operation in the elevation direction. The azimuthal coverage is achieved by mechanical rotation. It is estimated that a 6-10 s update time of volumetric dual-pol measurements can be obtained. Potential scientific applications include tornadoes, hurricanes, lightning, and radar aeroecology. The specifications, development progress, and predicted performance analysis of the system will also be discussed. The main PAIR subsystems are depicted in the following figure, where the electronic subsystems include RF front-end, transceiver, and digital backend, and the mechanical subsystems include the truck, array enclosure, chiller, and pedestal. The development status of those subsystems will be reported. The system integration is planned to begin in 2020. PAIR is a shared facility and will be available to the research community after it is commissioned.

Keywords: imaging radar, phased array radar, digital beamforming



Array Enclosure
International HV607 Truck
Chiller for cooling
Pedestal includes array positioner and a riser
Antenna
A full antenna panel is 8 x 8 elements
TRM
Consists of row combiner, core chip and GaN front end
FEC/MCC
Row Combiner
RF Front End
Transceiver
Converts from C-band to digital I & Q baseband signals
H V 1
H V 2
H V 3
H V 4
H V 5
H V 6
H V 7
H V 8
Digital Transceiver
Digital Transceiver
Backend
Stores all raw I & Q for post processing and generates a limited number of real time products
Digital Backend
Digital Backend