Airborne Phased Array Radar

An airborne Doppler radar is a critical tool for studying high-impact weather systems and related hazards, especially in hard to reach areas such as open ocean and complex terrain where operation of ground-based radars is inherently challenging. Major advances in radar technology have paved the way for the development of an Airborne Phased Array Radar (APAR) system that can provide unprecedented detailed observations of the dynamics and microphysics of high-impact storms such as hurricanes and mesoscale convective systems.

The APAR currently under design by NCAR/EOL consists of four removable C-band Active Electronically Scanned Arrays (AESA) mounted on the top, both sides, and the cargo door of the NSF/NCAR C-130 aircraft. Each AESA is approximately 1.8 m x 1.8 m in size and is made up of ~2,400 transmitting/receiving antenna elements with dual-polarization capabilities. The dual-polarization capabilities of AESA, in addition to an inherent beam agility associated with electronic steering, will provide more flexible scanning strategies and enhanced measurement capabilities.

These unique capabilities of APAR will open new research frontiers in high-impact weather research and advance knowledge about the formation and evolution of societally disruptive weather and environmental conditions leading to it as well as improved prediction and predictability via assimilation APAR data into numerical weather models ultimately leading to improved weather alerts to the public.
About APAR

The proposed APAR system consists of front and back end radar components. The front radar consists of the four AESAs mounted to the exterior of the aircraft. The back radar resides inside the aircraft and contains all APAR sub-systems (hardware/software). The C-130 nose surveillance radar data combined with the APAR surveillance mode reflectivity will provide enhanced situational awareness to allow for improved safety of aircraft operations during extreme weather. The 3D volume-scan data will help guide real-time radar operations and provide the basis for improved analysis of the phenomenon of interest. The APAR system will be a significant addition to the existing NSF/NCAR C-130 instrumentation suite, providing new insights and context to weather observations from the platform.

Advantages of APAR

The APAR system will be a state-of-the-art airborne weather radar with the following unique/advantageous features:

» Dual-Doppler capability and rapid scanning to observe the kinematics of storm structures.
» Dual-polarimetric capability allowing observations of storm microphysics and significantly improving our understanding of in-cloud mixed phase microphysical processes and leading to better estimates of heavy precipitation and potential impacts.
» C-band transmit frequencies to penetrate deeper into the heavy precipitating storms due to less attenuation than the extant X-band airborne radars.
» The ability to form multiple, simultaneous beams using digital beamforming techniques that allows for fast scanning and interrogation of rapidly developing weather systems such as tornadoes.
» An airborne radar mounted on a long duration aircraft to allow sampling of weather in remote locations.

Technical Specifications

» Frequency: 5.35 GHz – 5.45 GHz
» Total Elements per AESA: ~2400
» Beamwidth (El/Az): <2.2°
» Hybrid Digital Beamforming
» Antenna Gain: ~40 dB
» Min. Detectable Reflectivity @ 10 km: -13 dBZ
» Peak Transmit Power: ~10 kW

» Polarization: Dual Linear
» Typical Boresight Sampling Volume (Radial X Along Track X Cross Track): 150 m X 395 m X 380 m @ 10 km
» Along Track Spacing: <= 300 m (Aircraft Speed 120 ms⁻¹)
» Pulse Width: 0.5 μs to 40 μs

Contacts

APAR Principal Investigator
Dr. Vanda Grubišić
grubisic@ucar.edu
303.497.2040

APAR Chief Scientist
Dr. Wen-Chau Lee
wenchau@ucar.edu
303.497.8814

On the Web

www.eol.ucar.edu/instruments/apar