**Advanced Airborne Precipitation Radar (APR2)**

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The APR-2 is a dual-frequency (13 GHz & 35 GHz), Doppler, dual-polarization radar system. It has a downward looking antenna that performs cross track scans, covering a swath that is +/- 25 to each side of the aircraft path. Additional features include: simultaneous dual-frequency, matched beam operation at 13.4 and 35.6 GHz (same as GPM Dual-Frequency Precipitation Radar), simultaneous measurement of both like- and cross-polarized signals at both frequencies, Doppler operation, and real-time pulse compression (calibrated reflectivity data can be produced for large areas in the field during flight, if necessary).

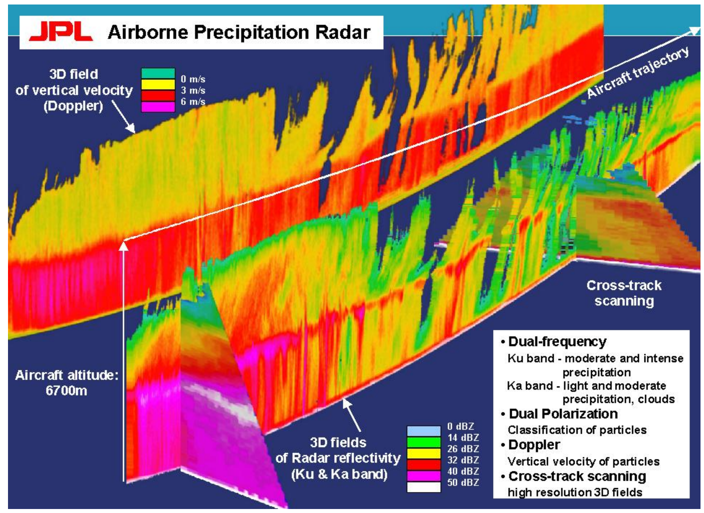


**Figure 1: Example of APR-2 data output**

The APR-2 is implemented to demonstrate as much of the spaceborne radar technology as possible, while making use of a mechanically scanned passive antenna for airborne operation. The APR-2 thus couples spaceflight-like digital electronics and lower frequency RF electronics with airborne-specific high frequency electronics and traveling wave tube amplifiers (TWTA). A 6U VME form factor was chosen for the digital electronics boards. The local oscillator and intermediate frequency (LO/IF) module was also constructed to fit within two slots in the same VME cage, providing an extremely compact implementation that is suitable for spaceborne operation. In a spaceborne implementation the same digital electronics and LO/IF module would be coupled with an active electronically-scanned antenna and associated electronics for up conversion and

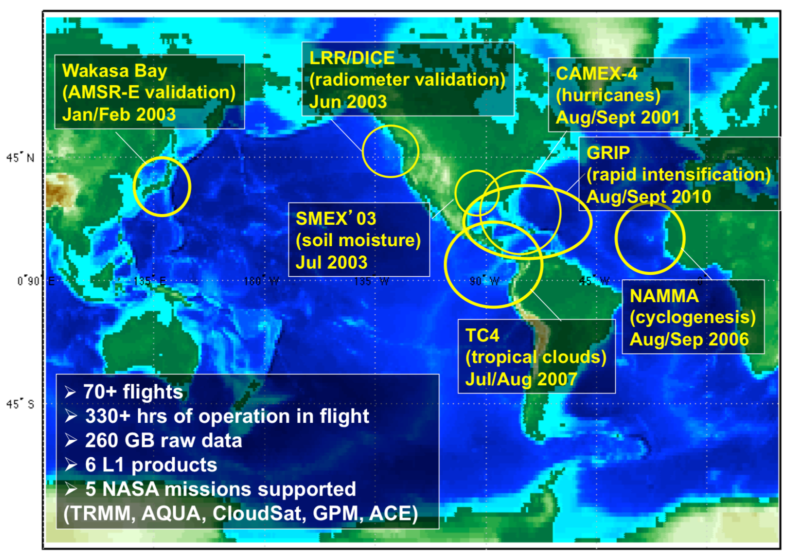


**Figure 2: Airborne missions on which APR-2 has flown**

down conversion. The radar operation can be described by tracing a pulse through the transmit and receive chains. The digital electronics generate linear FM chirps, which are passed to the RF electronics. The lower frequency (below 1.5 GHz) RF circuitry is all contained in the LO/IF module. This unit converts transmit chirp signals from 15 MHz up to 1405 MHz and down converts received IF signals from 1405 to 5 MHz. It also generates local oscillators at 40, 1350 and 1360 MHz, and provides the 10 MHz system master oscillator (MO). All other oscillators as well as the data system are locked to the 10 MHz MO, as required for pulse-to-pulse coherence.

The RF transmit front-end electronics for the APR-2 consists of five units: one local oscillator/ up converter (LO/U) unit; two TWTAs; and two waveguide front-end (WGFE) units. The LO/U receives two 1405 MHz IF chirp signals and a 10 MHz reference from the LO/IF. A 100 MHz crystal oscillator locked to the 10 MHz reference generates a signal that is used to phase lock two dielectric resonance oscillators operating at 12.0 and 17.1 GHz. The 12.0 LO is used for the first stage of up and down conversion for the Ku-band channels and the 17.1 GHz signal is doubled to yield a 34.2 GHz LO for the Ka-band channel. The 1405 MHz chirps are mixed with these local oscillator signals to yield chirps at 13.405 and 35.605 GHz.

**References**

G. A. Sadowy, A. C. Berkun, W. Chun, E. Im, and S. L. Durden, "Development of an advanced airborne precipitation radar," Microwave J., vol. 46, no. 1, pp. 84-98, January 2003.