CASA DUAL-DOPPLER SYSTEM

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Today's weather surveillance radars are designed for observing weather events for hundreds of kilometers. As a result, the majority of precipitation and wind observations made by these radars occur in the mid to upper troposphere. However, features associated with storms that occur in the first 3km of the troposphere are missed, resulting in limited observations. In addition, the spacing between radars in a network of these radars exceeds hundreds of kilometers. This spacing limits the feasibility of dual-Doppler wind retrievals that would provide valuable information of low-level wind events to end-users and researchers. To overcome the fundamental coverage limitations of today's weather surveillance radars, the NSF engineering research center for Collaborative Adaptive Sensing of the Atmosphere (CASA) has developed and deployed a test-bed of densely spaced networked X-band radars in southwestern Oklahoma, Integrative Project 1 (IP1). The topology of the IP1 network allows for higher resolution observations of the first 3 km of the troposphere and also provides large areas of overlapping coverage, ideal for dual- and multi-Doppler retrievals. Taking advantage of the dual-Doppler coverage in the IP1 network, a real-time dual-Doppler system has been developed to provide immediate low-level wind information to end-users. The dual-Doppler system consists of two subsystems, the scanning subsystem and the dual-Doppler retrieval subsystem.

The scanning subsystem incorporates the Distributed Collaborative Adaptive Sensing (DCAS) model in order to establish a scan strategy for each radar of the radars in the network. In a DCAS environment, fast coordinated sector scans are made by each radar in order to meet competitive end-user needs as weather evolves. The IP1 test-bed contains multiple candidate pairs that can be used for dual-Doppler wind retrievals. Under the DCAS model, the scanning subsystem optimizes the scan strategy to provide the best pair and beam crossing angle for a targeted area. Figure 1 shows the dual-Doppler observation capacity of the IP1 test-bed. After optimization the best radar pair and beam crossing angle are provided to the Meteorological Command & Control (MC&C) to steer the IP1 radars, and the dual-Doppler retrieval subsystem. Figure 2 shows the regions of the best dual-Doppler pairs in the network.

Using the best pair and beam crossing information from the scanning subsystem, the dual-Doppler retrieval subsystem provides end-users with real-time information on low-level wind events. Figure 3 illustrates the flow of the dual-Doppler retrieval subsystem. Moment data collected by each radar, and best pair and beam crossing angle information is streamed to the dual-Doppler retrieval subsystem. Due to the parallel nature of the radars' data streams, time synchronization between them is crucial for real-time execution. The use of a local data manager and ingester provides synchronization between the individual radar's data stream. From the ingester, the dual-Doppler retrieval subsystem grids the reflectivity and velocity data from each radar. Using the best pair and beam crossing angle, gridded fields are synthesized using the iterative dual-Doppler retrieval algorithm described in this paper. After syntheses, two or three dimensional vector wind information are provided as a product to end-users. CASA's focus on low-level weather features places a demand for high resolution and accuracy on the system without compromising the real-time performance. Figure 4 shows an example wind vector data retrieval for a tornado observed in the test bed on May 14, 2009. This paper presents the CASA dual-Doppler system and addresses the design, implementation, and performance of CASA's real-time dual-Doppler system.

[1] McLaughlin, D.J., et al, 2009: "Short-Wavelength Technology and the Potential for Distributed Networks of Small Radars System", *BMAS*, in press.

[2] Wang, Yangtin, V. Chandrasekar and Brenda Dolan, 2008: "Development of Scan Strategy for Dual-Doppler Retrieval in a Networked Radar System", Geoscience and Remote Sensing Symposium, 2008 IEEE international, Boston MA, 7-11 July 2008.

[3] Miller, L. J. and R.G. Strauch, 1974: "A Dual-Doppler Radar Method for the Determination of Wind Velocities within Precipitating Weather Systems", Remote Sensing of Environment, issue 3 pg219-235, 1974

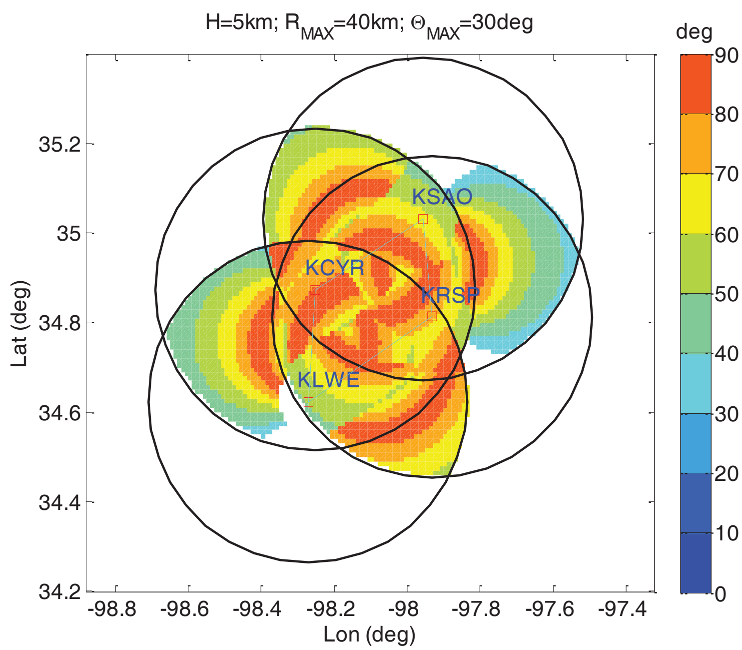

Figure 1 Dual-Doppler observation capacity of IP1 network.

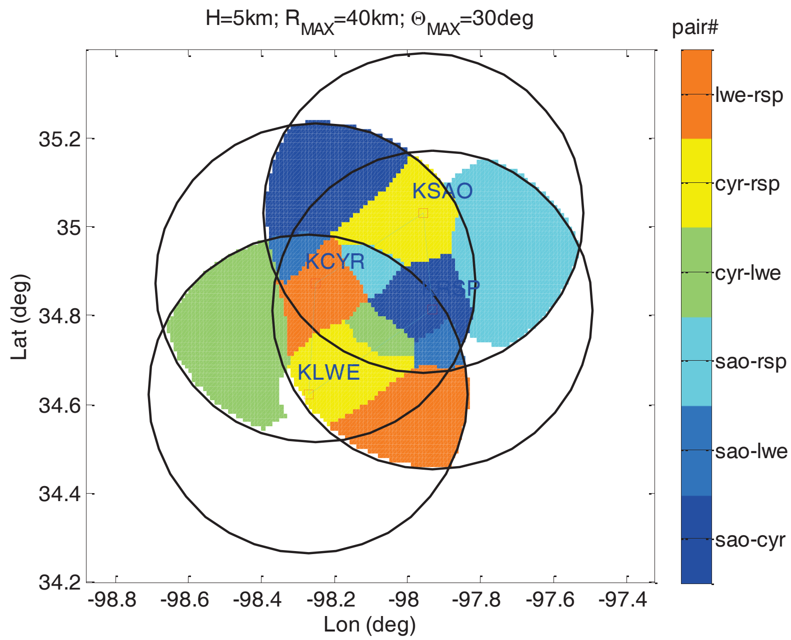

Figure 2 Best dual-Doppler pair regions in IP1 test-bed

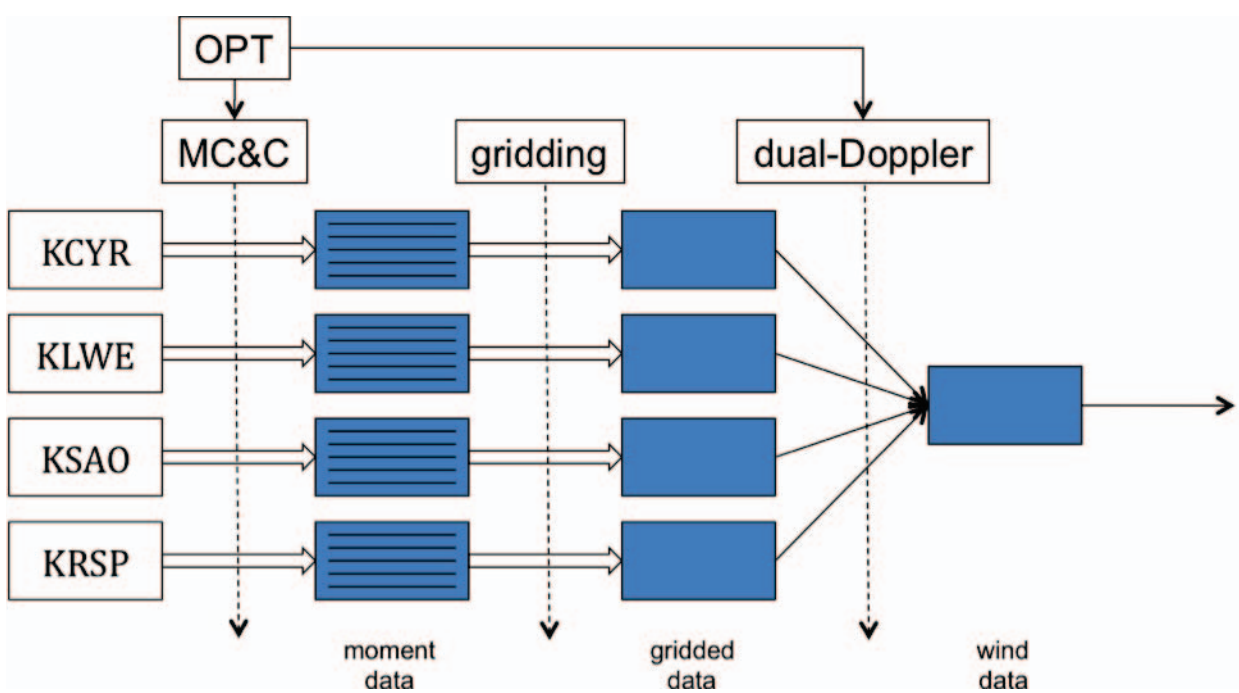

Figure 3 CASA dual-Doppler system process flow

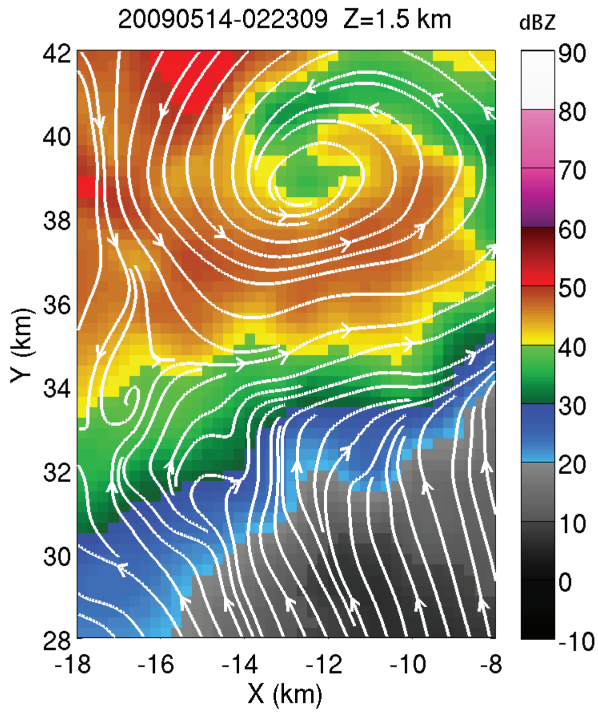

Figure 4 Example wind vector retrieval from CASA dual-Doppler system