COVERAGE COMPARISON OF SHORT RANGE RADAR NETWORKS VS. CONVENTIONAL WEATHER RADAR: CASE STUDY IN THE NORTHWESTERN UNITED STATES

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State-of-the-art weather surveillance relies on widely-spaced (hundreds of km apart) high-power Doppler radars that survey the middle and upper regions of the troposphere for storm monitoring, forecasting, and warning. For example, the 158 S-band radars deployed across the contiguous United States in the WSR-88D (or NEXRAD) network provide nearly complete coverage of the atmospheric volume at heights 3 km above ground level. However, owing to both the curvature of the earth and the spacing between these radars (230 km in the eastern US and 460 km in the western US) this radar network is capable of mapping only ~66 % of the troposphere at 2 km height and ~33 % of the troposphere at 1 km height. There is increasing recognition of the need to provide for more comprehensive low-level coverage of winds and rain in order to better support weather hazard warning and response functions.

Today's weather radars are physically large, high-power systems that require dedicated land and support infrastructure costing between US $5M and US $10M per site. Given size and cost, it is not practical to install substantially more of this class of radar as a means to improve low-level coverage. The Engineering Research Center for Collaborative Adaptive Sensing of the Atmosphere (CASA) was established by the National Science Foundation in 2003 to develop the concepts and technologies to enable future deployment of large numbers of low-cost, low-power radars as a means to provide improved radar coverage of the lower atmosphere. The CASA concept is to deploy thousands of small radars on rooftops and telecommunication towers as a way to complement or potentially replace the large radars in use today. Numerous issues related to the hardware and software system design, as well as the radar reliability, cost, and cost/benefit relative to the use of large radars need to be investigated as a prerequisite to such a deployment.

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The West Coast of Washington and the NE and SW corners of Wyoming are regions of the contiguous United States where NEXRAD coverage is incomplete. One approach to addressing these gaps is to install additional NEXRAD-class radars. Another potential approach is to install small radar networks of the type being investigated in the CASA project. This paper compares these two approaches. We provide a meteorological and user-need assessment of present radar coverage in these regions (based on a recent feasibility study led by J. Brotzge) as well as an objective assessment of the radar-coverage that would be achieved using the large radar and small radar approaches. For this evaluation we consider two classes of radar: long-range radars having similar attributes to the WSR-88D (eg, 10 cm wavelength, >250 km maximum range, 1 degree beamwidth, ~ 500 kW peak power); and short-range radars having attributes similar to those operating in CASA's Oklahoma prototype network (eg 3 cm wavelength, 40 km maximum range, 2 degree beamwidth). We first establish the number of both types of radar that would be needed to provide coverage over a given rectangular ground-domain. Next, we quantify the coverage-versus-altitude for both weather-event detection and precipitation estimation over these regions, considering the blockage caused by both the curved earth and the local terrain. We then frame the issue of cost/benefit of the two approaches.