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A 200-m Tall Instrumented Tower for Atmospheric Measurements in Wind Events

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DESCRIPTION

A 200-m tall instrumented tower dedicated to atmospheric measurements has been constructed at Texas Tech University's Wind Science and Engineering Research Center field facilities at Reese Technology Center (formerly Reese Air Force Base), in Lubbock County, Texas, approximately 15 km west of the city of Lubbock in the flat, aeolian-active landscape of the Southern High Plains (Figure 1). The tower includes instrumented boom arms (Figures 2, 3) at 10 levels to continuously collect high-resolution full-scale data on meteorological variables: *u*, *v*, *w* winds: pressure: relative humidity: temperature: and aerosol concentrations. Aerosols in the PM_{10} range are sensed via a nephelometer-type laser scattering device specially designed for operation during dust storms (Stopenhagen and Pottberg, 2000). Particulate concentrations are typically recorded as 1-minute averages; the other quantities are sampled and reported at tens of Hertz. Data collected on the tower is transmitted to a computer in a central building on the ground via a fiber optic system. The facility is expected to be operational in 2002. Schematic layouts of the boom arm and tower are given in figures 3 and 4.

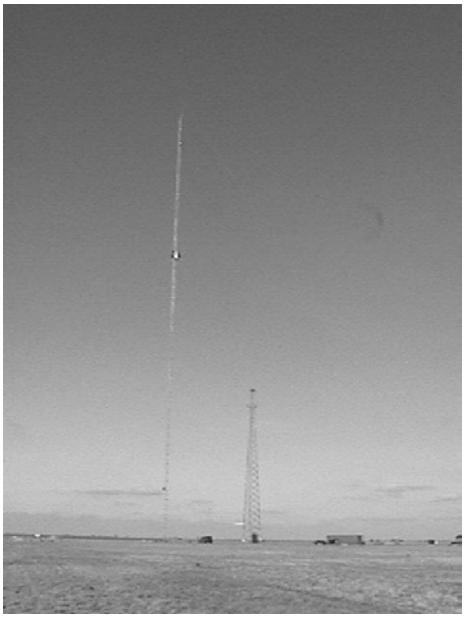

Figure 1. 200-meter tower (slender tower in foreground) at Reese site.

Figure 2. Close-up of tower section showing boom arm prior to deployment of instrumentation.

POTENTIAL APPLICATIONS TO AEOLIAN RESEARCH

Until now, vertical profiles and fluxes of aeolian dust emissions have only been measured at heights up to a few meters above the surface (e.g. Fryrear and Saleh, 1993). Standard meteorological towers are rarely greater than 10 meters tall: above this height, aerosols are characterized by sampling from buildings or other tall structures (usually in urban areas), tethered balloons or aircraft sampling, or remotely sensed by lidar. Other tall towers dedicated to meteorological research (Boulder, Colorado: Beijing, China: Cabauw, Netherlands) either are no longer in operation (Boulder) or not routinely used or designed for aerosol measurements.

The primary application of the tall tower at Reese Technology Center for research in aeolian processes, wind erosion and airborne dust will be to document concentrations, profiles and fluxes of particulate matter on a vertical scale of hundreds of meters. The Southern High Plains of Texas is an active mineral-aerosol-producing region, with blowing dust having been regularly reported in the vicinity of the present tower many days each year (Wigner and Peterson, 1987). The site's location at Reese Technology Center is > 10 km away from the urban influence of the city of Lubbock, and surrounded in all directions by agricultural fields vulnerable to wind erosion. However, land surfaces within the former Air Force base immediately surrounding the tower are not dust-emissive; they are typically paved (runways or roads) or vegetated (landscaped or prairie), with no significant local aerosol sources or other tall structures nearby, making it an ideal receptor site for particulate matter measurements.

The ten instrumented boom arms on the 200-m tall Lubbock tower will allow for simultaneous measurement of aerosol concentration along a vertical scale extending upward from the surface several orders of magnitude larger than past studies of aeolian emission and transport. The collocated meteorological instruments and fast-response aerosol sensors will allow for correlation of short-term aerosol concentrations with fluctuations in boundary-layer temperature, pressure, moisture, and wind fields. On longer temporal scales, dust concentrations and their variations with height could be correlated with different meteorological patterns and dust-storm forcing mechanisms characteristic of the Southern High Plains (Wigner and Peterson, 1987) and seasonal to interannual variations in land use, soil, and climatic factors.

There are many other potential applications of this facility and its data (which will be made available in the future to qualified investigators) for research in lower atmospheric boundary layer characterization as well as aeolian processes.

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Figure 3. Instrumentation layout along the tower boom arms.
Dimensions of instruments on diagram not necessarily to scale.

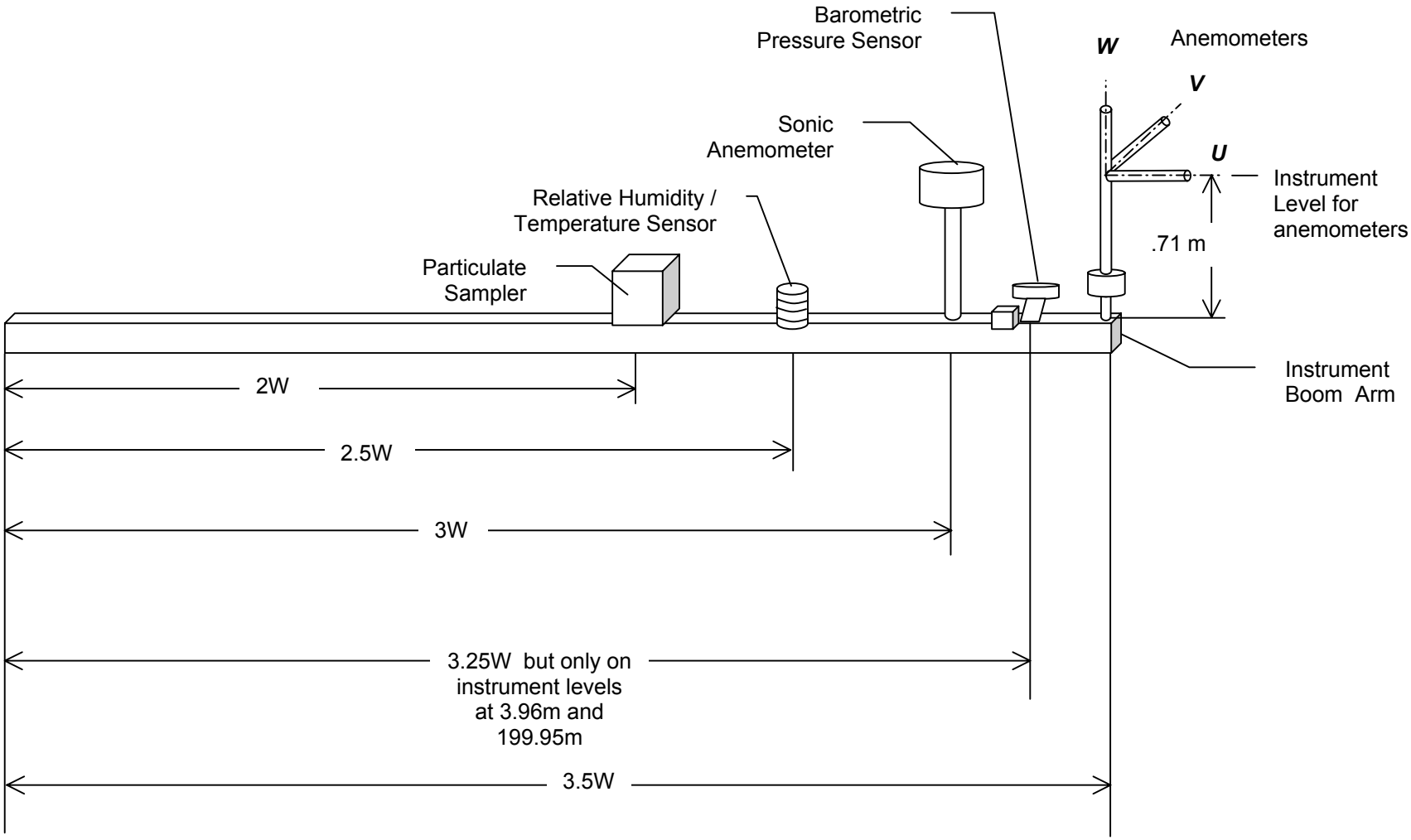

Figure 4. Schematic of tower levels. All heights given are for the anemometer level. The boom arm is .71m below the given level (see below).