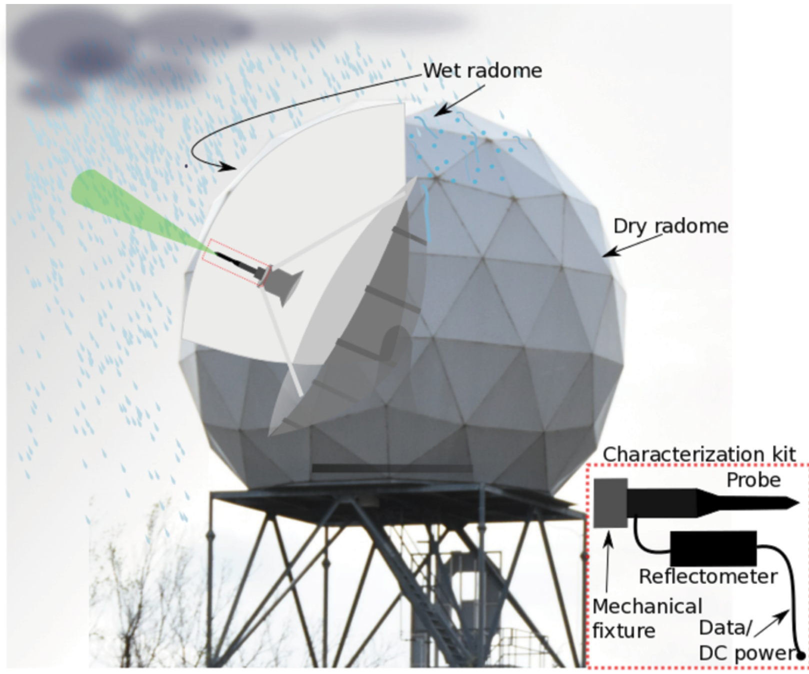
A Novel Instrument for Real-Time Measurement of Weather Radar Radome Attenuation

To achieve high measurement accuracy, weather radars—and in particular dual-polarization radars—are required to account for all sources of bias, with the primary source being the radome. Imperfections created during the radome fabrication process, as well as water distribution on the radome outer surface, affect radar performance. To mitigate the bias generated by the water formation, a hydrophobic paint is used on the radome surface. However, pollution, rain, and hail deteriorate the hydrophobic property, decreasing the radome performance over time. To compensate for this, we developed a novel instrument at the Advanced Radar Research Center of the University of Oklahoma to characterize the impact that the radome has on radar beam. The proposed technique employing this instrumentation enables full radio-frequency (RF) characterization of the radome in real time, by evaluating the level of reflections generated from the radome under different conditions (dirtiness, wetness, ice formation, snow, and varying temperature). This technique provides a potential solution for radome calibration in real time.

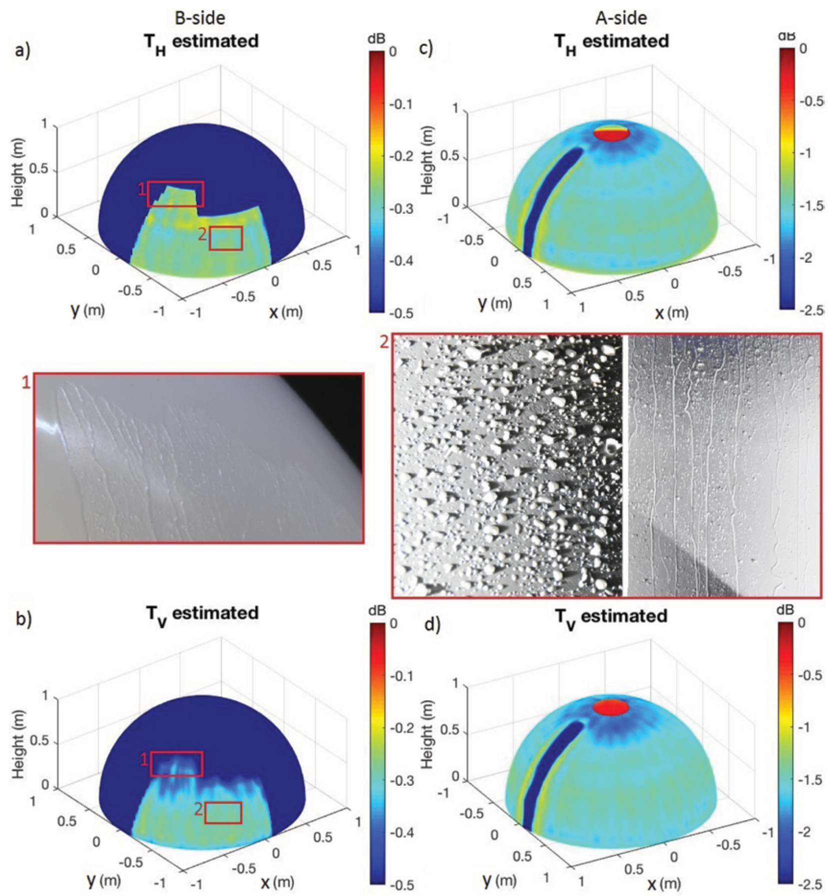


The proposed concept. **A schematic representation of the proposed concept, and a detailed illustration of the radome characterization kit.**

The instrument is composed of a reflectometer, time domain gating (TDG) algorithm, and a customized RF probe. The TDG algorithm is imperative to minimize the multipath reflections generated from the surrounding environment. To perform real-time characterization of the radome, the probe is mounted on the tip of the antenna and, therefore, scans in azimuth and elevation with resolution dictated by the radar system are possible. With this configuration, the probe collects reflections generated from the radome in the same direction that the radar is scanning, allowing our instrument to determine the effect of water on the radome outer surface when it rains.

The absorption of radar energy due to rainfall—attenuation—is obtained by modeling water as a continuous film whose thickness depends on the rain rate. Our mathematical model computes the electromagnetic properties of water as a function of the temperature and, by calculating the reflectance and transmittance through the slab, the absorption is obtained. Numerical simulations validated this algorithm by showing excellent agreement with our analytical results. The model was employed to evaluate the attenuation introduced by the water layer on the radome, not the radome itself. Since the material composing the radome is low loss, the absorption occurring inside the radome can be neglected. Numerical simulations showed that the attenuation obtained from just a film of water compared to a film of water with the radome included, produced a difference smaller than 5%, confirming that the radome absorption can be ignored.

Our concept was validated by conducting experiments on the bullet-shaped radome of the PX-1000 weather radar, both in dry and wet conditions. A six-axis robotic arm was placed in the location of the radar pedestal to facilitate the validation process. In this way, it was still possible to characterize the full geometry of the radome, maintaining the probe orthogonal to the surface, and assuring high accuracy of the probe position during the tests. The dry radome characterization highlighted the imperfections occurring during the fabrication process of the radome. The wet radome characterization was performed under artificial and natural rains. It was found that droplets produce a lower level of attenuation than a continuous film of water, but their attenuation is different in the horizontal and vertical planes, while the continuous film presents a more uniform attenuation in both planes.—Alessio Mancini (University of Oklahoma), J. L. Salazar, R. M. Lebrón, and B. L. Cheong, "A novel instrument for real-time measurement of attenuation of weather radar radome including its outer surface," in a forthcoming issue of the *Journal of Atmospheric and Oceanic Technology.*



Wet radome characterization. **Shown is the estimated transmittance (*T*) for the hemispherical part of the radome in wet conditions during natural rain. (a),(c) The transmittance when the signal is horizontally polarized, and (b),(d) the transmittance when the signal is vertically polarized. Shown in (a) and (b) are the results for the side of the radome where water distributed as droplets. Shown in (c) and (d) are the results for the side where water is distributed as a continuous film. Photos 1 and 2 of the positions identified by the red frame insets shown in (a) and (b) highlight the rivulets and droplets.**