Small Cassegrain Antenna for Passive Remote Sensing at L-Band

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This paper presents the design, construction and results of measurements of a dual polarized L- band antenna for the NASA Combined Radiometer and Radar System. The radiometer band covers 1.400 -1.427 GHz. and the radar band 1.250 to 1.350 GHz. The focus of this paper is on the radiometer band. The antenna is designed to replace the 48 inch diameter truck-mounted paraboloidal dish used in NASA remote sensing applications because of its excessive loss. It was found that changes of the ambient temperature produced fluctuations in the antenna noise temperature which reduced the accuracy of the radiometer calibration. These fluctuations are caused by the temperature dependent Ohmic loss in the antenna structure, the externally mounted cable connecting the Newtonian feed to the radiometer and in the patch used for the feed. Therefore the principal design goal for the new antenna was to eliminate the need for the cable and the patch and to reduce any additional loss without a degradation of its electrical performance and without increasing its size and weight.

A configuration that obviates the need for an external feed-to-radiometer cable connection is a Cassegrain antenna. Its additional advantage is that the feed structure can be designed to have a lower loss than the patch used in the Newtonian feed of the old antenna. Since classic Cassegrain antennas generally require reflectors with diameters of at least 30 wavelengths designing an antenna in a Cassegrain configuration incorporating a reflector with a diameter of only 5 to 6 wavelength represented a real challenge. This challenge was met with the design that employs a novel low loss dielectric (Rexolite) conical support structure for the subreflector. The cone diameter decreases linearly from its base at the apex to the subreflector. The novel feature in this design is that in addition to supporting the subreflector the cone also serves as a dielectric waveguide that illuminates the subreflector. The mechanism for this is the wave within the cone that travels from the apex of the paraboloid toward the subreflector and illuminates it by a partial leakage into the surrounding space. The resulting efficiency is appropriate for a truck- mounted antenna system. The input at the apex of the paraboloid employs a circular waveguide that supports two orthogonal TE11 modes thus providing the necessary dual polarization. As confirmed by simulations and measurements the gain and side lobe levels of the new low loss antenna are comparable to those of the old antenna.