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THE MICROWAVE RADIOMETER SIGNATURE OF ARTIFICALLY GENERATED SEA FOAM

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ABSTRACT

Microwave radiometer experiments have been undertaken to measure the thermal emission from artificially generated sea foam. This data will be used to quantify the physics of emission from the ocean to more accurately retrieve geophysical parameters of interest.

INTRODUCTION

There have been a series of aircraft measurements conducted by the Goddard group which unquestionably show that the microwave brightness temperature significantly increases with the percent foam coverage in the field of view of a radiometer. The discovery of this phenomenon suggested that microwave radiometers can be used to infer surface wind speed, since the percentage foam increases with increasing wind speed.

In order to conduct a comprehensive set of measurements, which would be extremely expensive if conducted from aircraft, a device was built which artificially generate foam. Measurements were then undertaken as function of radiometer frequency, viewing angle, and polarization with percent foam as a parameter.

The Foam Generator

The device is 4 x 4 feet square, and foam is generated by passing air through an array of porous glass "frits" and into a layer of saline water above the frits. The percent foam is controlled by regulating the air flow through the frits. The percent foam can be generated with good repeatibility, so that extensive radiometric measurements can be conducted a a function of viewing angle, frequency, and polarization over a known target.

Experimental Results

Measurements have been performed at X-band (10.69 GHz) and at S-band (2.65 GHz), and planning is underway to obtain measurements at K-band (37 GHz). Some of the initial S-band results are shown in the figures. Figure 1 shows absolute brightness temperature plotted vs angle with air flow, and hence, percent foam as a parameter for vertical polarization. The curve shows a rather dramatic increase in brightness as the percentage foam increases, and reaches an emissivity of approximately 0.9 at the highest air flow rate (near 100% foam coverage). The curve also shows that the Brewster angle occurs at lower values of the angle of incidence as the flow rate increases. This suggests a lowering of the dielectric constant of the target. Figure 2 shows the corresponding curves for horizontal polarization. This polarization also shows a substantial increase in brightness temperature at all angles of incidence as the air flow rate is increased. Figure 3 shows the increased brightness temperature as a function of air flow for both polarizations at a viewing angle of 55°. This curve indicates that horizontal polarization is much more responsive to changes in the percent foam coverage than is the vertical polarization - particularly as the surface becomes completely covered with foam. Satellite systems should therefore utilize the horizontal polarization in order to infer high wind speed.

An analytical model for the emissivity of foam will be generated when data is reduced at other electromagnetic frequencies.

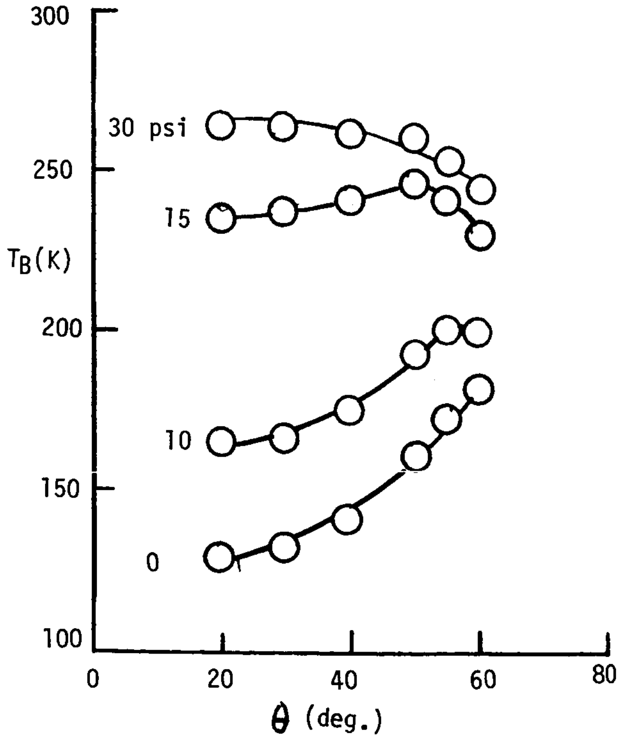

Fig. 1-Brightness temperature vs viewing angle (2.65 GHz, vertical polarization). Air flow in pounds per square inch.

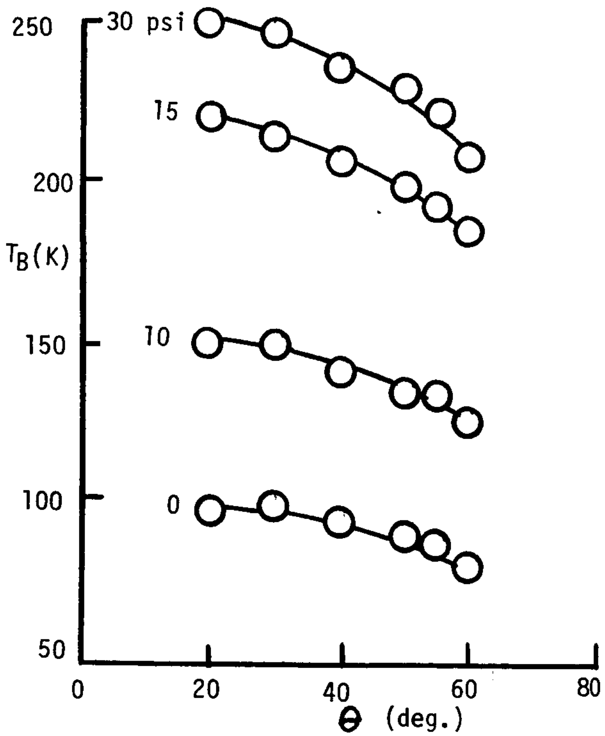

Fig. 2-Brightness temperature vs viewing angle (2.65 GHz, horizontal polarization). Air flow in pounds per square inch.

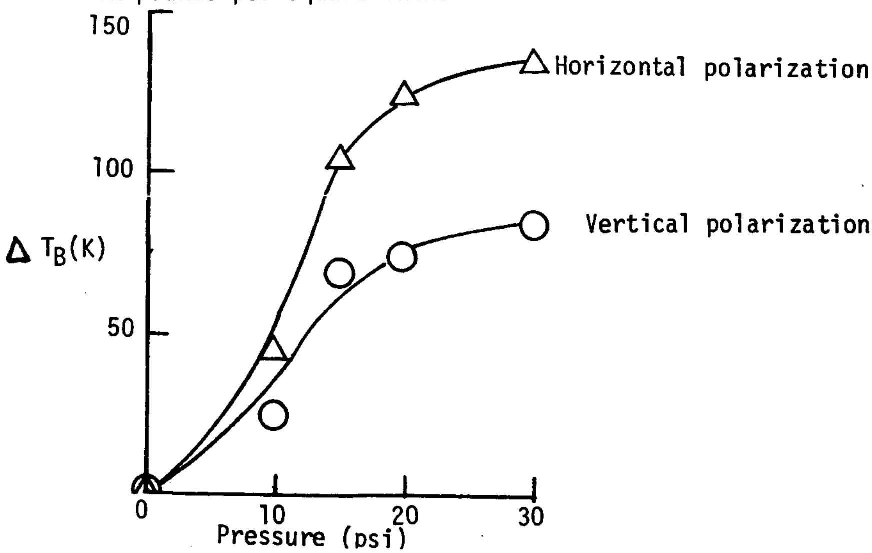

Fig. 3-Increased brightness temperature vs air flow in pounds per square inch (2.65 GHz, 55° viewing angle).