Ka-band Polarimetric Radiometer Calibration: Results from Recent Field Measurements

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The Ka-band Polarimetric Radiometer (KaPR) was designed and fabricated at the University of Massachusetts for ground- and platform-based brightness temperature measurements of geophysical media. This radiometer is fully polarimetric, i.e. it measures all four Stokes parameters. This paper reports the techniques for calibration of KaPR's brightness temperature measurements. The two receiver channels measuring horizontally and vertically polarized brightness temperatures are considered to be linear. The relationship between the input and output power of the radiometer is calibrated using two reference sources, a cold source and a hot source. The cold source is obtained through a tipcurve measurement to obtain the cosmic background radiation, considered to be 2.7 K (isotropic) in this frequency band. A quantitative measure of tipcurve goodness was developed to estimate the accuracy of the cold source measurement. An ambient load consisting of microwave absorber of nearly unity emissivity is used as a hot source reference. To ensure accurate calibration, the cold source and hot source measurements are both performed before the thermal conditions in the radiometer change significantly. Long-term gain variations of the system are corrected through frequent external calibration using tipcurve and ambient load measurements.

The stability of the radiometer's internal temperature is also crucial since many radiometer subsystems are sensitive to temperature variation. Very good temperature stability in the system is achieved by employing a thermoelectric heat/cool system. However, in most weather conditions short-term gain variations still exist. Internal reference noise source measurements are used to correct short-term gain variations, on the time scale of tens of seconds or less (I. Corbella et al., *IEEE Trans. Microwave Theory Techniques*, **50**, 1816-1820, 2002).

The calibration circle technique is used to calibrate U and V, the third and fourth Stokes parameters (A. Camps et al., *Radio Science*, **32**, 1821-1832, 1997). In this procedure, an internal reference noise source is input to both channels, and the phase in one of the receiver channels is varied from 0 to 360 degrees using a programmable phase shifter. The output obtained is an ellipse due to several potential error sources. A small change in the path length of one receiver channel with respect to the other introduces significant phase errors. The measured "calibration circle" is modeled by a best-fit ellipse using the least squares method. The gains of the U and V channels are calculated using the reference noise source input power and the axes of the best-fit ellipse. Finally, offset and phase errors are calculated from the ellipse.

During field measurements, platform pitch and roll motions introduce errors in the brightness temperature measurements due to incidence angle variation and polarization basis rotation. A correction algorithm is used to compensate for these fluctuations (I. Corbella et al., *IEEE Trans. Geosci. Remote Sensing*, **39**, 193-195, 2001). Results are presented from three experiments to measure the polarimetric emission of the ocean surface, including the FAIRS Experiment aboard the R/V FLIP in the eastern Pacific Ocean in 2000 and the POEWEX Experiment during October 2002.