Calibration of an L-Band Soil Moisture Radiometer Using System Identification Techniques

Miao Tian, *Student Member IEEE* and Albin J. Gasiewski, *Fellow, IEEE*

Center for Environmental Technology
Department of Electrical and Computer Engineering
University of Colorado at Boulder

October 12, 2007

ABSTRACT

This study focuses on the application of statistical system identification techniques to accurately calibrate a radiometer using internal noise references and front-end thermal measurements. Unlike the conventional two-load technique by assuming a simple affine relationship between the radiometer output voltage and input antenna temperature, to be general we treat a radiometer as a linear instrument with a number of unknown front-end parameters in addition to system gain and offset and then derive a general expression for the response of the radiometer to antenna temperature, with additional input data being the measured temperatures of all front-end components. Detailed response expressions are available for each of three calibration states: scene view, internal calibration cold and hot view.

According to the nature of fluctuation mechanisms in radiometers, for the gain variations we use a statistical method based on linear minimum mean-square error (LMMSE) estimation to determine the gain on a short time scale, then system identification based upon an orthogonal set of system thermal perturbations to estimate the deterministic response to thermal fluctuations on longer time scales. The process is iterated until convergence, with manufacturer's specifications and laboratory measurements of the components used to determine an estimate the system gain and offset to first order. This technique is applied to the calibration of an L-band soil moisture radiometer to estimate its system parameters. Calibration experiments which used the cold cosmic background as a radiation field for comparison were performed during July, 2007. The paper will present the comparison results illustrating the stability of the calibrated radiometer data under random thermal fluctuations. Figure 1(a) shows a comparison of sky temperature measurements between conventional and LMMSE techniques and 1(b) only shows the sky temperature measured from LMMSE.

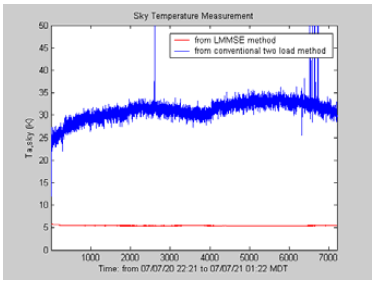

Fig. 1(a)

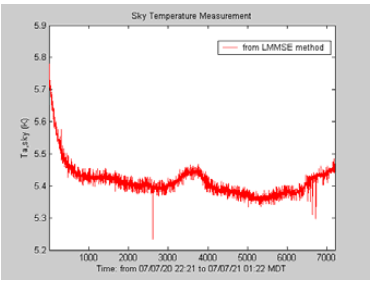

Fig. 1(b)