CAPABILITIES OF A MICROWAVE RADIOMETER NETWORK FOR TOMOGRAPHIC RETRIEVAL OF THE 3D-WATER VAPOR FIELD

Flavio Iturbide-Sanchez[1], Steven C. Reising[2], Robert W. Jackson[3]

[1]Microwave Remote Sensing Laboratory, University of Massachusetts, Amherst, MA 01003
[2]Microwave Systems Laboratory, Colorado State University, Fort Collins, CO 80523-1373
[3]Laboratory for Microwave and Millimeter-wave Devices and Applications, University of Massachusetts, Amherst, MA 01003

Recently, the maturation of MMIC technology has provided potential reductions in the volume, weight and cost of microwave and millimeter-wave radiometers for Earth remote sensing. Small and low-cost radiometers make feasible the implementation of two and three-dimensional (2-D and 3-D) arrays of sensors because they can be designed and produced in relatively large quantities. An example of the reductions afforded by MMIC technology is the prototype Miniaturized Water Vapor profiling Radiometer (MWVR), developed at the University of Massachusetts and recently moved to Colorado State University.

By mathematically combining information sensed at different times and from array elements at different positions, it is possible to produce an estimate of the object observed in both space and time. Although numerous mathematical methods are capable of retrieving the source field, 3-D emission tomographic methods are selected to retrieve the water vapor density in the atmosphere as a function of both altitude and horizontal position from measurements using a 2-D array of water vapor profiling microwave radiometers. 3-D emission tomography takes as input a set of emission measurements at discrete viewing angles and positions and provides an optimal solution to the inverse problem; i.e., the spatial structure and density of the source of the emission. When a time series of measurements is available, the 3-D tomographic solution is in reality a 4-D solution, using time as the fourth dimension.

Measurements from a small, 2-D network of ground-based radiometers can be combined using 3-D emission tomography to retrieve the 3-D water vapor field in the troposphere. In this paper, the choice of both a receiver topology and a scanning strategy are examined, based on both logistical constraints and calculated expectations of retrieval errors. The retrieval accuracy depends not only on the accuracy of the tomographic techniques and the positions/viewing angles of the radiometers, but also on single-sensor considerations such as the altitude resolution of radiometric sounding and the beamwidth of each radiometer.

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1. (a)
Steven Reising
Electrical and Computer Eng.
1373 Campus Delivery
Colorado State University
Fort Collins, CO
80523-1373 USA
reising@ieee.org
(b) 970-491-2228
(c) 970-491-2249

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3. (a)

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