# Preface to special section: Remote Sensing of the Earth's Environment by Microwave Radiometers and Radar

Ed R. Westwater

Cooperative Institute for Research in Environmental Sciences, University of Colorado/NOAA, Environmental Technology Laboratory, Boulder, Colorado, USA

J. Vivekanandan

Research Applications Program and Atmospheric Technology Division, National Center for Atmospheric Research, Boulder, Colorado, USA

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## 1. Introduction

[1] The Specialist Meeting on Microwave Remote Sensing 2001 (MRS'01) was held in Boulder, Colorado, on 5–9 November 2001. This meeting combined the 8th International Union of Radio Science (URSI) Commission *F* Symposium on Microwave Remote Sensing of the Earth, Oceans, Ice, and Atmosphere and the 7th Specialist Meeting on Microwave Radiometry. Meetings of both of these groups have been conducted on a regular basis since the late 1970s. Papers presented during the 2001 meeting illustrated state-of-the-art international remote sensing techniques and applications using microwave radar and radiometry from spaceborne, airborne, and surface-based platforms. The keynote talk, entitled "Airborne vectorized microwave imaging of the Earth," was given by Dr. Albin Gasiewski of the NOAA/Environmental Technology Laboratory. Oral and interactive sessions were held on the following topics: radar and radiometric polarimetry (including imaging); radar and radiometric calibration; advanced instrument techniques; satellite remote sensing of the atmosphere, land surface, and vegetation; ground-based remote sensing of the atmosphere and ocean; radiometric/radar modeling of scattering, emission, and radiative transfer; and special campaigns and field experiments. In addition to Commission *F* of URSI, sponsors of the meeting included: the IEEE Geoscience and Remote Sensing Society, the National Oceanic and Atmospheric Administration, the National Center for Atmospheric Research, and the National Aeronautics and Space Administration. Roughly 150 participants from 20 countries attended, and 153 papers (108 oral and 45 interactive) were presented. The 41 manuscripts accepted for publication in these two consecutive volumes of *Radio Science* (parts 1 and 2) represent a cross section of work presented at MRS'01, and it is hoped that these papers, in addition to being a valuable summary for conference attendees, will be of interest to the entire radio science community.

[2] A number of leading microwave specialists were invited to present papers representing their current research. One of the first to be invited was Dr. Yuri Trokhimovski of the Space Research Institute in Moscow, Russia. Although he accepted this invitation and originally had planned to attend, he developed a fatal illness and died on 2 February 2002. He was born on 26 July 1957 in Moscow, received a M. S. in space plasma physics from the Moscow Institute of Physics and Technology in 1980, and received a Ph.D. in experimental physics from the Space Research Institute, Russian Academy of Sciences, in 1983. Dr. Trokhimovski was internationally recognized as a leader in remote sensing


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of the ocean surface by radar and radiometry, and he published extensively in this field, including an article in this special section. This premature loss of an esteemed colleague and friend is felt by the remote sensing and radio science communities.

## 2. Special Section Topics Included in Part 1

### 2.1. Advanced Instrument Techniques and Calibration

[3] Eighteen oral and four interactive presentations were made on advanced instrument techniques with almost equal emphasis on radiometers and radar. In radiometry, several papers described polarimetric and synthetic aperture instruments for remote sensing of the Earth's surface, and several radar papers outlined techniques for measuring rain from ground-, aircraft- and space-based platforms. The paper by *Corbella et al.* [2003] presents a method to assess the performances of a space-borne interferometric radiometer measuring the brightness temperature of the Earth (ground and sea) surface. *Kutuza and Zagorin*'s [2003] paper describes the design of an instrument for spaceborne applications. *Rotbøll et al.* [2003] describe a fully polarimetric radiometer of the correlation type intended for L-band airborne measurements of polarimetric sea signatures. *Waldteufel et al.* [2003] describe the accuracy and resolution of a two-dimensional (2-D) synthetic aperture radiometer designed for global monitoring of soil moisture and salinity. *Tanner and Riley* [2003] describe the design of two new high-stability microwave water vapor radiometers along with a performance evaluation. Radar papers include a technique to measure rain from space in the paper by *Meneghini et al.* [2003], and *Zhang et al.* [2003] present error analyses and optimum configurations for spaced antennas.

[4] The session on radar and radiometric calibration had ten oral and two interactive presentations, with several devoted to calibration of synthetic aperture radiometers. Other topics included calibration of frequency modulated continuous wave (FMCW) millimeter-wave radars, synthetic aperture radar (SAR), and polarimetric radars. The paper by *Anterrieu et al.* [2003] describes the Soil Moisture and Ocean Salinity (SMOS) mission, which is a European Space Agency-led project aimed at global monitoring of surface soil moisture and sea surface salinity from spaceborne radiometric L-band observations. *Capsoni and Caboni* [2003] show that radiometers can be used to calibrate a single parameter radar and specifically to define the relationship between radar reflectivity and specific attenuation. *Vivekanandan et al.* [2003] present a novel method of calibrating radar reflectivity using polarization radar measurements in rain. In the last paper of this topic, *Fujita et al.* [2003] describe a polarization-rotating retrodirective reflector of Van Atta array design as a reference target for polarimetric calibration of a synthetic aperture radar.

### 2.2. Ground-Based Remote Sensing of the Atmosphere and Ocean

[5] Twenty-one oral and ten interactive papers were given in this session, describing radiometric, global positioning satellites, and radar techniques. Geophysical parameters that are sensed include sea spikes; foam and ocean roughness; sea-air temperature difference; boundary layer turbulence; atmospheric temperature, water vapor, cloud liquid, and rain; refractivity parameters; and satellite validation. Papers that describe ground-based (GB) passive sensing of the atmosphere include a paper in two parts by *Löhnert and Crewell* [2003] (part 1) and *Crewell and Löhnert* [2003] (part 2). Part 1 discusses the theory and accuracy of several measurement selections, and part 2 discusses the effects of measurement and absorption model errors on retrieval accuracy. In the paper by *Ruzhentsev* [2003], brightness temperature observations at 94 and 38 GHz are analyzed for a variety of cloudy conditions to infer cloud liquid content and temperature. Other ground-based papers to study the atmosphere include those by *Bosisio and Drufuca* [2003] (by a tomographic technique, angular scans from a ground-based radiometer are used to derive 2-D absorption structure), *Kadygrov et al.* [2003] (several low-altitude parameters are derived from a single-frequency scanning 5-mm radiometer), *Kutuza* [2003] (theoretical relations and experimental data are given to illustrate the temporal behavior of downwelling brightness temperature at 0.8 and 1.35 cm), *Cimini et al.* [2003] (scanning microwave and infrared radiometers are used in a tropical ocean experiment to derive boundary layer and oceanic temperature). A final passive GB paper by *Trokhimovski et al.* [2003] presents results of polarimetric microwave measurements of thermal emission from a water surface with artificial periodic structures.

[6] Ground-based radar techniques to observe the ocean surface are presented by *Gerstoft et al.* [2003] (estimation of low-altitude atmospheric refractivity from radar sea clutter observations), *Bolen and Chandrasekar* [2003] (they discuss verifying radar measurements from space), and *Smirnov et al.* [2003] (a two-scale model of a rough surface illuminated by a radar including a comparison of predictions with GB radar observations at 9.3 and 34.6 GHz).

## 3. Special Section Topics Included in Part 2

### 3.1. Satellite Remote Sensing, Including Polarimetry and Imaging

[7] Satellite remote sensing of the ocean and atmosphere is now a very mature, but active, science, as

evidenced by 20 oral and 12 interactive presentations. Topics included precipitation and hurricane monitoring, joint GPS and satellite water vapor measurements, data assimilation of satellite data into forecast models, sensing of wind speed and direction, salinity, sea surface temperature, and surface velocity in rivers. The paper by *Weng et al.* [2003] develops a postlaunch calibration scheme to sense clouds and precipitation using Advanced Microwave Sounding Unit (AMSU) window channel measurements. Other papers include that by *Meissner and Wentz* [2003] (a model of vertically and horizontally polarized brightness temperatures at 85.5 GHz that were measured by the Special Sensor Microwave Imager F13 over the oceans), and the effects of atmospheric stability on ocean observations are presented by *Shibata* [2003]. Three papers discuss problems associated with measurements of sea surface salinity from space: those by *Koblinsky et al.* [2003] (a discussion of Aquarius, a NASA/Earth System Science Pathfinder mission that proposes to make the first ever global measurements of sea surface salinity); *Skou* [2003] (a discussion of ionospheric effects on L-band brightness temperatures over the oceans when estimating sea surface salinity); and *Dinnat et al.* [2003], in which various factors affecting L-band emissivity models are discussed.

[8] Sixteen oral and five interactive papers were presented in the session on satellite remote sensing of the land surface and vegetation. Topics included modeling of land surface processes; remote sensing of soil moisture, forests, and snow; and AMSU operational hydrological products. Sensing of soil moisture is discussed by [*Morland et al.*, 2003]. *Kelly and Chang* [2003] discuss methods to infer snow depth from satellite observations. *Jezek et al.* [2003] describe two distinct missions to map Antarctica using SAR.

### 3.2. Field Campaigns, Theory, and Algorithms

[9] The derivation of geophysical parameters from remote measurements depends strongly on models that relate these parameters to radiometric, GPS, or radar measurements. Sophisticated models describing electromagnetic interactions with the ocean surface, soil, ice, rain, snow, and water vapor were presented in the 16 oral and 9 interactive papers of this session. A paper that applies measurements from an ocean campaign to techniques using a synthetic aperture radiometer to measure salinity is presented by *Camps et al.* [2003]. *Selbach et al.* [2003] described a campaign to study atmospheric water vapor. A sophisticated model to predict the effects of ocean currents on microwave measurements is presented by *Godin and Irisov* [2003]. Several papers consider remote sensing of the atmosphere and were devoted to the Tropical Rainfall Monitoring Mission (TRMM): those by *Bennartz and Bauer* [2003] (a study of the response of passive microwave observations to ice particle scattering and surface emissivity for frequencies at 85, 150, and 183 GHz); *Di Michele et al.* [2003] (a proposed statistical methodology to combine measurements from spaceborne microwave radar and radiometers); and *Tassa et al.* [2003] (a cloud-model based statistical retrieval technique for estimating surface precipitation and cloud profiles over ocean, called Bayesian Algorithm for Microwave Precipitation Retrieval (BAMPR)). The effect of retrieval algorithms is studied by *Mitnik and Mitnik* [2003]. In the paper by *Liu and Weng* [2003], an algorithm is developed to retrieve sea surface wind vectors from satellite microwave polarimetry. An active technique to measure water vapor is presented by *Eriksson et al.* [2003]. Finally, neural network retrieval techniques are applied to limb-sounding observations by *Jiménez et al.* [2003].

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J. Vivekanandan, Research Applications Program and Atmospheric Technology Division, National Center for Atmospheric Research, P. O. Box 3000, Boulder, CO 80307, USA. (vivek@ucar.edu)

E. R. Westwater, Cooperative Institute for Research in Environmental Sciences (CIRES), University of Colorado/NOAA, Environmental Technology Laboratory (ETL), 325 Broadway MS R/E/ET1, Boulder, CO 80305, USA. (Ed.R.Westwater@noaa.gov)