

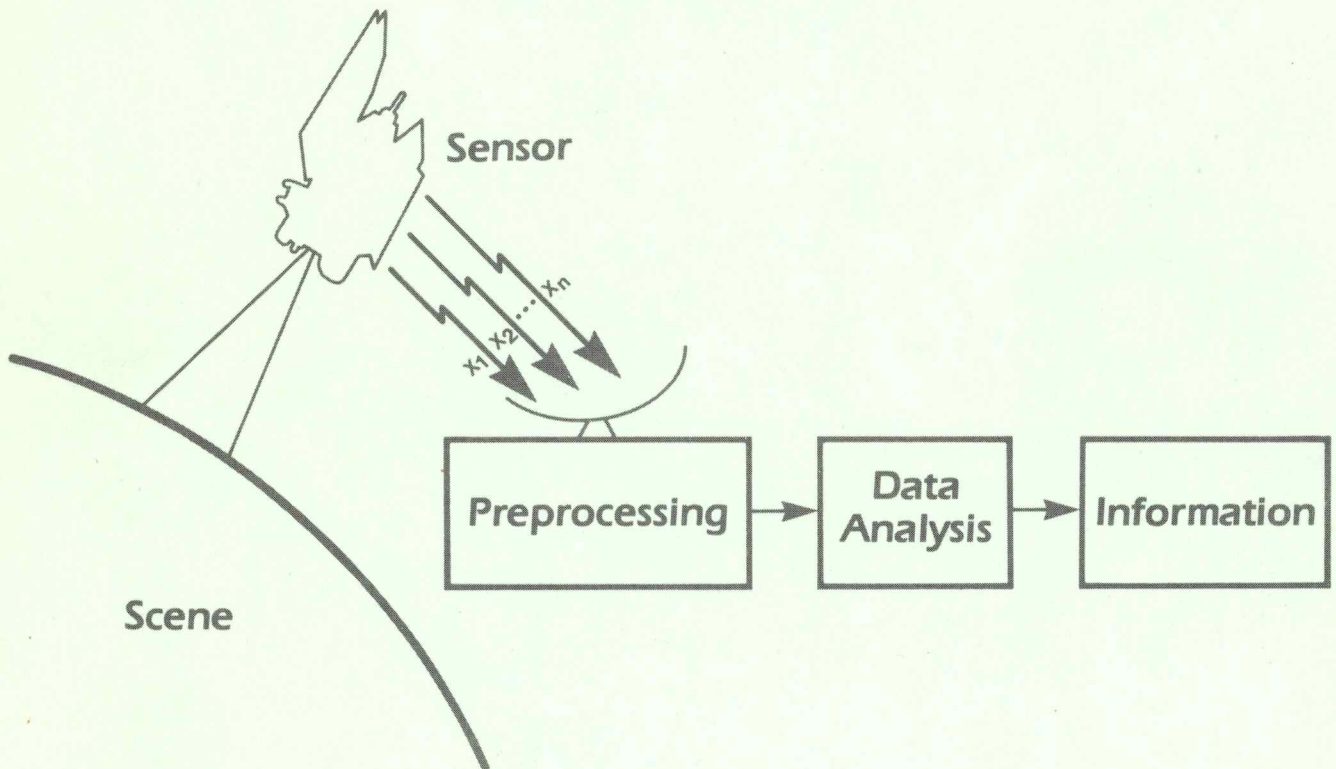
Jan

Eleventh International Symposium

Machine Processing of Remotely Sensed Data

with special emphasis on

Quantifying Global Process: Models, Sensor Systems, and Analytical Methods



June 25-27, 1985

Proceedings

Purdue University

Laboratory for Applications of Remote Sensing
West Lafayette, Indiana 47907 USA

Symposium at a Glance

	TUESDAY, JUNE 25	WEDNESDAY, JUNE 26	THURSDAY, JUNE 27
7:45	REGISTRATION - Fowler Hall		
8:00	OPENING PLENARY: GLOBAL BIOGEOCHEMICAL ISSUES Fowler Hall	3. GLOBAL PROCESSES Room 202 4. GEOLOGY Room 214 5. LANDCOVER HYDROLOGY Room 202	8. GEOGRAPHIC INFORMATION SYSTEMS Room 202 9. RADAR Room 214
12:00	Morning Breaks: 10:00-10:30 in Room 206. Visit the Exhibits.		
1:30	1. IMAGE PROCESSING I Room 202 2. ASSESSMENT OF TROPICAL ENVIRONMENT Room 214	6. MODELING ECOSYSTEMS Room 202 7. MULTISENSOR REMOTE SENSING STRATEGIES Room 214	10. IMAGE PROCESSING II Room 202 11. AGRICULTURAL REMOTE SENSING Room 214 12. POSTER SESSION Room 206
5:00	Afternoon Breaks: 3:00-3:30 in Room 206. Visit the Exhibits.		
5:30	<div style="border: 1px solid black; padding: 5px; text-align: center;"> INTERNATIONAL BANQUET St. Thomas Aquinas Center </div>		
7:30			

Eleventh International Symposium

**Machine Processing of
Remotely Sensed Data**

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**Quantifying Global Process:
Models, Sensor Systems, and Analytical
Methods**

June 25-27, 1985

Purdue University

Laboratory for Applications of Remote Sensing
West Lafayette, Indiana 47907 USA

Edited by S.K.Mengel and D.B.Morrison

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Preface

The theme of the Symposium - Quantifying Global Processes: Models, Sensor Systems, and Analytical Methods represents a re-dedication to the science of remote sensing, a change in emphasis both small and significant. At one level, the technology of remote sensing is well established and widely available; for example, anyone may purchase data, acquired by a satellite-borne sensor (Landsat), showing a synoptic view of a portion of the earth. Robust and accepted analysis techniques, some under development for more than 15 years, are implemented as commercially available hardware and software. Specialized companies will provide that analysis in a timely manner and competitively priced.

Yet a feeling exists that we do not know well the tool that is remote sensing. Its ultimate potential is not always obvious because too often we don't have knowledge of the science accompanying it. Papers in this symposium address this issue from two perspectives.

First, remote sensing is considered from an external perspective, as a unitized tool providing an alternate source of information of critically important problem areas. Some of these papers consider what this multidisciplinary tool might tell us about processes on the earth at not only the local and regional scales, but at the global scale. Using remote sensing techniques, can we gain better understanding of the causes and impact of acid precipitation on the environment of the world? How can these techniques better estimate the biological condition of vegetation or estimate environmental fluxes of elements and molecules and their influence on climate?

Secondly, from an internal perspective, the science in remote sensing techniques is addressed. These papers examine, for example, the linkage between remote sensing data and geographic information systems (GIS), the development of new state-of-the-art sensors and techniques for analysis of their data, and strategies for employing data from multiple sensors.

The breadth and diversity of the presentations is noteworthy. The remote sensing community is growing, actively enrolling more disciplines and addressing a widening range of issues.

Keith R. Carver, Co-Chairman Vern Vanderbilt, Co-Chairman

Symposium Chairmen

Keith R. Carver

Dr. Keith R. Carver received his B.S. in EE from the University of Kentucky in 1962, then received his M.S. and Ph.D. in EE from Ohio State University in 1963 and 1967 respectively. He was a member of the faculty at the University of Kentucky from 1967 to 1969. From 1969 to 1984 he was on the faculty in electrical engineering at New Mexico State University in Las Cruces.

From 1981 to 1982 Dr. Carver was on leave at NASA Headquarters where he was the microwave remote sensing program manager. From 1982 to 1984 he was the Director of the Engineering Research Center at New Mexico State University. In 1984 he accepted the position of Head of the Electrical and Computer engineering department at the University of Massachusetts.

Professor Carver has published extensively in microwave antenna engineering and microwave remote sensing. He was the recipient of the NASA Public Service award in 1983, the IEEE Centennial Medal in 1984, and distinguished service award of IEEE Geoscience and Remote Sensing Society in 1984. He is past President of the IEEE Geoscience and Remote Sensing Society. Currently Dr. Carver is Chairman of the SIR-C Science Working Group and the NASA EOS SAR panel.

Vern C. Vanderbilt

Dr. Vanderbilt was born in Toledo, Ohio on February 23, 1946. He received the B.S., M.S., and Ph.D. degrees in Electrical Engineering from Purdue University, West Lafayette, Indiana in 1968, 1971, and 1976, respectively.

From 1977 to 1979, he was a post-doctoral fellow at Purdue University Laboratory for Applications of Remote Sensing (LARS). He is currently a research engineer with LARS measuring and modeling the optical properties of both leaves and plant canopies. He is a member of IEEE, ASP, and Sigma Xi.

Sponsorship

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Kamlesh Lulla

Berrien Moore, III

David L. Peterson

Vincent Salomonson

Table of Contents

PREFACE	i	Image Processing On A Personal Computer H. J. Myers, R. Bernstein	34
SPONSORSHIP, SYMPOSIUM PROGRAM COMMITTEE, AND SESSION CHAIRMAN	iii	Which Calibration-Pulse Location Method is Robust? F. J. Gunther	35
TABLE OF CONTENTS	v	Estimation of The Location Parameter of A Multispectral Distribution By A Median Operation C. A. Pomalaza-Raez, Y.S. Fong	41
SESSION INDEX	ix		
OPENING PLENARY SESSION: GLOBAL BIOGEOCHEMICAL ISSUES	1		
The Earth as a System F. Bretherton	3		
The Evolution of Remote Sensing Science and Applications J. McElroy	4		
Remote Sensing In The Space Station Era D. Landgrebe	12		
Remote Sensing Instrumentation: Meeting the Challenge of Global Information Requirements S. Tilford	13		
1. IMAGE PROCESSING I	15		
High Accuracy Clustering Using Residual Image K. Fukue, H. Shimoda, T. Sakata,	17		
Multispectral Change Detection Using Difference Classification and Bitemporal Classification G.M. Halev	26		
2. ASSESSMENT OF TROPICAL ENVIRONMENT	49		
Some Observations on Remote Sensing of Tropical Environment K. Lulla	51		
A Microcomputer-Based Training Center For Remote Sensing and Resource Analyses: The Indonesian Example S. C. Ahearn, R. W. Kiefer, L. L. Seidl, U. S. Wiradisastra	53		
The Emergence of Airborne Video Techniques as an Alternative For Accessing Tropical Environments (A Historical Perspective) R. D. Mower	59		
Forest Cover Alteration Near the Town of Xinguara in the Brazilian Amazon S. E. Dicks	65		
The Incorporation of AVHRR Data in Operational Agroclimatic Assessment Programs in Thailand and Malaysia G. E. Johnson	66		

3. GLOBAL PROCESSES	67	The Study of The Natural Geographic Differences In The Coastal Areas of Water Covered Parts of Marmara Region in Turkey with the Help of Landsat-4 MSS Data Using an Unsupervised Classification Algorithm with Euclidean Distance	I. D. Maktav	122
A Global Model of Carbon-Nutrient Interactions	69			
B. Moore III, P. Gildea, C. Vorosmarty, J. Melillo, B. Peterson, B. Bergquist, K. Nadelhoffer				
Field and Airborne Spectral Characterization of Suspected Acid Deposition Damage in Red Spruce (<i>Picea rubens</i>) From Vermont	71	Calibration of Landsat-4 and 5 TM Thermal IR Data For Earth Surface Temperature Mapping	L. A. Bartolucci, D. F. Lozano-Garcia, P. E. Anuta	128
B. N. Rock, D. L. Williams, J. E. Vogelmann				
4. GEOLOGY	83	Assessment and Trends of Florida's Marine Fisheries Habitat: An Integration of Aerial Photography and Thematic Mapper Imagery	K. D. Haddad, B. A. Harris	130
Reconnaissance Clay Mineral Mapping in Southwestern Ontario by Microcomputer Processing of Radiometer Reflectance Data	85	6. MODELING ECOSYSTEMS		139
D. R. Gladwell, D. J. Boyd R. E. Lett		Adding Spatial Considerations to the JABOWA Model of Forest Growth	D. B. Botkin, T. E. Reynales, K. D. Woods	141
Direction-dependent Interpolation of Aeromagnetic Data	86	Detection of Biomass by an Empiric Albedo and Spectral Reflectance Model in the Sahara Desert from Landsat-Imagery	M. C. Mueksch	149
L. Brindt, H. Hauska				
Linear and Non-Linear Methods for Imaging Spectrometry	96	Modeling the Controls of Forest Productivity Using Canopy Variables	J. D. Aber, J. Fownes	157
J. E. Solomon				
Geological Applications of Thermal IR Remote Sensing on Mars	97	Hierarchical Classification of Multitemporal/ Multispectral Scanner Data	D. F. Lozano-Garcia, R. M. Hoffer	162
P. R. Christensen				
Processing of Thermal IR MSS Scanner Data (TIMS)	98	7. MULTISENSOR REMOTE SENSING STRATEGIES		171
A. B. Kahle		Analysis of Data Acquired by Shuttle Imaging Radar SIR-A and Landsat Thematic Mapper Over Baldwin County, Alabama	S.T. Wu	173
Use of Narrow Band Near IR Airborne MSS Data for Mineral Mapping	99	Processing of Multi-Sensor Remotely Sensed Data To A Standard Geocoded Format	T. A. Fisher, N. Minelli	183
M. H. Podwysoki, W. Collins				
5. LANDCOVER HYDROLOGY	101	Integration of High and Low Resolution Satellite Data for Crop Condition Assessment	R. J. Brown, C. Prevost	189
Hydrologic Modeling Using Landsat MSS Data	103			
D. P. Alexander, A. R. Rao				
A Measuring Reference System to Quantify the Desertification Process in a Semiarid Ecosystem Based on Landsat MSS Data	112			
J. C. de la Torre, J. H. Sasser, J. Lira				

Active and Passive Multispectral Thermal Infrared Remote Sensing for Mineral Identification A. B. Kahle, M. S. Shumate, D. B. Nash	197	Evaluation of the Information Content of a Shuttle Imaging Radar- B Multi-Angle Data Set P. W. Mueller, D. F. Lozano-Garcia, R. M. Hoffer, L. A. Bartolucci	266
Landsat MSS and Airborne Geophysical Data Combined for Mapping Granite in Southwest Nova Scotia V. R. Slaney	198	Preliminary Results of Four Polarization L-Band SAR Experiments D. Held	267
Estimation of Leaf Area Index and Biomass in Arboreal Forest Using Helicopter-Acquired C-Band Scaterometer and Optical Reflectance Data D. E. Pitts, G. D. Badhwar, E. Reyna	207	The SIR-C Experiment: Measuring New Variables From Space with SAR S. D. Wall	268
8. GEOGRAPHIC INFORMATION SYSTEMS	209	Design and Analysis of an X-Band Synthetic Aperture Radar for a Joint Mission with NASA.s Shuttle Imaging Radar H. M. Braun, W. Gilg, W. Kriegl,	271
Multisource Data Analysis in Remote Sensing and Geographic Information Processing P. H. Swain, J. A. Richards, T. Lee	211	10. IMAGE PROCESSING II	279
Satellite Remote Sensing Data as Input To Geographic Information Systems M. Ehlers, R. Welch	219	Global Environment Monitoring from Space -An Integrated Approach Using Remote Sensing J. Iisaka, D. G. Goodenough	281
A New Format Proposal F. C. Billingsley	220	Segmentation of SAR Imagery Using Gibbs Distribution Models H. Derin, H. Elliott, R. Soucy, J. Kuang	282
Landsat Thematic Mapper Geodetic Accuracy: Implications for Geocoded Map Compatability N. A. Bryant, A. L. Zobrist, R. E. Walker, B. Gokhmann	228	Range of Validity of Taylor Series Approach to Variance of Registration Error E. Salt, A. Wacker	292
9. RADAR	239	Forestry Change Detection with Thematic Mapper Data D. G. Goodenough, K. B. Fung, M. A. Robson	302
Semi-Operational Identification of Agricultural Crops from Airborne SLAR-Data P. Binnenkade, H. W. J. Van Kasteren, D. Uenk	241	Measurement of Thematic Mapper Data Quality R. C. Wrigley, C. A. Hlavka, J. S. Buis, R. A. Schowengerdt, C. Archwamety, D. H. Card	303
Radar Image Simulation as a Tool to Analyze Topographic Effects on Geometry and Radiometry of Radar Imagery G. Domik	248	A Clustering Algorithm for Remote Sensing Multispectral Data L. Dawei	315
Preliminary Science Results From The Shuttle Imaging Radar-B M. Ruzek	254	11. AGRICULTURAL REMOTE SENSING	319
		Agriculture Applications for Thermal Infrared Multispectral Scanner Data R. E. Pelletier, M. C. Ochoa, B. F. Hajek	321

The Tasseled Cap: Size, Shape and Orientation Changes Due to Soil Background A. R. Huete, R. D. Jackson	329	SESSION CHAIRMEN ADDRESS LIST	357
Spectral Delineation of Soils Derived from Alluvium Between Burhiganga and Meghna Rivers In Dhaka District, Bangladesh N. N. Chaudhuri, A. K. M. F. Bhuiyan, S. J. Kristof	338	AUTHOR ADDRESS LIST	359
		AUTHOR INDEX	367
POSTER PAPER PRESENTATIONS	339		
On Fast Feature Extraction (FFE) S. Bjornsson, J. A. Benidiktsson	341		
Examination of a Rapid Computational Approach Aimed at The High Precision Adjustment of TM Imagery for Distortions Due to Effects of Terrain M. L. Labovitz, J. W. Marvin, R. E. Wolfe	342		
Segmentation of Textured Images By A Maximum Likelihood Classifier Using Markov Mesh and Gaussian Joint Density Models A. Ioannidis, D. Kazakos	343		
Multi-Temporal vs Unit-Temporal Analysis of MSS Landsat Data On A Full State Basis S. B. Winings	344		
Sun Angle and Background Effects On Spectral Response of Simulated Forest Canopies K. J. Ranson, C. S. T. Daughtrv, L. L. Biehl	345		
An Integrated Approach For Vegetation/Landcover Mapping of Large, Inaccessible Areas M. Fleming	347		
Integrated Terrain Mapping With Digital Landsat Images in Mexico M. S. Perez, J. L. Aguilar, A. R. Alcantara	348		
Geological and Geomorphological Studies of Malwa Plateu (INDIA) Using Image Processing Technique - A Case Study S. K. Soni, A. N. Patel	349		
Wavelength Intensity Indices in Relation To Tree Condition and Leaf-Nutrient Content S. F. Shih, D. L. Myhre, G. J. Edwards, C. H. Blaquez, j. M. Gardner	350		

Session Index

OPENING PLENARY: GLOBAL BIOGEOCHEMICAL ISSUES	1
1. IMAGE PROCESSING I	15
2. ASSESSMENT OF TROPICAL ENVIRONMENT	49
3. GLOBAL PROCESSES	67
4. GEOLOGY	83
5. LANDCOVER HYDROLOGY	101
6. MODELING ECOSYSTEMS	139
7. MULTISENSOR REMOTE SENSING STRATEGIES	171
8. GEOGRAPHIC INFORMATION SYSTEMS	209
9. RADAR	239
10. IMAGE PROCESSING II	279
11. AGRICULTURAL REMOTE SENSING	319
12. POSTER PAPER PRESENTATIONS	339

Opening Plenary

Global Biogeochemical Issues

SESSION CHAIRMAN: Keith R. Carver

Dr. Keith R. Carver was born in Kentucky in 1940. He received his B.S. in EE from the University of Kentucky in 1962. He received his M.S. and Ph.D. from Ohio State University in 1963 and 1967 respectively, also in EE. Dr. Carver was a member of the faculty at the University of Kentucky from 1967 to 1969. From 1969 to 1984 he was on the faculty in the Department of Electrical Engineering at New Mexico State University in Las Cruces.

From 1981 to 1982 Dr. Carver was on leave from the University to be at NASA Headquarters where he was the microwave remote sensing program manager. From 1982 to 1984 he was the Director of the Engineering Research Center at New Mexico State University. In 1984 he accepted the position of Head of the Electrical and Computer Engineering Department at the University of Massachusetts.

Professor Carver has published extensively in microwave antenna engineering and microwave remote sensing. He was the recipient of the NASA Public Service award in 1983, the IEEE Centennial Medal in 1984. He is a past President of the IEEE Geoscience and Remote Sensing Society. Currently Dr. Carver is Chairman of the IEEE APS Distinguished Lecturer program, as well as being Chairman of the SIR-C Science Working Group and the NASA EOS SAR panel.

THE EARTH AS A SYSTEM

FRANCIS BREHERTON

National Center for Atmospheric Research
Boulder, Colorado

(Manuscript unavailable at time
of printing)

REMOTE SENSING IN THE SPACE STATION
ERA

DAVID LANDGREBE

Purdue University
Electrical Engineering Dept.
West Lafayette, Indiana

(Manuscript unavailable at
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REMOTE SENSING INSTRUMENTATION:
MEETING THE CHALLENGE OF GLOBAL
INFORMATION REQUIREMENTS

SHELBY TILFORD

National Aeronautics and
Space Administration
Washington, D.C.

1

Image Processing I

SESSION CHAIRMAN: David G. Goodenough

Dr. David Goodenough studied at the University of British Columbia in physics and subsequently obtained Masters and Doctorate degrees in astronomy from the University of Toronto. After several years teaching astronomy, he joined the Canada Centre for Remote Sensing where he is presently a Senior Research Scientist and Head of the Methodology Section. He has conducted extensive research in pattern recognition and image processing, particularly with regard to integration of data from aircraft and satellites. Dr. Goodenough is a member of the IEEE and the Canadian Remote Sensing Society. He has published more than 60 papers related to remote sensing. Presently, he is leading projects concerned with image analysis of thematic mapper image data and integration of geographic information systems with remote sensing image analysis systems.

IMAGE PROCESSING ON A PERSONAL COMPUTER

H. JOSEPH MYERS, RALPH BERNSTEIN

IBM Corporation
Palo Alto, California

(Manuscript unavailable at
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2

Assessment of Tropical Environment

SESSION CHAIRMAN: Kamlesh Lulla

Dr. Kamlesh Lulla is Assistant Director of Indiana State University Remote Sensing Laboratory and Assistant Professor of Remote Sensing and Physical Geography. Dr. Lulla received his B.Sc. (Hons) and M.Sc. (Hons) degrees in Ecology and Environmental Sciences. He obtained his first Ph.D. degree in Applied Ecosystem Ecology and his second Ph.D. degree in Remote Sensing and Physical Geography. Dr. Lulla has held postdoctoral positions in Europe India, and the United States. He is author of four chapters in Remote Sensing text books and over thirty-five papers in reputed journals. He is an active member of ASP, AAG and NCGE.

3

Global Processes

SESSION CHAIRMAN: Berrien Moore III

Dr. Berrien Moore III is on staff at the University of New Hampshire Complex Systems Research Center in Durham, New Hampshire.

4 Geology

SESSION CHAIRMAN: Anne B. Kahle

Dr. Kahle works at Jet Propulsion Laboratory
at Pasadena, California.

LINEAR AND NON-LINEAR METHODS FOR
IMAGING SPECTROMETRY

JERRY E. SOLOMON

Jet Propulsion Laboratory
Pasadena, California

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GEOLOGICAL APPLICATIONS OF THERMAL
IR REMOTE SENSING ON MARS

PHILLIP R. CHRISTENSEN

Arizona State University
Department of Geology
Tempe, Arizona

(Manuscript unavailable at
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PROCESSING OF THERMAL IR MSS
SCANNER DATA (TIMS)

ANNE B. KAHLE

Jet Propulsion Laboratory
Pasadena, California

(Manuscript unavailable at
press time)

USE OF NARROW BAND NEAR IR AIRBORNE
MSS DATA FOR MINERAL MAPPING

M. H. PODWYSOCKI, WILLIAM COLLINS

U. S. Geological Survey
Reston, Virginia

(Manuscript unavailable at
time of press)

5

Landcover Hydrology

SESSION CHAIRMAN: Vincent V. Salomonson

Dr. Vincent V. Salomonson is the Chief of the Laboratory for Terrestrial Physics at Goddard Space Flight Center and the Project Scientist for Landsat-4 and 5. At Goddard he has been seeking to assess the applications of space technology to research in the atmospheric and earth sciences for the past 16 years. Prior to Goddard, he spent three years as a Weather Officer in the United States Air Force. His academic training includes a B.S. degrees in Agricultural Engineering from Colorado State University, and in Meteorology from the University of Utah, and M.S. degree in Agricultural Engineering from Cornell University, and a Ph.D. in Atmospheric Science from Colorado State. He has approximately 90 publications in scientific journals, conferences proceedings, and NASA reports. He was Author-Editor of the Water Resources Chapter in the Second Edition of the Manual of Remote Sensing (Published 1983).

In 1975 he received the Goddard Exceptional Performance Award for his work as Chairman of the NASA Sub-discipline Panel for Water Resources. In 1976 Dr. Salomonson was awarded the NASA Exceptional Scientific Achievement Medal for outstanding contributions in the practical applications of remote sensing data to the water resources field. In 1983, he again received the NASA Exceptional Scientific Achievement Medal in recognition of his extensive contributions to land remote sensing for earth science and resource utilization.

6

Modeling Ecosystems

SESSION CHAIRMAN: David L. Peterson

Dr. Peterson is the Principal Scientist for biogeochemical cycling research in the Technology Applications Branch at NASA Ames Research Center. His interests are in the uses of remote sensing in conjunction with biological functional measurements for this discipline. He has conducted extensive applied research in forestry including inventory and modeling.

7

Multisensor Remote Sensing Strategies

SESSION CHAIRMAN: Joseph Cihlar

Dr. Cihlar works at the Canada Centre for
Remote Sensing in Ottawa, CANADA

ACTIVE AND PASSIVE MULTISPECTRAL THERMAL
INFRARED REMOTE SENSING FOR MINERAL
IDENTIFICATION

A. B. KAHLE, M. S. SHUMATE,
AND D. B. NASH JR.

Jet Propulsion Laboratory
Pasadena, California

(Manuscript unavailable at
press time)

ESTIMATION OF LEAF AREA INDEX AND BIOMASS
IN ARBOREAL FOREST USING HELICOPTER-
ACQUIRED C-BAND SCATEROMETER AND OPTICAL
REFLECTANCE DATA

DAVID E. PITTS, G. D. BADHWAR
AND E. REYNA

NASA/Johnson Space Center
Houston, Texas

(Manuscript unavailable at
press time)

8

Geographic Information Systems

SESSION CHAIRMAN: Frederic C. Billingsley

Fred Billingsley is a Technical Staff member in the Image Processing Applications and Development Section, Jet Propulsion Laboratory, California Institute of Technology, Pasadena, California, where he was responsible for building the Image Processing Laboratory. More recently, he has been supervisor of the Earth Resources Image Processing Group, a multi-disciplinary organization that is responsible for image processing for Landsat investigations. After a tour of duty at NASA Headquarters he returned to JPL, where he is now concerned with special tasks in data systems for advanced earth observations sensors. He has also been active on many NASA remote sensing working groups and committees. Mr. Billingsley is the author of many publications in the field of digital image processing and is the editor of the chapter on digital image processing in the Revised ASP Manual of Remote Sensing.

9

Radar

SESSION CHAIRMAN: Daniel N. Held

Daniel N. Held (S.67-M.68) Received the B.S., M.S., and ScD. degrees from Columbia University in 1968, 1971, and 1977, respectively.

He is presently Deputy Section Manager in the Radar Science and Engineering Section of the Jet Propulsion Laboratory, California Institute of Technology. He has been the principle investigator for a number of NASA Research Projects involved with the quantitative analysis and use of synthetic aperture radar data. He has recently been responsible for the SEASAT SAR Engineering performance evaluation which demonstrated the ultimate capability of that sensor to provide accurate cartographic and amplitude information. He has served in a radar system engineering capacity on the SIR-A, SIR-B, VOIR, and VRM programs, prior to his employment at JPL. He worked at the NASA Goddard Institute for Space Studies, where he was the system engineer/manager for the design, construction and testing of a millimeter-wave radio astronomy facility. Prior to Goddard, he worked for the Columbia University Astrophysics Laboratory on the HERO-A, X-ray Astronomy Satellite. Prior to the work at Columbia, he worked for the Bendix corporation, Navigation and control Division, on High-Resolution Solid-State Star Trackers.

Dr. Held is a member of the A.A.A.S. and Sigma Chi. He has served as a member of the Administrative Committee of the Geoscience and Remote Sensing Society of the IEEE. Two of his papers were awarded the 1978 "Microwave Prize", by the IEEE Microwave Theory and Technique Society for the best published paper of the year.

PRELIMINARY RESULTS OF FOUR POLARIZATION
L-BAND SAR EXPERIMENTS

DANIEL HELD

Jet Propulsion Laboratory
Pasadena, California

(Manuscript unavailable at
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10

Image Processing II

SESSION CHAIRMAN: Ralph Bernstein

Ralph Bernstein is a Senior Technical Staff Member at the IBM Palo Alto Scientific Center, Academic Computing and Information Systems Group, in Palo Alto, California. He joined the center in 1979 and is currently involved in image processing science, applications and systems development. He is a Principal Investigator on the current NASA Landsat-4 & 5 research program.

Mr. Bernstein has a B.S. and M.S. in EE from the University of Connecticut, and Syracuse University. He edited the book "Digital Image Processing for Remote Sensing". He has many publications in the field of digital image processing, geoscience, navigation, data management, and automatic control systems. He has patents and published disclosures in digital filtering, and automatic control systems.

He is a past member of the Space Science Board of the National Academy of Sciences (NAS), and a current member of the NAS Space Applications Board. He is chairman of the Space Applications Board Committee on Practical Applications of Remote Sensing from Space. He is also a consultant to the NASA Space Applications Advisory Committee (SAAC). Ralph Bernstein has received a number of awards and honors. Including election to Fellow of the Institute of Electrical and Electronics Engineers (IEEE), the IBM Outstanding Contribution Award, the NASA Medal for Exceptional Scientific Achievement. and election to Who's Who in America.

11

Agricultural Remote Sensing

SESSION CHAIRMAN: Edward T. Kanemasu

Dr. Kanemasu is a professor of agronomy and leader of the Evapotranspiration Laboratory at Kansas State University. He received B.S. and M.S. degrees from Montana State University and Ph.D. from the University of Wisconsin. He has been a faculty member at Kansas State since 1969 where he conducts research on evapotranspiration, water-use efficiency, radiation, energy and water balances, temperature and spectral reflectance characteristics, and growth and yield modeling of crops. Dr. Kanemasu is a Fellow of the American Society of Agronomy and has served as associate editor and technical editor of *Agriclimatology* and *Crop Modeling* for the *Agronomy Journal*.

12

Poster Paper Presentations

SESSION CHAIRMAN: Ernestine Cary

Ernestine Cary is a Ph.D. candidate in the Geography Department at Columbia University. Her dissertation research incorporates Landsat data in a study of agricultural systems in Western Kenya. She collected field data during her year as a Fulbright-Hayes Fellow, with support also from the National Geographic Society. Computer analysis is being done at the NASA/Goddard Institute for Space Studies, where she has also participated in AgRISTARS research

Before coming to GISS and Columbia University, she worked at the Laboratory for Applications of Remote Sensing (1971-76), where she was involved in technology transfer activities as well as in research. Her M.A. is in Geography from Columbia University, B.S. in Mathematics from Purdue University.

AN INTEGRATED APPROACH FOR VEGETATION/
LANDCOVER MAPPING OF LARGE, INACCESSIBLE AREAS

MICHAEL FLEMING

United States Government Services
EROS Field Office
Anchorage, Alaska

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Session Chairmen Address List

SYMPOSIUM CO-CHAIRMEN

Keith R. Carver
Electrical and Computer Engineering
University of Massachusetts
Amherst, MA 01003

Vern C. Vanderbilt
Purdue University/LARS
1291 Cumberland Avenue
West Lafayette, IN 47906

OPENING PLENARY SESSION

Keith R. Carver
Electrical and Computer Engineering
University of Massachusetts
Amherst, MA 01003

1. IMAGE PROCESSING I

David G. Goodenough
Canada Centre for Remote Sensing
2464 Sheffield Road
Ottawa K1A 0E 4
CANADA

2. ASSESSMENT OF TROPICAL ENVIRONMENT

Kamlesh Lulla
Remote Sensing Lab.
Geography Department
Indiana State University
Terre Haute, IN 47809

3. GLOBAL PROCESSES

Berrien Moore, III
University of New Hampshire
Complex Systems Research Center
O.Kane House
Durham, NH 03824-3535

4. GEOLOGY

Anne B. Kahle
Jet Propulsion Lab.
M/S 183-501
4800 Oak Grove Drive
Pasadena, CA 91109

5. LANDCOVER HYDROLOGY

Vincent Salomonson
National Aeronautics and
Space Administration
Goddard Space Flight Center
Greenbelt, MD 20771

6. MODELING ECOSYSTEMS

David L. Peterson
242-4 NASA/Ames Research
Center
Moffett Field CA. 94035

7. MULTISENSOR REMOTE SENSING STRATEGIES

Joseph Cihlar
Canada Centre for Remote
Sensing 717 Bellfast Road
Ottawa, CANADA K1A 047

8. GEOGRAPHIC INFORMATION SYSTEMS

Frederic C. Billingsley
Jet Propulsion Laboratory
4800 Oak Grove Drive
Pasadena, CA 91109

9. RADAR

Daniel Held
Jet Propulsion Laboratory
M/S 183-701
4800 Oak Grove Drive
Pasadena, CA 91109

10. IMAGE PROCESSING (II)

Ralph Bernstein
IBM Corporation
1530 Page Mill Road
Palo Alto, CA 94304

11. AGRICULTURAL REMOTE SENSING

E. T. Kanemasu
Kansas State University
E. T. Lab, Waters Annex
Manhattan, KS 66506

POSTER PAPER PRESENTATIONS

Ernestine Cary
Department of Environmental
Research
Cook College
P.O. Box 231 New Brunswick, NJ 08903

Author Address List

Aber, John D.
Department of Forestry
University of Wisconsin
Madison, Wisconsin 53705

Ahearn, Sean C.
Environmental Remote Sensing Center
1225 West Dayton Street
Madison, Wisconsin 53706

Aquilar, J. L.
Dpto. de Teledeteccion
Direccion General de Geografia
San Antonia Abad #124
06820 Mexico D.G., MEXICO

Alcantara, Ariel E.
Dpto. de Teledeteccion
Direccion General de Geografia
San Antonia Abad #124
06820 Mexico D.G.
MEXICO

Alexander, David P.
6 Kris Court
East Doncaster,
Victoria - 3109
Melbourne
AUSTRALIA

Archwamety, C.
Extraterrestrial Research
Division
Nasa/Ames Research Center
Moffett Field, CA 94035

Anuta, Paul E.
Purdue University/LARS
1291 Cumberland Avenue
West Lafayette, IN 47906

Badhwar, G. D.
NASA/Johnson Space Center
Biospheric Sciences Sec.
Houston, TX 77058

Bartolucci, Luis A.
Purdue University/LARS
1291 Cumberland Ave.
West Lafayette, IN 47906

Benidiktsson, J. A.
Laboratory for Inform.
Technology and Signal
Processing
University of Iceland
Reykjavik 107, ICELAND

Bergquist, B.
Ecosystems Center
Marine Biological Laboratory
Woods Hole, Maine

Bernstein, Ralph
IBM Corporation
1530 Page Mill Road
Palo Alto, CA 94304

Bhuiyan, A.K.M.F.
SPARRSO
BLANGLADESH

Biehl, Larry L.
Purdue University/LARS
1291 Cumberland Ave.
West Lafayette, IN 47906

Billingsley, Frederick C.
Jet Propulsion Lab.
4800 Oak Grove Drive
Pasadena, CA 91109

Binnenkade, P.
National Aerospace Lab.
NLR Amsterdam
The NETHERLANDS

Bjornsson, S.
Laboratory for Inform.
Technology and Signal
Processing
University of Iceland
Reykjavik 107, ICELAND

Blazque, C. H.
Citrus Research and Education
Center
University of Florida
Gainesville, Florida 32611

Botkin, Daniel B.
Environmental Studies Program
University of California
at Santa Barbara
Santa Barbara, CA 93106

Boyd, D.J.
Barringer Research Ltd.
304 Carlingview Drive
Rexdale, Ontario
CANADA M9W 5G2

Braun, Hans Martin
Dornier-System GmbH
7990 Friedrichsgafen 1
WEST GERMANY

Bretherton, Francis
NCAR
P.O. Box 3000
Boulder, CO

Brindt, Lars
Division of Physics
Lulea University of
Technology
S-951 87 Lulea
SWEDEN

Brown, Ronald J.
Canada Centre for Remote
Sensing
2464 Sheffield Road
Ottawa, Ontario
CANADA K1A0Y7

Brvant, Nevin A.
Jet Propulsion Lab
4800 Oak Grove Drive
Pasadena, CA 91109

Buis, J.S.
Extraterrestrial Research
Division
NASA/Ames Research Center
Moffett Field, CA 94035

Card, D.H.
Extraterrestrial Research
Division
NASA/Ames Research Center
Moffett Field, CA 94035

Chaudhuri, Nurun N.
SPARRSO
BANGLADESH

Chavez, J. Lira
Dpto. de Teledeteccion
Direccion General de
Geografia
San Antonio Abad #124
06820 Mexico D.F., MEXICO

Christensen, Phillip R.
Department of Geology
Arizona State University
Tempe, AZ 85287

Collins, William
U.S. Geological Survey
470 National Center
Reston, VA 22092

Daughtry, Craig S.
Purdue University/LARS
1291 Cumberland Ave.
West Lafayette, IN 47906

Derin, Haluk
Department of Electrical
and Computer Engineering
University of Massachusetts
Amherst, MA 01003

Dicks, Steve
Department of Geography
University of Florida
Gainesville, FL 32611

Domik, Gitta
Institute for Image
Processing and Computer
Graphics
Research Center Joanneum
Graz
Wastiangasse 6
A-8010 Graz
AUSTRIA

Edwards, G. J.
Citrus Research and Education
Center
University of Florida
Gainesville, Florida 32611

Ehlers, Manfred
Laboratory for Remote
Sensing and Mapping
Science
Department of Geography
University of Georgia
Athens, GA 30602

Elliott, H.
Department of Electrical
and Computer Engineering
University of Massachusetts
Amherst, MA 01003

Fisher, T. A.
Canada Centre for
Remote Sensing
2464 Sheffield Road
Ottawa K1A 0E4
CANADA

Fleming, Mike
USGS/EROS Field Office
4230 E. University Drive
Anchorage, AK 99508-4664

Fong, Y.S.
Clarkson College
Department of Electrical
and Computer Engineering
Postdam, NY 13676

Fownes, James H.
University of Wisconsin
Department of Forestry
Madison, Wisconsin 53706

Fukue, K.
Tokai University Research
and Information Center
2-28-4 Tomigaya
Shibuya-ku
Tokyo 151
JAPAN

Fung, K. B.
Canada Centre for Remote
Sensing
2464 Sheffield Road
Ottawa K1A 0E4
CANADA

Gardner, J. M.
Citrus Research and Education
Center
University of Florida
Gainesville, Florida 32611

Gildea, Patricia
University of New Hampshire
Complex Systems Research
Center
O.Kane House
Durham, NH 03824-3535

Gilg, Wolfgang
Dornier-System GmbH
Postfach 1360
7990 Friedrichsgafen 1
WEST GERMANY

Gladwell, D. R.
Barringer Research Ltd.
304 Carlingview Drive
Rexdale, Ontario
CANADA M9W 5G2

Gokhmann, B.
Jet Propulsion Lab.
4800 Oak Grove Drive
Pasadena, CA 91109

Goodenough, David G.
Canada Centre for
Remote Sensing
2464 Sheffield Road
Ottawa K1A 0E 4
CANADA

Gunther, Fred J.
Image Technology
Engineering Dept.
Computer Sciences Corporation
System Sciences Division
8728 Colesville Road
Silver Springs, MD 20910

Haddad, Kenneth
Florida Department of
Natural Resources
Bureau of Marine Research
100 Eighth Avenue, S.E.
St. Petersburg, FL 33701-5095

Hajek, Benjamin F.
Agronomy Department
Auburn University
Funchess Hall
Auburn, AL 36849

Haley, George M.
Santa Barbara Research
Center
Hughes Aircraft Corporation
75 Coromar Drive
Goleta, CA 93117

Harris, Barbara A.
Florida Department of
Natural Resources
Bureau of Marine Research
100 Eighth Avenue, S.E.
St. Petersburg, FL 33701-5095

Hauska, Hans
Division of Physics
Lulea University of Technology
S-951 87 Lulea
SWEDEN

Held, Daniel
Jet Propulsion Laboratory
M/S 183-701
4800 Oak Grove Drive
Pasadena, CA 91109

Hlavka, C. A.
Extraterrestrial Research
Division
NASA/Ames Research Center
Moffett Field, CA 94035

Hoffer, Roger M.
Forestry Department
Purdue University
West Lafayette, IN 47907

Huete, A. R.
U.S. Water Lab.
4331 East Broadway
Phoenix, AZ 85040

Iisaka, Joji
Canada Centre for
Remote Sensing
2464 Sheffield Road
Ottawa K1A 0E4, CANADA

Ioannidis, Antonis
SASC Technologies, Inc.
4400 Forbes Blvd.
Lanham, MD 20706

Jackson, Ray D.
U.S. Water Conservation Lab.
4331 East Broadway Road
Phoenix, AZ 85040

Johnson, Gary
NOAA/NESDIS
Room 200 Federal Bldg.
600 E. Cherry Street
Columbia, MO 65201

Kahle, Anne B.
Jet Propulsion Laboratory
MS 183-501
4800 Oak Grove Drive
Pasadena, CA 91109

Kazakos, Dimitri
Electrical Engineering
Department
University of Virginia
Charlottesville, VA

Kiefer, Ralph W.
Environmental Remote
Sensing Center
1225 West Dayton Street
Madison, WI 53706

Kriegel, Wolfgang
Dornier-System GmbH
Postfach 1360
7990 Friedrichsgafen 1
WEST GERMANY

Kristof, Stevan
LARS/Purdue University
1291 Cumberland Avenue
West Lafayette, IN 47906

Kuang, J.
Haluk Derin
Department of Electrical
and Computer Engineering
University of Massachusetts
Amherst, MA 01003

Labovitz, M.L.
SASC Technologies, Inc.
4400 Forbes Blvd.
Lanham, MD 20706-9998

Landgrebe, David
Electrical Engineering
Department
Purdue University
West Lafayette, IN 47907

Lee, Tong
School of Electrical
Engineering & Computer
Science and Centre for
Remote Sensing
University of New South
Wales
P.O. Box 1
Kensington, NSW 2033
AUSTRALIA

Lett, R. E.
Barringer Research Ltd.
304 Casrlingview Drive
Rexdale, Ontario
CANADA M9W 5G2

Li, Dawai
Zhanjian Electronic
Industrial Company
Zhanjian, Guangdong
CHINA (PRC)

Link, B.
Canada Centre for
Remote Sensing
2464 Sheffield Road
Ottawa K1A 0E4
CANADA

Lozano-Garcia, D. F.
LARS/Purdue University
1291 Cumberland Avenue
West Lafayette, IN 47906

Lulla, Kamlesh
Indiana State University
Remote Sensing Laboratory
Geography Department
Terre Haute, IN 47809

Maktav, Derya
Technical University of
Istanbul, Turkey
Department of Geodesy and
Photogrammetry
Ayazaga-Istanbul
TURKEY

Marvin, J.W.
SASC Technologies, Inc.
4400 Forbes Blvd.
Lanham, MD 20706-9998

McElroy, John
NOAA/NESDIS
HCH Room 5222, Stop A
Washington, D.C. 20233

Milillo, Jerry
University of New Hampshire
Complex Systems Research
Center
O.Kane House
Durham, NH 03824-3535

Minielly, N.
MacDonald Dettwiler &
Associates
CANADA

Moore, Berrien., III
University of New Hampshire
Complex Systems Research
Center
O.Kane House
Durham, NH 03824-3535

Mower, Roland D.
Geography Department
University of North Dakota
Grand Forks, ND 58202

Mueksch, Michaela C.
5180 Eschweiler-Nothberg
Caecilienstr. 6a
WEST GERMANY (F.R.G.)

Mueller, Paul W.
Purdue University/LARS
1291 Cumberland Avenue
West Lafayette, IN 47906

Myhre, D. L.
Soil Science Department
University of Florida
Gainsville, Florida 32611

Myers, H. Joseph
IBM Corporation
1530 Page Mill Road
Palo Alto, CA 94304

Nadelhoffer, K.
Ecosystems Center
Marine Biological Laboratory
Woods Hole, Main 02543

Nash, D. B.
Jet Propulsion Laboratory
4800 Oak Grove Drive
Pasadena, CA 91109

Ochoa, Michael C.
NASA/NSTL/ERL and
Auburn University
Bldg. 1100
NSTL, MS 39529

Patel, A.N.
Civil Engineering Dept.
A-7 University Quarters
A-B Road
Indore, M.P., INDIA

Pelletier, Romona E.
NASA/Earth Resources Lab.
Natl. Space Tech. Labs
NSTL, MS 39529

Perez, M.S.
Dpto. de Teledeteccion
Direccion General de Geografia
San Antonio Abad #124
06820 Mexico D.F.
MEXICO

Peterson, Bruce
University of New Hampshire
Complex Systems Research
Center
O.Kane House
Durham, NH 03824-3535

Peterson, David L.
242-4 NASA/Ames Research Center
Moffett Field, CA 94035

Pitts, David E.
NASA/Johnson Space Center
Biospheric Sciences Section
Houston, TX 77058

Podwysocki, M. H.
U.S. Geological Survey
Reston, VA 22092

Pomalaza-Raez, Carlos A.
Clarkson College
Department of Electrical
and Computer Engineering
Potsdam, NY 13676

Prevost, C.
Canada Centre for Remote
Sensing
2464 Sheffield Road
Ottawa, Ontario
CANADA K1A 0Y7

Ranson, K. J.
Purdue University/LARS
1291 Cumberland Ave.
West Lafayette, IN 47906

Rao, A. Ramachandra
Civil Engineering Dept.
Purdue University
West Lafayette, IN 47906

Reyna, E.
NASA/Johnson Space Center
Biospheric Sciences Section
Houston, TX 77058

Reynales, Tad E.
Environmental Studies Program
University of California
at Santa Barbara
Santa Barbara, CA 93106

Richards, John A.
School of Electrical Engineering
and Computer Science and Center
for Remote Sensing
University of New South Wales
P.O. Box 1
Kensington, NSW 2033
AUSTRALIA

Robson, N. A.
Canada Centre for Remote Sensing
2464 Sheffield Road
Ohawa K1A 0E4
CANADA

Rock, Barrett N.
Jet Propulsion Lab
M/S 183-501
4800 Oak Grove Drive
Pasadena, CA 91109

Ruzek, Martin J.
Jet Propulsion Lab.
M/S 183-701
4800 Oak Grove Drive
Pasadena, CA 91109

Sakata, T.
Tokai University Research
and Information Center
2-28-4 Tomigaya
Shibuya-ku
Tokyo 151
JAPAN

Salt, Eric
Electronics Systems Research
Group
Electrical Engineering Department
University of Saskatchewan
Saskatoon, Saskatchewan
CANADA S7N 0W0

Sasser, J. H.
Dpto. de Teledeteccion
Direccion General de Geografia
San Antonio Abad #124
06820 Mexico D.F.
MEXICO

Schowengerdt, R. A.
Extraterrestrial Research
Division
NASA/Ames Research Center
Moffett Field, CA 94035

Seidle, Larry L.
Environmental Remote
Sensing Center
1225 West Dayton Street
Madison, WI 53706

Shih, S. F.
Agricultural Engineering
Department
University of Florida
Gainesville, FL 32611

Shimoda, H.
Tokai University Research
and Information Center
2-28-4 Tomigaya
Shibuya-ku
Tokyo 151
JAPAN

Shumate, M. S.
Jet Propulsion Laboratory
4800 Oak Grove Drive
Pasadena, CA 91109

Slaney, V. R.
Radarsat Project Office
110 O'Connor Street
Room 200
Ottawa, K1P 5M9
CANADA

Solomon, Jerry E.
Jet Propulsion Laboratory
MS 183-501
4800 Oak Grove Drive
Pasadena, CA 91109

Soni, Siddharth K.
19/2, Manoramaganj
Indore-452 001
INDIA

Soucy, R.
Department of Electrical
and Computer Engineering
University of Massachusetts
Amherst, MA 01003

Swain, Philip H.
School of Electrical Engineering
Purdue University
West Lafayette, IN 47906

Tilford, Shelby
National Aeronautics and
Space Administration
Washington, D.C. 20546

Torre, J. D. de la
Dpto. de Teledeteccion
Direccion General de Geografia
San Antonio Abad #124
06820 Mexico D.F.
MEXICO

Uenk, D.
Center for Agrobiological
Research
Bornsesteeg 2
Wageningen, HOLLAND

Vogelmann, James E.
Jet Propulsion Laboratory
M/S 183-501
4800 Oak Grove Drive
Pasadena, CA 91109

Van Kastern, H. W. J.
Center for Agrobiological
Research
Bornsesteeg 2
Wageningen, HOLLAND

Vorosmarty, Charles
University of New Hampshire
Complex Systems Research
Center
O.Kane House
Durham, NH 03824-3535

Wacker, A. G.
Electronics Systems
Research Group
Electrical Engineering
Department
University of Saskatchewan
Saskatoon, Saskatchewan
CANADA S7n OWO

Walker, R. E.
Jet Propulsion Laboratory
4800 Oak Grove Drive
Pasadena, CA 91109

Wall, Steve
Jet Propulsion Laboratory
M/S 183-701
4800 Oak Grove Drive
Pasadena, CA 91109

Welch, Roy
Laboratory for Remote
Sensing and Mapping
Science
Department of Geography
University of Georgia
Athens, GA 30602

Williams, Darrel L.
National Aeronautics and Space Admin.
Goddard Space Flight Center
Greenbelt, Maryland 20771

Winings, Sherman B.
Remote Sensing Branch
Statistical Research Division
United States Department of
Agriculture
14th and Independence
Washington, D.C. 20250

Wiradisastra, Uup S.
Institut Pertanian Bogor
Department of Soil Science
Bogor, INDONESIA

Wolfe, R. W.E.
SASC Technologies, Inc.
4400 Forbes Blvd.
Lanham, MD 20706-9998

Woods, Kerry D.
Environmental Studies Program
University of California
at Santa Barbara
Santa Barbara, CA 93106

Wrigley, R. C.
Extraterrestrial Research
Division
NASA/Ames Research Center
Moffett Field, CA 94035

Wu, S. T.
Earth Resources Laboratory
NASA/Nat.l. Space Technology
Laboratories
NSTL Station, MS 39529

Zobrist, A. L.
Jet Propulsion Laboratory
4800 Oak Grove Drive
Pasadena, CA 91109

Index

	Page		Page
Aber, John D.	157	Bryant, Nevin A.	228
Ahearn, Sean C.	53	Buis, J.S.	303
Aguilar, J.L.	348	Card, D.H.	30
Alcantara, Ariel E.	348	Carver, K. R.	i,i
Alexander, David P.	103	Cary, Ernestine	339
Archwamety, C.	303	Chaudhuri, Nurun N.	338
Anuta, Paul E.	128	Chavez, J. Lira	112
Badhwar, G.D.	207	Christensen, Phillip R.	97
Bartolucci, Luis A.	128,266	Cihlar, J.	171
Benidiktsson, J.A.	341	Collins, William	99
Bergquist, B.	69	Daughtry, Craig S.	345
Bernstein, Ralph	34,279	Derin, Huluk	282
Bhuiyan, A.K.M.F.	338	Dicks, Steve	65
Biehl, Larry L.	345	Domik, Gitta	248
Billingsley, Frederick C.	209,220	Edwards, G. J.	350
Binnenkade, P.	241	Ehlers, Manfred	219
Bjornsson, S.	341	Elliott, H.	282
Blazquez, C. H.	350	Fisher, T. A.	183
Botkin, Daniel B.	141	Fleming, Mike	347
Boyd, D. J.	85	Fong, Y.S.	41
Braun, Hans M.	271	Fownes, James H.	157
Bretherton, Francis	3	Fukue, K.	17
Brindt, Lars	86	Fung, K.	302
Brown, Ronald J.	189	Gardner, J. M.	350

	Page		Page
Gildea, Patricia	69	Marvin, J.W.	342
Gilg, Wolfgang	271	McElroy, John	4
Gladwell, D. R.	85	Milillo, Jerry	69
Gokhmann, B.	228	Minielly, N.	183
Goodenough, David G.	15,281,302	Moore, Berrian., III	67,69
Gunther, Frederick J.	35	Mower, Roland D.	59
Haddad, Kenneth D.	113	Mueksch, Michaela C.	149
Hajek, Benjamin F.	321	Mueller, Paul W.	266
Halev, George M.	26	Myers, H. Joseph	34
Harris, Barbara A.	130	Myhre, D. L.	350
Hauska, Hans	86	Nadelhoffer, K.	69
Held, Daniel	239,267	Nash, D.	197
Hlavka, C.A.	303	Ochoa, Michael C.	321
Hoffer, Roger M.	162,266	Patel, A.N.	349
Huete, A.R.	329	Pelletier, Romona E.	321
Iisaka, Joji	281	Perez, M.S.	348
Ioannidis, Antonis	343	Peterson, Bruce	69
Jackson, Raymond D.	329	Peterson, David L.	139
Johnson, Gary	66	Pitts, David E.	207
Kahle, Anne B.	83,98,197	Podwyssocki, M.H.	99
Kazakos, Dimitri	343	Pomalaza-Raez, Carlos A.	41
Kiefer, Ralph W.	53	Prevost, C.	189
Kriegl, Wolfgang	271	Ranson, K.J.	345
Kristof, Stevan	338	Rao, A. Ramachandra	103
Kuang, J.	282	Reyna, E.	207
Labovita, M.L.	342	Reynales, Tad E.	141
Landgrebe, David	12	Richards, John A.	211
Lee, Tong	211	Robson, M. A.	302
Lett, R.E.	85	Rock, Barrett N.	71
Li, Dawai	315	Ruzek, Martin J.	254
Lozano-Garcia, D. F.	128,162,266	Sakata, T.	17
Lulla, Kamlesh	49,51	Salomonson, V.	101
Maktav, Derya	122	Salt, Eric	292

	Page
Sasser, J. H.	112
Schowengerdt, R. A.	303
Seidle, Larry L.	53
Shih, S. F.	350
Shimoda, H.	17
Shumate, M.	197
Slaney, V. R.	198
Solomon, Jerry E.	96
Soni, Siddharth K.	349
Soucy, R.	282
Swain, Philip H.	211
Tilford, Shelby	13
Torre, J. D. de la	112
Uenk, D.	241
Vanderbilt, V. C.	i
Van Kasteren, H. W. J.	241
Vogelmann, James E.	71
Vorosmarty, Charles	69
Wacker, A. G.	292
Walker, R.	228
Wall, Steve	268
Welch, Roy	219
Williams, Darrel L.	71
Winings, Sherman B.	344
Wiradisastra, Uup S.	53
Wolfe, R. E.	342
Woods, K. D.	141
Wrigley, R. C.	303
Wu, S. T.	173
Zobrist, A. L.	228

