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Series: Bromley, D. Allan, Files
Subseries: Global Climate Change Files

OA/ID Number: 62051
Folder ID Number: 62051-003

Folder Title:
Global Change Research Program (2) [1 of 3] [1990]

Stack:

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THE WHITE HOUSE
WASHINGTON

January 4 '90

Dr. Michael Boskin:

Dear Michael:

Sorry it took so long to
get this to you but I had to
find out what our arrangement
with WSGS Rally was.

Please feel free to pick up
the travel estimate if you think
this one too low.

Best regards.

Alan.

THE WHITE HOUSE

WASHINGTON

January 4, 1990

MEMORANDUM FOR JOHN H. SUNUNU

FROM: MICHAEL J. BOSKIN
D. ALLAN BROMLEY *Alan*

SUBJECT: CONTRIBUTIONS BY CEA AND OSTP TO THE GLOBAL
WARMING ISSUE AND RESULTING BUDGET PROBLEMS

We are writing to express our concern over the mismatch between our existing resources and the prominent role the President wants CEA and OSTP to take on the global warming issue.

To undertake its role, CEA is going to need one senior staff person working on global warming on a full-time basis. Our senior staff resources are already stretched very thin, and taking away one of our few senior staffers to work on this issue will dramatically reduce our ability to work on other important economic policy matters: the forecast, trade, monetary policy, etc. The CEA has already taken on significant extra responsibilities. For example, even our very limited financial contributions to the Presidential mission to Poland and our membership on the Structural Impediments Initiative with Japan have a significant impact on our minuscule budget. The CEA travel budget is especially tight and is already more than fully accounted for (we are already relying on 501(c)(3) and on other government agencies to help us pay a significant share of our travel expenses).

OSTP is also very thin in personnel with a single staff member having the responsibility for science and technology matters relating to energy and the environment. Recently she has been spending essentially all her time in work relating to the DPC Working Group on Global Climate Change. To continue that work and take on the additional organizational responsibilities for the April science and economics research conference that we are co-chairing, OSTP will require additional staff assistance and like CEA, additional travel support. It too is currently relying on 501(c)(3) and other agencies for administrative travel costs.

To enable OSTP to proceed it has obtained the services of a liaison staff member from the U.S. Geological Service at no cost for a period of 3 months--one now past. On his departure it will be essential for OSTP to replace him for the coming year with an appropriate detailee for whom OSTP will pay 50% of the total compensation package.

It would seem easiest and most sensible to resolve these funding and personnel problems by tapping a small amount of EPA's or NASA's budget to help OSTP and CEA. In addition to some travel expenses and specific consulting expenses associated with organizing the April conference--totalling an estimated \$20,000 for both CEA and OSTP, it would be especially helpful to CEA if funding could be provided for one senior personnel slot for CEA as soon as possible (estimated cost roughly \$75,000) and to OSTP if similar funding could be provided to cover 50% of a similar salary.

We would thus request your help in making available about \$132,500 to enable us to proceed effectively to implement the President's immediate global change program.

We shall much appreciate your help.

Rm 360
EXECUTIVE OFFICE OF THE PRESIDENT
COUNCIL OF ECONOMIC ADVISERS

DATE: 12-21-89

TO: Damar Hawkins

FROM: Steven Landefeld SL

Attached is a draft of the letter we discussed. Dr. Boskin is leaving tomorrow afternoon, and he would like to get this to Governor Sununu before he leaves. Could you please fill in the OSTP blanks (including rough dollar amounts) along with any other suggestions you may have and try and get it back to me by 10:00 a.m.

Many thanks.

Attachment

December 21, 1989

MEMORANDUM FOR GOVERNOR SUNUNU

FROM: MICHAEL J. BOSKIN
D. ALLAN BROMLEY

SUBJECT: Contributions by CEA and OSTP to the
Global Warming Issue and Resulting Budget Problems

We are writing to express our concern over the mis-match between our existing resources and the prominent role the President wants CEA and OSTP to take on the global warming issue.

To undertake its role, CEA is going to need one senior staff person working on global warming on a full-time basis. Our senior staff resources are already stretched very thin, and taking away one of our few senior staffers to work on this issue will dramatically reduce our ability to work on other important economic policy matters: the forecast, trade, monetary policy, etc. The CEA has already taken on significant extra responsibilities. For example, even our very limited financial contributions to the Presidential mission to Poland and our membership on the Structural Impediments Initiative with Japan have had a significant impact on our miniscule budget. The CEA travel budget is especially tight and is already more than fully accounted for (we are already relying on 501(c)(3) and on other government agencies to help us pay a significant share of our travel expenses).

OSTP is also very thin in personnel, but they have been able to obtain a detailee from the U.S. Geological Survey and their immediate concern is with...

It would seem easiest and most sensible to resolve these funding and personnel problems by tapping a small amount of NASA's budget to help OSTP and CEA. In addition to some travel expenses... It would be especially helpful to CEA if NASA could pay for one senior personnel slot for CEA as soon as possible (estimated cost roughly \$75,000) and to OSTP.

specific consulting expenses associated with organizing the April conference - totaling an estimated \$20,000 for both CEA and OSTP if similar funding could be provided to cover 50% similar salary

continue on B

(B)

We would thus request ~~that~~ your help in making available about \$132,500 to enable us to proceed effectively to implement the President's immediate global change program.

We shall much appreciate your help.

(A)

OSTP is also very thin in personnel with a single staff member having the responsibility for science and technology matters relating to energy and the environment. Recently he has been spending essentially all his time in work relating to the DOE Working Group on Global Climate Change. To continue that work and take on the additional organizational responsibilities for the April science and economics research conference that we are cohosting, OSTP will require additional staff assistance and like CEA additional travel support. It too is currently relying on 501(c)(3) and other agencies for almost its entire travel costs.

To enable OSTP to proceed it has obtained the services of a liaison staff member from the US Geological Service ~~for~~ at no cost for a period of 3 months - one now ~~completed~~ past. On his departure it will be essential for OSTP to replace him for ~~at least 3 months~~ the coming year with an appropriate detail for whom OSTP will pay 50% of the total compensation package.

THE WHITE HOUSE
WASHINGTON

DATE: 1-19

TO: Alan Bromley

FROM:

ANDY CARD

Andy

Do you know anything
about a Global Warming
conference that the National
Academy of Sciences is
hosting 1/24?

"INVITATION FOR DR. BROMLEY"

TYPE: Invitations/speeches

DOCUMENT NUMBER:

1st this invitation
is for WEDNESDAY...

You are scheduled for
a possible Murder
Board...

and you have a FCCSET
meeting from 3:30 to
5:00.

Accept _____ Regret ☒

*Can't make
it so
no*

SPEECH: YES NO

FROM: FRANK PRESS
NATIONAL ACADEMY OF SCIENCES

DATE OF EVENT: 01/24/90

LOCATION OF EVENT: WASHINGTON, D.C.

TIME OF EVENT: 01:30PM

SUBJECT: INVITE TO ATTEND AS A SPECIAL GUEST AT A DISCUSSION
ON GREENHOUSE WARMING.

RSVP: 01/24/90

CONTACT PERSON: DEBORAH STINE

CONTACT NUMBER: (202)334-1250

INVITATION ACCEPTED? YES NO

COPIES TO: Nancy Maynard
James Wyngaarden

REMARKS: 1/22/90 Regretted to Deborah Stine for DAB.
Informed Nancy Maynard.

DATE OF LETTER: 01/09/90

DATE RECEIVED: 01/16/90

FILE: NEOB

90361-3

NATIONAL ACADEMY OF SCIENCES

2101 CONSTITUTION AVENUE, NW WASHINGTON, D. C. 20418

OFFICE OF THE PRESIDENT

January 9, 1990

The Honorable D. Allan Bromley
Assistant to the President
for Science and Technology
Office of Science and Technology Policy
Old Executive Office Building Room 358
17th and Pennsylvania Avenue, N.W.
Washington, D.C. 20506

Dear Allan:

The Honorable Daniel J. Evans, Chair of the Panel on Policy Implications of Greenhouse Warming, and I would like to invite you as a special guest to an important discussion of scientific controversies surrounding the "greenhouse effect" to be held by the study panel at the Academy on January 24, 1990. We are also inviting Admiral Watkins, Mr. Reilly, and Governor Sununu. The open session portion of the meeting will begin at 1:30 pm at the National Academy of Sciences Building, 2101 Constitution Avenue, N.W., Washington, D.C. in the Lecture Room.

Congress directed EPA to commission the Academy to evaluate policy options for mitigating and responding to climatic change. It also asked the Academy to "establish the scientific consensus on the rate and magnitude of climate change." The meeting of the study panel on January 24 will include presentations from scientific experts with a range of views on the greenhouse effect. They will address two topics: First, what will be indicators that greenhouse warming is occurring, and when will we be able to say whether or not greenhouse warming has happened, if at all? Second, what do models predict, with what uncertainties, and what is the time scale for reducing the uncertainties? The list of scientific experts taking part in the discussion is enclosed for your information. The discussion will likely be lively, and should provide a clear review of the current state of scientific understanding of greenhouse warming.

I have also included a short description of the panel and its membership. We hope that you will be able to attend this very important discussion as well as join us for a reception and dinner that evening. The dinner should provide you with a chance to interact with the panel and its guests for the evening. The invited dinner speaker is Dr. Fred Bernthal from the State Department. If you have any questions, please contact Deborah Stine at (202)334-1250 or Lawrence E. McCray at (202)334-2424.

Yours sincerely,



Frank Press
President

Enclosures (2)

cc: Nancy Maynard

POLICY IMPLICATIONS OF GREENHOUSE WARMING

MITIGATION PANEL ROSTER

*Thomas H. Lee (Chair), Professor Emeritus, Department of Electrical Engineering & Computer Science, Massachusetts Institute of Technology, Cambridge, Massachusetts and former director of the Laboratory for Electromagnetic and Electronic Systems at Massachusetts Institute of Technology (Member NAE)

Peter G. Brewer, Senior Scientist, Chemical Oceanography, Woods Hole Oceanographic Institution, Woods Hole, Massachusetts and Program Director, Marine Chemistry, National Science Foundation

Robert Crandall, Senior Fellow, Brookings Institution, Washington, DC and former deputy director, Council on Wage and Price Stability

*Richard N. Cooper, Professor of Economics, Harvard University, Cambridge, Massachusetts and former Under-Secretary of State

Robert E. Evenson, Professor of Economics, Economic Growth Center, Yale University, New Haven, Connecticut

*Robert A. Frosch, Vice President, General Motors Research Labs, Warren, Michigan, former Administrator of the National Aeronautics and Space Administration, and former Assistant Executive Director of the United Nations Environment Program (Member NAE)

Richard Garwin, Fellow, Thomas J. Watson Research Center, IBM, Yorktown Heights, New York, former consultant, President's Science Advisory Committee, and former chair, National Research Committee's Solar Energy Research Committee (Member NAS, NAE, IOM)

Joseph Glas, Director, Freon Products Division, E. I. du Pont, Wilmington, Delaware

Kai N. Lee, Associate Professor, Institute for Environmental Studies and Department of Political Science, University of Washington, Seattle, Washington, former member, advisory panel on radioactive waste disposal, Office of Technology Assessment, and member, NAS Board on Radioactive Waste Management

Gregg Marland, Scientist, Environmental Science Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee

*Jessica T. Mathews, Vice President, World Resources Institute, Washington, DC and former Director of the Office of Global Issues at the National Security Council

Arthur H. Rosenfeld, Professor of Physics, University of California, Berkeley, and Director, Center for Building Science, Lawrence Berkeley Laboratory, Berkeley, California

Edward S. Rubin, Professor, Mechanical Engineering & Public Policy Director, Center for Energy and Environmental Studies, Carnegie-Mellon University, former member National Research Council Energy Research Board, and former member advisory committee on national air pollution control technology, US EPA

Milton Russell, Professor of Economics and Senior Fellow, Energy, Environment and Resources Center, University of Tennessee, Knoxville, Tennessee, Collaborating Scientist, Oak Ridge National Laboratory, Oak Ridge, Tennessee, and former assistant administrator for policy, planning, and evaluation, US EPA

*Stephen H. Schneider, Head, Interdisciplinary Climate Systems, National Center for Atmospheric Research, Boulder, Colorado and an expert on global climate models

Eugene B. Skolnikoff, Professor of Political Science, Massachusetts Institute of Technology, Cambridge, Massachusetts and member, advisory committee on science and technology, US Department of State

Thomas H. Stix, Associate Director of Academic Affairs, Plasma Physics Laboratory, and Associate Chairman, Department Astrophysical Science, Princeton University, Princeton, New Jersey.

*Maurice Strong, Under-Secretary-General, United Nations, Chair, Strovast Holdings Inc., Ottawa, Canada, and former Director-General of the Canadian Office of External Aid

Edith Brown Weiss, Professor, Georgetown University Law Center, Washington, DC, former advisor, US arms control and disarmament agency, and former member, National Research Council Water Science and Technology Board

*Synthesis panel members

Don Roper
378-8634
B-2-f.c.

POLICY IMPLICATIONS OF GLOBAL WARMING

EFFECTS PANEL ROSTER

*George F. Carrier (Chair), T. Jefferson Coolidge Professor of Applied Mathematics, Emeritus, Harvard University, Cambridge, Massachusetts and chair of the 1985 NAS committee on Atmospheric Effects of Nuclear Explosions (Member NAS, NAE)

Guy Brasseur, National Center for Atmospheric Research, Boulder, Colorado and an expert on climate models

Wilfried Brutsaert, Professor of Hydrology, Civil and Environmental Engineering, Cornell University, Ithaca, New York

Robert D. Cess, Leading Professor, Atmospheric Sciences, State University of New York, Stony Brook, New York

Herman Chernoff, Professor of Statistics, Harvard University, Cambridge, Massachusetts (Member NAS)

John Imbrie, H.L. Doherty Professor of Oceanography, Department of Geological Sciences, Brown University, Providence, Rhode Island (Member NAS)

Thomas B. Karl, Meteorologist, Climate Research & Applications, National Climate Data Center, Asheville, North Carolina

Michael C. MacCracken, Physicist and Division Leader, Atmospheric and Geophysical Sciences, Lawrence Livermore Laboratory, University of California, Livermore, California and Principle Scientist, Department of Energy's Carbon Dioxide Research Program

Berrien Moore, Professor and Director, Institute for the Study of Earth, Oceans, and Space, University of New Hampshire, Durham, New Hampshire and member, National Research Council Committee on Global Change

*Synthesis Panel Member

POLICY IMPLICATIONS OF GLOBAL WARMING

ADAPTION PANEL ROSTER

*Paul E. Waggoner (Chair), Distinguished Scientist, Connecticut Agricultural Experiment Station, New Haven, Connecticut and chair of the American Association for the Advancement of Science Panel on Climatic Variability, Climate Change and the Planning and Management of U.S. Water Resources (Member NAS)

Jesse Ausubel, Fellow, Science and Public Policy, Rockefeller University, Director, Studies in Science, Technology and Government, Carnegie Institute, New York, New York, and former director, Programs Office, National Academy of Engineering

Clark Binkley, Professor, School of Forestry & Environmental Studies, Yale University, New Haven, Connecticut

Mary M. Kritz, Department of Rural Sociology, Cornell University, Ithaca, New York and chair of the Committee on International Migration of the International Union for the Scientific Study of Population

Joshua Lederberg, President, Rockefeller University, New York, New York and recipient of Nobel Prize (1958) (Member NAS, IOM)

William Lewis, Partner, McKinsey & Company, Washington, DC, former senior operations officer, the World Bank, and former assistant secretary for policy and evaluation, US Department of Energy

Jon Liebman, Professor of Environmental Engineering, University of Illinois, Urbana, Illinois

*William D. Nordhaus, Professor of Economics, Yale University, New Haven, Connecticut, former member of the President's Council of Economic Advisors and member of the 1983 NAS Carbon Dioxide Assessment Committee

*Gordon H. Orians, Professor of Zoology and Director, the Institute for Environmental Studies, University of Washington, Seattle, Washington (Member NAS)

William E. Riebsame, Director, Natural Hazards Research and Applications Information Center, University of Colorado, Boulder, Colorado and author of the United Nations Environmental Programme volume Assess Social Implications of Climate Fluctuation: A Guide to Climate Impact Studies

Norman Rosenberg, Senior Fellow and Director, Climate Resources Program, Resources for the Future, Washington, DC, consultant to National Oceanic and Atmospheric Administration and to the Water Resources Institute of the US Department of Interior, and former member, National Research Council Board on Atmospheric Science and Climate

*Sir Crispin Tickell, Ambassador to the United Nations from the United Kingdom, New York, New York and author of Climate Change and World Affairs

Daniel P. Sheer, President, Water Resources Management, Columbia, Maryland and Technical Director, Interstate Commission on the Potomac River Basin

*Synthesis Panel Member

POLICY IMPLICATIONS OF GREENHOUSE WARMING

SYNTHESIS PANEL ROSTER

Daniel J. Evans (Chair), Daniel J. Evans & Associates, Seattle, Washington

Robert McCormick Adams, Secretary, Smithsonian Institution, Washington, DC (Member NAS)

George F. Carrier, T. Jefferson Coolidge Professor of Applied Mathematics, Emeritus, Harvard University, Cambridge, Massachusetts and chair of the 1985 NAS Committee on Atmospheric Effects of Nuclear Explosions (Member NAS, NAE)

Richard N. Cooper, Professor of Economics, Harvard University, Cambridge, Massachusetts and former Under-Secretary of State

Robert A. Frosch, Vice President, General Motors Research Labs, Warren, Michigan, former Administrator of the National Aeronautics and Space Administration, and former Assistant Executive Director of the United Nations Environment Program (Member NAE)

Mahbub ul Haq, Special Advisor to the Administrator, United Nations Development Programme, New York, New York

Thomas H. Lee, Professor Emeritus, Department of Electrical Engineering and Computer Science, Massachusetts Institute of Technology, Cambridge, Massachusetts and former Director of the Laboratory for Electromagnetic and Electronic Systems at Massachusetts Institute of Technology (Member NAE)

Jessica T. Mathews, Vice President, World Resources Institute, Washington, DC and former Director of the Office of Global Issues at the National Security Council

William D. Nordhaus, Professor of Economics, Yale University, New Haven, Connecticut, former member of the President's Council of Economic Advisors and member of the 1983 NAS Carbon Dioxide Assessment Committee

Gordon H. Orians, Professor of Zoology and Director of the Institute for Environmental Studies, University of Washington, Seattle, Washington (Member NAS)

Stephen H. Schneider, Head, Interdisciplinary Climate Systems, National Center for Atmospheric Research, Boulder, Colorado and an expert on global climate models

Maurice Strong, Under-Secretary-General, United Nations, Chair, Strovast Holdings, Inc., Ottawa, Ontario, Canada, and former Director-General of the Canadian Office of External Aid

Sir Crispin Tickell, Ambassador to the United Nations from the United Kingdom, New York, New York and author of Climate Change and World Affairs

Victoria J. Tschinkel, Senior Consultant, Landers Parsons & Uhlfelder, Tallahassee, Florida and former Secretary of the Florida State Department of Environmental Regulations

Paul E. Waggoner, Distinguished Scientist, Connecticut Agricultural Experiment Station, New Haven, Connecticut and chair of the American Association for the Advancement of Science Panel on Climatic Variability, Climate Change and the Planning and Management of U.S. Water Resources (Member NAS)

NATIONAL ACADEMY OF SCIENCES
NATIONAL ACADEMY OF ENGINEERING INSTITUTE OF MEDICINE
COMMITTEE ON SCIENCE, ENGINEERING, AND PUBLIC POLICY

PANEL ON POLICY IMPLICATIONS
OF GREENHOUSE WARMING

2101 Constitution Avenue, N.W.
Washington, D.C. 20418
(202) 334-1517

For further information contact:
Rob Coppock Tel. 202-334-1517
Fax 202-334-1597

NAS/NAE/IOM Study on
Policy Implications of Greenhouse Warming

At the request of Congress, the U.S. Environmental Protection Agency has commissioned a study on policy implications of greenhouse warming by the Committee on Science, Engineering and Public Policy, a unit of the councils of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine. The panel is expected to prepare a report before the end of 1990.

Potential warming of the global climate is now of concern to governments throughout the world, and was a major focus of the Paris economic summit in June. But it is hard to assess the costs and benefits of environmental policies, and it is even more difficult to achieve international agreement on what to do about the human activities with the greatest potential impact on global climate: stationary and mobile burning of fossil fuels, use of chlorofluorocarbons (CFCs), deforestation, and various releases of methane.

In light of this growing domestic and international concern, the study will review research and analysis relevant to greenhouse warming. A careful assessment will be made of existing data and what must be done to improve current understanding of the underlying phenomena. The report will include, if appropriate, recommendations for actions that would be needed to mitigate and adapt to greenhouse effects if such actions be warranted. It will examine both the underlying phenomena and the expected efficiency and effectiveness of policy interventions in a comprehensive analysis.

A main focus of the study will be on policy interventions and their relative effectiveness. Although the study will be addressed in large part to U.S. policy officials, many of the options to be assessed may require multinational effort. The study is expected to contribute a careful, technically-sound review that will be of use to the Congress as well as to the Executive Branch and the international community.

The study's "Synthesis" panel is being chaired by the Honorable Daniel J. Evans, until last year U.S. Senator from the State of Washington. Senator Evans, a registered civil engineer and former college president was Governor of the State of Washington from 1965-77. He chaired the

Pacific Northwest Power and Conservation Planning Council from 1981-83. Among other activities he is a member of the Board of Directors of the Nature Conservancy.

In carrying out its charge, the Synthesis panel membership is being augmented by three groups looking at three interrelated sets of issues.

[A] Direction and rate of change

The "Effects" group will assess current knowledge about climate change and predictions of physical effects. The objective is to judge the adequacy of present research, uncertainties in that research, and ways our understanding could be improved. The quality of the data record, uncertainties in the evidence, and time and effort required to reduce uncertainties all need to be examined. It may also be necessary to interpret existing information in terms of new indices of warming (e.g., degree-years, peak temperature), not just change in mean global temperature.

[B] Mitigation policies and their effectiveness

The "Mitigation" group will examine the range of policy interventions that might mitigate changes in the earth's radiative balance, assessing these options in terms of their expected impacts, costs, and at least in qualitative terms, their relative cost-effectiveness. This analysis will attempt to identify options that could be implemented with reasonable confidence within a decade, more speculative possibilities requiring substantial additional development, and proposals that are not worth pursuing because of faulty physics, chemistry, or biology.

[C] Adaptation strategies

The "Adaptation" group will examine both the consequences of climate change and strategies for adapting to those changes. The group will attempt to develop appropriate indices and units of measurement; considerations include rates of change, peak stresses, regional distribution, and timing. The analysis will attempt to examine the sensitivity of systems or subsystems, their capacity to adapt or adjust to changes, the speed with which this natural adjustment can be accomplished, and possible interventions that would help systems cope with anticipated changes. The group will consider costs and benefits of such interventions and attempt to set the stage for choosing among alternatives, including examination of what will be done locally and privately and what should be done by government, should actions be warranted.

The list of individuals participating in the study is attached.

National Academy of Sciences/National Academy of Engineering/Institute of Medicine
Committee on Science, Engineering, and Public Policy

PANEL ON POLICY IMPLICATIONS OF GREENHOUSE WARMING

Discussion of Greenhouse Warming Science Controversies

National Academy of Sciences Building
Lecture Room

January 24, 1990

Discussants: James Hansen, Goddard Institute for Space Studies
Richard Lindzen, Massachusetts Institute of Technology
Gordon MacDonald, MITRE Corporation
Jerry Mahlman, National Oceanic and Atmospheric Admin.
Veerabhadran Ramanathan, University of Chicago
William Reifsnyder, Yale University
Kevin Trenberth, National Center for Atmospheric Res.

1:30 What will be indicators that greenhouse warming is occurring, and when will we be able to say whether or not greenhouse warming has happened, if at all?

Opening statements: James Hansen
Kevin Trenberth

3:00 Break

3:15 What do models predict, with what uncertainties, and what is the timescale for reducing the uncertainties?

Opening statements: Jerry Mahlman
Richard Lindzen

5:00 Comments from Audience*

- * Time permitting, members of the audience may make short statements to the panel.

THE WHITE HOUSE

WASHINGTON

January 29, 1990

MEMORANDUM FOR THE GLOBAL CHANGE WORKING GROUP

FROM: D. ALLAN BROMLEY
Chairman

Duan

SUBJECT: Meeting of the Global Change Working Group

There will be a meeting of the Global Change Working Group on Tuesday, January 30, 1990 from 2:00 to 3:00 p.m. in the Roosevelt Room for principals only. Please call Dean Schultheiss at 456-6722 if you are able to attend.

The issues to be discussed include (1) the guidelines for the U.S. delegation to the plenary meeting of the IPCC, (2) the President's speech to the IPCC and suggestions for the text of his remarks, and (3) the dates for the White House Conference on Science and Economics Research on the Environment.

Enclosed is a copy of the guidelines to the U.S. IPCC delegation. The guidelines were prepared by an interagency working group headed by OES at the State Department and reflect consensus working level recommendations for U.S. policy. Two points warrant specific consideration as you review the document:

(1) The first is the structure of negotiations of a climate convention (see "Preparations for Negotiation of a Climate Convention" on pages 8-11). The U.S. position has consistently been that any climate convention, and the negotiation process leading thereto, would follow the model used in dealing with the stratospheric ozone problem -- a broad framework convention calling for research and the exchange of data (the Vienna Convention), followed by targeted protocols (such as the Montreal Protocol on CFCs). Alternatives to this approach are (a) the negotiation of a comprehensive framework convention that itself contains specific provisions spelling out emissions reductions or (b) the negotiation of a general framework convention accompanied by concurrent negotiation of specific protocols.

(2) The second is the future of the IPCC (see "Future of IPCC" on pages 13 and 14) and whether it should be the forum for climate convention negotiations or whether those negotiations will be conducted in another forum (e.g., the U.N. General Assembly).

Please review the guidelines carefully and be prepared to make any specific comments at Tuesday's meeting, as it is essential that the Working Group act at that time. Also please be advised that both documents are close hold. Please refrain from making additional copies.

NATIONAL SPACE COUNCIL
EXECUTIVE OFFICE OF THE PRESIDENT
WASHINGTON, D.C. 20500

March 8, 1990

MEMORANDUM FOR ALLAN BROMLEY

FROM: MARK ALBRECHT

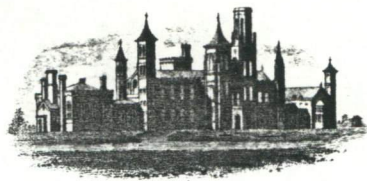
SUBJECT: Global Change Research

The Vice President received the attached letter from Tom Lovejoy. The proposals for specialized processing of Landsat data appear to be particularly relevant to global change research. I wonder if you or your staff might review these proposals and determine if further action is needed. I would be happy to work with you in making either of these proposals happen if you think they merit federal attention.

Attachment

3/12/90
Nancy Maynard
Please comment
ASA Paid
check Thruout
with people ym
trust.
DOB.

RECEIVED
90 MAR 9 P 5: 59
OFFICE OF THE
DIRECTOR



SMITHSONIAN INSTITUTION
Washington, D.C. 20560
U.S.A.

113481
MA
THE V. P. HAS SEEN

February 9, 1990

The Vice President
Old Executive Office Building
Washington, DC 20501

Dear Mr. Vice President:

Thank you for the time you gave us Friday last at the swearing in of PCAST. We had a good inaugural meeting at a misty Camp David the following morning.

Governor Sununu and I talked at lunch about the Brazilian deforestation problem and he encouraged me to be in touch with you about the enclosed proposal. The basic problem is that there is no single agreed upon number for the extent of Amazonian deforestation. As a consequence a great deal of energy is wasted arguing about what the number really is, rather than getting on and doing something about the problem. The proposed binational study is designed to resolve this: if NASA (with the National and Air Space Museum) and INPE (Brazil's space agency) agree on a number, it will be beyond criticism. The proposal was made with science and technology funds for Brazil at the State Department in mind, but it turned out that they had already been disbursed. The International Space Year has an element in it which may bear on this project which I am looking into now.

Martin Harwit, Director of the National Air and Space Museum, has brought to my attention a similar but more modest project with respect to Czechoslovakia. Martin had a visit recently from President Havel's brother Ivan. The Czech government is very concerned about the state of its forest and would be grateful, indeed eager, for a Landsat analysis of forest cover as per the enclosed. This would seem an excellent way to help the Czechs help themselves?

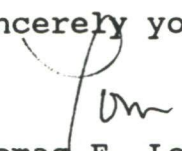
Both these projects speak to the continuing major value of Landsat over the next few years.

The Vice President
February 9, 1990
page two

As a member of PCAST I am both honored and pleased to help
in any way I can.

With all best wishes,

Sincerely yours,



Thomas E. Lovejoy
Assistant Secretary for
External Affairs

TEL/crt

cc: Governor Sununu
Professor Bromley

encls. (2)



February 7, 1990

MEMORANDUM TO: Tom Lovejoy

FROM: Martin Harwit

SUBJECT: Landsat Studies of Deforestation in Czechoslovakia

Czechoslovakia now has the most serious deforestation problem in all of Europe. The country's once dense woodlands, estimated to cover more than 25% of land area, are rapidly deteriorating.

We can expect the problems now faced by Czechoslovakia increasingly to afflict other industrial nations in the years ahead. Coming to grips with the problem in this country may show us ways to deal with it worldwide.

A delegation of Czech scientists will be in Washington next week and wishes to discuss this issue. Soon thereafter, a visit from President Havel is anticipated. One way the United States could help this nation as it struggles to free itself from the political and environmental damage inflicted during decades of bureaucratic centralism, would be to provide assistance in coping with this very serious problem.

The Smithsonian Institution houses one of the nation's advanced image reduction and analysis facilities in the Center for Earth and Planetary Studies of the National Air and Space Museum. Its researchers have wide ranging experience in the computer processing of satellite remote sensing data to cull out the information required to deal with different physical aspects of terrain. They are prepared to work with and train Czech scientists in the use of these techniques to obtain maps designed to highlight the scope and rate of deforestation. Their Czech colleagues would conduct "ground truth" inspections of sites, in order to calibrate and help interpret the satellite images, in a recursive process that would ultimately lead to accurate mapping of the deforestation in the entire country.

Information on the amount and rate of deforestation is critical to defining the magnitude of the problem. Landsat Multispectral Scanner (MSS) and Thematic Mapper (TM) data can resolve areas of 80 meters and 30 meters, respectively, sampling visible and infrared wavelengths. Thematic Mapper images are available from 1982 to the present and MSS images are available from 1972 to present. Thus it is possible to examine the change

in the forested areas over a 18 year period and establish a monitoring program. Land-use classification maps of the forested areas can be digitally generated using Landsat data. The amounts of formerly forested area lost can be measured relative to both a 1972 and 1982 baseline. Quantitative estimates of the magnitude and rate of deforestation can be made. A minimum of 56 Landsat scenes are required to produce a mosaic that completely covers the country for a given period. The total cost of image data acquisition, computer processing, equipment, and labor is estimated to be \$200,000.

A Proposal Submitted to the Department of State
Office of Oceans and Environment

QUANTITATIVE ASSESSMENT OF TROPICAL DEFORESTATION IN THE
AMAZON BASIN OF BRAZIL USING SATELLITE DATA

Submitted by

Laboratory for Terrestrial Physics
NASA/Goddard Space Flight Center
Greenbelt, Maryland 20771

Principal Investigator:

Compton J. Tucker
Laboratory for Terrestrial Physics, Code 623
NASA/Goddard Space Flight Center
Greenbelt, Maryland 20771 USA
(301) 286-7122

Co-Investigators:

Ross F. Nelson
Laboratory for Terrestrial Physics, Code 623
NASA/Goddard Space Flight Center
Greenbelt, MD 20771 USA

Alberto W. Setzer
Department of Meteorology
Instituto de Pesquisas Espaciais
San Jose dos Campos BRAZIL

Patricia A. Jacobberger and Thomas R. Watters
Center for Earth and Planetary Studies
National Air and Space Museum
Smithsonian Institution
Washington, D.C. 20076 USA

Total Cost: \$1,563,717 for 1 Year

May 2, 1989

SIGNATURE PAGE

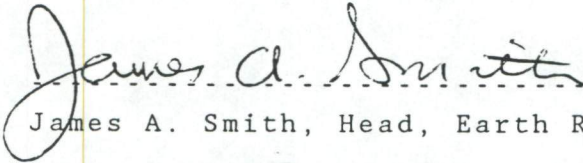
NASA/Goddard Space Flight Center



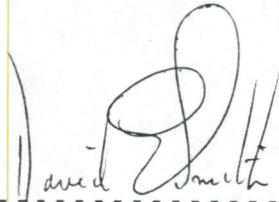
Compton J. Tucker, principal investigator



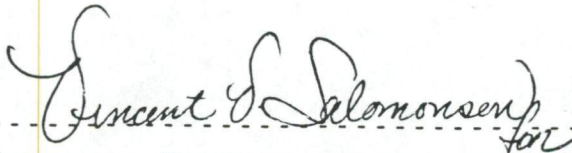
Ross F. Nelson, co-investigator



James A. Smith, Head, Earth Resources Branch



David E. Smith, Acting Chief, Laboratory for Terrestrial Physics



James A. Trainor, Director of Science

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EXECUTIVE SUMMARY

Tropical deforestation is occurring at a rapid and accelerating rate. While this is accepted as fact for specific areas, there is extreme controversy over the extent and rate of tropical deforestation at country, continental, and global scales. Unless controlled, tropical deforestation will result in the loss of over half of the planet's plant and animal species and will significantly elevate atmospheric concentrations of CO₂, CH₄, and CO. It is imperative to address this question immediately. Policy-makers and scientists must know the actual extent of tropical forests and tropical deforestation in order to formulate a conservation strategy if this is needed.

A few deforestation studies have been performed for the southern Amazon Basin of Brazil using satellite data coupled with ground verification. This area, the states of Acre, Rondonia, and Mato Grosso, is experiencing rapid, drastic and sometimes irreversible changes due to intensifying human occupation. The most important finding of these studies is the rapid and nonlinear rate at which tropical deforestation is occurring in many areas of the Amazon Basin of Brazil (figures 3 and 4).

We propose an expanded, comprehensive, and bi-lateral Brazilian-American study of the deforestation and state of forests as of 1987-1989 for the entire Amazon Basin of Brazil using data from two different satellite sensor systems coupled with a series of field verifications. We will provide a comprehensive assessment of tropical deforestation and forest state within 15 months after the work begins with an accuracy of at least 80%. We will propose a continuation of the research for successive years to determine year-to-year changes in tropical deforestation in Brazil.

INTRODUCTION

Background

Tropical forests (including moist evergreen and seasonal forests) once covered ~24,500,000 km² of the terrestrial surface (Whittaker and Likens, 1975) and are now estimated to cover only ~10,000,000 km² (Wilson, 1986). This dramatic decrease has generated widespread concern and calls for tropical forest conservation. These concerns can be traced to the fact that approximately 8,000,000 km² of tropical land have been converted to agriculture, ~3,000,000 km² are under shifting cultivation, and ~3,500,000 km² have been converted to pasture (Salati and Vose, 1983). The Amazon Basin contains ~60% of our planet's remaining tropical forest with Brazil containing ~50% of the global total (Mares, 1986). For this reason, Brazil finds itself at the center of attention concerning conservation of tropical forests (fig. 1).

Tropical forests are home to the greatest diversity of plant and

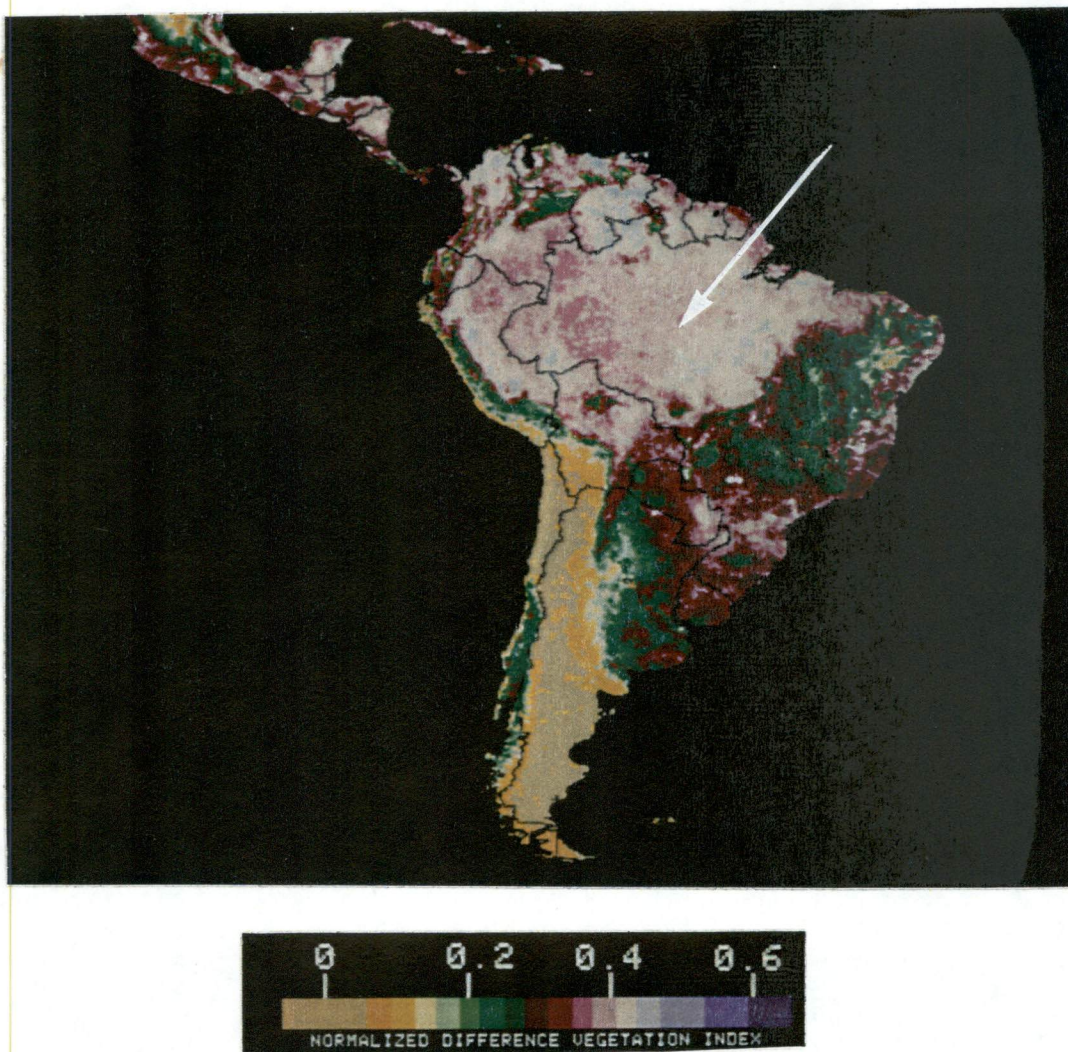


Figure 1. Vegetation index map of South America derived from the NOAA advanced very high resolution radiometer (AVHRR) data. The Amazon Basin is clearly delineated as indicated by the arrow. Note the large porportion of the Amazon Basin within Brazil(from Malingreau and Tucker, 1988).

animal life known on the earth and contain over half of our planet's plant and animal species. It is estimated they contain in excess of 5 million plant and animal species(Prance, 1982). Wilson(1986) notes that ~1.7 million species have been described, ~750,000 insects, ~47,000 vertebrates, and ~250,000 plants. Some workers feel the number of total species could go as high as 30 million(Erwin, 1986). Taxonomists have only identified a small percentage of the several million tropical species. One principal adverse effect of tropical deforestation would be mass extinctions comparable to that which last occurred ~60-70 million years ago at the end of the Mesozoic era when the dinosaurs, among many other species, became extinct. These mass extinctions will result from tropical forest habitat destruction.

In addition to mass extinctions resulting from tropical forest habitat destruction, indirect and disruptive effects on precipitation patterns would also occur within South America. Salati and Vose(1983, 1984) have reported that ~50% of the rainfall falling in the Amazon Basin is recycled. Tropical deforestation would disrupt longitudinal profiles of precipitable water and cause much drier conditions in the temperate zone of South America.

Widespread tropical deforestation in the Amazon Basin would also result in significant additions to global atmospheric CO₂(Woodwell *et al.*, 1983). The biological mass (biomass) of tropical forest vegetation contains several centuries-worth of accumulated carbon. The burning of large amounts of forest vegetation, and subsequent decomposition, releases this carbon into the atmosphere as CO₂ over a short period of time. Since the Brazilian Amazon now comprises ~50% of the remaining global tropical forest, the amount of CO₂ potentially to be released from deforestation is of global importance.

Brazil contains the majority of the tropical forests within the Amazon Basin. The so-called 'Legal Amazon' covers ~5,000,000 km² of which 70% is occupied by the non flooded (Terra Firme) forest. The rest includes swamp forest, flooded grassland and cerrado (scrub savanna). The difficulties of monitoring changes in this large area have resulted in substantial disagreements on the extent of deforestation. Recently, the World Bank published figures stating

that ~600,000 km² of the Legal Amazon was "cleared" (Mahar, 1989) while Brazilian sources state that only ~250,000 km² was cleared (*Washington Post*, 1989). These two reports from 1989 illustrate the disagreement over actual figures for deforestation in the Amazon Basin. Similar disagreements have existed historically over deforestation rates for the Amazon Basin. Disagreement will continue unless verifiable quantitative data are available.

Satellite remote sensing is the only means for resolving discrepancies concerning forest area and rates of deforestation. Research by Tucker *et al.* (1984), Nelson and Holben (1986), Nelson *et al.* (1987b), and Malingreau and Tucker (1988) has shown that satellite remote sensing can quantify tropical deforestation. There are no technical reasons why these satellite-based techniques cannot be applied to a large area like the Amazon Basin to resolve this controversy.

Satellite Remote Sensing

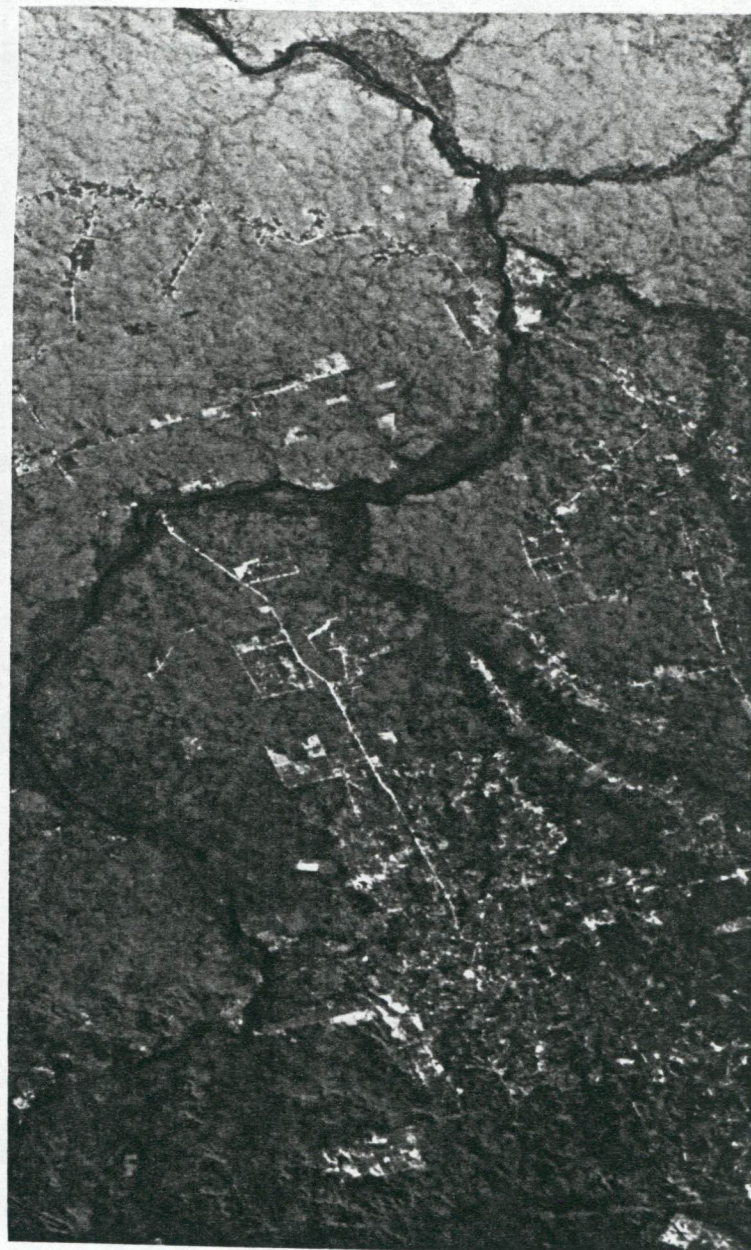
Tropical deforestation has been studied with Landsat, meteorological satellite, space shuttle, and geostationary satellite data (Nelson and Holben, 1986; Tardin *et al.*, 1979 and 1980; Tucker *et al.*, 1984; Woodwell *et al.*, 1983 and 1987; Nelson *et al.*, 1987b; Malingreau and Tucker, 1988). Landsat multispectral scanner (MSS) and thematic mapper (TM) data can resolve areas 80-m and 30-m in size, respectively, and are collected every 16 days. This frequency of observation, coupled with the high probability of clouds and the frequent presence of smoke from forest-clearing fires, can result in useful data being collected only every 1 to 3 years for areas of interest. This frequency of observation is reduced if there is no Landsat receiving station operating in the area of interest.

~200 Landsat scenes are required to completely map the Brazilian Amazon. Fortunately, the Amazon Basin has frequent Landsat satellite data available. The Instituto de Pesquisas Espaciais (INPE) of Brazil has routinely collected and archived Landsat data from South America since 1977. These data have already been proven successful in detecting progressive deforestation (fig. 2).

It is our opinion that a method of stratification can be employed



July 24, 1981



July 23, 1984

Figure 2. Landsat multispectral scanner imagery (80-m resolution) from Mato Grosso, Brazil showing the extent of deforestation between July 24, 1981 and July 23, 1984. Areas of deforestation appear as the blue colors while the undisturbed forest appear as red colors (from Nelson *et al.*, 1987b).

as suggested by Nelson *et al.* (1987a) to reduce the number of Landsat scenes required for determining Amazon Basin tropical forest area and deforestation from 200 scenes to 60 scenes. The stratification will be based upon (1) a photographic mosaic of Landsat data compiled for the entire Amazon Basin and (2) the analysis of 1-km meteorological satellite data. Detailed analysis can then be limited to 60 Landsat scenes. This approach, using a combination of satellite data, will provide the quantitative forest area and deforestation data required while covering the entire Amazon Basin of Brazil.

Digital Landsat data must be used in many areas to determine the extent of tropical forest area and deforestation in Brazil. Landsat data can be easily ground verified because of their high spatial resolution and, most importantly, they exist in appreciable numbers since 1977 for Brazil because INPE has received and archived them.

Tropical forest area and deforestation have also been studied with NOAA polar-orbiting meteorological satellite data from the advanced very high resolution radiometer (AVHRR) sensor carried on the National Oceanic and Atmospheric Administration's (NOAA) satellites. These satellites record imagery twice every day (0230 and 1430 hours for NOAA-11 and 0730 and 1930 hours for NOAA-10). This high frequency of observation usually results in a series of images which can provide at least one cloud-free image of most tropical areas during each year's relative dry season. The 1-km ground resolution is suitable for identifying large-scale deforestation (Tucker *et al.*, 1984; Malingreau and Tucker, 1988), and also can detect fires as small as 1-2 ha in size (Kaufman *et al.*, 1988; Setzer, 1988).

The AVHRR has three thermal bands which are useful for forest studies. Tucker *et al.* (1984) have reported that the greatest spectral contrast between forest and deforested areas was in the 3.5-3.9 μm AVHRR channel. This channel is sensitive to temperatures in the 0° to 100° C range. We have found this channel is the most appropriate to detect cleared areas greater than 1 km^2 since a substantially different radiation balance results in cleared areas being warmer than adjacent land where forest still stands (fig. 3). AVHRR data have been used since 1982 to study areas like the Brazilian state of Rondonia with great success (fig. 4).

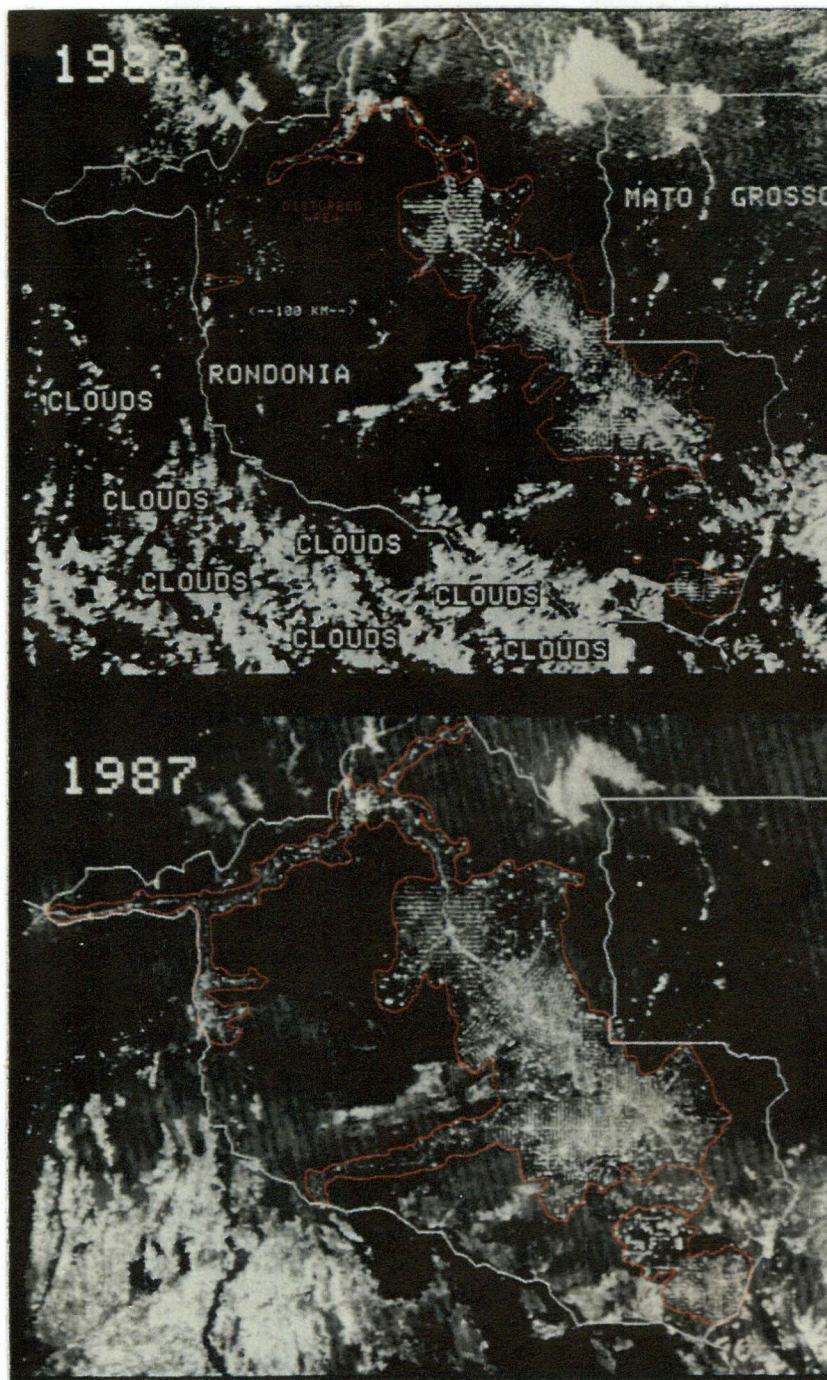


Figure 3. Advanced very high resolution radiometer data from July 1982 (top) and July 1987 (bottom) for the state of Rondonia. The line surrounding the points where deforestation activities are taking place identifies the "disturbance area"; the lighter areas within are cleared of forest vegetation. Areas of naturally occurring savanna were identified from existing vegetation maps and excluded from further consideration. Note the dramatic increase in the extent of deforestation within the main colonization area associated with highway BR-364 from 1982 to 1987. The 1982 data produced a deforestation estimate of $\sim 10,000 \text{ km}^2$ as compared to $\sim 38,000 \text{ km}^2$ in 1987. Both satellite images are from the the 3.5-3.9 μm thermal channel of the AVHRR. The image covers an area of $\sim 700 \times 600 \text{ km}$ (see also figure 4).

SATELLITE ESTIMATES OF DEFORESTATION

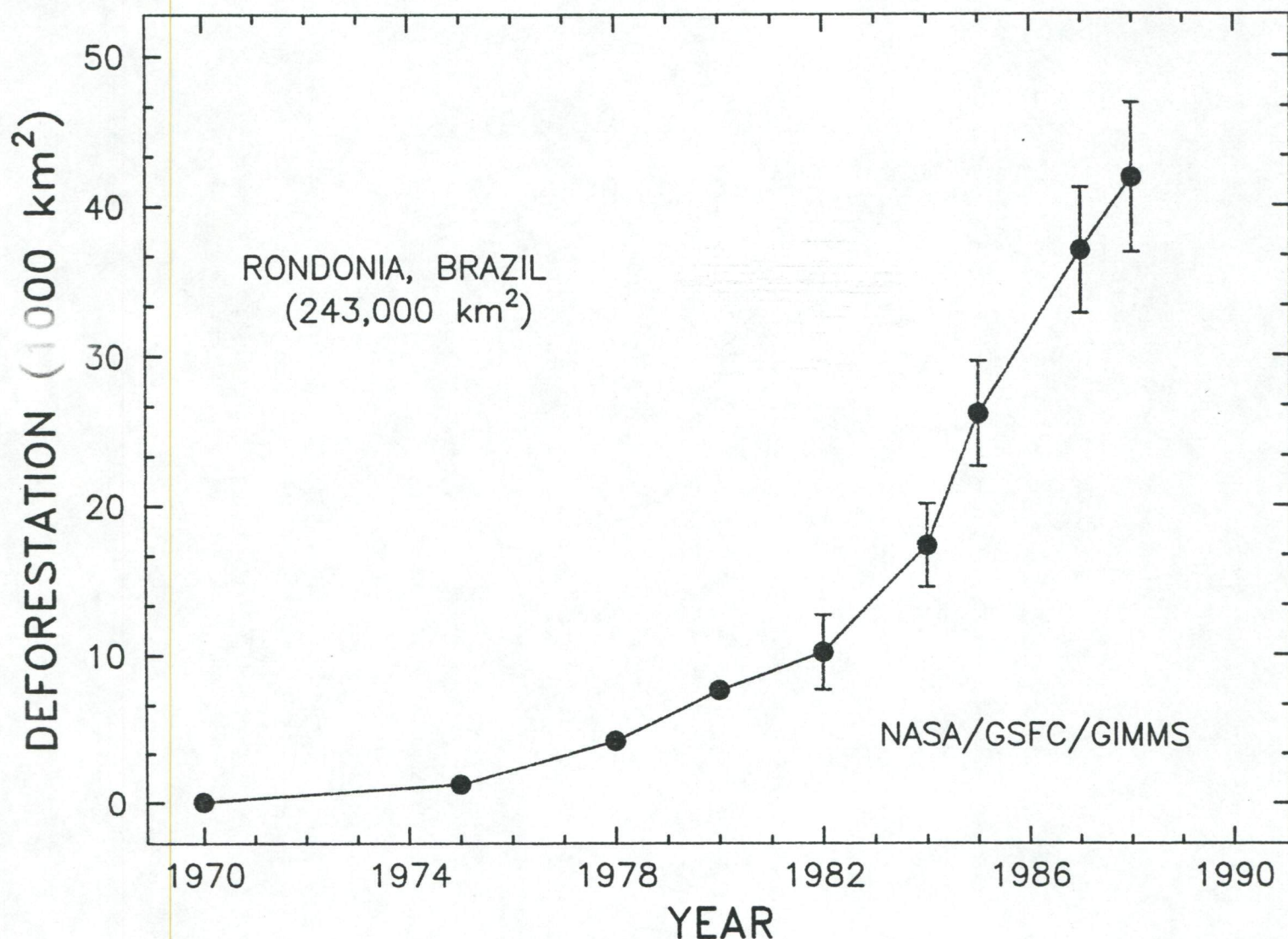


Figure 4. Deforestation in Rondonia from 1970 to 1988 showing the rapid increase in clearing rates since 1980. The 1970 to 1980 data are from Tardin *et al.* (1980). The 1982, 1984, 1985, 1987, and 1988 estimates are from the analysis of AVHRR data at NASA/Goddard (Tucker *et al.*, 1984; Malingreau and Tucker, 1988). Note the changes in slope of the data line with time which indicates when the paving of BR-364, a major highway, was started and when it was completed (see also fig. 3).

We propose to use a combination of Landsat 30-m ground resolution data with 1-km data from meteorological satellites. This will provide complete coverage of the Brazilian Amazon (from the NOAA meteorological satellites) at a 1-km ground resolution, with detailed 30-m Landsat data in areas where such detail is required to determine areas of tropical forest and deforestation. In addition, we propose to assemble a basin-wide mosaic of Landsat thematic mapper images for 1987-1989. The mosaic will provide a relatively inexpensive overview of the entire Amazon Basin, and will complement the basin-wide 1-km NOAA data and selected digital scenes of Landsat data.

APPROACH

A joint Brazilian-American program is proposed to assess the area of the tropical forest and determine the areal extent of deforestation for the Amazon Basin of Brazil using meteorological satellite and Landsat data. To minimize the imprecision of what we mean by *deforestation* in the context of this proposal, we use it herein as the conversion of a forest canopy into a barren area or another vegetation community dominated by grass, shrub, or field crops. It is our intention to produce estimates for 1987-1989 of forest and non-forest for the Amazon Basin of Brazil. Basin-wide data from Brazil are available within the Laboratory of Terrestrial Physics which summarize the spatial extent of vegetation types in the Amazon as of 1970. These data will be used to insure that our forest conversion figures are based upon areas which are/were naturally forested. The proposed research will have as its major objective to produce forest area and deforestation estimates for the entire Brazilian Amazon within 15 months after starting with a quantitative accuracy of at least 80%.

A carefully-selected group of Brazilian and American scientists has been assembled, all of whom have detailed experience with the analysis of satellite data and/or have analyzed satellite data from the Amazon Basin of Brazil. It will be imperative to involve the Brazilian Space Agency (INPE) in our proposed research. Not only are there several Brazilian scientists at INPE with extensive experience in analyzing satellite data from the Amazon, but the

use of the INPE aircraft will be invaluable in our proposed program of ground verifications. It is anticipated that the actual analyses of the satellite data will be done in parallel. NASA/Goddard Space Flight Center and the National Air and Space Museum will divide the Landsat thematic mapper analyses between them to achieve the proposed research objectives. It is only by working in parallel that the project can be completed and an accuracy level of at least 80% maintained within 15 months for the Brazilian Amazon Basin. The proposed research will be accomplished as follows:

1. Data Acquisition

Immediately after the proposed project is approved for funding, the principal investigator will visit INPE in Sao Jose dos Campos and review all available Landsat MSS and TM data for 1987-1989 (note: C.J. Tucker visited INPE in September 1988 and can attest to the availability of cloud-free thematic mapper data for the entire Amazon Basin for 1987-1988). An order will be placed at that time for the most recent (i.e., 1987-1989) thematic mapper 30-m resolution data in photographic form for the entire Amazon Basin (~200 images). When these data are received, copies of them will be made at the National Air and Space Museum's photographic laboratory and put to three uses: (A) A photographic mosaic will be assembled at a scale of 1:1,000,000 for the entire Amazon Basin by technicians at the National Air and Space Museum; (B) 60 areas will be selected for detailed digital analyses of forest/nonforest; and (C) 15 areas of significant forest alteration (i.e., Rondonia, Acre, Mato Grosso) will be selected; the Landsat thematic mapper photographic products ordered for the red, near-infrared, and middle-infrared channels; manual photo interpretation of the images into forest and non-forest categories will be done; the results will be digitized; and subsequently compared to the results of the Landsat thematic mapper digital analysis to see if this inexpensive method may provide accurate estimates of deforestation.

2. Basin-Wide Analysis: NOAA AVHRR

NOAA AVHRR meteorological data (1-km spatial resolution) will be obtained every day during the relatively dry seasons for the entire Brazilian Amazon Basin for the time period of May 1989 through April 1990. These coarse-resolution data will be analyzed to detect areas where activities associated with forest conversion are taking place. Such activities (i.e. road opening, mining, logging, clearing for agriculture, burning etc.) identify the areas where deforestation is occurring (Tucker *et al.*, 1984; Malingreau and Tucker, 1988; see also fig. 3).

Daily AVHRR 1430 and 1930 hours data will be processed to screen for fires, smoke, clouds, data dropouts, and to determine general quality. Two different types of digital analyses will then be applied to the AVHRR data: (A) Every day's data will be processed during each region's burning season after the method of Kaufman *et al.* (1988) to determine the location of fires, the area of smoke, cloud cover fraction, and estimate the optical thickness of areas which are "clear". The location of fires has been shown by Malingreau and Tucker (1988) to be an excellent indicator of where forest alteration is occurring. We propose to use it as an indicator for selecting areas for detailed Landsat thematic mapper analysis; and (B) Clear images from the entire Amazon Basin of Brazil will be assembled and analyzed for deforestation by use of the 3.55-3.95 μm channel as shown in figure 3. The method used to produce figure 3 is as follows: (1) Vegetation maps were consulted and only forested areas were analyzed further to detect for deforestation. (2) Areas of undisturbed tropical forest are selected and the mean and variance produced. The mean 3.55-3.95 μm forest value plus twice the standard deviation of the same is used as the threshold for determining forest/non-forest within the bounded area of interest. (3) This is applied to the area of interest to determine the forest alteration pixel count and then converted to spatial extent. (4) These results are double-checked against Landsat photographic and digital data from the same area. (5) Field verifications are made against the Landsat photographic data to determine accuracy. Results from field verifications in Rondonia from 1982, 1984, 1985, and 1987 have shown the AVHRR deforestation estimates to have an accuracy of plus or

minus 20%(Malingreau and Tucker, 1988).

AVHRR 1-km data are only useful for studying large-scale deforestation. For this reason, it will be necessary to devote most of our effort to analyses of Landsat 30-m data. Most of the deforestation in the Brazilian Amazon is not as systematically organized as it is in Rondonia(fig. 3).

3. Detailed Analysis: Landsat Thematic Mapper

Based upon the results from #1(A) and #2, 60 Landsat scenes will be selected for detailed analysis. These will be selected from areas where the photographic mosaic and/or the analysis of the AVHRR data indicate tropical forest alteration is occurring. Once the 60 areas have been selected (each 185 km x 185 km), digital thematic mapper 30-m data for 1987-1989 will be obtained from INPE and analyzed. We propose to use the method of Nelson *et al.* (1987b) to provide detailed assessment of tropical forest area and deforestation. To expedite the proposed research, the principal investigator will obtain ~10 Landsat digital thematic mapper scenes while he is in Brazil and return with them to the USA. This will enable the proposed thematic mapper digital analyses to start immediately upon his return from Brazil.

Quantitative estimates of the extent of forest cover and deforestation will be developed for the Amazon using an integrated sampling procedure similar to one used by Nelson *et al.*(1987b). Multi-resolution satellite imagery will be used in a three stage design. AVHRR 1-km data and the thematic mapper photographic mosaic will serve as the primary stage[see Approaches #1(A) and #2], the thematic mapper digital scene as the second stage, and blocks within the thematic mapper scene as the third stage. AVHRR 1-km data and the thematic mapper photographic mosaic will be used to partition the entire Basin into three strata: 1) forested areas beng actively cleared; 2) forest areas with little or no ongoing conversion; and 3) nonforest. Active versus inactive forested areas will be differentiated based on the ratio of cleared to forested area. The AVHRR 1-km interpretation/stratification will be compared to the thematic mapper photographic mosaic to verify the reliability of the

AVHRR-based stratification.

Landsat thematic mapper scenes will be randomly selected within each of the three strata. A majority of the scenes (45) will be selected in the forest/active stratum in order to provide an accurate forest area and deforestation baseline in these rapidly changing locations. The sampling concentration will facilitate accurate, retrospective forest conversion rate studies in the event historical satellite data are acquired in the high-activity areas. Fewer scenes (15) will be allocated to the inactive forest and the nonforest strata.

Each Landsat thematic mapper scene will be subsampled; full scene processing will not be done. Sixteen systematically located sample blocks will be used in each scene. Each block of data will incorporate an area ~15 km on a side (~ 225 km²). This systematic sampling approach will include 11 percent of the available digital data in each TM scene. The Landsat digital data will be processed in discrete blocks in order to circumvent problems associated with intra-scene spectral variability and to reduce computer requirements. Two stage cluster sampling procedures (which make up the second and third stages of the overall design) will be used to convert block estimates into thematic mapper scene and stratum estimates of forest area.

The overall statistical design involves a two-stage cluster sample procedure within a stratified random sample. Work by Nelson et al. (1987a) in the continental U.S. has demonstrated the concept and accuracy of this particular approach for forest area estimation. The design permits the majority of the TM scenes to be allocated to areas in the Amazon Basin where most of the conversion activity is occurring. The procedures which comprise this study, and the forest area estimates which result, will be repeatable. As such, future studies of similar scope will be able to use these estimates as a baseline for change estimation.

The Landsat thematic mapper digital analyses will be divided between the image analysis laboratories of the Center for Earth and Planetary Studies of the National Air and Space Museum and the Laboratory

for Terrestrial Physics of the NASA/Goddard Space Flight Center. This will permit the analysis to proceed in parallel for the various selected areas in the Amazon Basin. Close communication will be maintained between investigators at the National Air and Space Museum and those at NASA/Goddard Space Flight Center as these organizations are less than 20 miles apart.

RESULTS

We propose to complete our determination of the extent and location of deforestation within the Amazon Basin of Brazil within 15 months after the proposal is approved. All of the results we propose to produce will be geographically registered and thus will be compatible with any geographic information system. At the conclusion of the proposed research the following will be delivered to the funding agency:

1. A Landsat thematic mapper photographic mosaic of the entire Amazon Basin of Brazil at a scale of 1:1,000,000 (with 30-m resolution) for 1987-1989. This proposed component will be directed by P.A. Jacobberger and will be produced by technicians at the Center for Earth and Planetary Studies who are experienced in assembling mosaics. The resulting mosaic will be available for display at the Department of State, National Air and Space Museum, or for any other location at the decision of the funding agency.
2. Geographically-registered AVHRR data for the Amazon Basin of Brazil from 1988-1989 showing (A) the frequency and location of fire activity and (B) the 1-km large-scale estimates of deforestation. This proposed component will be directed by C.J. Tucker, Y.J. Kaufman, and A. Setzer of INPE. This work will be conducted in parallel at NASA/Goddard and at INPE in Sao Jose dos Campos. The Brazilian government is interested in this work because it provides information within a few hours on unauthorized forest burning. This "fire monitoring" work has been done operationally at INPE by Setzer since 1987.
3. Geographically-registered results of deforestation produced from thematic mapper digital data for 60 Landsat scenes of the Amazon

Basin of Brazil from 1987-1989. This proposed component will be directed by R.F. Nelson and will be performed in parallel between researchers at the National Air and Space Museum who will analyze 20 scenes and NASA/Goddard Space Flight Center who will analyze 40 scenes. Nelson will work closely with P.A. Jacobberger and T.R. Watters to accomplish this objective.

4. A comparison between deforestation results produced from manually interpreted thematic mapper photographic products and the digital analysis of the same thematic mapper data. If successful, this would represent a major advancement in deforestation monitoring. This proposed component will be directed by C.O. Justice of the University of Maryland who works with Tucker under a cooperative agreement between NASA and the Geography Department of his institution.

5. A final report covering all aspects of the analyses performed under the proposed research. It is also expected that several reviewed, scientific journal articles will result from the proposed research activity. C.J. Tucker will be responsible for the preparation of the final report.

COORDINATION/COOPERATION BETWEEN NASA AND THE SMITHSONIAN

NASA/Goddard Space Flight Center will assume over-all technical and financial management for the proposed research. The proposed research involving the U.S.-based investigators will be highly integrated on a day-to-day basis. It is anticipated that almost daily exchanges of personnel will occur as the proposed analyses progress. NASA/Goddard and the National Air and Space Museum both share and have unique capabilities with respect to the proposed research: NASA/Goddard is one of the most experienced scientific groups in the analysis of 1-km AVHRR data for deforestation monitoring; The National Air and Space Museum is highly capable in producing excellent mosaics as anyone who has visited there can attest; and both organizations are skilled and experienced in the digital analyses of Landsat thematic mapper data.

COORDINATION/COOPERATION WITH INPE OF BRAZIL

We propose to make every effort possible, with guidance and direction from the Department of State, to involve INPE in the proposed research. To facilitate this, \$524,400 is proposed to be transferred to INPE to support their involvement. One of the first activities under the proposed research is for a meeting in Brazil between the principal investigator and his INPE counterparts to map out a common collaborative effort for the proposed research. A series of personnel exchanges between INPE and the Goddard Space Flight Center/National Air and Space Museum are anticipated and reflected in the budget under travel.

It is the opinion of C.J. Tucker that a common program of work can be (1) decided upon and, most importantly, (2) executed between INPE and the U.S. investigators. Tucker has cooperated directly with INPE since 1986 and is a co-investigator on the INPE Earth Observing System (Eos) interdisciplinary proposal recently approved by NASA/Headquarters.

The budget contains \$524,400 ear-marked for INPE. \$363,400 of this amount will be spent in the U.S. to purchase U.S.-made equipment to upgrade the INPE NOAA satellite receiving station; \$110,000 is for direct personnel support; \$32,000 is to support the use of the INPE aircraft for 4 field verification missions; \$14,000 is for travel (mainly to the U.S.); and \$5,000 is to purchase film and other supplies for the INPE aircraft to support the field verification missions.

However, should it prove impossible to involve INPE in the proposed work, it is mandatory that the proposed research be conducted and not hindered nor adversely impacted by INPE's lack of participation. The proposal is written in such a fashion that, if necessary, the proposed research can be executed without INPE's scientific involvement.

REFERENCES

- Erwin, T.L. 1986. News and Comment. *Science* 234:14-15.
- Fearnside, P.M., 1986. Spatial concentration of deforestation in the Amazon Basin. *Ambio* 15:74-81.
- Kaufman, Y.J., C.J. Tucker, and I.Y. Fung, 1988. Remote sensing of biomass burning in the tropics. *Advances in Space Research* (in press).
- Mahar, D.J., 1989. Government Policies and Deforestation in Brazil's Amazon Region. World Bank, Washington, D.C., 56 pp.
- Malingreau, J.P. and C.J. Tucker, 1988. Large-scale deforestation in the southern Amazon Basin of Brazil. *Ambio* 17:49-55.
- Mares, M.A., 1986. Conservation in South America: Problems, consequences, and solutions. *Science* 233:734-739.
- Nelson, R.F. and B.N. Holben. 1986. Identifying deforestation in Brazil using multiresolution satellite data. *Int. J. of Remote Sensing* 7(3):429-448.
- Nelson, R.F., D. Case, N. Horning, V. Anderson, and S. Pillai. 1987a. Continental Land Cover Assessment Using Landsat MSS Data. *Remote Sensing of Environment* 21:61-81.
- Nelson, R.F., N. Horning, and T.A. Stone. 1987b. Determining the rate of forest conversion in Mato Grosso, Brazil, using Landsat MSS and AVHRR data. *Int. J. Remote Sensing* 8(12):1767-1784.
- Prance, G.T., 1982. *Extinction is Forever*, Columbia Univ. Press, New York.
- Salati, E. and P.B. Vose, 1983. Depletion of tropical rain forests. *Ambio* 12:67-71.
- Salati, E. and P.B. Vose, 1984. Amazon Basin: A system in equilibrium.

Science 225:129-138.

Setzer, A.W., 1988. Relatório de atividades do projecto IBDF-INPE "SEQE"--Ano 1987, Relatório INPE-4534-RPE/565(Instituto Nacional de Pesquisas Espaciais, São José dos Campos).

Tardin, A.T. et al., 1979. Levantamento de áreas de desmatamento na Amazonia Legal através de imagens do satellite Landsat. Relatório INPE 411-NTE/142(Instituto Nacional de Pesquisas Espaciais, São José dos Campos).

Tardin, A.T. et al., 1980. Relatório INPE 1649-RPE/103(Instituto Nacional de Pesquisas Espaciais, São José dos Campos).

Tucker, C.J., B.N. Holben, and T.E. Goff, 1984. Intensive forest clearing in Rondonia, Brazil as detected by satellite remote sensing. *Remote Sensing of Environment* 15:255-261.

Washington Post, 1989. Brazil angrily unveils plan for the Amazon. *Washington Post*, April 7, 1989, pp. 1 and 18.

Whittaker, R.H. and G.E. Likens, 1975. Primary production: The biosphere and man, in *Primary Production of the Biosphere*(eds. Lieth, H. and Whittaker, R.H.; Springer Verlag, New York).

Wilson, E.O., 1986. News and Comment, *Science* 234:14-15.

Woodwell, G.M. et al., 1983. Global deforestation: contribution to atmospheric carbon dioxide. *Science* 222:1081-1086

Woodwell, G.M., R.A. Houghton, T.A. Stone, R.F. Nelson, and W. Kovalick. 1987. Deforestation in the Tropics: New Measurements in the Amazon Basin Using Landsat and NOAA Advanced Very High Resolution Radiometer Imagery. *J. of Geophysical Research* 92(D2):2157-2163.

PERSONNEL

NASA/Goddard and National Air and Space Museum:

C.J. Tucker will be the principal investigator of the proposed research. Tucker has been active in the use of NOAA AVHRR data for studying large-scale deforestation since 1982 and has worked successfully with INPE since 1986 on studies of the Amazon using satellite data. He will assume day-to-day management of the proposed research and be responsible for the final report. Tucker will also work directly on the analysis of the 1-km AVHRR data with Kaufman.

R.F. Nelson will be a co-investigator and will be responsible for directing the Landsat thematic mapper analyses. Nelson has extensive experience with the analyses of Landsat MSS and TM data for deforestation assessment. He will be assisted by B.N. Holben, A.G. Kerber, and D.W. Williams, all of whom are civil servants in the Earth Resources Branch of the Laboratory for Terrestrial Physics at NASA/Goddard Space Flight Center. Nelson will also supervise the 3 full-time scientific analysts and coordinate all thematic mapper digital analyses with the Center for Earth and Planetary Studies' co-investigators.

C.O. Justice and Y.J. Kaufman, both with the University of Maryland, will each devote 0.5 man year of effort to the proposed research. This manpower will be augmented by 2 Ph.D. students from the Department of Geography at the University of Maryland and 3 full time image analysts who will be employed under contract by NASA/Goddard. Justice will be responsible for digitizing the deforestation results derived from the manual interpretation of thematic mapper photographic products and their subsequent analysis. He will also direct the efforts of the 2 graduate students who will work full-time on the proposed research. Kaufman, an atmospheric physicist, will concentrate his efforts on the analysis of the AVHRR data for tropical fire detection.

P.A. Jacobberger and T.R. Watters will also be co-investigators and will direct the proposed research activities which will be conducted at the National Air and Space Museum. Both Jacobberger

and Watters are experienced with the analysis of thematic mapper digital data, its interpretation, and will each devote 0.5 man years of effort to the proposed research at no cost. This will be augmented by 4 additional man years of effort of contractor support. Jacobberger will direct the assembly of the 1:1,000,000 thematic mapper photographic mosaic and will share the responsibility with Watters for directing the digital analyses conducted in parallel at the National Air and Space Museum. Jacobberger and Watters will work closely with Nelson to insure that the same analysis methods are used in the thematic mapper digital analyses.

K.J. Ranson will work closely with the Landsat thematic mapper analyses group directed by Nelson and will apply fractal analysis to the forest alteration patterns obtained from the 30-m satellite studies. E.L. Levine will devote her time to geographical information system analyses of Amazon Basin soil data which resides within the Laboratory for Terrestrial Physics in digital form and will couple this with the Landsat thematic mapper forest alteration results. V. Kalb, a mathematician and numerical methods expert, will assist as needed should any aspect of the the proposed research require unique software or modifications to existing software. She will also assist in the compilation of the Basin-wide deforestation figures into a GIS-compatible format. Kalb is the author of ~50% of the software used within the GIMMS group for their analyses of AVHRR data.

Instituto de Pesquisas Espaciais:

Alberto Setzer of INPE will be a co-investigator of the proposed research and will direct the NOAA AVHRR and Landsat studies conducted at INPE. Setzer has extensive experience in the Amazon and also with the analysis of NOAA AVHRR data for monitoring fires in near-real time. He will also be responsible for organizing the field verification program and the integrated use of the INPE aircraft. Setzer has recently been named to head Brazilian Amazon Basin research efforts at INPE.

COMPUTER RESOURCES

All of the AVHRR analyses will be performed on the dedicated Hewlett Packard-Ramtek image analysis systems of the Global Inventory Monitoring and Modeling Study (GIMMS). The Landsat thematic mapper digital analysis will be performed on Vax 11/780 computers located in the Laboratory for Terrestrial Physics and in the Center for Earth and Planetary Studies. The Vax 8200 in the Laboratory for Terrestrial Physics will also be used as required. These computer systems are more than adequate to perform the level of work we propose within the proposed schedule. Both of these computer systems run around the clock almost every day of the year.

The digitizing of the Landsat thematic mapper photographic products will be conducted in the Digital Cartographic Laboratory of the University of Maryland's Department of Geography under the direction of C.O. Justice.

BUDGET

I. NASA/Goddard Space Flight Center

1. Personnel:

C.J. Tucker(PI; biologist).....	0.5 my	no cost	(civil servant)
R.F. Nelson(co-I; forester).....	0.7 my	no cost	(civil servant)
B.N. Holben(physical scientist)...	0.5 my	no cost	(civil servant)
V. Kalb(computer scientist).....	0.5 my	no cost	(civil servant)
E. Levine(soil scientist).....	0.5 my	no cost	(civil servant)
A. Kerber(geographer).....	0.5 my	no cost	(civil servant)
D.W. Williams(forester).....	0.25my	no cost	(civil servant)
K.J. Ranson(forester).....	0.25my	no cost	(civil servant)
C.O. Justice(geographer).....	0.5 my	\$ 45,000	(Un. Maryland)
Y.J. Kaufman(physicist).....	0.5 my	\$ 45,000	(Un. Maryland)
Scientific Analyst(3@100%).....	3.0 my	\$135,000	(\$45,000/yr ea.)
Graduate Students(2@100%).....	2.0 my	40,000	(\$20,000/yr ea.)
sub-Total:	9.7 my	\$265,000	(3.7 my no cost)

2. Satellite Data:

Daily AVHRR 1-km data for 365 days(1989).....	\$ 36,500	(\$100/day)
60 Landsat TM images for 1987-1989.....	\$216,000	(\$3,600 ea.)
200 Landsat TM photo products for mosaic.....	\$ 50,000	(\$250 ea.)
45 TM photoproducts(3 channels for 15 scenes)....	\$ 11,250	(\$250 ea.)
sub-Total:	\$313,750	

3. Image Processing:

AVHRR 1-km data(365 days).....	\$ 21,900	(\$60/day)
40 Landsat TM images for 1988-1989.....	\$120,000	(\$3,000/image)
Digitization and analysis of 15 TM photo products	\$ 12,000	(\$800/photo product)
sub-Total:	\$153,900	

4. Misc.

Travel(coordination with Brazil, etc.).....	\$ 16,000	(8 trips@\$2000/trip)
Field verification in Brazil.....	\$ 24,000	(6 person months)
Supplies, storage, tapes, etc.....	\$ 10,000	
sub-Total:	\$ 50,000	

TOTAL NASA/GSFC PROPOSAL COST: 9.7 my \$782,650

II. National Air and Space Museum

1. Personnel:

P.A. Jacobberger(co-I).....	0.5 my	no cost	(civil servant)
T.A. Watters(co-I).....	0.5 my	no cost	(civil servant)
Postdoctoral Fellow.....	1.0 my	\$ 40,100	
Scientific Analyst.....	1.0 my	\$ 40,000	
Graduate Students(2@100%).....	2.0 my	\$ 40,000	(\$20,000/yr ea.)
sub-Total:	5.0 my	\$120,100	(1.0 my no cost)

2. Image Processing:

20 Landsat TM images for 1987-1989.....	\$ 60,000	(\$3,000/image)
200-image photographic mosaic.....	\$ 10,000	(\$50/image)
sub-Total:	\$ 70,000	

3. Misc.

Travel(coordination with Brazil, etc.).....	\$ 8,000	(4 trips@\$2000/trip)
Supplies, storage, tapes, etc.....	\$ 4,000	
sub-Total:	\$ 12,000	

4. Overhead (27% of \$202,100).....\$ 54,567

TOTAL NASM PROPOSAL COST: 5.0 my \$256,667

BUDGET(cont.)

III. Brazilian INPE Component

Equipment Upgrade(INPE's HRPT receiving station)	\$363,400	(US-made hardware)
Scientific Staff Support(2 full time scientists)	\$ 70,000	(@\$35,000/yr ea.)
Technician Support(2 full time technicians)	\$ 40,000	(@\$20,000/yr ea.)
4 10-day flights with INPE aircraft	\$ 32,000	(\$800/day*40 days)
Travel(mainly to USA)	\$ 14,000	(7 trips @ \$2,000)
Misc.(film for INPE aircraft, supplies, etc.)	\$ 5,000	

TOTAL INPE PROPOSAL COST:	\$524,400
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BUDGET SUMMARY

I. NASA/Goddard	\$ 782,650	(9.7 my)
II. National Air and Space Museum	\$ 256,667	(5.0 my)
III. Instituto de Pesquisas Espaciais	\$ 524,400	

GRAND TOTAL FOR PROPOSED RESEARCH:	\$1,563,717	(14.7 my)

INPE's HARDWARE UPGRADE

INPE requires a substantial hardware upgrade to replace obsolete hardware in their NOAA receiving station. This will permit INPE to monitor fire activity in near-real time and directly contribute to Brazil's ability to police unauthorized deforestation. The actual hardware quotation is available upon request.

Refurbishment of Scientific Atlanta equipment	\$ 230,000
Microvax-II computer and accessories	\$ 95,500
Versatec/Versacolor C2766-CM plotter	\$ 21,500
Seiko thermal color printer model CH-5312	\$ 14,000
Hewlett Packard thinkjet 2225A printer	\$ 400
Hewlett Packard 7475A plotter	\$ 2,000

TOTAL INPE HARDWARE UPGRADE:	\$ 363,400
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Time Table for the Proposed Research

Starting date: August 1, 1989:

1. August 1989:

- A. PI, co-I's, and DoS personnel visit INPE to solidify their involvement and negotiate transfer of funds to INPE.
- B. 1987-1989 Landsat digital data and thematic mapper photographic data for Amazon Basin mosaic ordered from INPE. Areas of major forest alteration will be selected for detailed digital study.
- C. Basin-wide AVHRR coverage obtained retroactively to May 1, 1989 and will continue until April 30, 1990. Data to be acquired every day.
- D. Discussions in Brazil with INPE to solidify their involvement.
- E. Ten 1987-1989 Landsat thematic mapper digital tapes obtained for selected areas while PI is in Brazil and carried back to USA by PI.

2. August-November 1989:

- A. Daily 1-km AVHRR data obtained and analysis started of same for entire Amazon Basin of Brazil.
- B. Analysis started on the ten thematic mapper tapes brought back from Brazil by the PI.
- C. INPE scientists visit NASA/Goddard and NASM to plan joint approach to proposed research and assign specific responsibilities.
- D. First flight with the INPE aircraft made to check on burning season.

3. November-December 1989:

- A. Digital and photographic data received from INPE and start-up of analysis of same.
- B. Field visits to Rondonia, Acre, Para, and Mato Grosso made in collaboration with INPE and ground study groups. INPE aircraft second flight made after burning season to verify satellite data.
- C. 15 photographic images selected, manually analyzed, and results digitized for subsequent comparison to digital analysis.

4. January-February 1990:

- A. Amazon Basin 1987-1989 photographic mosaic completed.
- B. 1989 AVHRR 1-km studies for southern Amazon Basin completed.
- C. Daily AVHRR data acquisition started for northern Amazon Basin.
- D. Landsat TM and MSS digital analyses of 40 scenes continues.
- E. Selected US personnel visit INPE to review progress to date.
- F. INPE aircraft mission made to northern Amazon Basin for field verification purposes.

5. March-August 1990:

- A. Analysis of digitized TM photographic data completed.
- B. Analysis of 1989-1990 AVHRR data for northern Amazon Basin completed.
- C. Field visits made to northern Amazon Basin for ground verification.
- D. TM digital analyses completed for 1987-1989 data.
- E. Re-analysis of selected digital scenes conducted if required.
- F. INPE scientists visit US and concur on analysis to date.
- G. INPE aircraft mission made to selected areas for specific verification purposes.

6. September-November 1990:

- A. Deforestation figures for Brazilian Amazon for 1987-1989 finished.
- B. INPE and US scientists jointly compile summary document.
- C. Final report completed and delivered to Department of State and to appropriate ministry in Brazil.
- D. Continuation of efforts for 1989-1990 for Brazilian Amazon if requested and funded.
- E. Retroactive studies undertaken for any portion of 1975-1987 if requested and funded.

CURRICULUM VITAE

NAME: Compton J. Tucker

PRESENT POSITION: Physical Scientist
Earth Resources Branch
Laboratory for Terrestrial Physics
NASA/Goddard Space Flight Center

RESEARCH AREA
EXPERIENCE: Plant Sciences, Remote Sensing of
Vegetation

EDUCATION: 1969 - B.S. Biology
Colorado State University
1973 - M.S. College of Forestry
Colorado State University
1975 - Ph.D. College of Forestry
Colorado State University

PREVIOUS POSITIONS: 1970 - 1971 Ecological Research Assistant
Colorado State University
1971 - 1975 Graduate Research Assistant
IBP Grassland Biome
1975 - 1977 National Academy of Sciences
Postdoctoral Fellow
NASA/Goddard Space Flight Center

PROFESSIONAL SOCIETIES: American Association for the Advancement of
Science
Remote Sensing Society

AWARDS AND HONORS: 1985 - Automatic Award, American Society of
Photogrammetry
1986 - NASA Exceptional Scientific Achievement Medal
1988 - NASA/GSFC Senior Fellow

PUBLICATIONS

1. 1975 "Shortgrass Praire Spectral Measurements," C.J. Tucker, L.D. Miller, and R.L. Pearson, Photogrammetric Engineering and Remote Sensing, 41(9):1157-1162.
2. 1976 "Three-dimensional Chlorophyll Concentrations in a High Biomass Blue Groma Canopy," C.J. Tucker and M.W. Garratt, J. Range Management, 29(2):170-171.
3. 1976 "Design of a Mobile Field Spectrometer Laboratory," L.D. Miller, R.L. Pearson and C.J. Tucker, Photogrammetric Engineering and Remote Sensing, 42(4):569-572.
4. 1976 "A Hand-held Spectral Radiometer to Estimate Gramineous Biomass," R.L. Pearson and C.J. Tucker, Applied Optics, 16(2):416-418.
5. 1976 "Spectral Mapping of Shortgrass Praire Biomass," R.L. Pearson, C.J. Tucker and L.D. Miller, Photogrammetric Engineering and Remote Sensing, 42(3):317-323.
6. 1976 "Sensor Design for Monitoring Vegetation Canopies," C.J. Tucker and E.L. Maxwell, Photogrammetric Engineering and Remote Sensing, 42(11):1399-1410.
7. 1977 "Leaf Optical System Modeled as a Stochastic Process," C.J. Tucker and M.W. Garratt, Applied Optics, 16:635-642.
8. 1977 "Asymptotic Nature of Grass Canopy Reflectance," Photogrammetric Engineering and Remote Sensing, 43(8):1059-1067.
9. 1977 "Resolution of Grass Canopy Biomass Classes," Photogrammetric Engineering and Remote Sensing, 43(8):1059-1067.
10. 1977 "Spectral Estimation of Grass Canopy Variables", Remote Sensing of Environment, 6(1):11-28.
11. 1977 "Soil Spectra Contributions to Grass Canopy Spectral Reflectance", C.J. Tucker and L.D. Miller, Photogrammetric Engineering and Remote Sensing, 43(6):721-726.
12. 1978 "Are Two Photographic Infrared Sensors Required?", Photogrammetric Engineering and Remote Sensing, 44(3):289-295.
13. 1978 "Post Senescent Grass Canopy Remote Sensing", Remote Sensing of Environment, 7(2):203-210.
14. 1978 "A Comparison of Satellite Sensor Bands for Vegetation Monitoring", Photogrammetric Engineering and Remote Sensing, 44(11):1169-1180.
15. 1979 "Red and Photographic Infrared Linear Combinations for Monitoring Vegetation", Remote Sensing of Environment, 8(2):127-150.

16. 1979 "Temporal Spectral Measurements of Corn and Soybean Crops", C.J. Tucker, J.H. Elgin, and J.E. McMurtrey, Photogrammetric Engineering and Remote Sensing, 45(5):643-653.
17. 1979 "Monitoring Corn and Soybean Crop development with Hand-held Radiometer Spectral Data", C.J. Tucker, J.H. Elgin, J.E. McMurtrey and C.J. Fan, Remote Sensing of Environment, 8(3):237-248.
18. 1980 "Evaluation of a Hand-held Radiometer for Estimating Pasture Biomass in Iceland", C.J. Tucker and I. Thornsteinsson, Journal of Agricultural Research Iceland, 12(1):11-25.
19. 1980 "Relationship of Crop Radiances to Alfalfa Agronomic Values", C.J. Tucker, J.H. Elgin, and J.E. McMurtrey, International Journal of Remote Sensing, 1(1):69-76.
20. 1980 "Limitations on the Applications of a Ground-Based Spectral Technique for Determining Rain Forest Leaf Area Index", B.N. Holben, C.J. Tucker and J.W. Robinson, Photogrammetric Engineering and Remote Sensing, 46(12):1555-1561.
21. 1980 "Radiometric Resolution for Monitoring Vegetation: How Many Bits are Needed?", International Journal of Remote Sensing, 1(3):241-254.
22. 1980 "Relationship of Spectral Data to Grain Yield Variation", C.J. Tucker, B.N. Holben, J.H. Elgin and J.E. McMurtrey, Photogrammetric Engineering and Remote Sensing, 46(5):657-666.
23. 1980 "Remote Sensing of Leaf Water Content in the Near Infrared", Remote Sensing of Environment, 10:23-32.
24. 1980 "A Spectral Method for Determining the Percentage of Green Herbage Material in Clipped Samples", Remote Sensing of Environment, 9(2):175-181.
25. 1980 "A Three-band Hand-held Radiometer for Field Use", C.J. Tucker, W.H. Kley and G.J. Sundstrom, Science 211:281-283.
26. 1980 "Spectral Assessment of Soybean Leaf Area and Leaf Biomass", B.N. Holben, C.J. Tucker and C.J. Fan, Photogrammetric Engineering and Remote Sensing, 46(5):651-656.
27. 1980 "A Critical Comparison of Remote Sensing and Other Nondestructive Biomass Estimation Methods", C.J. Tucker, Forage Science, 35(3):177-183.
28. 1981 "Remote Sensing of Total Dry-matter Accumulation in Winter Wheat", C.J. Tucker, B.N. Holben, J.H. Elgin and J.E. McMurtrey, Remote Sensing of Environment, 11:171-189.

29. 1981 "Temporal Relationships Between Spectral Response and Agronomic Variables of a Corn Canopy", D.S. Kimes, B.L. Markham, C.J. Tucker and J.E. McMurtrey, Remote Sensing of Environment.
30. 1981 "The Relationship of Temporal Spectral Response of a Corn Canopy to Grain Yield and Final Dry Matter Accumulation", B.L. Markham, D.S. Kimes, C.J. Tucker and J.E. McMurtrey, Photogrammetric Engineering and Remote Sensing, 48(11):1599-1605.
31. 1981 "Thematic Mapper Simulator Data", C.J. Tucker and C.O. Justice, International Journal of Remote Sensing, 2(1):101-103.
32. 1983 "Satellite Remote Sensing of Total Dry Matter Production in the Senegalese Sahel", C.J. Tucker, C. Vanpraet, E. Boerwinkel, and A. Gaston, Remote Sensing of Environment, 13:461-474.
33. 1984 "Monitoring Vegetation in the Nile Delta with NOAA-6 and NOAA-7 AVHRR Data", C.J. Tucker, J.A. Gatlin and S.R. Schneider, Photogrammetric Engineering and Remote Sensing, 50:53-61.
34. 1984 "Intensive Forest Clearing in Rondonia, Brazil, as Detected by Satellite Remote Sensing", C.J. Tucker, B.N. Holben, and T.E. Goff, Remote Sensing of Environment, 15:255-261.
35. 1984 "Objective Assessment of Advanced Very High Resolution Radiometer Data for Land Cover Mapping", J.R.G. Townshend and C.J. Tucker, International Journal of Remote Sensing, 5:497-504.
36. 1984 "Optimal Directional View Angles for Remote-Sensing Missions", D.S. Kimes, B.N. Holben, C.J. Tucker and W.W. Newcomb, International Journal of Remote Sensing, 5:887-908.
37. 1984 "Satellite Measurements of Surface Albedo and Temperature in Semi-Desert", J. Otterman and C.J. Tucker, Journal of Climate and Applied Meteorology, 24:288-235.
38. 1985 "The Potential of Satellite Remote Sensing of Ecological Conditions for Desert Locust Survey and Forecasting", C.J. Tucker, J.U. Hielkema and J. Roffey, International Journal of Remote Sensing, 6:127-138.
39. 1985 "Determination of Volcanic Dust Deposition of El Chichon using Ground Satellite", C.J. Tucker and M. Matson, International Journal of Remote Sensing, 6:619-627.
40. 1985 "African Land Cover Classification Using Satellite Data", C.J. Tucker, J.R.G. Townshend and T.E. Goff, Science, 227:369-375.
41. 1985 "Satellite Remote Sensing of Total Herbaceous Biomass Production in the Senegalese Sahel: 1980-1984", C.J. Tucker, C.L. Vanpraet, M.J. Sharman and G. Van Ittersum, Remote Sensing of Environment, 17:233-249.

42. 1985 "North American Vegetation Patterns Observed with the NOAA-7 Advanced Very High Resolution Radiometer", S.N. Goward, C.J. Tucker, and D.G. Dye, Vegetatio, 64:3-14.
43. 1985 "Phenology of Global Vegetation Using Meteorological Satellite Data", C.O. Justice, J.R.G. Townshend, B.N. Holben and C.J. Tucker, International Journal of Remote Sensing, 8:1271-1318.
44. 1985 "Multitemporal Dimensionality of Images of Normalized Difference Vegetation Index at Continental Scales", J.R.G. Townshend, T.E. Goff and C.J. Tucker, IEEE Trans. Geosci. Remote Sens. 6:888-895.
45. 1986 "The Relationship Between Atmospheric CO₂ Variations and a Satellite-derived Vegetation Index", C.J. Tucker, I.Y. Fung, C.D. Keeling, and R.H. Gammon, Nature 319:195-199.
46. 1986 "Assessment of Ecological Conditions Associated with the 1980 Desert Locust Plague Upsurge in West Africa Using Environmental Satellite Data", J.U. Hielkema, J. Roffey and C.J. Tucker, Int. J. Remote Sensing 7:1609-1622.
47. 1986 "Satellite Remote Sensing of Desert Spatial Extent", C.J. Tucker and C.O. Justice, Desertification Contral Bulletin 13:2-50.
48. 1986 "Maximum Normalized Difference Vegetation Index Images for Sub-Saharan Africa for 1983-1985", Int. J. Remote Sens. 7:1383-1384.
49. 1986 "Satellite Remote Sensing of Primary Production", Int. J. Remote Sensing 7:1395-1416.
50. 1986 "Satellite Remote Sensing of Rangelands in Botswana. II. NOAA AVHRR and Herbaceous Vegetation", S.D. Prince and C.J. Tucker, Int. J. Remote Sensing 7:1555-1570.
51. 1986 "Monitoring the Grasslands of the Sahel 1984-1985", C.J. Tucker, C.O. Justice, and S.D. Prince, Int. J. Remote Sens. 7:1571-1582.
52. 1987 "Application of AVHRR Vegetation Index to Study Atmosphere-Biosphere Exchange of CO₂", I.Y. Fung, C.J. Tucker, and K.C. Prentice, J. Geophysical Res. 92:2999-3015.
53. 1987 "Prediction of Rift Valley Fever Activity in Kenya by Satellite Remote Sensing Imagery", K.J. Linthicum, C.L. Bailey, F.G. Davies, and C.J. Tucker, Science 235:1656-1659.
54. 1987 "Monitoring Vegetation Using NIMBUS-7 Scanning Multichannel Microwave Radiometer Data", B.J. Choudhury, C.J. Tucker, R.E. Golus, and W.W. Newcomb, Int. J. Remote Sens. 8:533-189.
55. 1987 "Satellites et Dynamique Globale de la Vegetation", J.P. Malingreau and C.J. Tucker, La Recherche 18:180-189.

56. 1987 "Satellite Remote Sensing of Drought Conditions", C.J. Tucker and B.J. Choudhury, Remote Sens. Environment, (in press).
57. 1987 "Monitoring global vegetation using Nimbus-7 37 GH₃ Data: Some Empirical Relations:", B.J. Choudhury and C.J. Tucker, Int. J. Remote Sens. 8:1085-1090.
58. 1988 "Desert encroachment", H.E. Dregne and C.J. Tucker, Desertification Control Bulletin 23:243-251.
59. 1988 "Green biomass and rainfall in semi-arid sub-Saharan Africa", H.E. Dregne and C.J. Tucker, J. Arid Environments 15:245-252.
60. 1988 "Large-scale deforestation in the southeastern Amazon Basin of Brazil", J.P. Malingreau and C.J. Tucker, Ambio 17:49-55.

NAME:

Brent N. Holben

PRESENT POSITION:

Physical Scientist
Earth Resources Branch
Laboratory for Terrestrial Physics

**RESEARCH AREA
EXPERIENCE:**

Agronomy, Micrometeorology, Remote Sensing

EDUCATION:

1972 - B.S. Agronomy
University of Idaho
1975 - M.S. Watershed Sciences
Colorado State University

PREVIOUS POSITIONS:

1975 - 1978 Climatologist
Puerto Rico Nuclear Center
San Juan, Puerto Rico

PROFESSIONAL SOCIETIES:

American Society of Photogrammetry
The Remote Sensing Society

PUBLICATIONS

1. 1975 "An Insolation Model Useful for Mountainous Topography", presented to Am. Meteorol. Soc. Ag. and Forestry Conference in Tucson, Arizona.
2. 1975 "The Development and Sensitivity Analysis of a Model for Estimating Insolation Climate in Mountainous Topography", Master's Thesis, Dept. of Earth Resources, College of Forestry, Colorado State University, Fort Collins, Colorado.
3. 1978 "Evaluation of a 2-spectral Band Radiometric Technique for Green Leaf Area Index Estimation in a Tropical Rain Forest", B.N. Holben and C.J. Tucker, presented to ACSM-ASP Fall Technical Meeting in Albuquerque, New Mexico.
4. 1979 "Examination of Lambertian and Non-Lambertian Models for Simulating the Topographic Effect on Remotely Sensed Data", C.O. Justice and B.N. Holben, NASA/GSFC TM-80557.
5. 1979 "Precipitation Distribution and Rainage Networks in the Luquillo Mountains", B.N. Holben, J.A. Colon, M. Canals and F. Santos, In: Methodologies and Instruments. Center for Energy and Environment Research, Capparra Hts. Stn. San Juan, Puerto Rico 00935.
6. 1979 "Spectral Assessment of Winter Wheat Total Dry Matter Accumulation and Final Grain Yield", C.J. Tucker, B.N. Holben, J.H. Elgin and J.E. McMurtrey III, In: Summaries. Thirteenth International Symposium on Remote Sensing of Environment, April 23-27.
7. 1980 "The Topographic Effect on the Spectral Response of Nadir Pointing Sensors", B.N. Holben and C.O. Justice, Photogrammetric Engineering and Remote Sensing 46(9):1191-1200.
8. 1980 "Relationship of Spectral Data to Grain Yield Variation", C.J. Tucker, B.N. Holben, J.H. Elgin, Jr. and J.E. McMurtrey III, Photogrammetric Engineering and Remote Sensing 46(5):657-666.
9. 1980 "Spectral Assessment of Soybean Leaf Area and Leaf Biomass", B.N. Holben, C.J. Tucker and C.J. Fan, Photogrammetric Engineering and Remote Sensing 46(5):651-656.
10. 1980 "Limitations on the Application of a Ground-Based Spectral Technique for Determining Rain Forest Leaf Area Index", B.N. Holben, C.J. Tucker and J. Robinson, Photogrammetric Engineering and Remote Sensing 46(12):1555-1561.
11. 1980 "The Contribution of the Diffuse Light Component to the Topographic Effect on Remotely Sensed Data", C.O. Justice and B.N. Holben, NASA/GSFC TM 80728, June.

12. 1980 "Angular Considerations in Off-Nadir Viewing of Soil and Vegetation", C.J. Tucker and B.N. Holben, accepted to International Journal of Remote Sensing.
13. 1981 "An Examination of Spectral Band Ratioing to Reduce the Topographic Effect on Remotely Sensed Data", B.N. Holben and C.O. Justice, International Journal of Remote Sensing 2(2):115-133.
14. 1981 "Application of Digital Terrain Data to Quantify and Reduce the Topographic Effect on Landsat Data", C.O. Justice, S. Wharton and B.N. Holben, International Journal of Remote Sensing 2(3):213-230.
15. 1981 "Remote Sensing of Total Dry-Matter Accumulation in Winter Wheat", C.J. Tucker, B.N. Holben, J.H. Elgin, Jr., and J. McMurtrey III, Remote Sensing of Environment 11:171-189.
16. 1981 "Reflectivity of TFE--A Washable Surface--Compared with that of BaSO₄", J.B. Schutt, B.N. Holben, C.M. Shai, and J.H. Henninger, Appl. Opt. 20(12):203-2035.
17. 1983 "Leaf water stress detection utilizing thematic mapper bands 3, 4 and 5 in soybean plants", B.N. Holben, J.B. Schutt and J. McMurtrey III, Int. J. Remote Sensing, 1983, 4(2):289-297.
18. 1983 "Effects of atmospheric and view angle illumination geometry of visible and near-IR AVHRR radiance data", B. Holben and R.S. Fraser, In Proceedings of Seventeenth International Symposium of Remote Sensing of Environment.
19. 1984 "Red and near-infrared sensor response to off-nadir viewing", B. Holben and R.S. Fraser, Int. J. Remote Sensing 5(1):145-160.
20. 1984 "Intensive forest clearing in Rondonia, Brazil as detected by satellite remote sensing", C.J. Tucker, B.N. Holben and T.E. Goff, Remote Sensing of Environment 15:255-261.
21. 1984 "Optimal directional view angles for remote sensing missions", D.S. Kimes, B.N. Holben, C.J. Tucker, W.W. Newcomb, Int. J. Remote Sensing 5(6):887-908.
22. 1985 "Analysis of the phenology of global vegetation using meteorological satellite data", C.O. Justice, J.R.G. Townshend, and B.N. Holben, International Journal of Remote Sensing (6):1271-1318.
23. 1986 "Directional reflectance response in AVHRR red and near-infrared bands for three cover types and varying atmospheric conditions", B.N. Holben, D.S. Kimes and R.S. Fraser, Remote Sensing of Environment.

24. 1986 "Characteristics of maximum-value composite images from temporal AVHRR data", B.N. Holben, Int'l. J. of Remote Sensing 7(11):1417-1434.
25. 1986 "Monitoring East African vegetation using AVHRR data", C.O. Justice, B.N. Holben and M.D. Gwynne, Int'l. J. of Remote Sensing 7(11):1453-1474.
26. 1986 "Identifying deforestation in Brazil using multiresolution satellite data", R. Nelson and B. Holben, International J. of Remote Sensing, 7(3):429-448.
27. 1986 "Directional Reflectance Response in AVHRR Red and Near-IR Bands for Three Cover Types and Varying Atmospheric Conditions", B. Holben, D. Kimes and R.S. Fraser, Remote Sensing of Environment, 19(3):213-236.
28. 1987 "Satellite detection of tropical burning in Brazil", M. Matson and B.N. Holben, Int'l. J. Remote Sensing 8(3):509-517.
29. 1987 "Global Evaluation of a Satellite-Based Ecological Index Using Field and Simulated Data", E. Box, B. Holben and V. Kalb, submitted to Science.
30. 1988 "Temporal and Spatial Variability of Aerosol Optical Depth in the Sahel Region", B. Holben and T. Eck, in preparation.

RESUME

PATRICIA A. JACOBBERGER

EDUCATION:

Washington University in St. Louis 1982: Ph.D., Earth and Planetary Sciences

University of Nebraska 1977: B.S., Geology

EMPLOYMENT HISTORY:

1983-present Research Geologist, Center for Earth and Planetary Studies, National Air and Space Museum, Smithsonian Institution, Washington, D.C. 20560. Research specialties: Desert fringe and Sahelian geomorphology; desertification processes; remote sensing.

1982-1983 Assistant Professor, Department of Geology, Appalachian State University. Courses taught: Geomorphologic Processes; Environmental Geology; Physical Geology.

1980-1982 Graduate Research Assistant, McDonnell Center for the Space Sciences; research leading to completion of Ph.D. dissertation: "Remote Sensing of Arid Lands".

1977-1980 Edward H. White III Astronaut Fellow, McDonnell Center for the Space Sciences; research on application of remote sensing techniques to geological interpretation of terrestrial desertification processes and desert morphology.

1977 Geologist, Amoco Production Company; stratigraphic and structural analysis of northwest limb of Anadarko Basin.

EXPERIENCE:

Principal Investigator: 1985- ; Environmental Processes and Spectral Reflectance Characteristics Associated with Soil Erosion in Desert Fringe Regions. National Aeronautics and Space Administration.

Co-Investigator: 1985- ; Temporal and Spectral Variations of Sand Dunes in the Central Western Desert of Egypt. Programme d'Evaluation Preliminaire SPOT.

Principal Investigator: 1986- ; Sediment Sampling and Paleoenvironmental Study of the Tombouctou Region, Mali. James Smithson Society.

Principal Investigator: 1984-1985; Remote Sensing Study of the Geology, Geomorphology and Response to Climatic Trends in the Upper Inland Niger Delta, Mali. Smithsonian Institution Scholarly Studies Program.

Chairman: 1988- ; Coastal Deserts, Ocean Circulation and Sea Levels Working Group, Project 252 of the International Geological Correlation Programme.

Member: 1987- ; Academic Hiring and Appraisal Committee, Smithsonian Institution.

Member: 1986- ; Research Policy Committee, Smithsonian Institution.

Member: 1986- ; Steering Committee for Earth Sciences; Office of Fellowships and Grants, Smithsonian Institution.

Chairman: 1985; Research Working Group, National Air and Space Museum, Smithsonian Institution.

Member: 1984; Research Working Group, National Air and Space Museum, Smithsonian Institution.

PROFESSIONAL SOCIETIES:

Member, American Geophysical Union

Member, Geological Society of America

Member, Society of Economic Paleontologists and Mineralogists

Member, American Society for Photogrammetry and Remote Sensing

Member, Sigma Xi

INVITED PAPERS:

Jacobberger, P.A. (1987) "Interaction of fluvial and aeolian processes in desertification," in Proceedings, Twentieth International Symposium on Remote Sensing of Environment: Remote Sensing for Africa, Nairobi, December 4-10, 1986, p.87-94.

Jacobberger, P.A. (1985) "Changes in Morphologic and Aeolian Processes in the Upper Inland Niger Delta of Mali as a Function of Drought", in Proceedings of the International Workshop on Sand Transport and Desertification in Arid Lands, Khartoum, 17-26 November, 1985, in press.

PUBLICATIONS:

Jacobberger, P.A. (1988) "Seasonal color and brightness changes in the region of Tombouctou," submitted June 1988.

Jacobberger, P.A. (1988) "Mapping abandoned river channels in Mali through directional filtering of thematic mapper data," Remote Sensing of Environment, in press.

Jacobberger, P.A. (1988) "Drought-related changes to geomorphologic processes in central Mali," Geological Society of America Bulletin, v. 100, p.351-361.

Jacobberger, P.A. (1988) "Remote sensing and field study of drought-related changes in the inland Niger delta of Mali," in Proceedings, Twentieth International Symposium on Remote Sensing of Environment: Remote Sensing for Africa, Nairobi, December 4-10, 1986, p. 1379-1385.

Maxwell, T.A. and Jacobberger, P.A. (1988) "Remote sensing observations of sand movement in the Bahariya depression, Western Desert of Egypt," in Proceedings, Twentieth International Symposium on Remote Sensing of Environment: Remote Sensing for Africa, Nairobi, December 4-10, 1986, p. 721-729.

Jacobberger, P.A. (1988) "Mapping the abandoned fluvial system of the Azaouad depression using MSS and TM Data," in Proceedings, Twentieth International Symposium on Remote Sensing of Environment: Remote Sensing for Africa, Nairobi, December 4-10, 1986, p. 821-826.

Jacobberger, P.A. (1987) "Geomorphology of the Upper Inland Niger Delta", Journal of Arid Environments, v. 13, p. 95-112.

Principal Investigator: 1984-85 Sahelian Land Use Project

- Jacobberger, P.A. (1985) "Geomorphology of the Upper Inland Niger Delta", In National Air and Space Museum Research Report, 1985, Smithsonian Institution Press, Washington, D.C., p. 116-131.
- Jacobberger, P.A. (1984) Enhanced discriminability within Landsat MSS images using pre-determined spectral data subsets for principal components analysis: An examples over the Inland Niger Delta, Mali, Proceedings, International Symposium on Remote Sensing of Environment, Third Thematic Conference: Remote Sensing for Exploration Geology, Colorado Springs, Colorado, April 16-19, 1984, p. 567-572.
- Jacobberger, P.A. and T.A. Maxwell (1984) Sediment provenance determinations as a means of mapping lithologies in the southern Sinai, Egypt, Proceedings, International Symposium on Remote Sensing of Environment, Third Thematic Conference: Remote Sensing for Exploration Geology, Colorado Spring, Colorado, April 16-19, 1984, p. 811-816.
- Jacobberger, P.A., R.E. Arvidson and D.L. Rashka (1983) Application of Landsat multispectral scanner and sediment spectral reflectance measurements to mapping of the Meatiq Dome, Egypt. Geology, v. 11, p. 587-591.
- Jacobberger, P.A. (1982) Drought-induced wind erosion in southwestern Kansas, U.S.A. -- Integration of Landsat, Seasat and Airborne Multispectral data, Proceedings of the Fifteenth International Symposium on Remote Sensing of Environment, Cairo, Egypt, January 1982, p. 937-946.
- Jacobberger, P.A., D.L. Rashka, R.E. Arvidson, and R. Batiza (1982) Use of Landsat multispectral scanner data in geologic mapping of the Meatiq Dome, Central Eastern Desert, Egypt, Proceedings of the Fifteenth International Symposium on Remote Sensing of Environment, Cairo, Egypt, January 1982, p. 775-779.
- Arvidson, R.E. and P. Jacobberger (1982) Mapping oases and soil types from Landsat digital multispectral scanner data -- Kharga Depression, Western Desert, Egypt. Proceedings of the Fifteenth International Symposium on Remote Sensing of Environment, Cairo, Egypt, January 1982, p. 565-569.
- Arvidson, R.E., P.A. Jacobberger and D. Rashka (1981) Rock and soil mapping and change detection from Landsat multispectral scanner data -- clues to limits of interpretability from Viking Orbiter color data. Reports of Planetary Geology Program 1981, NASA TM 84211, p. 455-456.
- Jacobberger, P.A. and R.E. Arvidson (1981) Detection of color changes in southwest Kansas using Landsat multispectral scanner data, The Compass, v. 58, no. 3, p. 43-49.

Jacobberger, P., R. Arvidson and E. Guinness (1980) The Meatiq Dome Egypt -- an earth analog study of rock type discrimination using broad-band visible and reflected IR data. Reports of Planetary Geology Program 1980, NASA TM 82385, p. 442-444.

ABSTRACTS:

Jacobberger, P.A. (1988) "Seasonal color changes in the Azaouad dunefield near Tombouctou, Mali, submitted for presentation at the Annual Meeting, Geological Society of America.

Jacobberger, P.A., Maxwell, T.A., and Hooper, D.M. (1988) "Spectral and morphologic variations along the Abu Muharik dune system (Western Desert of Egypt), submitted for presentation at the Annual Meeting, Geological Society of America.

Hooper, D.M. and Jacobberger, P.A. (1987) "Spectral reflectance properties of stabilized dunes west of the Okavango Delta, Botswana, GSA Abstracts with Programs, v. 19, p. 707.

Jacobberger, P.A. (1986) "Mapping the Abandoned Fluvial System of the Azaouad Depression using MSS and TM Data," in Summaries of Presentations, Twentieth International Symposium on Remote Sensing of Environment: Remote Sensing for Africa, Nairobi, December 4-10, 1986, p. 66-67.

Jacobberger, P.A. (1986) "Remote Sensing and Field Study of Drought-related Changes in the Inland Niger Delta of Mali," in Summaries of Presentations, Twentieth International Symposium on Remote Sensing of Environment: Remote Sensing for Africa, Nairobi, December 4-10, 1986, p. 196-197.

Maxwell, T.A. and P.A. Jacobberger (1986) Remote Sensing Observations of Sand Movement in the Bahariya Depression, Western Desert of Egypt," in Summaries of Presentations, Twentieth International Symposium on Remote Sensing of Environment: Remote Sensing for Africa, Nairobi, December 4-10, 1986, p. 49.

Hooper, D.M. and P.A. Jacobberger (1986) "Spectral Characteristics of Dunes and Interdune Corridors West of the Okavango Delta, Botswana," in GSA Abstracts with Programs, v. 18, n. 6, p. 640.

Jacobberger, P.A. (1986) "Drought-related Changes in the Inland Niger Delta of Mali," in GSA Abstracts with Programs, v. 18, p. 644.

Jacobberger, P.A. (1985) "Changes in Surface Hydrology in the Upper Inland Niger Delta of Mali as a Function of Drought". EOS, v. 66, p. 262.

Jacobberger, P.A. (1985) "Drought-related Surface Changes in the Upper Inland Niger Delta of Mali," GSA Abstracts with Programs, v. 17, p. 617.

- Jacobberger, P.A. (1984) Enhanced discriminability within Landsat MSS images using pre-determined spectral data subsets for the principal components analysis: An example over the inland Niger Delta, Mali, in Summaries of Presentations, International Symposium on Remote Sensing of Environment, Third Thematic Conference, Colorado Springs, Colorado, April 16-19, 1984.
- Jacobberger, P.A. and T.A. Maxwell (1984) Sediment provenance determinations as a means of mapping lithologies in the central Eastern Desert of Egypt and southern Sinai, in Summaries of Presentations, International Symposium on Remote Sensing of Environment, Third Thematic Conference, Colorado Springs, Colorado, April 16-19, 1984.
- Jacobberger, P.A. (1984) "Morphology and Changes in Surface Hydrology in the Upper Inland Niger Delta, Mali." In GSA Abstracts with Programs, v. 16, p. 549.
- Jacobberger, P.A. (1982) Mapping surface materials in the Bahariya Oasis, Western Desert, Egypt using simple clustering techniques on Landsat MSS data. in Summaries of Presentations, Second Thematic Conference, International Symposium on Remote Sensing of Environment, Fort Worth, Texas, November 1982.
- Jacobberger, P.A. (1982) Applications of Landsat digital MSS data in geologic mapping: Meatiq Dome, Central Eastern Desert, Egypt. GSA Abstracts with Programs, v. 14, p. 268.
- Jacobberger, P. (1980) Color changes in southwest Kansas, possibly related to soil erosion. Missouri Academy of Sciences Bulletin 8, no. 3, p. 13.
- Jacobberger, P. (1980) Color changes related to soil erosion in southwest Kansas as detected by Landsat. EOS, v. 61, p. 238.

CURRICULUM VITAE

Name: Christopher Owen Justice

Present Address: NASA/Goddard Space Flight Center
Earth Resources Branch/Code 623
Greenbelt, MD 20771 USA
Phone: (301) 286-7372

U.K. Address: Dyrham Park, Near Chippenham, Wiltshire, SN14 8ER
Phone: 027-582-2501

Date of Birth: May 16, 1952

Nationality: British

Marital Status: Married

Education

1974 - 77 Ph.D. Geography, Reading University, U.K.

1970 - 73 B.A. (Hons.) Geography, Reading University, U.K.

1963 - 70 Buckhurst Hill, County High School, Chigwell Essex, U.K.

EMPLOYMENT

1973 - 74 Research Assistant, Anglo Argentinian Geoscopy Experiment
University of Reading, Geography Department

1976 - 77 Research Demonstrator, University of Reading, Geography
Department (A demonstratorship permitted higher degree
research to be undertaken while assisting with the
teaching of undergraduate laboratory and field classes).

1977 - 81 Resident Research Associate, Earth Resources Branch
(Code 623), NASA/Goddard Space Flight Center, Greenbelt,
Maryland, USA. (Funded by National Academy of Sciences
and the National Research Council).

1981 Consultant--Clyde Surveys, UK, Land Use Specialist, World
Bank Transmigration Project, Kalimantan, Indonesia.

1981 - 83 Resident Research Fellow, Earthnet Programme Office,
ESA/ESRIN, Frascati, Italy. (Funded by the European
Space Agency Fellowship Programme.)

1983 - 87 Faculty Research Associate, Civil Engineering Department,
University of Maryland, College Park, MD, USA. (Funded
by NASA/GSFC.)

1985 Consultant--UN/FAO, Remote Sensing of African Grasslands,

Sudan FAO, TCP/SUD/5418

1987

Assistant Research Scholar, Geography Department,
University of Maryland. (Funded by NASA/GSFC.)

Current Research Activities (1983-)

Full time participation in the Global Inventory Monitoring & Modelling Studies project at NASA/GSFC. The project is composed of a series of collaborative research projects primarily concerned with applying coarse resolution satellite data to global vegetation studies in the context of NASA's Earth System Science Program (Ref. #22).

I. Continental Land Cover Classification

This study involves the development of methodologies to apply high temporal frequency, coarse spatial resolution satellite data from AVHRR and SMMR sensors to continental scale vegetation mapping (Refs. #27, 31, 32, 34).

II. Sahelian Grasslands Study

The objective of the study is to monitor interannual variations in primary production of the annual grasslands. The study is a cooperative program with UN/FAO, UNEP/GEMS, US/AID and the International Livestock Center for Africa (ILCA) involving field data collection programs in conjunction with airborne radiometric surveys in Mali, Senegal, Niger and Sudan.

One of the prime objectives of the study is to build up a long term satellite data base to help understand the mechanism of the Sahelian Drought and the resultant effects on the vegetation of the region. Interest lies in developing satellite based early warning system to improve the food security of the Sahelian Zone (Refs. #4, 11, 35).

III. Evaluation of the sensor requirements for the NASA/MODIS sensing system

This study is part of the definition phase for an advanced coarse resolution global monitoring system planned for launch as part of NASA's Earth Observing System in the 1990's (Refs. #16, 21).

Previous Remote Sensing Research (Chronological Order)

I. The Anglo Argentinian Geoscopy Experiment (1973-1975)

"Evaluation of photography obtained from Skylark Earth Resources rockets of Central Argentina for terrain resources/soil survey/land use survey mapping, and geological structure/landform (geomorphological) surveys." (Refs. #3, 29)

II. Ph.D. Thesis Research (1974-1977)

An examination of the effects of various terrain and surface cover properties on the spectral response from Landsat Multispectral

Scanners. The aim of the research was to study the effect of various terrain and surface cover properties on the spectral response from Landsat Multispectral Scanners in an area of complex terrain and surface cover distribution, In S.Italy. (Refs. #24, 8)

III. Land Use Mapping in Mediterranean Environments (1974-1984)

A research project to develop methodologies for deriving detailed thematic maps from remotely sensed satellites data of mediterranean environments utilizing digital image processing and analysis techniques. (Refs. #26, 30, 20, 19)

IV. Modelling the Topographic Effect on Sensor Response (1979-1981)

Project designed to quantify the topographic effect on remotely sensed satellite data. The study included ground based radiometric measurement of simulated terrain conditions and use of digital terrain data to apply the model to satellite data. (Refs. #5, 12, 13, 6, 7, 23)

V. Remotely Sensed Satellite Data and Ancillary Data Integration and Analysis (1979-1980)

Examination of methods for integrating remotely sensed data and ancillary data for cover classification. Examination of the role and contributions of remotely sensed data to environmental modelling in a Geographic Information System Framework. (Refs. #25, 18, 27)

VI. Land Use/Soil Mapping, Kalimantan, Indonesia (June-August 1981)

This project included detailed ground mapping of land cover/land use and soil unit mapping at 1:50,000 scale for an area of tropical rain forest. The objective of the study was the production of land capability maps for agricultural development. (Ref. #1)

VII. Sensor System Evaluation & Image Quality Analysis (1981-1983)

Research undertaken whilst at the ESA Earthnet Programme Office included evaluation and modification of the Landsat 3 RBV data produced by the ESA/Fucino ground receiving station with particular reference to radiometric correction procedures and the design of a Quality Assessment System for the Earthnet Landsat D Thematic Mapper processing chain. (Refs. #2, 33, 10)

Miscellaneous Contributions

Organization of International Meetings

- | | |
|------|---|
| 1982 | 1 st European Thematic Mapper Meeting, Frascati, Italy |
| 1985 | AVHRR Grasslands Research Meeting, Nairobi, Kenya |

Invited Committees

- | | |
|------|-----------------------|
| 1983 | NASA TM Science Panel |
|------|-----------------------|

1985 NASA MODIS Instrument Panel

Editor

IJRS Special Edition on Monitoring the Grasslands of Semi-Arid
Africa using NOAA-AVHRR Data, Vol. 7, No. 11

Invited participation in the Royal Geographical Society. 'Kora' Expedition,
Kenya (1985)

Invited participation in U.N. Training Course on Remote Sensing for the
African Environment. ILE IFE, Nigeria 1984; Yamakoukro, Ivory Coast 1985.

PUBLICATIONS

1. Clyde Surveys Ltd., 1982. Phase III feasibility studies and detailed engineering report for transmigration settlements development in Central and West Kalimantan (Hanjaliipan Area). Maidenhead, Berkshire, U.K.
2. Dosiere, P. and C.O. Justice, 1983. Spatial and radiometric resolution of the Landsat-3 RBV system. International Journal of Remote Sensing, Vol. 4, No. 2.
3. Drennan, D.S.H., J.R. Hardy, R.A.G. Savigear, J.R.G. Townshend, C.J. Bray, I.R. Galloway, C.O. Justice, E.S. Owen-Jones, 1974. The interpretation and use of false color infra-red and true color photography of part of Argentina obtained by Skylark Earth Resources rockets in: "Proceedings, Ninth International Symposium on Remote Sensing of Environment", Ann Arbor: Environmental Research Institute of Michigan, Volume II, pp. 1475-1496.
4. Hiernaux, P. and C.O. Justice, 1986. Suivi du developement vegetal au cours de l'ete 1984 dans le Sahel Malien. Int. J. Remote Sensing 7(11): 1515-1532.
5. Holben, B.N. and C.O. Justice, 1979. Evaluation and modeling of the topographic effects on the spectral response from nadir pointing sensors. NASA/GSFC TM 80305, 19 pp.
6. Holben, B.N. and C.O. Justice, 1980. The topographic effects on spectral response from nadir pointing sensors. Photogram. Eng. and Remote Sensing, Vol. 4-6, No. 9, pp. 1191-1200.
7. Holben, B.N. and C.O. Justice, 1981. An examination of spectral band ratioing to reduce the topographic effect on remotely sensed data. Int. J. Remote Sensing, Vol. 2, pp. 115-133 (Also NASA/GSFC TM 80640).
8. Justice, C.O., 1978. An examination of the relationships between selected ground properties and Landsat MSS data in an area of complex terrain in southern Italy. Proc. American Society of Photogrammetry Fall Meeting, Albuquerque, New Mexico, pp. 303-328.
9. Justice, C.O., 1983. The contribution of remote sensing to the inventory and monitoring of natural resources Proc. Conference of Renewable Resources Inventories, Corvallis, Oregon. 362-367.
10. Justice, C.O. and L. Fusco, 1984. A preliminary analysis of Landsat-4 Thematic Mapper radiometric performance in Landsat-4 Science Investigations Summary (ed. J. Barker) NASA Conference Publication 2326, NASA/GSFC, Greenbelt, Maryland, Vol. II.
11. Justice, C.O. and P. Hiernaux, 1986. Monitoring the grasslands of the Sahel using NOAA/AVHRR data: Niger 1983. Int. J. Remote Sensing 7(11): 1475-1498.
12. Justice, C.O. and B.N. Holben, 1979. Examination of Lambertian and non-Lambertian models for simulating the topographic effects on remotely

sensed data. NASA/GSFC TM 80557.

13. Justice, C.O. and B.N. Holben, 1980. An examination of the contribution of the diffuse light component to the topographic effect on remotely sensed data. NASA/GSFC TM 80760, 39 pp.
14. Justice, C.O., B.N. Holben, M. Gwynne, 1986. Monitoring East African vegetation using NOAA/AVHRR data. Int. J. Remote Sensing 7(11):1453-1474.
15. Justice, C.O., J.P. Malingreau, and J.U. Hielkema, 1984. The application of satellite remote sensing techniques for monitoring natural vegetation, crops, and rainfall. Proc. UN/FAO Workshop on Early Warning Systems in Developing Countries in Asia and the Pacific Region. Bangkok (ESC/RAPA/WMES/3.3).
16. Justice, C.O., B. Markham, J.R.G. Townshend and R. Kennard. Spatial Degradation of Satellite Data. (Submitted to IJRS).
17. Justice, C.O., M.K. Sharman, and K.D. Singh. A comparison of AVHRR and MSS data for mapping the forests in India (in preparation).
18. Justice, C.O. and J.R.G. Townshend, 1981. Integrating ground data with remote sensing. IN: Townshend, J.R.G. (ed.) Integrated Land Resource Surveys and Remote Sensing, George Allen and Unwin (Publishers) Ltd., pp. 38-53.
19. Justice, C.O. and J.R.G. Townshend, 1981. The use of remotely sensed satellite data for providing land cover information for Natural Resource Inventories of Mediterranean Lands - In - Townshend, J.R.G. (ed.) Integrated Land Resource Surveys and Remote Sensing. George Allen and Unwin (Publishers) Ltd., pp. 133-148.
20. Justice, C.O. and J.R.G. Townshend, 1981. A comparison of unsupervised classification procedures of Landsat MSS data for an area of complex surface conditions in Basilicata, S. Italy. Remote Sensing of the Environment. 12, 407-420. (Also NASA/GSFC TM 82098).
21. Justice, C.O. and J.R.G. Townshend. Selecting the spatial resolution of satellite sensors required for global monitoring of land transformations (submitted to IJRS).
22. Justice, C.O., J.R.G. Townshend, B.N. Holben and C.J. Tucker, 1985. Analysis of the Phenology of Global Vegetation using Meteorological Satellite Data. Int. J. Remote Sensing 6(8): 1272-1318.
23. Justice, C.O., S. Wharton and B.N. Holben, 1981. Using digital terrain data to quantify and reduce the topographic effect on Landsat data. Int. J. Remote Sensing, Vol. 2, No. 3, pp. 213-230 (Also NASA/GSFC TM 81988, 32 pp.).
24. Justice, C.O., D.F. Williams, J.R.G. Townshend and R.A.G. Savigear, 1975. The provision of environmental information from space imagery for Basilicata Province, Southern Italy. In: Proceedings 2nd Annual General

Conference of the Remote Sensing Society, Silsoe, pp. 1-39.

25. Knapp, E.M., C.O. Justice and K.J. Ingram, 1979. Integration of Landsat data with ancillary data for improved environmental analysis: Current Status and future directions. Proceedings 17th Annual Conference of the Urban and Regional Information System Association, San Diego, CA.
26. Townshend, J.R.G. and C.O. Justice, 1980. The unsupervised classification of MSS Landsat data for mapping spatially complex vegetation. *Int. J. Remote Sensing*, Vol. 1, No. 2, pp. 105-120.
27. Townshend, J.R.G. and C.O. Justice, 1981. Image Processing: a users view. *Int. J. Remote Sensing*, Vol. 2, No. 4, pp. 331-349.
28. Townshend, J.R.G. and C.O. Justice, 1986. Analysis of the dynamics of African vegetation using the Normalized Difference Vegetation Index. *Int. J. Remote Sensing* 7(11):1435-1446.
29. Townshend, J.R.G., R.A.G. Savigear, C.O. Justice, J.R. Hardy, D.S.H. Drennan and C.J. Bray, 1974. A comparison of the capabilities of ERTS and the Earth Resources Skylark rocket within Central Argentina, in "European earth resources satellite experiments: Proceedings of a symposium held at Frascati, Italy. 28 Jan. - 1 Feb. 1974" (eds. B.T. Battrick and N.T. Duc), Paris: ESRO, SP-100, pp. 383-403.
30. Townshend, J.R.G., D.F. Williams and C.O. Justice, 1978. An evaluation of Landsat 3 RBV imagery for an area of complex terrain in Southern Italy. *Proc. 13th International Symposium on Remote Sensing of the Environment*, Ann Arbor, Michigan, Vol. II, pp. 1839-1852.
31. Townshend, J.R.G., C.O. Justice and V. Kalb 1987. Characterization and Classification of South American Land Cover Types using Satellite Data. *Int. J. Remote Sensing*.
32. Townshend, J.R.G., C.O. Justice and C.J. Tucker, 1986. Techniques for continental land cover and classification using remotely sensed satellite data. *Proc. Symp. on Mapping from Modern Imagery*. Edinburgh ISPRS/RSS: 34-44.
33. Tucker, C.J. and C.O. Justice, 1981. Thematic Simulator Data. *Int. J. Remote Sensing*, Vol. 2, No. 1, pp. 101-103.
34. Tucker, C.J. and C.O. Justice, 1986. Satellite remote sensing of desert spatial extent. *Desertification Control Bulletin* 13:2-5.
35. Tucker, C.J., C.O. Justice and S.D. Prince, 1986. Monitoring the grasslands of the Sahel 1984-1985. *Int. J. Remote Sensing* 7(11):1571-1582.

NAME: Virginia L. Kalb

PRESENT POSITION: Mathematician
Earth Resources Branch
Laboratory for Terrestrial Physics

RESEARCH AREA
EXPERIENCE: Image Processing

EDUCATION: 1975 - B.A. University of Maryland
1977 - M.A. University of Maryland

PREVIOUS POSITIONS: 1977 - 1981 Mathematician
Ground Systems & Data Management Branch
Systems Division
1981 - 1984 Mathematician
Instrument Systems Branch
Instrument Division

PUBLICATIONS

1. 1987 "Comparison of North and South American Biomes from AVHRR Observations", S.N. Goward, A. Kerber, D.G. Dye and V. Kalb, Geocarto.
2. 1987 "Characterization and Classification of South American Land Cover Types Using Satellite Data", International Journal of Remote Sensing.
3. 1987 "Evaluating Satellite Assessment of Terrestrial Primary Production", E. Box, B. Holben and V. Kalb, submitted to Science.
4. 1987 "GIMMS Interactive Mapping/Image Processing", V.L. Kalb, and T.E. Goff, to be presented at HP Interex Conference in October, 1987.

NAME:

Arlene G. Kerber

PRESENT POSITION:

Physical Scientist
Earth Resources Branch
Laboratory for Terrestrial Physics

RESEARCH AREA

EXPERIENCE:

Digital Image Analysis and Interpretation of Remotely
Sensed Data--MSS, TM, AVHRR; Large Scale Climate-
Vegetation Interactions using AVHRR; Laboratory and
field study assessment of the thermal region

EDUCATION:

1965 - A.B. Biology
University of Michigan
1966 - M.S. Biology
University of Michigan
1970 - M.A. Social Studies
Eastern Michigan

PREVIOUS POSITIONS:

1978 - 1983 Physical Scientist
Eastern Regional Remote Sensing
Applications Center
NASA/GSFC
1977 - 1978 Physical Scientist
Earth Resources Laboratory
NASA/NSTL
1975 - 1977 Remote Sensing Specialist
Lockhead Electronics Co.
NASA/JSC
1971 - 1974 Assistant in Research
Environmental Research Institute of Michigan

PROFESSIONAL SOCIETIES:

American Society of Photogrammetry and Remote Sensing

PUBLICATIONS

1. 1976 The Tri-County Pilot Study, C.A. Reeves, T.W. Austin and A.G. Keber, LEC 8657, July 1976.
2. 1977 Ten Ecosystem Study Processing Manual, A.G. Kerber, LEC-10127, February 1977.
3. 1978 U.S. Army Corps of Engineers Environmental Information System ASVT, A.G. Kerber, Project Final Report, NASA Earth Resources Laboratory, National Space Technology Laboratories, March 1978.
4. 1982 Minnesota Landsat Irrigated Land Survey, A.G. Kerber, Y.C. Lu and D. Biessel, Technical Memorandum 84952, NASA/Goddard Space Flight Center, August 1982.
5. 1983 "Comparative Accuracies of AVHRR and MSS Data Used for Level I Land Cover Classifications", J.C. Gervin, R.G. Witt, A.G. Kerber, Y.C. Lu, R. Sekhon and B. Bly, Proceedings of the 49th Annual Meeting American Society of Photogrammetry, March 13-18, 1983, Washington, DC, pp. 334-342.
6. 1983 "Comparison of Level I Land Cover Classification Accuracy for MSS and AVHRR Data", J.C. Gervin, A.G. Kerber, R.G. Witt, Y.C. Lu and R. Sekhon, Seventeenth International Symposium on Remote Sensing of Environment, Ann Arbor, MI, May 9-13, 1983.
7. 1983 Vermont Landsat Land Cover Inventory Program, A.G. Kerber and Y.C. Lu, Final Report, NASA/Goddard Space Flight Center, July 1983.
8. 1983 "Utility of the Advanced Very High Resolution Radiometer (AVHRR) Middle Infrared and Thermal Channels in Land Cover Mapping", A.G. Kerber, National Conference on Resource Management Applications: Energy and Environment, August 22-26, 1983, San Francisco, CA.
9. 1983 "Floodplain Land Cover Mapping Using Thematic Mapper Data", A.G. Kerber, J.C. Gervin, Y.C. Lu, W. Ryerson and R. Marcell, Proceedings of the 4th U.S. Army Corps of Engineers Remote Sensing Conference, November 7-9, 1983, Reston, VA.
10. 1985 "Comparison of Level I Land Cover Accuracy for MSS and AVHRR Data", J.C. Gervin, A.G. Kerber, R.G. Witt, Y.C. Lu and R. Sekhon, International Journal of Remote Sensing, Vol. 6, No. 1, pp. 47-57.
11. 1985 "Floodplain Land Cover Mapping Using Thematic Mapper Data", A.G. Kerber, J.C. Gervin, Y.C. Lu, R. Marcell and H.A. Edwards, Invited Paper, Proceedings of the 19th International Symposium on Remote Sensing of Environment, October 1985.
12. 1986 "Utility of the AVHRR Channels 3 and 4 in Land Cover Mapping", A.G. Kerber and J.B. Schutt, Photogrammetric Engineering and Remote Sensing, Vol. 52, No. 12, December 1986, pp. 1877-1883.

13. 1987 "Comparison of North and South American Biomes from AVHRR Observations", S.N. Goward, A.G. Kerber, D. Dye and V. Kalb, Geocarto International, Vol. 2, No. 1, March 1987, pp. 27-39.
14. 1987 "Relationships of Soils and Vegetative Growth in South America Using Satellite Imagery", E.R. Levine, A.G. Kerber, T. Cook, and J. Kimble, Annual Meeting of American Society of Agronomy, Atlanta, Georgia.

Name:

Dr. Yoram J. Kaufman

Present address:

13114 Broadmore Rd., Silver Spring, MD 20904

Telephones:

Work-301-286-4866, Home-301-989-0773

Citizenship:

Israeli, Permanent resident in the U.S. since March 1, 1984. Applied for citizenship March 1, 1989.

Education:

Ph. D.

June 1979, Dept. of Geophysics and Planetary Sciences, Tel-Aviv University, Tel-Aviv, Israel.

University,

M. Sc.

Nov. 1974, Faculty of Physics, Technion - Israel Institute of Technology, Haifa, Israel.

B. Sc.

May 1972, Faculty of Physics, Technion, Israel.

Research and academic employment:

1981-present:

Scientist at the Dept. of Meteorology, University of Maryland, College Park, MD and NASA/Goddard SFC, Greenbelt, MD 20771. Theoretical and experimental research in Atmospheric Optics and Remote Sensing.

1985-1987:

Senior Research Associate, Dept. of Physics, Technion, Israel. Research in Infrared Physics and Atmospheric Optics. Teaching. undergraduate and graduate courses.

1979-1981:

National Research Council fellow at NASA/Goddard SFC, Greenbelt MD.

1975-1979:

Doctorate studies in Atmospheric Optics and Remote Sensing and teaching.

1973-1978:

Israel Army service - Physicist. Research and teaching.

1971-1973:

Studies in Electro Optics at the Technion and M. Sc. research on CO₂ lasers and saturable absorbers. Teaching assistant at the Faculty of Physics.**Research Interest**

My main research objective is to study the optical characteristics of the atmosphere, by theoretical and experimental methods. The results of this research are applied to design better remote sensing techniques, that are used to study the characteristics of the earth surface and its interaction with the atmosphere.

This research interest was developed during my Ph. D. studies, which involved development of approximate solutions to the equation of radiative transfer, first for a uniform surface, and then for a nonuniform surface. This radiative transfer model was used to develop methods for simultaneous remote sensing of surface albedo, the aerosol loading and the single scattering albedo from an image acquired over surface with strong contrasts (e.g. a sea shore). The model was redeveloped, with higher accuracy during my NRC residency (and later on while working for the University of Maryland in NASA/GSFC) and applied to study the effect of the atmosphere on human vision, on resolution of satellite imagery, on classification of surface features and on separability of field classes. We found that the atmosphere has a profound effect on remote sensing. It can reduce the apparent sensor resolution from 30m to 50m, and cause a misclassification of an inland water body, that can be classified as a wheat stuble. These strong atmospheric effects over nonuniform surfaces, as predicted by theory, requested experimental verifications. We performed field and laboratory measurements to verify the very basic results of the predictions of radiative transfer over a nonuniform surface. It was concluded that the radiative transfer model as well as Monte Carlo simulations can predict the atmospheric effect, but they tend to overestimate the range of the adjacency effect (the effect of a bright surface on the radiation over a nearby dark surface).

Withdrawal/Redaction Sheet

(George Bush Library)

Document No. and Type	Subject/Title of Document	Date	Restriction	Class.
01. Resume	Resume of Yoram J. Kaufman [social security number redacted] (3 pp.)	3/13/89	(b)(6)	

Collection:

Record Group: Bush Presidential Records
Office: Science and Technology Policy, Office of (OSTP)
Series: Bromley, D. Allan, Files
Subseries: Global Climate Change Files
WHORM Cat.:
File Location: Global Change Research Program (2) [1 of 3] [1990]

Date Closed:	4/6/2010	OA/ID Number:	62051-003
FOIA/SYS Case #:	2005-0336-F	Appeal Case #:	
Re-review Case #:		Appeal Disposition:	
P-2/P-5 Review Case #:		Disposition Date:	
AR Case #:		MR Case #:	
AR Disposition:		MR Disposition:	
AR Disposition Date:		MR Disposition Date:	

RESTRICTION CODES

Presidential Records Act - [44 U.S.C. 2204(a)]

P-1 National Security Classified Information [(a)(1) of the PRA]
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 P-3 Release would violate a Federal statute [(a)(3) of the PRA]
 P-4 Release would disclose trade secrets or confidential commercial or financial information [(a)(4) of the PRA]
 P-5 Release would disclose confidential advice between the President and his advisors, or between such advisors [(a)(5) of the PRA]
 P-6 Release would constitute a clearly unwarranted invasion of personal privacy [(a)(6) of the PRA]

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Freedom of Information Act - [5 U.S.C. 552(b)]

(b)(1) National security classified information [(b)(1) of the FOIA]
 (b)(2) Release would disclose internal personnel rules and practices of an agency [(b)(2) of the FOIA]
 (b)(3) Release would violate a Federal statute [(b)(3) of the FOIA]
 (b)(4) Release would disclose trade secrets or confidential or financial information [(b)(4) of the FOIA]
 (b)(6) Release would constitute a clearly unwarranted invasion of personal privacy [(b)(6) of the FOIA]
 (b)(7) Release would disclose information compiled for law enforcement purposes [(b)(7) of the FOIA]
 (b)(8) Release would disclose information concerning the regulation of financial institutions [(b)(8) of the FOIA]
 (b)(9) Release would disclose geological or geophysical information

An important question brought up by these studies was what are the important atmospheric parameters that have to be measured or estimated in order to perform a correction and how to determine these characteristics from satellite imagery. Methods were developed for estimating the aerosol optical thickness and the single scattering albedo from the surface and from satellite imagery. The estimated aerosol characteristics were used in a correction scheme. The derived aerosol characteristics can be used not only to correct the imagery of the surface for the atmospheric effects, but also to measure the loading, characteristics and transport of dense aerosol due to air pollution or due to fires and the effect of these emissions on the tropospheric and stratospheric chemistry and global climate.

Presently the remote sensing techniques are applied to study the effect of the extensive biomass burning in the tropics on the atmospheric composition. Aerosol particulates emitted in the fires are related to the emission of other trace gases and, as a result, can serve as tracers for their emission. The effect of the particulates on cloud albedo is also studied. Due to increase in the concentration of the CCN in the cloud, and the increase in the concentration of pollutants in the cloud, emission of particulates can cause an increase in the albedo of thin clouds (and thus global cooling) and decrease in the albedo of thick clouds (and thus global warming). Remote sensing techniques require continuous verification. We are studying new measurements techniques from the ground, in which, in addition to the aerosol optical thickness also the path radiance and the aerosol scattering phase function and size distribution can be determined.

List of journal publications:

1. Y. J. Kaufman and U.P. Oppenheim, 1974: 'Rate equations of high gain lasers and determination of laser parameters', Appl. Opt., 13, 374-378.
2. U. P. Oppenheim and Y. J. Kaufman, 1974: 'Molecular saturation and the criterion for passive Q-switching', IEEE J. Quant. Elect., QE-10, 533-540.
3. Y. J. Kaufman and A. Gersten, 1976: 'Simultaneous heating and temperature measurements by an IR laser beam', Appl. Opt., 15, 353-357.
4. Y. J. Kaufman, 1976: 'Passive Q-switching at high intensities and high absorber pressures', Appl. Opt., 15, 1530-1534.
5. Y. J. Kaufman, 1976: 'High gain IR laser in passive Q-switching: operating criterion', Appl. Opt., 15, 1535-1540.
6. Y. J. Kaufman, S. Ruchin and U.P. Oppenheim, 1977: 'Nonlinear absorption of SF₆ at high IR intensities and high pressures', Appl. Opt., 16, 1187-1191.
7. Y. J. Kaufman and U.P. Oppenheim, 1977: 'Time resolved molecular extinction and heat effects induced by IR radiation', Appl. Opt., 16, 1931-1935.
8. Y. J. Kaufman, 1978: 'Influence of the atmosphere on the contrast of the Landsat images', COSPAR: Space Res., XVII, Pergamon Press, Oxford, 65-68.
9. Y. J. Kaufman, 1979: 'Effect of the earth atmosphere on contrast for zenith observation', J. Geoph. Res., 84, 3165-3172.
10. Yu. Mekler and Y.J. Kaufman, 1980: 'The effect of earth's atmosphere on contrast reduction for a nonuniform surface albedo and two-halves field', J. Geoph. Res., 85, 4067-4083.
11. U. Samir, Y.J. Kaufman, L.H. Brace and H.C. Briton, 1980: 'The dependence of ion density in the wake of the AE-C satellite on the ratio of the body size to Debye length in an [O⁺]-dominated plasma', J. Geoph. Res., 85, 1769-1772.
12. U. Samir and Y.J. Kaufman, 1980: 'An assessment of the relative importance of body and plasma properties in determining the ion current. Distribution in the wake of an ionospheric satellite', J. Atmos. Terr. Physics, 42, 533-543.
13. J. Otterman, Y.J. Kaufman, M. Podolak and S. Ungar, 1980: 'Dependence of the spectral surface irradiance on aerosol properties and surface reflectivity', Solar Energy, 24, 279-286.
14. J. Otterman, S. Ungar, Y.J. Kaufman and M. Podolak, 1980: 'Atmospheric effect on radiometric

- imaging from satellites under low optical thick- ness conditions', *Rem. Sens. Environ.*, 9, 115-129.
15. Y.J. Kaufman, 1981: 'Combined eye-atmosphere visibility model', *Appl. Opt.*, 20, 1525- 1531.
 16. Y.J. Kaufman and J.H. Joseph, 1982: 'Determination of surface albedos and aerosol extinction characteristics from satellite imagery', *J. Geoph. Res.*, 20, 1287-1299.
 17. Y.J. Kaufman, 1982: 'Solution of the equation of radiative transfer for remote sensing over two-dimensional surface reflectivity', *J. Geoph. Res.*, 20, 4137-4147.
 18. Yu. Mekler and Y.J. Kaufman, 1982: 'contrast reduction by the atmosphere and retrieval of nonuniform surface reflectance', *Appl. Opt.*, 21, 310-316.
 19. Y.J. Kaufman and R.S. Fraser, 1983: 'Different atmospheric effects on remote sensing of uniform and nonuniform surfaces', *Adv. Space Res.*, 2, 147-155.
 20. Y.J. Kaufman and R.S. Fraser, 1983: 'Light extinction by aerosol during summer air pollution', *J. Appl. Meteor.*, 22, 1694-1706.
 21. Y.J. Kaufman and R.S. Fraser, 1984: 'The effect of finite field size on classification and atmospheric correction', *Rem. Sens. Environ.*, 15, 95- 118.
 22. Y.J. Kaufman, 1984: 'Atmospheric effect on spatial resolution of surface imagery', *Appl. Opt.*, 23, 3400-3408.
 23. R.S. Fraser, Y.J. Kaufman and R.L. Mahoney, 1984: 'Satellite measurements of aerosol mass and transport', *J. Atmos. Environ.*, 18, 2577-2584.
 24. Yu. Mekler, Y.J. Kaufman and R.S. Fraser, 1984: 'Reflectivity of the atmosphere-inhomogeneous surface system: Laboratory simulation', *J. Atmos. Sci.*, 41, 2595-2604.
 25. Y.J. Kaufman, 1984: 'Atmospheric effect on remote sensing of surface reflectance', *SPIE*, 475, 20-33.
 26. Y.J. Kaufman, 1984: 'The atmospheric effect on separability of field classes measured from satellite', *Rem. Sens. Environ.*, 18, 21-34.
 27. R.S. Fraser and Y.J. Kaufman, 1985: 'The relative importance of aerosol scattering and absorption in remote sensing', *IEEE J. Geosc. Rem. Sens.*, GE-23, 525-633.
 28. Y.J. Kaufman, T.W. Brakke and E. Eloranta, 1986: 'Field experiment to measure the radiative characteristics of a hazy atmosphere', *J. Atmos. Sci.*, 43, 1136-1151.
 29. Yu. Mekler and Y.J. Kaufman, 1986: 'Visibility of the Halley's nucleus from Giotto spacecraft', *ICARUS*, 64, 20-26.
 30. T. Lee and Y.J. Kaufman, 1986: 'The effect of surface non-Lambertianity on remote sensing of ground reflectance and vegetation index', *IEEE J. Geosci. Rem. Sens.*, GE-24, 699-708.
 31. R.S. Fraser and Y.J. Kaufman, 1986: 'Calibration of satellite sensors after launch', *Appl. Opt.*, 25, 1177-1185.
 32. Y.J. Kaufman, 1987: 'Satellite sensing of aerosol absorption', *J. Geoph. Res.*, 92, 4307-4317.
 33. Y.J. Kaufman, 1988: 'Atmospheric effect on spectral signature - measurements', *COSPAR XXVI*, *Adv. Space Res.* 7, 203-206.
 - 34a. Y.J. Kaufman, 1987: 'The effect of subpixel clouds on remote sensing', *COSPAR XXVI*, *Adv. Space Res.* 7, 207-210.
 - 34b. Y.J. Kaufman, 1987: 'The effect of subpixel clouds on remote sensing', *Int. J. Rem. Sens.*, 8, 839-857.
 35. Y.J. Kaufman, and C. Sandra, 1988: 'Satellite remote sensing of aerosol loading over land', *'Aerosols and Climate'*, Ed. P.V. Hobbs and M. P. McCormick, A. Deepak Publ., Hampton, VA.
 36. Y.J. Kaufman, and C. Sendra, 1988: 'Algorithm for atmospheric corrections of visible and near IR satellite imagery', *Int. J. Rem. Sens.*, 9, 1357-1381.
 37. Y.J. Kaufman, 1988: 'Atmospheric effect on spectral signature - measurements and corrections', *IEEE J. geos. and Rem. Sens.* GE-26, July, 1988.
 38. Y.J. Kaufman, R.S. Fraser and R.A. Ferrare, 1988: 'Satellite remote sensing of large scale air pollution - method', submitted to *J. Geoph. Res.* (April)

39. R.A. Ferrare, R.S. Fraser and Y.J. Kaufman 1988: 'Satellite remote sensing of large scale air pollution - measurements of forest fires smoke', submitted to J. Geoph. Res. (April)
40. Y.J. Kaufman, C.J. Tucker and I. Fung, 1988: 'Remote sensing of biomass burning in the tropics', to be published in COSPAR XXVII, Adv. Space Res.
41. Y.J. Kaufman and B.N. Holben, 1989: 'Calibration of the AVHRR visible and near-IR bands by atmospheric scattering, ocean glint and desert reflection', in preparation for IEEE Trans. Geoph. and Rem. Sens.

Invited presentation in national or international conferences

1. Y.J. Kaufman, and R.S. Fraser, 1982: 'Different atmospheric effects in remote sensing of uniform and nonuniform surfaces', COSPAR 24th Plenary meeting, Ottawa, Canada.
2. R.S. Fraser and Y.J. Kaufman, 1982: 'Determination of aerosol loading from satellite imagery over land', COSPAR 24th Plenary meeting, Ottawa, Canada.
3. Y.J. Kaufman, 1983: 'Atmospheric effects on spatial resolution and classification of surface imagery', 21st Aerospace Sciences meeting, Reno, Nevada.
4. Y.J. Kaufman, 1984: 'Atmospheric effects on remote sensing of surface reflectance', SPIE critical review of remote sensing, Crystal City, Virginia.
5. Y.J. Kaufman, 1987: 'An algorithm for atmospheric corrections', ISLSCP Satellite data algorithm workshop, JPL, Pasadena, California.
6. Y.J. Kaufman, 1988: 'Remote sensing of atmospheric aerosol over water and land', Australian conference on remote sensing, Canberra, Australia.

Participation in NASA investigations

1. Co-Investigator in: 'Satellite sensing of air pollution', 1980-1987.
2. Co-Investigator in: 'Atmospheric effects on remote sensing of the earth's surface', 1982-1988.
3. Member of NASA Multispectral linear array (MLA) science team, 1981-1983.
4. Co-Investigator in: Remote sensing of the effect of biomass burning on the atmosphere, NASA/GSFC director's discretionally funds, 1988 and 1989.
5. Co-Principal investigator in: 'Calibration of the AVHRR visible and near-IR bands by atmospheric scattering, ocean glint and desert reflection', approved for 1989.
6. Co-Principal investigator in: 'Automatic atmospheric correction for remote sensing of the earth's surface', approved for 1989.
7. Co-Principal investigator in: 'Remote sensing of biomass burning', pending approval for 1989.
8. Principal investigator - member of EOS-MODIS team on: Remote sensing of atmospheric aerosol and application to aerosol climatology, biomass burning and atmospheric corrections', since 1989.

NAME: Elissa R. Levine

PRESENT POSITION: Physical Scientist
Earth Resources Branch
Laboratory for Terrestrial Physics

RESEARCH AREA
EXPERIENCE: Soil Science

EDUCATION: 1978 - B.S. Natural Resource Management
Kansas State University
1981 - M.S. Agronomy
The Pennsylvania State University
1984 - Ph.D. Agronomy
The Pennsylvania State University

PREVIOUS POSITIONS: 1975 Student Trainee Soil Conservationist
USDA Soil Conservation Service
South Hutchinson, Kansas
1976 Student Trainee Soil Scientist
USDA Soil Conservation Service
Beloit, Kansas
1975 - 1977 Lab Technician
Soil Fertility Research Laboratory
and Tutor
Department of Agronomy
Kansas State University
1980 Soil Scientist
USDA Soil Conservation Service
Clearfield, Pennsylvania
1978 - 1981 Research and Teaching Assistant
Department of Agronomy
The Pennsylvania State University
1981 - 1984 Research and Teaching Assistant
Institute for Land and Water Resources
The Pennsylvania State University
1984 - 1986 Private Consultant
Soils and Land Use
Computer Programming
New Haven, Connecticut
1985 - 1986 Post-Doctoral Fellow
Plant Science Department
University of Connecticut
1986 Resident Research Associate
National Research Council of the
National Academy of Sciences
NASA/Goddard Space Flight Center
1986 Physical Scientist, Earth
Resources Branch NASA/GSFC

PROFESSIONAL SOCIETIES:

American Society of Agronomy
Soil Science Society of America
Society of Soil Scientists of Southern New England
Gamma Sigma Delta, the Honor Society of Agriculture
Sigma Delta Epsilon, Graduate Women in Science
Mid Atlantic Association of Professional Soil
Scientists

PUBLICATIONS

1. 1981 "Time as a Factor in the Genesis of Soil Formed from Glacial Till in Northeastern Pennsylvania", E.R. Levine, M.S. Thesis, Department of Agronomy, The Pennsylvania State University, University Park, PA.
2. 1983 "Soil Development in Till of Various Ages in Northeastern Pennsylvania", E.R. Levine and E.J. Ciolkosz, Quaternary Research 19:85-99.
3. 1983 "Evaluation of Acid Rain Sensitivity of Pennsylvania Soils", E.J. Ciolkosz and E.R. Levine, Research Project Tech. Completion Report, A-058-PA, U.S. Dept. of the Interior, Washington, DC.
4. 1984 "An Evaluation of the Sensitivity of Pennsylvania Soils of Acid Precipitation", E.R. Levine, Ph.D. Thesis, Dept. of Agronomy, The Pennsylvania State University, University Park, PA.
5. 1986 "A Computer Simulation Model for Soil Genesis Applications", E.R. Levine and E.J. Ciolkosz, Soil Sci. Soc. Am. J. 50:661-667.
6. 1986 "Modeling Soil Genesis Using Characterization and Remotely Sensed Data", E.R. Levine, J.R. Irons and E.J. Ciolkosz, Agronomy Abstracts, 78th Annual Meeting, American Society of Agronomy, New Orleans, Louisiana.
7. 1986 "Soils as a Predictor of Groundwater Pollution from Pesticides", E.R. Levine, Cooperative Extension Service Publication, University of Connecticut.
8. 1987 "Relationships of Soils and Vegetative Growth in South America Using Satellite Imagery", E.R. Levine, A.G. Kerber, T. Cook, and J. Kimble. Agronomy Abstracts, 79th Annual Meeting, American Soc. of Agronomy, Atlanta, Georgia.
9. 1987 "Soil Moisture and Temperature Regimes - Their Relationships to Vegetative Index in Africa. T.D. Cook, E. Levine, H. Eswaran, and W. Reybold. Agronomy Abstracts, 79th Annual Meeting, American Soc. of Agronomy, Atlanta, Georgia.
10. 1988 "Computer Simulation of Soil Sensitivity to Acid Rain," E.R. Levine and E.J. Ciolkosz, Soil Sci. Soc. Am. J. 52:209-215.
11. 1989 "A method for predicting soil temperature on a monthly basis", E.R. Levine and K. Anderson, in preparation.
12. 1989 "Boreal forest ecosystem dynamics: Linking forest succession, soil process, and radiation models", K.J. Ranson, E.R. Levine, J. Smith and H. Shugart, in preparation.
13. 1989 "Changes in Boreal Forest Soils and Response to Global Climate Change", E.R. Levine, Ecological Society of America Annual Meeting.

14. 1989 "Using Remotely Sensed Spectral Reflectance to Identify Soils",
W.T. Lawrence, J.R. Irons and E.R. Levine.
15. 1989 "Climate, soil, and Vegetation Index Relationships in South
America", A.G. Kerber and E.R. Levine, in prep.
16. 1989 "A Method for Predicting Soil Temperature on a Monthly Basis",
E.R. Levine and K. Anderson, in prep.
17. 1989 "The Effect of Climate Change on Soils of the Boreal Forest",
E.R. Levine, in prep.
18. 1989 "A Simple Model for Predicting Monthly Soil Moisture", E.R.
Levine, in prep.
19. 1989 "Iron Oxide Distribution in Soils of the Northeastern U.S. and its
Relationship to Sulfate Absorption", W.W. Waltman, E.R. Levine
and E.J. Ciolkosz, in prep.

NAME:

Ross F. Nelson

PRESENT POSITION:

Physical Scientist
Earth Resources Branch
Laboratory for Terrestrial Physics

RESEARCH AREA
EXPERIENCE:

The use of AVHRR and Landsat digital data for monitoring tropical and subtropical forest conversion, development of statistical and image processing procedures for subcontinental and continental resource assessment, use of airborne laser data to characterize the forest canopy and to estimate forest biomass and timber volume, use of aircraft and satellite scanner data for delineating insect defoliation.

EDUCATION:

1974 - B.S. Forestry
University of Maine, Orono
1979 - M.S. Forestry/Remote Sensing
Purdue University

PREVIOUS POSITIONS:

1977 - 1979 Research Assistant
Purdue University

AWARDS:

1983 Special Achievement Award
1985 Group Achievement Award - TM Data
Analysis Team

PUBLICATIONS

1. 1979 "Computer-Aided Processing of Landsat MSS Data for Classification of Forestlands", LARS Technical Report 102679, Laboratory for Applications of Remote Sensing W. Lafayette, IN, 95 pp.
2. 1979 "Digital Processing of Landsat MSS and Topographic Data to Improve Capabilities for Computerized Mapping and Forest Cover Types", R.M. Hoffer, M.D. Fleming, L.A. Bartolucci, S.M. Davis, and R.F. Nelson, LARS Technical Report 011579, Laboratory for Applications Remote Sensing, W. Lafayette, IN, 159 pp.
3. 1980 "Procedure 1 and Forestland Classification Using Landsat Data", R.F. Nelson and R.M. Hoffer, Presentation and Publication, Proceedings of Machine Processing of Remotely Sensed Data, Purdue University, W. Lafayette, IN, pp. 319-324.
4. 1980 "Evaluation of Landsat Data Analysis for Forest Survey", R.P. Mroczynski, R.M. Hoffer, R.F. Nelson, LARS Technical Report 101880, Laboratory for Applications of Remote Sensing, W. Lafayette, IN, 41 pp.
5. 1981 "A Comparison of Two Methods for Classifying Forestlands", International Journal of Remote Sensing, 2(1):49-60.
6. 1981 "Defining the Temporal Window for Monitoring Forest Canopy Defoliation Using Landsat", Presentation and Publication, ASP-ACSM Meeting, Technical Papers, Washington, DC, pp. 367-382.
7. 1982 "Evaluation of the Temporal Registration of Landsat Scenes", R.F. Nelson and G. Grebowsky, International Journal of Remote Sensing, 3:45-50.
8. 1982 "Detecting Forest Canopy Change Using Landsat", AgRISTARS Final Report RR-62-04258, NASA/Goddard Space Flight Center, Greenbelt, MD, 80 pp.
9. 1982 "Development of a Statewide Landsat Digital Data Base for Forest Insect Damage Assessment", D.L. Williams, L.E. Dottavio, and R.F. Nelson, Presentation and publication, Auto Carto V, ISPRS, Crystal City, VA.
10. 1982 "The Application of Remote Sensing in Geobotanical Exploration for Metal Sulfides - Results from the 1980 Field Season", M.L. Labovitz, E.J. Masuoka, R. Bell, A.W. Siegrist, and R.F. Nelson, NASA/Goddard Space Flight Center, Greenbelt, MD, 45 pp.
11. 1983 "The Application of Remote Sensing in Geobotanical Exploration for Metal Sulfides, Results from the 1980 Field Season at Mineral, Virginia", M.L. Labovitz, E.J. Masuoka, R. Bell, A.W. Siegrist, and R.F. Nelson, Economic Geology 78(4):750-760.
12. 1983 "Forest Canopy Change Detection Using Landsat", Photogrammetric Engineering and Remote Sensing 49(9):1303-1314.

13. 1983 "The Applications of Remote Sensing in Geobotanical Exploration for Metal Sulfides", E.J. Masuoka, M.L. Labovitz, R. Bell, R.F. Nelson, P.W. Broderick, and R.W. Ludwig, International Symposium on Remote Sensing of Environment, Second Thematic Conference, Remote Sensing for Exploration Geology, Fort Worth, TX, pp. 669-677.
14. 1983 "Monitoring the Defoliation of Hardwood Forests in Pennsylvania Using Landsat", C.L. Dottavio, R.F. Nelson, and D.L. Williams, Final Report, NASA/Goddard Space Flight Center, Greenbelt, MD, 31 pp. and Appendices.
15. 1983 "Preliminary Evaluation of Thematic Mapper Sensor Characteristics Relative to Land Cover/Land Use Discrimination", D.L. Williams, J.R. Irons, B.L. Markham, R.F. Nelson, D.L. Toll, R.S. Latty, and M.L. Stauffer, In J.H. McElroy and E.L. Hancock, ed. Space Applications at the Crossroads, 21st Goddard Memorial Symposium, Univelt, Inc., San Diego, CA, pp. 67-78.
16. 1983 "Impact of Thematic Mapper Sensor Characteristics on Classification Accuracy", D.L. Williams, J.R. Irons, B.L. Markham, R.F. Nelson, D.L. Toll, R.S. Latty and M.L. Stauffer, IEEE Digest/Proceedings of the 1983 International Geoscience and Remote Sensing Symposium, August 31 - September 2, 1983, San Francisco, CA, IEEE Cat. No. 83CH1837-4: pp. 5.1-5.9.
17. 1984 "Quick Look Analysis of TM Data of the Washington, DC Area", D.L. Williams, J.R. Irons, B.L. Markham, R.F. Nelson, D.L. Toll, R.S. Latty and M.L. Stauffer, Proceedings of the Early Results from Landsat-4 Symposium, February 22-24, 1983, NASA/GSFC, Greenbelt, MD, 13 pp.
18. 1984 "A Statistical Evaluation of the Advantages of Landsat Thematic Mapper Data in Comparison to Multispectral Scanner Data", D.L. Williams, J.R. Irons, B.L. Markham, R.F. Nelson, D.L. Toll, R.S. Latty and M.L. Stauffer, IEEE Transactions on Geoscience and Remote Sensing, GE-22(3): 294-302.
19. 1984 "Determining Forest Canopy Characteristics Using Airborne Laser Data", R.F. Nelson, W. Krabill, and G. MacLean, Remote Sensing of Environment, 15:201-212.
20. 1984 "Classifying Northern Forests Using Thematic Mapper Simulator Data", R.F. Nelson, R.S. Latty and G. Mott, Photogrammetric Engineering and Remote Sensing, 50(5):607-617.
21. 1984 "The Effects of Sensor Advancements on Thematic Mapper Data Classification", J.R. Irons, B.L. Markham, R.F. Nelson, D.L. Toll, D.L. Williams, R.S. Latty, R.L. Kennard and M.L. Stauffer, Environment, Paris, France, October 1-5, 1984.

22. 1984 "Carbon Flux to the Atmosphere Using Satellite Data of Tropical Deforestation", T.A. Stone, R.A. Houghton, G.M. Woodwell, R.F. Nelson, and W. Kovalick, Proceedings, A.G.U., San Francisco, CA, December 1984, EOS 65(45):847.
23. 1985 "The Effects of Spatial Resolution of the Classification of Thematic Mapper Data", J.R. Irons, B.L. Markham, R.F. Nelson, D.L. Toll, D.L. Williams, R.S. Latty, and M.L. Stauffer, International Journal of Remote Sensing 6(8):1385-1403.
24. 1985 "A Georeferenced Landsat Digital Data Base for Forest Insect Damage Assessment", D.L. Williams, R.F. Nelson and C.L. Dottavio, International Journal of Remote Sensing 6(5):643-656.
25. 1985 "Experimental Evidence for Spring and Fall Windows for the Detection of Geobotanical Anomalies through the Remote Sensing of Overlying Vegetation", M.L. Labovitz, E.J. Masuoka, R. Bell, R.F. Nelson, C.A. Larsen, L.K. Hooker and K.W. Troensegaard, International Journal of Remote Sensing 6(1):195-216.
26. 1985 "Reducing Landsat MSS Scene Variability", Photogrammetric Engineering and Remote Sensing 51(5):583-593.
27. 1985 "Sensor-Induced Temporal Variability of Landsat MSS Data", Remote Sensing of Environment 18:35-48.
28. 1985 "Information Extraction Performance Comparisons Between Variable Spatial Resolutions and Variable Classifiers", R. Latty, R. Nelson, B. Markham, D. Williams, D. Toll, and J. Irons, LIDQA Conference, Fall 1985, Indianapolis, IN.
29. 1985 "Performance Comparisons Between Information Extraction Techniques Using Variable Spatial Resolution Data", R. Latty, R. Nelson, B. Markham, D. Williams, D. Toll, and J. Irons, Photogrammetric Engineering and Remote Sensing 51(9):1459-1470.
30. 1986 "Use of Remotely Sensed Data for Assessing Forest Stand Conditions in the Eastern United States", D.L. Williams and R.F. Nelson, IEEE Transactions and Geoscience and Remote Sensing, AgRISTARS Special Issue GE-24(1):130-138.
31. 1986 "Identifying Deforestation in Brazil Using Multiresolution Satellite Data", R.F. Nelson and B.N. Holben, International Journal of Remote Sensing 7(3):429-448.
32. 1986 "Directional Reflectance Distributions of a Hardwood and Pine Forest Canopy", D.S. Kimes, W.W. Newcomb, R.F. Nelson, and J.B. Schutt, IEEE Transactions on Geoscience and Remote Sensing 24(2):281-293.
33. 1986 "A Determination of Sampling Intensity to Characterize a Landsat MSS Scene Using Two Block Sizes", N. Horning, R.F. Nelson, D.W. Case, American Society of Photogrammetry and Remote Sensing Technical Papers, Anchorage, AL, Fall 1986, pp. 244-254.

34. 1986 "Monitoring Tropical Deforestation in Mato Grosso, Brazil Using Landsat MSS and AVHRR Data", R. Nelson and N. Horning, Final Report, Code 623, NASA/Goddard Space Flight Center Greenbelt, MD, 47 pps.
35. 1987 "Continental Land Cover Assessment Using Landsat MSS Data", R.F. Nelson, D.W. Case, N. Horning, V. Anderson, and S. Pillai, Remote Sensing of Environment, 21:61-81.
36. 1987 "Determining Rate of Forest Conversion in Mato Grosso, Brazil Using Landsat MSS and AVHRR Data", R. Nelson, N. Horning, and T. Stone, International Journal of Remote Sensing 8(12):1767-1784.
37. 1987 "Estimating Forest Biomass and Volume Using Airborne Laser Data", R. Nelson, W. Krabill, and J. Tonelli, Remote Sensing of Environment, in press.
38. 1987 "Deforestation in the Tropics: New Measurements in the Amazon Basin Using Landsat and NOAA Advanced Very High Resolution Radiometer Imagery", G.M. Woodell, R.A. Houghton, T.A. Stone, R.F. Nelson, and W. Kovalick, Journal of Geophysical Research 92(D2):2157-2163.
39. 1988 "Laser Applications in the Assessment of Vegetation Yield, Vigor, and Species Type", E. Chappelle, D. Williams, R. Nelson and J. McMurtrey, submitted to Laser Focus.
40. 1988 "Large Scale Forest Resource Assessment Using Landsat and Airphotos", R. Nelson, V. Anderson and N. Horning, submitted to Journal of World Forest Resource Management.
41. 1988 "The Use of Airborne Lasers for Estimating Forest Canopy and Stand Characteristics", R. Nelson, R. Swift and W. Krabill, submitted to Journal of Forestry.

NAME: K. Jon Ranson

PRESENT POSITION: Physical Scientist
Earth Resources Branch
Laboratory for Terrestrial Physics

RESEARCH AREA
EXPERIENCE: Radiative Transfer in Vegetation Canopies,
Forest Dynamics, Natural Resource and Agriculture
Remote Sensing

EDUCATION: 1972 - B.S. Watershed Sciences
Colorado State University
1975 - M.S. Earth Resources
Colorado State University
1983 - Ph.D. Agronomy
Purdue University

PREVIOUS POSITIONS: 1985 - 1986 Research Agronomist
Laboratory for Applications of
Remote Sensing (LARS)
Purdue University
1984 Post-Doctoral Research Associate
Purdue University
1980 - 1983 Graduate Instructor
Agronomy Department and LARS
Purdue University
1978 - 1980 Research Associate
Department of Forest and Wood
Sciences
Colorado State University
1976 - 1978 Research Associate
Earth Resources Department
Colorado State University
1972 - 1975 Graduate Research Assistant
Earth Resources Department
Colorado State University
1971 - 1972 Junior Research Technician
Department of Watershed Sciences
Colorado State University
1971 NSF Student Originated Studies
Department of Watershed Sciences
Colorado State University
1969 - 1971 Work Study Student
Department of Watershed Sciences
Colorado State University

PROFESSIONAL SOCIETIES: American Society for Photogrammetry
and Remote Sensing

HONORARIES: Sigma Xi

PUBLICATIONS

1. 1980 "The Lambertian Assumption and Landsat Data", J.A. Smith, T.L. Lin and K.J. Ranson, Photogramm. Engin. Remote Sens. 46(9):1183-1189.
2. 1980 "A Monte Carlo Simulation of Canopy Absorption", D.S. Kimes, K.J. Ranson and J.A. Smith, Photosynthetica 14(1):55-64.
3. 1980 "Interpreting Vegetation Reflectance Measurements as a Function of Solar Zenith Angle", D.S. Kimes, J.A. Smith and K.J. Ranson, Photogramm. Engin. Remote Sens. 46(12):1563-1573.
4. 1981 "Thermal Vegetation Canopy Modeling Studies", J.A. Smith, K.J. Ranson, D. Nguyen, L. Balick, L. Fritschen and B. Hutchinson, Remote Sens. Environ. 11:311-326.
5. 1983 "A Study of the Angular Reflectance Characteristics of Corn and Soybean Canopies," K.J. Ranson, Ph.D. Dissertation, Purdue University, (Diss. Abstr. 84-07598).
6. 1984 "Soybean Canopy Modeling Data Sets," K.J. Ranson, L.L. Biehl and C.S.T. Daughtry, LARS Tech. Rep. No. 071584, Purdue University, West Lafayette, IN 47907.
7. 1985 "Variation in Spectral Response of Soybeans with Respect to Illumination View and Canopy Geometry," K.J. Ranson, L.L. Biehl and M.E. Bauer, Int. J. Remote Sens. 6:1827-1842.
8. 1985 "Sun-Angle Effects on Reflectance Factors of Corn Canopies," K.J. Ranson, C.S.T. Daughtry, L.L. Biehl and M.E. Bauer, Remote Sens. Environ. 18:147-161.
9. 1985 "Two-Dimensional Leaf Orientation Distributions," D.E. Strebel, N.S. Goel and K.J. Ranson, IEEE Trans. Geosci. Remote Sens. Vol. GE-22:640-647.
10. 1986 "Sun-Angle View Angle and Background Effects on Spectral Response of Simulated Balsam Fir Canopies," K.J. Ranson, C.S.T. Daughtry and L.L. Biehl, Photogramm. Engin. Remote Sensing 52:649-658.
11. 1986 "Measuring and Modeling Biophysical and Optical Properties of Diverse Vegetative Canopies," C.S.T. Daughtry and K.J. Ranson, Final Report NASA Contract NAS-16528. LARS Report 043086, Purdue University, W. Lafayette, IN 47907, 56 pp.
12. 1986 "Forecasting Vegetative Stress via Remote Sensing Techniques", C.J. Johannsen and K.J. Ranson, M.S. Zuber, E.B. Lillehoj and B.L. Renfro, eds., Aflatoxin in Maize: A proceedings of the workshop, CIMMYT, Mexico, D.F. April 7-11, pp. 110-118.
13. 1986 "Assessing Vegetation Characteristics with Multispectral Data", C.S.T. Daughtry and K.J. Ranson, ASAE Winter Meeting, Paper No. 86-3514, Chicago, IL, Dec. 16-19.

14. 1987 "Scene Shadow Effects on Multispectral Response," K.J. Ranson and C.S.T. Daughtry, IEEE Trans. Geosci. Rem. Sens., GE-25:502-509.
15. 1987 "Inferring Spectral Reflectance of Plant Elements by Simple Inversion of Bidirectional Reflectance Measurements," J. Otterman, D.E. Strebel and K.J. Ranson, Remote Sens. Environ. 21:215-228.
16. 1987 "Backscattering at 5GHz from Corn Canopies", C.S.T. Daughtry, K.J. Ranson and L.L. Biehl, Agronomy Abstracts, American Society of Agronomy Annual Meetings, Atlanta, GA, Nov. 29-Dec. 4.
17. 1988 "Estimating big bluestem albedo from directional reflectance measurements", J.R. Irons, K.J. Ranson and C.S.T. Daughtry, Remote Sensing of Environ. in press.
18. 1988 "Characterization of Forest Ecosystem Dynamics Through Modeling and Remote Sensing Observations", K.J. Ranson, J.A. Smith and F.G. Hall, Proc. IGARSS '88 Symp. Edinburgh, Scotland, Sept. 13-16.
19. 1989 "A new Technique for Measuring the Optical Properties of Small Leaves", C.S.T. Daughtry, L.L. Biehl and K.J. Ranson, (in press) Remote Sens. Environ.
20. 1989 "C-Band Backscattering from Corn Canopies", C.S.T. Daughtry, K.J. Ranson and L.L. Biehl, accepted to Int'l Journal Remote Sensing.
21. 1989 "Forest and grassland ecosystem studies using ASAS", J.I. Irons, K.J. Ranson, D.L. Williams, R.R. Irish, F.G. Huegel and M.E. Bauer, Third Interagency Airborne Geoscience Workshop, La Jolla, CA 21-24 Feb.
22. 1989 "Forest and Grassland Ecosystem Studies Using the Advanced Solid-state Array Spectrometer", IGARSS'89, Vancouver, Canada 10-14 July. (abstract submitted).
23. 1989 "Change in conifer needle optical properties as a function of age", D.L. Williams, K.J. Ranson and J.R. Donnelly, Ecological Society of America Annual Meeting. Toronto, Canada, 6-10 August. (abstract submitted).

THOMAS R. WATTERS

ADDRESS:

1801 Merrifields Dr.
Silver Spring, MD 20906

EDUCATION:

George Washington University, Ph.D., Geology (1981-1985). Dissertation: Compressional Deformation and the Tectonic Evolution of the Tharsis Region of Mars.

Bryn Mawr College, M.A., Geology (1977-1979), Thesis: The Aubrites: Their Origin and Relationship to Enstatite Chondrites.

West Chester University, B.S., Earth Sciences (1973-1977), Honors: Magna Cum Laude, Dean's List, Kappa Delta Phi, Who's Who in American Colleges and Universities, William P. Phillips Memorial Scholarship.

EXPERIENCE:

Research Geologist, Center for Earth and Planetary Studies, Smithsonian Institution, Planetary Geology and Tectonics and Digital Image Processing (1981-present).

Consultant, Geology Department, George Washington University, Geologic Applications of the Scanning Electron Microscope (1982-1984).

Research Assistant, Department of Terrestrial Magnetism, Carnegie Institution of Washington, Electron Microprobe and Fission Track Studies of Meteorites (1980-1981).

Research Fellowship, American Museum of Natural History, Electron Microprobe and Petrographic Study of Aubreyttes and Related Meteorites (1978-1980).

Teaching Assistant, Bryn Mawr College (1977-1979), Physical and Historical Geology, Crystallography and Optical Crystallography.

Undergraduate Assistant, West Chester University (1973-1977), Teaching Assistant in General and Advanced Astronomy, Physical and Historical Geology, Operation and Maintenance of Observatory and X-ray Diffraction Equipment.

X-ray Diffraction Analysis of Clay Minerals in Hudson River Valley, Weston Environmental Co. (1977).

SKILLS:

Digital image processing of planetary and Landsat data. Adaptation and use of E.L.A.S. image processing software. Programming (Fortran, Basic, PL1G, Prime Computer Command Procedure Language (CPL), and Prime Computer operating language, Primos, Prime Assembly Language. Image processing software development. Development of computer hardware interface software. System Administration of a Prime computer. Computer equipment: Prime, Tektronix, Advanced Electronic Design, Honeywell, Electron Microprobe, Microanalysis, Scanning Electron Microscope, X-ray diffraction, Atomic Absorption, UVV spectrophotometry, Photography (black and white and color), drafting, teaching, preparation and presentation of scholarly research papers.

REFERENCES:

- Dr. Ted A. Maxwell, Chairman, Center for Earth and Planetary Studies, National Air and Space Museum, Smithsonian Institution, Washington, D.C.
- Dr. George G. Stephens, Associate Professor of Geology, George Washington University, Washington, D.C.
- Dr. M. L. Crawford, Chairman, Department of Geology, Bryn Mawr College, Pennsylvania.

PUBLICATIONS:

- Watters, T.R. and M. Prinz (1979) Aubrites: Their Origin and Relationship to E Chondrites, Lunar and Planet. Sci. X, p. 1319-1321, The Lunar and Planetary Institute, Houston.
- Watters, T.R. (1979) Aromatum Chaos: Catastrophic Flooding or Pure Gravitational Sliding, EOS, Transact. AGU, v. 60, n. 18, p. 306.
- Watters, T.R. and M. Prinz (1979) Aubrites: Their Origin and Relationship to Enstatite Chondrites, Proc. Lunar and Planet. Sci. Conf. 10th, p. 1073-1093.
- Watters, T.R. and M. Prinz (1980) Mt. Egerton and the Aubrite Parent Body. Lunar and Planet. Sci. XI, The Lunar and Planetary Institute, Houston, p. 1225-1227.
- Watters, T.R., M. Prinz, E.R. Rambaldi, and J.T. Wasson (1980) Alpha 78113, Mt. Egerton and the Aubrite Parent Body, Meteoritics, v. 15, p. 407.
- Rajan, R.S., T.R. Watters, and B.K. Kothari (1980) Variation of Fission tracks in the surfaces of olivines from Murchison: Time Differences or Heterogeneity of ²⁴⁴pu on a Microscale, Meteoritics, v. 15, p. 351.
- Rajan, R.S., T.R. Watters, and B.K. Kothari (1980) Variation of Fission Tracks on the surfaces of olivines from Murchison Carbonaceous Chondrite, Carnegie Institution of Washington Annual Report 1979-1980, p. 551-553.

- Rajan, R.S., G. Poupeau, A.S. Tamhane, J. Gooding, and T.R. Watters (1981) Incorporation of olivines in the matrix of carbonaceous chondrites: When did it all happen, *Meteoritics*, v. 16, p. 378.
- Watters, T.R. and T.A. Maxwell (1981) Ridge-Fault Intersections and Tharsis tectonics. Papers presented at Third International Colloquium on Mars, p. 270-272.
- Watters, T.R. and T.A. Maxwell (1981) Ridge-rille intersections in the Tharsis Province of Mars. NASA TM-84211, p. 383-385.
- Maxwell, T.A. and T.R. Watters (1981) Ridge orientations in the Tharsis Province of Mars: Deviation from Tharsis related trends. NASA TM-84211, p. 380-382.
- Watters, T.R. and T.A. Maxwell (1982) Strain estimates for the ridged plains of Mars: Evidence of compression in the Coprates Quadrangle. NASA TM-85127, p. 279-281.
- Watters, T.R. and G.C. Stephens (1983) SEM and Electron microprobe studies of dissolution cleavage in the Martinsburg formation of northern Virginia, Geological Soc. Amer., in press.
- Watters, T.R. and T.A. Maxwell (1983) Lithospheric thickness based on volcano spacing in the Tharsis region of Mars. Proc. Lunar and Planet. Sci. Conf. 14th, Lunar and Planet. Institute, Houston, p. 836-837.
- Watters, T.R. and T.A. Maxwell (1983) Estimates of the extent and magnitude of compressional deformation southeast of the Tharsis region of Mars. EOS, Transactions, AGU, v. 64, n. 18, p. 257.
- Wynn, J.G., B. Waitzeneger, T.R. Watters, H. Mirzai-Pouinak, and A. Gardner (1983) Aeromagnetic survey and interpretive maps of the San Simon 15' quadrangle Arizona and New Mexico. U.S. Geol. Survey Open-File Report 83-631, USGS, Reston, Va.
- Watters, T.R. and T.A. Maxwell (1983) Cross-cutting relations and relative ages of ridges and faults in the Tharsis region of Mars. *Icarus*, v. 56, p. 278-298.
- Watters, T.R. and T.A. Maxwell (1984) Compressional features in the Tharsis region of Mars: I. Geographic extent of deformation. Reports of Planetary Geology, NASA Tech. Mem. 86246, p. 301-303.
- Watters, T.R. and T.A. Maxwell (1984) Compressional features in the Tharsis region of Mars: II. Orientations and timing of deformation. Reports of Planetary Geology, NASA Tech. Mem. 86246, p. 304-306.
- Watters, T.R. (1984) Gravity induced compressive stress in the Tharsis region of Mars. Proc. Lunar and Planet. Sci. Conf. 15th, Lunar and Planetary Institute, Houston, p. 898-899.

- Maxwell, T.A. and T.R. Watters (1984) Photogeology of structural landforms in the Tharsis region of Mars. National Air and Space Museum Research Report 1984, Smithsonian Institution Press, p. 135-147.
- Watters, T.R. and T.A. Maxwell (1985) Mechanisms of basalt-plains ridge deformation. Report of Planetary Geology Program, 1984, NASA Tech. Mem. 87563, p. 479-481.
- Watters, T.R. and T.A. Maxwell (1985) Fold model for ridges of the Tharsis region of Mars. Proc. Lunar and Planet. Sci. Conf. 16th, Lunar and Planetary Institute, Houston, p. 897-898.
- Maxwell, T.A. and T.R. Watters (1985) The Mars ancient cratered terrain - smooth plains boundary: Implications of Viking color data for the Amenthes region. Proc. Lunar and Planet. Sci. Conf. 16th, Lunar and Planetary Institute, Houston, p. 526-527.
- Watters, T.R. (1985) Basalt-plains ridges: analogs and fold mechanisms. National Air and Space Museum Research Report 1985, Smithsonian Institution Press, p. 225-226.
- Watters, T.R. (1985) Ridges of the Tharsis and Columbia Plateaus: A fold model. GSA Abstracts with Programs, v. 17, p. 745.
- Watters, T.R. and T.A. Maxwell (1986) The Tharsis plateau ridge system: Inferred and predicted compressive stresses. Report of Planetary Geology Program, 1985, NASA Tech. Mem. 88383, p. 406-407.
- Watters, T.R. and T.A. Maxwell (1986) Strain estimates for basalt plains ridges on Mars, Earth, and the Moon. Proc. Lunar and Planetary Sci. Conf. 17th, Lunar and Planetary Institute, Houston, p. 929-930.
- Watters, T.R. and T.A. Maxwell (1986) Orientation, relative age and extent of the Tharsis ridge system. EOS, v. 67, n. 20, p. 487.
- Watters, T.R. and T.A. Maxwell (1986) Orientation, relative age and extent of the Tharsis Plateau ridge system. J. Geophys. Res., v. 91, p. 8113-8125.
- Watters, T.R. (1986) The Tharsis Plateau: A case for thin-skinned deformation on Mars. GSA Abstracts with Programs, v. 18, p. 783.
- Watters, T.R. (1986) Structural analysis of the volcanic plains of the Columbia Plateau using Seasat radar. EOS, v. 67, p. 1075.
- Watters, T.R. (1987) Volcanic-Plains ridges on the terrestrial planets: A comparison of the Columbia and Tharsis Plateaus. Geol. Soc. Am. Abstracts with Programs, v. 19, p. 463.
- Watters, T.R. (1987) The volcanic plains ridges of the Chryse and Amazonis depressions. Proc. Lunar and Planet. Sci. Conf. 18th, Lunar and Planetary Institute, Houston, p. 1064-1065.

- Watters, T.R. (1987) Thin and thick-skinned deformation in the Tharsis region of Mars (Abstract). Reports of Planetary Geology and Geophysics Program, 1986, NASA Tech. Memo. 89810, p. 481-483.
- Watters, T.R. (1987) The volcanic plains ridges of the Chryse and Amazonis depressions. Proc. Lunar and Planet. Sci. Conf. 18th, Lunar and Planetary Institute, Houston, p. 1064-1065.
- Watters, T.R. (1987) The origin of volcanic-plains anticlinal ridges: The role of reverse and thrust faulting. Geol. Soc. Am. Abstracts with Programs, v. 19, p. 883.
- Watters, T.R. (1988) Arches, Anticlinal Ridges, Crenulate and Sub-crenulate Ridges: The Wrinkle Ridge Assemblage. Reports of Planetary Geology and Geophysics Program, 1987, NASA Tech. Memo. 4041, p. 470-472.
- Watters, T.R. (1988) The Periodic Nature and Possible Origin of Anticlinal Ridge Spacings on the Tharsis and Columbia Plateaus. Reports of Planetary Geology and Geophysics Program, 1987, NASA Tech. Memo. 4041, p. 473-475.
- Watters, T.R. (1988) Strain Distribution in the Anticlinal Ridges of the Columbia Plateau: Implications for Their Origin and the Origin of First-order Ridges on the Terrestrial Planets. Proc. Lunar and Planet. Sci. Conf. 19th, Lunar and Planetary Institute, Houston, p. 1243-1244.
- Watters, T.R. (1988) The Wrinkle Ridge Assemblage. Proc. Lunar and Planet. Sci. Conf. 19th, Lunar and Planetary Institute, Houston, p. 1245-1246.
- Watters, T.R., M.J. Tuttle and J. Chadwick (1988) Mare Ridge - Highland Scarp Structures and Upland Scarps on the Moon, Mars and Mercury. Proc. Lunar and Planet. Sci. Conf. 19th, Lunar and Planetary Institute, Houston, p. 1247-1248.
- Watters, T.R. (1988a) Anticlinal ridges on the terrestrial planets. J. Geophys. Res. in press.
- Watters, T.R. (1988b) The Columbia and Tharsis plateaus: A comparison of anticlinal ridges. Submitted to the Fourth Columbia River Basalt Symposium Special Paper, Geol. Soc. America.
- Watters, T.R. and M.J. Tuttle (1988) Evidence of a shear system associated with the deformed basalts of the Columbia Plateau: Implications for the ridged plains units on Mars. Submitted to Geological Society of America Abstracts with Programs.

Miscellaneous Publications:

Reports of Planetary Geology and Geophysics Program - 1984, compiled by H.E. Holt and T.R. Watters, NASA Technical Memorandum 87563, 618 p.

INVITED PAPERS:

Fourth Columbia River Basalt Symposium, Geological Society of America,
Cordilleran Section (1987)

PAPERS PRESENTED:

10th Lunar and Planetary Science Conference (1979)
Spring Meeting of the American Geophysical Union (1979)
11th Lunar and Planetary Science Conference (1980)
43rd Meteorological Society Meeting (1980)
3rd International Colloquium on Mars (1981)
14th Lunar and Planetary Science Conference (1983)
Spring Meeting of the American Geophysical Union (1983)
Geological Society of America, Northeast Section (1983)
ELAS Users Group Conference (1984)
Geological Society of America Annual Meeting (1985)
16th Lunar and Planetary Science Conference (1985)
17th Lunar and Planetary Science Conference (1986)
Geological Society of America Annual Meeting (1986)
Fall Meeting of the American Geophysical Union (1986)
18th Lunar and Planetary Science Conference (1987)
19th Lunar and Planetary Science Conference (1988)

POSTERS PRESENTED:

Geological Society of America Annual Meeting (1987)

GRANTS:

Co-Investigator: 1983-present: Photogeologic Investigations of Planetary
Tectonic Features. National Aeronautics and Space Administration.
Co-Investigator: 1985-present: Environmental Processes and Spectral
Reflectance Characteristics Associated with Soil Erosion in Desert
Fringe Regions. National Aeronautics and Space Administration.
Co-Investigator: 1986-present: Remote Sensing Investigations of Possible
Intraplate Fault Reactivation During Red Sea Rifting. National
Aeronautics and Space Administration.

Principal Investigator: 1986-1987: Structural Geology and Origin of Basalt-Plains Ridges. National Aeronautics and Space Administration.

Principal Investigator: 1987- : Volcanic Plains Deformation on the Terrestrial Planets. National Aeronautics and Space Administration.

Principal Investigator: 1987- : The Nature and Origin of Periodically spaced Tectonic Features on Mars. National Aeronautics and Space Administration.

Principal Investigator: Analysis of Tectonic Features on the Terrestrial Planets. Submitted to National Aeronautics and Space Administration.

PROFESSIONAL SOCIETIES:

Member; Geological Society of America

Member; American Geophysical Union

NAME: Darrel L. Williams

PRESENT POSITION: Physical Scientist
Earth Resources Branch
Laboratory for Terrestrial Physics

**RESEARCH AREA
EXPERIENCE:** Collection, Analysis and Interpretation of
Remotely Sensed Data, with Emphasis on
Forest Canopies

EDUCATION: 1973 - B.S. Forest Science
Pennsylvania State University
1974 - M.S. Forest Science
Pennsylvania State University
1986 Ph.D. candidate in Biogeography
University of Maryland

PREVIOUS POSITIONS: 1973 - 1974 Graduate Research Assistant

PROFESSIONAL SOCIETIES: American Society of Photogrammetry
and Remote Sensing
Association of American Geographers

HONORARIES: Alpha Zeta
Phi Epsilon Phi
Xi Sigma Pi

PUBLICATIONS

1. 1973 "Survey and Inventory of Forest Resources", B.J. Turner and D.L. Williams, Interdisciplinary Applications and Interpretations of ERTS Data Within the Susquehanna River Basin, Type III Annual Report, NAS 5-23133.
2. 1974 "Computer Analysis and Mapping of Gypsy Moth Defoliation Levels in Northeastern Pennsylvania Using ERTS-1 Data", D.L. Williams and B.J. Turner, Remote Sensing of Earth Resources, University of Tenn., Tullahoma, Tenn., pp. 487-501.
3. 1974 "Classification and Mapping of Coal Refuse, Vegetative Cover Types and Forest Types by Digital Processing ERTS-1 Data", B.F. Meremback, D.M. Thompson, B.J. Turner and D.L. Williams, Interdisciplinary Applications and Interpretations of ERTS Data Within the Susequehanna River Basin, Type II Annual Report, NAS 5-23133.
4. 1975 "Computer Analysis and Mapping of Gypsy Moth Defoliation Levels in Pennsylvania Using Landsat-1 Digital Data", Proceedings of the NASA Earth Resources Survey Symposium, NASA/JSC, Houston, TX, Vol. I-1, pp. 167-181.
5. 1976 "A Canopy-Related Stratification of a Southern Pine Forest Using Landsat Digital Data", Proceedings of the Fall Convention of the American Society of Photogrammetry, Seattle, Wash., pp. 231-239.
6. 1976 "Forest Land Management by Satellite: Landsat-Derived Information as Input to a Forest Inventory System", D.L. Williams and G.F. Haver, NASA/Intralab Publication.
7. 1977 "A Reduction in Ag/Residential Signature Conflict Using Principal Components Analysis of Landsat Temporal Data", D.L. Williams and F.Y. Borden, Proceedings of the Fall Convention of the American Society of Photogrammetry, Little Rock, Ark., pp. 230-238.
8. 1978 "Monitoring Gypsy Moth Defoliation by Applying Change Detection Techniques to Landsat Imagery", D.L. Williams and M.L. Stauffer, Proceedings of the Symposium on Remote Sensing for Vegetation Damage Assessment, ASP, Falls Church, VA, pp. 221-229.
9. 1978 "Monitoring Forest Canopy Alteration Around the World with Digital Analysis of Landsat Imagery", L.D. Miller and D.L. Williams, Proceedings of the International Symposium on Remote Sensing for Observation and Inventory of Earth Resources and the Endangered Environment, July 2-8, 1978, Freiburg, Federal Republic of Germany, pp. 1721-1761, Vol. III.
10. 1979 "A Forester's Look at the Application of Image Manipulation Techniques to Multitemporal Landsat Data", D.L. Williams, M.L. Stauffer and K.C. Leung, Proceedings of the Fifth Annual Symposium on Machine Processing of Remotely Sensed Data, IEEE Cat. No. 79-CH 1430 - 8 MPRSD, pp. 368-376.

11. 1979 "What Can the Forestry Community Expect from Landsat-D Thematic Mapper Data?" D.L. Williams and M.L. Stauffer, Proceedings of the Symposium on Remote Sensing of Natural Resources, University of Idaho, Moscow, Idaho, pp. 475-492.
12. 1979 "Data Acquisition and Projected Applications of the Observations from Landsat-D", D.L. Williams and V.V. Salomonson Proceedings of the Fall Convention of the American Society of Photogrammetry, Sioux Falls, SD, pp. 16-29.
13. 1980 "Sensor Parameter Study: Literature Review and Experimental Plan", C.L. Dottavio, D.L. Williams, B.L. Markham and M. Labovitz, AgRISTARS Report RR-60-04009.
14. 1981 "Information Expectations from Landsat-D", V.V. Salomonson, D.L. Williams and J.L. Barker, Proceedings of 15th International Symposium on Remote Sensing of Environment, Environmental Research Institute of Michigan, pp. 81-94.
15. 1981 "Integration of Digital Elevation Model Data and Landsat MSS Data to Quantify the Effects of Slope Orientation in the Classification of Forest Canopy Condition", D.L. Williams and K.J. Ingram, Proceedings of the 7th International Symposium on Machine Processing of Remotely Sensed Data, Purdue University, pp. 352-362.
16. 1982 "Mapping a Southern Pine Plantation with Satellite and Aircraft Scanner Data: A Comparison of Present and Future Landsat Sensors", C.L. Dottavio and D.L. Williams, Journal of Applied Photographic Engineering, Vol. 8, No. 1, Feb. 1982, pp. 58-62.
17. 1982 "Summary of Research Addressing the Potential Utility of Thematic Mapper Data for Renewable Resources Applications", J.R. Irons and D.L. Williams, Proceedings of the Harvard Computer Graphics Symposium, July 1982, Boston, MA. (Also, NASA Technical Memorandum 83965).
18. 1982 "Development of a Statewide Landsat Digital Data Base for Forest Insect Damage Assessment", D.L. Williams, C.L. Dottavio and R.F. Nelson, Proceedings of the Auto-Carto 5/ISPRS IV Symposium, Crystal City, VA, August 1982, pp. 191-203.
19. 1982 "The ORSER Landsat Data Base of Pennsylvania", B.J. Turner and D.L. Williams, Proceedings of the National Conference on Energy Resource Management, Vol. 1, Baltimore, MD, September, pp. 149-160.
20. 1983 "Satellite Technology: An Improved Means for Monitoring Forest Insect Defoliation", C.L. Dottavio and D.L. Williams, Journal of Forestry, Vol. 81, No. 1, January 1983, pp. 30-34.

21. 1983 "Final Report: Monitoring the Defoliation of Hardwood Forests in Pennsylvania Using Landsat", C.L. Dottavio, R.F. Nelson and D.L. Williams, March 1983, NASA/GSFC, Greenbelt, MD, 31 pp. and appendices.
22. 1983 "Preliminary Evaluation of Thematic Mapper Sensor Characteristics Relative to Land Cover/Land Use Discrimination", D.L. Williams, J.R. Irons, B.L. Markham, R.F. Nelson, D.L. Toll, R.S. Latty and M.L. Stauffer, Space Applications at the Crossroads, Proceedings of the American Astronautical Societies Twenty-First Goddard Memorial Symposium, March 22-25, 1983. NASA/GSFC, Greenbelt, MD, eds. J.H. McElroy and E.L. Heacock, Univelt, Inc., San Diego, CA, pp. 67-78.
23. 1983 "Impact of Thematic Mapper Sensor Characteristics on Classification Accuracy", D.L. Williams, J.R. Irons, B.L. Markham, R.F. Nelson, D.L. Toll, R.S. Latty and M.L. Stauffer, IEEE Digest/Proceedings of the 1983 International Geoscience and Remote Sensing Symposium, August 31-September 2, 1983, San Francisco, CA, IEEE, Cat. No. 83CH1837-4, pp. 5.1-5.9.
24. 1984 "An Overview of TM "Applications" Research", D.L. Williams, Landsat-4, Science Characterization Early Results, Vol. IV, NASA Conference Pub. 2355, pp. 1-6.
25. 1984 "Quick Look Analysis of TM Data of the Washington, D.C., Area", D.L. Williams, J.R. Irons, B.L. Markham, R.F. Nelson, D.L. Toll, R.S. Latty and M.L. Stauffer, Landsat-4 Science Characterization Early Results, Vol. IV, NASA Conference Publication 2355, pp. 237-250.
26. 1984 "A Statistical Evaluation of the Advantages of Landsat Thematic Mapper Data in Comparison to Multispectral Scanner Data", D.L. Williams, J.R. Irons, B.L. Markham, R.F. Nelson, D.L. Toll, R.S. Latty and M.L. Stauffer, IEEE Transactions on Geoscience Remote Sensing, Vol. GE-22, No. 3: pp. 294-302.
27. 1984 "The Effects of Sensor Advancements on Thematic Mapper Data Classification", J.R. Irons, B.L. Markham, R.F. Nelson, D.L. Toll, D.L. Williams, R.S. Latty and M.L. Stauffer, Proceedings of the Eighteenth International Symposium on Remote Sensing of Environment, October 1-5, Paris, France, pp. 1759-1773.
28. 1984 "Collection of In situ Forest Canopy Spectra Using a Helicopter: A Discussion of Methodology and Preliminary Results", D.L. Williams, C.L. Walthall and S.N. Goward, Proceedings of the 1984 Machine Processing of Remotely Sensed Data Symposium, Purdue University, pp. 94-106.

29. 1985 "The Effects of Spatial Resolution on the Classification of Thematic Mapper Data", J.R. Irons, B.L. Markham, R.F. Nelson, D.L. Toll, D.L. Williams, R.S. Latty and M.L. Stauffer, International Journal of Remote Sensing, Vol. 6, No. 8, pp. 1385-1403.
30. 1985 "A Georeferenced Landsat Digital Data Base for Forest Insect Damage Assessment", D.L. Williams, R.F. Nelson and C.L. Dottavio, International Journal of Remote Sensing, Vol. 6, No. 5, pp. 643-656.
31. 1985 "Performance Comparisons Between Information Extraction Techniques Using Variable Spatial Resolution Data", R.S. Latty, R. Nelson, B. Markham, D. Williams, D. Toll and J. Irons, Photogrammetric Engineering and Remote Sensing, Vol. 51, No. 9, pp. 1459-1470.
32. 1985 "Field and Airborne Spectral Characterization of Suspected Acid Deposition Damage in Red Spruce (Picea rubens) from Vermont", B.N. Rock, D.L. Williams and J.E. Vogelmann, Proceedings of the 1985 Machine Processing of Remotely Sensed Data Symposium, Purdue University, pp. 71-81.
33. 1985 "Remote Sensing in Forest Science", D.L. Williams, Proceedings of the Forest-Atmosphere Interaction Workshop, Lake Placid, NY, Oct. 1-5, 1985.
34. 1986 "Use of Remotely Sensed Data for Assessing Forest Stand Conditions in the Eastern United States", D.L. Williams and R.F. Nelson, IEEE Transactions, AgRISTARS Special Edition, Vol. GE-24, No. 1, pp. 130-138.
35. 1986 "Remote Detection of Forest Damage", B.N. Rock, J.E. Vogelmann, D.L. Williams, A.F. Vogelmann and T. Hoshizaki, BIOSCIENCE, Vol. 36, No. 7, pp. 439-445.
36. 1986 "Remote Sensing: Tool in Acid Rain Research", D.L. Williams, Forest Industries, Vol. 113, No. 5, pp. 31-33.
37. 1986 "Laser Induced Fluorescence (LIF) from Plant Foliage", E.W. Chappelle and D.L. Williams, IGARSS '86 Symposium, Zurich, Switzerland, Sept. 8-11, Ref. ESA SP-254, pp. 1591-1598.
38. 1987 "Obtaining Spectral Reflectance Factor Measurements of Stressed Forest Vegetation", D.W. Case and D.L. Williams, Proceedings of the Fall Convention of the American Society of Photogrammetry and Remote Sensing, Reno, NV, pp. 150-160.
39. 1987 "Laser Induced Fluorescence (LIF) from Plant Foliage", E.W. Chappelle and D.L. Williams, IEEE Transactions, Vol. GE-25, No. 6, pp. 726-736.
40. 1987 "A Transportable Hemispherical Illumination System for Making Reflectance Factor Measurements", D.L. Williams and F.M. Wood, Remote Sensing Environment, 23:131-140.

41. 1988 "Acquisition of spectral reflectance data using an artificial source of hemispherical illumination", D.L. Williams, F.M. Wood, and D.W. Case, IN: SPIE, Vol. 924, Paper #931, Recent Advances in Sensors, Radiometry, and Data Processing for Remote Sensing, [ed.] P.N. Slater, SPIE--The International Society of Optical Engineering, Bellingham, WA, pp. 262-272.
42. 1988 "The use of quantitative remote sensing techniques to assess forest decline damage in Vermont", D.L. Williams, D.W. Case, and E.W. Chappelle, IN: Remote Sensing Applications for Acid Deposition, [ed.] L.K. Fenstermaker, Environmental Research Center, Univ. of Nevada, Las Vegas, Las Vegas, NV, pp. 37-56.
43. 1988 "Use of lasers in the remote assessment of vegetation", E.W. Chappelle, D.L. Williams, R.F. Nelson, and J.E. McMurtry, submitted, by invitation, to: Laser Focus, 8 pp.



UNITED STATES DEPARTMENT OF COMMERCE
Office of the Secretary
Washington, D.C. 20230

March 30, 1990

Honorable D. Allan Bromley
Assistant to the President
for Science and Technology
The White House
Washington, D.C. 20500

Dear Dr. Bromley:

As my office has informed you, Secretary Mosbacher would be pleased to cohost a reception at the National Air and Space Museum on April 16, 1990.

Should you or your staff have any questions or concerns, please don't hesitate to contact me at (202) 377-5880.

Sincerely,

Meghan E. Molloy
Director of Scheduling

EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF SCIENCE AND TECHNOLOGY POLICY
WASHINGTON, D.C. 20508

DATE: 4-10-90

TO:

Dr. Fran Marie Kuhl

ADDRESS:

TELEPHONE NUMBER:

653-2966

FAX NUMBER:

653-2034

FROM:

Marian Nida

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*Global Change
file*

EPA chief Reilly denies rift with Bush officials

By Joyce Price
THE WASHINGTON TIMES

EPA Chief William K. Reilly admits President Bush is "calling the tunes on the environment" for the administration but says he supports the president's policies and does not have major differences with other key administration players.

Appearing yesterday on NBC-TV's "Meet the Press," Mr. Reilly denied that he is a "Trojan horse" within the Bush administration — a characterization made by syndicated columnist Robert Novak on the show.

Mr. Reilly also denied that he leaks controversial administration environmental position papers, that Budget Director Richard Darman won't talk to him and that he has important differences with Chief of Staff John Sununu on the issue of global warming. All the denials were in response to questions or accusations made by Mr. Novak.

"I talk to Mr. Darman all the time," Mr. Reilly said. He added that the 12 percent increase in EPA's budget for fiscal 1991 is "more important than our personal relationship."

Although published reports have indicated Mr. Reilly has been unhappy that the Bush administration has not taken more aggressive positions on issues such as global warming, Mr. Reilly did everything but call Mr. Bush the environmental president yesterday. He called the president's clean-air bill "very ambitious, very aggressive" and said it will be "good for the environment and good for the economy."

Reports in February indicated there was a significant policy dispute inside the administration over whether the president should call for strong measures to help reduce what some

environmentalists believe will be a significant warming of the earth's atmosphere.

While the EPA and the departments of State and Energy wanted Mr. Bush to take a strong stand in a speech to the Intergovernmental Panel on Climate Change, the president took a more conservative approach endorsed by Mr. Sununu. Mr. Sununu, who has a degree in nuclear engineering, questions the validity of computer models that have forecast global warming.

Asked about Mr. Sununu yesterday, Mr. Reilly said, "My views on global warming are very much the same as those of Gov. Sununu. He has strong concerns about the models, and he understands the models better than anyone I know."

Data released last week by the National Aeronautics and Space Administration raised more questions about the global warming theory. Satellites taking the most precise global temperatures ever found no evidence of global warming from the "greenhouse effect," or an overloading of the atmosphere by emissions from fossil fuels. The data were collected from 1979 through 1988 by the TIROS-N series of weather satellites.

Asked about that study yesterday, Mr. Reilly said: "The study is based on 10 years of satellite studies and collection of data. That's not a sufficient time period to draw any conclusions. We're not likely to have any indisputable information on climate change or see it in the near future."

But he said "the consensus in the scientific community" is that a buildup of carbon dioxide will lead to warmer temperatures and the climate change may be significant.

NATIONAL ACADEMY OF SCIENCES

2101 CONSTITUTION AVENUE, NW WASHINGTON, D. C. 20418

OFFICE OF THE PRESIDENT

April 10, 1990

Dr. D. Allan Bromley
Assistant to the President
for Science & Technology
Director, Office of Science
and Technology Policy
Room 360, OEOB
Washington, D.C. 20506

Dear Allan:

In response to your letter of March 21, Bob White and I are delighted to offer the Academy's facilities for the reception for the White House Conference on Science and Economic Research Related to Global Change on April 17 from 6:30 p.m. to 8:00 p.m. As co-hosts for this event, we are pleased to waive the usual fees attached to the use of the Academy facilities. Ms. Cindy Bienvenue, director of our Meetings Office, will be available to advise the Conference Staff on logistical arrangements as well as non-Academy expenses such as catering, etc.

We are pleased to take part in this important event and look forward to welcoming the Conference participants on April 17.

Yours sincerely,



Frank Press
President

cc: Robert M. White
Cindy Bienvenue

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TELEGRAM

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TAGS: TSPL, PINR, CVIS, UR, US

SUBJECT: U. S. -SOVIET COOPERATION IN BASIC SCIENCES:
THE JOINT COMMITTEE: OSIP'YAN SCHEDULE

REF: STATE 114989

1. S&T COUNSELOR 11 APRIL MET WITH ACADEMY VICE-PRESIDENT OSIP'YAN TO DELIVER NSF DIRECTOR BLOCH'S LETTER OF CONGRATULATIONS ON OSIP'YAN'S APPOINTMENT TO THE NEW PRESIDENTIAL COUNCIL (LETTER REPTEL; CONVERSATION ON PRESIDENTIAL COUNCIL SEPTTEL). IN COURSE OF THE CONVERSATION, OSIP'YAN EXPLAINED HIS HOPES AND PLANS FOR THE JCM AND HIS OTHER ACTIVITIES THERE.

2. ON THE QUESTION OF PARTICIPATION IN THE GLOBAL CHANGE CONFERENCE, OSIP'YAN SAID THAT LAVEROV VERY MUCH WANTS HIM THERE, BUT HE "SEES NO BIG REASON TO BE INCLUDED." HE PREFERS TO LEAVE THE DECISION TO DR BROMLEY. OSIP'YAN NOTED THAT HE HAS "NO ENVIRONMENTAL COMPETENCY"; S&T COUNSELOR NOTED CEA CHAIRMAN BOSKIN'S EXPLANATION THAT WE ARE HOPING THE CONFERENCE WILL GET TOGETHER ENVIRONMENTAL, S&T, AND ECONOMIC EXPERTS, A FUSION THAT WE HAVE YET TO ACHIEVE VERY WELL IN OUR OWN COUNTRY. OSIP'YAN OBSERVED THAT, IN SUCH A CASE, PERHAPS HIS PARTICIPATION WOULD MAKE SENSE, BUT HE WOULD STILL LEAVE THE QUESTION TO BROMLEY. (PLEASE ADVISE GLOBAL CHANGE COORDINATORS AS APPROPRIATE).

2. OSIP'YAN VERY MUCH WANTS TO ADVANCE THE BINATIONAL UNIVERSITY PROJECT DURING HIS VISIT. HE HAS PLANS TO MEET WITH RON SCHMIDT AND TO VISIT GEORGE MASON UNIVERSITY, PROBABLY ON MONDAY. IF THE TRIP TO DUKE OR OTHER WAY TO ARRANGE A MEETING WITH FUGUA IS A POSSIBILITY, OSIP'YAN WOULD LIKE TO DO SO. (IF HE GOES TO DUKE, HE WOULD NEED AN AMENDMENT TO HIS VISA AFTER ARRIVAL, A PROCESS THAT IS A SIMPLE ONE, AS WE ARE ADVISING SEPTTEL).

3. BECAUSE OF A MEETING OF THE PRESIDENTIAL COUNCIL ON SATURDAY, OSIP'YAN WILL HAVE TO DELAY HIS DEPARTURE PAST THAT OF THE REST OF THE JCM GROUP. HE WILL FLY TO WASHINGTON VIA NEW YORK ON SUNDAY. 14

Dr Bromley,

Do you have any guidance?

DAB:

Our answer to all countries on this issue of extra delegates is that they are welcome to make them part of their own delegation but we are space limited

and each delegation is making such
adjustments within their own delegation
(10 on each delegation plus 3 embassy seats in back)

Vance