CIRA

Cooperative Institute for Research in the Atmosphere

Colorado State University
Foothills Campus
Fort Collins, Colorado 80523

Colorado State University
National Oceanic and Atmospheric Administration

CIRA

A SYNOPSIS OF ACTIVITY

JANUARY 1 - DECEMBER 31, 1983

Third Mid-year Report

March 1984

Thomas H. Vonder Haar
Director

PREFACE

This third "mid-year" report from the Cooperative Institute for Research in the Atmosphere (CIRA) is intended to communicate scientific results and information about current activities to NOAA and CSU scientists, students and staff as well as other interested parties. Each year we plan to issue this mid-year report as well as an annual report from CIRA.

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COOPERATIVE INSTITUTE FOR RESEARCH IN THE ATMOSPHERE

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Thomas H. Vonder Haar, Director
Ray Garcia, Research Coordinator

The Cooperative Institute for Research in the Atmosphere (CIRA) established September 1980, is jointly sponsored by Colorado State University (CSU) and the National Oceanic and Atmospheric Administration (NOAA) and has a close relationship with NOAA's Environmental Research Laboratories (ERL) and the National Environmental Satellite, Data, and Information Service (NESDIS). It was formed to increase the effectiveness of atmospheric research of mutual interest to NOAA, CSU, the state and the nation. Additional objectives are to provide a center for cooperation in specified research programs by scientists from Colorado, the nation and other countries and to hasten the training of atmospheric scientists. All Colorado State University or NOAA organizational elements are invited to participate in the Institute's atmospheric research programs.

As its research themes, CIRA has concentrated on the scientific problems of observation and analysis related to: global climate dynamics, applications of satellite data, atmospheric quality, and local area weather research relating to 1) forecasting and 2) economic benefits. Atmospheric quality research is currently being done through an alliance with the National Park Service. With the locating of the NOAA/NESDIS/RAMM Branch (Regional Mesoscale and Meteorology Branch) at CIRA, emphasis is placed on development of meteorological satellite data for research purposes and environmental applications. Internationally, the involvement is with the satellite cloud climatology project. In addition to the above mentioned themes, the Institute has proposed two candidate themes for 1984. The first theme, Atmospheric Radiation, will focus on water substance components (vapor, cloud forms, ice cubes, etc.) that tie in with current on-going fire experiments throughout the United States. A current CIRA research project is outlining a methodology for determining some measure of the optical thickness of clouds. The second theme, Agricultural Applications, will concentrate in the area of agricultural yield forecasts (particularly internationally). A primary focal point will be developing yield models of precipitation estimations.

Currently the University departments engaged in CIRA research are: atmospheric science, civil engineering, economics, electrical engineering, psychology, recreation resources, and statistics. Thirty-eight separate research projects have been funded through CIRA which includes an IPA (Intergovernmental Personnel Act) with Dr. T. Michael Carter located at the Maryland office of the National Weather Service.

CIRA personnel comprise a list of 15 fellows, 4 visiting fellows, 11 research associates and 3 visiting scientists. Since the inception of CIRA, 2 Ph.D.s and 4 Master of Science degrees have been awarded. Each year the visiting fellows program allows for at least two scientists to conduct individual research at Colorado State University.

In September of 1983 CIRA sponsored a workshop entitled "Research on Weather and Climate Applications at CSU" in an effort to bring together the University faculty to discuss their multidisciplinary studies involving the atmospheric sciences. Researchers from several CSU departments participated in the workshop, providing interaction among departments. CIRA is planning to hold this type of workshop each year to enhance communication among the CSU faculty, and with government agency atmospheric researchers.

CIRA PERSONNEL

Director	Vonder Haar, T.
Research Coordinator	R. Garcia
Fellows	Alberty, R., NOAA/ERL Beran, D., NOAA/ERL Brier, G., CSU, Atmospheric Science Brubaker, T., CSU, Electrical Engineering Cochrane, H., CSU, Economics Golden, J., NOAA/ERL Grant, L., CSU, Atmospheric Science Gray, W., CSU, Atmospheric Science Haas, G., CSU, Recreation Resources Loomis, R., CSU, Psychology Department McKee, T., CSU, Atmospheric Science Mielke, P., CSU, Statistics Pielke, R., CSU, Atmospheric Science Purdom, J., NOAA/NESDIS/RAMM, CSU Sinclair, P., CSU, Atmospheric Science
Visiting Fellows	Carter, M., in Washington on IPA Hillger, D., CSU, Atmospheric Science Mahrer, Y., The Hebrew University of Jerusalem Mugnai, A., Instituto Di Fisica Dell'Atmosfera, Rome
Visiting Scientists	Ashbaugh, L., UC-Davis/NPS/CSU Campbell, G., RIC/CSU Malm, W., NPS/CSU
Post-doctoral Fellow	Yeh, M.
Research Associates	Allen, N., CSU/CIRA--employee Birkenheuer, D., located at NOAA/ERL--employee Davis, W., CSU/CIRA--employee Green, R., NOAA/NESDIS/RAMM, CSU Kruidenier, M., CSU, Atmospheric Science Lipschutz, R., located at NOAA/ERL--employee MacDonald, B., CSU/CIRA--employee Phillips, R., NOAA/NESDIS, CSU Weaver, J., NOAA/NESDIS/RAMM, CSU Winston, H., located at NOAA/ERL--employee Zehr, R., NOAA/NESDIS/RAMM, CSU

Agency Acronyms

CSU:	Colorado State University
ERL:	Environmental Research Laboratory
NESDIS:	National Environmental Satellite, Data, and Information Service
NOAA:	National Oceanic and Atmospheric Administration
NPS:	National Park Service
RAMM:	Regional Mesoscale & Meteorology Branch
RIC:	Research Institute of Colorado
UC-Davis:	University of California, Davis

RESEARCH ACTIVITIES

September 1, 1980 - December 31, 1983

PRINCIPAL INVESTIGATOR(S)	TITLE	SPONSOR'S NUMBER	DATES
L. Grant	A Design for Assessing On-going Operational Cloud Seeding	NA80RA-C-00017*	10/1/79 - 3/30/81
P. Sinclair/ J. Purdom	Genesis and Development of Deep Convective Storms	NA80AA-D-00056*	4/15/81 - 4/14/82
T. Vonder Haar/ T. Brubaker	Satellite Data Reception and Analysis Equipment and Support	NA80AA-D-00082*	7/1/80 - 9/30/81
H. Cochrane	Estimating the Uses and Benefits Derived from PROFS	NA80RA-C-00183*	8/1/80-11/30/82
T. Vonder Haar/ E. Smith	The Development of a Daytime Multispectral Radiative Signature Technique for Estimation of Rainfall from Satellites	NA80SA-C-00746*	7/15/80-5/31/82
T. McKee	Colorado Demonstration Intergovernmental Climate Project	NA80AA-D-00118*	9/1/80-8/31/83
T. McKee	Surface Data Network Archives for PROFS	NA80RA-G-00201*	8/1/80-5/31/82
T. Vonder Haar	Cooperative Institute for Research Visiting Members Program	NA81RA-H-00001*	10/1/80-6/30/84
L. Grant	Long-range Planning for Weather Modification	NA81RA-H-00001* Amendment 1, Item 2	11/1/80-3/31/82
G. Brier	Research on Statistical Techniques for Improvement of Long Range Forecasts	NA81AA-D-00039*	2/1/81-7/31/84

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**NASA

PRINCIPAL INVESTIGATOR(S)	TITLE	SPONSOR'S NUMBER	DATES
T. Vonder Haar/ J. Purdom (T. Brubaker)	Satellite Studies & Focal Point Activities for PROFS	NA81RA-H-00001* Amendment 2, Item 4	2/1/81-11/30/83
M. Carter	The Design of Improvements in Severe Weather Warning Programs Utilizing Concepts and Products Derived from PROFS	NA81RA-H-00001* Amendment 2, Item 3	10/1/80-10/31/82
T. Vonder Haar	Pilot Studies for the International Satellite Cloud Climatology Project	NA81AA-D-00058*	3/1/81-1/31/84
P. Mielke/ G. Brier	Development of Validation and Verification Techniques for Precipitation Estimation from Satellites	NA81RA-H-00001* Amendment 3, Item 5	4/1/81-9/30/82
L. Grant	Testing and Development of Ice Nucleation Materials and Generation Calibration	NA81RA-H-00001* Amendment 5, Item 7	2/1/81-9/30/82
W. Cotton	Numerical Simulation and Observational Analysis of the Dynamics Response of Towering Cumuli to Massive Seeding	NA81RA-H-00001* Amendment 4, Item 6	4/1/81-9/30/83
T. Vonder Haar	Mesoscale Research	NA81RA-H-00001* Amendment 6	8/1/81-7/31/84
W. Gray	Hurricane-Typhoon Studies in Support of NOAA Hurricane Research and Forecasting	NA81RA-H-00001* Amendment 9, Item 9	3/1/82-2/28/83

*NOAA
**NASA

PRINCIPAL INVESTIGATOR(S)	TITLE	SPONSOR'S NUMBER	DATES
P. Sinclair/ J. Purdom	The Genesis and Development of Deep Convective Storms: A New Approach to Their Prediction and Possible Modification	NA82RA-C-00103*	7/1/82-9/30/83
T. Vonder Haar/ J. Purdom	Satellite Data Reception and Analysis Equipment and Support for Research Activities	NA82AA-H-00026*	9/1/82-12/1/83
S. Cox/ T. McKee	An Investigation of the Application of Monte Carlo Method in Problems in Visibility	John Muir Inst. (National Park Service)	8/24/82-6/30/83
R. Loomis	Development of Psychological Indicators of Visual Quality Judgments	John Muir Inst. (National Park Service)	8/24/82-6/30/83
E. Reiter	Atmospheric Transport Processes Affecting Visibility in National Parks	John Muir Inst. (National Park Service)	8/24/82-6/30/83
W. Sadeh	Statistical Reduction and Analyses of Visibility-Related Data and Statistical Modeling of Visibility-Related Variables and Processes	John Muir Inst. (National Park Service)	8/24/82-6/30/83
R. Pielke	Local Transport & Dispersion in National Parks	NA81RA-H-00001* Amendment 12, Item 10	9/1/82-8/31/83
M. Carter	Federal IPA - Severe Warning Program	*	8/25/82-11/9/84
G. Haas	A Study of Park Visitors', Related Behaviors, and Their Relationship to Air Quality	NA81RA-H-00001* Amendment 13	1/1/83-12/31/83

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PRINCIPAL INVESTIGATOR(S)	TITLE	SPONSOR'S NUMBER	DATES
N. Allen/ T. Vonder Haar	Air Quality Data Telemetry Assistance	NA81RA-H-00001*	4/1/83 - 3/31/84
G. Haas/ R. Loomis	Identification of Visibility Impairment	NA81RA-H-00001*	5/1/83 - 6/9/84
E. Reiter	Atmospheric Transport Processes Affecting Visibility in National Parks (Application of Long-Range Transport Model)	NA81RA-H-00001*	7/1/83 - 6/30/84
R. Pielke	Mesoscale Modeling	NA81RA-H-00001*	6/1/83 - 7/31/84
S. Cox/ T. McKee	An Investigation of the Application of Monte Carlo Methods to Problems in Visibility	NA81RA-H-00001*	7/1/83 - 6/30/84
S. Cox	Ground Based Monitoring of Cloud Base & Cloud Optical Depth	NA83AA-D-00063*	9/1/83 - 8/31/84
W. Cotton/ R. McAnelly	Analysis of the Meso-B-scale Structure of Mesoscale Convective Complexes	NA81RA-H-00001* Item 17	9/1/83 - 1/31/84
T. McKee	Climatology of Hourly Precipitation in Colorado	NA83RAA02600*	7/1/83 - 10/31/83
G. Brier	Statistical Studies	NA83RAA0116*	2/22/83 - 2/21/84
J. Purdom/ T. Vonder Haar	Investigations of Severe/Tornadic Thunderstorm Development and Evolution Based on Satellite and AVE/SESAME/VAS Data	NAGW-504**	9/1/83 - 8/31/84
L. Grant	Supplemental Design Plans for the National Program of Federal/ State/Local Cooperative Weather Modification Research	NA83RAC00088*	9/1/83 - 3/15/84

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PAPERS, REPORTS AND PRESENTATIONS

September 1, 1980 - December 31, 1983

Project #5-31258

A Design for Assessing On-going Operational Cloud Seeding Programs

Principal Investigators: L. Grant/P. Mielke/T. Vonder Haar

Sponsor's #NA80RA-C-00017, 10/1/79 - 3/30/81

Reports

Grant, Lewis O., and Paul W. Mielke, Jr., 1982: Final report to Weather Modification Office, NOAA, for Contract No. NA80RAC00017, Volume I, September 15, 1982.

Grant, Lewis O., and Paul W. Mielke, Jr., 1982: Final Report to Weather Modification Program Office, NOAA, for Contract No. NA80RAC00017, Volume II, September 15, 1982.

Project #5-31259

Genesis and Development of Deep Convective Storms

Principal Investigators: P.C. Sinclair/J.F.W. Purdom

Sponsor's #NA80AA-D-00056; 4/15/81 - 4/14/82

Papers

Purdom, J.F.W., 1982: Integration of research aircraft data and 3 minute interval GOES data to study the genesis and development of deep convective storms. Preprint Volume: 12th Conference on Severe Local Storms, January 11-15, 1982, San Antonio, TX, AMS, Boston, MA.

Sinclair, P.C., and J.F.W. Purdom, 1983: The genesis and development of deep convective storms. Final report on Contract NA80AA-D-00056, ISSN 0737-5352, CIRA Paper No. 1. Cooperative Institute for Research in the Atmosphere, Colorado State University, Ft. Collins, CO.

Sinclair, P.C., and J.F.W. Purdom, 1983: Shuttle recovery requirements and the development of arc cloud lines from thunderstorm outflows. Preprint Volume, Ninth Conference on Aerospace and Aeronautical Meteorology, June 6-9, 1983, Omaha, NE, AMS, Boston, MA.

Presentations

Purdom, J.F.W., 1981: New thoughts on tornado genesis from combining satellite and conventional radar data. Presented at IGRSS Conference (by J. Purdom), June 9, Washington, DC.

Purdom, J.F.W., 1981: Using satellite and radar data to understand the mechanisms of tornado genesis. Presented at NASA/GSFC/Goddard Laboratory for Atmospheric Science (by J. Purdom), June 10, Greenbelt, MD.

Purdom, J.F.W., 1981: Understanding thunderstorm development and tornado genesis using satellite data. Presented to NESS (by J. Purdom), June 11, Washington, DC.

Purdom, J.F.W., 1981: Using satellite and radar data to better understand and nowcast tornadic storms. Presented at Joint Meteorology and SSEC Coloquium (by J. Purdom), December 6, University of Wisconsin, Madison, WI.

Purdom, J.F.W., 1982: The development and evolution of deep convection--Using satellite data to nowcast tornadoes. Presented to U.S.A.F. (by J. Purdom), two sessions: April 5-7; April 7-9, Offutt AFB, NE.

Project #5-31259 (cont'd.)

Sinclair, P.C., and J.F.W. Purdom, 1982: Integration of research aircraft data and 3 minute interval GOES data to study the genesis and development of deep convective storms. Presented at the 12th Conference on Severe Local Storms, January 11-15, 1982, San Antonio, TX.

Sinclair, P.C., and J.F.W. Purdom, 1983: Shuttle recovery requirements and the development of arc cloud lines from thunderstorm outflows. Presented at the Ninth Conference on Aerospace and Aeronautical Meteorology, June 6-9, 1983, Omaha, NE.

Project #5-31260

Satellite Data Reception and Analysis Equipment and Support

Principal Investigators: T. Vonder Haar/T. Brubaker

Sponsor's #NA80AA-D-00082, 7/1/80 - 9/30/81

Papers

Green, Robert N., and Melanie A. Kruidenier, 1982: Interactive data processing for mesoscale forecasting applications. Prepared for the 9th Conference on Weather Forecasting and Analysis, June 28-July 1, 1982, Seattle, WA, AMS, Boston, MA.

Kruidenier, Melanie A., 1983: Application of GOES satellite soundings to forest fire management. Preprint Volume: 7th Conference on Fire & Forest Meteorology, April 25-29, 1983, Fort Collins, CO, AMS, Boston, MA.

Plomondon, Brian L., 1982: Suomi-Sony Video Cassette Archive - EMR 822-02 Interface, March 26.

Report

Vonder Haar, Thomas H., Thomas A. Brubaker, 1982: Final Report on Satellite Data Reception and Analysis Equipment and Support, Contract NA80AA-D-00082, September 19, 1982.

Project #5-31261

Estimating the Uses and Benefits Derived from PROFS

Principal Investigator: H. Cochrane

Sponsor's #NA80RA-C-00183, 8/1/80 - 11/30/82

Papers

George, D.H., and T.M. Carter, 1983: An automated warning data management system (AWADS). NOAA/ERL, Boulder, CO and Cooperative Institute for Research in the Atmosphere, Colorado State University, Ft. Collins, CO.

Reiter, E., J.D. Sheaffer, H. Cochrane, J. Cook, G.R. Johnson, H. Leong, T. Nakagawa, 1982: The effects of atmospheric variability on energy utilization and conservation. Environmental Research Paper No. 32, Colorado State University, March.

Nakagawa, T., 1982: Measuring the value of short-term weather forecasts: Electric power generation, a case study. Ph.D. Dissertation, Department of Economics, Colorado State University, Ft. Collins, CO, December.

Reports

Cochrane, H.C., T. Nakagawa and A. Harney, 1982: The value of weather information in the power generation industry: A case study. Final Report for NOAA Contract NA80RA-C-00183. Colorado State University, Ft. Collins, CO.

Presentations

Cochrane, H.: Determining the economic value of short-term weather forecasts. 3rd Conference on the Meteorology of the Upper Atmosphere, AMS, San Diego, CA, January 20-22, 1981.

Cochrane, H.: PROFS and power plant scheduling: A case study of the Public Service Company of Colorado. Presented to Public Service Company.

Cochrane, H.: PROFS and power plant scheduling: A case study of the Public Service Company of Colorado. Presented to professional staff (3 presentations), Boulder, CO.

Project #5-31262

The Development of a Daytime Multispectral Radiative Signature Technique for Estimation of Rainfall from Satellites

Principal Investigators: T. Vonder Haar/E. Smith

Sponsor's #NA80SA-C-00746, 7/15/80 - 5/31/82

Reports

Smith, E.A. and T.H. Vonder Haar, 1980: Atmospheric environments and the complex indices of refraction for water and ice. Report 1--NOAA Contract NA-80-SAC-00746, Department of Atmospheric Science, Colorado State University, Ft. Collins, CO, 49 pp.

Smith, E.A. and T.H. Vonder Haar, 1980: Water cloud microphysics. Report 2--NOAA Contract NA-80-SAC-00746, Department of Atmospheric Science, Colorado State University, Ft. Collins, CO, 85 pp.

Smith, E.A. and T.H. Vonder Haar, 1980: Ice cloud microphysics. Report 3--NOAA Contract NA-80-SAC-00746, Department of Atmospheric Science, Colorado State University, Ft. Collins, CO, 50 pp.

Smith, E.A. and T.H. Vonder Haar, 1980: Single scattering models for distributions of spherical and cylindrical hydrometeors. Report 4--NOAA Contract NA-80-SAC-00746, Department of Atmospheric Science, Colorado State University, Ft. Collins, CO, 111 pp.

Smith, E.A. and T.H. Vonder Haar, 1980: The microwave radiative transfer model. Report 5--NOAA Contract NA-80-SAC-00746, Department of Atmospheric Science, Colorado State University, Ft. Collins, CO, 14 pp.

Smith, E.A. and T.H. Vonder Haar, 1981: The shortwave radiative transfer models. Report 6--NOAA Contract NA-80-SAC-00746, Department of Atmospheric Science, Colorado State University, Ft. Collins, CO, 97 pp.

Smith, E.A. and T.H. Vonder Haar, 1981: The infrared radiative transfer models. Report 7--NOAA Contract NA-80-SAC-00746, Department of Atmospheric Science, Colorado State University, Ft. Collins, CO, 44 pp.

Smith, E.A. and T.H. Vonder Haar, 1982: First year project summary of a daytime multispectral radiative signature technique for estimation of rainfall from satellites. Cooperative Institute for Research in the Atmosphere, Colorado State University/National Oceanic and Atmospheric Administration, Ft. Collins, CO, 4 pp.

Smith, E.A. and T.H. Vonder Haar, 1982: The development of a multispectral radiative signature technique for estimation of rainfall from satellites. Final Report, NOAA Contract NA-80-SAC-00746, Department of Atmospheric Science, Colorado State University, Ft. Collins, CO, 77 pp.

Vonder Haar, T.H. and E.A. Smith, 1982: Combined spaceborne and conventional measurements for precipitation estimation. Precipitation measurements from space. Workshop Report (Atlas and Thiele Editors), NASA/Goddard Space Flight Center, Greenbelt, MD, D176-D183.

Presentations

Vonder Haar, T.H. and E.A. Smith, 1981: Combined spaceborne and conventional measurements for precipitation estimation. Workshop on Precipitation Measurements from Space, NASA/Goddard Space Flight Center, April 28-May 1, Greenbelt, MD.

Smith, E.A., T.H. Vonder Haar, R. Welch and W. Wiscombe, 1981: Contractor´s Report. AgRISTARS Precipitation Contractors´ Workshop, NOAA/NESS, June 16-19, Washington, DC.

Smith, E.A. and T.H. Vonder Haar, 1982: Contractor´s Report. AgRISTARS Precipitation Contractors´ Workshop, NOAA/NESS, August 23-25, Washington, DC.

Project #5-31263

Colorado Demonstration - Intergovernmental Climate Program

Principal Investigator: T. McKee

Sponsor's #NA80AA-D-00118; 9/1/80 - 8/31/83.

Reports

Crow, L.W., Consultants, Inc., 1982: Report on methods of estimating precipitation in mountainous areas of Colorado. Subcontract LWC #276, August 1982.

Doesken, N., and T. McKee, 1983: An inventory of requests for climate information in Colorado. Climatology Report No. 83-5. Colorado Climate Center, Department of Atmospheric Science, Colorado State University, Ft. Collins, CO, 24 pp.

Doesken, N.J., T. McKee and D. Ebel, 1982: Colorado solar radiation data with supplemental climatic data. Climatology Report 82-2, Department of Atmospheric Science, Colorado State University, Ft. Collins, CO, 99 pp.

McKee, T., and N. Doesken, 1983: Colorado demonstration -- Intergovernmental climate program. FY1982 Annual Report. Colorado Climate Center, Department of Atmospheric Science, Colorado State University, Ft. Collins, CO, 2 pp.

McKee, T., and N. Doesken, 1984: Colorado demonstration -- Intergovernmental climate program. Final Report to the National Climate Program Office/NOAA. Department of Atmospheric Science, Colorado State University, Ft. Collins, CO, 43 pp.

McKee, T., N. Doesken and H. Cochrane, 1982: Final report - Colorado intergovernmental climate program - May 1982. Climatology Report 82-1, Department of Atmospheric Science, Colorado State University, Ft. Collins, CO, 103 pp.

Project #5-31264

Surface Data Network Archives for PROFS

Principal Investigator: T. McKee

Sponsor's #NA80RA-G-00201, 8/1/80 - 9/30/82.

Papers

Smith, Jeffrey Ken, 1982: Undisturbed clear day diurnal winds and temperature pattern in northeastern Colorado. M.S. Thesis, Colorado State University, Ft. Collins, CO.

Reports

McKee, T., W. Cotton, N. Doesken and G. Tripoli, 1981: Report of the PROFS mesoscale network workshop, November 18-19, 1980.

McKee, T., 1981: Surface data network archives for PROFS - Summary of Program 5-31264, October 1981.

McKee, T., and J. Kleist, 1983: Final technical report - PROFS surface data archive. Cooperative Institute for Research in the Atmosphere, Colorado State University, Ft. Collins, CO.

Project #5-31265

Cooperative Institute for Research Visiting Members Program

Principal Investigator: T. Vonder Haar

Sponsor's #NA81RA-H-00001, 10/1/80 - 6/30/84.

Papers

Hillger, D.W., and T. Vonder Haar, 1983: Precipitable water vapor and thickness fields over the Tasman Sea on 28 October 1982. First International TOVS Study Conference: Intercomparison of Satellite Derived Temperature Profiles, Igls, Austria, August 29 - September 2, 10 pp.

Jacobowitz, H., 1983: History of the determination of the Channel 12 sensitivity. Cooperative Institute for Research in the Atmosphere, Colorado State University, Ft. Collins, CO., 5 pp.

Mahrer, Y., and R. Avissar, 1984: A numerical simulation of the greenhouse microclimate. Cooperative Institute for Research in the Atmosphere, Colorado, Ft. Collins, CO. To be published in Mathematics and Computers in Simulation.

Mahrer, Y., and M. Segal, 1984: Model evaluations of the impact of perturbed weather conditions on soil-related characteristics. Cooperative Institute for Research in the Atmosphere, Colorado State University, Ft. Collins, CO. Submitted to Soil Science.

Mahrer, Y., and M. Segal, 1984: On the effect of islands geometry and size on inducing sea breeze circulation. Cooperative Institute for Research in the Atmosphere, Colorado State University, Ft. Collins, CO. Submitted to J. Atmos. Sci.

Saufley, D., 1982: Navigation of geosynchronous satellite images. Cooperative Institute for Research in the Atmosphere, Colorado State University, Ft. Collins, CO.

Saufley, D., 1982: Navigation of VAS data. Cooperative Institute for Research in the Atmosphere, Colorado State University, Ft. Collins, CO.

Segal, M., Y. Mahrer, R.A. Pielke, and R.C. Kessler, 1984: Model evaluation of the summer daytime induced flows over southern Israel. Cooperative Institute for Research in the Atmosphere, Colorado State University, Ft. Collins, CO. Submitted to Israel J. Earth Sci.

Workshop on Satellite Meteorology, 1982: Part I: Satellite and their data. Cooperative Institute for Research in the Atmosphere, Colorado State University, Ft. Collins, CO and Committee on Meteorological Aspects of Aerospace Systems, AMS, Boston, MA.

Project #5-31265 (cont'd.)

Workshop on Satellite Meteorology, 1982: Part II. Satellite image analysis and interpretation. Cooperative Institute for Research in the Atmosphere, Colorado State University, Ft. Collins, CO and Committee on Meteorological Aspects of Aerospace Systems, AMS, Boston, MA.

Workshop on Satellite Meteorology, 1982: Part III. Satellite soundings and their uses. Cooperative Institute for Research in the Atmosphere, Colorado State University, Ft. Collins, CO and Committee on Meteorological Aspects of Aerospace Systems, AMS, Boston, MA.

Yeh, Hwa-Young, and Kuo-Nan Liou, 1982: Remote sounding of cloud parameters from a combination of infrared & microwave channels. J. of Clim. & App. Meteor., 22(2), 201-213.

Yeh, H.-Y., and T.H. Vonder Haar, 1983: On the temperature field and cloud parameters inversion in cirrus cloudy atmospheres. Cooperative Institute for Research in the Atmosphere, Colorado State University, Ft. Collins, CO.

Yeh, H.-Y., T.H. Vonder Haar, and K.-N. Liou, 1983: Temperature profile and cloud parameters inversion in cirrus cloudy atmospheres. Submitted to the J. Atmos. Sc.

Reports

Bausch, W., 1983: Final Report - Development of an urban lawn irrigation scheduling program. Department of Agricultural and Chemical Engineering, Colorado State University, Ft. Collins, CO.

Vonder Haar, T., K. Greiner, 1982: Annual report to the Advisory Board, September 1980 - June 1981. Cooperative Institute for Research in the Atmosphere, Colorado State University, Ft. Collins, CO.

Vonder Haar, T., 1982: CIRA, a synopsis of activity, September 1980 - December 1981, 1st mid-year report (February). Cooperative Institute for Research in the Atmosphere, Colorado State University, Ft. Collins, CO.

Vonder Haar, T., K.S. Greiner, 1982: Annual report on Cooperative Institute for Research Visiting Members Program, November 1982. Cooperative Institute for Research in the Atmosphere, Colorado State University, Ft. Collins, CO.

Presentations

Ashbaugh, Lowell, 1982: Transport of fine particle sulfur in the western United States. Seminar at Colorado State University, Ft. Collins, CO (November 11th).

Jacobowitz, H., 1983: Modelling the earth's radiation budget. Colorado State University, Ft. Collins, CO (August 5th).

Johnson, Donald R., 1982: The seasonal variation of the planetary scale heat sources and sinks and the thermally-forced planetary scale response. Guest lecturer. Colorado State University, Ft. Collins, CO (June 14th).

Johnson, Donald R., 1982: The forcing and maintenance of the planetary scale circulation of the atmosphere. Guest lecturer. Colorado State University, Ft. Collins, CO (June 15th).

Johnson, Donald, R., 1982: The forcing of the extratropical cyclone within an angular momentum perspective. Guest lecturer. Colorado State University, Ft. Collins, CO (June 16th).

Johnson, Donald R., 1982: Diagnostics of observed and numerically simulated extratropical cyclones. Guest lecturer. Colorado State University, Ft. Collins, CO (June 17th).

Johnson, Donald R., 1982: An isentropic perspective of atmospheric jet streaks and scale interaction. Guest lecturer. Colorado State University, Ft. Collins, CO (June 22nd).

Lipton, A., 1983: A classification-discrimination method for retrieving moisture profiles from satellite radiances. Presented at the Fifth Conference on Radiation, Baltimore, Amer. Meteor. Soc.

Mahrer, Y., 1983: Remote sensing techniques for assessing plant water stress. Fellow. Cooperative Institute for Research in the Atmosphere, Colorado State University, Ft. Collins, CO (December 1st).

Mugnai, A., 1984: Passive microwave inference of precipitation by satellite: A numerical study on the effects of an evolving cloud medium. CIRA Visiting Fellow. Colorado State University, Ft. Collins, CO (March 20).

Panofsky, H.A., 1982: Meteorology in the last half century - A personal perspective. Guest lecturer. Colorado State University, Ft. Collins, CO (December 10th).

Presentations, lectures and training exercises in support of the WMO Training Course "Satellite Data for Operational Purposes". Colorado State University, September 12 - November 4, 1983.

Project #5-31268

Long-range Planning for Weather Modification

Principal Investigator: L. Grant

Sponsor's #NA81RA-H-00001, Amendment 1, Item 2, 11/1/80 - 3/31/82

Report

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Project #5-31269

Research on Statistical Techniques for Improvement on Long Range Forecasts

Principal Investigator: G. Brier

Sponsor's #NA81AA-D-00039, 2/1/81- 7/31/84.

Report

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Presentations

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Project #5-31270

Satellite Studies & Focal Point Activities for PROFS

Principal Investigators: T. Vonder Haar/J.F.W. Purdom (T. Brubaker)

Sponsor's #NA81RA-H-00001, Amendment 2, Item 4, 2/1/81 - 9/30/83

Papers

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Project #5-31270 (cont'd.)

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Project #5-31270 (cont'd.)

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Purdom, James F.W., 1982: The development and evolution of deep convection. Presented in Atmospheric Science Seminar Series (by J. Purdom), May 27, Colorado State University, Ft. Collins, CO.

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Purdom, J., 1983: Development of tornadoes in severe thunderstorms. Presented at NOAA/NESDIS (by J. Purdom), February 9, Washington, D.C.

Purdom, J., 1983: Uses of satellite data for mesoanalysis and short range forecasting. Presented at AMS Chapter Meeting, March 1, Omaha, NE.

Purdom, J., 1983: Rapid scan data uses in nowcasting convective development. Presented at PROFS/ERL (by J. Purdom), March 16, Boulder, CO.

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Project #5-31270 (cont'd.)

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Project #5-31271

The Design of Improvements in Severe Weather Warning Programs Utilizing Concepts and Products Derived from PROFS

Principal Investigators: T.M. Carter

Sponsor's #NA81RA-H-00001, Amendment 1, Item 3, 10/1/80 - 10/31/82

Paper

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Reports

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Presentations

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Project #5-31272

Pilot Studies for the International Satellite Cloud Climatology Project

Principal Investigator: T. Vonder Haar

Sponsor's #NA81AA-D-00058, 3/1/81 - 7/31/83.

Papers

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Reports

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Smith, E.A., 1982: Indirect calibration of weather satellites and the impact on cloud amount retrieval. Cooperative Institute for Research in the Atmosphere, Colorado State University/National Oceanic and Atmospheric Administration, Ft. Collins, CO, 16 pp.

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Presentations

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Project 5-31272 (cont'd.)

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Project #5-31273

Development of Validation and Verification Techniques for Precipitation Estimation from Satellites

Principal Investigators: P. Mielke/G. Brier

Sponsor's #NA81RA-H-00001, Amendment 3, Item 5, 4/1/81 - 9/30/82.

Reports

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Project #5-31274

Testing and Development of Ice Nucleation Materials and Generation Calibration

Principal Investigator: L. Grant

Sponsor's #NA1RA-H-00001, Amendment 5, Item 7, 2/1/81 - 9/30/82.

Paper

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Project #5-31275

Numerical Simulation and Observational Analysis of the Dynamic Response of Towering Cumuli to Massive Seeding

Principal Investigator W. Cotton

Sponsor's #NA81RA-H-00001, Amendment 4, Item 6, 4/1/81 - 9/30/83.

Papers

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Reports

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Project #5-31276

Mesoscale Research

Principal Investigator: T. Vonder Haar

Sponsor's #NA81RA-H-00001, Amendment 6, 8/1/81 - 7/31/83.

Paper

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Haugen, D., and Robert Lipschutz: A verification program for severe convective storm forecasts.

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Project #5-31278

Hurricane-Typhoon Studies in Support of NOAA Hurricane Research and Forecasting

Principal Investigator: W. Gray

Sponsor's #NA81RA-H-00001, Amendment 9, Item 9, 3/1/82 - 2/28/83.

Reports

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Project #5-31279

The Genesis and Development of Deep Convective Storms: A New Approach to Their Prediction and Possible Modification

Principal Investigators: P. Sinclair/J. Purdom

Sponsor's #NA82RA-C-00103, 7/1/82 - 9/30/83

Papers

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Presentations

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Purdom, J.F.W., J.F. Weaver, and R.N. Green, 1983: Analysis of rapid interval GOES data for the 9 July 1982 New Orleans airliner crash. Presented at the Ninth Conference on Aerospace and Aeronautical Meteorology, June 6-9, 1983, Omaha, NE.

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Sinclair, P.C., and J.F.W. Purdom, 1983: Shuttle recovery requirements and the development of arc cloud lines from thunderstorm outflows. Presented at the Ninth Conference on Aerospace and Aeronautical Meteorology, June 6-9, 1983, Omaha, NE.

Project #5-31280

Satellite Data Reception and Analysis Equipment and Support for Research Activities

Principal Investigators: T. Vonder Haar/J. Purdom

Sponsor's #NA82AA-H-00026, 9/1/82 - 12/1/83

Papers

Green, Robert N., and Melanie A. Kruidenier, 1982: Interactive data processing for mesoscale forecasting applications. Preprints, 9th Conference on Weather Forecasting and Analysis, June 28-July 1, 1982, Seattle, WA, AMS, Boston, MA.

Green, R.N., and H.A. Parker, 1983: Application of satellite and radar data to severe thunderstorm analysis. Preprints 13th Conf. on Severe Local Storms, Tulsa, Amer. Meteor. Soc.

Reports

Vonder Haar, T., J. Purdom, 1982: Quarterly report #1 for the period September 1, 1982 - November 30, 1982.

Presentations

Green, R.N., 1982: Image processing systems as tools for atmospheric research. Presented at the Department of Atmospheric Science (by R. Green), Colorado State University, Ft. Collins, CO, September 2.

Green, R.N., 1983: An operationally-oriented satellite and radar product. Presented at Colorado State University (by R. Green), Ft. Collins, CO, May 23.

Green, R.N., and M.A. Kruidenier, 1982: Interactive data processing for mesoscale forecasting applications. Presented at the 9th Conference on Weather Forecasting and Analysis (by M. Kruidenier). June 28-July 1, 1982, Seattle, WA, AMS, Boston, MA.

Purdom, J.F.W., 1981: Possible uses of rapid scan satellite data in the CCOPE experiment. Presented at NCAR (by J. Purdom), January 6, Boulder, CO.

Purdom, J.F.W., 1981 Satellite systems, orbits and how satellite data fits into short range forecast programs. Presented to Environmental Research Laboratories (by J. Purdom), February 26, Boulder, CO.

Purdom, J.F.W., 1981: What has been learned from rapid scan satellite data analysis and what the future holds. Presented to NESS (by J. Purdom), December 10, Washington, DC.

Project 5-31280 (cont'd.)

Purdom, J.F.W., 1982: Current satellite systems and uses of the data. Presented to ERL (by J. Purdom), February 25, Boulder, CO.

Purdom, J.F.W., 1982: The development and evolution of deep convection--Using satellite data to nowcast tornadoes. Presented to U.S.A.F. (by J. Purdom), two sessions: April 5-7, April 7-9, Offutt AFB, NE.

Purdom, J.F.W., 1982: Convective scale interaction and its implications for weather modification. Presented to North Dakota Weather Modification Board (by J. Purdom), May 11, Bismarck, ND.

Purdom, J.F.W., 1982: Satellite data and convective weather modification. Presented to North Dakota Weather Modification Advisory Board (by J. Purdom), June 15, Bowman, ND.

Purdom, J.F.W., 1982: Satellite data applications for short range forecasting. Presented to NESS (by J. Purdom), September 13, Washington, DC.

Purdom, J.F.W., 1982: Satellite data as a tool in understanding thunderstorm development and evolution. Presented to Office of the Federal Coordinator for Meteorological Services (by J. Purdom), September 16, Rockville, MD.

Purdom, J.F.W., 1982: Using satellite data to understand the development and evolution of deep convection. Presented at the Headquarters NOAA/RD Seminar (by J. Purdom), September 16, Rockville, MD.

Purdom, J., 1983: Tornadoes - Why some storms have them and others don't. Presented at University of Wisconsin (by J. Purdom), February 8, Madison WI.

Purdom, J., 1983: Development of tornadoes in severe thunderstorms. Presented at NOAA/NESDIS (by J. Purdom), February 9, Washington, D.C.

Purdom, J., 1983: Uses of satellite data for mesoanalysis and short range forecasting. Presented at AMS Chapter Meeting, March 1, Omaha, NE.

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Purdom, J., 1983: Satellite data for short range weather forecasting. Presented at Cape Kennedy AMS Chapter, June 22, Orlando, FL.

Project 5-31280 (cont´d.)

Purdom, J., 1983: Satellite nowcasting. Presented at the WMO Workshop on Very Short-range Forecasting Systems Research Aspects (by J. Purdom), August 15-17, Boulder, CO.

Project #5-31281

Local Transport and Dispersion in National Parks

Principal Investigator: R. Pielke

Sponsor's #NA81RA-H-00001, Amendment 12, Item 10, 9/1/82 - 8/31/83

Papers

McNider, R.T., and R.A. Pielke, 1984: Numerical simulation of slope and mountain flows. J. Appl. Meteor. (submitted December 1983).

Ookouchi, Y., M. Segal, R.C. Kessler, and R.A. Pielke, 1984: Evaluation of soil moisture effects on the induction and modification of mesoscale circulations. Mon. Wea. Rev. (submitted December 1983).

Pielke, R.A., 1984: Mesoscale dynamics: Thermal and orographic mesoscale atmospheric systems - An essay. Chapter in the Joe Smagorinsky volume, Academic Press (to be submitted).

Project #5-31284

Intergovernmental Personnel Act -- NOAA, National Weather Service

Principal Investigator: M. Carter

Dates: 8/25/82 - 8/24/83

Papers

Baker, E.J., and T.M. Carter, 1984: The role of public information in public response to warnings. Third Conf. on Meteorology of the Coastal Zone, Amer. Meteor. Soc.

Carter, T.M., 1983: Probability of hurricane/tropical storm conditions: A user's guide for local decision makers. Cooperative Institute for Research in the Atmosphere, Colorado State University, Ft. Collins, CO, 25 pp.

George, D.H., and T.M. Carter, 1983: An automated warning data management system. Preprint Volume 13th Conf. on Severe Local Storms, Tulsa, Amer. Meteor. Soc., J19-J22.

Presentations

Carter, T.M., 1983: Results of the Minnesota Study relating to (a) emergency service agencies and (b) the general public. Presented at NWS Disaster Preparedness Conference, January 10-14, Fort Worth, TX.

Carter, T.M., 1983: Results of the Minnesota study relating to (a) emergency service agencies and (b) the general public. Presented to the Fort Worth Chapter of the AMS. (January 13)

Carter, T.M., 1983: Hallgren briefing. Presented to Southern and Eastern Region attendees of NWS Disaster Preparedness Conference (January 12).

Carter, T.M., 1982: Hurricane strike probabilities: Use and interpretation by local officials and the general public. Presented at Colorado State University, July 14, 1983, Ft. Collins, CO.

Project #5-31285

A Study of Park Visitors' Visibility, Related Behaviors and Their Relationship to Air Quality.

Principal Investigator: G. Haas

Sponsor's #NA81RA-H-00001, Amendment 13; 1/1/83 - 12/31/83.

Report

Ross, David M., Glenn E. Haas, and Ross J. Loomis, 1983: Study plan for a project entitled assessment of visibility impairment on visitor enjoyment and utilization of park resources. Submitted to Air Quality Division, National Park Service. Colorado State University, Ft. Collins, CO.

Project #5-31286

Air Quality Data Telemetry Assistance

Principal Investigators: N. Allen/T. Vonder Haar

Sponsor's #NA81RA-H-00001, Amendment 16, 3/1/83 - 3/31/84

No Papers, Reports or Presentations to date.

Project #5-31287

Identification of Visibility Impairment

Principal Investigators: G. Haas/R. Loomis

Sponsor's #NA81RA-H-00001, 5/1/83 - 4/30/84

No Papers, Reports or Presentations to date.

Project #5-31288

Atmospheric Transport Processes Affecting Visibility in National Parks
(Application of Long-Range Transport Model)

Principal Investigator: E. Reiter

Sponsor's #NA81RA-H-00001, 7/1/83 - 6/30/84

No Papers, Reports or Presentations to date.

Project #5-31289

Mesoscale Modeling

Principal Investigator: R. Pielke

Sponsor's #NA81RA-H-00001, 6/1/83 - 7/31/84

Papers

McNider, R.T., and R.A. Pielke, 1984: Numerical simulation of slope and mountain flows. J. Appl. Meteor. (submitted December 1983).

Ookouchi, Y., M. Segal, R.C. Kessler, and R.A. Pielke, 1984: Evaluation of soil moisture effects on the induction and modification of mesoscale circulations. Mon. Wea. Rev. (submitted December 1983).

Pielke, R.A., 1984: Mesoscale dynamics: Thermal and orographic mesoscale atmospheric systems - An essay. Chapter in the Joe Smagorinsky volume, Academic Press (to be submitted).

Project #5-31290

An Investigation of the Application of Monte Carlo Methods to Problems in Visibility

Principal Investigators: S. Cox/T. McKee

Sponsor's #NA81RA-H-00001, 7/1/83 - 6/30/84

No Papers, Reports or Presentations to date.

Project #5-31291

Ground Based Monitoring of Cloud Base & Cloud Optical Depth

Principal Investigator: S. Cox

Sponsor's #NA83AA-D-00063, 9/1/83 - 8/31/84

No Papers, Reports or Presentations to date.

Project #5-31292

Analysis of the Meso-B-Scale Structure of Mesoscale Convective Complexes

Principal Investigators: B. Cotton/R. McAnelly

Sponsor's #NA81RA-H-00001, Item 17, 9/1/83 - 1/31/84

Papers

Cotton, W.R., R.L. McAnnelly, and J.M. Schmidt, 1984: A multi-scale analysis of the development of a mesoscale convective complex. International Conf. on Mesoscale Meteorology, Melbourne, Australia, 6-10 February.

Reports

Cotton, W.R., R.L. McAnelly, and K.R. Knupp, 1984: Analysis of the meso-B-scale structure of mesoscale convective complexes. Report to WRP/NOAA. Cooperative Institute for Research in the Atmosphere, Colorado State Univesity, Ft. Collins, CO.

Project #5-31293

Supplemental Design Plans for the National Program of
Federal/State/Local Cooperative Weather Modification Research

Principal Investigator: L. Grant

Sponsor's #NA83RAC00088, 9/1/83 - 3/15/84

No Papers, Reports or Presentations to date.

Project #5-31295

Mesoscale Analysis and Forecast Product Development for Severe Storm Nowcasting

Principal Investigators: J. Purdom/T. Vonder Haar

Sponsor's #NA84AA-D-00017, 2/1/84 - 1/30/85

No Papers, Reports or Presentations to date.

Project #5-31995

Investigations of Severe/Tornadic Thunderstorm Development and Evolution Based on Satellite and AVE/SESAME/VAS Data

Principal Investigators: J. Purdom/T. Vonder Haar

Sponsor's #NAGW-504, 9/1/83 - 8/31/84

No Papers, Reports or Presentations to date.

Project #5-36090

An Investigation of the Application of Monte Carlo Method to Problems in Visibility

Principal Investigators: S. Cox/T. McKee

Sponsor: John Muir Institute, 8/24/82 - 6/30/83

Reports

Davis, J., T. McKee, and S. Cox, 1983: An investigation of the application on Monte Carlo. Final Report (September). Cooperative Institute for Research in the Atmosphere, Colorado State University, Ft. Collins, CO.

Project #5-36091

Development of Psychological Indicators of Visual Quality Judgments

Principal Investigator: R. Loomis

Sponsor: John Muir Institute, 8/24/82 - 6/30/83

Reports

Bell, P.A., R.J. Loomis, W. Malm, M. Kiphart, and G.E. McGlothin, 1983: A utility model for predicting visitor response to national park attributes: Vista visibility, driving time, and waiting time. Cooperative Institute for Research in the Atmosphere, Colorado State University, Ft. Collins, CO.

Bell, P.A., R.J. Loomis, W. Malm, and G.E. McGlothin, 1983: Test of an ordered logit model of the impact of impaired visibility on visitor enjoyment of the Grand Canyon. Final Report. Cooperative Institute for Research in the Atmosphere, Colorado State University, Ft. Collins, CO.

Loomis, R.J., H.A. Cross, M. Kiphart, J. Molenar, and W. Malm, 1983: Perceptual sensitivity to pictorial representations of layered haze. Cooperative Institute for Research in the Atmosphere, Colorado State University, Ft. Collins, CO.

Project 5-36092

Atmospheric Transport Processes Affecting Visibility in National Parks

Principal Investigator: E. Reiter

Sponsor. John Muir Institute, 8/24/82 - 6/30/83

Reports

Reiter, E.R., J.D. Sheaffer, and J. Bresch, 1983: Atmospheric transport processes affecting visibility in national parks. Final Report to John Muir Institute for Environmental Studies.

Project 5-36093

Statistical Reduction and Analysis of Visibility-related Data and Statistical Modeling of Visibility-related Variables and Processes

Principal Investigator: W. Sadeh

Sponsor: John Muir Institute, 8/24/82 - 6/30/83

No Papers, Reports or Presentations to date.

NOAA/NESDIS/RAMM Branch

Papers

Caracena, F., R.A. Maddox, J.F.W. Purdom, J.F. Weaver, and R.N. Green, 1983: Multi-scale analyses of meteorological conditions affecting Pan American World Airways Flight 759. NOAA/ERL, Boulder, CO and NOAA/NESDIS, Ft. Collins, CO, 53 pp.

Green, Robert N., 1980: Global weather experiment data from the National Environmental Satellite Service. Bul. Am. Meteor. Soc., 61(10), October 1980.

Green, Robert N., and Melanie A. Kruidenier, 1982: Interactive data processing for mesoscale forecasting applications. Preprints, 9th Conference on Weather Forecasting and Analysis, June 28-July 1, 1982, Seattle, WA, AMS, Boston, MA.

Green, R.N., and H.A. Parker, 1983: Application of satellite and radar data to severe thunderstorm analysis. Preprints 13th Conf. on Severe Local Storms, Tulsa, Amer. Meteor. Soc.

Johnson, R.H., G.S. Young, J.J. Toth, and R.M. Zehr, 1984: Mesoscale weather effects of variable snow cover over northeast Colorado (submitted to Mon. Wea. Rev.).

McBride, John L., and Raymond Zehr, 1981: Observational analysis of tropical cyclone formation. Part II: Comparison of non-developing versus development systems. J. of Atmos Sc., 38(6), June 1981.

Purdom, J., 1981: Combining satellite and conventional data for very short range forecasting purposes. Proceedings, IAMAP Symposium, August 25-28, 1981, Hamburg.

Purdom, James F.W., 1982: Subjective interpretation of geostationary satellite data for nowcasting. Chapter 3.1 from Nowcasting (K.A. Browning, Ed.), Academic Press Inc. (London) Limited.

Purdom, J.F.W., 1982: Summary Report: Satellite Facilities Committee. Proceedings: Sixth Annual Workshop on Meteorological and Environmental Inputs to Aviation Systems. October 26-28, University of Tennessee Space Institute, Tullahoma, TN.

Purdom, J.F.W., 1983: Diagnosing the mesoscale state of the atmosphere using satellite data. Preprints 13th Conf. on Severe Local Storms, Tulsa, Amer. Meteor. Soc.

Purdom, J.F.W., 1984: Using satellite imagery for short range forecasting. Preprints International Conference on Mesoscale Meteorology, Melbourne, Australia, February 6-10.

Purdom, James F.W., and John F. Weaver, 1982: Nowcasting during the 10 April 1979 tornado outbreak: A satellite perspective. Preprints, 12th Conference on Severe Local Storms, January 11-15, 1982, San Antonio, TX, AMS, Boston, MA.

Purdom, James F.W., and Kevin Marcus, 1982: Thunderstorm trigger mechanisms over the southeast United States. Preprints, 12th Conference on Severe Local Storms, January 11-15, 1982, San Antonio, TX, AMS, Boston, MA.

Purdom, J.F.W., and T.H. Vonder Haar, 1983: Product user's guide, enhancing GOES infrared imagery for nowcast applications. Cooperative Institute for Research in the Atmosphere, Colorado State University, Ft. Collins, CO, 21 pp.

Purdom, James F.W., Robert N. Green and Hugh A. Parker, 1982: Integration of satellite and radar data for short range forecasting and storm diagnostic studies. Preprints, 9th Conference on Weather Forecasting and Analysis, June 28-July 1, 1982, Seattle, WA, AMS, Boston, MA.

Purdom, J.F.W., J.F. Weaver and R.N. Green, 1983: Analysis of rapid interval GOES data for the 9 July 1982 New Orleans airline crash. Preprint Volume, Ninth Conference on Aerospace and Aeronautical Meteorology, June 6-9, 1983, Omaha, NE, AMS, Boston, MA.

Sinclair, P.C. and James F.W. Purdom, 1982: Integration of research aircraft and 3 minute interval GOES data to study the genesis and development of deep convective storms. Preprints, 12th Conference on Severe Local Storms, January 11-15, 1982, San Antonio, TX, AMS, Boston, MA.

Sinclair, P.C., and J.F.W. Purdom, 1983: The genesis and development of deep convective storms. Final report on Contract NA80AA-D-00056, ISSN 0737-5352, CIRA Paper No. 1. Cooperative Institute for Research in the Atmosphere, Colorado State University, Ft. Collins, CO.

Sinclair, P.C., and J.F.W. Purdom, 1983: Shuttle recovery requirements and the development of arc cloud lines from thunderstorm outflows. Preprint Volume, Ninth Conference on Aerospace and Aeronautical Meteorology, June 6-9, 1983, Omaha, NE, AMS, Boston, MA.

Weaver, John F., and Frank P. Kelly, 1982: A mesoscale, climatologically-based forecast technique for Colorado. Preprints, 9th Conference on Weather Forecasting and Analysis, June 28-July 1, 1982, Seattle, WA, AMS, Boston, MA.

Weaver, John F., and Stephan P. Nelson, 1982: Multiscale aspects of thunderstorm gust fronts and their effects on subsequent storm development, Mon. Wea. Rev., 110(7).

Weaver, John F., and John M. Brown, 1982: Forecasting an unusual weather event in Colorado: 15 October 1980. Bul. Am. Meteor. Soc., 63(10), October 1982.

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Zehr, R.M., 1981: Combining satellite, radar, and conventional data to observe mesoscale features pertinent to thunderstorm development, NOAA/NESS/RAMM Branch, Colorado State University, Ft. Collins, CO.

Zehr, Raymond M., 1982: Thunderstorm motion analyses. Preprints, 9th Conference on Weather Forecasting and Analysis, June 28-July 1,1982, Seattle, WA, AMS, Boston, MA.

Zehr, R.M., 1983: Case studies of three severe thunderstorm events in eastern Colorado. Preprints 13th Conf. on Severe Local Storms, Tulsa, Amer. Meteor. Soc.

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Zehr, Raymond M., and James F.W. Purdom, 1982: Examples of a wide variety of thunderstorm propagation mechanisms. Preprints, 12th Conference on Severe Local Storms, January 11-15, 1982, San Antonio, TX, AMS, Boston, MA.

Films

Purdom, James F.W., 1981: The importance of thunderstorm outflow boundaries in the development of deep convection. WAB 456, 29 minutes (sound film), The Walter A. Bohan Company, Park Ridge, IL.

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Green, Robert N., and Melanie A. Kruidenier, 1982: Interactive data processing for mesoscale forecasting applications. Presented at the 9th Conference on Weather Forecasting and Analysis (by M. Kruidenier), June 28-July 1, 1982, Seattle, WA, AMS, Boston, MA.

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Purdom, James F.W., 1981. Forecasting severe storms using satellite image data. Presented at the National Weather Service Central Region (by J. Purdom), February 6, Kansas City, MO.

Purdom, James F.W., 1981: Training seminars on using satellite data for severe storm forecasting and isolation of tornado threat areas. Presented to U.S.A.F. Offutt AFB (by J. Purdom), 2 sessions: February 9-11, February 11-13, Offutt AFB, NE.

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Purdom, James F.W., 1981: Satellite image analysis for meteorological understanding. Presented to Northern Illinois University (by J. Purdom), March 19, DeKalb, IL.

Purdom, James F.W., 1981: Satellite observations of tornadic storms. Presented at Joint Meteorology and SSEC Colloquium (by J. Purdom), June 5, University of Wisconsin, Madison, WI.

Purdom, James F.W., 1981: New thoughts on tornado genesis from combining satellite and conventional radar data. Presented at IGRSS Conference (by J. Purdom), June 9, Washington, DC.

Purdom, James F.W., 1981: Using satellite and radar data to understand the mechanisms of tornado genesis. Presented at NASA/GSFC/Goddard Laboratory for Atmospheric Science (by J. Purdom), June 10, Greenbelt, MD.

Purdom, James F.W., 1981. Understanding thunderstorm development and tornado genesis using satellite data. Presented to NESS (by J. Purdom), June 11, Washington, DC.

Purdom, James F.W., 1981: Uses of satellite imagery for mesoscale analysis and nowcasting. Training sessions presented to PROFS/ERL (by J. Purdom), July 27-29, Boulder, CO.

Purdom, James F.W., 1981: Uses of rapid scan satellite data for downburst analyses. Presented to NCAR (by J. Purdom), November 17, Boulder, CO.

Purdom, James F.W., 1981: Using satellite and radar data to better understand and nowcast tornadic storms. Presented at Joint Meteorology and SSEC Coloquium (by J. Purdom), December 6, University of Wisconsin, Madison, MI.

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Purdom, James F.W., 1982: The development and evolution of deep convection--Using satellite data to nowcast tornadoes. Presented to U.S.A.F. (by J. Purdom), two sessions: April 5-7, April 7-9, Offutt AFB, NE.

Purdom, James F.W., 1982: Convective scale interaction and its implications for weather modification. Presented to North Dakota Weather Modification Board (by J. Purdom), May 11, Bismarck, ND.

Purdom, James F.W., 1982: Satellite data and NWS operational needs. Presented to ERL/NWS Technical Exchange Conference (by J. Purdom), May 13, Estes Park, CO.

Purdom, James F.W., 1982: The development and evolution of deep convection. Presented in Atmospheric Science Seminar Series (by J. Purdom), May 27, Colorado State University, Ft. Collins, CO.

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Purdom, James F.W., 1982: Mesoscale interpretation of satellite imagery. Presented at Workshop in Satellite Meteorology (by J. Purdom), July 21, Colorado State University, Ft. Collins, CO.

Purdom, James F.W., and Kevin Marcus, 1982: Thunderstorm trigger mechanisms over the southeast United States. Presented at the 12th Conference on Severe Local Storms (by J. Purdom), January 11-15, San Antonio, TX, AMS, Boston, MA.

Purdom, J.F.W., 1984: Using satellite imagery for short range forecasting. Presented at the International Conference on Mesoscale Meteorology, Melbourne, Australia, February 6-10.

Purdom, James F.W., and John F. Weaver, 1982: Nowcasting during the 10 April 1979 tornado outbreak: A satellite perspective. Presented at the 12th Conference on Severe Local Storms (by J. Purdom), January 11-15, San Antonio, TX, AMS, Boston, MA.

Purdom, James F.W., Robert N. Green and Hugh H. Parker, 1982: Integration of satellite and radar data for short range forecasting and storm diagnostic studies. Presented at the 9th Conference on Weather Forecasting and Analysis (by J. Purdom), June 28-July 1, Seattle, WA, AMS, Boston, MA.

Purdom, James F.W., 1982: Satellite data applications for short range forecasting. Presented to NESS (by J. Purdom), September 13, Washington, DC.

Purdom, James F.W., 1982: Uses of rapid scan satellite data in understanding and forecasting storm development presented to NESS (by J. Purdom), September 14, Wallops Island, VA.

Purdom, James F.W., 1982: Satellite data as a tool in understanding thunderstorm development and evolution. Presented to Office of the Federal Coordinator for Meteorological Services (by J. Purdom), September 16, Rockville, MD.

Purdom, James F.W., 1982: Using satellite data to understand the development and evolution of deep convection. Presented at the Headquarters NOAA/RD Seminar (by J. Purdom), September 16, Rockville, MD.

Purdom, J., 1983: Tornadoes - Why some storms have them and others don't. Presented at University of Wisconsin (by J. Purdom), February 8, Madison WI.

Purdom, J., 1983: Development of tornadoes in severe thunderstorms. Presented at NOAA/NESDIS (by J. Purdom), February 9, Washington, D.C.

Purdom, J., 1983. Uses of satellite data for mesoanalysis and short range forecasting. Presented at AMS Chapter Meeting, March 1, Omaha, NE.

Purdom, J., and J. Weaver, 1983: Satellite training workshop for severe weather applications. Presented at Offutt AFB (by J. Purdom and J. Weaver), February 28 - March 4, Omaha, NE.

Purdom, J., 1983: Rapid scan data uses in nowcasting convective development. Presented at PROFS/ERL (by J. Purdom), March 16, Boulder, CO.

Purdom, J., 1983: Satellite imagery interpretation and its uses for severe storm analysis. Presented at the University of Wyoming (by J. Purdom), May 11, Laramie, WY.

Purdom, J., R. Green, J. Weaver, and R. Zehr, 1983: Short range forecasting techniques using satellite data. Presented at PROFS/ERL (by J. Purdom), May 26, Boulder, CO.

Purdom, J., J. Weaver, and R. Green, 1983: Analysis of rapid interval GOES data for the 9 July 1982 New Orleans Airliner Crash. Presented at the Ninth Conference on Aerospace and Aeronautical Meteorology (by J. Purdom), June 6-9, Omaha, NE.

Purdom, J., 1983: Satellite data for short range weather forecasting. Presented at Cape Kennedy AMS Chapter, June 22, Orlando, FL.

Purdom, J., and R. Zehr, 1983: Satellite training workshop. Presented at Patrick AFB (by J. Purdom and R. Zehr), June 27 - July 1, Patrick AFB, FL.

Purdom, J., 1983: Satellite nowcasting. Presented at the WMO Workshop on Very Short-range Forecasting Systems Research Aspects (by J. Purdom), August 15-17, Boulder, CO.

Purdom, J., and P. Sinclair, 1983: A review of the 1983 Aircraft Flight Program conducted to study arc cloud lines. Presented at NASA, August 31, Marshall Space Flight Center.

Sinclair, P.C., and James F.W. Purdom, 1982. Integration of research aircraft and 3 minute interval GOES data to study the genesis and development of deep convective storms. Presented at the 12th Conference on Severe Local Storms (by J. Purdom), January 11-15, San Antonio, TX, AMS, Boston, MA.

Weaver, John F., 1981: Using satellite and conventional data for severe storm environment forecasting. Presented to PROFS/ERL (by J. Weaver), July 29, Boulder, CO.

Weaver, John F., 1982: Severe weather spotting. Presented to University of Northern Colorado (by J. Weaver), April 23, Greeley, CO.

Weaver, John F., 1982: How to recognize severe weather from the ground. C.S.U. Campus Police Training Lecture (by J. Weaver), June 9, Colorado State University, Ft. Collins, CO.

Weaver, John F., 1982: Satellite orbits. Presented at Workshop in Satellite Meteorology (by J. Weaver), July 19, Colorado State University, Ft. Collins, CO.

Weaver, John F., 1983: Results from the 1982 satellite compositing study (by J. Weaver), May 3, Colorado State University, Ft. Collins, CO.

Weaver, J.F., 1983: Interactive processing systems used for PROFS applications by NESDIS/RAMM. Presented at the University of Wyoming (by J. Weaver), March 18, Laramie, WY.

Weaver, J.F., 1983: Results from the 1982 satellite compositing study. Presented at Colorado State University (by J. Weaver), May 3, Ft. Collins, CO.

Weaver, J.F., 1983: Tornadoes and severe thunderstorms: Visual interpretation and chasing. American Meteorological Meeting, October 10, Colorado State University, Ft. Collins, CO.

Weaver, John F., and Frank P. Kelly, 1982: A mesoscale, climatologically-based forecast technique for Colorado. Presented at the 9th Conference on Weather Forecasting and Analysis (by J. Purdom), June 28-July 1, Seattle, WA, AMS, Boston, MA.

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"Research on Weather and Climate Applications at CSU" - A Review

The first workshop covering "Research on Weather and Climate Applications at CSU" was organized by CIRA in 1983, as a means of bringing together the University faculty to discuss multidisciplinary studies related to atmospheric science. Under joint sponsorship by CIRA and CSU's Office of the Vice President for Research, three days of meetings were held during September at the Pingree Park Campus.

Thirty-seven scientists from several CSU departments and affiliated agencies participated in the conference and presented the scope of recent research. Sessions of invited presentations focused on the following:

1. Instrumentation, facilities and techniques in use at CSU for atmospheric studies; including analysis programs employing radar, laser, satellites, aircraft, ground-based instrumentation and laboratory measurements.
2. Applications of related fields to meteorological research; in particular, the contribution of advanced statistical, mathematical, and engineering principles to field studies and theoretical investigations.
3. Meteorological components which are often critical to include in research under the disciplines of forestry, water/air resources management, agriculture, microbiology, and others.

Five sessions of discussion in small groups were also helpful in emphasizing the commonality of theoretical tools and operational requirements needed in the various studies. Topics for these discussions included the resource management concerns within Colorado, transfer of research results outside the University, working arrangements with other institutions, anticipated requirements for facilities and technical/scientific personnel, and the graduate-level education opportunities in atmospheric science at CSU.

The workshop provided a stronger basis for interaction among the participants, and led to fruitful exchange of ideas and suggestions. Both the discussion and presentation sessions have been described in the "Summary Report for CIRA Workshop, Research on Weather and Climate Applications at CSU" by Melanie Kruidenier which is available from the CIRA office. This type of conference is planned yearly to promote collaboration among the CSU faculty and with agency scientists.

EXPANDED REPORTS - A SELECTION

DEVELOPMENT OF PSYCHOLOGICAL INDICATORS FOR ASSESSMENT OF VISIBILITY

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NA81RA-H-00001, 5/1/83 - 6/9/84

ABSTRACT

Initial laboratory studies of observer sensitivity to varied intensities of haze revealed differential levels of performance at detecting haze presence as assessed by a procedure based on Signal Detection Theory. Observers easily detected haze in computer-generated 35 mm slide stimuli at green contrast levels between -.10 to -.30. Detection of haze significantly declined at contrast levels below -.10 and should approach chance levels of detection at intensities with green contrast readings of less than -.01. Under controlled levels of laboratory-based assessment, human observers are very sensitive to the presence of layered haze in slide presentations of a national park vista scene. A second indicator measured observer awareness of haze in scenic vistas and used interviews of visitors at three vista sites in Grand Canyon National Park. Preliminary evidence suggests a definite relationship between visibility as measured by Standard Visual Range (SVR) and visitor reports of haze present as measured by an interview question. Awareness of haze increases as Standard Visual Range decreases.

An Indicator of Visual Sensitivity to Layered Haze

One very basic question that can be investigated is how sensitive the human eye is to the presence of layered haze in a vista scene. An optimal procedure for answering this question is to test subjects under controlled laboratory conditions with stimuli that contain well-defined levels of layered haze. A computer-generated process for creating 35 mm slides with controlled levels of haze intensities has been developed and provided stimuli for measuring visual sensitivity. Many procedures exist for assessing human sensory detection of some physical stimulus set. To develop an indicator of sensitivity for the present research, a procedure based on Signal Detection Theory was employed with a clear scenic view treated as the noise condition and layered haze present in the slide picture serving as the signal plus noise condition. The stimulus magnitude for intensity of layered haze was measured in green contrast values and ranged for a set of eight slides haze intensities from readings of -.016 to -.28.

In an initial experiment, a small sample of subjects (N=4) viewed an equal number of clear or standard slides in twice daily testing sessions for a five day period. This design, which uses an intensive testing procedure on a few subjects, is commonly used to determine sensory limits or thresholds. Subjects answered "yes" if they thought haze was present, and "no" for the clear condition. A sensitivity index (d') that indicates how well subjects could discriminate between distributions of clear slides and distributions of haze (signal) slides was used as one dependent variable. Mean d' calculated across the four subjects for the eight haze intensity levels are displayed in Figure 1. As would be expected, sensitivity decreased with lower intensity levels and subjects had more difficulty discriminating between clear and haze slides. A significant difference occurred in d' across the eight intensities ($F(7,21) = 2.94$, $p<.05$), with the major difference showing up between the lowest contrast rating (Green contrast = -.016) and the sixth highest contrast rating (Green contrast = -.19). An interesting afterimage effect happened at the highest intensity levels. Subjects reported an afterimage after viewing the intense haze layers. This afterimage could account for the drop in d' at the two highest intensity levels.

Another dependent measure of observer performance is the percentage of "hits" or correct detections of haze condition slides. Subjects showed a significant decline in hits for lower haze intensity slides ($F(7,21) = 2.61$, $p<.05$) as shown in Figure 2. As can be seen from examining the figure, a major change in hit rates occurs between the lowest and all other haze levels. This finding was supported by performing a Newman-Keuls *post hoc* test which revealed that the mean number of hits at the -.016 contrast level was significantly less than at all other levels. No other mean comparisons were significant. No difference was found in "false alarms" or false positive reporting of haze in clear slides grouped with the eight levels of haze slides.

The fact that hits declined significantly for the lowest haze intensity suggests that level may be approaching threshold or a point of minimal sensitivity. It is important to note that subjects performed well (i.e., correctly detected haze when it was present and avoided false alarms on clear slides) across all levels. Average performance was nearly 70% hits even in the lowest haze intensity condition. Considerable individual variation did occur in the lowest intensity condition as shown in Figure 3. Hit rates are plotted against false alarm rates for each subject in the two extreme haze conditions; that of

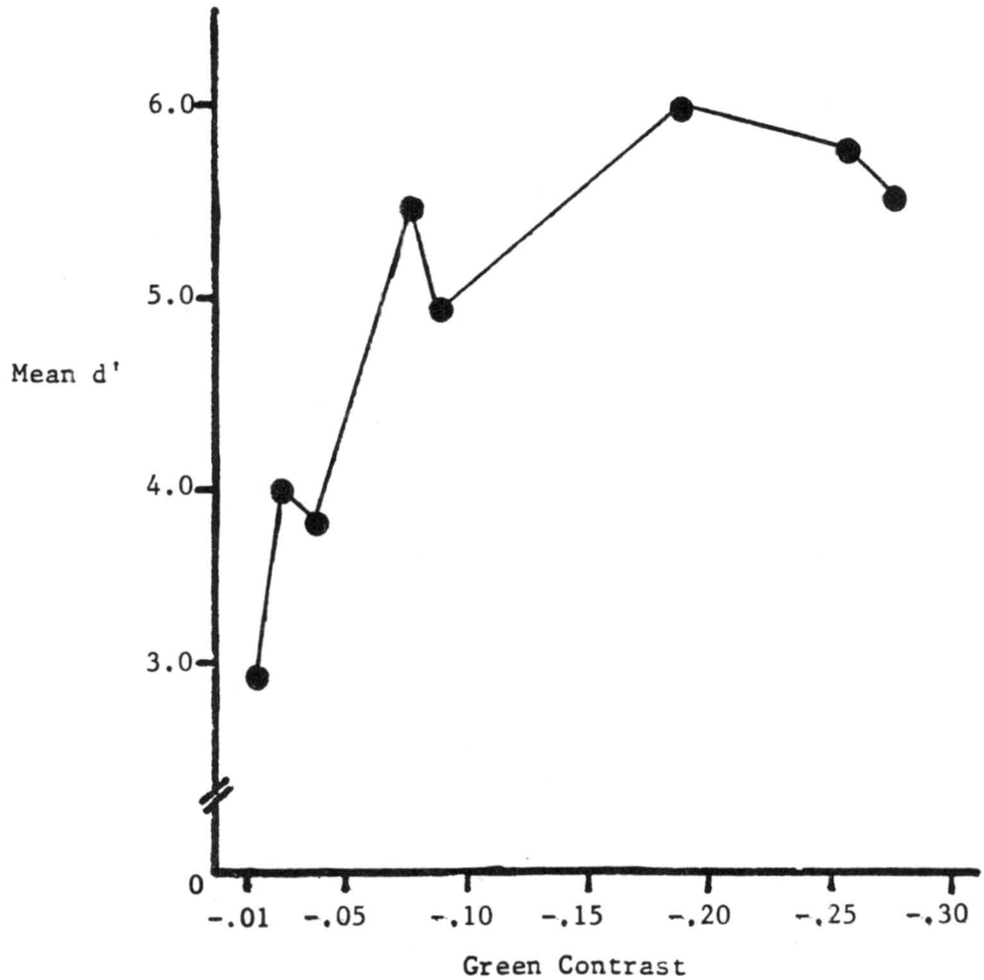

Figure 1. Mean d' sensitivity values for eight intensities (Green Contrast) of layered haze pictured in 35 mm slides.

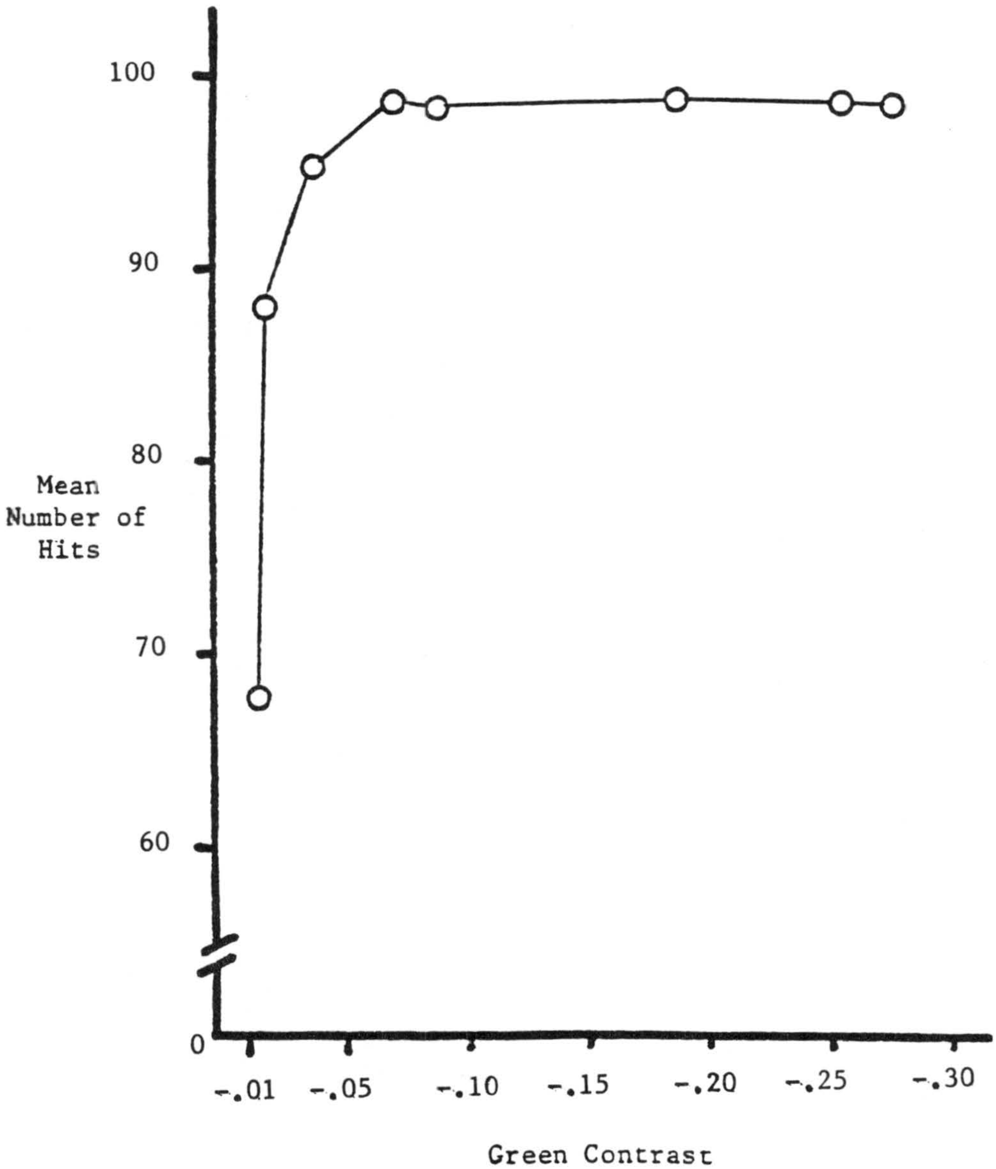

Figure 2. Mean hit rates for eight layered haze intensities (Green Contrast) pictured in 35 mm slides.

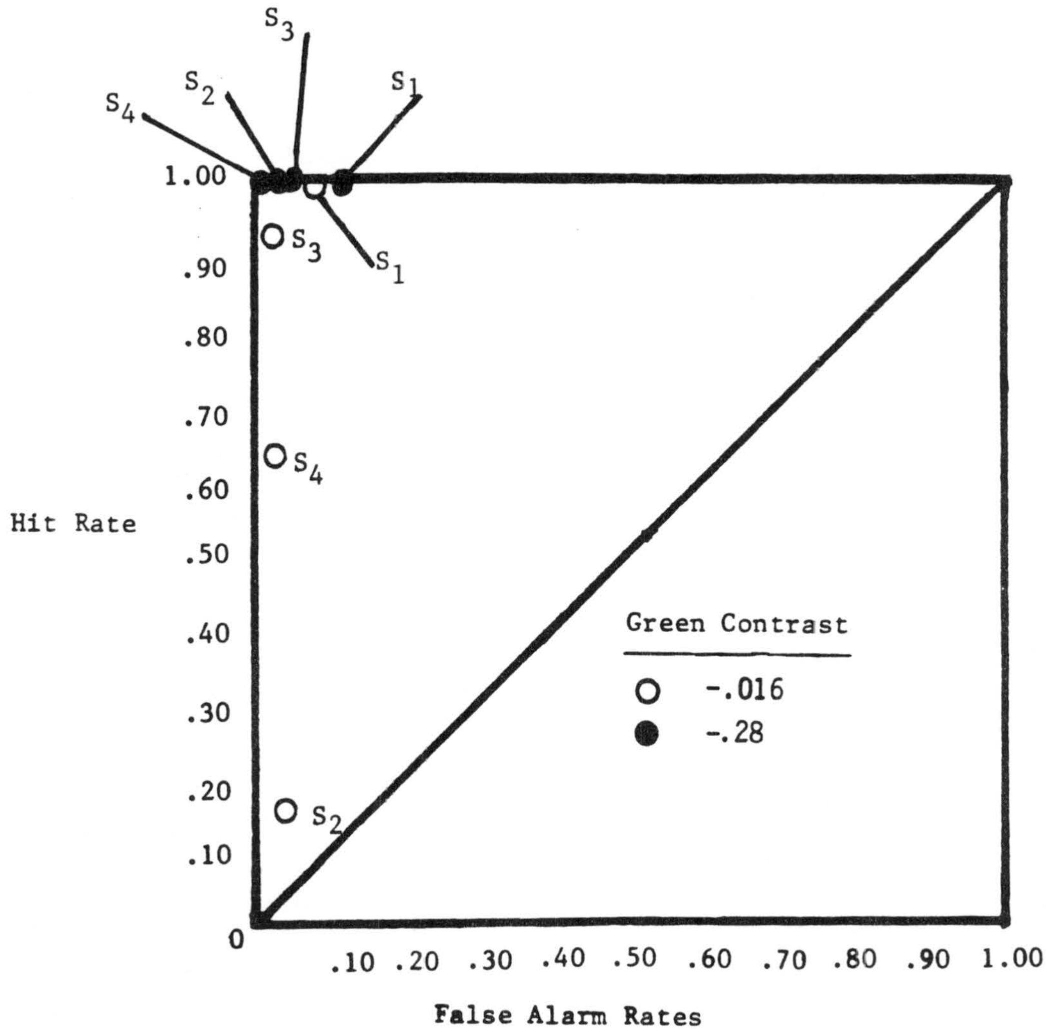

Figure 3. Individual (N = 4) hit rates and false alarm rates for highest and lowest haze intensity (Green Contrast) slides.

-.016 contrast or the lightest intensity and that of -.28 contrast or heaviest haze level. As seen in Figure 3, all four subjects correctly detected haze in all presentations for the highest intensity level, but subject #2 performed well below a fifty-percent level of hits in the lowest intensity condition and two other subjects dropped under their levels for the highest haze intensity conditions. The current lowest levels of haze intensities are not weak enough to exhaust subject performance at the detection task.

A second experiment (N=8) using the four lowest intensity slides from the first experiment replicated the d' and hit rate results from the first experiment. Subjects had more difficulty detecting the weaker haze stimuli, but still performed at above fifty percent levels of detection. A third experiment currently in progress uses new slides with haze intensities with contrast levels below -.016 and should exhaust observer ability to detect haze present in the scenic slides.

An obvious qualification to this work on sensitivity is that it is laboratory based, as opposed to using on-site observer assessments, and the stimuli used are 35 mm slides with computer-generated haze conditions. There is, however, some evidence for fairly high consistency between on-site and photographic slide based assessments (for example, see Steward, Middleton, Downton and Ely, 1983). To get an estimate of on-site park visitor awareness of haze detectable in a scenic view, a second psychological indicator based on field interviews has been developed.

An Indicator of Park Visitor Awareness of Haze

A sample (N=1,766) of visitors to the Grand Canyon National Park during the summer of 1983 were asked whether or not there was haze present at vista viewpoints. Those visitors who were aware of haze present were asked to rate the haze level on a four point scale that ranged from slightly to extremely hazy. The haze awareness questions were part of a more extensive visitor survey (see Ross, Haas and Loomis, 1983).

Subgroups of visitors who reported (1) no haze, (2) rated haze as slight or moderate, or (3) assigned an extreme rating for presence of haze were randomly drawn from the total sample of interviews and the grouped haze ratings plotted against Standard Visual Range (SVR) data. Daily estimates of the SVR were provided through a regular air quality monitoring program at the park and/or could be estimated from 35 mm slides taken at the time of each interview. Figure 4 shows the mean haze awareness responses and the corresponding 95 percent confidence intervals for the grouped awareness scores across four different ranges of SVR which represent equal changes in contrast. Examination of Figure 4 reveals that the visitors' reported awareness of haze increased as visibility (SVR) decreased. With the exception of the third SVR range (151-211 km), all of the 95 percent confidence intervals of the grouped haze rating data were outside of each other for the SVR ranges.

Outcomes from other analyses also suggest a relationship between the variables of interview haze ratings and SVR. Results of a regression analysis revealed a significant relationship between the two variables and showed that awareness of haze could be accurately predicted by SVR. In addition, a negative correlation ($r = -.13$, $\underline{p} = .001$) was obtained between SVR and haze ratings for the interview sample as a whole.

The two indicators briefly described in this summary, sensitivity for layered haze related to contrast coefficients and visitor awareness of haze related to contrast coefficients and visitor awareness of haze

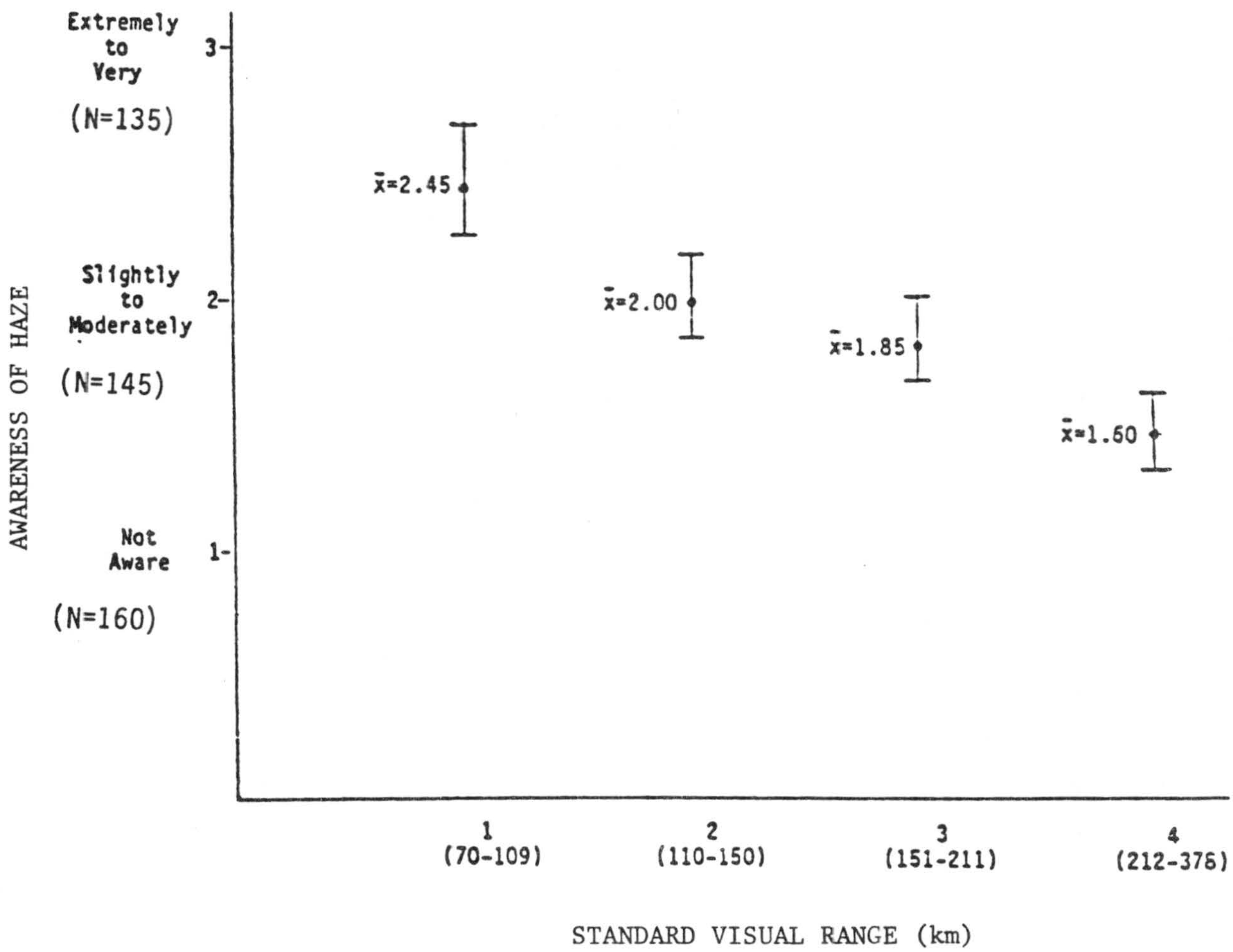

Figure 4. Visitor awareness of haze mean scores and 95 percent confidence intervals for categories of Standard Visual Range which represent equal interval changes in contrast.

related to Standard Visual Range, show promise of providing reliable ways of documenting how people perceive visibility and changes in visual quality of scenic views in National Parks. However, these indicators need to be refined and results replicated. Other indicators of human perception and reaction to visibility are being developed as part of the total project and include (1) creation of a field observer protocol for rating specific visual attributes of layered and uniform haze, (2) assessment of impacts of awareness of haze on visitor enjoyment of a park setting, and (3) testing of an ordered Logit model of the impact of different visibility levels on visitor decision making about effort expended to use park attributes (see Bell, Loomis, Malm and McGlothlin, 1983).

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ATMOSPHERIC TRANSPORT PROCESSES AFFECTING VISIBILITY IN NATIONAL PARKS

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NA81RA-H-00001

7/1/83 - 6/30/84

Determining the effects of long-range pollutant transport upon visual air quality in Class I areas has become a research goal of the National Park Service. To attain this goal, research has proceeded along two pathways. First, development and refinement of long-range transport models which are suitable for use in the western United States is taking place. Second, case studies of pollutant episodes at various national parks are being conducted in order to specify the meteorological conditions responsible for high sulfur and low visibility episodes.

1. Development, Refinement and Application of a Long-Range Transport Model.

Dispersion by wind shear has been found to dominate turbulent diffusion for long travel times (Saffman, 1962; Tyldesley and Wallington, 1965). A model that simulates the effect of vertical wind shear was developed by Air Resources Laboratories (Draxler and Taylor, 1982; Draxler, 1982a, 1982b). This model was modified for the present study and is called Colorado State University's Long-Range Multilayer Atmospheric Transport (CSU-LORMAT) model. LORMAT is a simple Lagrangian puff trajectory model which calculates eight backward trajectories per day of up to 72 hours duration originating from a single site. LORMAT simulates the effect of wind shear by splitting the daytime mixed layer into a maximum of four sublayers at night. During the daytime, lateral puff spread is minimal due to the presence of induced vertical mixing and consequent absence of wind shear. An examination of many southwestern United States temperature soundings from the summer months showed afternoon mixing heights often reaching or exceeding 5000 m above the terrain. Therefore, the model top was placed at 5000 m. At night, with the absence of vertical mixing, the daytime mixed layer separates into stratified divergent layers with the potential for large lateral spread. The four model layers are decoupled from each other and are advected by separate winds.

Examples of spatial probability maps generated using a technique developed by Ashbaugh et al. (1983) are shown in Figures 1 and 2. Figure 1 is the residence time probability for trajectories arriving at the Grand Canyon during the period September 1980 to August 1981. It can be seen that the predominant wind flow is from the southwest of the Grand Canyon. Figure 2 is the high concentration conditional probability density function. It represents the percentage of time that a parcel which resides over a geographic location will arrive at the Grand Canyon with a fine sulfur concentration >372 ng/m^3. High probability areas include the southern Arizona and New Mexico smelter regions and central California. Other parks will be examined in the future.

2. National Park Service Data Base Development.

In cooperation with other projects conducting National Park Service research, this project has been involved in the development of two data bases. The first data base, which archives the NAMER-WINDTEMP data (Childs et al., 1983a) was developed to increase the efficiency of long-range transport models such as ATAD (Heffter, 1980) and LORMAT on the CSU Cyber computer. The second data base, still in development, will be used to archive all National Park Service environmental data, including

Figure 1: OVERALL RESIDENCE TIME
SEPTEMBER 1980 - AUGUST 1981
GRAND CANYON, AZ.

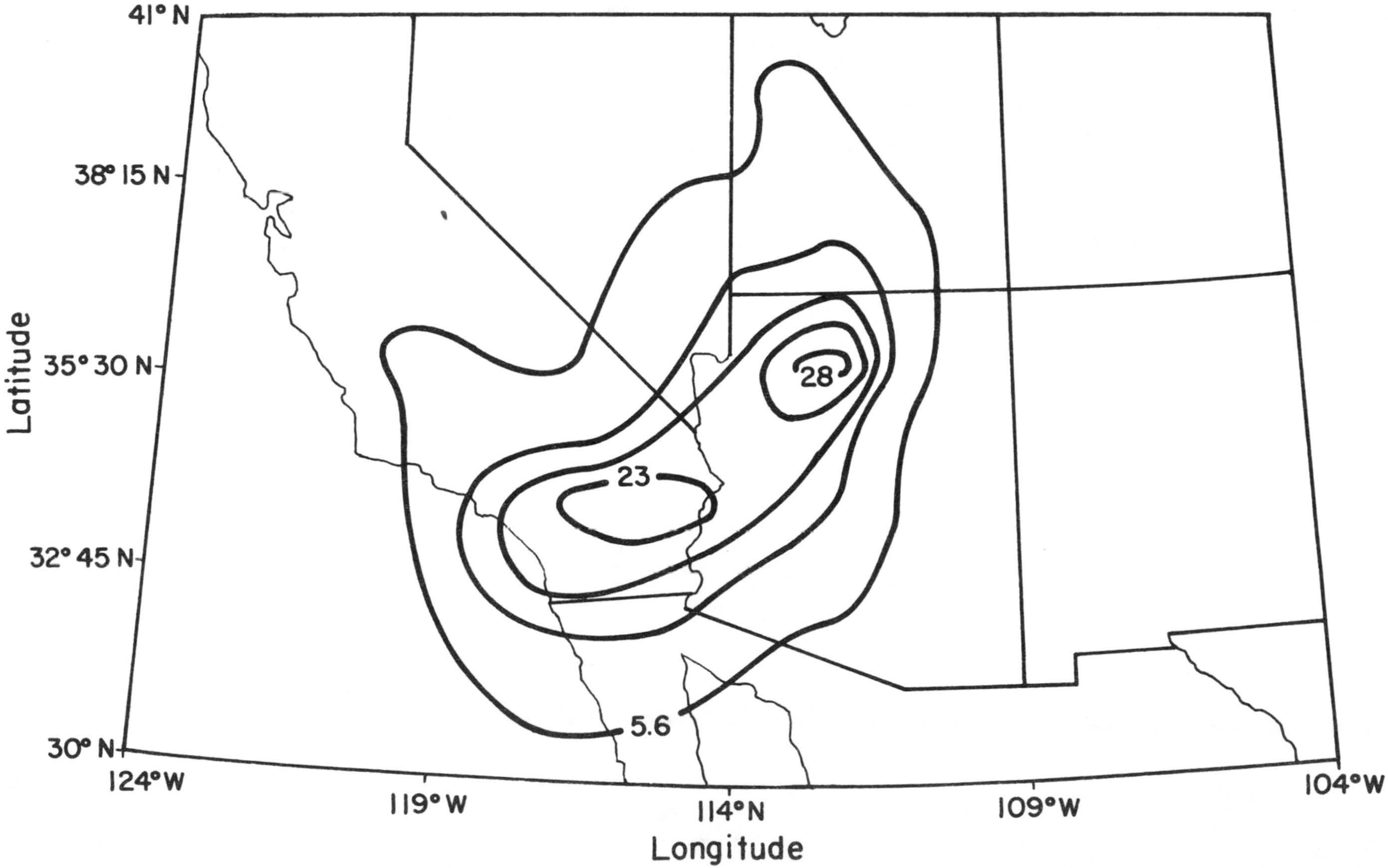
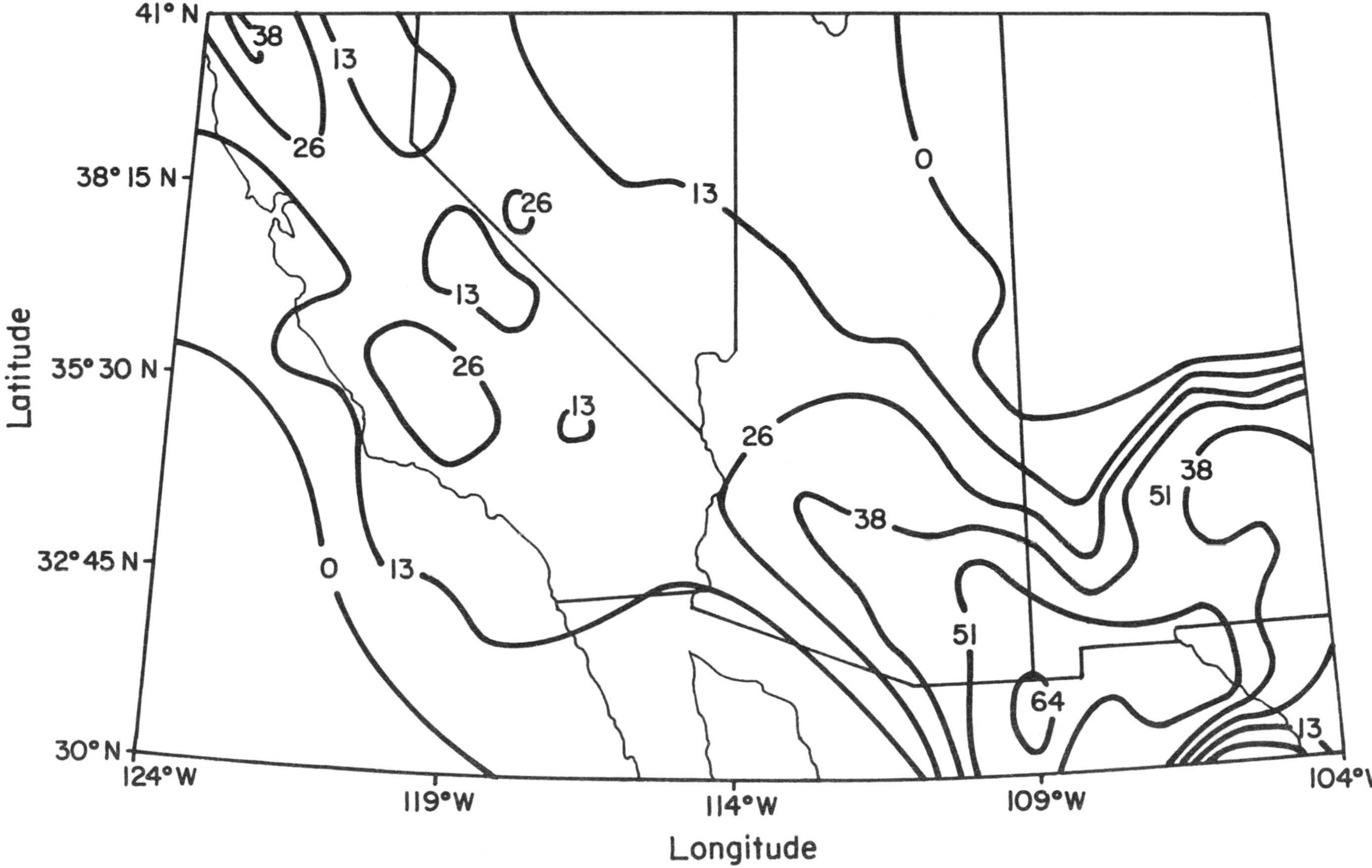


Figure 2: HIGH CONCENTRATION CONDITIONAL PROBABILITY
SEPTEMBER 1980–AUGUST 1981
GRAND CANYON, AZ.



visibility, particulate, and surface meteorological data (Childs et al., 1983b).

3. Case Studies of Meteorological Conditions Associated with Regional Scale Episodes of High Sulfur Concentrations.

Episodes of high sulfur concentrations were identified over two different regions: Arizona and New Mexico, and North and South Dakota. The atmospheric concentration data of various elements obtained from the Western Fine Particle Network (WFPN) stations were used to identify the episodes. The network covered the states of North Dakota, South Dakota, Montana, Wyoming, Colorado, Utah, Arizona and New Mexico.

(a) Arizona and New Mexico Regional Episode.

In September, 1979, the stations in Arizona and New Mexico recorded high sulfur concentrations throughout the month. The major sulfur sources over this region are copper smelters located in the southern Arizona area.

According to the temperature sounding records at Tucson and Winslow, Arizona, the atmosphere during the day was unstable near the surface and neutral up to about 5000 m above the terrain throughout the period, indicating that a very strong vertical mixing process took place over the region.

Monthly-average wind fields of four different layers over the area between 30° and 41°N, and between 104° and 124°N were calculated for September, 1979. The wind vector fields were obtained for the layers between the terrain surface and 300 m, between 300 and 1867 m, between 1867 m and 3433 m, and between 3433 m and 5000 m. An objective analysis technique based on one developed by Barnes (1964 and 1973), which has been adapted to the CSU-LORMAT model, was used to obtain gridded wind vector fields at 00Z and 12Z daily. The vector components at each grid were averaged to obtain monthly average wind vector fields.

The monthly average wind field for the month of September 1979 showed:

(i) Wind speeds were very slow throughout the atmosphere up to 5000 m over the region of Arizona and New Mexico.

(ii) Anticyclonic flow patterns were dominant over the region with the center of an anticyclone located along the northern part of the state border between Arizona and New Mexico. The causes of this episode can be summarized as follows:

(a) Sulfur emitted at the source areas was very effectively mixed vertically into the atmosphere. The mixing layer height during the period reached to more than 5000 m above the terrain. The presence of stable air above the 500-mb level prevented vertical mixing above this level.

(b) Because of stagnant motion and infrequent precipitation events, the accumulation of sulfur in the mixing layer took place over the region of Arizona and New Mexico.

(c) An anticyclonic flow pattern throughout the atmosphere up to more than 5000 m was responsible for the transport and dispersion from the source areas in southern Arizona to the region covering the states of Arizona and New Mexico.

(b) North and South Dakota Regional Episode.

The WFPN stations in North and South Dakota recorded high concentrations of sulfur during the period from late March to early April, 1980. The episode ended when a cold front passed through the region on April 5, 1980.

The region was under the influence of high pressure systems which were centered over eastern Canada and the northeastern United States.

The sounding records at stations in the region during the episode showed:

(i) Throughout the atmosphere very stable vertical temperature structures prevailed over the region.

(ii) Wind speeds were less than 5 m/sec throughout the atmosphere, and winds were from the directions of east and southeast.

Backward trajectory calculations showed that during the episode air parcels arriving at the region had originated in the eastern states.

Unlike the episode in the southwestern United States described previously, this episode over the Dakotas was caused by the transport of sulfur which was contained in a low atmospheric layer. The vertical temperature structure was too stable to allow efficient vertical mixing of pollutants. We suspect that local sources of sulfur might have played a minor role in elevating the concentrations.

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AGROMETEOROLOGICAL ORIENTED MODELLING OF THE SOIL-ATMOSPHERE INTERACTION

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NA81RA-H-00001

10/1/80 - 6/30/84

Modelling of the soil-atmosphere system conceptually should consider a two way interactive system. In most modelling studies relating to this system, however, both components of this system are not equally refined. In many atmospheric modelling studies, for example, a prescription of the soil forcing is adopted, while the equivalent approach is commonly adopted to represent the atmosphere in soil modelling studies.

In recent years several modellers have developed soil-atmosphere coupled models with a refined and balanced emphasis in the refinement of both components (e.g. [1], [2], [3], and [4]). In these models the soil component also includes vegetation. While [1] and [2] have been oriented toward improvement of the atmospheric boundary layer predictions, [3] and [4] have been oriented toward agrometeorological studies.

Generally, adopting agrometeorological modelling can be beneficial for either research, applied, or operational purposes. In many situations modelling and observational agrometeorological evaluations can be used as complimentary to each other. Some of the agrometeorological studies in this direction [3] and [4] (or earlier versions) are outlined briefly. Other implications of these studies are also indicated.

Examples of past studies include the model evaluation of polyethylene mulching effects on soil temperature for solar heating [3]. Other studies were oriented toward i) evaluations of surface microrelief effects on soil temperature and moisture [5] and ii) optimization of greenhouse siting [4]. Observational data gathered in the course of those studies supported the accuracy of the model predictions.

During 1983 an effort was made through CIRA to extend these types of studies. One direction involved seasonal/annual model predictions which included:

i) Model evaluations of the effect of the change in surface albedo on the annual pattern of soil temperature.

ii) Model evaluation of the impact of slope inclination and azimuth on the irrigation needs in semi-arid zones.

Emphasis was also given to studies oriented toward utilizing a coupled model for operational agrometeorological needs. Examples include:

i) Modelling of the impact of anticipated weather perturbations (such as cloudiness and passages of warm or cold fronts) on agrometeorological related parameters. Fig. 1 (from [6]), illustrates the impact of such weather perturbations on soil temperature at the beginning of the growing season in Israel (mid-March). Using the meteorological model in a 3-D version (or 2-D version if appropriate), linked to a 1-D soil model at each of the meteorological model grid points can provide an operational tool for predictions of this type of situation.

ii) Preliminary studies relating to frost predictions. This is of crucial agrometeorological importance in many geographical locations, especially at the beginning of the growing season. The current studies were related to nocturnal surface and near surface air temperature predictions in shallow valleys.

Further extension and refinement of the aforementioned studies as

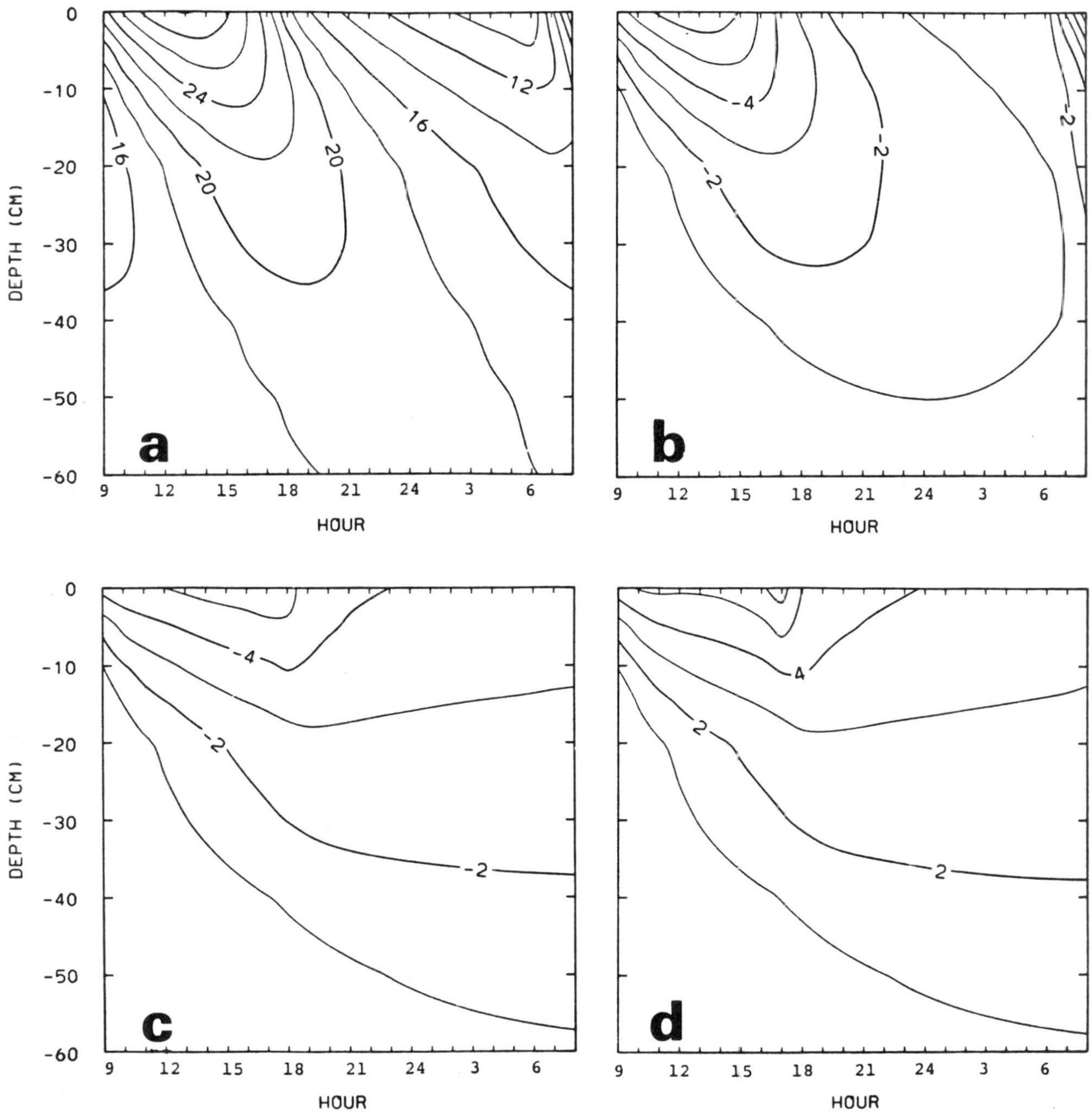

Fig. 1 - Soil thermal patterns as function of depth and time. (a) temperature (^{o}C) for normal day case, (b) soil temperature differences between a cloudy day and a normal day (^{o}C), (c) same as (b), except for a warm front case. (For more details see Mahrer and Segal, 1984).

well as the initiation of additional investigations of this type are planned.

Finally, it is worth noting the potential implications in other areas of this coupled soil-atmosphere modelling. In the recent decade the problem of desertification attributed to the impact of anthropological activities (e.g. the Sahel in Africa), is a matter of growing concern. Also, most recent assessments of the impact of the increase in CO_2 and other trace 'greenhouse' gas concentrations in the atmosphere suggest that if the current trends in these emissions continue, a long range process of desertification in some areas and the opposite trends in other areas, is anticipated. Adequate modelling evaluations of various aspects relating to such processes need a refined soil-vegetation description, which is lacking in the current studies because of existing computer capacity. The next generation of computers are expected to enable such refinements, hence, the insight provided by the current studies may be beneficial in the implementation of such refinements in the future. In the interim, until more powerful computers become available, they can provide some scaling relating to the soil-vegetation forcing in these processes, assuming an initial prescribed atmosphere state.

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