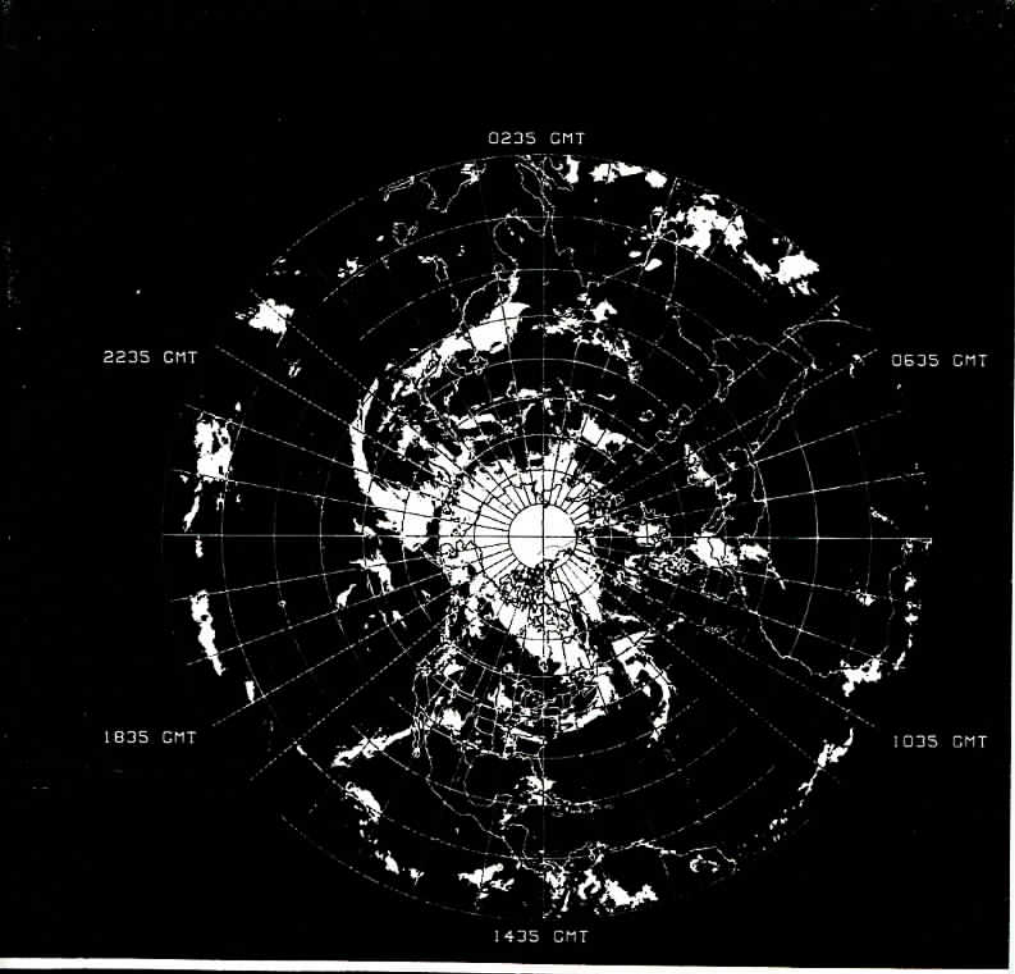

AMERICAN WATER RESOURCES ASSOCIATION

International Symposium on

SATELLITE HYDROLOGY

(Fifth Annual William T. Pecora Symposium)

June 10–15, 1979

Holiday Inn-Downtown Hotel
Sioux Falls, South Dakota

HOST

EROS DATA CENTER

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DONALD R. WIESNET

NOAA/NESS, S-33
Washington, D.C. 20233
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Technical Program Chairman

MORRIS DEUTSCH

U. S. Geological Survey/EROS Program Office
1925 Newton Square, East – Mail Stop 730
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★ ★ ★ ★ **NUMBERS YOU SHOULD KNOW WHILE IN SIOUX FALLS** ★ ★ ★ ★

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Convention/Visitors Bureau 336-1620
Chamber of Commerce 336-1620
Community Information 334-6645

NOTES

SUNDAY P.M. ★ ★ ★ JUNE 10

REGISTRATION
3:30 P.M. – 8:30 P.M.
(Hotel Lobby)

MONDAY A.M. ★ ★ ★ JUNE 11

PLENARY SESSION
9:00 A.M. – 12:00 Noon
(International East & West Rooms)

CHALLENGES FOR SATELLITE TECHNOLOGY IN NATIONAL WATER AND ENVIRONMENTAL PROGRAMS

Chairman: **DAVID S. JOHNSON,** Associate Director, NOAA, Rockville, Maryland.

WELCOMING REMARKS

Honorable WILLIAM JANKLOW, Governor, South Dakota.

Honorable RICK KNOBE, Mayor, Sioux Falls, South Dakota.

DANIEL D. EVANS, President, American Water Resources Association; Hydrology & Water Resources Department, Univ. of Arizona, Tucson.

DONALD R. WIESNET, Symposium General Chairman; NOAA/NESS/ESG, Washington, D.C.

MORRIS DEUTSCH, Chairman, Symposium Technical Program Committee; USGS, Reston, Virginia.

ALLEN H. WATKINS, Chief, EROS Data Center, Sioux Falls, South Dakota.

KEYNOTE SPEAKERS

P – 1. **JOSEPH CRAGWALL,** Associate Director, U. S. Geological Survey, Reston, Virginia – *Remote Sensing in Hydrology – A Challenge to Scientists.*

P – 2. **ROBERT A. CLARK,** Associate Director, NOAA/National Weather Service, Silver Spring, Maryland – *Satellite Applications in River and Flood Forecasting.*

P – 3. **PITT THOME,** Director, Resource Observation Division, NASA HQ, Washington, D.C. – *NASA Water Resources/Hydrology Remote Sensing Program in the 1980's.*

P – 4. **VERNON HAGEN,** Acting Chief, Hydraulics Hydrologic Branch, U. S. Army Corps of Engineers, HQDA, Washington, D.C. – *Corps of Engineers Utilization of Satellites for Hydrologic Purposes.*

P – 5. **TED ENGMAN,** Chief, Hydrology Laboratory, USDA, Beltsville, Maryland – *Agriculture's Needs Related to Satellite Hydrology.*

P – 6. **ED LANGHAM,** Deputy Manager, SURSAT Project Office, Department of Energy, Mines and Resources, Ottawa, Ontario, Canada – *A Review of Canada's Present and Future Remote Sensing Activities Related to Hydrology.*

MONDAY P.M. ★ ★ ★ JUNE 11

CURRENT SATELLITE TECHNOLOGY
1:30 P.M. – 5:00 P.M.
(International East & West Rooms)

The purpose of these state-of-the-art technology sessions is to introduce remote sensing terminology, to give a brief overview of hydrologic applications of satellite data, and to familiarize the user community with available image products regarding both Landsat and operational environmental satellite systems. Scientists from both the EROS Data Center and NOAA will give detailed presentations addressing operation of the satellite systems, satellite data characteristics, principles of image analysis, and data availability.

Examples of computer processing of Landsat data for analysis of hydrologic problems will be presented in the Data Analysis Laboratory demonstrations during the EROS Data Center tours.

Chairman: **DONALD T. LAUER,** Chief, Applications Branch
EROS Data Center, U. S. Geological Survey
Sioux Falls, South Dakota

1. Landsat Satellite Systems

1–1. **JAMES R. LUCAS,** Applications Scientist, Technicolor Graphic Services, Inc., EROS Data Center, Sioux Falls, South Dakota – *Landsat Satellite Data and Characteristics.*

1–2. **RUSSELL A. POHL,** Chief, Data Production Branch, U. S. Geological Survey, EROS Data Center, Sioux Falls, South Dakota – *Landsat Data Availability.*

2. Operational Environmental Satellite Systems

2–1. **EDWARD W. FERGUSON,** Manager, NESS Satellite Field Station, NOAA, NESS, Kansas City, Missouri – *Geostationary and Polar Orbiting Satellite Systems.*

2–2. **EUGENE R. HOPPE,** Chief, Satellite Data Services Division, NOAA, EDIS, Washington, D.C. – *Archiving and Dissemination of Operational Environmental Satellite Data.*

RECEPTION
7:30 P.M.
(Holidome)

HYDROLOGIC DATA RELAY
8:30 A.M. – 10:30 A.M.
(International East Room)

Chairman: **ALLEN F. FLANDERS,** Assistant to the Associate Director National Weather Service, NOAA, Silver Spring, Maryland

8:30 3 – 1. **MERLE L. NELSON,** National Environmental Satellite Service, NOAA, Suitland, Maryland – *The GOES Data Collection System.*

8:50 3 – 2. **TIMOTHY D. BUCKELEW,** New England Div., Corps of Engineers, Waltham, Massachusetts – *Adapting GOES DCS for Use by the Corps of Engineers.*

9:10 3 – 3. **CHARLES A. McCULLOUGH,** Div. of Flood Management, California Dept. of Water Resources, Sacramento, California – *Satellite Telemetry of Hydrologic Data in California.*

9:30 3 – 4. **IAN A. REID,** Dept. of Environment, Ottawa, Ontario, Canada; **CLAUDE PESANT,** Quebec Dept. of Natural Resources, Quebec City, Quebec, Canada; **B. E. GOODISON,** Atmospheric Environment Service, Environment Canada, Downsview, Ontario, Canada – *Monitoring Canada's Water Resources in Remote Regions by Satellite Telemetry.*

9:50 3 – 5. **RICHARD W. PAULSON, WILLIAM G. SHOPE,** U. S. Geological Survey, Reston, Virginia – *Application of Satellite Telemetry by the U. S. Geological Survey for the Support of Hydrologic Data Collection.*

10:10 3 – 6. **CHARLES E. COTE, J. EARL PAINTER,** NASA/Goddard Space Flight Center, Greenbelt, Maryland – *Advanced Technology for Satellite Data Collection Systems.*

NOTES

METEOROLOGY
8:30 A.M. – 10:30 A.M.
(International West Room)

Chairman: **JAY S. WINSTON,** Director, Meteorological Satellite Laboratory National Environmental Satellite Service, NOAA, Washington, D.C.

8:30 4 – 1. **RODERICK A. SCOFIELD,** National Environmental Satellite Service, NOAA, Washington, D.C. – *A Satellite-Derived Technique for Estimating Rainfall From Thunderstorms and Hurricanes.*

8:50 4 – 2. **J. P. JOLLY,** The Shawinigan Engineering Company Ltd., Montreal, Quebec, Canada – *Use of GOES Enhanced Infrared Imageries to Determine Storm Rainfall Amounts and Areal Extents in Data-Deficient Regions.*

9:10 4 – 3. **WILLIAM L. WOODLEY, CECELIA G. GRIFFITH,** National Hurricane and Experimental Meteorology Laboratory, ERL, NOAA, Miami, Florida; **JOHN A. AUGUSTINE,** Weather Modification Program Office, ERL, NOAA, Boulder, Colorado – *Rain Estimation Over Several Areas of the Globe Using Satellite Imagery.*

9:30 4 – 4. **ERIC C. BARRETT,** Univ. of Bristol, United Kingdom – *Satellite Rainfall Estimation by Cloud Indexing Methods for Desert Locust Survey and Control.*

9:50 4 – 5. **M. G. FOWLER, H. K. BURKE, K. R. HARDY, N. K. TRIPP,** Environmental Research & Technology, Inc., Concord, Massachusetts – *The Estimation of Rain Rate Over Land From Microwave Sensors.*

10:10 4 – 6. **H. J. JUNG, E. RASCHKE,** Institute for Geophysics and Meteorology, Univ. of Cologne, Federal Republic of Germany – *Determination of Rainfall Rates From Measurements of the Satellites Nimbus 5 and Nimbus 6.*

NOTES

HYDROLOGIC DATA RELAY
(Poster Session)
10:30 A.M. – 12:00 Noon
(Embassy Rooms)

3 – 7. **ERIC L. MORGAN,** Tennessee Technological Univ., Cookeville; **KENNETH W. EAGLESON,** Dept. of Natural Resources, Raleigh, North Carolina; **RAYMOND HERRMANN,** USDI, National Park Service, Atlanta, Georgia; **NORMAN D. McCOLLOUGH, JR.,** Univ. of Tennessee, Knoxville – *Recent Developments in Acquiring Real-Time Biological Water Quality Information: Automated Biomonitoring Applications to Remote Platforms and Satellite Retrieval.*

3 – 8. **ENRICO P. MERCANTI,** NASA/Goddard Space Flight Center, Greenbelt, Maryland – *Data Relay Satellites for Water Monitoring and Management.*

KEYNOTE LUNCHEON
12:15 P.M. – 1:15 P.M.
(Starlite Room)

History of the Landsat Applications Program

DR. ARCH PARK, Program Manager, Landsat-D Applications
General Electric Corporation, Beltsville, Maryland

NOTES

METEOROLOGY
(Poster Session)
10:30 A.M. – 12:00 Noon
(Embassy Rooms)

4 – 7. **ARNOLD GRUBER,** National Environmental Satellite Service, NOAA, Washington, D.C. – *Atmospheric Water Vapor as Determined From TIROS N.*

4 – 8. **J. D. LIN, P. BOCK, J. J. ALFANO,** Univ. of Connecticut, Storrs – *Modeling the Terrestrial Hydrology for the Global Atmosphere: The Need for Remotely Sensed Areal Data.*

4 – 9. **Y. P. VUILLAUME,** GDTA, Toulouse, France – *Meteorological Satellites and Airborne Multispectral Data Help for Evapotranspiration and Net Radiation Budget Mapping.*

4 – 10. **LINWOOD F. WHITNEY, LEROY D. HERMAN,** National Environmental Satellite Service, NOAA, Washington, D.C. – *A Statistical Approach to Rainfall Estimation Using Geostationary Satellite Data.*

4 – 11. **DANIEL G. ANDERSON,** Water Resources Division, U. S. Geological Survey, Reston, Virginia – *Roles of Satellites in Hydrology.*

KEYNOTE LUNCHEON
12:15 P.M. – 1:15 P.M.
(Starlite Room)

History of the Landsat Applications Program

DR. ARCH PARK, Program Manager, Landsat-D Applications
General Electric Corporation, Beltsville, Maryland

NOTES

SNOW AND ICE
1:30 P.M. – 3:30 P.M.
(International East Room)

Chairman: **ALBERT RANGO,** Senior Research Hydrologist
Hydrospherics Sciences Branch, NASA/Goddard Space Flight Center
Greenbelt, Maryland

1:30 5 – 1. **C. J. BOWLEY, J. C. BARNES,** Environmental Research & Tech., Inc., Concord, Massachusetts – *Satellite Snow Mapping Techniques With Emphasis on the Use of Landsat.*

1:50 5 – 2. **J. F. HANNAFORD,** Sierra Hydrotech, Placerville, California; **A. J. BROWN,** Snow Surveys Branch, Dept. of Water Resources, Sacramento, California – *Application of Snowcovered Area to Runoff Forecasting in Selected Basins of the Sierra Nevada, California.*

2:10 5 – 3. **R. S. WILLIAMS, JR., J. G. FERRIGNO,** U. S. Geological Survey, EROS Program, Reston, Virginia – *Satellite Image Atlas of Glaciers.*

2:30 5 – 4. **D. R. WIESNET,** NOAA/NESS/ESG, Washington, D.C.; **C. P. BERG,** NOAA Corps, Washington, D.C. – *The Satellite Record of the Winter of 1979 in North America.*

2:50 5 – 5. **P. GLOERSEN,** NASA/Goddard Space Flight Center, Greenbelt, Maryland; **W. J. CAMPBELL,** U. S. Geological Survey, Tacoma, Washington; **R. O. RAMSEIER,** Sursat Project, Dept. of Fisheries & Oceans, Ottawa, Ontario, Canada; **H. J. ZWALLY,** NASA/Goddard Space Flight Center, Greenbelt, Maryland – *Arctic Sea Ice Variations From Time-Lapse Passive Microwave Imagery.*

NOTES

WATER QUALITY AND ENVIRONMENT
1:30 P.M. – 3:30 P.M.
(International West Room)

Chairman: **RICHARD J. BLACKWELL,** Supervisor,
Earth Resources Applications Group
Jet Propulsion Laboratory, Pasadena, California

1:30 6 – 1. **WILLIAM J. CAMPBELL,** NASA/Goddard Space Flight Center, Greenbelt, Maryland – *An Application of Landsat and Computer Technology to Potential Water Pollution From Soil Erosion.*

1:50 6 – 2. **T. T. ALFÖLDI,** Canada Centre for Remote Sensing, Ottawa, Ontario, Canada; **J. C. MUNDAY, JR.,** Virginia Institute of Marine Science, Gloucester Point, & College of William & Mary, Williamsburg, Virginia; **CARL L. AMOS,** Atlantic Geoscience Centre, Energy, Mines & Resources Canada, Dartmouth, Nova Scotia – *Verification of a System for Automated Multidate Landsat Measurement of Suspended Solids.*

2:10 6 – 3. **DAVID J. SCHAEFFER, ROBERT P. CLARKE, DONNA F. SEFTON,** Illinois Environmental Protection Agency, Springfield; **D. H. P. BOLAND,** U. S. Environmental Protection Agency, Las Vegas, Nevada – *Assessment and Classification of Selected Illinois Lakes Through the Application of Space Technology.*

2:30 6 – 4. **FRANK L. SCARPACE,** Marine Studies Center, Univ. of Wisconsin, Madison; **KEN HOLMQUIST, ALAN W. VOSS,** Photogrammetry & Remote Sensing Section, Tennessee Valley Authority, Chattanooga, Tennessee – *The Use of Landsat to Predict Water Quality.*

2:50 6 – 5. **HERBERT W. HOFFMAN,** National Weather Service Forecast Office, Rosemont, Illinois – *Thermal Patterns of Lake Michigan and Lake Superior From Satellite Remote Sensors and Its Uses.*

NOTES

SNOW AND ICE
(Poster Session)
3:30 P.M. – 5:00 P.M.
(Embassy Rooms)

5 – 6. **R. LOUGEAY,** Dept. of Geography, Arizona State Univ., Tempe – *Potentials of Mapping Buried Glacier Ice With Landsat Thermal Imagery.*

5 – 7. **W. O. RASMUSSEN, P. F. FFOLLIOTT,** School of Renewable Natural Resources, Univ. of Arizona, Tucson – *Prediction of Water Yield From Arizona Snowpacks Using Satellite Imagery and a Snowmelt Simulation Model.*

5 – 8. **C. J. MERRY, H. L. McKIM, R. E. BATES, S. G. UNGAR,** Earth Sci. Branch, Res. Div., U. S. Army Cold Regions Res. & Eng. Lab., Hanover, New Hampshire; **S. COOPER,** Water Control Branch, U. S. Army Engineer, Waltham, Massachusetts; **J. M. POWER,** Water Resources Branch, Environment Canada, Ottawa, Ontario, Canada – *Snow Cover Mapping in Northern Maine Using Landsat Digital Processing Techniques.*

5 – 9. **M. D. SMALLWOOD, J. C. BARNES,** Environmental Research & Tech., Inc., Concord, Massachusetts – *Application of HCMM Thermal Data to Snow Hydrology Programs.*

5 – 10. **M. E. KIRBY, R. T. LOWRY,** Intera Environmental Consultants Ltd., Ottawa, Ontario, Canada – *Iceberg Detectability Problems Using SLAR and SAR Systems.*

5 – 11. **D. A. ELLERBRUCH, H. S. BOYNE, R. WITTMAN, R. JONES,** National Bureau of Standards, Electromagnetics Div., Boulder, Colorado – *Microwave Measurements and Modeling of Properties of Snowpacks.*

5 – 12. **A. T. C. CHANG, D. HALL, J. FOSTER, A. RANGO, J. C. SHIUE,** NASA/Goddard Space Flight Center, Greenbelt, Maryland – *Passive Microwave Sensing of Snow Characteristics Over Land.*

5 – 13. **B. A. SHAFER,** Soil Conservation Service, Denver, Colorado; **CHARLES F. LEAF,** Consulting Hydrologist, Sterling, Colorado; **JAMES K. MARRON,** USDA, Soil Conservation Service, Denver, Colorado – *Snowmelt Runoff Forecasting Using Landsat Imagery in the Rio Grande and Arkansas River Basins of Colorado.*

5 – 14. **W. H. STILES, F. T. ULABY,** Remote Sensing Laboratory, Univ. of Kansas Center for Research, Lawrence – *Monitoring Snow With Microwaves.*

5 – 15. **G. OSTREM,** Norweigian Water Power Board, Oslo, Norway; **H. ODEGARD,** International Business Machines, Oslo, Norway; **T. ANDERSEN,** Norweigian Water Power Board, Oslo, Norway – *Operational Use of Satellite Data for Snow Inventory and Runoff Forecast.*

5 – 16. **ROLAND HOFER,** Jet Propulsion Lab., California Institute of Technology, Pasadena, California; **CHRISTIAN MÄTZLER,** Institute of Applied Physics, Univ. of Bern, Switzerland – *Passive Microwave Remote Sensing of Snow Parameters – A Review of a Long Term Measuring Campaign.*

FILM FESTIVAL
7:30 P.M.
(International East Room)

Chairman: **LT. CRAIG BERG,** NOAA Corps, Washington, D.C.

WATER QUALITY AND ENVIRONMENT
(Poster Session)
3:30 P.M. – 5:00 P.M.
(Embassy Rooms)

6 – 6. **CHARLES KILLPACK, ROBERT MOORE,** Holcomb Research Institute, Butler Univ., Indianapolis, Indiana – *Testing the Usability of Landsat Multispectral Scanner (MSS) Data as an Automated Data Source in a Non-Point Source Water Quality Model.*

6 – 7. **EDWARD YOST,** Science Engineering Research Group, Long Island University, Greenvale, New York; **MORRIS DEUTSCH,** EROS Program, U. S. Geological Survey, Reston, Virginia; **LYNNE MYERS,** Library of Parliament, Ottawa, Ontario, Canada – *Observations of Water Quality Conditions and Circulation Patterns in Western Lake Ontario From Optically Enhanced Landsat Data.*

6 – 8. **A. Y. SMITH, RICHARD J. BLACKWELL,** Jet Propulsion Laboratory, Pasadena, California – *Application of Digital Image Processing Techniques and Information Systems to Water Quality Monitoring of Lake Tahoe.*

6 – 9. **HENRY F. FOSTEL, JAMES E. MANLEY,** Development Planning Div., Baltimore Regional Planning Council, Baltimore, Maryland; **JAMES P. ORMSBY,** NASA/Goddard Space Flight Center, Greenbelt, Maryland – *The Use of Landsat Multispectral Data to Derive Land Cover Information for the Location and Quantification of Non-Point Source Water Pollutants.*

6 – 10. **CHARLES W. WELBY,** North Carolina State Univ., Raleigh; **A. M. WITHERSPOON,** Dept. of Botany, North Carolina State Univ., Raleigh; **R. E. HOLMAN III,** The Mitre Corporation, McLean, Virginia – *Trophic State Determination for Shallow Coastal Lakes From Landsat Imagery.*

FILM FESTIVAL
7:30 P.M.
(International East Room)

Chairman: **LT. CRAIG BERG,** NOAA Corps, Washington, D.C.

NOTES

SATELLITE HYDROLOGY OVERVIEW
(Panel)
8:30 A.M. – 9:45 A.M.
(International East & West Rooms)

Moderator: **PAUL BOCK,** Professor of Hydrology and Water Resources
University of Connecticut, Storrs; Member, Space Applications Board
National Academy of Engineering

O – 1. **S. WALT McCANDLESS,** User Systems Engineering Company, Annandale, Virginia – *Water Sensing Satellites.*

O – 2. **VINCENT D. SALOMONSON, ALBERT RANGO,** respectively, Chief Scientist, Landsat-D Program; Senior Research Hydrologist, Hydrospherics Sciences Branch; Goddard Space Flight Center, NASA, Greenbelt, Maryland – *Satellite Data Requirements of the International Water Resources Community.*

O – 3. **DONALD R. WIESNET,** Senior Research Hydrologist, NOAA/NESS, Washington, D.C.; **MORRIS DEUTSCH,** Research Coordinator, Hydrology, EROS Program, U. S. Geological Survey, Reston, Virginia – *An Overview of Applications of Satellite Data for the Hydrological Sciences.*

O – 4. **DANIEL G. ANDERSON,** Chief, Office of Remote Sensing, Water Resources Div., U. S. Geological Survey, Reston, Virginia – *Satellites Versus Conventional Methods in Hydrology.*

NOTES

FUTURE OF SATELLITE REMOTE SENSING IN STATE AND LOCAL GOVERNMENTS
10:00 A.M. – 12:00 Noon
(International East & West Rooms)

Chairman: **LEONARD C. SLOSKY,** Staff Director
Natural Resource and Environment Task Force
Intergovernmental Science, Engineering and Technology Advisory Panel
Executive Office of the President, Washington, D.C.

Panel Members:

F – 1. **DR. ARTHUR MORRISSEY,** Senior Policy Analyst, Office of Science and Technology Policy, Executive Office of the President, Washington, D.C.

F – 2. **DR. FRED DOYLE,** Acting Director, EROS Program, U. S. Geological Survey, Reston, Virginia.

F – 3. **SALLY BAY CORNWELL,** Director, Environmental Data Center, Office of the Governor, Sacramento, California.

F – 4. **BRUCE RADO,** Georgia Dept. of Natural Resources, Atlanta, Georgia.

F – 5. ~~**JAMES J. GEHRIG,** Staff Member, U. S. Senate Committee on Commerce, Science and Technology~~, Washington, D.C. DARRELL R. BRANSCOME (in House of Reps.)

F – 6. **RICHARD RICHARDSON,** South Dakota Planning Commission, Pierre, South Dakota.

NOTES

SURFACE WATER
1:30 P.M. – 3:30 P.M.
(International East Room)

Chairman: **ALBERT N. WILLIAMSON,** Research Physicist
Waterways Experiment Station, U. S. Army Corps of Engineers
Vicksburg, Mississippi

1:30 7 – 1. **M. L. BRYAN,** Jet Propulsion Laboratory, Pasadena, California – *The Use of Radar Imagery for Surface Water Investigations.*

1:50 7 – 2. **ROBERT K. HOLZ, V. R. BAKER,** Univ. of Texas, Austin – *An Examination of Fluvial Morphological Characteristics of Western Amazon Streams From ASTP Photographs.*

2:10 7 – 3. **L. E. LINK, J. B. MASON, J. G. COLLINS,** U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi – *The Corps' Military Hydrology Research Program.*

2:30 7 – 4. **ROBERT CERMAK, ARLEN FELDMAN, R. PAT WEBB,** Hydrologic Engineering Center, U. S. Army Corps of Engineers, Davis, California – *Hydrologic Land Use Classification Using Landsat: A Comparison of Alternative Procedures.*

2:50 7 – 5. **A. N. WILLIAMSON,** U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi – *Landsat Data for Regulatory Permit Monitoring.*

NOTES

WETLANDS
1:30 P.M. – 3:30 P.M.
(International West Room)

Chairman: **VIRGINIA CARTER,** Research Biologist
Water Resources Division, U. S. Geological Survey
Reston, Virginia

1:30 8 – 1. **ROBERT J. FINLEY,** Bureau of Economic Geology, Univ. of Texas, Austin; **SAM McCULLOCH,** Texas Natural Resources Information System, Austin; **PEGGY HARWOOD,** Council of State Planning Agencies, National Governors' Assoc., Washington, D.C. – *Landsat Classification of Coastal Wetlands in Texas.*

1:55 8 – 2. **PATRICIA T. GAMMON,** U. S. Geological Survey, Suffolk, Virginia; **VIRGINIA CARTER,** U. S. Geological Survey, Reston, Virginia; **WAYNE G. ROHDE,** Technicolor Graphic Services, Inc., EROS Data Center, Sioux Falls, South Dakota – *Landsat Digital Classification of the Vegetation of the Great Dismal Swamp With an Evaluation of Classification Accuracy.*

2:20 8 – 3. **C. LISETTE ERNST, R. M. HOFFER,** Laboratory for Application of Remote Sensing, Purdue Univ., Lafayette, Indiana – *Using Landsat MSS Data With Soils Information to Identify Wetland Habitats.*

2:45 8 – 4. **J. C. GERVIN,** NASA/Goddard Space Flight Center, Greenbelt, Maryland; **S. F. SHIH,** NASA/Kennedy Space Center, Florida – *Improved Calculations of the Roughness Coefficient for Natural Wetlands.*

3:10 8 – 5. **P. W. ROSE, P. C. ROSENDAHL,** National Park Service, Homestead, Florida – *A Multispectral Classification and Analysis of Landsat Imagery to Determine the Hydrologically Active Zones of the Shark River Slough, Everglades National Park, Florida.*

NOTES

SURFACE WATER
(Poster Session)
3:30 P.M. – 5:00 P.M.
(Embassy Rooms)

7 – 6. **M. S. AKHAVI,** Technical-Scientific Univ., Tehran, Iran; **PAT S. CHAVEZ, PATRICIA A. TERMAIN,** U.S. Geological Survey, Flagstaff, Arizona – *Digital Analyses of Enhanced Landsat Data Depicting Hydrologic Features of the Daryacheh-ye-Namak Area, Iran.*

7 – 7. **G. ALLORD,** U.S. Geological Survey, Madison, Wisconsin – *Improving Streamflow Estimates Using Landsat.*

7 – 8. **W. H. ANDERSON, G. E. JOHNSON,** Technicolor Graphic Services, Inc., EROS Data Center, Sioux Falls, South Dakota – *Assessing Effects of the 1975 Red River Flood on the Agricultural Landscape of North Dakota and Minnesota.*

7 – 9. **J. KRUUS,** Atmospheric Environment Service, Environment Canada, Ottawa, Ontario, Canada; **MORRIS DEUTSCH,** EROS Program, U. S. Geological Survey, Reston, Virginia; **P. L. HANSEN,** New Brunswick Dept. of the Environment, Fredericton, New Brunswick, Canada; **H. L. FERGUSON,** Atmospheric Environment Service, Environment Canada, Ottawa, Ontario, Canada – *Flood Applications of Satellite Imagery.*

7 – 10. **Z. D. KALENSKY, W. C. MOORE,** Environment Canada, Ottawa, Ontario, Canada; **L. R. SCHERK,** Consultant, Ottawa, Ontario, Canada – *Flood Delineation by Satellite.*

7 – 11. **M. MATSON, C. P. BERG, D. R. WIESNET,** NOAA/NESS, Washington, D.C. – *A Note on Indirect Detection of Seiches in Great Salt Lake, Utah.*

7 – 12. **M. P. McADAMS,** Remote Sensing Laboratory, Iowa Geological Survey, Iowa City – *Quantitative Analysis of Landsat Flood Mapping Capabilities.*

7 – 13. **D. R. WIESNET, C. P. BERG, M. MATSON,** NOAA/NESS, Washington, D.C. – *Assessing the Red River of the North 1978 Flood From NOAA Satellite Data.*

7 – 14. **ED LANGHAM,** Sursat Project Office, Dept. of Energy, Mines, and Resources, Ottawa, Ontario, Canada – *Collection of Radar Imagery of the 1979 Red River Flood.*

WILLIAM T. PECORA AWARDS DINNER
7:30 P.M.
(International East & West Rooms)

Keynote Speaker:
The Honorable THOMAS ANDERSON, Michigan House of Representatives, Lansing, Michigan.

Presentation of the Pecora Award:
PITT THOME, Director, Resource Observation Div., NASA, Washington, D.C.

Presentation of Centennial Award to the U. S. Geological Survey by the American Water Resources Association:
DANIEL D. EVANS, President, AWRA, Tucson, Arizona.

WETLANDS
(Poster Session)
3:30 P.M. – 5:00 P.M.
(Embassy Rooms)

8 – 6. **L. F. WERTH, M. P. MEYER,** College of Forestry, Univ. of Minnesota, St. Paul – *A Comparison of Remote Sensing Techniques for Wetland Classification and Mapping in the Minneapolis-St. Paul Metropolitan Area (West Half).*

8 – 7. **R. G. BEST, D. G. MOORE,** Remote Sensing Institute, South Dakota State Univ., Brookings – *Landsat Interpretation of Prairie Lakes and Wetlands of Eastern South Dakota.*

8 – 8. **J. C. GERVIN,** NASA/Goddard Space Flight Center, Greenbelt, Maryland; **S. F. SHIH,** NASA/Kennedy Space Center, Florida – *Improvements in Lake Volume Predictions Using Landsat Data.*

8 – 9. **T. DINCER,** Deli Huseyin Pasa Cad., Ozyurt Yapi Koop, Istanbul, Turkey; **S. HUTTON,** Consultant, Shepshed, England – *An Application of Satellite Imagery in the Study of the Okavango Swamp – Botswana.*

WILLIAM T. PECORA AWARDS DINNER
7:30 P.M.
(International East & West Rooms)

Keynote Speaker:
The Honorable THOMAS ANDERSON, Michigan House of Representatives, Lansing, Michigan.

Presentation of the Pecora Award:
PITT THOME, Director, Resource Observation Div., NASA, Washington, D.C.

Presentation of Centennial Award to the U. S. Geological Survey by the American Water Resources Association:
DANIEL D. EVANS, President, AWRA, Tucson, Arizona.

NOTES

COASTAL ZONE
8:30 A.M. – 10:30 A.M.
(International East Room)

Chairman: **JOHN ESTES**, Director
Geography Remote Sensing Unit
Univ. of California, Santa Barbara

8:30 9 – 1. **M. K. BUTERA**, NASA, ERL, Slidell, Louisiana – *Computer Implemented Remote Sensing Techniques for the Measurement of Coastal Productivity and Nutrient Transport Systems.*

9:00 9 – 2. **J. R. JENSEN**, Dept. of Geography, Univ. of Georgia, Athens; **J. E. ESTES, LARRY TINNEY**, Geography Dept., Remote Sensing Unit., Univ. of California, Santa Barbara; **M. R. MEL**, Geoscientific & Consulting, Playa Del Rey, California – *Multispectral Kelp Resource Survey.*

9:30 9 – 3. **V. KLEMAS**, Center for Remote Sensing, Univ. of Delaware, Newark – *Remote Sensing of Coastal Currents and Pollutants.*

10:00 9 – 4. **E. B. PRITCHARD, R. C. HARRISS**, NASA, Langley Research Center, Hampton, Virginia – *Aerospace Remote Sensing of the Coastal Zone for Water Quality and Biotic Productivity Applications.*

NOTES

WATER USE AND MANAGEMENT
8:30 A.M. – 10:30 A.M.
(International West Room)

Chairman: **FRED H. RUGGLES**, Hydraulic Engineer,
Office of the Assistant Chief Hydrologist for
Scientific Publications and Data Management
U. S. Geological Survey, Reston, Virginia

8:30 10 – 1. **C. W. WELBY**, Dept. of Geosciences, North Carolina State Univ., Raleigh; **A. M. WITHERSPOON**, Dept. of Botany, North Carolina State Univ., Raleigh; **R. E. HOLMAN III**, The Mitre Corp., McLean, Virginia – *Trophic State Determination for Shallow Coastal Lakes From Landsat Imagery.*

9:00 10 – 2. **D. D. BARILE**, Center for Coastal Zone Research, Florida Institute of Technology, Melbourne – *Landsat Multispectral Data Applications in Determining Land Use and Hydroperiod.*

9:30 10 – 3. **W. B. KRABILL**, NASA Wallops Flight Center, Wallops Island, Virginia; **R. L. BROOKS**, EG&G Washington Analytical Services Center, Pocomoke City, Maryland – *Land Subsidence Monitoring Using Satellite Altimetry.*

10:00 10 – 4. **R. L. MILLER**, Div. of Forestry, Oklahoma Dept. of Agriculture, Broken Bow; **T. H. SILKER**, Dept. of Forestry, Oklahoma State Univ., Stillwater; **J. P. DAWSON**, Oklahoma Foundation for Research & Development Utilization, Inc., Edmond – *Correlating Vegetation, Soils, and Surficial Geologic Formations Using Landsat Data and an Integrated Analytical System.*

NOTES

COASTAL ZONE
(Poster Session)
10:30 A.M. – 12:00 Noon
(Embassy Rooms)

9 – 5. **JOHN JENSEN,** Dept. of Geography, Univ. of Georgia, Athens; **J. E. ESTES, LARRY TINNEY,** Geography Remote Sensing Unit, Univ. of California, Santa Barbara – *Automated Analysis of Macrocystis Along the Southern California Coast.*

9 – 6. **HIROAKI OCHIAI,** Oceanography Dept., Toba Merchant Marine College, Toba-city, Japan; **YASUSHI SUZUKI,** Facom Information Processing Co., Tokyo, Japan – *Digital Analysis of Landsat MSS Data and Application for Marine Environment of Coastal Area.*

9 – 7. **F. A. KOHOUT,** U. S. Geological Survey, Water Resources Div., Woods Hole, Massachusetts; **R. C. MUNSON,** National Oceanic and Atmospheric Administration, Norfolk, Virginia; **R. M. TURNER,** U. S. Geological Survey, Reston, Virginia; **W. R. ROYAL,** Warm Mineral Springs, Florida – *Satellite Observations of a Geothermal Submarine Spring Off Florida's West Coast.*

9 – 8. **YU-HWA WANG,** Coastal and Oceanographic Engineering, Univ. of Florida, Gainesville – *Satellite Applications to a Coastal Inlet Stability Study.*

9 – 9. **C. W. WELBY,** Dept. of Geology, North Carolina State Univ., Raleigh; **L. J. PIETRAFESA,** Dept. of Marine Sciences and Engineering, North Carolina State Univ., Raleigh – *Combined Satellite Imagery for Study of Coastal Circulation, Raleigh and Onslow Bays, North Carolina.*

9 – 10. **MICHAEL WILSON, PEGGY O'NEIL,** NASA Hq., Washington, D.C.; **MORRIS DEUTSCH,** USGS/EROS Program Office, Reston, Virginia; **JOHN ESTES,** Geography Remote Sensing Unit, Univ. of California, Santa Barbara – *The Potential of Satellite Systems for Monitoring Oil in the Coastal Zone.*

9 – 11. **DONALD STEVEN GRAHAM,** Dept. of Civil Engineering, Univ. of Florida, Gainesville; **JOHN M. HILL,** Div. of Engineering Research, Louisiana State Univ., Baton Rouge; **B. A. CHRISTENSEN,** Dept. of Civil Engineering, Univ. of Florida, Gainesville – *Use of Enhanced Landsat Images to Verify a Real-Time Esturine Quality Model.*

NOTES

WATER USE AND MANAGEMENT
(Poster Session)
10:30 – 12:00 Noon
(Embassy Rooms)

10 – 5. **LARRY TINNEY,** Geography Remote Sensing Unit, Univ. of California, Santa Barbara; **SHARON WALL,** Space Sciences Laboratory, Univ. of California, Berkeley; **ROBERT COLWELL,** Univ. of California, Berkeley; **JOHN ESTES,** Geography Remote Sensing Unit, Univ. of California, Santa Barbara, California – *Irrigated Lands Assessment for Water Management Applications Pilot Test.*

10 – 6. **LARRY TINNEY, JEFFREY HOLLOWAY, JAY BAGGETT, JOHN ESTES,** Geography Remote Sensing Unit, Univ. of California, Santa Barbara – *A Multistage Mapping Approach to Inventory Irrigated Cropland Using Landsat and Aircraft Imagery.*

10 – 7. **R. A. JOHNSON, T. L. JOHNSON,** Geography Program, U.S. Geological Survey, Reston, Virginia – *Mapping Irrigated Cropland and Pasture in Western Kansas.*

10 – 8. **F. W. RUGGLES,** Univ. of Louisville, Louisville, Kentucky – *A Bibliography With Selected Annotations of Remote Sensing as it Applies to Crop Irrigation.*

10 – 9. **P. H. RAHN,** Dept. of Geology, South Dakota School of Mines, Rapid City – *Remote Sensing of Erosion on the Missouri River, South Dakota.*

10 – 10. **KIRK B. WEBSTER,** Suwanee River Water Management District, White Spring, Florida; **JAMES R. LUCAS,** Technicolor Graphic Services, Inc., EROS Data Center, Sioux Falls, South Dakota; **RICHARD J. MUSGROVE,** Suwanee River Water Management District, White Spring, Florida; **AARON L. HIGER,** U. S. Geological Survey, WRD, Miami, Florida – *Selected Irrigation Acreage Estimated in Northern Florida From Landsat Data.*

10 – 11. **DONNA B. HANKINS,** Director, NASA Technology Transfer Project, Humboldt State Univ., Arcata, California; **LAWRENCE FOX III,** Forestry Dept., Humboldt State Univ., Arcata, California; **KENNETH MAYER,** NASA Technology Transfer Project, Humboldt State University, Arcata, California – *Surface Conditions Affecting Anadromous Fish on the Hoopa Valley Indian Reservation – California.*

NOTES

GROUND WATER
1:30 P.M. – 3:30 P.M.
(International East Room)

Chairman: **WAYNE A. PETTYJOHN,** Professor, Dept. of Geology & Mineralogy
Ohio State Univ., Columbus, Ohio

1:30 11 – 1. **WAYNE A. PETTYJOHN,** Dept. of Geology & Mineralogy, Ohio State Univ., Columbus – *Ground Water and Satellites – An Overview.*

1:50 11 – 2. **LISA BABCOCK,** Dames & Moore, Phoenix, Arizona; **LOCH ETHRIDGE,** Phillips Petroleum, Bartlesville, Oklahoma; **ROBERT SCHOWENGERDT,** Office of Arid Lands, Univ. of Arizona, Tucson; **CHARLES E. GLASS,** Mining and Geological Engineering, Univ. of Arizona, Tucson – *Correlation of Geologic Structure Inferred From Computer-Enhanced Landsat Imagery With Underground Water Supplies in Arizona.*

2:10 11 – 3. **PERRY H. RAHN,** Dept. of Geology and Geologic Engineering, South Dakota School of Mines and Technology, Rapid, City; **DONALD G. MOORE,** Remote Sensing Institute, South Dakota State Univ., Brookings – *Evaluation of Landsat Data for Locating Shallow Glacial Aquifers in Eastern South Dakota.*

2:30 11 – 4. **A. G. BOBBA, J. E. BRUTON, R. P. BUKATA,** Remote Sensing Section, Applied Research Division, National Water Research Institute, Canada Centre for Inland Waters, Burlington, Ontario, Canada – *Application of Landsat Digital Data to the Location of Hydrologically Active Source Areas.*

2:50 11 – 5. **WOLFGANG KRUCK,** Federal Institute for Geosciences & Natural Resources, Hannover, Federal Republic of Germany – *Hydrogeologic Interpretation of Landsat Imagery in Arid Zones of West and South Africa.*

3:10 11 – 6. **LINDA ZALL, ORVILLE RUSSELL,** Energy/Environment Group, Earth Satellite Corporation, Washington, D.C. – *Ground Water Exploration Programs in Africa.*

NOTES

SOIL MOISTURE
1:30 P.M. – 3:30 P.M.
(International West Room)

Chairman: **BRUCE BLANCHARD**, Director, Remote Sensing Center
Texas A & M Univ., College Station

1:30 12 – 1. **T. J. SCHMUGGE,** NASA/Goddard Lab for Atmospheric Sciences, Goddard Space Flight Center, Greenbelt, Maryland; **T. J. JACKSON,** USDA/SEA/AR Hydrology Laboratory, Beltsville, Maryland; **H. L. McKIM,** USACE Cold Regions Research and Engineering Lab, Hanover, New Hampshire – *Survey of Methods for Soil Moisture Determination.*

1:55 12 – 2. **R. W. NEWTON,** Remote Sensing Center, Texas A & M Univ., College Station – *Characteristics of Microwave Emission and Scattering of Significance to Satellite Remote Sensing of Soil Water.*

2:20 12 – 3. **F. T. ULABY, G. BRADLEY, C. DOBSON,** Univ. of Kansas Center of Research, Inc., Remote Sensing Laboratory, Lawrence – *Potential Application of Satellite Radar to Monitor Soil Moisture.*

2:45 12 – 4. **J. L. HEILMAN, D. G. MOORE,** Remote Sensing Institute, South Dakota State Univ., Brookings – *Hydrologic Investigation of Eastern South Dakota Using HCMM Data.*

3:10 12 – 5. **H. K. BURKE,** Environmental Research Technology, Inc., Concord, Massachusetts; **W. J. BURKE,** Boston College, Chestnutville, Massachusetts – *Prospects and Requirements for Space-Borne Microwave Radiometers for Detecting Soil Moisture Content of Agricultural Fields.*

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GROUND WATER
(Poster Session)
3:30 P.M. – 5:00 P.M.
(Embassy Rooms)

11 – 7. **K. P. SINGH,** Univ. of Delhi, India; **T. H. LEE WILLIAMS,** Dept. of Geography, Univ. of Kansas, Lawrence – *Landsat Groundwater Studies in Parts of Haryana and Punjab States.*

11 – 8. **LYNNE MYERS,** Library of Parliament, Ottawa, Ontario, Canada; **MORRIS DEUTSCH,** USGS/EROS Program Office, Reston, Virginia; **ALLAN FALCONER,** Spectral Data Corp., Regional Remote Sensing Facility, Nairobi, Kenya – *Optical Enhancements of Landsat Spectral and Temporal Data Indicative of Hydrogeologic Conditions in the Lake Ontario Basin.*

11 – 9. **JEFFREY RISNER,** Ohio Environmental Protection Agency, Columbus – *Problems Encountered Using Landsat Imagery of the Libyan Sahara Desert to Locate Desert Agricultural Projects Sites.*

11 – 10. **FRANCIS A. KOHOUT,** USGS, WRD, Woods Hole, Massachusetts; **D. R. WIESNET,** NOAA/NESS/ESG, Washington, D.C.; **MORRIS DEUTSCH,** USGS/EROS Program Office, Reston, Virginia; **JOHN SHANTON,** USGS, Reston, Virginia – *Submarine Spring Investigation by Remote Sensing, Jamaica, West Indies.*

FRIDAY ★ ★ ★ JUNE 15

FIELD TRIP
8:00 A.M. – 5:30 P.M.

Field Trip Leaders: **DONALD G. MOORE,** Head Education and Training, Remote Sensing Institute, South Dakota State Univ., Brookings.

RICHARD FIDLER, District Chief, Water Resources Division, U. S. Geological Survey, Huron, South Dakota.

NOTES

SOIL MOISTURE
(Poster Session)
3:30 P.M. – 5:00 P.M.
(Embassy Rooms)

12 – 6. **STANLEY R. SCHNEIDER, DAVID F. McGINNIS, JR., JOHN A. PRITCHARD,** National Environmental Satellite Service, NOAA, Washington, D.C. – *Delineation of Drainage Features in North and South Dakota Using Satellite Infrared Data.*

12 – 7. **DONNA J. STETZ, JAMES R. LUCAS,** Technicolor Graphic Services, Inc., EROS Data Center, Sioux Falls, South Dakota – *Landsat Temporal Analysis of Glacial Terrain in Southeastern Wisconsin.*

FRIDAY ★ ★ ★ JUNE 15

FIELD TRIP
8:00 A.M. – 5:30 P.M.

Field Trip Leaders: **DONALD G. MOORE,** Head Education and Training, Remote Sensing Institute, South Dakota State Univ., Brookings.

RICHARD FIDLER, District Chief, Water Resources Division, U.S. Geological Survey, Huron, South Dakota.

NOTES

SPECIAL TOURS

EARTH RESOURCES OBSERVATION SYSTEMS (EROS) DATA CENTER TOURS

Tours of the EROS Data Center will be featured during the Symposium. The tours through the modern Data Center will include user services' operations, applications assistance and training facilities, high volume photographic laboratories and equipment, and the central computer complex. Highlighting the tours will be a visit to the Data Analysis Laboratory. Demonstrations of interactive digital and analog image analysis equipment will be conducted to illustrate techniques for the analysis of hydrologic applications using satellite images. Applications scientists will be available to answer questions on specific image analysis techniques and equipment capabilities.

Information regarding the schedule for the Data Center Tours will be available at the Registration Desk.

SATURDAY 8:00 A.M. – 5:30 P.M. **JUNE 9**

FIELD TRIP

REMOTE SENSING OF HYDROLOGY IN EASTERN SOUTH DAKOTA

A one day field trip illustrating the remote sensing of hydrology in eastern South Dakota will be conducted in connection with the Pecora Symposium. The tour is being organized by the Remote Sensing Institute of South Dakota State University and the Water Resources Division of the USGS. The tour will consist of six stops for observations of the following: 1) Thermal Inertia Mapping for Hydrogeologic Applications, 2) Hydrologic Properties of Soil, 3) Wetland Ecology of Shallow Glacial Prairie Potholes, 4) Irrigation, 5) Hydrogeologic Applications of Energy Balance Measurements, and 6) Data Collection Platforms with Hydrologic Measurements.

All stops will be manned by professionals who have conducted remote sensing or other research investigations at the sites. Tour guides will provide general commentary on the hydrology of Eastern South Dakota while in transit between stops. The tour will be conducted on Saturday, June 9, and repeated on Friday, June 15. Travel will be by bus which will leave Sioux Falls at 8:00 A.M. and return at 5:30 P.M. A guidebook will be provided which will give the itinerary, contain illustrations of remote sensing and ground data, and describe the test sites and uses of remote sensing for measuring or mapping particular characteristics. A set of descriptive slides will be provided to each field trip participant. These will be useful for class lectures and for providing an understanding of the applications of remote sensing to the water resources of the glacial landscape of eastern South Dakota.

Each trip will be limited to 45 persons, on a first-come, first-served basis. The only cost to participants will be a $5.00 charge for a luncheon. This cost is to be paid by participants at the Registration Desk.

SUNDAY 3:30 P.M. – 8:30 P.M. **JUNE 10**

REGISTRATION (Lobby)

(Hours for following days will be posted.)

MONDAY 7:30 P.M. **JUNE 11**

RECEPTION (Holidome)

Meet and enjoy the company of your colleagues.

TUESDAY **JUNE 12**

12:15 P.M. KEYNOTE LUNCHEON (Starlite Room)

HISTORY OF THE LANDSAT APPLICATION PROGRAM

DR. ARCH PARK, Program Manager, Landsat-D Applications
General Electric Corporation, Beltsville, Maryland

7:30 P.M. FILM FESTIVAL (International East Room)

The Film Festival will begin with a preview of sites that will be included as part of the field trip on Friday, June 15. Following this viewing, additional films on remote sensing techniques and applications will be shown.

WEDNESDAY 7:30 P.M. **JUNE 13**

WILLIAM T. PECORA AWARDS DINNER (International East & West Rooms)

Keynote Speaker:
The Honorable THOMAS ANDERSON, Michigan House of Representatives, Lansing, Michigan.

Presentation of the Pecora Award:
PITT THOME, Director, Resource Observation Div., NASA, Washington, D.C.

Presentation of Centennial Award to the U. S. Geological Survey by the American Water Resources Association:
DANIEL D. EVANS, President, AWRA, Tucson, Arizona.

FRIDAY 8:00 A.M. – 5:30 P.M. **JUNE 15**

FIELD TRIP

REMOTE SENSING OF HYDROLOGY IN EASTERN SOUTH DAKOTA

Please refer to the writeup for Saturday, June 9, in this section.

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AWRA STAFF SUPPORT

Bea Williams, Special Projects Coordinator
Charlene Young, Production Editor/Composer Operator
Debra Olsen, Project Secretary & Bookeeper

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ANNOUNCEMENT OF FUTURE MEETING

FIFTEENTH AMERICAN WATER RESOURCES CONFERENCE

"Water Resources Management in a Changing Society"

and

SYMPOSIUM on

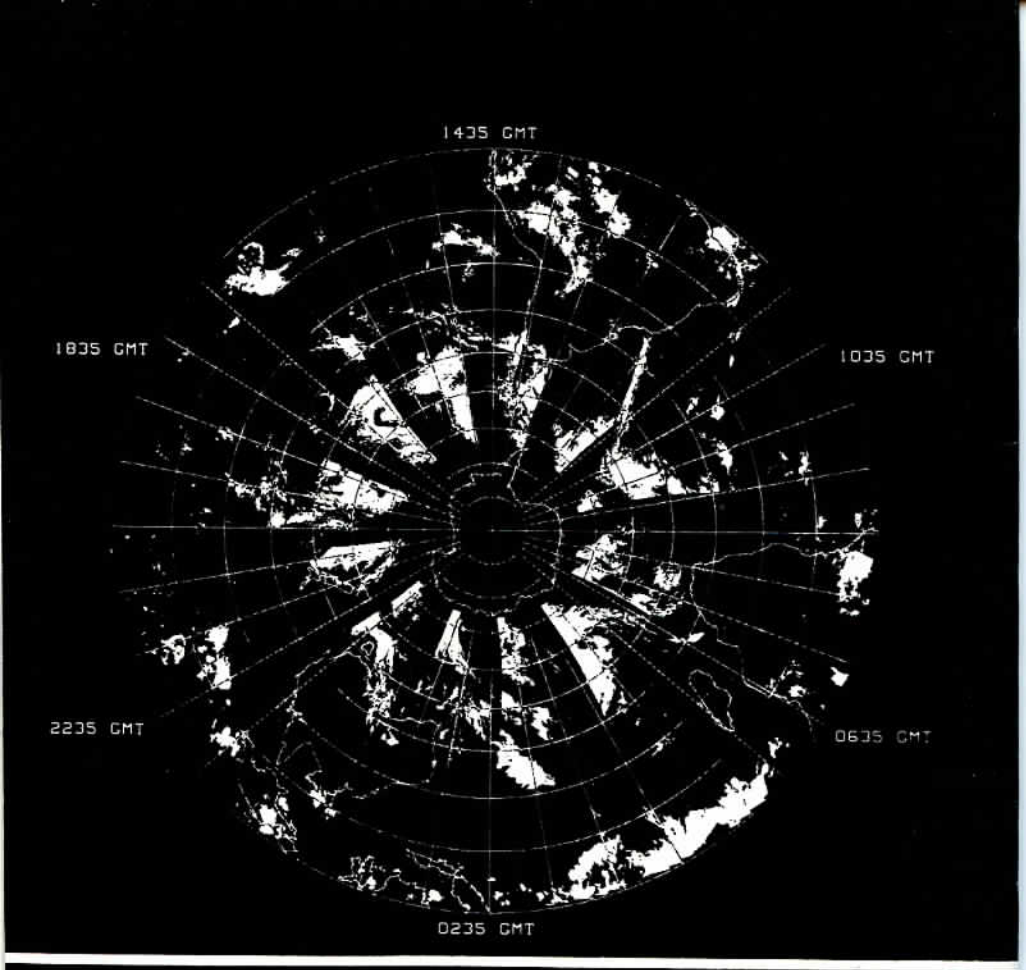
"The Use of Scientific Information in Planning for Environmental Quality Objectives"

Aladdin Hotel
Las Vegas, Nevada
September 24–28, 1979

The 1979 Conference of the American Water Resources Association will address "Water Resources Management in a Changing Society." Many aspects of water resources management, development, planning, research, education, and information systems will be discussed. An AWRA National Symposium will be held concurrently which will explore the use of scientific information in planning for environmental quality objectives. The extent to which current scientific information is being incorporated in planning will also be considered.

Three field trips will be held in conjunction with the Conference and Symposium: (1) to the Nevada Atomic Test Site; (2) to Hoover Dam, the highest concrete dam in the Western Hemisphere; and (3) to the Las Vegas Wash and its environs for a close look at the most modern attempt to deal with the problems of water pollution and scarcity.

For further information, write AWRA, St. Anthony Falls Hydraulics Laboratory, Mississippi River at Third Avenue, S.E., Minneapolis, Minnesota 55414.



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