NOAA Technical Report NESDIS 16

TEMPORAL AND SPATIAL ANALYSES OF CIVIL MARINE SATELLITE REQUIREMENTS

Washington, D.C.
February 1986

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Environmental Satellite, Data, and Information Service

NOAA TECHNICAL REPORTS

National Environmental Satellite, Data, and Information Service

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EDIS 33 Accurate Least-Squares Techniques Using the Orthogonal Function Approach. Jerry Sullivan, March 1980. (PB80 223241)

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NESDIS 4 Some Applications of Satellite Radiation Observations to Climate Studies. T. S. Chen, George Ohring, and Haim Ganot, September 1983. (PB84 108109)

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(Continued on inside back cover)

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Nancy J. Hooper and
John W. Sherman III

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U.S. DEPARTMENT OF COMMERCE
Malcolm Baldrige, Secretary

National Oceanic and Atmospheric Administration
Anthony J. Calio, Administrator

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FORWARD

Not many years ago oceanographers assumed that the ocean environment changed so slowly that observations taken at one point in the ocean could be compared with similar observations at another point even though the observations were taken several years apart. Average conditions in the ocean could thus be established."

"Uses of the Sea" Edmund A. Gullion, Editor*

This comment was made eight years after the launch of the first earth-observing satellite by the National Aeronautics and Space Administration, and ten years before the launch of any sensors designed to make oceanic observations from space. At the time of the comment it was recognized that "present theories do not satisfactorily explain or predict all of the many fluctuations that have been observed over a wide span of time." The basis for the statement was made on the use of bigger and faster ships and improved instrumentation and data processing techniques.

The success of Seasat and Nimbus-7 in further improving understanding of the dynamics of the ocean, in particular the most dynamic portion--the surface, prompted federal agencies to review the role of satellites in addressing national marine needs. This review led to the creation of the concept of the National Oceanic Satellite System (NOSS). Subsequently, the National Oceanic and Atmospheric Administration conducted a series of national workshops to address the needs of the civil oceanic community for satellite data. A document entitled "Report of the Conference on the National Oceanic Satellite System," dated September 1980, was published by the Department of Commerce. While NOSS was indefinitely deferred, the concept was highly successful in uniting the marine community as a cohesive voice in establishing the need for operational marine satellites.

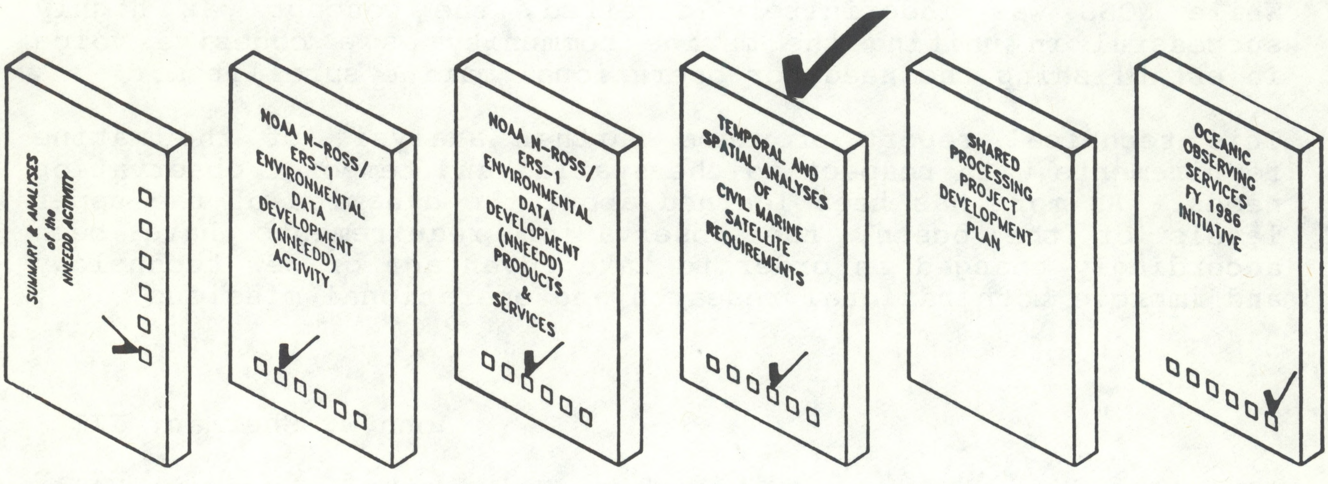
This technical report provides further analysis of the marine requirements with respect to the spatial and temporal observation needs. As more has been learned about the dynamics of the upper levels of the ocean, the observation requirements have been accordingly changed in order to take advantage of new technology and improve both national research and operational missions.

John W. Sherman, III

*The American Assembly, Columbia University, Prentice-Hall, Englewood Cliffs, N.J., 1968, pp 17-18.

PREFACE

- o The document is one of a series of documents that defines NOAA's opportunity to increase oceanic observing services well beyond those presently provided.
- o This opportunity has been designated as the NOAA N-ROSS/ERS-1 Environmental Data Development Activity and is accomplished by using satellite systems already under development by other agencies.
- o NOAA becomes a gateway to oceanic data derived from non-NOAA satellites; a gateway that will not exist without the NNEEDD Activity.
- o This document contains the analysis of the temporal and spatial requirements of the civil marine community for satellite derived data.
- o The documents in this series include:



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I. INTRODUCTION

Background

During the late spring of 1980, five workshops were sponsored by the National Oceanic and Atmospheric Administration (NOAA) of the Department of Commerce to insure representation of civil marine requirements in the National Oceanic Satellite System (NOSS).[1] While the NOSS concept did not mature as a United States satellite system, it did coalesce the requirements of the marine community.

This focus on satellite requirements indicated that not all users had the same requirements and that a single user did not necessarily have the same requirements for all applications. Applications of the same types of satellite-derived data vary greatly depending on the use for local, regional, or global coverage. However, this focus on satellite requirements did show that, given the stated goals of the NOSS program, a significant number of marine requirements could be addressed.

Table 1 shows the stated goals for oceanic operational geophysical measurements as defined by the NOSS program.[2] The analyses conducted in the NOSS Conference Report did not discriminate between the relationship of the NOSS goals in Table 1 and the actual projected capabilities of NOSS. As example, while a goal of 12 hours for frequency of coverage for winds was established, the actual capability of the system was around 36 to 42 hours. The major limitation to the NOSS program was that the initial system consisted of a single satellite. Such a single-satellite system

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1 Report of the Conferences on the National Oceanic Satellite System; DOC/NOAA/NESS, September, 1980.

2 NOSS, National Oceanic Satellite System; Joint effort by NASA, DOC/NOAA, and DOD/Navy, Air Force, and Army, March 23, 1979.

Table 1

National Oceanic Satellite System

Goals for Operational Geophysical Measurements

Parameter	Accuracy	Resolution	Frequency	Delay
Wind				
Speed	2 m/s	25km	12h	3h
Direction	10 deg	25km	12h	3h
Sea Surface Temperature				
Global	1.0°C	25km	3 days	12h
Local	0.5°C	10km	1 day	12h
Waves (Sea State)				
Significant Wave Height	0.3m	25km	12h	3h
Direction	10 deg	25km	12h	3h
Ice				
Cover	15%	20km	3 days	12h
Thickness	2m	50km	3 days	12h
Age	New, 1st Yr, Multi-Yr	20km	3 days	12h
Sheet Height	0.5m Change	10km	1 year	30 days
Water Mass Definition				
Chlorophyll	Within Factor of 2	0.4km	2 days	8h
Turbidity	Lo, Med, Hi	0.4km	1 day	10h
Horizontal Surface Currents				
Speed	5 cm/s	20km	1 day	1 day
Direction	10 deg	20km	1 day	1 day

with swathwidths typical of oceanic sensors provides coverage every 36 to 42 hours, and thus cannot meet the NOSS goals as stated in Table 1.

The NOSS Workshops provided a worksheet for volunteers to complete. Of the more than 400 attendees at the workshops, 150[3] completed the worksheets. Thirty-three (33) of these were academic users, 43 were commercial users, and 74 were governmental users.[4] These 150 users responded for their own specific needs and thus did not necessarily respond for all ocean parameters listed.

The NOSS Conference Worksheet is contained in the appendix to this report. Question 3 of the worksheet asked the respondents to define temporal and spatial requirements of the marine community. Temporal resolution provided by satellites is an especially critical element for marine users, particularly those concerned with safety at sea. Respondents were specifically asked for the oceanic measurements required to support their activities for each of the following parameters:

- Wind Velocity;
- Wave Height/Direction;
- Sea Surface Temperature;
- Sea Ice Measurement;
- Ocean Current Velocity;
- Chlorophyll;
- Diffuse Attenuation Coefficient (Turbidity); and
- Other.

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3 The original NOAA Conference Report cited in Footnote 1 above was based on 144 responses.

4 It is noted that of the 74 governmental users responding, 31 were from military organizations.

The analyses in the NOSS Conference Report weighed the NOSS goals against user requirements and not the single-satellite coverage of NOSS against user requirements. The analyses in that report did not provide detailed responses to Question 3 which is analyzed in this report. As done in the original study, these analyses distinquish between governmental, academic, and commercial users.

Summary

- This study evaluated the marine temporal and spatial requirements of the marine community based on the NOSS Conference Worksheets.
- The marine community requirements have been divided into three groups: Governmental, Academic, and Commercial.
- Requirements for surface winds, temperature, waves, sea ice, color-derived information, and currents and circulation were analyzed.
- No analyses were conducted to divide the user requirements into local, regional, or global needs.
- The following general conclusions may be drawn with regard to temporal coverage requirements:

Frequency (hours)	Percent Met
<3	100
3	~90
6	~70
12	~50
24	~35

- There is a great variance in the above percentages depending on the oceanic parameter.
- The spatial resolution requirements are more varied than temporal resolution requirements, but in general can be met by present-day technology and are independent of multi-satellite systems.

II. TEMPORAL REQUIREMENTS

Overview

The analysis of the frequency of coverage for wind velocity, sea surface temperature, wave height/direction, sea ice measurement, chlorophyll, diffuse attenuation coefficient (turbidity), and ocean current velocity are summarized in Figure 1 for all marine users. For users who needed data less frequently than 24 hours, their requirements would be satisfied by the 24-hour requirement and were thus assigned to that group. Similarly, a user who needs data 3 times a day was put in the 6-hour group.

Generally 70% or more of all users are satisfied by 6-hour coverage. However, a special note is made with regard to users requiring data derived from an ocean color instrument for which more than 80% are satisfied with 24-hour coverage. A detailed breakout for color-derived chlorophyll is shown in Figure 2 wherein the 24-hour coverage of Figure 1 is divided into $\geq$ 1 week, 3 days, and 1 day. This level of detail for chlorophyll is not carried forward in the remaining analysis of this section.

The relationship of the temporal coverage requirements to satellite characteristics is considered in Section IV of this report.

Requirement Analysis by User Type and Parameter

Figures 3 through 9 present the temporal coverage analysis for the prime marine parameters to be derived from oceanic satellite sensors based on types of users. The total column is the same as that shown in Figure 1 for the given marine parameter.

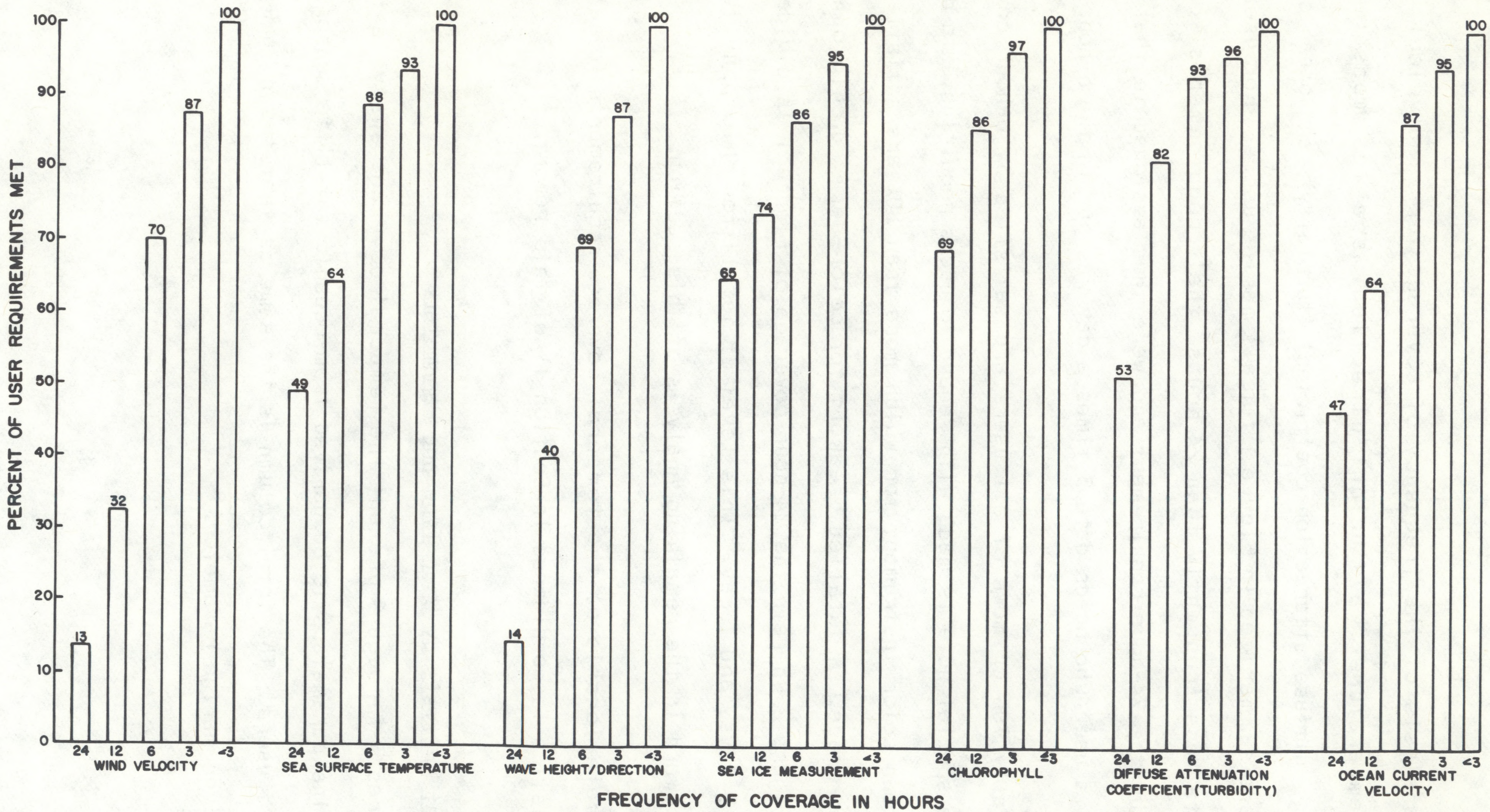

FIGURE 1. OVERVIEW OF MARINE TEMPORAL REQUIREMENTS

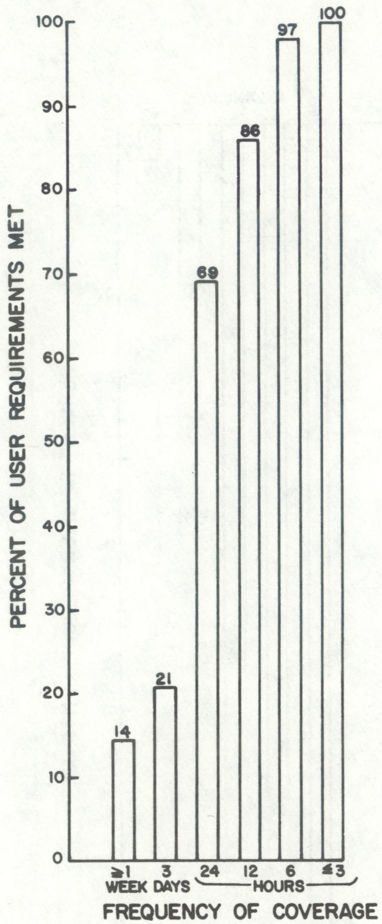

FIGURE 2. DETAIL OF TEMPORAL REQUIREMENTS FOR CHLOROPHYLL

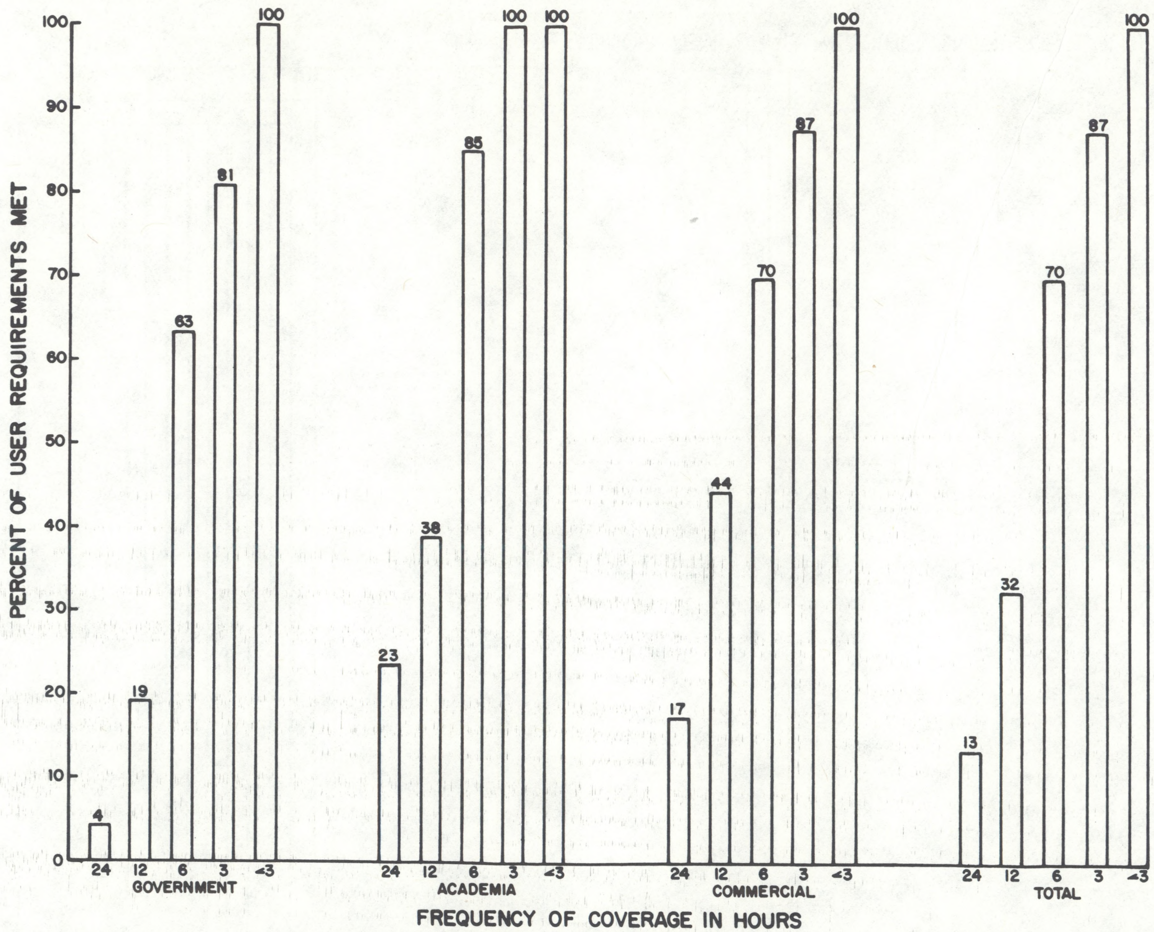

FIGURE 3. TEMPORAL REQUIREMENTS FOR WIND VELOCITY

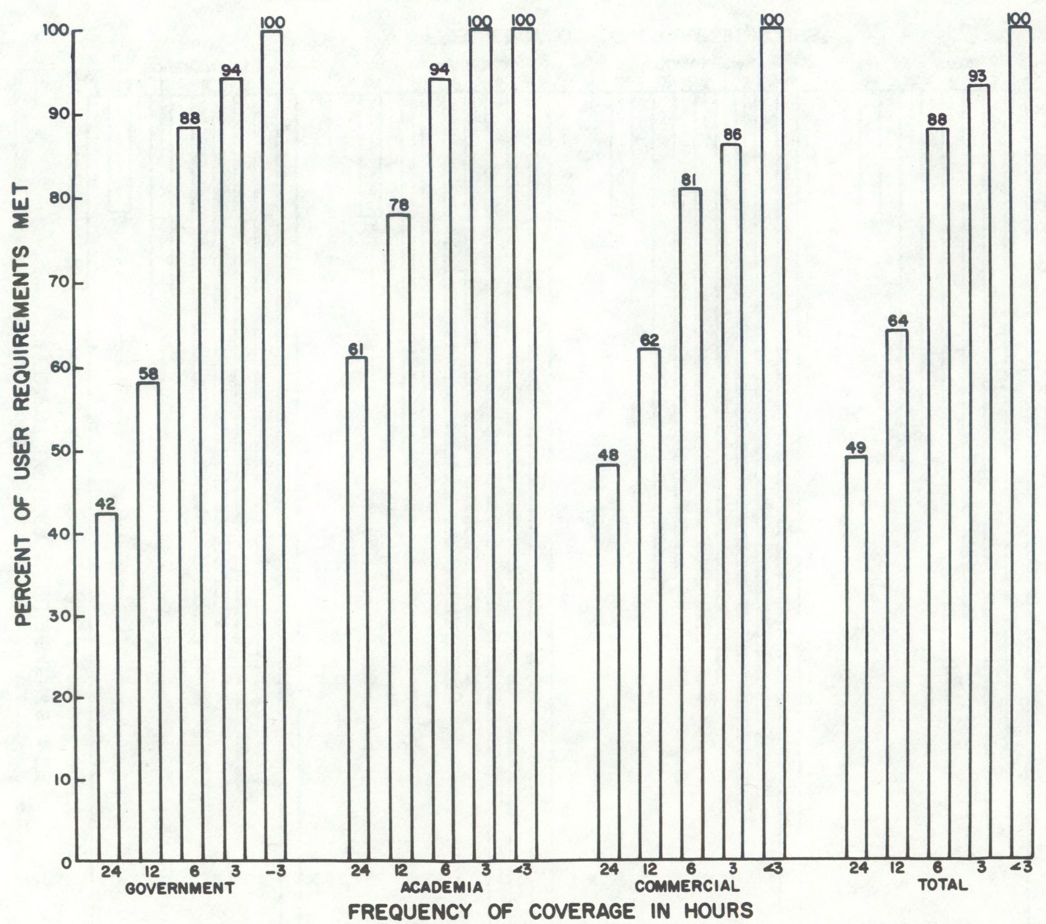

FIGURE 4. TEMPORAL REQUIREMENTS FOR SEA SURFACE TEMPERATURE

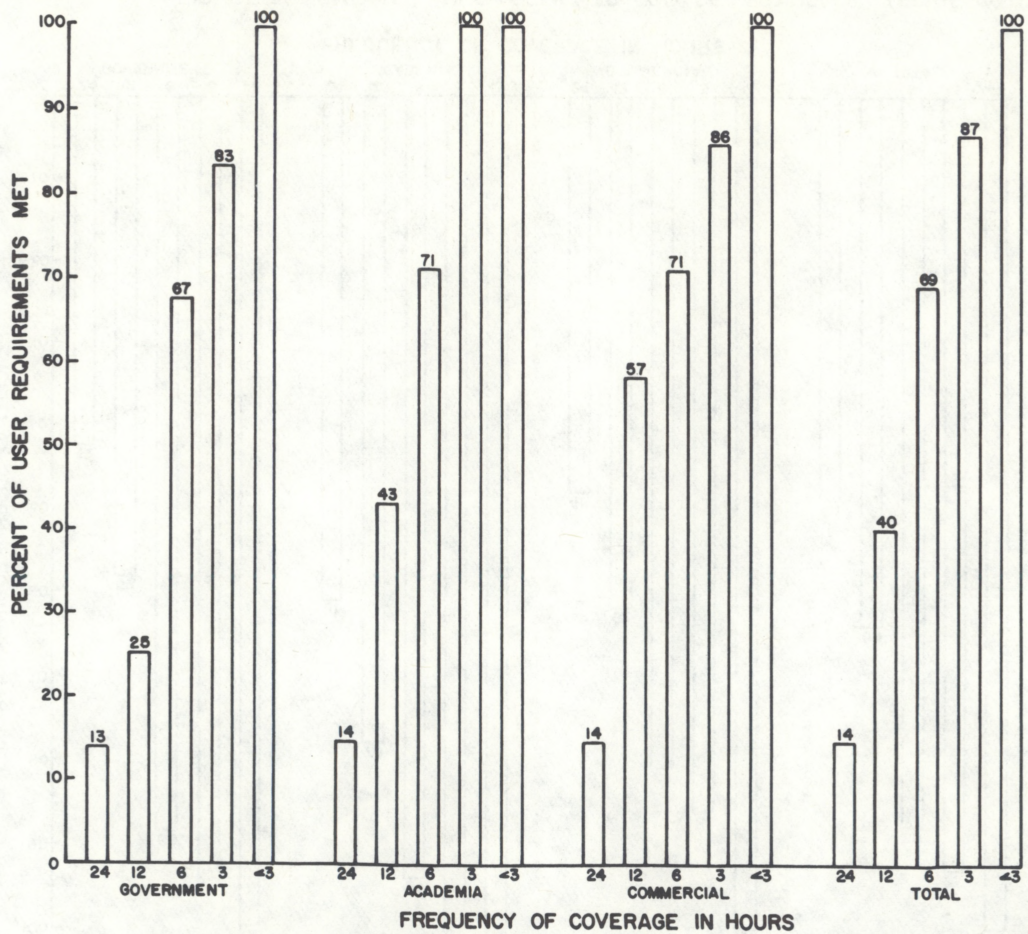

FIGURE 5. TEMPORAL REQUIREMENTS FOR WAVE HEIGHT/DIRECTION

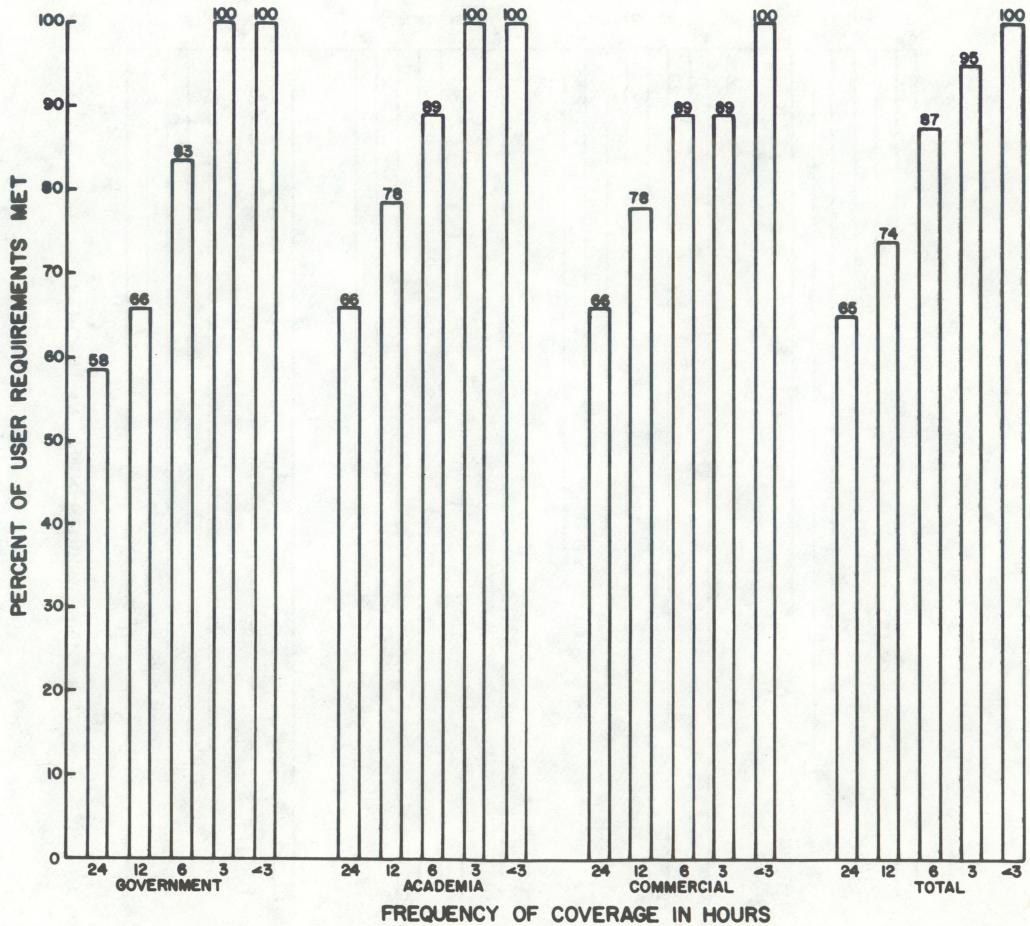

FIGURE 6. TEMPORAL REQUIREMENTS FOR SEA ICE MEASUREMENT

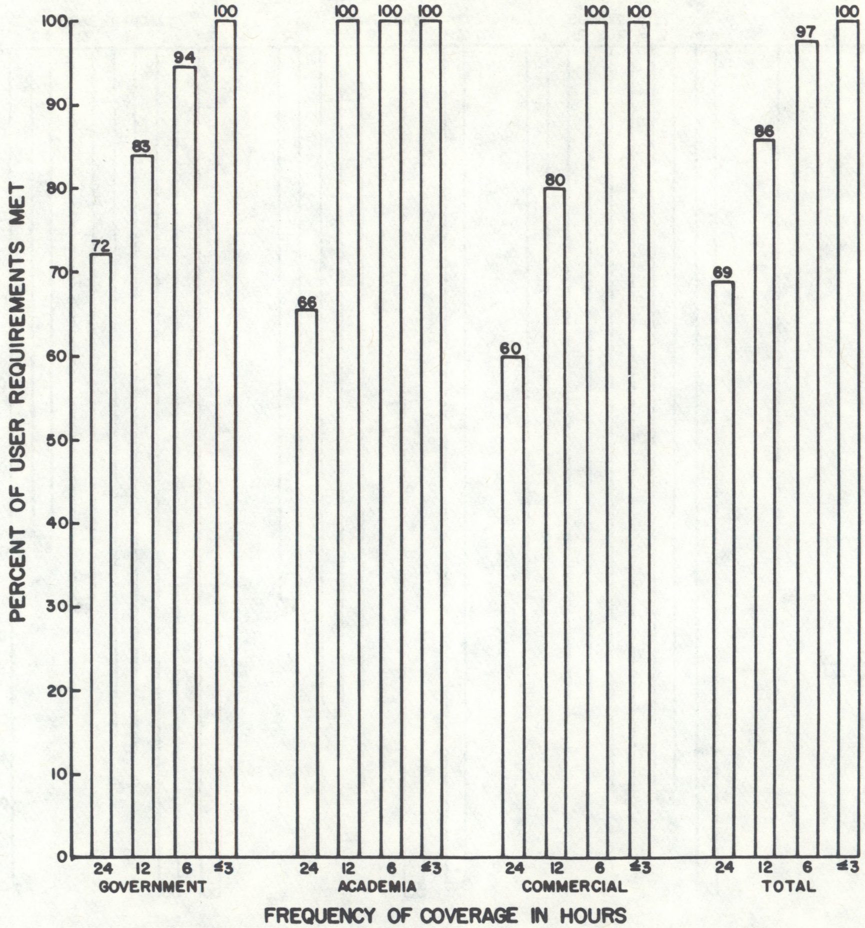

FIGURE 7. TEMPORAL REQUIREMENTS FOR CHLOROPHYLL

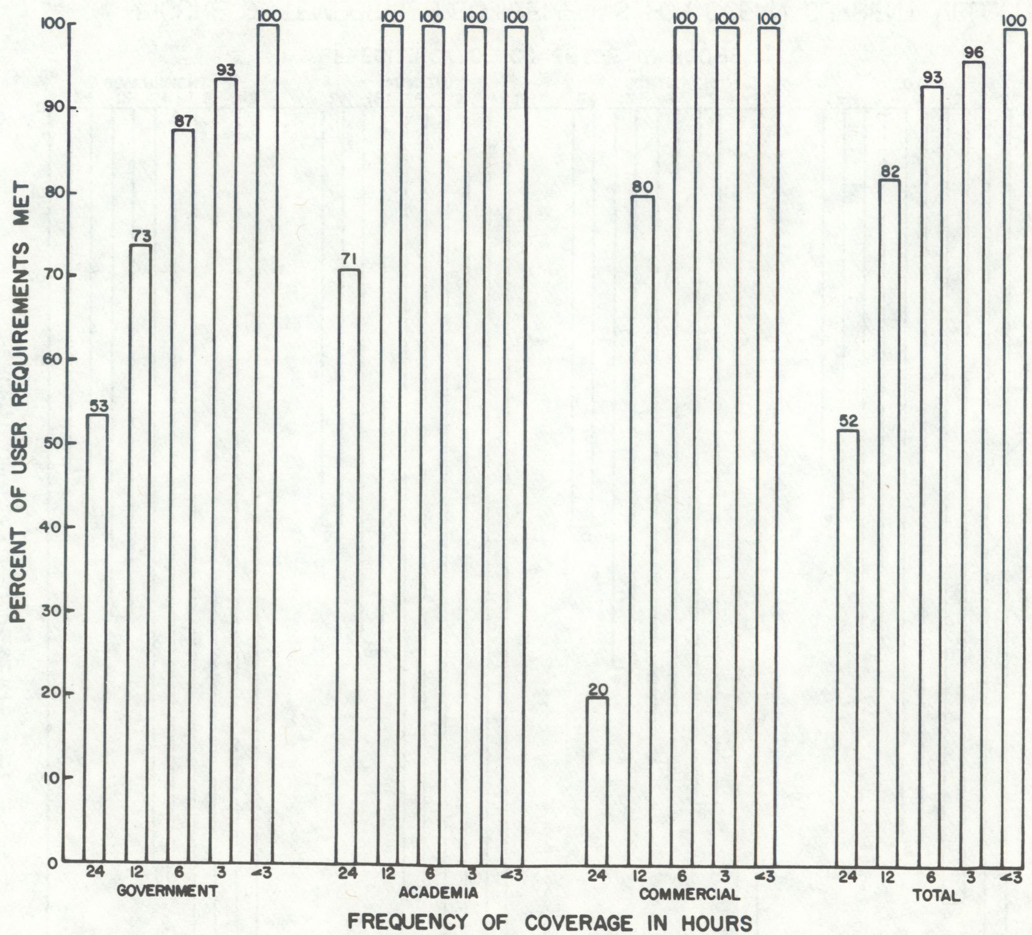

FIGURE 8. TEMPORAL REQUIREMENTS FOR DIFFUSE ATTENUATION COEFFICIENT (TURBIDITY)

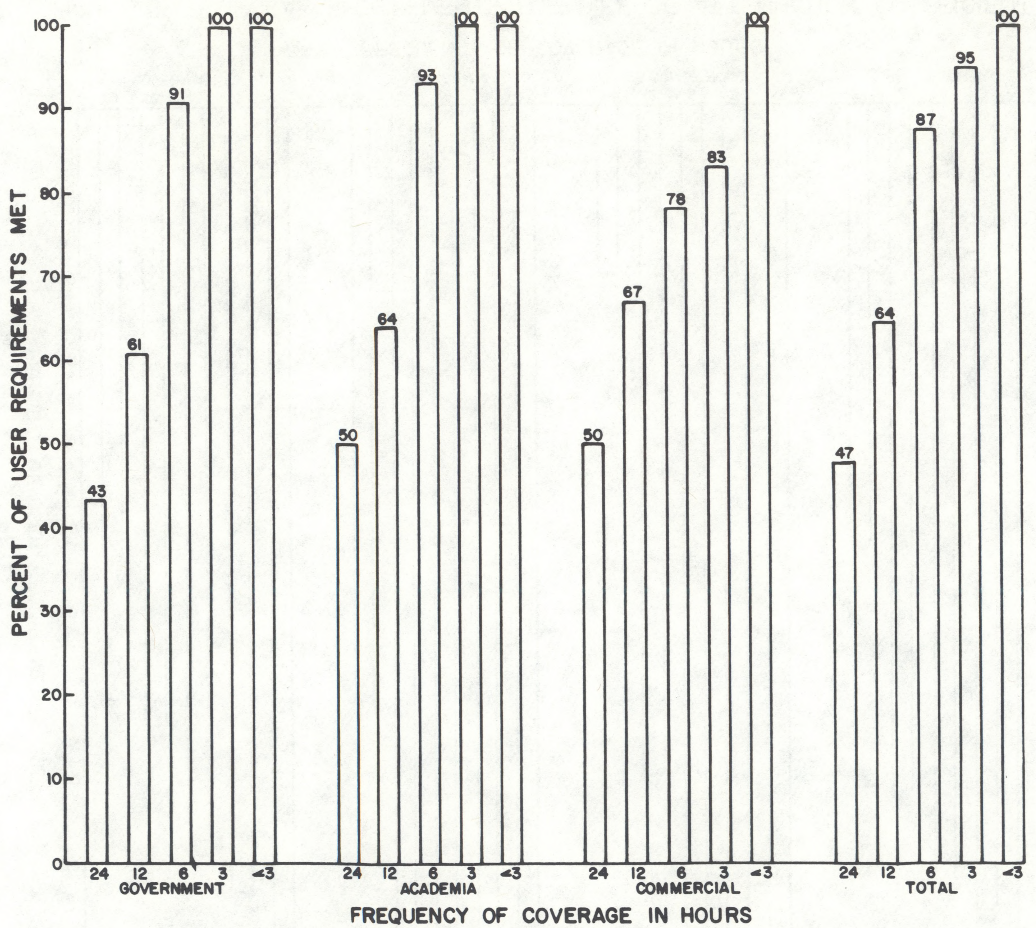

FIGURE 9. TEMPORAL REQUIREMENTS FOR OCEAN CURRENT VELOCITY

III. SPATIAL REQUIREMENTS

Overview

The spatial characteristics of satellite sensors depend upon the specific design of the instruments. Thus, while temporal coverage is dependent upon the number of satellites and the swathwidth of the sensors, spatial coverage is dependent solely upon the sensors. In this regard, NOSS and other oceanic satellites typically perform well in addressing user requirements. Figure 10 is the overview of marine spatial requirements which indicate that, with the exception of color-derived products, resolutions on the order of 10-25 km satisfy a large number of users.

The spatial requirements are highly influenced by the users' applications to local, regional, and global problems. The analysis in this regard was outside the scope of this study which was focused primarily on the temporal coverage aspects.

Requirement Analysis by User Type and Parameter

Figures 11 through 17 define the user requirements for spatial resolution for satellite sensors for the prescribed parameters.

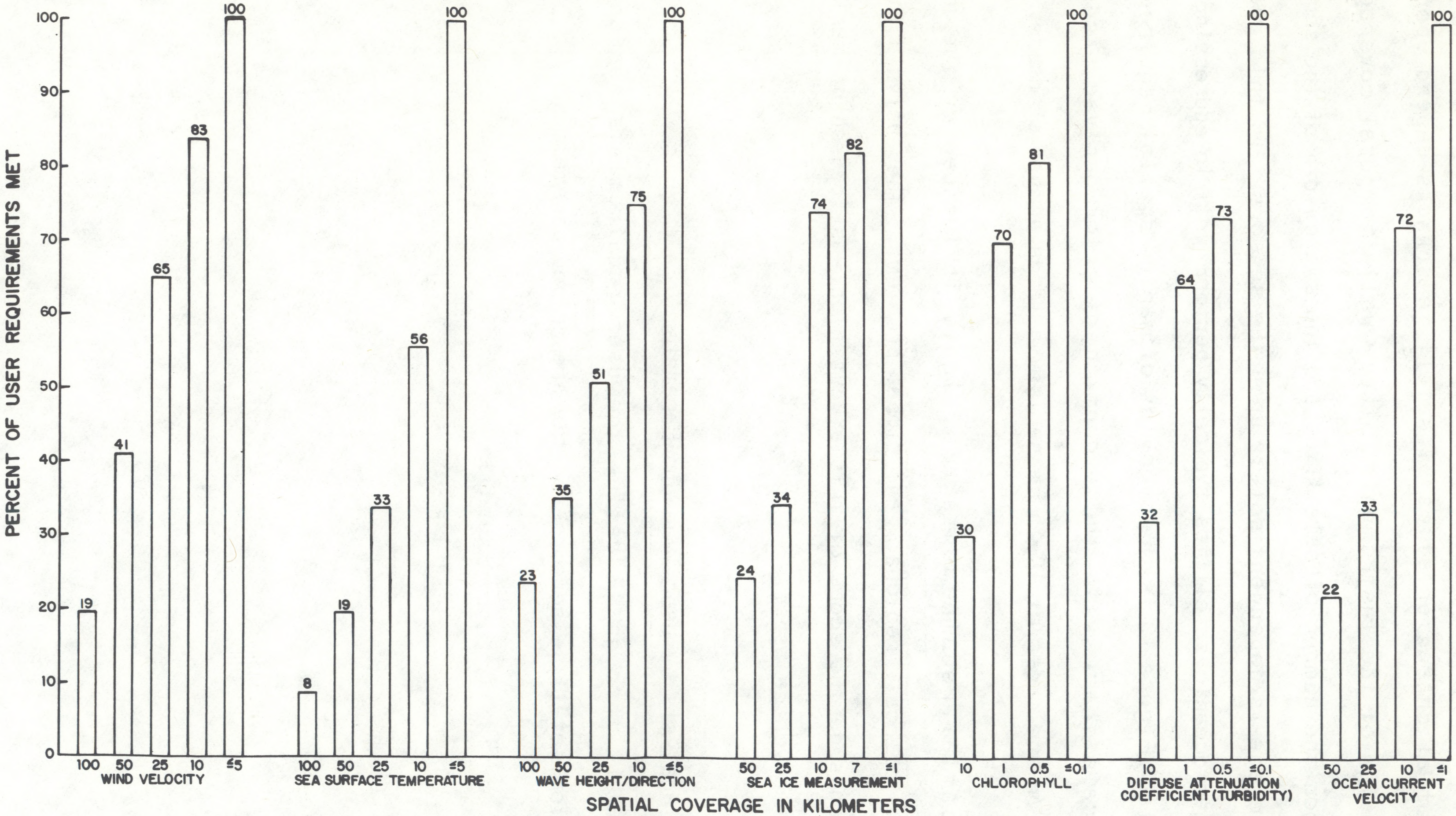

FIGURE 10. OVERVIEW OF MARINE SPATIAL REQUIREMENTS

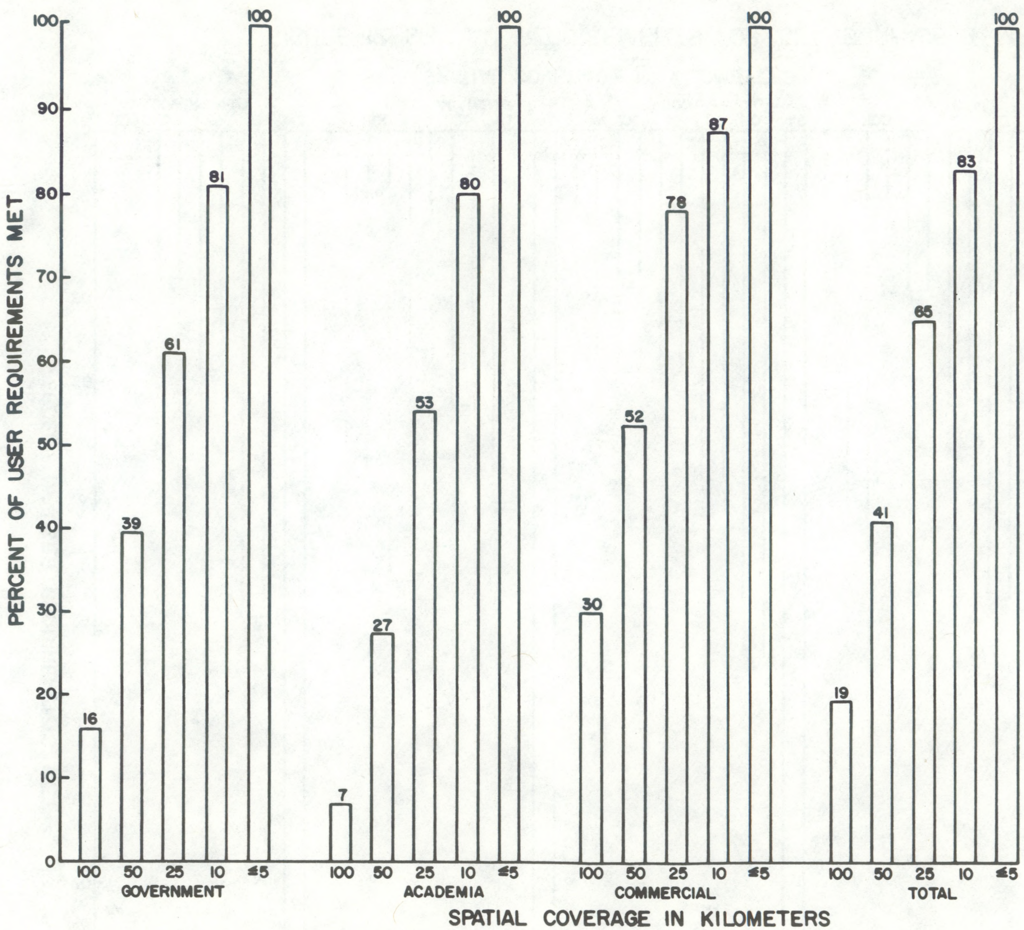

FIGURE 11. SPATIAL REQUIREMENTS FOR WIND VELOCITY

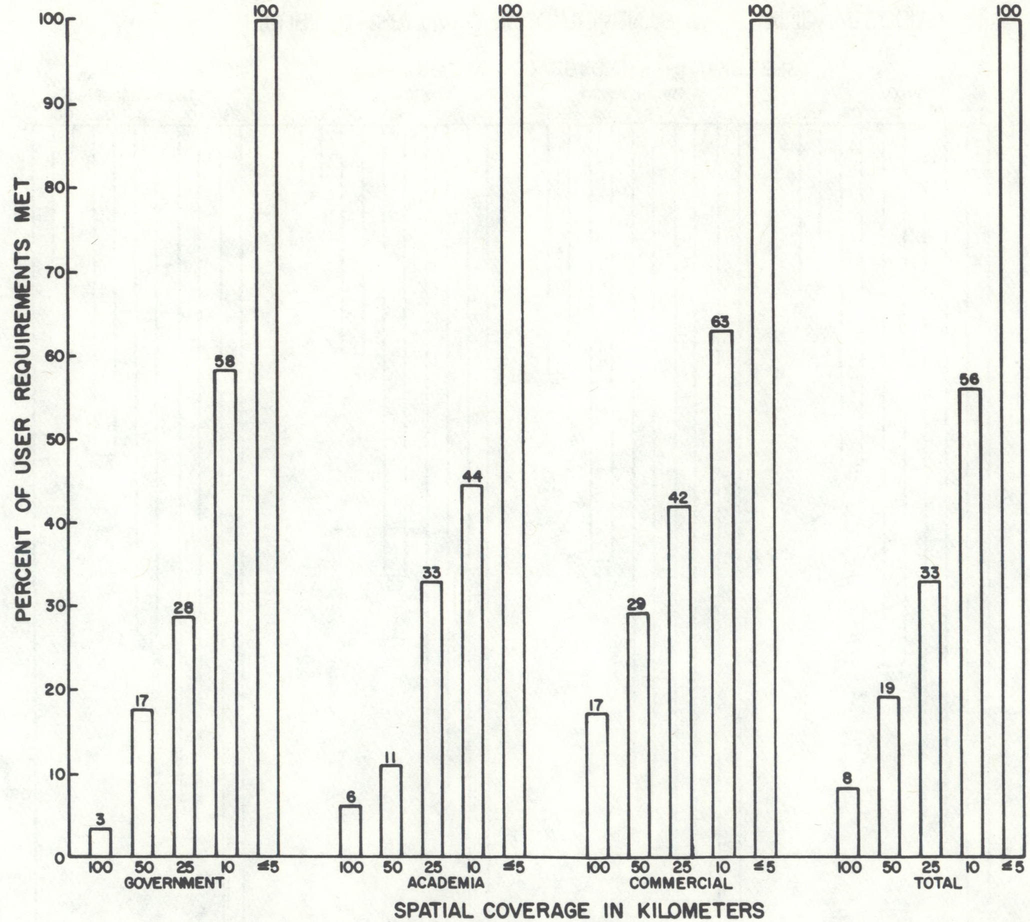

FIGURE 12. SPATIAL REQUIREMENTS FOR SEA SURFACE TEMPERATURE

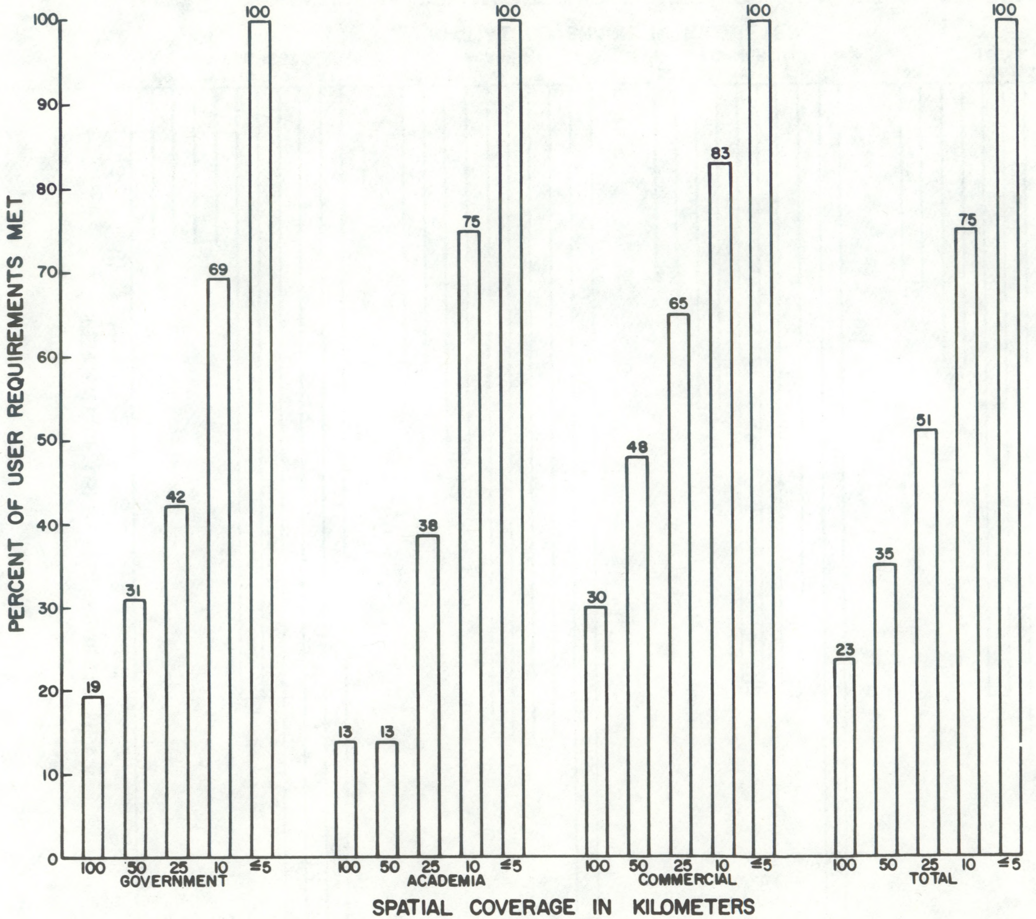

FIGURE 13. SPATIAL REQUIREMENTS FOR WAVE HEIGHT / DIRECTION

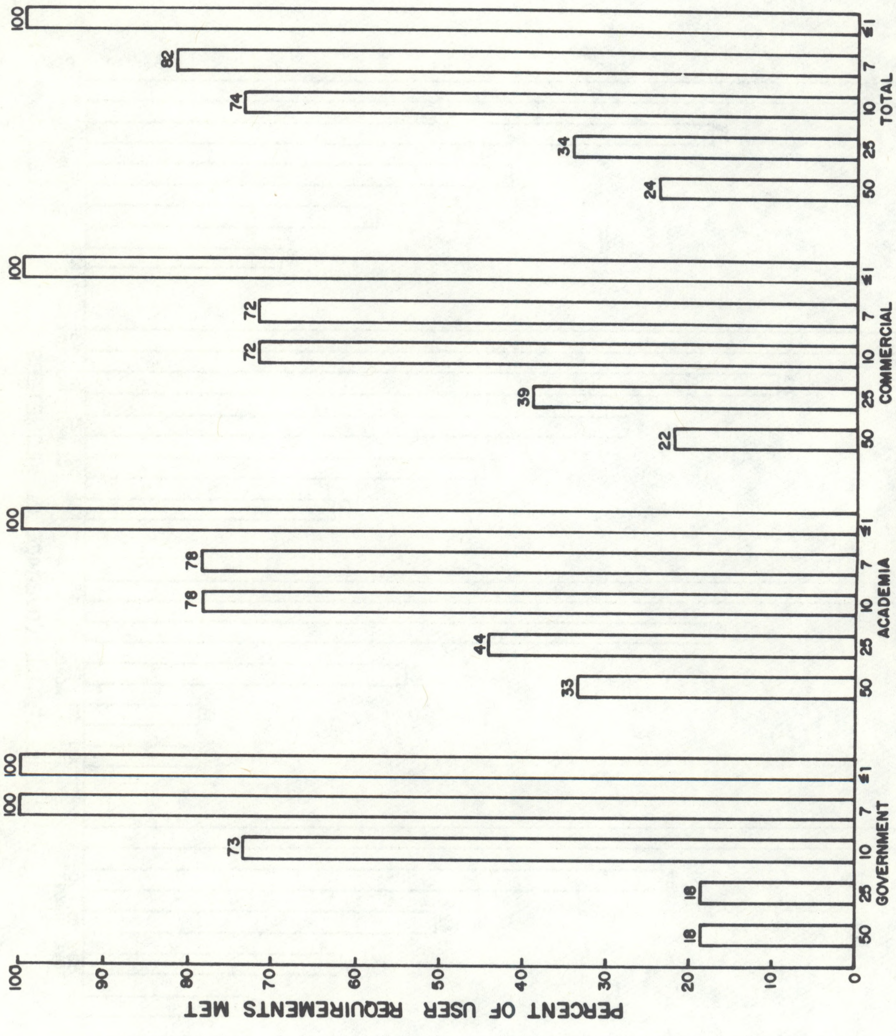

FIGURE 14. SPATIAL REQUIREMENTS FOR SEA ICE MEASUREMENT

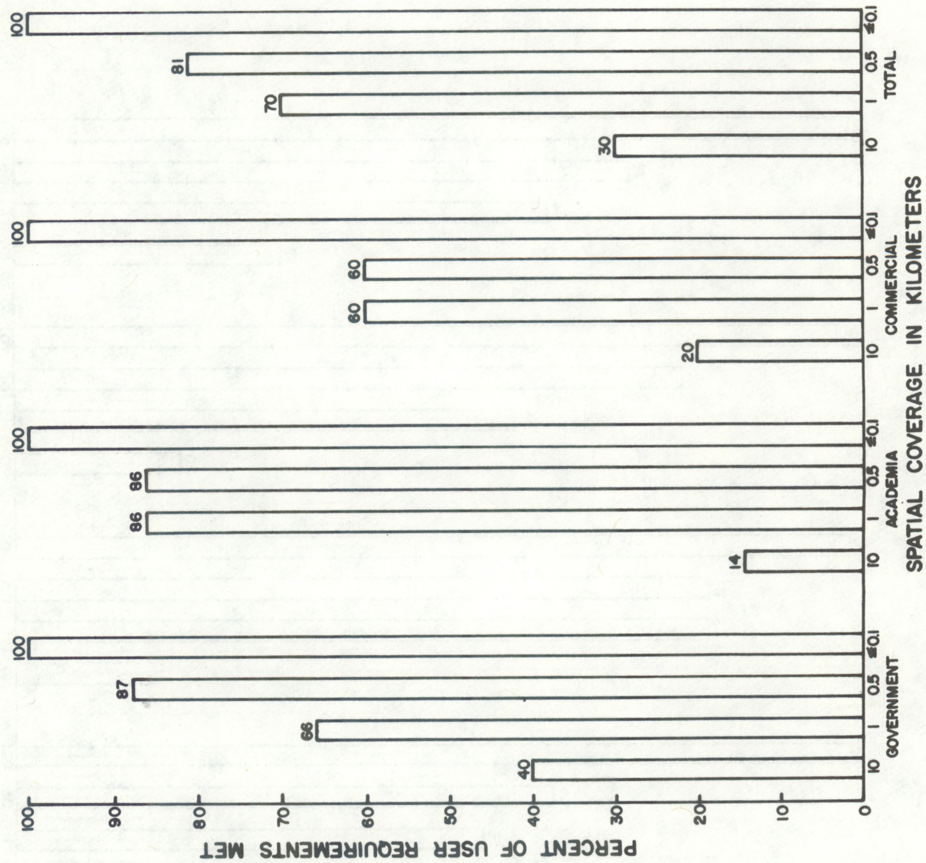

FIGURE 15. SPATIAL REQUIREMENTS FOR CHLOROPHYLL

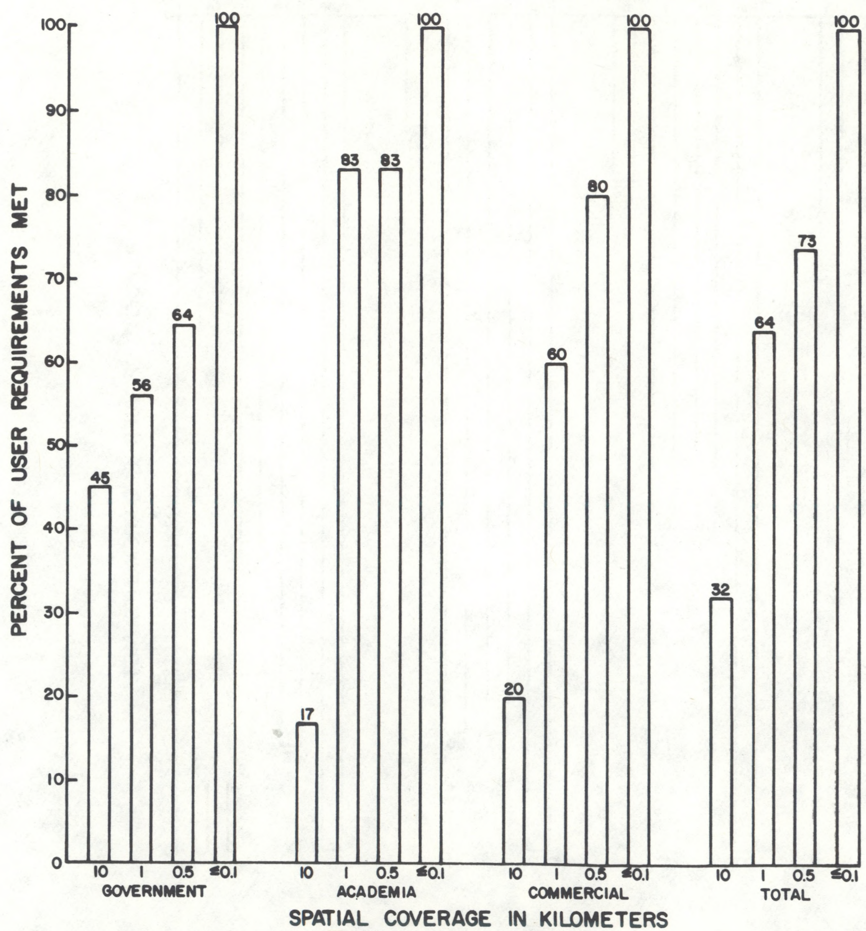

FIGURE 16. SPATIAL REQUIREMENTS FOR DIFFUSE ATTENUATION COEFFICIENT (TURBIDITY)

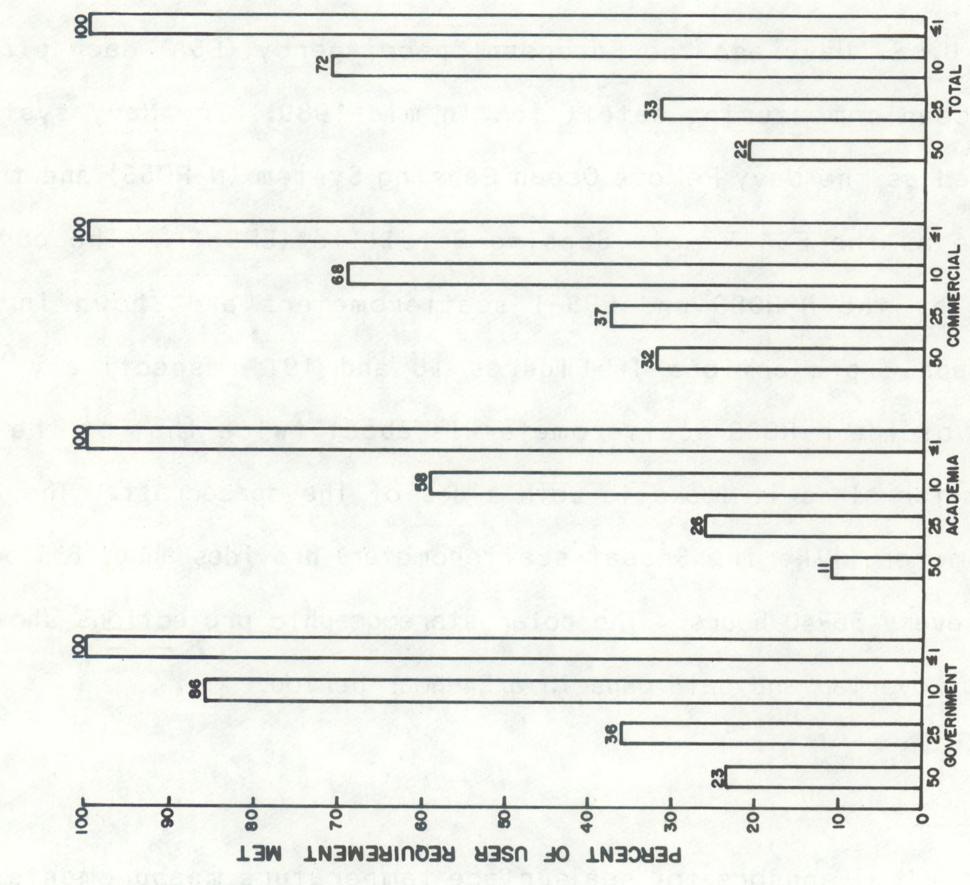

FIGURE 17. SPATIAL REQUIREMENTS FOR OCEAN CURRENT VELOCITY

IV. SATELLITES VERSUS TEMPORAL COVERAGE REQUIREMENTS

The temporal coverage of a single satellite primarily depends on the specific sensor swathwidth at the ocean surface. Because surface winds are the highest priority measurement and a driving function for the forecast of both winds and waves[5], this discusion focuses on only those sensors capable of deriving surface winds, i.e., scatterometers and microwave radiometers. Excluded are altimeters which also provide surface wind speed and wave height data, but at least six altimeter satellites are required to provide 24-hour global coverage when used as the sole source of wind or wave data.

The U. S. Navy and the European Space Agency (ESA) each plans to launch oceanic measuring satellites in mid-1989. The Navy system is designated as the Navy Remote Ocean Sensing System (N-ROSS) and the ESA satellite as the ESA Remote Sensing Satellite (ERS-1). The coverage provided by the N-ROSS and ERS-1 scatterometers are shown in polar stereographic projections in Figures 18 and 19, respectively.[6] The coverage of the N-ROSS scatterometer is about twice that of the ERS-1 scatterometer since it looks to both sides of the spacecraft. The N-ROSS scatterometer (like the Seasat scatterometer) provides about 85% oceanic coverage every 36-40 hours. The polar stereographic projections show both regions of overlap and data gaps in a 24-hour period.

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[5] Also, typical sensors for sea surface temperature measurements using infrared radiometers have larger swathwidths than microwave sensors used for wind measurements.

[6] Additional details on the actual swathwidths, orbits, and timing are contained in the paper "NOAA N-ROSS/ERS-1 Environmental Data Development (NNEEDD) Activity, NOAA/NESDIS, September, 1984.

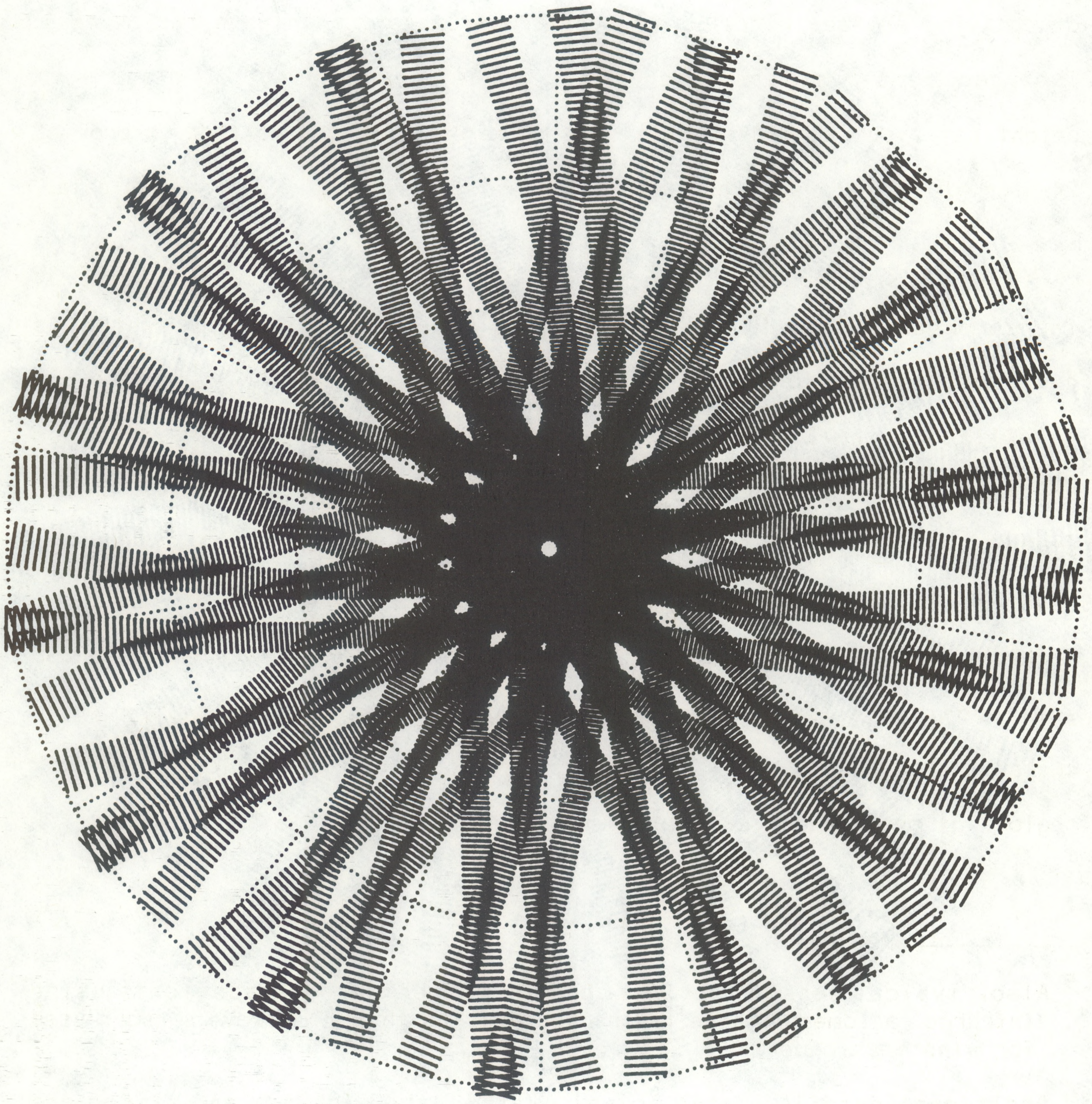

FIGURE 18. NROSS, ONE-DAY COVERAGE (13 ORBITS)

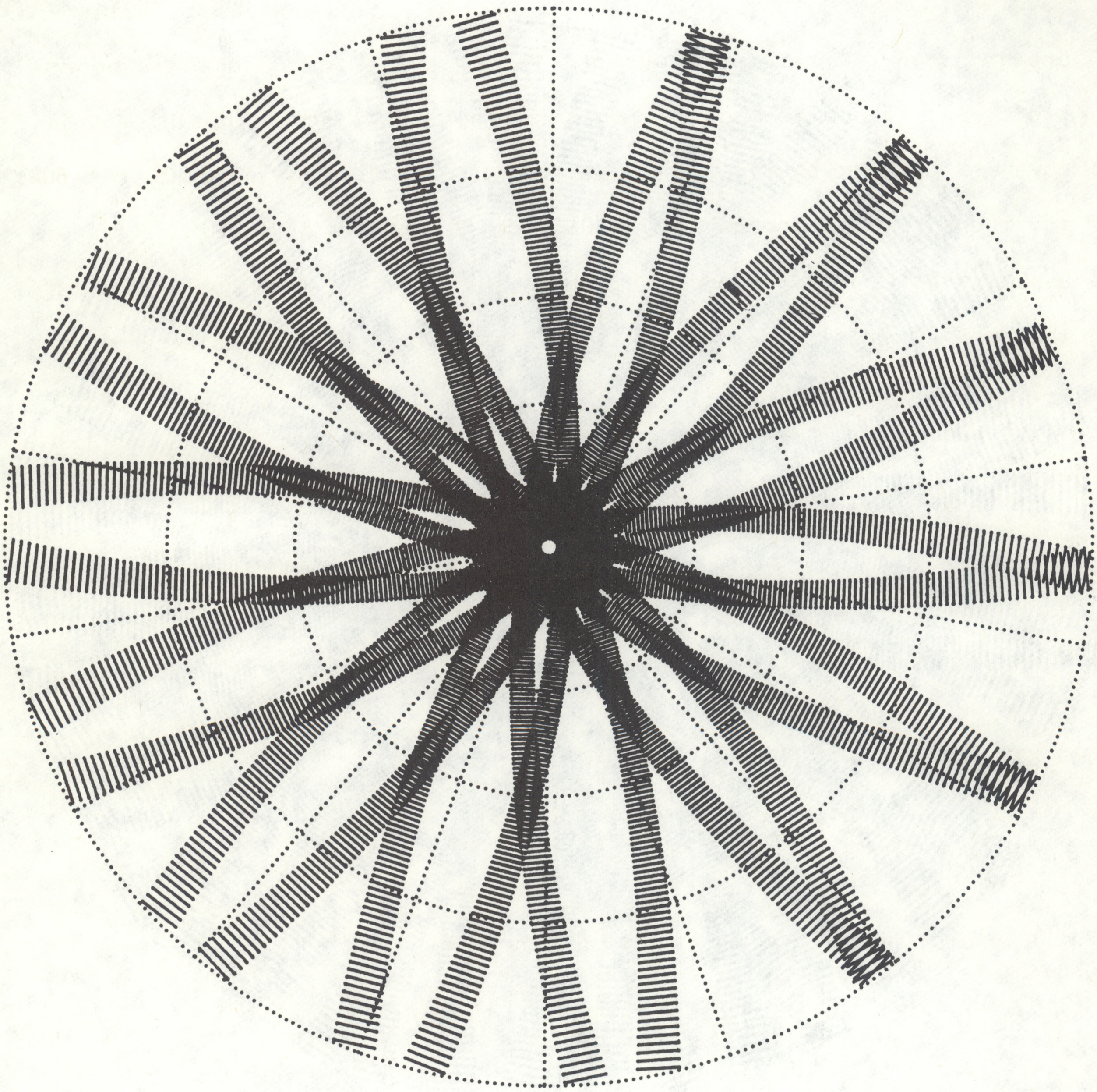

FIGURE 19. ERS-1, ONE-DAY COVERAGE (13 ORBITS)

The critical element to bring together the scatterometer system appears to be the Special Sensor Microwave Imager (SSM/I) instrument on both DMSP and N-ROSS. The coverage is shown in Figure 20 for the SSM/I coverage for one day. The coverage diagrams in Figures 18-20 are based on 13 orbits per day when actually N-ROSS, ERS-1, and DMSP satellites will have 14.26, 14.33, and 14.17 orbits per day, respectively. After 13 orbits, overlap with previous orbits begin and the coverage diagrams stopped at 13 orbits each to make the orbits distinct. Thus, the daily coverage provided by these three systems is approximately 30%, 60%, and 80% for the ERS-1 scatterometer, N-ROSS scatterometer, and SSM/I. If it is assumed that 3 SSM/I's and 2 scatterometers are simultaneously in orbit, then global oceanic coverage at the 80% plus level will be obtained in the 6-8 hour time period.

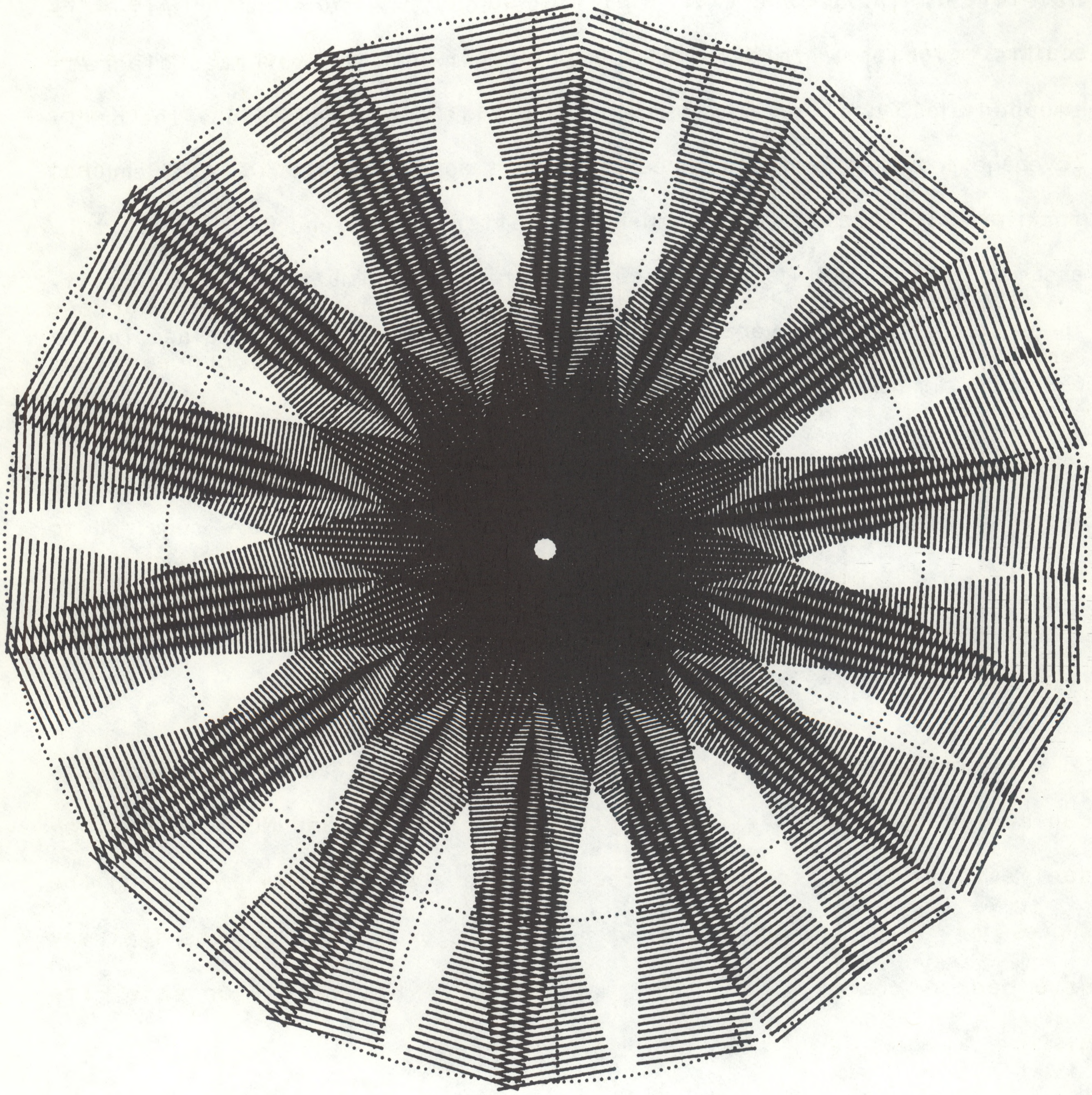

FIGURE 20. SSM/I, ONE-DAY COVERAGE (13 ORBITS)

V. CONCLUSIONS

The analyses presented here for the orbital coverage are not rigorous because the actual orbits may not be precisely those suggested and the sensors may be modified somewhat as their development continues. However, it is believed that the estimates prepared here are correct to the 10 to 15% level. It apears then that the suggested sensor ensemble of 2 scatterometers and 3 SSM/I's will provide near-global coverage in the 6-8 hour time period. This is the temporal coverage requirement that satisfied 70% of the marine users of surface wind data and products, the highest priority ocean parameter.

The satellite coverage for the other parameters of sea surface temperature, waves, sea ice, ocean color products, and currents and circulation have not been generated, but are estimated to be also at the 70% level of satisfying user requirements for the sensors on N-ROSS, DMSP, and NOAA satellites. Two ocean color instruments (OCI's) are required to meet this requirement for color-derived products. However, sea ice related products will be basically satisfied with one synthetic aperture radar (SAR) and one SSM/I.

In conclusion, it is believed that if 70% of marine user requirements can be met by a synthesis of N-ROSS, ERS-1, DMSP, and NOAA satellite-derived data (as described in the proposed NNEEDD activity), then the success of the proposed NOAA approach will far exceed the success that may have been achieved by any previously proposed satellite or satellite system.

VI. ACKNOWLEDGEMENTS

The work of the following people is acknowledged for their assistance in the preparation of this report: Ms. Arva Jackson, Chief of User Affairs, NOAA/NESDIS, for providing the funding for this report; and Mr. Ed King, Aerospace Engineering Technician, Oceanic Sciences Branch, NOAA/NESDIS, for drafting Figures 1 through 7 of this report.

APPENDIX

NOSS CONFERENCE WORKSHEET

1. BACKGROUND INFORMATION (OPTIONAL)

NAME ______________________________

ORGANIZATIONAL AFFILIATION ______________________________

ADDRESS ______________________________

____

______________________________ ZIP ______________

PHONE Area Code ( ) ______________________________

---

2. TYPE ORGANIZATION

- [ ] Government (federal, state or local)
- [ ] R&D
- [ ] Engineering
- [ ] Forecast/Prediction Services
- [ ] Petroleum related
- [ ] Other (please specify) ______________

Major responsibilities ______________________________

____

The response to this worksheet represents:

- [ ] Individual professional judgment
- [ ] Agency/Organization position
- [ ] Consortium position (If Consortium, please specify type Consortium and identify if members have responded in either of the first two categories)

Type ______________________ Category ______________

- [ ] Other ______________________________

____

3. WHAT OCEANIC MEASUREMENTS ARE REQUIRED TO SUPPORT YOUR ACTIVITY AND ON WHAT GRID OR RESOLUTION?

	Spatial Grid	Temporal Resolution
Wind velocity		
Wave height/direction		
Sea surface temperature		
Sea ice measurement		
Ocean current velocity		
Chlorophyll		
Diffuse attenuation coefficient/ turbidity		
Other		

4. AFTER SATELLITE DATA ACQUISITION, DATA IS REQUIRED IN

- [ ] Near-real time
  - [ ] within 3 hours
  - [ ] within 6 hours
  - [ ] within 12 hours
  - [ ] within 24 hours
  - [ ] 24 hours to 1 week
  - [ ] other
- [ ] Non-real time
  - [ ] 1 to 2 weeks
  - [ ] 2 to 4 weeks
  - [ ] 4 weeks or longer
  - [ ] other

5. DATA IS REQUIRED OVER SCALES OF

- [ ] Local and coastal (100's of kilometers)
- [ ] Regional (1,000's of kilometers)
- [ ] Global (10,000's of kilometers)

Does your coverage vary or remain fixed?

- [ ] Varies
- [ ] Fixed

6. DATA FROM NOSS MUST BE DISTRIBUTED TO USERS. HOW BEST SHOULD SUCH COMMUNICATIONS BE ESTABLISHED?

- ☐ Dial-In Techniques (near-real time)
- ☐ Dial-In Techniques (non-real time)
- ☐ Computer-to-computer (near-real time)
- ☐ Computer-to-computer (non-real time)
- ☐ Telecopy/Wefax, etc.
- ☐ CCTS (from archive) via mail
- ☐ Photographic products via mail
- ☐ Other/Comment ______________________

____

7. GEOPHYSICAL DATA WILL PROBABLY BE THE MOST COMMON FORM OF NOSS DATA. HOWEVER, CALIBRATED, LOCATED, ENGINEERING DATA (LEVEL 1) WILL BE POTENTIALLY AVAILABLE TO USERS.

Do you need these data in: ☐ Near-real time ☐ Non-real time

Are the requirements for Level 1 the same as for questions 3, 4, and 5?

☐ Yes ☐ No

If No, please comment on differences.

____

____

____

____

____

____

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8. DOES NEAR-REAL TIME DATA/ANALYSES NEED TO BE RECEIVED

☐ Continuously as available; ☐ Only during normal working hours;

☐ Only intermittently on a task basis; ☐ Other ______________________

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9. IF POSSIBLE WOULD IT BE OF BENEFIT TO COMBINE NOSS GEOPHYSICAL MEASUREMENTS WITH OTHER GEOPHYSICAL DATA SOURCES FOR NON-REAL TIME DATA?

☐ Yes ☐ No ☐ No preference

The NOSS data distribution system will have the capability of producing analyses of oceanic parameters from NOSS data merged with other analyses. Will you be accessing:

☐ NOSS data only
☐ NOSS and other data
☐ Both
☐ Other/Comment ______________________________

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10. HAVE YOU USED ANY DATA FROM GOES, TIROS-N/NOAA, GEOS-3, SEASAT OR NIMBUS-7 SATELLITES?

☐ Yes ☐ No

Would the availability of these data be useful?

☐ Yes ☐ No ☐ Other/Comment __________

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Would reprocessing of these data to the NOSS Formats be useful? (Note: a time delay of a year or more may be required)

☐ Yes ☐ No ☐ Other/Comment __________

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11. ARE YOU AWARE THAT CERTAIN DATA COSTS MAY BE BORNE BY YOU AS A USER (TERMINAL INTERFACE, COMMUNICATION LINKS, ETC.)?

☐ Yes ☐ No ☐ Comment ______________________

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For non-real time users current CCT's cost is about $60.00 and photographic products vary according to type, size, etc. Do you find these costs a reasonable basis for NOSS data charges?

☐ Yes ☐ No ☐ Comment ______________________

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12. WHAT SHOULD BE THE ROLE OF PRIVATE ENTERPRISE IN PROVIDING INFORMATION-EXTRACTION VALUE-ADDED SERVICES TO SATISFY YOUR CONTINUING INFORMATION REQUIREMENTS? WHAT CAN THE FEDERAL GOVERNMENT DO TO ASSURE THE SUCCESS OF THIS ROLE?

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13.a. DO YOU HAVE COMMENT ON HOW BEST TO CONTINUE A DIALOGUE BETWEEN NOAA/NOSS AND USERS?

- [ ] Publications, i.e. quarterly
- [ ] Workshops/Conferences
- [ ] Presentations at professional/trade meetings
- [ ] Establish specific discipline groups
- [ ] Other ____

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b. Do you have any suggestions on how best to organize the interface between private sector (academic and industrial) and NOAA?

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14. OTHER COMMENTS, SUGGESTIONS, ISSUES.

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Conference Managers:

HRM, Inc.
1101 30th Street N.W., Suite 301
Washington, D.C. 20007

(202) 338-9071

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(Continued from inside cover)

NESDIS 6 Spatial and Temporal Distribution of Northern Hemisphere Snow Cover. Burt J. Morse (NESDIS) and Chester F. Ropelewski, October 1983. (PB84 118348)

NESDIS 7 Fire Detection Using the NOAA--Series Satellites. Michael Matson and Stanley R. Schneider (NESDIS), Billie Aldridge and Barry Satchwell (NWS), January 1984. (PB84 176890)

NESDIS 8 Monitoring of Long Waves in the Eastern Equatorial Pacific 1981-83 Using Satellite Multi-Channel Sea Surface Temperature Charts. Richard Legeckis and William Pichel, April 1984. (PB84 190487)

NESDIS 9 The NESDIS-SEL Lear Aircraft Instruments and Data Recording System. Gilbert R. Smith, Kenneth O. Hayes, John S. Knoll, and Robert S. Koyanagi, June 1984. (PB84 219674)

NESDIS 10 Atlas of Reflectance Patterns for Uniform Earth and Cloud Surfaces (NIMBUS-7 ERB--61 Days). V.R. Taylor and L.L. Stowe. (PB85 12440)

NESDIS 11 Tropical Cyclone Intensity Analysis Using Satellite Data. Vernon F. Dvorak, September 1984. (PB85 112951)

NESDIS 12 Utilization of the Polar Platform of NASA's Space Station Program for Operational Earth Observations. John H. McElroy and Stanley R. Schneider, September 1984. (PB85 1525027AS)

NESDIS 13 Summary and Analyses of the NOAA N-ROSS/ERS-1 Environmental Data Development Activity. John W. Sherman III, February 1984. (PB85 222743/43)

NESDIS 14 NOAA N-ROSS/ERS-1 Environmental Data Development (NNEEDD) Activity. John W. Sherman III, February 1985. (PB86 139284 A/S)

NESDIS 15 NOAA N-ROSS/ERS-1 Environmental Data Development (NNEEDD) Products and Services. Franklin E. Kniskern, February 1985. (in press)

NESDIS 16 Temporal and Spatial Analyses of Civil Marine Satellite Requirements. Nancy J. Hooper and John W. Sherman III, February 1985. (in press)

NESDIS 17 reserved

NESDIS 18 Earth Observations and The Polar Platform. John H. McElroy and Stanley R. Schneider, January 1985. (PB85 177624/AS)

NESDIS 19 The Space Station Polar Platform: Integrating Research and Operational Missions. John H. McElroy and Stanley R. Schneider, January 1985. (PB85 195279/AS)

NESDIS 20 An Atlas of High Altitude Aircraft Measured Radiance of White Sands, New Mexico, in the 450-1050 nm Band. Gilbert R. Smith, Robert H. Levin and John S. Knoll, April 1985. (PB85 204501/AS)

NESDIS 21 High Altitude Measured Radiance of White Sands, New Mexico, in the 400-2000 nm Band Using a Filter Wedge Spectrometer. Gilbert R. Smith and Robert H. Levin, April 1985. (PB85 206084/AS)

NESDIS 22 The Space Station Polar Platform: NOAA Systems Considerations and Requirements. John H. McElroy and Stanley R. Schneider, June 1985. (PB86 109246/AS)

NESDIS 23 The Use of TOMS Data in Evaluating and Improving the Total Ozone from TOVS Measurements. James H. Lienesch and Prabhat K.K. Pandey, July 1985. (PB86 108412/AS)

NOAA SCIENTIFIC AND TECHNICAL PUBLICATIONS

The National Oceanic and Atmospheric Administration was established as part of the Depa Commerce on October 3, 1970. The mission responsibilities of NOAA are to assess the socioeconom of natural and technological changes in the environment and to monitor and predict the state of Earth, the oceans and their living resources, the atmosphere, and the space environment of the E

The major components of NOAA regularly produce various types of scientific and technical tion in the following kinds of publications:

PROFESSIONAL PAPERS—Important definitive research results, major techniques, and special investigations.

CONTRACT AND GRANT REPORTS—Reports prepared by contractors or grantees under NOAA sponsorship.

ATLAS—Presentation of analyzed data generally in the form of maps showing distribution of rainfall, chemical and physical conditions of oceans and atmosphere, distribution of fishes and marine mammals, ionospheric conditions, etc.

TECHNICAL SERVICE PUBLICATIONS—Reports containing data, observations, instructions, etc. A partial listing includes data serials; prediction and outlook periodicals; technical manuals, training papers, planning reports, and information serials; and miscellaneous technical publications.

TECHNICAL REPORTS—Journal quality with extensive details, mathematical developments, or data listings.

TECHNICAL MEMORANDUMS—Reports of preliminary, partial, or negative research or technology results, interim instructions, and the like.

NATIONAL ENVIRONMENTAL SATELLITE, DATA, AND INFORMATION SERVICE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

Rockville, MD 20852