NOAA Technical Report NESDIS 15

# NOAA N-ROSS/ERS-1 ENVIRONMENTAL DATA DEVELOPMENT (NNEEDD) PRODUCTS AND SERVICES

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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NESS 92 Satellite Infrared Observations of Oceanic Long Waves in the Eastern Equatorial Pacific 1975 to 1981. Richard Legeckis, November 1982. (PB83 161133)

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EDIS Series

EDS 29 GATE Convection Subprogram Data Center: Final Report on Rawinsonde Data Validation. Robert W. Reeves, March 1978. (PB-281-861)

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EDIS 31 Calibration and Intercomparison of the GATE C-Band Radars. M. Hudlow, R. Arkell, V. Patterson, P. Pytlowany, F. Richards, and S. Geotis (MIT), November 1979. (PB81 120305)

EDIS 32 Distribution of Radiosonde Errors. Harold L. Crutcher, May 1979. (PB-297-383)

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

EDIS 34 An Application of Stochastic Forecasting to Monthly Averaged 700 mb Heights. Albert Koscielny, June 1982. (PB82 244625)

NESDIS Series

NESDIS 1 Satellite Observations on Variations in Southern Hemisphere Snow Cover. Kenneth F. Dewey and Richard Heim, Jr., June 1983. (PB83 252908)

NESDIS 2 NODC 1 An Environmental Guide to Ocean Thermal Energy Conversion (OTEC) Operations in the Gulf of Mexico. National Oceanographic Data Center (DOC/NOAA Interagency Agreement Number EX-76-A-29-1041), June 1983. (PB84 115146)

NESDIS 3 Determination of the Planetary Radiation Budget From TIROS-N Satellites. Arnold Gruber, Irwin Ruff, and Charles Earnest, August 1983. (PB84 100916)

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

NESDIS 5 A Statistical Technique for Forecasting Severe Weather From Vertical Soundings by Satellite and Radiosonde. David L. Keller and William L. Smith, June 1983. (PB84 114099)

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Franklin E. Kniskern

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U.S. DEPARTMENT OF COMMERCE
Malcolm Baldrige, Secretary

National Oceanic and Atmospheric Administration
Anthony J. Calio, Administrator

National Environmental Satellite, Data, and Information Service
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## FORWARD

"The moisture and varying temperature of the land depends largely upon the positions of the currents in the ocean, and it is thought that when we know the laws of the latter we will, with the aid of meteorology, be able to say to the farmers hundreds of miles distant from the sea, 'You will have an abnormal amount of rain during next summer' or 'the winter will be cold and clear' and by these predictions they can plant a crop to suit the circumstances or plant an unusual amount of food for their stock."

Lt. John E. Pillsbury,
The Gulf Stream, 1891

For more than one hundred years those with great intuitive understanding knew of the nature of Earth forces and the coupling of energy from one sphere of influence to another. While Lt. Pillsbury's recognition of the coupling between ocean and atmosphere went essentially unheralded into the twentieth century, now these spheres of influence are being identified as the twenty-first century approaches. This new recognition is primarily focused on the dearth of oceanic information to permit a comprehensive understanding of the coupling of the ocean to other Earth phenomena.

The NOAA N-ROSS/ERS-1 Environmental Data Development (NNEEDD) Activity is a major component in the collection of oceanic data to support the day-to-day operational needs of the marine community. It will, however, become a major building block in the long term marine data needs to identify cycles associated with the hydrosphere, cryosphere, atmosphere, lithosphere, and biosphere. The products and services outlined in this document are derivable from the proposed NNEEDD Activity and have drawn on nearly fifteen years of research and analysis of potential space systems to address operational and research requirements. These requirements are contained in a separate NNEEDD publication.

John W. Sherman, III

# PREFACE

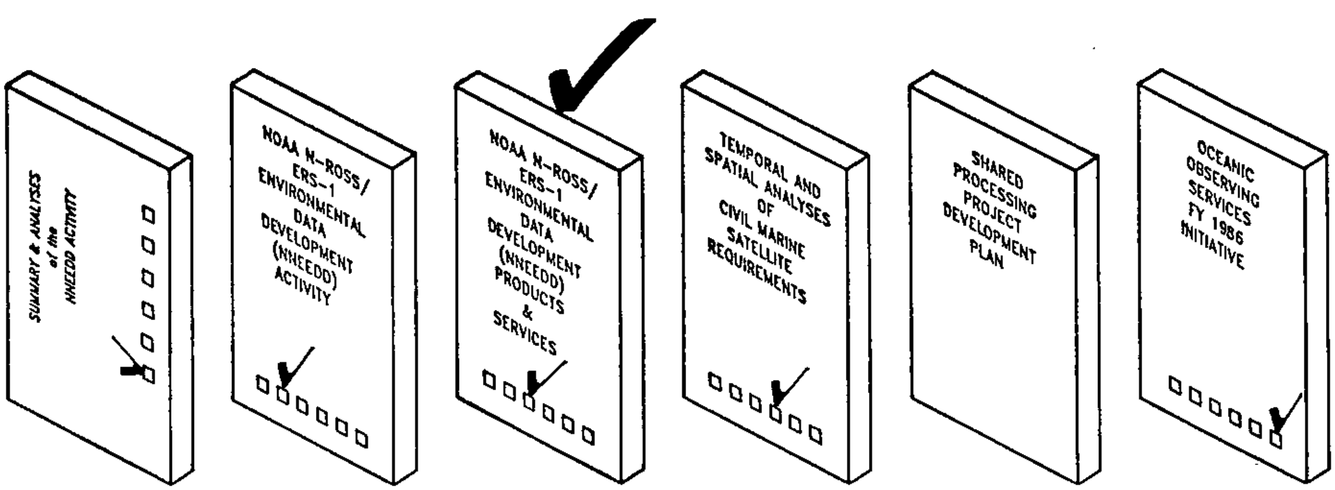
- The document is one of a series of documents that defines NOAA's opportunity to increase oceanic observing services well beyond those presently provided.

- 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.

- NOAA becomes a gateway to oceanic data derived from non-NOAA satellites; a gateway that will not exist without the NNEEDD Activity.

- This document defines the products and services that are obtainable through the proposed NNEEDD Activity.

- The documents in this series include:



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## SUMMARY

This study focuses on products and services expected from the Navy-Remote Ocean Sensing System (N-ROSS) and the European Space Agency's (ESA) first Remote-Sensing Satellite (ERS-1). The NOAA N-ROSS/ERS-1 Environmental Data Development (NNEEDD) Activity will put into place a system capable of handling all-all-weather oceanic data planned through the remainder of this century, including the polar-platform associated with the Space Station.* This statement may appear all-encompassing, but these two satellite systems carry all generic-types of ocean-measuring instruments except ocean color. The NNEEDD Activity will provide global data from the following approved new satellite systems:

| Satellite (Agency) | Launch Date |
|---|---|
| Geosat (Navy) | March 1985 |
| DMSP SSM/I (AF) | Mid-1986 |
| ERS-1 (ESA) | Mid-1989 |
| N-ROSS (Navy) | Mid-1990 |

Further, the proposed NNEEDD Activity will provide data on winds, waves, sea surface temperature, sea and lake ice, and currents and circulation, on a near real-time basis. Once the national commitment is made it will permit the value-added industry to provide new or improved services to their present markets and to develop new markets.

The NNEEEDD Activity will also include data and information from other satellite systems as these systems are approved for either research or applications. These include NASA's TOPEX, Japan's ERS-1** (and MOS-1 if appropriate), and Canada's Radarsat. Over the next six years, nineteen new oceanic sensors are planned for launch on eight satellites. These are:

| Active Microwave Sensors | | | Passive Sensors | | | |
|---|---|---|---|---|---|---|
| Altimeter/Scatterometer/SAR | | | Frequency/Microwave/IR/Visible | | | |
| Geosat | ERS-1 | ERS-1 | N-ROSS | DMSP(2) | ERS-1 | |
| ERS-1 | N-ROSS | Radarsat | | ERS-1 | MOS-1 | MOS-1 |
| N-ROSS | JERS-1 | JERS-1 | | N-ROSS | | |
| JERS-1 | (Radarsat) | | | JERS-1 | | |
| 4 | 3(4) | 3 | 1 | 5 | 2 | 1 |

TOTAL = 19

*Ocean color data as derived from an ocean color instrument is defined in separate documentation.
**Designated as JERS-1.

Presently, oceanic global data is derived from 2,000-4,000 ship and buoy reports and 30,000-70,000 satellite sea surface temperature retrievals per day. By the 1991-92 period these data reports will increase in approximately the following manner:

(Ships, Buoys, NOAA-Series, Geosat, DMSP, N-ROSS, and ERS-1 Only)
Data Reports Per Day in Thousands

| | 1984 | 1985 | 1986 | 1987 | 1988 | 1989-90 |
|---|---|---|---|---|---|---|
| Wind | | | | | | |
| Speed | 2-4 | 60 | 1,000 | 2,000 | 2,000 | 4,000 |
| Direction | 2-4 | 2-44 | 2-4 | 1-4 | 2-4 | 400-910 |
| Sea Surface Temperature | 30-70 | 30-70 | 30-70 | 30-70 | 30-70 | 650 |
| Waves | 2-4 | 60 | 60 | 60 | 60 | 120 |

The NNEEDD Activity is vital to the continued economic growth of U.S. marine activities. The U.S. civil oceanic community will have access to data from the above satellites only through NOAA participation with other agencies' satellites, and the U.S. oceanic community will have very limited access to foreign data without NOAA involvement.

## I. Introduction

The primary operational requirement by both the military and civilian oceanographic community is to have a global, all weather sea surface observation capability on a real-time basis. The DOD/Navy requires N-ROSS/ERS-1 type oceanographic data for the selection of operating areas, ship routing, strategic submarine operations, logistics resupply and tactical ship routing. The Navy also requires improved oceanographic predictions which involve high wind and sea areas, ice conditions in the polar areas and ocean thermal structure. NOAA, on the other hand, has the primary Federal civilian responsibility for monitoring oceanic phenomena. NOAA requires global, all-weather oceanographic data to support such diverse activities as: management and conservation of marine resources; the prediction of weather; the protection of life and property; the preservation, conservation and development of the Nation's coastal resources, and the provision of maps, charts, surveys and specialized data for safe navigation.

Oceanographic data requirements come from a variety of civilian users including Federal, State and local governments; marine transportation industries; commercial fisheries; coastal and offshore oil and gas industries; designers, builders and operators of coastal and offshore structures; and marine recreation groups.

The acquisition of global oceanic data is essential to the National Climate Program. NOAA operates a National Climate Program Office that plans, coordinates and guides the overall national effort. One of the objectives of the National Climate Program is to provide observations that establish an accurate and reliable record of the climate system. Special importance is attached to the implementation of a comprehensive ocean monitoring program. Also, without further advances in oceanographic data observation, global meteorological and oceanographic prediction models will not be improved because boundary and initial conditions cannot be specified.

The requirements and needs of the civil marine community for satellite-derived information have been evolving within NOAA for the last dozen years. Some of the papers that have been written supporting these requirements are as follows:

(1) Apel, J.R. and Sherman, J.W., III, 1973: Monitoring the Seas from Space: NOAA's Requirements for Oceanographic Satellite Data, Report AOML-LORS 6.731, NOAA/DOC, Miami, Florida; June.

(2) Miller, B.P. 1975: Seasat Economic Assessment Summary and Conclusions, Econ, Inc., Princeton, New Jersey, NASA Contract No. NASW-2558, August.

(3) Sherman, J.W.,III (Editor) 1979/80: NOAA Workshop on Oceanic Remote Sensing, Volume I: Action Summary and Report, Volume II: Workshop Support Documentation, NOAA/DOC, Washington, D.C.: Volume I December, 1979, and Volume II - March, 1980.

(4) Strong, A.E. and McClain, E.P. 1984: Improved Ocean Surface Temperatures from Space - Comparisons with Drifting Buoys, Bull. Amer. Meteorol. Soc. 65, 138-142, February.

(5) Honhart, D.C., 1984: Navy Remote Ocean Sensing System (N-ROSS), SPIE Tech. Symp. East, Conf. 481; May.

Since 1980 there have been no plans for a civilian oceanographic satellite program. However the proposed Navy Remote Ocean Sensing System (N-ROSS) which will carry some of the same sensors as SEASAT-A and the previously proposed NOSS will benefit the civilian community. In addition ERS-1 with its scatterometer, altimeter and both high and low bit data Synthetic Aperture Radar (SAR) present data sets complimentary to N-ROSS. There is a great opportunity for NESDIS to become involved and assume a central role in both the N-ROSS and ERS-1 missions.

## II. Requirements for Products and Services

This section describes and shows the oceanographic analyses products (Level III) anticipated to be available after the launch of N-ROSS and ERS-1. Products utilizing data from other satellite sensors including the AVHRR from the TIROS-N series are also included. This products list is derived from the National Oceanic Satellite System (NOSS) Products List developed in 1980. The products are listed in order of their priority for operational use by user agencies as determined by a task force consisting of representatives from NASA, DOC/NOAA, and DOD/Navy. The priority of these requirements were surface winds, sea surface temperatures, waves and sea ice. For the purpose of this paper, the wind and wave parameters have been combined and the wave products are listed after the wind products. Although the tri-agency task force determined the priority of these products prior to 1980, their findings are still valid today. By studying the oceanographic parameters (e.g. wind, SST) that will be measured by N-ROSS and ERS-1 and from which these products will be derived, a better understanding of the requirements can be ascertained.

Wind and Waves - Wind speed and direction was considered the top priority parameter to be measured by remote sensing. Since waves are a result of wind conditions, the requirements and needs for wind and wave data are many times synonymous. Tables 1 and 2 show the wind speed and direction and wave products respectively. The wind and wave requirements can be focused in three main areas:

(1) Naval ships, commercial ships and recreational boats;
(2) offshore oil and gas; and
(3) wind and wave data needed for forecasting and (hindcast) wave models.

A good example of the shipping industries needs for wind and wave data is the storm that damaged the Queen Elizabeth II bound for New York on September 18, 1978. The ship encountered heavy sea and swell with winds gusting to 64 knots. During the "QE-II" storm, SEASAT-A with its altimeter to measure wave height and its scatterometer to measure vector wind velocity passed over the storm. Had SEASAT wind and wave data been available in real time, early warning of the explosive deepening of the storm could have been transmitted to the Queen Elizabeth II. These warnings would have permitted evasive action by steering due south for about half a day to avoid high waves. The altimeter and scatterometer instruments aboard both N-ROSS and ERS-1 will provide a means to measure wind and wave conditions allowing timely storm warnings to be issued to ships at sea.

Offshore oil and gas platforms are particularly vulnerable to high wind and waves. Between 1955 and 1974, 46 of the 95 mobile drilling rig mishaps were caused by bad weather. Sufficient warning of severe storms and high waves is needed for decision making of either evacuation or moving the drilling rig. Again, data from N-ROSS and ERS-1 will provide forecasters with information to better assess the deepening potential and movement of severe storms.

More vector wind velocity data are presently needed as input into numerical weather forecasts. There forecasts prepared on large computers cannot forecast initial stages of storm development because the grid spacing required to accommodate global weather models is too course to detect early stages and subsequent rapid development of vortices and low pressure troughs. Also, satellite wave observations are needed before wave models required for hindcasting can be much improved beyond their present state.

Table 1. Wind Speed and Direction Products

| Products | Data Set Resolution - KM | Production Frequency | Time in Data Base | Accuracy Goals | Geographical Coverage | Data Source |
|---|---|---|---|---|---|---|
| Global Plotted Wind Barbs | 200 | 6 hours | 12 hours | ± 2.0 m/s ± 16° | Global | Scatt, Alt, Ship, Buoy |
| Regional Plotted Wind Barbs | 50 | 6 hours | 12 hours | ± 2.0 m/s ± 16° | Regional | Scatt, Alt, Ship, Buoy |
| Local Plotted Wind Barbs | 25 | 6 hours | 12 hours | ± 2.0 m/s ± 16° | Local | Scatt, Alt Ship, Buoy |
| Global Wind Stress Isopeth Analysis | 200 | 24 hours | 24 hours | Not Applicable | Global | Scatt |
| Mean Resultant Wind Speed and Direction | 200 | Monthly | 1 Month | ± 2.0 m/s ± 16° | Global | Scatt, Alt, Ship, Buoy |
| Mean Wind Speed | 200 | Monthly | 1 Month | ± 2.0 m/s | Global | Scatt, Alt, Ship, Buoy |
| Maximum Wind Speed | 200 | Monthly | 1 Month | ± 2.0 m/s | Global | Scatt, Alt, Ship, Buoy |
| Mean Resultant Wind Speed and Direction | 200 | Monthly | 1 Month | Not Applicable | Global | Scatt |

Table 2. Wave Products

| Products | Data Set Resolution-KM | Production Frequency | Time in Data Base | Accuracy Goals | Geographical Coverage | Data Source |
|---|---|---|---|---|---|---|
| H 1/3 Global Isopleth Analysis | 100 | * 6 Hours | 12 Hours | 0.5m | Global | Alt, Ship, Buoy |
| H 1/3 Regional Isopleth Analysis | 25 | * 6 Hours | 12 Hours | 0.5m | Regional | Alt, Ship, Buoy |
| Global Maximum Wave Height | 100 | Monthly | 1 Month | 0.5m | Global | Alt, Ship, Buoy |

* Production Frequency of 12 hours for these products will be sufficient prior to N-ROSS and ERS-1.

Sea Surface Temperature (SST) - While there will be some operational all weather remote sensing of winds, waves and ice from GEOSAT and DMSP, no all weather remote sensing of sea surface temperatures (SST) will occur until the launch of N-ROSS and ERS-1. Table 3 shows the sea surface temperature products. Presently, data from the IR sensors aboard the TIROS-N series satellites are used to produce the sea surface temperature and ocean thermal feature analyses. Great strides have been made in analyzing ocean thermal boundaries such as the Gulf Stream and warm and cold eddies. The 1-KM IR data from the Advanced Very High Resolution Radiometer (AVHRR) provides the analyst with detailed imagery in clear or mostly clear weather. Also, 100KM, 50KM and 14KM composite SST charts are computer produced from the 4KM AVHRR data on TIROS-N using various cloud screening techniques. Clouds present over an area for an extended period of time limits the number of observations and decreases the quality of the analysis. NESDIS' goal over the next couple of years is to develop and produce interactive, higher resolution SST analyses (possible as high as 2KM) along the coastal areas of the United States. Clouds will still be a limiting factor in the quality of the analyses.

The Low Frequency Microwave Radiometer (LFMR) aboard N-ROSS and the Along-Track Scanning Radiometer (ATSR) aboard ERS-1 will satisfy the requirements of the fisheries for all weather SST data. Although the spatial resolutions will not be as good, - 25 KM for the LFMR in the microwave channels and 50KM for the ATSR versus 1KM for the AVHRR - the microwave data combined with the AVHRR should provide quality data for global, regional and local SST and ocean thermal feature analyses. Before satellite observations, a long held "rule of thumb" was that a fisherman spent 80 percent of his time looking for fish. The AVHRR data has greatly reduced this search time and the addition of microwave data from N-ROSS and ERS-1 will reduce it even further.

The Climate Analysis Center will also benefit from global, all weather SST measurements. One of their prime requirements for long-range weather forecasting is sea surface temperature data over the oceans in all weather situations.

Ice - The shipping industry, oil and gas companies, the Coast Guard and the fisheries are some of the major users that require ice analyses and forecasts when operating in the polar regions. Table 4 provides the ice products. The Navy/NOAA Joint Ice Center (JIC) composed of personnel from the Department of the Navy and NOAA is tasked with providing sea ice analyses and forecast pro-

Table 3. Sea Surface Temperature Products

| Products | Data Set Resolution - KM | Production Frequency | Time in Data Base | Accuracy Goals | Geographical Coverage | Data Source |
|---|---|---|---|---|---|---|
| Global SST Isopleth Analysis including Ice Edge | 50 | Twice/Week | ½ Week | ± 1.0°C | 75°S-80°N | All Satellites Ship, Buoy |
| Regional SST Isopleth Analysis | 14-25 | Twice/Week | ½ Week | ± 1.0°C | Regional | All Satellites, Ship, Buoy |
| Local SST Isopleth Analysis | 1-8 | Refresh Daily | 1 Week | ± 0.7°C | Local | AVHRR, LFMR, ATSR, VAS, Ship, Buoy |
| Frontal Feature Analysis | 1-8 | Refresh Daily | 1 Week | NA | Local | AVHRR, LFMR, ATSR |
| Global Monthly Means and Anomaly & Density of Ship & Satellite Data | 100 | Once/Month | 1 Month | ± 1.0°C | 75°S-80°N | All Satellites, Ship, Buoy |
| Global Semi-Monthly Mean SST and Anomaly | 100 | Twice/Month | ½ Month | ± 1.0°C | 75°S-80°N | All Satellites, Ship, Buoy |

ducts to the users noted above as well as DOD, NOAA, and other private, government and international organizations. Over the past several years, satellite imagery has been the main source of data for the JIC. AVHRR IR and visible data at 1KM resolution provide good definition of the ice edge and leads and provide adequate estimates of the concentration boundaries. The AVHRR data is not adequate for determining ice age or the thickness of the ice. Cloud cover also precludes observation of any ice features with the AVHRR.

The JIC, in order to partially fulfill their requirement to provide complete ice analyses for both hemispheres, has used microwave imagery from the Nimbus satellites. However the spatial resolution for the microwave data is only 25KM which is adequate for only the ice edge and large leads in the ice. Thus the JIC needs all-weather, higher resolution satellite data that will detect the age, thickness and roughness of the ice. For example ships that resupply the North Slope of Alaska encounter 75-80 percent cloud cover in the summertime when the pack ice completely separates from the fast ice along the north coast of Alaska.

The altimeter aboard GEOSAT and the Special Sensor Microwave Imager (SSM/I) aboard both DMSP and N-ROSS will enable all-weather observation of the ice. Although the 12.5KM resolution of the ice of the SSM/I data is an improve ment over the 25KM resolution data from Nimbus, detailed ice analyses will still not be possible. However the high bit rate data SAR imagery with its 30 meter resolution and ability to measure ice thickness will greatly aid the JIC in its production of detailed ice analyses and forecasts in the seas surrounding Alaska. If the SAR data are received timely, the JIC will be able to provide close support for ships transiting the ice pack in the Bering, Chukchi, and Beufort Seas. Further requirements from the JIC include access to digital satellite data from NESDIS when these data become available.

A complete data system was planned for NOSS called the NOAA-NOSS Oceanic Data System (NNODS) which would have provided for the processing, generation and dissemination of NOSS products. NNODS would have also interfaced with other NOAA, government and private sector users. Further elaboration will not be made in this paper, but the technical plan for NNODS is described in Section 4 of the NOAA Program Development Plan for NOSS. One possible solution for processing the ERS-1 low bit rate data would be to format these data to appear similar to the N-ROSS data so the algorithms would be similar and could run on the Navy computers.

## Table 4. Ice Products

| Products | Data Set Resolution | Production Frequency | Time in Data Base | Accuracy Goals | Geographical Coverage | Data Source |
|---|---|---|---|---|---|---|
| Global Ice Edge Analysis | 1-12.5km | Weekly | 1 Week | 1-12.5 km | Arctic and Antarctic | AVHRR, Alt, SSM/I |
| Regional Ice Edge Analysis | 1-12.5km | 3 Times/Week | ½ Week | 1-12.5 km | Alaskan Seas and other areas as needed | AVHRR, Alt, SSM/I |
| | 30m-100m | Refresh Daily | 3 Days | 100m | Alaskan Seas | SAR |
| Global Ice Consentration Analysis | 1-25km | Weekly | 1 Week | ± 10-20% | Arctic and Antarctic | AVHRR, SSM/I |
| Regional Ice Consentration Analysis | 1-25km | 3 times/week | ½ Week | ± 10-20% | Alaskan Seas and other areas as needed | AVHRR, SSM/I |
| | 30m-100m | Refresh Daily | 3 Days | + 10% | Alaskan Seas | SAR |
| Global Ice Age Analysis | 1-25km | Weekly | 1 Week | New, 1st yr. Multi-year (estimate) | Arctic and Antarctic | AVHRR, SSM/I |
| Regional Ice Age Analysis | 1-25km | 3 Times/Week | ½ Week | New, 1st yr. multi-yr. (estimate) | Alaskan Seas and other areas as needed | AVHRR, SSM/I |
| | 30m-100m | Refresh Daily | 3 Days | New, 1st yr. multi-year | Alaskan Seas | SAR |
| Regional Ice Thickness Analysis | 30m-100m | Refresh Daily | 3 Days | To be determined | Alaskan Seas | SAR |

Ice continued

| Products | Data Set Resolution | Production Frequency | Time in Data Base | Accuracy Goals | Geographical Coverage | Data Source |
|---|---|---|---|---|---|---|
| Sea Ice Topography Analysis | 30m-100m | Refresh Daily | 3 Days | To be determined | Alaskan Seas | SAR |
| Ice Sheet Height | 10km | Yearly | 1 Year | + 2.0m | Antarctica Greenland | Alt. |
| Mean Minimum and Maximum Ice Edge Extent | 1-12.5km | Monthly | 1 Month | 1-12.5km | Arctic and Antarctic | AVHRR, Alt, SSM/I |
| Ice Concentration Mean and Anomaly | 1-25km | Monthly | 1 Month | ± 10-20% | Arctic and Antarctic | AVHRR, SSM/I |

Note: The ice edge, ice concentration and ice age parameters will likely be produced as one analysis for both the global and regional products.

## GLOSSARY OF TERMS

ALT - Altimeter
ATSR - Along-Track Scanning Radiometer
AVHRR - Advanced Very High Resolution Radiometer
H 1/3 - Significant Wave Height Radiometer
NNODS - NOAA/NOSS Oceanic Data System
NOSS - National Oceanic Satellite System
SAR - Synthetic Aperture Radar
Scatt - Scatterometer
SSM/I - Special Sensor Microwave Imager
Time in Data Base - The lapse of time between the generation of a product and updating of that product.
VAS - Visible-Infrared Spin Scan Radiometer (VISSR) Atmospheric Sounder.

## III. Conclusion

The above discussion attempts to outline the oceanographic data requirements from government and civilian users. Essentially these requirements culminate in the products listed in Tables 1 through 4. This products list, although only an estimate of the anticipated products at this time, is based on our experience with TIROS-N and the planning of NOSS. It is hoped that these products will help fulfill the requirements of the oceanographic user community. A Glossary of Terms is included to explain the acronyms cited in the text and tables.

(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

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