

NOAA Technical Memorandum NWS HYDRO-22

ANNOTATED BIBLIOGRAPHY OF NOAA PUBLICATIONS OF  
HYDROMETEOROLOGICAL INTEREST

John F. Miller

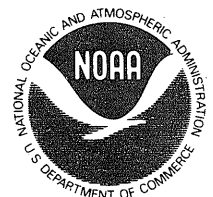
Washington, D.C.  
May 1975

Reprinted August 1975

UNITED STATES  
DEPARTMENT OF COMMERCE  
Rogers C. B. Morton, Secretary

NATIONAL OCEANIC AND  
ATMOSPHERIC ADMINISTRATION  
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National Weather  
Service  
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INTRODUCTION

General bibliographies of Government publications are issued periodically, but they cover publications in a wide variety of fields of interest. The selection of publications providing information in some particular field is often difficult. This bibliography is intended to fill a particular purpose of providing the engineer or hydrologist with a summary of that information published by NOAA. Many requests from engineers and others for hydrometeorological information indicate that many are not aware that much of the information required is already available in published form.

This bibliography is not intended to be a comprehensive listing of everything that has been published by NOAA scientists in the field of hydrometeorology. The primary medium for the publication of NOAA research results is through recognized scientific journals, e.g., Journal of Geophysical Research, Water Resources Research, Journal of Applied Meteorology, etc. Contract research reports prepared by the various universities or private research organizations and submitted to NOAA in fulfillment of contracts are considered as reports of the individual organizations and are not listed.

The material listed in this publication was selected by the author to list relevant publications prepared by NOAA in approximately the past 20 years. As may be recognized, a good many of these publications are out of print. Certainly a portion of the research results in some of these reports have been invalidated by later investigations. They are listed because they may provide the only source for some useful information or because they provide valuable background information on various topics. These publications are on the shelves of many libraries. Local National Weather Service Offices maintain files of many of these publications for reference purposes. Additionally, the Environmental Data Service and the National Weather Service, Office of Hydrology, also maintain reference copies of most of these publications that may be examined.

There is no clear-cut line between publications that are strictly of meteorological interest and those that are of hydrometeorological interest. These decisions were made by the author and reflect the general interest of the meteorologists within the Office of Hydrology, National Weather Service.

Department of Commerce policy limits free distribution of publications. The following are entitled to receive free copies of available publications upon request (generally one copy of a given publication): (1) Federal, State, and local government agencies; (2) cooperative observers who furnish observational data to NOAA; (3) organizations publishing environmental data for industry-wide use; (4) foreign governments and other organizations under exchange agreements approved by the NOAA Libraries Division; (5) authorized depository libraries; (6) public information media; (7) individuals connected with state colleges or experiment stations having a cooperative agreement with NOAA providing for distribution of publications. These designated official copies may be obtained from the Environmental Data Service or from the Environmental Research Laboratory.

Priced NOAA publications for individuals other than those mentioned in the preceding paragraph should be purchased from either the Government Printing Office or the National Technical Information Service. As costs are increasing, only some prices are given for publications available from the Government Printing Office. Prices for publications of the National Technical Information Service are obtainable from them or their latest catalogs. Reference numbers for ordering publications from the National Technical Information Service are given with the appropriate citations.

Prices for subscriptions to NOAA periodicals vary as costs change. The current price for a subscription may be obtained by inquiry to the Environmental Data Service (EDS) or to the National Climatic Center (NCC). Other prices quoted for publications from the NCC are for current publication stocks. If these are exhausted, charges will be based on the cost of reproducing the file copy on request or for the reprinting of the publication, whichever is appropriate.

Omission of the "Availability" portion under a citation in the text indicates that current non-purchasable publications are available through the Environmental Data Service. Publication stocks are maintained by the Environmental Data Service, the Environmental Research Laboratory, and the Government Printing Office for only a limited period, generally no longer than 3 years. If older publications are not available through the National Technical Information Service, copies occasionally may be maintained by the office preparing the report or requests may be sent to the Environmental Data Service for appropriate referral.

## Key to Availability

- GPO Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.
- NTIS National Technical Information Service, U.S. Department of Commerce, 5285 Port Royal Rd., Springfield, Va. 22151.
- EDS Libraries and Information Division (D82), Environmental Science Information Center, Environmental Data Service, NOAA, U.S. Department of Commerce, 3300 Whitehaven St., NW., Washington, D.C. 20235.
- ERL Publications Services Division (R57), Environmental Research Laboratories, NOAA, U.S. Department of Commerce, Boulder, Colo. 80302.
- NCC National Climatic Center, U.S. Department of Commerce, Federal Bldg., Asheville, N.C. 28801.
- H Historical information and background purposes.

Abstracts of NOAA scientific and technical publications, including NOAA contractor and grantee reports and publications by NOAA authors appearing in journals, conference proceedings, and books, are listed in "NOAA Publications Announcements," issued about twice monthly at no charge. Publications are arranged in about 22 subject fields.

## 1. CLIMATOLOGICAL DATA AND OBSERVATIONS

## 1.1. "Selective Guide to Climatic Data Sources," Key to Meteorological Records Documentation No. 4.11, 1969.

The types of climatic data available in published and unpublished forms are described. Examples of formats of published data are shown, their historical backgrounds are discussed, and how these may be obtained is explained. Also, references to sources where data were published during different time periods are given.

Availability: NCC, \$1.

## 1.2. "Climatological Data."

This publication is issued monthly and annually for each State or combination of States, the Pacific area, and Puerto Rico and the Virgin Islands.

The monthly issue presents a table of monthly averages, departures from normal, extremes, etc., of precipitation and temperature and tables of daily precipitation, temperature, snowfall, and snow on ground, evaporation, and wind and soil temperature. Monthly and seasonal snowfall and heating degree day data are published in the July issue only. A station index map and table are also presented.

The annual issue contains monthly and annual average values and departures from normal of most data given in the monthly issue.

Availability: NCC.

### 1.3. "Climatological Data, National Summary."

This publication is issued monthly and annually on a national basis.

The monthly issue gives general summaries of weather, river, and flood conditions and presents the following data alphabetically by State and station name for selected stations: monthly averages, departures from normal, extremes, etc., of pressure, temperature, relative humidity, precipitation, wind, and sky cover; storms by type, number, deaths, and damage; flood stage data; and daily and monthly average solar radiation data. Summaries of other meteorological data are also presented.

The annual issue gives general summaries of weather, tornadoes, tropical storms, etc., and river and flood conditions, related charts and tables, and presents annual average data for selected stations alphabetically by State and station. Also, data on maximum precipitation for durations from 5 to 180 minutes are included.

Availability: NCC.

### 1.4. "Local Climatological Data."

This publication is issued monthly and annually for each of about 300 cities where National Weather Service first-order stations are located.

The monthly issue, "Local Climatological Data," presents detailed climatological and meteorological data for the particular station.

The annual issue, "Local Climatological Data Annual Summary with Comparative Data," presents monthly and annual averages, plus normals, means, and extremes of record, etc., of climatological and meteorological data and a station location table showing changes in the location and exposure of instruments and related information.

Availability: NCC.

### 1.5. "Hourly Precipitation Data."

This publication is issued monthly and annually for each State or combination of States.

The monthly issue presents alphabetically by station hourly and daily precipitation amounts for stations equipped with recording gages. A station location map is also included.

The annual issue, "Hourly Precipitation Data, Annual Summary," gives a station index table showing monthly and annual total precipitation amounts for stations equipped with automatic recording gages and a station location map.

Availability: NCC.

### 1.6 "Climatic Summary of the United States by States, Supplement for 1951-60," Climatology of the U.S. Series No. 86, 1963-64.

This publication was printed for each State or combination of States, Puerto Rico and the Virgin Islands, and the West Indies.

The following monthly and annual data are presented for each State alphabetically by station: monthly totals of precipitation and snowfall and mean temperature for each month for the period 1951-1960; means for 10-year period and for the total record for total precipitation, total snowfall, mean temperature, and maximum and minimum temperature; means for the 10-year period only are given for the number of days with precipitation  $\geq .10$  and  $\geq 0.50$ , days with temperatures  $\geq 90^{\circ}\text{F}$  or  $\leq 32^{\circ}\text{F}$  and mean evaporation; maximum and minimum temperatures of record are given for the 10-year period and for the total record. A station index and history table, showing changes in the locations and exposures of instruments and related information, is also included.

Issues for 106 specified climatological sections of the United States, including Puerto Rico and the Virgin Islands, were first published in the "Climatic Summary of the United States by Sections," for the period covering from the time stations began to 1930. Another supplement, "Climatic Summary of the United States by States, Supplement for 1931-52," Climatology of the U.S. Series No. 11, has also been published.

Availability: NCC.

### 1.7. "World Weather Records."

This publication is issued by geographic regions for 10-yr periods. Data are listed by country or area name, station name, WMO number, latitude and longitude, and elevation. Monthly and annual mean values of station pressure, sea-level pressure, and temperature and monthly and annual total precipitation are given in sequential order.

The most current issue for 1951-60 is printed in six volumes: Vol. I, North America; Vol. II, Europe; Vol. III, South and Central America,

West Indies, Caribbean area, and Bermuda; Vol. IV, Asia; Vol. V, Africa; and Vol. VI, Australia, New Zealand, Antarctica, Oceanic islands, and Ocean Weather ships.

Availability: NCC.

1.8. "Climates of the States," Climatology of the U.S. Series No. 60, 1959 and some revised editions.

This publication was printed for each State, Puerto Rico, and the Virgin Islands based on the 20-yr period 1931-52. Issues for some States have been revised to include the recent data.

The following are presented: a climatological summary of each State; tables of freeze data, monthly and annual mean temperature and precipitation by climatological division, and long-record monthly and annual normals, means, and extremes of precipitation, temperature, relative humidity, wind, and sunshine; and charts of mean maximum and minimum temperatures for January and July and mean annual precipitation.

Availability: NCC.

1.9. "Climatic Atlas of the United States," published in 1968, reprinted in 1974.

Maps showing the national distributions of monthly, annual, and/or seasonal mean, normal, and/or extreme values of temperature, precipitation, wind, barometric pressure, relative humidity, dew point, sunshine, sky cover, heating degree days, solar radiation, and evaporation are presented. Originally, separate sheets were made available as soon as printed. The entire set--a total of 40 large sheets containing 271 climatic maps and 15 tables--was bound into this atlas.

Availability: NCC.

1.10. "Decennial Census of the U.S. Climate, Monthly Normals of Temperature, Precipitation, and Heating Degree Days," Climatology of the U.S. Series No. 81, 1973.

This publication was printed for each State or combination of States based on the period 1941-70. Values of normal monthly and annual mean temperature and precipitation for National Weather Service first-order stations and for a large number of substations are given. Monthly and annual heating and cooling degree day normals are given for a representative number of stations in each State.

Availability: NCC.

1.11. "Monthly Averages of Temperature and Precipitation for State Climatic Division 1941-70," Climatology of the United States No. 85, 1973.

Monthly and annual divisional averages of temperatures and precipitation for the period 1941-70 for each State. Each value is the simple arithmetic average of the data for all States in the division that furnished both temperature and precipitation records.



1.12. "Summary of Hourly Observations," Climatography of the U.S. Series No. 82, 1963.

This publication was printed for each station where 24 hourly observations were recorded daily for the period 1951-60. The contents are: a narrative description of the location and topography of each station; tables of temperature and wind speed-relative humidity occurrences, frequency of hourly occurrences of precipitation amounts, and percentage frequencies of wind direction and speed, ceiling-visibility, sky cover, wind and relative humidity, and a station location table showing changes in the location and exposure of instruments and related information.

Availability: NCC.

1.13. "Storage Gage Precipitation Data for Western United States,"

This publication is issued annually and includes all stations in the West having storage gages requiring reading and maintenance only at monthly or seasonal intervals. Monthly and/or seasonal precipitation totals and a station index table and map are given.

Availability: NCC,

1.14. "Storm Data."

This publication is issued monthly and contains information for all States. It lists chronologically by State occurrences of storms and unusual weather phenomena, together with data on the paths of individual storms, deaths, injuries, and property damage, and gives a brief description of associated details.

Availability: NCC.

1.15. "Substation Observations," NWS Observations Handbook No. 2, 1972 edition.

This publication serves as a guide to cooperative observers who take and record observations of temperature, precipitation, evaporation, soil temperature, or atmospheric phenomena for the National Weather Service. Instructions pertain to the exposure and operation and maintenance of instruments and equipment.

Availability: GPO, NCC, \$1.

## 2. CLIMATOLOGICAL STUDIES

2.1. "Bibliography of Climate," NOAA Technical Memorandum EDS BC sub-series, published irregularly.

Annotated bibliographies on climates of various regions of the world are presented in this series. Entries on precipitation, humidity, and other studies of hydrometeorological interest are included.

2.2. "Bibliography of Climatic Maps," NOAA Technical Memorandum EDS BM subseries, published irregularly.

Annotated bibliographies of climatic maps for various regions of the world are presented in this series. Entries pertinent to hydro-meteorological studies for the various regions are included.

2.3. "Climates of the World," Jan. 1969, 28 pp.

The principal features of climates of all continents are discussed briefly. Worldwide temperatures and precipitation are illustrated by maps. Monthly and annual temperatures are presented in tabular form for approximately 800 stations throughout the world.

2.4. "Climates of the United States," 1973, 113 pp.

The climates of the United States and their causes and events of interest are described and illustrated by maps and diagrams, some adapted from item 1.9. This publication is not as lengthy or as detailed as item 1.8.

Availability: GPO, NCC, \$1.15.

2.5. "Historical and Climatological Study of Grinnel Glacier, Montana," ESSA Technical Memorandum WBTM WR 24, July 1967, 26 pp.

A study of the precipitation and temperature history of Grinnell Glacier, Mont., is presented.

Availability: NTIS (PB-178-071).

2.6. "Climate Along a Pipeline from the Arctic to the Gulf of Alaska," ESSA Technical Memorandum WBTM AR-2, Dec. 1968.

A brief climatic summary of a north-south route across Alaska is presented.

2.7. "Climate of the North Slope of Alaska," NOAA Technical Memorandum NWS AR-4, Feb. 1971.

Available climatological data for the Alaskan North Slope are presented.

2.8. "Frequency and Intensity of Freezing Rain/Drizzle in Ohio," NOAA Technical Memorandum NWS ER-51, Feb. 1973, 6 pp.

Using the Poisson probability distribution, a mean recurrence table of annual number of days with freezing rain or drizzle for several return periods was devised for eight Ohio locations.

Availability: NTIS (COM-73-10570).

2.9. "Radar Precipitation Study ESSA Interoceanic Canal Project, Final Report," ESSA Technical Memorandum ERL-ARL-23, July 1970, 115 pp.

A precipitation climatology was developed from weather radar and rain gage data obtained in eastern Panama and northwestern Columbia.

Summaries of monthly rainfall frequency maps for several times of day and statistics on areal coverage of precipitation and vertical extent of clouds with precipitation-size droplets are included.

Availability: NTIS (PB-194-416).

2.10 "Sacramento Weather Radar Climatology," ESSA Technical Memorandum WRTM-52, July 1970.

Average monthly and seasonal hourly radar echo frequencies are presented.

Availability: NTIS (PB-193-347).

2.11. "Study on Duration of Measurable Precipitation at Birmingham," ESSA Technical Memorandum SRTM 27, Sept. 1966.

A climatological study on duration of measurable precipitation at Birmingham, Ala., is presented.

2.12. "Study on Duration of Measurable Precipitation at Lubbock, Texas," ESSA Technical Memorandum SRTM-34, Apr. 1967.

A climatological study on the duration of measurable precipitation at Lubbock, Tex., is presented.

2.13. "Persistence of Precipitation at 108 Cities in the Conterminous United States," ESSA Technical Memorandum WBTM TDL-31, May 1970, 84 pp.

Values of persistence of precipitation for each of the four seasons are derived for 108 cities in the conterminous United States for a selected combination of time intervals. These values show significant differences between stations and seasons.

NOTE:

1. See "Hurricanes," items 9.3 through 9.7 and 9.11.
2. See "Precipitation Forecasting," items 15.1 through 15.6.
3. See "Precipitation, Hurricane," items 16.1 and 16.3.
4. See "Precipitation, Mean and Normal," item 17.1.
5. See "Precipitation Probability," item 19.19.
6. See "Storms," items 28.3, 28.4, and 28.9.

### 3. CLOUDS, LIQUID WATER CONTENT IN STORMS

3.1. "Measurements by Aircraft of Condensed Water in Great Plains Thunderstorms," ESSA Technical Memorandum IERTM NSSL-19, 1966.

The results obtained in flights on five thunderstorm days in Oklahoma are presented. The maximum value reported was  $43.7 \text{ g/m}^3$ . A diagram, relating liquid water content to rainfall rate, indicates that  $33 \text{ g/m}^3$  corresponds to 50 in. per hr. Actual rain gage measurements of up to 24-27 in. per hr for durations of a few minutes are reported.

Availability: NTIS (PB-173-048).

3.2. "The Distribution of Liquid Water in Hurricanes," National Hurricane Research Project Report No. 62, 1963.

Data on liquid water content of clouds, as measured by airplane flights through four hurricanes, are presented. The maximum value obtained was  $9.5 \text{ g/m}^3$ .

Availability: NTIS (PB-168-411).

3.3. "Water Load in Convective Storms and Its Influence on Storm Kinetics," ESSA Technical Memorandum ERLTM-APCL 6, Mar. 1969, 55 pp.

The growth rate and accumulation of precipitation water mass in convective cloud updrafts is examined.

NOTE:

1. See "Storms" item 28.8.

#### 4. DEW POINTS, MAXIMUM PERSISTING

NOTE:

1. See "Climatological Data and Observations," items 1.1 and 1.9.
2. See "Relative Humidity," item 23.1.

#### 5. DROUGHT

5.1. "Drought Bibliography," NOAA Technical Memorandum EDS 20, June 1971.

Bibliographic citations of literature on agricultural, hydrologic, and meteorological drought are given. Abstracts are given where available.

Availability: NTIS (COM-71-00937).

5.2. "Meteorological Drought," Weather Bureau Research Paper No. 45 1965.

An index of drought severity (Palmer drought index), which permits time and regional comparisons is developed.

5.3. "Meteorological Drought in West Virginia," ESSA Technical Memorandum EDS 11, Sept. 1969.

Palmer drought index values and precipitation data for the years 1931-67 are tabulated for regional climatic divisions of West Virginia.

Availability: NTIS (PB-187-474).

#### 6. EVAPORATION

6.1. "Evaporation Maps of the United States," Weather Bureau Technical Paper No. 37, 1959.

The geographic distributions of average annual Class A pan evaporation, lake evaporation, and Class A pan coefficient are shown based on data

for the period 1946-55 at 146 stations. Also, the geographic distributions of average May-October evaporation and standard deviation of annual Class A pan evaporation are shown.

6.2. "Evaporation from Pans and Lakes," Weather Bureau Research Paper No. 38, 1955.

Techniques for estimating reservoir evaporation from pan evaporation and other meteorological data are described.

NOTE:

See "Climatological Data and Observations," items 1.1 through 1.3, 1.6, 1.8, 1.9, and 1.15.

## 7. FLOODS

7.1. "Rainfall and Floods of April, May and June 1957 in the South-Central States," Weather Bureau Technical Paper No. 33, 1958.

Storms and floods are described and tabulations of hourly and daily rainfall amounts for stations in the storm area, Texas to Missouri, are given.

7.2. "Hurricane Rains and Floods of August 1955, Carolinas to New England," Weather Bureau Technical Paper No. 26, 1956.

Storm and floods are described and tabulations of hourly and daily rainfall amounts for the Eastern States from South Carolina to Maine are presented.

7.3. "The Meteorological and Hydrological Aspects of the May 1968 New Jersey Floods," Weather Bureau Technical Memorandum ER-32, Feb. 1969, revised July 1970, 35 pp.

Major flooding occurred in northern and east-central New Jersey May 29-31, 1968. Crest stages resulting from the flooding were generally the highest in this area since 1936 and in selected river basins since 1903.

Availability: NTIS (PB-194-222).

7.4. "Kansas-Missouri Floods of June-July 1951," Weather Bureau Technical Paper No. 17, 1952.

The storms and floods are described and tabulations of hourly and daily rainfall amounts and river stages are presented.

7.5. "Floods of April 1952--Upper Mississippi, Missouri, Red River of the North," Weather Bureau Technical Paper No. 23, 1954.

The causes and development of the floods are described and daily meteorological and river stage data are presented.

7.6. "Snowmelt Floods of March-April 1960," Weather Bureau Technical Paper No. 45, 1962.

The causes and development of the floods are described and precipitation and river gage data are presented.

7.7. "The March-May 1965 Floods in the Upper Mississippi, Missouri, and Red River of the North Basins," ESSA Technical Report WB-4, 1967.

The meteorological events leading to the record-breaking floods are described. Statistics on flood and crest stages, areas and periods of flooding, warnings issued, and flood damages are presented.

7.8. "The March-April 1969 Snowmelt Floods in the Red River of the North, Upper Mississippi, and Missouri Basins," NOAA Technical Report NWS-13, Apr. 1971, 92 pp.

The record and near record floods in the North Central States in the spring of 1969 are described.

Availability: NTIS (COM-71-50269).

#### Joint NOAA/USGS Flood Reports

Reports on major recent floods are being prepared as a cooperative effort of NOAA and the Geological Survey. These reports will be published in the Geological Survey Professional Paper Series.

7.9. "The Black Hills-Rapid City Flood of June 9-10, 1972: A Description of the Storm and Flood," Geological Survey Professional Paper No. 877.

A description of the meteorological situation that produced the extreme flood event is given. An analysis of the precipitation data is presented. Hydrologic data on peak stages and discharge are given for the creeks along the eastern slopes of the Black Hills.

7.10. "Hurricane Agnes: Rainfall and Floods June-July 1972," Geological Survey Professional Paper (in preparation).

The life history of Hurricane Agnes, including the tropical depression and tropical storm stages, is traced. Associated rainfalls are analyzed and compared with climatological recurrence values. These are followed by a description of the streamflows of each affected basin. A summary of peak stages and discharges and comparison data for previous floods at 989 stations are presented. Deaths and flood damages are compiled.

7.11. "Southeastern United States Flood, March 14-18, 1973," Geological Survey Professional Paper (in preparation).

A description of the meteorologic and hydrologic events during the floods of March 1973 in the Tennessee, Yazoo, and Tombigbee River Basins is presented.

7.12. "The Mississippi River Basin Flood of Spring 1973," Geological Survey Professional Paper (in preparation).

A description of the meteorologic and hydrologic events that resulted in the record-breaking floods on the Mississippi River in the spring of 1973 is presented.

NOTE:

1. See "Climatological Data and Observations," item 1.3.
2. See "River and Flood Forecasting," item 24.3.

## 8. HYDROLOGIC CYCLE

8.1. "The Hydrologic Cycle," 1974, 8 pp.

The marine, atmospheric, and land phases of the cycle and the National Weather Service hydrologic services are described.

Availability: GPO; EDS, official copies.

## 9. HURRICANES

9.1. "Hurricane--The Greatest Storm on Earth," 36 pp.

The incidence and general causes of hurricanes, their structure, dynamics, and destructive effects, NOAA's work on warnings, Hurricane Hunters, hurricane modification, and individual and community safety rules are described.

Availability: GPO; EDS, official copies.

9.2. "Tropical Cyclones of the North Atlantic," Weather Bureau Technical Paper No. 55, 1965.

Tracks and frequencies of tropical storms and hurricanes for the period 1871-1963 are presented. Tracks are shown on maps for each year and by months and by other calendar periods.

9.3. "Climatology of Atlantic Tropical Storms and Hurricanes," ESSA Technical Report WB-6, May 1968, 18 pp.

Sections on hurricane formation, frequency, motion, and structure are presented.

9.4. "Climatology of Atlantic Tropical Cyclones by Two and One-half Degree Latitude-Longitude Boxes," Weather Bureau Technical Memorandum SR-44, Feb. 1969, 3 pp., 44 maps.

Climatological and statistical analyses of Atlantic tropical storms and hurricanes by 2 1/2° latitude-longitude boxes are presented.

9.5. "Digitized Atlantic Tropical Cyclone Tracks," NOAA Technical Memorandum NWS SR-55, July 1971, 147 pp.

The source regions and eventual disposition of all tropical cyclones passing through unit 2 1/2° latitude-longitude boxes during the 84-yr period of record 1886-1969 are shown. Also, the mean vector speed and direction and the mean scalar speeds of cyclones as they pass through each unit box are presented.

Availability: NTIS (COM-71-00984).

9.6. "Atlantic Hurricane Frequencies Along the U.S. Coastline," NOAA Technical Memorandum NWS SR-58, June 1971, 14 pp.

The total number of incidents and the frequency of hurricanes and tropical storms for 50-mi segments of the Gulf of Mexico and Atlantic coastlines are presented.

Availability: NTIS (COM-71-00796).

9.7. "Some Climatological Characteristics of Hurricanes and Tropical Storms, Gulf and East Coasts of the United States," NOAA Technical Report (in preparation).

A climatology of hurricane factors important to storm surges is presented for the Gulf of Mexico and Atlantic coasts of the United States. Factors presented are: frequency of entering, exiting, and alongshore hurricanes; ratio of tropical storms to hurricanes; central pressures of hurricanes and tropical storms; radius of maximum winds and speed of forward motion for hurricanes; and direction of motion for entering hurricanes.

9.8. "Meteorological Considerations Pertinent to Standard Project Hurricane, Atlantic and Gulf Coasts of the United States," National Hurricane Research Project Report No. 33, Nov. 1959.

A description of the meteorological factors pertinent to the most severe hurricane reasonably characteristic of a region.

Availability: NTIS (PB-166-855).

9.9. "Memorable Hurricanes of the United States Since 1873," Weather Bureau Technical Memorandum SR-56, 1969, revised May 1971.

Whether or not a hurricane is notable and should be remembered depends upon many things. The selections in this publication are limited to those that have made landfall in the United States or have been near misses. Also, most of them were major, extreme, or great hurricanes.

Availability: NTIS (COM-71-00610).

9.10. "Florida Hurricanes," ESSA Technical Memorandum WBTM SR-38, Nov. 1967.

Descriptive and historical information on hurricanes, particularly as they affect Florida, is provided. The life cycle of hurricanes, their location, tracking, and specific hurricane characteristics are described.

Availability: NTIS (PB-182-220).



9.11. "Preliminary Climatic Data Report Hurricane Agnes June 14-23, 1972," NOAA Technical Memorandum EDS NCC-1, Aug. 1972.

A brief storm history and climatological data on the pressure, winds, tides, rainfall, and runoff associated with Agnes are provided in this preliminary report.

Availability: NTIS (COM-72-11225), NCC, EDS.

9.12. "Hurricane Agnes, June 14-23, 1972," Preliminary Reports on Hurricanes and Tropical Storms, Sept. 1972, 190 pp.

Weather Service advisories and bulletins on Hurricane Agnes are listed. A brief storm history is given.

9.13. "Reconstruction of the Surface Pressure and Wind Fields of Hurricane Helene," National Hurricane Research Project Report No. 59, Nov. 1962, 44 pp.

Study reconstructs the pressure and wind fields associated with this severe hurricane during the time it threatened the coastal region of Southeastern United States.

9.14. "An Analysis of Hurricane Betsy," Weather Bureau Technical Memorandum SR-41, Jan. 1969, 9 pp.

Hourly weather observations from several reporting stations were used to produce analyses of ceiling heights, visibility, precipitation intensity, and surface wind gusts associated with Hurricane Betsy of 1965.

Availability: NTIS (PB-182-383).

9.15. "Hurricane Camille, August 14-22, 1969 (Preliminary Report)," Sept. 1969, 58 pp.

The advisories, bulletins, and statements issued by the Weather Bureau on this hurricane are listed. A brief storm history is given.

9.16. "On the Maximum Intensity of Hurricanes," National Hurricane Research Project Report No. 14, Dec. 1957.

An attempt to determine the minimum pressure that can occur within a hurricane is described. This minimum pressure is related to the temperature of the sea surface over which the hurricane moves.

Availability: NTIS (PB-166-839).

9.17. "The Three-Dimensional Wind Structure Around a Tropical Cyclone," National Hurricane Research Project Report No. 15, Jan. 1958.

Wind data from a number of hurricanes are combined to obtain a composite of the hurricane circulation.

Availability: NTIS (PB-168-369).

9.18. "Surface Winds Near the Center of Hurricanes (and Other Cyclones)," National Hurricane Research Project Report No. 39, Sept. 1960.

Observed wind and pressure data from 14 hurricanes in the Gulf of Mexico and along the Atlantic coast of the United States are presented. Data from three tropical storms off the middle Atlantic coast are also included.

Availability: NTIS (PB-166-842).

9.19. "Some Properties of Hurricane Wind Fields as Deduced from Trajectories," National Hurricane Research Project Report No. 49, Nov. 1961.

Surface wind fields for hurricanes are simulated by a trajectory technique. The technique applies to moving, as well as stationary, storms.

Availability: NTIS (PB-168-398).

9.20. "On the Evolution of the Wind Field During the Life Cycle of Tropical Cyclones," National Hurricane Research Project Report No. 65, Nov. 1963.

The structure of the wind field of tropical cyclones and its changes with time during the intensification and dissipation stages are studied by means of radial wind profiles recorded by research aircraft.

Availability: NTIS (PB-168-414).

9.21. "On the Filling of Tropical Cyclones Over Land," National Hurricane Research Project Report No. 66, Dec. 1963.

The processes that resulted in the dissipation of a tropical cyclone over land were investigated. The investigation was based upon the study of the eddy fluxes of latent and sensible heat and the dissipation of kinetic energy at the Earth's surface. A comparison was made of the rates of energy exchange at the surface after the character of the lower boundary had changed from water to land.

Availability: NTIS (PB-168-415).

9.22. "A Study of Hurricane Rainbands," National Hurricane Research Project Report No. 69, Mar. 1964.

The structure and variability of the spiral rainbands of hurricanes are described using data from more than 75 rainbands selected from tropical cyclones that occurred between 1957 and 1962.

Availability: NTIS (PB-168-417).

9.23. "A Simple Model of the Hurricane Inflow Layer," Technical Note 18-National Hurricane Research Laboratory-75, Nov. 1965.

A simple numerical model of the hurricane inflow layer is constructed. A pressure profile representative of an actual hurricane is specified.

Availability: NTIS (PB-169-210).

9.24. "Changes of the Maximum Winds in Atlantic Tropical Cyclones as Deduced from Central Pressure Changes," NOAA Technical Memorandum ERL WMPO-6, Aug. 1973.

Changes of maximum winds for Atlantic tropical storms have been studied. Mean values and standard deviations of these changes were computed and are presented by 5° squares of latitude and longitude. These data have also been stratified by direction of storm movement.

Availability: NTIS (COM-73-11952/1AS); ERL, official copies.

NOTE:

1. See "Clouds, Liquid Water Content in Storms," item 3.2.
2. See "Floods," item 7.2.
3. See "Precipitation, Hurricane," items 16.1 and 16.2.
4. See "Storm Surges," items 29.1 through 29.4, 29.8, 29.9, and 29.10.
5. See "Weather Modification," item 33.5.

## 10. PRECIPITABLE WATER

10.1. "Mean Precipitable Water in the United States," Weather Bureau Technical Paper No. 10, 1949.

Tabulations and maps showing average monthly and annual distributions of atmospheric moisture in the layers from the surface to 8 km and from 2 to 8 km over the 48 States are presented based on the period of record ending in 1943.

Availability: H.

10.2. "Tables of Precipitable Water and Other Factors for a Saturated Pseudo-Adiabatic Atmosphere," Weather Bureau Technical Paper No. 14, 1951.

Tables showing variations of atmospheric moisture, pressure, and temperature with height are presented.

10.3. "Calculation of Precipitable Water," Weather Bureau Technical Memorandum TDL-33, June 1970, 61 pp.

Two methods of calculating precipitable water are given in terms of data obtainable from a radiosonde or rawinsonde observation. Method I is based on the premise that aqueous vapor pressure (or dew point) and temperature are reported for altitudes with reference to mean sea level. Method II is predicated on the basis that the values are reported for respective specified barometric pressure levels.

Availability: NTIS (PB-193-600).

NOTE:

See "Relative Humidity," item 23.2.

## 11. PRECIPITATION, COMPUTED

11.1. "A Comparison of Kinematically Computed Precipitation with Observed Convective Rainfall," ESSA Technical Memorandum IERTM NSSL-25, 1965.

Observed wind and moisture patterns in an extensive squall-line development are used to compute precipitation from a continuity equation for moist air. Horizontal flux of water vapor accounts for about 80 percent of observed rainfall; and when the local change in water vapor content is included in the moisture-balance equation, the computed budget accounts for 95 percent of the actual rainfall production.

Availability: NTIS (PB-168-445).

11.2. "Three Dimensional Wind Flow and Resulting Precipitation in a Northern California Storm," Weather Bureau Research Paper No. 44, 1963.

A reconstruction of the temperature, wind, pressure, and moisture distributions in a major storm is presented.

## 12. PRECIPITATION, DEPTH-AREA-DURATION ANALYSIS

12.1. "Manual for Depth-Area-Duration Analysis of Storm Precipitation," Weather Bureau Cooperative Studies Technical Paper No. 1, 1946.

The standard procedures used by various Federal agencies for making these analyses are described.

Availability: As a World Meteorological Organization publication with the same title (WMO No. 237. TP 129). Order from: UNIPUB, Inc., P.O. Box 433, New York, New York 10016.

## 13. PRECIPITATION, DISTRIBUTION; TIME AND SPACE

13.1. "A Preliminary Examination of Areal Characteristics of Precipitation in New Mexico," Weather Bureau Technical Memorandum SR-40, Nov. 1968, 14 pp.

Statistics on the areal coverage of precipitation by State climatic divisions are presented.

Availability: NTIS (PB-182-222).

13.2. "Areal Coverage of Precipitation in Northwestern Utah," ESSA Technical Memorandum WBTM WR-56, Sept. 1970.

The percentage of area to be covered by precipitation if it occurs is discussed.

Availability: NTIS (PB-194-389).

13.3. "A Study of the Areal Distribution of Radar Detected Precipitation at Charleston, S.C.," ESSA Technical Memorandum WBTM ER-31, Oct. 1968, 3 pp., 36 figures.

A series of charts showing the areal distribution of radar-detected precipitation within 125 nautical miles of the Weather Bureau Airport Station at Charleston, S.C., is presented.

Availability: NTIS (PB-180-480).

13.4. "Areal Shower Distribution--Mountain Versus Valley Coverage," ESSA Technical Memorandum CR-3, June 1966.

A study of summer showers over the Colorado mountains is presented.

13.5. "A Study of the Effect of Sea Surface Temperature on the Areal Distribution of Radar Detected Precipitation Over the South Carolina Coastal Waters," ESSA Technical Memorandum WBTM ER-23, June 1967, 9 pp.

Using data for the period July 1-30, 1963, the precipitation frequency maximum was found over the warmer waters of the Gulf Stream in contrast to the cooler waters near shore.

Availability: NTIS (PB-180-612).

13.6. "Time Distribution of Precipitation in 4- to 10-Day Storms--Ohio River Basin," NOAA Technical Memorandum NWS HYDRO 13, May 1973.

This report suggests a characteristic time distribution for precipitation frequency values for the 4- through 10-day durations over the subject basin. The suggested distribution was developed from over a 1,400-storm sample for each duration and based on data for 1937-66.

Availability: NTIS (COM-72-11139).

13.7. "Time Distribution of Precipitation in 4- to 10-Day Storms--Arkansas-Canadian River Basins," NOAA Technical Memorandum NWS HYDRO-15, June 1973.

Same description as above item but based on data for 1941-70.

Availability: NTIS (COM-73-11169).

NOTE:

1. See "Precipitation, Hurricane," items 16.3 and 16.4.

14. PRECIPITATION, EXCESSIVE AND MAXIMUM OBSERVED

14.1. "Excessive Precipitation Techniques," Key to Meteorological Records Documentation No. 3.081, 1958.

The various criteria used for defining excessive precipitation and the different ways the data were measured and published are discussed. Names of the various periodicals in which these data were published are listed.

14.2. "Maximum Recorded United States Point Rainfall for 5 Minutes to 24 Hours at 207 First-Order Stations," Weather Bureau Technical Paper No. 2, revised 1963.

Data are presented in tables and on maps.

Availability: H.

14.3. "Maximum Station Precipitation for 1, 2, 3, 6, 12, and 24 Hours," Weather Bureau Technical Paper No. 15, published in parts for individual states.

Tables of maximum amounts for the period 1940-50 for about 2,000 recording-gage stations in 27 states are presented.

Availability: H.

14.4. "Maximum 24-Hour Precipitation in the United States," Weather Bureau Technical Paper No. 16, 1952.

Tables of maximum 24-hr amounts for the period of record ending 1949 for 7,355 stations in the 48 states are presented.

Availability: H.

14.5. "Heavy Rains in Colorado—June 16 and 17, 1965," ESSA Technical Memorandum WBTM CR-4, July 1966.

The meteorological factors associated with this storm are discussed briefly.

14.6. "Weather Extremes," NOAA Technical Memorandum NWS WR-28, Apr. 1968, revised Nov. 1971, 21 pp.

Fifteen categories covering the elements of temperature, precipitation, snowfall, atmospheric pressure, and wind are listed for 14 western cities, 13 western states.

Availability: NTIS (COM-71-01126).

NOTE:

1. See "Climatological Data and Observations," items 1.1 through 1.6, 1.8, and 1.14.
2. See "Climatological Studies," item 2.4.

## 15. PRECIPITATION, FORECASTING

15.1. "Charts Giving Station Precipitation in the Plateau States from 700-Mb Lows During Winter," ESSA Technical Memorandum WBTM TDL-12, Oct. 1967, 54 pp.

Lows are classified into three intensity categories according to the departure from normal of the central height. For each category,

the average precipitation amount, extent, and frequency of occurrence over a grid system are presented.

Availability: NTIS (PB-176-742).

15.2. "Charts Giving Station Precipitation in the Plateau States from 850- and 500-Millibar Lows During Winter," ESSA Technical Memorandum WBTM TDL-25, Sept. 1969, 9 pp., 2 apps.

Probabilities of precipitation from 850- and 500-mb lows are derived for selected stations in the intermountain West during winter.

Availability: NTIS (PB-187-476).

15.3. "A Synoptic Climatology of Winter Precipitation from 700-Mb Lows for the Intermountain Areas of the West," Weather Bureau Technical Note 45 TDL-4, May 1966.

The location and intensity of low systems during the winter in relation to the frequency and amount of precipitation at each of 34 stations in the plateau region are given.

Availability: NTIS (PB-170-635).

15.4. "Synoptic Climatological Studies of Precipitation in the Plateau States from 850-, 700-, and 500-Millibar Lows During Spring," NOAA Technical Memorandum NWS TDL-48, Aug. 1972, 130 pp.

The synoptic climatology of precipitation over the plateau states or intermountain region of the western part of the United States during spring is derived using 12-hr precipitation amounts (expressed as a percent of the 7-day normal) for 13 yr at 157 stations.

Availability: NTIS (COM-73-10069).

15.5. "Synoptic Climatological Studies of Precipitation in the Plateau States from 850-Millibar Lows During Fall," NOAA Technical Memorandum NWS TDL-49, Aug. 1972.

The synoptic climatology of precipitation from upper level lows at 850 mb over the intermountain region of Western United States during September, October, and November is discussed. The average precipitation amount, distribution, and frequency of occurrence are derived and related to the level, intensity, and location of the upper low.

Availability: NTIS (COM-74-10464).

15.6. "Precipitation Probabilities in the Western Region Associated with Winter 500-Mb Map Types," ESSA Technical Memorandum WBTM WR 45-1, Dec. 1969, 91 pp.

Twelve-hr precipitation climatologies as specified by 500-mb flow patterns were generated. Development of types, proper usage, limitations, and other general information is discussed. Types along with their climatologies and a listing of type dates are also included.

This is part 1 (as indicated by the -1 in the series title) of a set covering the four seasons. Parts 2, 3, and 4 have identical titles--except spring, summer, or fall, respectively.

Availability: NTIS (PB-188-248, PB-189-434, PB-189-414, and PB-189-435).

15.7. "Forecasting Precipitation at Bakersfield, California, Using Pressure Gradient Vectors," NOAA Technical Memorandum NWS WR-78, July 1972.

An objective method for forecasting probability of precipitation at Bakersfield, Calif., is described.

Availability: NTIS (COM-72-11146).

15.8. "Objective Forecast of Precipitation Over the Western Region of the United States," NOAA Technical Memorandum NWS WR-89, Sept. 1973, 47 pp.

The climatology of 500-mb winter flow types is presented as follows: frequency of occurrence of seven characteristic 500-mb height configurations and associated patterns of vorticity, vertical velocity, higher and lower pressure levels, dew-point depressions, frequency of precipitation, etc.

Availability: NTIS (COM-73-11946/3GA).

15.9. "A Paradox Principle in the Prediction of Precipitation Type," NOAA Technical Memorandum NWS WR-72, Feb. 1972.

A method utilizing 500-mb temperature, in addition to 1000-mb thickness, in forecasting precipitation type is described.

Availability: NTIS (COM-72-10432).

15.10. "Forecasting Type of Precipitation," NOAA Technical Memorandum NWS ER-45, Jan. 1972.

An objective technique for forecasting precipitation type in Eastern United States out to 48 hr is described.

Availability: NTIS (COM-72-10316).

15.11. "Forecasting Precipitation Type at Greer, South Carolina," NOAA Technical Memorandum NWS ER-44, Dec. 1971.

An objective technique for forecasting precipitation type at Greer, S.C., is described.

Availability: NTIS (COM-72-10332).

15.12. "Predicting Precipitation Types," ESSA Technical Memorandum WBTM WR-49, Mar. 1970.

A method of predicting precipitation types over the Sierra Nevadas is described.

Availability: NTIS (PB-190-962).



15.13. "Predicting the Conditional Probability of Frozen Precipitation," NOAA Technical Memorandum NWS TDL-51, Mar. 1974, 38 pp.

A system producing objective forecasts of conditional probability of frozen precipitation for the conterminous United States is described.

Availability: NTIS (COM-74-10909/1GA).

15.14. "On Quantitative Precipitation Forecasting," National Hurricane Research Project Report No. 38, Aug. 1960.

A method of quantitative precipitation forecasting is discussed.

Availability: NTIS (PB-180-085).

15.15. "An Objective Aid to Forecasting Summertime Showers Over the Lower Rio Grande Valley of South Texas," NOAA Technical Memorandum NWS SR-79, Jan. 1975, 14 pp.

Local forecast study directed primarily to the short-range forecasting of areal coverage of summertime air-mass showers over the Lower Rio Grande Valley. The best predictors were the mean relative humidity in the 850- to 700-mb and the 650- to 500-mb layers at the latest atmospheric sounding at Brownsville.

NOTE:

1. See "Climatological Studies," items 2.8 and 2.11 through 2.13.
2. See "Precipitation Distribution, Time and Space," items 13.3 through 13.5.
3. See "Precipitation Probability," items 19.16 through 19.18.
4. See "Snow," items 27.5 and 27.6.

## 16. PRECIPITATION, HURRICANE

16.1. "Climatological Regime of Rainfall Associated With Hurricanes After Landfall," ESSA Technical Memorandum WBTM ER-29, June 1968, 25 pp.

A climatology of hurricane rainfall for the Northeastern United States is described. Three items are presented: 1) climatology of areal average and maximum point rainfall depths for 24 hr after a hurricane's landfall, 2) characteristic rainfall patterns for the duration of hurricanes as they neared then passed over a land mass, and 3) unusual hurricane rainfall events of record.

Availability: NTIS (PB-179-341).

16.2. "Rainfall Associated With Hurricanes," National Hurricane Research Project Report No. 3, 1956.

Meteorological summaries, isohyetal maps, and maximum depth-area-duration data for over 200 tropical storms are presented.

Availability: NTIS (PB-168-360).

16.3. "Effects of Tropical Cyclone Rainfall on the Distribution of Precipitation Over the Eastern and Southern United States," ESSA Professional Paper No. 1, June 1967, 67 pp.

The effects of tropical storm rainfall on the distribution of mean precipitation over the Eastern and Southern United States are described.

16.4. "Frequency and Areal Distribution of Tropical Storm Rainfall in the United States Coastal Region on the Gulf of Mexico, ESSA Technical Report WB-7, July 1968, 33 pp.

Rainfall within 150 mi of the storm track and 100 mi inside the coastline during the period 24 hr before landfall to 24 hr after are discussed.

NOTE:

1. See "Floods," Weather Bureau Technical Paper No. 26, item 7.2.
2. See "Hurricanes," items 9.11 and 9.22.

17. PRECIPITATION, MEAN AND NORMAL

17.1. "Normal Monthly Number of Days with Precipitation of 0.5, 1.0, 2.0 and 4.0 Inches or More in the Contiguous United States," Weather Bureau Technical Paper No. 57, 1966.

Four series of 12 maps of the United States, each 1:10,000,000, present data based on the 30-yr period 1931-60.

17.2. "Washington Metropolitan Area Precipitation and Temperature Patterns," ESSA Technical Memorandum WBTM ER-28.

Maps showing mean annual and seasonal precipitation, mean annual snowfall, and mean seasonal temperatures for the 20-yr period 1946-65 are presented. Also, total precipitation in wettest and driest months and temperature in coldest and warmest months are shown.

Availability: NTIS (PB-179-340).

17.3. "Quantiles of Monthly Precipitation for Selected Stations in the Contiguous United States," ESSA Technical Report EDS-6, Aug. 1968.

The gamma and mixed gamma distributions were fitted to 30-yr monthly precipitation series for 122 first-order weather stations. Quantiles for selected probabilities from 0.02 to 0.98 are presented.

Availability: NTIS (PB-180-057).

17.4. "Monthly Precipitation--Amount Probabilities for Selected Stations in Virginia," ESSA Technical Memorandum WBTM ER-30, June 1968.

A statistical analysis of 30-yr monthly precipitation data at six well-dispersed stations is presented.

Availability: NTIS (PB-179-342).

## NOTE:

1. See "Climatological Data," items 1.1 through 1.4, 1.6, and 1.8 through 1.11.
2. See "Precipitation, Hurricane," item 16.3.
3. See "Precipitation Probability," items 19.1, 19.2, and 19.22.
4. See "Snow," item 27.3.

## 18. PRECIPITATION, MEASUREMENTS (EQUIPMENT)

## Gages

18.1. "History of Weather Bureau Precipitation Measurements," Key to Meteorological Records Documentation No. 3.082, 1963.

The various gages that have been used and how measurements are made are described.

18.2. "Final Report--Test and Evaluation of the Fischer and Porter Precipitation Gage," ESSA Technical Memorandum WBTM T&EL-7, Oct. 1968 28 pp.

The 2-yr test on this gage is discussed.

Availability: NTIS (PB-180-290).

18.3. "A Rainfall Rate Sensor," ESSA Technical Memorandum ERLTM NSSL-42, Nov. 1968, 10 pp.

An instrument designed to measure rainfall rate is described. Rain passes from a collector into a reservoir formed between two concentric electrodes while it empties from the reservoir through a small nozzle at its base.

Availability: NTIS (PB-183-979).

18.4. "A Selective Precipitation Indicator," ESSA Technical Memorandum WBTM EDL-4, July 1968, 10 pp. and figures.

An electronic instrument, designed to sense or detect the presence of dew, frost, drizzle, rain, or snow, to differentiate between these forms, and to render a report concerning their incidence, duration, and type is described.

Availability: NTIS (PB-179-344).

## Radar-Rain Gage Comparisons

18.5. "Comparison of Gage and Radar Methods of Convective Precipitation Measurement," NOAA Technical Memorandum ERL OD-18, Mar. 1973, 74 pp.

Raingage and radar methods of estimating convective rainfall over an area in Florida are discussed and compared in the context of the Experimental Meteorology Laboratory's multiple cloud seeding experiment.

Availability: NTIS (COM-73-10727).

18.6. "A Rain Gage Evaluation of the Miami Reflectivity Rainfall Rate Relation," ESSA Technical Memorandum ERLTM AOML-3, Sept. 1969, 16 pp.

Fifty comparisons were made between shower rainfall recorded by rain gages and observed with radar to evaluate the reflectivity-rainfall rate relation to provide a foundation for other radar studies in the Miami area.

18.7. "A Case Study of Radar Determined Rainfall as Compared to Rain Gage Measurement," NOAA Technical Memorandum NWS ER-42, July 1971, 7 pp.

WSR-57 radar-estimated rainfall amounts during a 36-hr storm period are obtained by using Wilson's Rainfall Rate-Echo Intensity, RR-EI, chart. These estimates are compared with rainfall data from three tipping buckets.

Availability: NTIS (COM-71-00897).

#### Radar

18.8. "A Preliminary Report on Correlation of ARTCC Radar Echoes and Precipitation," NOAA Technical Memorandum NWS WR-66, June 1971.

The ability of ARTCC radars to detect precipitation of minor or great intensity is described.

Availability: NTIS (COM-71-00829).

18.9. "Precipitation Detection Probabilities by Salt Lake ARTC Radars," ESSA Technical Memorandum WBTM WR-31, July 1968, 12 pp.

ARTC radar locations in the intermountain region are shown and areas of "good" and "poor" precipitation detection capabilities are delineated.

Availability: NTIS (PB-179-084).

18.10. "Precipitation Detection Probabilities by Los Angeles ARTC Radars," NOAA Technical Memorandum NWS WR-67, July 1971.

Same description as above item, 18.9.

Availability: NTIS (COM-71-00925).

18.11. "Range of Radar Detection Associated with Precipitation Echoes of Given Heights by the WSR-57 at Missoula, Montana," NOAA Technical Memorandum NWS WR-85, Apr. 1973.

The range of radar detection associated with precipitation echoes of given heights is discussed.

Availability: NTIS (COM-73-11030).

18.12. "Meteorological Radar Signal Intensity Estimation," NOAA Technical Memorandum ERL NSSL-64, Sept. 1973, 95 pp.

The digital integrator processing techniques used to reduce the variance of precipitation echo power estimates are described. The

19.2. "Characteristics and Probabilities of Precipitation in China," NOAA Technical Report EDS-8, Sept. 1969.

The availability of China's climatological data is discussed. Spatial distribution of monthly precipitation probabilities of selected amounts is given.

Availability: NTIS (PB-188-420).

19.3. "Rainfall Intensities for Local Drainage Design in the United States," Technical Paper No. 24, Aug. 1953, revised Feb. 1955.

This was the initial generalized study of precipitation frequency data. Values for durations from 5 to 240 minutes are presented.

Availability: H.

19.4. "Rainfall Intensities for Local Drainage Design in Western United States," Technical Paper No. 28, Nov. 1956.

This is an expansion of item 19.3, above, to provide values for durations to 24 hr.

Availability: H.

19.5. "Rainfall Intensity-Duration-Frequency Curves for Selected Stations in the United States, Alaska, Hawaiian Islands, and Puerto Rico," Technical Paper No. 25, 1955.

Curves for 203 stations show 5-min to 24-hr intensities for return periods of 2, 5, 10, 25, 50, and 100 yr.

Availability: H.

19.6. "Rainfall Intensity-Frequency Regime," Technical Paper No. 29, Part I, The Ohio Valley, 1957; Part 2, Southeastern United States, 1958; Part 3, The Middle Atlantic Region, 1958; Part 4, Northeastern United States, 1959.

A continuation of the generalized precipitation frequency studies for the United States that was started with Technical Paper Nos. 24 and 28, items 19.3 and 19.4, respectively. These papers were the first major study for short durations since the investigations by David L. Yarnell in August 1935.

Availability: H.

19.7. "Rainfall Frequency Atlas of the United States for Durations from 30 Minutes to 24 Hours and Return Periods from 1 to 100 Years," Technical Paper No. 40, 1961 (reprinted 1963). Information for 11 Western States superseded by NOAA Atlas 2, item 19.8.

Forty-nine maps showing 30-min 1-, 2-, 3-, 6-, 12-, and 24-hr point precipitation for return periods of 1, 2, 5, 10, 25, 50, and 100 yr and interpolation diagrams for obtaining values for intermediate

statistical properties of precipitation echoes are reviewed and related to measurements of atmospheric and WSR-57 weather radar parameters.

Availability: NTIS (COM-73-11923/2GA); ERL, official copies.

18.13. "A Grid Method for Estimating Precipitation Amounts by Using the WSR-57 Radar," ESSA Technical Memorandum WRTM-19, Dec. 1966.

A method for estimating precipitation amounts based on radar reflectivity, from echoes that are predominantly from snow, has been developed for operational use in the mountainous area around Missoula, Mont., and is discussed.

18.14. "Radar Rainfall Pattern Optimizing Technique," NOAA Technical Memorandum ERL NSSL-67, Mar. 1974, 25 pp.

Estimates of precipitation are improved when quantitative radar data are combined with rain gage observations. Gage observations are used to calibrate radar data as well as to estimate precipitation in areas without radar data. Radar data added to gage observations increased the explained variance at test gages beyond that given by gage data alone from 66 to 72 percent and 50 to 59 percent for the same calibrating gages. Large storm-to-storm variations in average radar calibration and large spatial correction variations within storms were attributed to propagation effects.

Availability: NTIS (COM-74-10906/7GA); ERL, official copies.

18.15. "Manually Digitized Radar Grids: A Comparison of Resolution Capabilities For a Heavy Rainstorm Situation," NOAA Technical Memorandum NWS SR-80, Feb. 1975, 11 pp.

The present grid size used in the Manually Digitized Radar Program (MDR) was quartered to provide a greater definition of the area covered by heavy rain. A storm centered near Bakersfield, Tex. on September 19, 1974 was used to illustrate the value of the system.

NOTE:

1. See "Climatological Studies," items 2.9 and 2.10.
2. See "Precipitation Distribution, Time and Space," items 13.3 and 13.5.
3. See "Radar," items 21.1 through 21.3.

## 19. PRECIPITATION, PROBABILITY (FREQUENCY)

19.1. "Precipitation Probability for Eastern Asia," NOAA Atlas 1, July 1971, 71 pp.

Precipitation amounts for each month are presented for 10 probability levels between 0.10 and 0.99 (five levels as maps and five as tables).

Availability: NTIS (COM-72-50446).

durations and return periods are presented. Ratios for obtaining 5-, 10-, and 15-min precipitation from 30-min values are also presented. Area reduction curves for reducing point values for areas up to 400 mi<sup>2</sup> are included.

19.8. "Precipitation Frequency Atlas of Western United States," NOAA Atlas 2, 1973.

Generalized maps are presented for the 6- and 24-hr point precipitation for return periods of 2, 5, 10, 25, 50, and 100 yr. Equations and interpolation diagrams are provided for determining values for other durations less than 24 hr and for intermediate return periods. Area reduction curves for adjusting point values for areas up to 400 mi<sup>2</sup> are included. This Atlas is published in a separate volume for each of the 11 Western States.

Availability: GPO: Vol. I, Montana, \$8.35; Vol. II, Wyoming, \$8.45; Vol. III, Colorado, \$10.10; Vol. IV, New Mexico, \$8.45; Vol. V, Idaho, \$8.45; Vol. VI, Utah, \$10.10; Vol. VII, Nevada, \$8.45; Vol. VIII, Arizona, \$8.35; Vol. IX, Washington, \$8.45; Vol. X, Oregon, \$8.45; and Vol. XI, California, \$10.30. EDS, official copies.

19.9. "Generalized Estimates of Probable Maximum Precipitation and Rainfall-Frequency Data for Puerto Rico and Virgin Islands," Technical Paper No. 42, 1961.

The same type data described in item 19.7 are presented.

19.10. "Rainfall Frequency Atlas of the Hawaiian Islands for Areas to 200 Square Miles, Durations to 24 Hours, and Return Periods from 1 to 100 Years," Technical Paper No. 43, 1962.

The same type data described in item 19.7 are presented.

19.11. "Probable Maximum Precipitation and Rainfall-Frequency Data for Alaska," Technical Paper No. 47, 1963.

The same type data described in item 19.7 are presented.

19.12. "Two- to Ten-Day Precipitation for Return Periods of 2 to 100 Years in the Contiguous United States," Technical Paper No. 49, 1964.

Twenty-four maps showing 2-, 4-, 7-, and 10-day point precipitation values for return periods of 2, 5, 10, 25, 50, and 100 yr and interpolation diagrams for obtaining values for intermediate durations and return periods are presented. Area reduction curves for reducing point values for areas up to 400 mi<sup>2</sup> are also included.

19.13. "Two- to Ten-Day Rainfall for Return Periods of 2 to 100 Years in the Hawaiian Islands," Technical Paper No. 51, 1965.

The same type data described in item 19.12 are presented.

19.14. "Two- to Ten-Day Precipitation for Return Periods of 2 to 100 Years in Alaska," Technical Paper No. 52, 1965.

The same type data described in item 19.12 are presented.

19.15. "Two- to Ten-Day Rainfall for Return Periods of 2 to 100 Years in Puerto Rico and Virgin Islands," Technical Paper No. 53, 1963.

The same type data described in item 19.12 are presented.

19.16. "Climatological Probabilities of Precipitation for the Conterminous United States," ESSA Technical Report WB-5, Dec. 1967, 60 pp.

Probabilities of 6-, 12-, and 24-hr precipitation (0.01 in. or more) for 108 stations, showing diurnal and seasonal trends, are given.

19.17. "Conditional Probabilities of Precipitation Amounts in the Conterminous United States," ESSA Technical Memorandum WBTM TDL-18, Mar. 1969, 89 pp.

Conditional probabilities of precipitation are derived from a 15-yr period of record for 108 selected stations within the 48 conterminous States. The required condition is that precipitation occurs within given periods.

Availability: NTIS (PB-183-144).

19.18. "Climatic Frequency of Precipitation at Central Region Stations," ESSA Technical Memorandum WBTM CR-8, Nov. 1966.

The frequency of measurable precipitation (0.01 in. or more) for locations and time periods for which local forecasts are issued is discussed. The station data were subjected to a space-and-time smoothing to reduce sampling error and to get a homogeneous set of values.

19.19. "Climatological Precipitation Probabilities," ESSA Technical Memorandum WRTM-2, Dec. 1965.

Tables showing monthly climatological probabilities of 0.01 in. or more precipitation for 48 stations in Western United States are presented.

19.20. "Conditional Probabilities for Sequences of Wet Days at Phoenix, Arizona," NOAA Technical Memorandum NWS WR-86, June 1973.

The probability of "k" additional days with precipitation given that "i" consecutive days with thunderstorms have just occurred at Phoenix is presented.

Availability: NTIS (COM-73-11264); EDS, official copies.



19.21. "Average Weekly Rainfall and Probabilities during the Planting-Growing-Harvesting Period in South Carolina," NOAA Technical Memorandum NWS CRS-14, Mar. 1973, 48 pp.

Weekly average values of precipitation were computed for 31 weeks, from April 24 through November 26, for 17 locations. Weekly precipitation probabilities were computed and are tabulated.

19.22. "Climatology of Rainfall Probabilities for Oahu, Hawaii," NOAA Technical Memorandum NWS PR-10, Apr. 1972, 48 pp.

This study is designed to provide the statistical probability of rainfall by months for the island of Oahu, HI.

Availability: NTIS (COM-73-10242); EDS, official copies.

19.23. "An Application of the Gamma Distribution Function to Indian Rainfall," ESSA Technical Report EDS-5, Aug. 1968, 47 pp.

This report investigates (1) whether the monthly monsoon rainfall at Indian stations can be characterized by the incomplete gamma distribution function, (2) the length of period required to permit stabilization of the estimates of the distribution parameters, and (3) the correlation of month-to-month rainfall during the monsoon season.

Availability: NTIS (PB-180-056).

19.24. "A Note on a Gamma Distribution Computer Program and Graph Paper," NOAA Technical Report EDS-11, Apr. 1973, 92 pp.

The gamma distribution function may be used as a model for many sets of data. A FORTRAN IV computer program is presented that provides the analytic solution to a set of data. It gives the probabilities of exceeding or not exceeding arbitrary amounts and indicates the amounts exceeded or not exceeded for arbitrary probabilities. A specialized graph paper is also constructed.

Availability: NTIS (COM-73-11401); EDS, official copies.

NOTE:

1. See "Climatological Data and Observations," item 1.12.
2. See "Climatological Studies," item 2.8.
3. See "Precipitation Distribution, Time and Space," items 13.6 and 13.7.
4. See "Precipitation, Hurricane," item 16.4.
5. See "Precipitation, Mean and Normal," items 17.3 and 17.4.

20. PRECIPITATION, PROBABLE MAXIMUM (PMP)

20.1. "Seasonal Variation of the Probable Maximum Precipitation East of the 105th Meridian for Areas from 10 to 1,000 Square Miles and Durations of 6, 12, 24, and 48 Hours," Hydrometeorological Report No. 33, 1956.

Maps showing the 24-hr 200 mi<sup>2</sup> PMP and curves for adjusting those values for durations of 6, 12, and 48 hr and for areas from 10 to 1,000 mi<sup>2</sup> are presented.

20.2. "Generalized Estimates of Probable Maximum Precipitation for the United States West of the 105th Meridian for Areas to 400 Square Miles and Durations to 24 Hours," Technical Paper No. 38, 1960.

Major storms are discussed and maps showing 1-, 6-, and 24-hr PMP for 10 mi<sup>2</sup> are presented. An interpolation diagram and area-reduction curves are provided for estimating values for intermediate durations and areas up to 400 mi<sup>2</sup>. Superseded for all but the region east of the Continental Divide by later studies. See items 20.3 and 20.4 and by studies currently in preparation for publication.

20.3. "Interim Report--Probable Maximum Precipitation in California, Hydrometeorological Report No. 36, 1961, revisions of 1969.

Estimates of PMP for storm durations up to 72 hr for basin areas up to several thousand mi<sup>2</sup> throughout the Pacific drainage of California are provided by months through the primary precipitation season of October to April.

20.4. "Probable Maximum Precipitation, Northwest States," Hydrometeorological Report No. 43, 1966.

Generalized estimates of PMP are presented for areas up to 5,000 mi<sup>2</sup> and durations to 72 hr. Also, critical sequences of wind, temperature, and dew point for optimum snowmelt conditions are presented.

20.5. "Probable Maximum Precipitation and Rainfall-Frequency Data for Alaska for Areas to 400 Square Miles, Durations to 24 Hours, and Return Periods from 1 to 100 Years," Weather Bureau Technical Paper No. 47, 1963.

Maps showing 1-, 6-, and 24-hr probable maximum point precipitation are presented, and an interpolation diagram and area-reduction curves for obtaining values for intermediate durations for areas up to 400 mi<sup>2</sup> are provided.

20.6. "Probable Maximum Precipitation in the Hawaiian Islands," Hydrometeorological Report No. 39, 1963.

Point values of 24-hr PMP on maps and a depth-area-duration relation for reducing those values for durations down to 30 min and for areas up to 200 mi<sup>2</sup> are presented.

20.7. "Generalized Estimates of Probable Maximum Precipitation and Rainfall Frequency Data for Puerto Rico and Virgin Islands," Weather Bureau Technical Paper No. 42, 1961.

The same data described in item 20.5 are presented.

20.8. "Probable Maximum Precipitation and TVA Precipitation for Tennessee River Basins Up to 3,000 Square Miles in Area and Durations to 72 Hours," Hydrometeorological Report No. 45, May 1969.

Generalized estimates of PMP and TVA precipitation are presented for durations from 1 to 72 hr for basin sizes from a few to 3,000 mi<sup>2</sup>. Antecedent rainfall criteria are provided also for use as indices to soil moisture conditions and existing streamflows at the beginning of the critical rainfalls.

20.9. "Probable Maximum Precipitation and Snowmelt Criteria for Red River of the North Above Pembina, and Souris River Above Minot, North Dakota," Hydrometeorological Report No. 48, May 1973, 69 pp.

Generalized estimates of PMP are provided for durations from 6 to 72 hr and areas from 10 to 40,000 mi<sup>2</sup> centered on the Souris and Red River of the North drainages. Suggested areal and time distributions are provided. Critical snowpack accumulations and snowmelt criteria are given.

Availability: GPO, 90 cents; EDS, official copies.

20.10. "Meteorological Conditions for the Probable Maximum Flood on the Yukon River above Rampart, Alaska," Hydrometeorological Report No. 42, 1966.

Estimates of PMP and critical values of temperature, wind, and snow cover for optimum snowmelt conditions are presented.

20.11. "Probable Maximum Precipitation Over the Susquehanna River Basin Above Harrisburg, Pa.," Hydrometeorological Report No. 40, 1965.

Estimates for durations from 6 to 72 hr and for areas from 10 mi<sup>2</sup> to total basin area (24,100 mi<sup>2</sup>) are presented.

20.12. "Probable Maximum and TVA Precipitation Over the Tennessee River Basin Above Chattanooga," Hydrometeorological Report No. 41, 1965.

Estimates for durations from 6 to 72 hr for the total basin (21,400 mi<sup>2</sup>) and one subarea (7,980 mi<sup>2</sup>) are presented. Variation of PMP during March through September is also given.

20.13. "Probable Maximum Precipitation on the Upper South Platte River, Colorado, and Upper Mississippi River, Minnesota," Hydrometeorological Report No. 44, 1968.

Several critical isohyetal patterns for determining the probable maximum flood on the Upper South Platte River above Chatfield, Colo., and on eight subbasins of the Minnesota River are presented. Critical sequences of 6-hr rainfall increments are included.

20.14. "Meteorological Criteria for Extreme Floods for Four Basins in the Tennessee and Cumberland River Watersheds," Hydrometeorological Report No. 47, May 1973, 59 pp.

PMP and TVA precipitation estimates for 16,170- and 26,780-mi<sup>2</sup> basins in the Tennessee River drainage and 2,734- and 11,674-mi<sup>2</sup> basins in the Cumberland River watershed for durations to 72 hr are presented. Suggested areal and time distributions of precipitation are provided.

Availability: GPO, 90 cents; EDS, official copies.

20.15. "Probable Maximum Precipitation, Mekong River Basin," Hydro-meteorological Report No. 46, May 1970, 152 pp.

Generalized estimates of PMP for 5,000 to 25,000 km<sup>2</sup> drainages for durations up to 3 days covering the Lower Mekong River Basin are determined.

20.16. "Meteorological Estimation of Extreme Precipitation for Spillway Design Floods," ESSA Technical Memorandum WBTM HYDRO 5, Oct. 1967, 29 pp.

The reasons for the meteorological approach to design in the United States are reviewed, the procedures for estimating PMP are summarized, and trends are examined.

Availability: NTIS (PB-177-687).

NOTE:

See "Storms," items 28.11 through 28.13.

## 21. RADAR, HYDROLOGIC APPLICATIONS

21.1. "Video Integrator and Processor," ESSA Technical Memorandum WBTM EDL-8, Feb. 1969, 17 pp., 2 apps.

The design and operation of a new weather radar intensity contouring device is described.

Availability: NTIS (PB-183-510).

21.2. "The National Weather Service Manually Digitized Radar Program and Some Applications," NOAA Technical Memorandum NWS SR-75, Apr. 1974, 26 pp.

Descriptions of the manually digitized radar program, its application to flash flood forecasting, and the tracking of radar patterns are given.

Availability: NTIS (COM-74-11149/3GA); EDS, official copies.

21.3. "The Use of Radar in Flash Flood Forecasting," ESSA Southern Region Technical Memorandum 23, 1966.

The results of correlation studies between a dense network of rain gages in Oklahoma (175 recording gages in 1,100 mi<sup>2</sup>) and the WSR-57 radar at Norman, Okla., are presented. It is shown that radar can assess areal rainfall in shower type precipitation significantly better than the present rain gage network density.

## NOTE:

1. See "Climatological Studies," items 2.9 and 2.10.
2. See "Precipitation Measurements," items 18.5 through 18.14 and 18.15.
3. See "Storms," items 28.5 and 28.6.
4. See "Storm Surges," item 29.16.

## 22. RADIATION, SOLAR AND SKY

22.1. "Weekly Mean Values of Daily Total Solar and Sky Radiation," Weather Bureau Technical Paper No. 11, 1949 (Supplement No. 1, 1955).

Seasonal variation curves of radiation for 30 stations in the United States are presented. The supplement presents data for five additional stations.

22.2. "Sunshine and Cloudiness at Selected Stations in the United States, Alaska, Hawaii and Puerto Rico," Weather Bureau Technical Paper No. 12, 1951.

Average monthly values based on period of record ending 1948 are presented in tabular form for about 80 stations in the United States.

22.3. "Infrared Radiation from Air to Underlying Surface," Technical Note 44 Hydro-1, May 1966, 35 pp.

A computer method for calculating the flux of infrared radiation from the atmosphere, with or without clouds, to the Earth's surface is described.

Availability: NTIS (PB-170-664).

## NOTE:

See "Climatological Data and Observations," items 1.3, 1.4, 1.8, 1.9, and 1.12.

## 23. RELATIVE HUMIDITY

23.1. "Method for Obtaining Wet-Bulb Temperature by Modifying the Psychrometric Formula," NOAA Technical Memorandum EDS BOMAP-11, June 1974.

A method of obtaining wet-bulb temperature from air temperature, relative humidity, and pressure is described. The algorithm provides values consistent within  $\pm 0.01^\circ\text{C}$  with the input data.

Availability: EDS.

23.2. "Estimating Mean Relative Humidity from the Surface to 500 Millibars by Use of Satellite Pictures," ESSA Technical Memorandum NESC TM-23, Mar. 1970.

A method for estimating atmospheric relative humidity by using satellite cloud photographs is described.

Availability: NTIS (PB-191-741).

## NOTE:

See "Climatological Data and Observations," items 1.3, 1.4, 1.8, 1.9, and 1.12.

## 24. RIVER AND FLOOD FORECASTING

## 24.1. "Floods and Flood Warnings," 6 pp.

The Weather Service's flood forecasting and warning services and community and individual actions recommended during flood emergencies are described.

Availability: GPO (C55.2:F65); EDS.

## 24.2. "Flash Flood, The Treacherous Torrent," poster.

Flash flood safety rules and flood watch and warning terms used by the National Weather Service are described.

Availability: GPO (C55.2:F61); EDS.

## 24.3. "Elements of River Forecasting," ESSA Technical Memorandum WBTM HYDRO 9, Mar. 1969, 57 pp.

Elementary explanations of how to forecast volume of surface runoff, distribution of volume at a point, and changes in hydrograph as water moves downstream are given. (Supersedes ESSA Technical Memorandum WBTM HYDRO-4.)

Availability: NTIS (PB-185-969).

## 24.4. "Predicting the Runoff from Storm Rainfall," Weather Bureau Research Paper No. 34, 1951.

The technique for developing graphical rainfall-runoff relations is described.

## 24.5. "Flood Warning Benefit Evaluation--Susquehanna River Basin (Urban Residences)," ESSA Technical Memorandum WBTM HYDRO-10, Mar. 1970, 42 pp.

The effectiveness of a flood warning service, coupled with either temporary flood-proofing or evacuation of residential structures, in reducing flood damage is discussed.

Availability: NTIS (PB-190-984).

## 24.6. "Direct Search Optimization in Mathematical Modeling and a Watershed Model Application," NOAA Technical Memorandum NWS HYDRO-12, Apr. 1971, 52 pp.

Application of Pattern Search, a direct search optimization technique, to mathematical modeling is described.

Availability: NTIS (COM-71-00616).

24.7. "National Weather Service River Forecast System Forecast Procedures," NOAA Technical Memorandum NWS HYDRO-14, Dec. 1972.

The necessary steps for developing a river forecast system based on conceptual hydrologic modeling are described. The techniques and programs required from the initial processing of basin data to the preparation of forecasts are provided. The programs are written for a large-capacity digital computer and are generalized for use on any river system.

Availability: NTIS (COM-73-10517); EDS, official copies.

24.7A. "National Weather Service River Forecast System, Forecast Procedures-Programs and Test Data," Dec. 1972.

A file containing computer programs for the efficient implementation of a conceptual hydrologic model for river forecasting is provided. Test data are also included. There are eight programs written in the FORTRAN IV language and nine sets of test data. Five programs are used for data processing and data manipulation. Model calibration, historical hydrograph simulation, and operational river flow forecasting programs are included. There are 17 files comprised of 12360 card images (records). The computer programs are written for CDC 6600 computers.

Dec. 72, 1 reel mag tape, specify tape recording mode desired: 7 track, 556 BPI, even parity, BCD; or 9 track, 800 BPI, odd parity, EBCDIC.

Availability: NTIS (COM-73-10298).

24.8. "A Dynamic Model of Stage-Discharge Relations Affected by Changing Discharge," NOAA Technical Memorandum NWS HYDRO-16, Nov. 1973, 38 pp., apps. A and B, 13 pp.

A mathematical model is developed to simulate the dynamic relationship between stage and discharge when the energy slope is variable due to changing discharge. Either stage or discharge may be computed if the other is specified.

Availability: NTIS (COM-74-10818); EDS, official copies.

24.9. "Numerical Properties of Implicit Four-Point Finite Difference Equations of Unsteady Flow," NOAA Technical Memorandum NWS HYDRO-18, Mar. 1974, 38 pp.

Linearized model equations of the quasi-linear differential equations of unsteady gradually varied flow are utilized to investigate the effect of the discretization of the continuous partial derivatives with implicit four-point finite-difference quotients. The investigation is generalized to include various four-point implicit difference schemes.

24.10. "National Weather Service River Forecast System--Snow Accumulation and Ablation Model," NOAA Technical Memorandum NWS HYDRO-17, Nov. 1973, 223 pp.

A conceptual model of the snow accumulation and ablation process and the associated computer subroutines and programs that enable the

model to be used in conjunction with the National Weather Service River Forecast System are described.

Availability: NTIS (COM-74-10728/5GA); EDS, official copies.

24.10A. "National Weather Service River Forecast System, Snow Accumulation and Ablation Model - Programs and Test Data," Oct. 1973.

The magnetic tape contains computer programs and test data for the National Weather Service River Forecast System, Snow Accumulation and Ablation model. The complete source deck of the two programs used for model calibration (the verification and optimization programs) are included. In addition, the tape contains snow subroutines for the operational river forecasting program and three programs to compute mean areal air temperature. The test data are for the Passumpsic River at Passumpsic, Vermont. Precipitation, potential evapotranspiration, air temperature, and streamflow data are included. The programs are written in FORTRAN IV language and extended for use on CDC 6600/SCOPE 3.3 computer system. There are 12 files comprised of 11342 card images (records) on the magnetic tape.

Specify tape recording mode desired: 7 track, 556 BPI, even parity, BCD- or 9 track, 800 BPI, odd parity EBCDIC. Includes documentation, COM-74-10728.

Availability: NTIS (COM-74-10930, set: 2 tapes); (COM-74-10931/5GA).

24.11. "Application of the SSARR Model to a Basin Without Discharge Record," ESSA Technical Memorandum WBTM WR-55, Aug. 1970, 14 pp.

The SSARR (Streamflow Synthesis and Reservoir Regulation) model was designed to be a general, flexible model with special provisions for use in daily river forecasting operations. It has been tested on many basins with adequate data, thus demonstrating its ability to reliably synthesize watershed response to both rainfall and snowmelt.

Availability: NTIS (PB-194-394).

24.12. The Effects of Dams, Reservoirs and Levees on River Forecasting," ESSA Technical Memorandum ER-16, Sept. 1966.

The effect of manmade controls on river flow and river forecasting is discussed. The river system portrayed is hypothetical.

24.13. "Forecasting the Spring 1969 Midwest Snowmelt Floods," NOAA Technical Memorandum NWS CR-40, Feb. 1971, 21 pp.

The winter of 1968-69 in the upper Midwest experienced a long period of heavy snow of high water content over a large area, with widespread disastrous spring floods in its wake. The use of hydrologic data by the National Weather Service to estimate flood potential up to 2 1/2 months before the onset of flooding and for day-to-day short-term flood forecasting is described.

Availability: NTIS (COM-71-00489).



24.14. "Flash Flood Forecasting and Warning Program in the Western Region," NOAA Technical Memorandum NWS WR-82, Dec. 1972.

A description of the conditions that cause flash floods in Western United States, the requirements for an effective warning program, and procedures useful in developing flash flood watches are described.

Availability: NTIS (COM-73-10251); EDS, official copies.

NOTE:

1. See "Radar (Hydrologic Applications)," items 21.2 and 21.3.
2. See "Storm Surges," item 29.16.
3. See "Streamflow Frequency Analysis," items 30.1 and 30.2.
4. See "Water Management," items 31.1 and 31.2.

## 25. RIVER STAGES

25.1. "River Forecasts Provided by the National Weather Service," published annually.

This publication is issued annually. River forecast points and miscellaneous information about the location, together with the highest stage observed during the period of record and highest for the year are given.

Prior to 1972, daily river gage data, highest stages of record, and descriptions of gage locations were published in "Daily River Stages."

Availability: NCC, inquire as to price. Issues for years prior to 1950 are out of print.

NOTE:

See "Climatological Data and Observations," items 1.1 and 1.3.

## 26. SATELLITE METEOROLOGY

26.1. "Study of the Use of Aerial and Satellite Photogrammetry for Surveys in Hydrology," ESSA Technical Memorandum NESCTM-14, Mar. 1970, 22 pp.

Possible applications of photogrammetry in problems of hydrology are explored.

Availability: NTIS (PB-191-735).

26.2. "Applications of Environmental Satellite Data to Oceanography and Hydrology," ESSA Technical Memorandum NESCTM-19, Jan. 1970, 12 pp.

Three applications of satellites are discussed: (1) large-scale mapping of sea-surface temperatures, (2) relation between sunglint patterns and the ocean wave spectrum and low-level wind stress, and (3) mapping of major snow and ice boundaries.

Availability: NTIS (PB-190-652).

## NOTE:

1. See "Precipitation Measurements," items 18.15 and 18.16.
2. See "Snow," item 27.7

## 27. SNOW

## 27.1. "Snow Cover Surveys by Eastern Snow Conference," published annually.

This report presents monthly data on snow depths and water equivalents for the season December through April. The data are for some 700 stations in New England, New York, and Pennsylvania.

Availability: Regional Hydrologist, National Weather Service Eastern Region, 585 Stewart Ave., Garden City, N.Y. 11530.

## 27.2. "Frequency of Maximum Water Equivalent of March Snow Cover in North Central United States," Weather Bureau Technical Paper No. 50, 1964.

The relationship between maximum snow depths and their water equivalents is described. Two sets of six maps showing water equivalent for the first and second halves of March for return periods of 2, 5, 10, 25, 50, and 100 yr are provided.

## 27.3. "Snowfall, Snowfall Frequencies, and Snow Cover Data for New England," ESSA Technical Memorandum EDS-12, Dec. 1969, 15 pp.

Seasonal total snowfall averages and extremes, frequencies of various snowfall intensities from 1 to 8 in. in a day, and snow cover data are presented in a series of eight maps and two tables.

Availability: NTIS (PB-194-221).

## 27.4. "Climatic Data Report, Southeastern Snow Storm, February 8-11, 1973," NOAA Technical Memorandum EDS NCC-2, May 1973.

A brief storm history and some pertinent climatological data are provided in this preliminary report.

Availability: NCC and EDS, official copies.

## 27.5. "A Synoptic Climatology of Blizzards on the North-Central Plains of the United States," NOAA Technical Memorandum NWS CR-39, Feb. 1971.

The type weather situation that will produce blizzard conditions over the north-central Plains is described.

Availability: NTIS (COM-71-00369).

## 27.6. "A Synoptic Climatology for Snowstorms in Northwestern Nevada," NOAA Technical Memorandum NWS WR-73, Feb. 1972.

A climatological aid for forecasting snow in northwestern Nevada.

Availability: NTIS (COM-72-10338).

27.7. "Experimental Large-Scale Snow and Ice Mapping with Composite Minimum Brightness Charts," ESSA Technical Memorandum NESCTM-12, Sept. 1969.

A composite minimum brightness chart is a computer product derived from digitized and rectified satellite video data. Displays a means of suppressing transient cloudiness and enhancing major snow and ice features in satellite imagery. Examples are presented and limitations are discussed.

Availability: NTIS (PB-186-362).

NOTE:

1. See "Climatological Data and Observations," items 1.2, 1.5, and 1.9.
2. See "Precipitation Forecasting," item 15.16.
3. See "River and Flood Forecasting," item 24.10.
4. See "Storms," item 28.14.

## 28. STORMS, GENERAL

28.1. "Lightning," 6 pp.

The phenomenon of lightning and safety rules are discussed.

Availability: GPO (C55.102:L62); EDS, official copies.

28.2. "Thunderstorms," 6 pp.

The causes, life cycle, destructive offspring, and incidence of thunderstorms, including thunderstorm safety rules, are discussed.

Availability: GPO (C55.2:T42); EDS, official copies.

28.3. "Mean Number of Thunderstorm Days in the United States," Weather Bureau Technical Paper No. 19, 1952.

Tabulations and maps show mean monthly and seasonal number of days with thunderstorms for 266 stations in the United States.

28.4. "Thunderstorms and Hail Days Probabilities in Nevada," NOAA Technical Memorandum NWS WR-74, Apr. 1972.

At five sites in Nevada, probabilities for selected number of thunderstorm days in a month and in a year and probabilities for a selected number of hail days in a year were determined.

Availability: NTIS (COM-72-10554); EDS.

28.5. "A Study of Radar Echo Distribution in Arizona During July and August," NOAA Technical Memorandum NWS WR-77, July 1972, 25 pp.

Hourly composite radar charts for the summer months of July and August of 1970 and 1971 are provided for the greater part of Arizona. These

charts clearly illustrate the pronounced diurnal regime of thunderstorm activity.

Availability: NTIS (COM-72-11136); EDS.

28.6. "Structure and Movement of the Severe Thunderstorms of April 3, 1964, as Revealed from Radar and Surface Mesonetwork Data Analysis," ESSA Technical Memorandum ERL TM NSSL-41, Oct. 1968, 47 pp.

Detailed analyses of radar echoes, NSSL Beta-network data and upper air soundings recorded on April 3, 1964, are made to investigate possible mechanisms of the movement of severe thunderstorms.

Availability: NTIS (PB-183-310).

28.7. "The Role of Persistence, Instability, and Moisture in the Intense Rainstorms in Eastern Colorado, June 14-17, 1965," ESSA Technical Memorandum WBTM HYDRO-3, 1967, 21 pp.

The meteorological characteristics of the rain-favoring inflow of air into the storm, which caused widespread flooding and the greatest flood of record in Denver, are evaluated.

Availability: NTIS (PB-174-609).

28.8. "Papers on Oklahoma Thunderstorms, April 29-30, 1970," NOAA Technical Memorandum ERL NSSL-69, 1974, 233 pp.

A collection of papers analyzing an eight-hour series of events that ranged from small hailstorms to gigantic, tornado-spawning maelstroms. The data are among the most detailed storm observations acquired to that time.

Availability: NTIS (COM 74-11474/AS).

28.9. "Meteorology of Major Storms in Western Colorado and Eastern Utah," ESSA Technical Memorandum WBTM HYDRO-7, 1968, 80 pp.

Forty-two major storms are analyzed to determine relative influence of moisture, topography, and proximity of upper lows or troughs on precipitation.

Availability: NTIS (PB-177-491).

28.10. "Meteorology of Flood-Producing Storms in the Mississippi River Basin," Hydrometeorological Report No. 34, 1956.

Characteristics of outstanding storms are described.

28.11. "Meteorology of Hypothetical Flood Sequences in the Mississippi River Basin," Hydrometeorological Report No. 35, 1959.

The meteorological situations associated with historical floods are described and hypothetical floods for design purposes by combining historical floods are derived.

28.12. "Meteorology of Hydrologically Critical Storms in California," Hydrometeorological Report No. 37, 1962.

Characteristics of outstanding storms are described.

28.13. "Meteorology of Flood-Producing Storms in the Ohio River Basin," Hydrometeorological Report No. 38, May 1961.

This report describes the meteorological characteristics of major flood-producing storms over the Ohio River Basin.

28.14. "Midwestern Snowstorm Models and the February 1973 Storm Over Georgia," NOAA Technical Memorandum NWS SR-74, Dec. 1973.

The record snowstorm over Southeastern United States in February 1973 is examined and compared with midwestern snowstorms.

Availability: NTIS (COM-74-10260).

NOTE:

1. See "Climatological Data and Observations," items 1.2, 1.3 (annual), and 1.14.
2. See "Clouds, Liquid Water Content in Storms," items 3.1 and 3.2.
3. See "Hurricanes," items 9.2, 9.3, 9.9, 9.11, 9.12, 9.13, and 9.15.

## 29. STORM SURGES

29.1. "Some Problems Involved in the Study of Storm Surges," National Hurricane Research Project Report No. 4, Dec. 1956.

The various forces that affect the height of the sea and the response of the sea to these forces are reviewed.

Availability: H. NTIS (PB-166-838).

29.2. "Characteristics of the Hurricane Storm Surge," Weather Bureau Technical Paper No. 48, 1963.

The development of storm surges is described and data on outstanding hurricane-produced surges along the Gulf and Atlantic coasts are presented.

Availability: NTIS (COM-74-11424/AS).

29.3. "SPLASH (Special Program to List Amplitudes of Surges from Hurricanes) I. Landfall Storms," NOAA Technical Memorandum NWS TDL-46, Apr. 1972, 55 pp.

Two separate methods (based on dynamics) to estimate or forecast the surge are described. The first method, in which precomputed nomograms are used, is designed only to arrive at a peak surge value. In the second method, a dynamic model is used to compute surges along the entire coastline.

Availability: NTIS (COM-72-10807); EDS.

29.4. "SPLASH (Special Program to List Amplitudes of Surges from Hurricanes). Part 2. General Track and Variant Storm Conditions," NOAA Technical Memorandum NWS TDL-52, Mar. 1974, 62 pp.

An operational computer program is expanded to accommodate storms with generalized motions of not too great complexity. Examples are storms that move alongshore, recurve, remain stationary, accelerate, and landfall (exit). Also, storm strength and size are allowed to vary in a continuous monotonic manner with time.

Availability: NTIS (COM-74-10925/7GA); EDS, official copies.

29.5. "Joint Probability Method of Tide Frequency Analysis Applied to Atlantic City and Long Beach Island, N.J.," ESSA Technical Memorandum WBTM HYDRO 11, Apr. 1970, 109 pp.

The frequency analysis of combined storm surges and periodic tides prepared by ESSA as part of the Long Beach Island study is described. These frequencies apply to the ocean beach. Studies of wave action and possible variations in water levels inshore from the ocean side of the island are not covered.

Availability: NTIS (PB-192-745).

29.6. "Storm Tide Frequencies on the South Carolina Coast," NOAA Technical Report NWS No. 16.

The present NOAA procedures for determining open coast storm tide frequencies are described. A brief climatological summary of major hurricanes affecting the South Carolina coast is given.

29.7. "Storm Tide Frequency Analysis for the Coast of Georgia," NOAA Technical Memorandum NWS HYDRO-19, Sept. 1974, 28 pp.

Storm-tide height frequencies are developed for the Georgia coast. The procedures used are those described in 29.6.

Availability: NTIS (COM-74-11746/AS); EDS, official copies.

29.8. "Storm Tide Frequency for the Gulf Coast of Florida from Cape San Blas to St. Petersburg Beach," NOAA Technical Memorandum NWS HYDRO-20. (in press).

Storm-tide height frequencies are developed for a portion of the Florida Gulf of Mexico coast. The procedures used are those described in 29.6.

29.9. "Storm Tide Frequency Analysis for the Coast of Puerto Rico," NOAA Technical Memorandum NWS HYDRO (in preparation).

Storm-tide height frequencies are developed for the coast of Puerto Rico. The procedure used is a modification of that described in 29.6.

29.10. "Estimation of Hurricane Storm Surge in Apalachicola Bay, Florida," NOAA Technical Report NWS No. 17 (in press).

The adaptation of the Ried-Bodine bay model to provide tide frequency values in Apalachicola Bay is described. The model is adapted to accept as input the results of SPLASH.

29.11. "Joint Probability Method of Tide Frequency Analysis Applied to Apalachicola Bay and St. George Sound, Fla.," NOAA Technical Report, NWS (in preparation).

The model developed by Overland (item 29.10) is used to develop storm-tide height frequencies for two bays along the Florida coast. The open coast storm-tide frequency values from item 29.8 were used for the outer coast values.

29.12. "A Mean Storm Surge Profile," ESSA Technical Memorandum WBTM SR-49, Dec. 1969, 2 pp., 4 figures.

Data from 19 great hurricanes (950-mb or lower) making landfall in the United States south of 35° latitude have been analyzed to show the variation and extremes in the heights of the water levels. A mean storm surge profile has been constructed.

Availability: NTIS (PB-188-422).

29.13. "A Preliminary View of Storm Surges Before and After Storm Modifications," NOAA Technical Memorandum ERL WMPO-3, May 1973.

A theoretical discussion of the effects of tropical storm modification on the resulting storm is presented. A two-dimensional dynamic surge model is used.

Availability: NTIS (COM-73-11304); ERL, official copies.

29.14. "Forecasting Extratropical Storm Surges for the Northeast Coast of the United States," NOAA Technical Memorandum NWS TDL-50, Jan. 1974.

Empirical forecast equations for 10 locations from Portland, Me., to Norfolk, Va., are given. Input to the equations are forecast sea-level pressures at grid points.

Availability: NTIS (COM-74-10719); EDS, official copies.

29.15. "Criteria for a Standard Project Northeaster for New England North of Cape Cod," National Hurricane Research Project No. 68, Mar. 1967.

The criteria for storms producing severe tides along the New England coast between Provincetown, Mass., and the Canadian border are developed.

29.16. "An Example of Radar as a Tool in Forecasting Tidal Flooding," ESSA Technical Memorandum WBTM ER-24, Aug. 1967.

A procedure for using radar to detect echo lines associated with shifts and, therefore, to forecast tidal flooding, is described.

Availability: NTIS (PB-180-613).

29.17. "Giant Waves Hit Hawaii," ESSA Technical Memorandum WBTM PR-8, Sept. 1970, 40 pp.

The successful prediction of the arrival time of storm-generated heavy waves in Hawaii during early December 1969 is described.

Availability: NTIS (COM-71-00021).

29.18. "A Lake Erie Storm Surge Forecasting Technique," ESSA Technical Memorandum WBTM TDL-24, Aug. 1969, 23 pp.

Two methods of forecasting storm surge on Lake Erie at Buffalo, N.Y., and Toledo, Ohio, are presented. One method is for manual use; the other is for computer use where numerical weather forecasts are available.

Availability: NTIS (PB-185-778).

NOTE:

See "Wind Waves," item 35.3.

### 30. STREAMFLOW FREQUENCY ANALYSIS

30.1. "Methods of Flow Frequency Analysis," Notes on Hydrologic Activities Bulletin No. 13, Interagency Committee on Water Resources, Subcommittee on Hydrology, 1966.

The five methods most commonly used by Federal agencies in making frequency studies of runoff at individual streamflow stations are described. Some of these methods are also used for analysis of rainfall frequency.

30.2. "A Uniform Technique for Determining Flood Flow Frequencies," Bulletin No. 15, Water Resources Council, Hydrology Committee, Dec. 1967.

The log-Pearson Type III method for flood flow frequency analysis is recommended and its application is described.

NOTE:

Neither of the above is a NOAA publication, but NOAA is represented on the Hydrology Committee. For information, write to: Water Resources Council, 2120 L Street, NW., Suite 800, Washington, D.C. 20037.



### 31. WATER MANAGEMENT

#### 31.1. "The National Weather Service and Water Management," 1973, 15 pp.

The National Weather Service's river and water supply forecasting services and hydrometeorological research for water management planning and design are described.

Availability: GPO; EDS.

#### 31.2. "Effective Use of Non-Structural Methods in Water Management," ESSA Technical Memorandum WBTM CR-34, Mar. 1970, 12 pp.

The use of nonstructural methods, such as flood plain regulation, floodproofing, flood forecasting, seasonal and annual forecasts of water supply, and weather modification, as an effective approach to attaining water management objectives, is described.

### 32. WATER SUPPLY FORECASTS

#### 32.1. "Water Supply Outlook for Northeastern United States," published monthly from October through September.

Issues are published the first of each month for the water year. Estimates of water-year flow to be expected from various watersheds in New England and New York are presented.

Availability: National Weather Service, River Forecast Center, Box 688, Hartford, Conn. 06101.

#### 32.2. "Water Supply Outlook for Western United States," published monthly from January to May.

Issues are published the first of each month from January to May. Estimates of water-year flow to be expected from numerous watersheds west of 104° W. are presented.

Availability: EDS.

#### 32.3. "Water Supply Outlook for the State of Alaska," published monthly from April through October.

Issues are published the first of each month from April through October. Estimates of water-year flow to be expected from selected watersheds in Alaska are presented.

Availability: National Weather Service, River Forecast Center, 632 Sixth Avenue, Anchorage, Ak. 99501.

## 33. WEATHER MODIFICATION

33.1. "An Annotated Bibliography on Weather Modification 1960-1969," NOAA Technical Memorandum EDS ESIC-1, June 1972, 413 pp.

Annotated references on statistical evaluation of cloud seeding operations and potentialities, cloud seeding theories and experiments, legal aspects of weather modification, economic implications, hail control and lightning suppression, cloud and fog dissipation, atomic explosion effects, hurricane control, and large-scale climate modification are provided.

Availability: NTIS (COM-72-11287); EDS, official copies.

33.2. "Bibliography of the Urban Modification of the Atmospheric and Hydrologic Environment," NOAA Technical Memorandum EDS-21, Feb. 1974.

A representative cross-section of the literature related to urban modification of climate is presented. Only those references to city climates that contain comparisons with adjacent rural climates are included. Among topics covered are precipitation, radiation, temperature, floods, ground water, runoff, sedimentation, stream temperature, and water quality.

Availability: NTIS (COM-74-10962/AS); EDS, official copies.

33.3. "Ground Rainfall Data for the 1968 Florida Cloud Seeding Experiment," ESSA Technical Memorandum EDS-17, Aug. 1970, 15 pp.

Maps of ground rainfall data are depicted for the Research Laboratories 1968 Florida cloud seeding experiment. These maps are for information only, and no conclusions are drawn.

Availability: NTIS (PB-194-366).

33.4. "Florida Cumulus Seeding Experiment for Drought Mitigation, April-May 1971," NOAA Technical Memorandum ERL OD-9, Nov. 1971, 165 pp.

In the spring of 1971, the Experimental Meteorology Laboratory undertook a dynamic cumulus seeding program in two target areas, one to the north and the other to the south of Lake Okeechobee, Fla. Evaluation was by rain gages and 10-cm radars, the WSR-57 of the National Weather Service, and the calibrated radar of the University of Miami (beginning May 10).

Availability: NTIS (COM-72-10149); ERL, official copies.

33.5. "Stormfury Cumulus Seeding Experiment 1965: Statistical Analysis and Main Results," ESSA Technical Memorandum IERTM APCL-3, Apr. 1967, 47 pp.

Basis and results of a randomized seeding experiment carried out on 23 tropical oceanic cumulus clouds on 9 days in the summer of 1965 are given.

33.6. "An Airborne Pyrotechnic Cloud Seeding System and Its Use," ESSA Technical Memorandum ERL TM APCL-5, May 1968, 27 pp.

The development, testing, and use of an airborne pyrotechnic cloud seeding system is described.

33.7. "Intensive Study of Three Seeded Clouds on May 16, 1968," ESSA Technical Memorandum ERLTM APCL-8, May 1969, 42 pp.

Three cumulus clouds were seeded over south Florida. Following seeding, one of the clouds dissipated without growth, while the other two grew explosively. This paper analyzes the history of each cloud with observations and with a numerical model. The model results predicted appropriately the variation in growth.

33.8. "Optimizing the Measurement of Convective Rainfall in Florida," NOAA Technical Memorandum NOAA TM ERL WMPO-18, July 1974, 106 pp.

The report discusses in five sections: (1) definition of the nature of Florida convective rains, (2) calculation of area-mass rainfall using gages deployed over a 220-mi<sup>2</sup> area, (3) estimation of area rainfall using S-band radar with gages in small dense arrays serving as the basis for comparison, (4) definition of the gaging requirements to measure area-mass rainfall within a specified accuracy over large areas using gages, and (5) specification of the accuracy of a combined gage and radar system for the measurement of areal convective precipitation.

Availability: NTIS (COM-74-11554/4GA); ERL, official copies.

33.9 "A Case Study of Two Stormfury Cloudline Seeding Experiments," NOAA Technical Memorandum ERL WMPO-21, Feb. 1975, 45 pp.

Two cloudline seeding cases were selected for study from the Project STORMFURY cloudline exercises. One case involved clouds in a rather active convective environment while the other case was more isolated. Both cases showed more growth in seeded than unseeded clouds but no unbiased control clouds were monitored.

#### 34. WIND

34.1. "History of Weather Bureau Wind Measurements," Key to Meteorological Records Documentation No. 3.151, 1963.

The various types of anemometers that have been used are described.

Availability: NCC.

34.2. "Wind Persistence Probability," ESSA Technical Memorandum ERLTM ARL-10, Feb. 1969, 32 pp.

Wind persistence is evaluated based on 5-yr standard hourly reports from 61 weather stations in the United States. The probability that a wind direction would persist in a sector of given size for hourly time periods starting with 2 hr was computed by season, direction of the center of the sector, and wind speed.

## NOTE:

1. See "Climatological Data and Observations," items 1.1 through 1.4, 1.8, 1.9, and 1.12.
2. See "Hurricanes," items 9.13, 9.17 through 9.20 and 9.24.

## 35. WIND WAVES

35.1. "Wave Climatology for the Great Lakes," NOAA Technical Memorandum NWS TDL-40, Feb. 1971, 61 pp.

This study is based upon 10 yr of wave observations, which are summarized for each of the lakes according to month of yr. Also, an overall summary for all months together is given for each lake.

Availability: NTIS (COM-71-00368).

35.2 "Wind Waves on the Great Lakes," ESSA Technical Memorandum WBTM CR-21, May 1968, 15 pp.

Deep water waves, including their characteristics, formation, height forecasting, and the effects of these waves on small craft are discussed.

35.3. "Cause and Prediction of Beach Erosion," NOAA Technical Memorandum NWS ER-55, Dec. 1973.

The oceanographic and meteorological factors involved in beach erosion are discussed. Eleven cases in New Jersey and eight cases in Long Island were investigated and the results are summarized.

Availability: NTIS (COM-74-10036); EDS.

## NOTE:

See "Storm Surges," items 29.16 and 29.18.