NOAA Technical Memorandum NWS WR-160

EASTERN NORTH PACIFIC TROPICAL CYCLONE OCCURRENCES DURING INTRASEASONAL PERIODS

Salt Lake City, Utah
February 1981

U.S. DEPARTMENT OF COMMERCE / National Oceanic and Atmospheric Administration / National Weather Service

NOAA TECHNICAL MEMORANDA
National Weather Service, Western Region Subseries

The National Weather Service (NWS) Western Region (WR) Subseries provides an informal medium for the documentation and quick dissemination of results not appropriate, or not yet ready, for formal publication. The series is used to report on work in progress, to describe technical procedures and practices, or to relate progress to a limited audience. These Technical Memoranda will report on investigations devoted primarily to regional and local problems of interest mainly to personnel, and hence will not be widely distributed.

Papers 1 to 25 are in the former series, ESSA Technical Memoranda, Western Region Technical Memoranda (WRTM); papers 24 to 59 are in the former series, ESSA Technical Memoranda, Weather Bureau Technical Memoranda (WBTM). Beginning with 60, the papers are part of the series, NOAA Technical Memoranda NWS. Out-of-print memoranda are not listed.

Papers 2 to 22, except for 5 (revised edition), are available from the National Weather Service Western Region, Scientific Services Division, P.O. Box 11188, Federal Building, 125 South State Street, Salt Lake City, Utah 84147. Paper 5 (revised edition), and all others beginning with 25 are available from the National Technical Information Service. U.S. Department of Commerce, Sills Building, 5285 Port Royal Road, Springfield, Virginia 22151. Prices vary for all paper copy; $3.50 microfiche. Order by accession number shown in parentheses at end of each entry.

ESSA Technical Memoranda (WRTM)

2 Climatological Precipitation Probabilities. Compiled by Lucianne Miller, December 1965.
3 Western Region Pre- and Post-FP-3 Program, December 1, 1965, to February 20, 1966. Edward D. Diemer, March 1966.
5 Station Descriptions of Local Effects on Synoptic Weather Patterns. Phillip Williams, Jr., April 1966 (revised November 1967, October 1969). (PB-17800)
8 Interpreting the RAREP. Herbert P. Benner, May 1966 (revised January 1967).
11 Some Electrical Processes in the Atmosphere. J. Latham, June 1966.
17 A Digitalized Summary of Radar Echoes within 100 Miles of Sacramento, California. J. A. Youngberg and L. B. Overaas, December 1966.
21 An Objective Aid for Forecasting the End of East Winds in the Columbia Gorge, July through October. D. John Coparanis, April 1967.
22 Derivation of Radar Horizons in Mountainous Terrain. Roger G. Pappas, April 1967.

ESSA Technical Memoranda, Weather Bureau Technical Memoranda (WBTM)

25 Verification of Operational Probability of Precipitation Forecasts, April 1966-March 1967. W. W. Dickey, October 1967. (PB-176240)
26 A Study of Winds in the Lake Mead Recreation Area. R.P. Augulis, January 1968. (PB-177830)
28 Weather Extremes. R. J. Schmidli, April 1968 (revised July 1968). (PB-178928)
29 Small-Scale Analysis and Prediction. Philip Williams, Jr., May 1968. (PB-178425)
30 Numerical Weather Prediction and Synoptic Meteorology. Capt. Thomas D. Murphy, U.S.A.F., May 1968. (AD-673365)
31 Precipitation Detection Probabilities by Salt Lake ARTC Radars. Robert K. Belesky, July 1968. (PB-179084)
32 Probability Forecasting--A Problem Analysis with Reference to the Portland Fire Weather District. Harold S. Ayer, July 1968. (PB-179289)
35 Joint ESSA/FAA ARTC Radar Weather Surveillance Program. Herbert P. Benner and DeVon B. Smith, December 1968 (revised June 1970). (AD-681857)
36 Temperature Trends in Sacramento--Another Heat Island. Anthony D. Lentini, February 1969. (PB-183055)
37 Disposal of Logging Residues without Damage to Air Quality. Owen P. Cramer, March 1969. (PB-183057)
39 Upper-Air Lows over Northwestern United States. A. L. Jacobson, April 1969. (PB-184296)
40 The Man-Machine Mix in Applied Weather Forecasting in the 1970's. L.W. Snellman, August 1969. (PB-185068)
42 Analysis of the Southern California Santa Ana of January 15-17, 1966. Barry B. Aronovitch, August 1969. (PB-185670)
43 Forecasting Maximum Temperatures at Helena, Montana. David E. Olsen, October 1969. (PB-185762)
44 Estimated Return Periods for Short-Duration Precipitation in Arizona. Paul C. Kangieser, October 1969. (PB-187763)
46 Applications of the Net Radiometer to Short-Range Fog and Stratus Forecasting at Eugene, Oregon. L. Yee and E. Bates, December 1969. (PB-190476)
47 Statistical Analysis as a Flood Routing Tool. Robert J. C. Burnash, December 1969. (PB-188744)
48 Tsunami. Richard P. Augulis, February 1970. (PB-190157)
49 Predicting Precipitation Type. Robert J.C. Burnash and Floyd E. Hug, March 1970. (PB-190962)
50 Statistical Report on Aeroallergens (Pollens and Molds) Fort Huachuca, Arizona, 1969. Wayne S. Johnson, April 1970. (PB-191743)
51 Western Region Sea State and Surf Forecaster's Manual. Gordon C. Shields and Gerald B. Burdwell, July 1970. (PB-193102)
52 Sacramento Weather Radar Climatology. R. G. Pappas and C.M. Veliquette, July 1970. (PB-193347)
54 A Refinement of the Vorticity Field to Delineate Areas of Significant Precipitation. Barry B. Aronovitch, August 1970.
55 Application of the SSARR Model to a Basin without Discharge Record. Vail Schermerhorn and Donald W. Kuehl, August 1970. (PB-194394)
56 Areal Coverage of Precipitation in Northwestern Utah. Philip Williams, Jr., and Werner J. Heck, Sept. 1970. (PB-194389)
57 Preliminary Report on Agricultural Field Burining vs. Atmospheric Visibility in the Willamette Valley of Oregon. Earl M. Bates and David O. Chilcote, September 1970. (PB-194710)
58 Air Pollution by Jet Aircraft at Seattle-Tacoma Airport. Wallace R. Donaldson, October 1970. (COM-71-00017)
59 Application of PE Model Forecast Parameters to Local-Area Forecasting. Leonard W. Snellman, Oct. 1970. (COM-71-00016)

NOAA Technical Memoranda (NWS WR)

60 An Aid for Forecasting the Minimum Temperature at Medford, Oregon. Arthur W. Fritz, October 1970. (COM-71-00120)
63 700-mb Warm Air Advection as a Forecasting Tool for Montana and Northern Idaho. Norris E. Woerner, February 1971. (COM-71-00349)
64 Wind and Weather Regimes at Great Falls, Montana. Warren B. Price, March 1971.
66 A Preliminary Report on Correlation of ARTCC Radar Echoes and Precipitation. Wilbur K. Hall, June 1971. (COM-71-00829)
69 National Weather Service Support to Soaring Activities. Ellis Burton, August 1971. (COM-71-00956)
71 Western Region Synoptic Analysis-Problems and Methods. Philip Williams, Jr., February 1972. (COM-72-10433)
74 Thunderstorms and Hail Days Probabilities in Nevada. Clarence M. Sakamoto, April 1972. (COM-72-10554)
75 A Study of the Low Level Jet Stream of the San Joaquin Valley. Ronald A. Willis and Philip Williams, Jr., May 1972. (COM-72-10707)
76 Monthly Climatological Charts of the Behavior of Fog and Low Stratus at Los Angeles International Airport. Donald M. Gales, July 1972. (COM-72-11140)
77 A Study of Radar Echo Distribution in Arizona During July and August. John E. Hales, Jr., July 1972. (COM-72-11136)
78 Forecasting Precipitation at Bakersfield, California, Using Pressure Gradient Vectors. Earl T. Riddiough, July 1972. (COM-72-11146)
79 Climate of Stockton, California. Robert C. Nelson, July 1972. (COM-72-10920)
80 Estimation of Number of Days Above or Below Selected Temperatures. Clarence M. Sakamoto, October 1972. (COM-72-10021)
81 An Aid for Forecasting Summer Maximum Temperatures at Seattle, Washington. Edgar G. Johnson, Nov. 1972. (COM-73-10150)
82 Flash Flood Forecasting and Warning Program in the Western Region. Philip Williams, Jr., Chester L. Glenn, and Roland L. Raetz, December 1972. (Rev. March 1978) (COM-73-10251)
83 A Comparison of Manual and Semiautomatic Methods of Digitizing Analog Wind Records. Glenn E. Rasch, March 1973. (COM-73-10669)
86 Conditional Probabilities for Sequences of Wet Days at Phoenix, Arizona. Paul C. Kangieser, June 1973. (COM-73-11264)
87 A Refinement of the Use of K-Values in Forecasting Thunderstorms in Washington and Oregon. Robert Y.G. Lee, June 1973. (COM-73-11276)
89 Objective Forecast of Precipitation over the Western Region of the United States. Julia N. Paegle and Larry P. Kierulff, September 1973. (COM-73-11946/3AS)
91 Arizona "Eddy" Tornadoes. Robert S. Ingram, October 1973. (COM-73-10465)
92 Smoke Management in the Willamette Valley. Earl M. Bates, May 1974. (COM-74-11277/AS)
93 An Operational Evaluation of 500-mb Type Regression Equations. Alexander E. MacDonald, June 1974. (COM-74-11407/AS)
94 Conditional Probability of Visibility Less than One-Half Mile in Radiation Fog at Fresno, California. John D. Thomas, August 1974. (COM-74-11555/AS)
96 Map Type Precipitation Probabilities for the Western Region. Glenn E. Rasch and Alexander E. MacDonald, February 1975. (COM-75-10428/AS)
97 Eastern Pacific Cut-Off Low of April 21-28, 1974. William J. Alder and George R. Miller, January 1976. (PB-250-711/AS)
98 Study on a Significant Precipitation Episode in Western United States. Ira S. Brenner, April 1976. (COM-75-10719/AS)
99 A Study of Flash Flood Susceptibility--A Basin in Southern Arizona. Gerald Williams, August 1975. (COM-75-11360/AS)

NOAA Technical Memorandum NWS WR-160

EASTERN NORTH PACIFIC TROPICAL CYCLONE OCCURRENCES DURING INTRASEASONAL PERIODS

Preston W. Leftwich and Gail M. Brown

National Hurricane Center
Miami, Florida
February 1981

UNITED STATES
DEPARTMENT OF COMMERCE

NATIONAL OCEANIC AND
ATMOSPHERIC ADMINISTRATION

National Weather
Service
Richard E. Hallgren, Director

This Technical Memorandum has been reviewed and is approved for publication by Scientific Services Division, Western Region.

L. W. Snellman, Chief
Scientific Services Division
Western Region Headquarters
Salt Lake City, Utah

CONTENTS

EASTERN NORTH PACIFIC TROPICAL CYCLONE OCCURRENCES DURING INTRASEASONAL PERIODS

Preston W. Leftwich and Gail M. Brown[1]
National Hurricane Center[2]
Coral Gables, Florida 33146

ABSTRACT. In conjunction with development of statistical models for prediction of tropical cyclone motion in the Eastern North Pacific Ocean, the National Hurricane Center (NHC) has compiled tracks of tropical cyclones occurring during the period 1949-1979. This study presents computer plots of these storm tracks for intraseasonal periods ranging from ten days to one month. Basic statistics concerning storm frequencies are also included.

1. INTRODUCTION

Tropical cyclones in the Eastern North Pacific basin, as elsewhere, are categorized by their maximum sustained surface winds. Tropical depressions have winds less than 34 knots (63 km/h), tropical storms have winds from 34 to 63 knots (63-117 km/h), and hurricanes have winds greater than 63 knots (119 km/h). For the purposes of this study, the Eastern North Pacific basin extends from the coasts of the United States, Mexico, and Central America westward to 140° west longitude and from approximately 5° to 35° north latitude. During the period 1949-1979, 337 tropical cyclones reaching at least tropical storm strength have been documented.

Previous studies have been made concerning the climatology of Eastern North Pacific tropical cyclones for specific interests. Eidemiller (1978) presented frequencies of tropical cyclones affecting the southwestern United States and northwestern Mexico. Court (1980) discussed tropical cyclones which affected coastal areas during the first half of this century. Renard and Bowman (1976) described the climatology and forecasting of storms in this basin using data for the period 1965-1972. Hansen (1972) presented climatologies of frequency, duration, intensity, and areas of formation and dissipation. More general discussions of the origin and development of tropical cyclones in this region were offered by Gray (1968, 1975). Statistics concerning motion and frequencies of Eastern North Pacific tropical cyclones are contained in Crutcher and Quayle (1974).

Development of a statistical model, EPCLPR, based on climatology and persistence (Neumann and Leftwich 1977), was the initial motivation for compilation of these storm tracks. These tracks were also used in development of another statistical model, EPHC77 (Leftwich and Neumann 1977), which includes 500-mb geopotential heights as predictors. Recent work has led to additions of wind and central sea-level pressure data to corresponding storm positions. Compiled

[1]*Current affiliation: Student, Pennsylvania State University.*
[2]*Study partially supported by NOAA/ERL-AOML-National Hurricane Research Laboratory (NHRL).*

data have been stored on a computer card deck and a magnetic tape in a format described by Jarvinen and Caso (1978) for Atlantic tropical cyclones. These data will be available through the National Climatic Center, which is located in Asheville, North Carolina.

2. DATA SOURCES

Information used in preparation of charts and figures was extracted from the recently compiled data set. Basic storm tracks for the period 1949-1975 were acquired from the United States Navy in Monterey, California. Initially, storm positions were given at 12-h intervals. Interpolations of positions to 6-h intervals were made by use of a scheme devised by Akima (1970), with some subjective modifications. From 1976-1979, storm tracks were prepared by the Eastern Pacific Hurricane Center (EPHC) located in Redwood City, California. All tracks are smoothed so that they represent the large-scale motion of the storm's circulation. A thorough review of these storm tracks was made by Arnold Court under contract[3] from the National Weather Service. His work concentrated on extensions of tracks inland and resulted in additions and/or modifications to 81 storm tracks included in our original data set. A final review, including checks for consistency as well as errors, was made once the data had been placed in our card deck.

Before the advent of operational meteorological satellites, land stations, ships at sea, and aerial reconnaissance reports provided information on tropical cyclones in the Eastern North Pacific basin. The greatest number of reports was received from ships at sea. Generally, these ships were traveling in the periphery of a storm's circulation, and the distance to the storm's center was unknown. As warnings became better, even fewer ships encountered the central regions of storms. Aerial reconnaissance was infrequent and concentrated into periods when a storm was threatening land areas. Passage of a storm directly over a land station was also infrequent. Undoubtedly, some weaker and short-lived storms in remote oceanic areas were not detected. Prior to 1965, tracks were only documented for tropical storms and hurricanes. From 1965-1979, depression stages have been included for both formative and dissipative stages. Tracks of all tropical depressions that did not reach at least tropical storm intensity have been excluded.

The first location of a tropical cyclone in the Eastern North Pacific Ocean by satellite was made by TIROS III on July 19, 1961 (Mull 1962). As in other tropical cyclone basins, advent of operational satellite coverage greatly increased the capability for detecting and tracking of storms. This is supported by the increase in the mean number of observed tropical cyclones per year from 8.6 for 1949-1964 to 14.6 for 1965-1979.

Classification of maximum intensity as hurricane versus tropical storm was not made prior to 1954. Intensity at various stages of the tracks was not documented until 1965, but development of techniques to estimate winds from satellite pictures has greatly enhanced availability of wind data in recent

[3] *Contract NA-79-WD-C-00006.*

years. Most wind speeds appearing in our data set were either taken from official advisories issued by the EPHC or estimated from information published in annual summaries appearing in the Monthly Weather Review or Mariners Weather Log.

3. TRACKS AND FREQUENCIES

Figure 1 is a computer plot of all tropical cyclone tracks in the recently compiled data set. Although little detail for individual storms is shown, such presentation depicts both the concentration and range of storm tracks in the Eastern North Pacific basin. Tracks of storms which developed in the Eastern North Pacific basin and moved west of 140°W are truncated at 140°W.

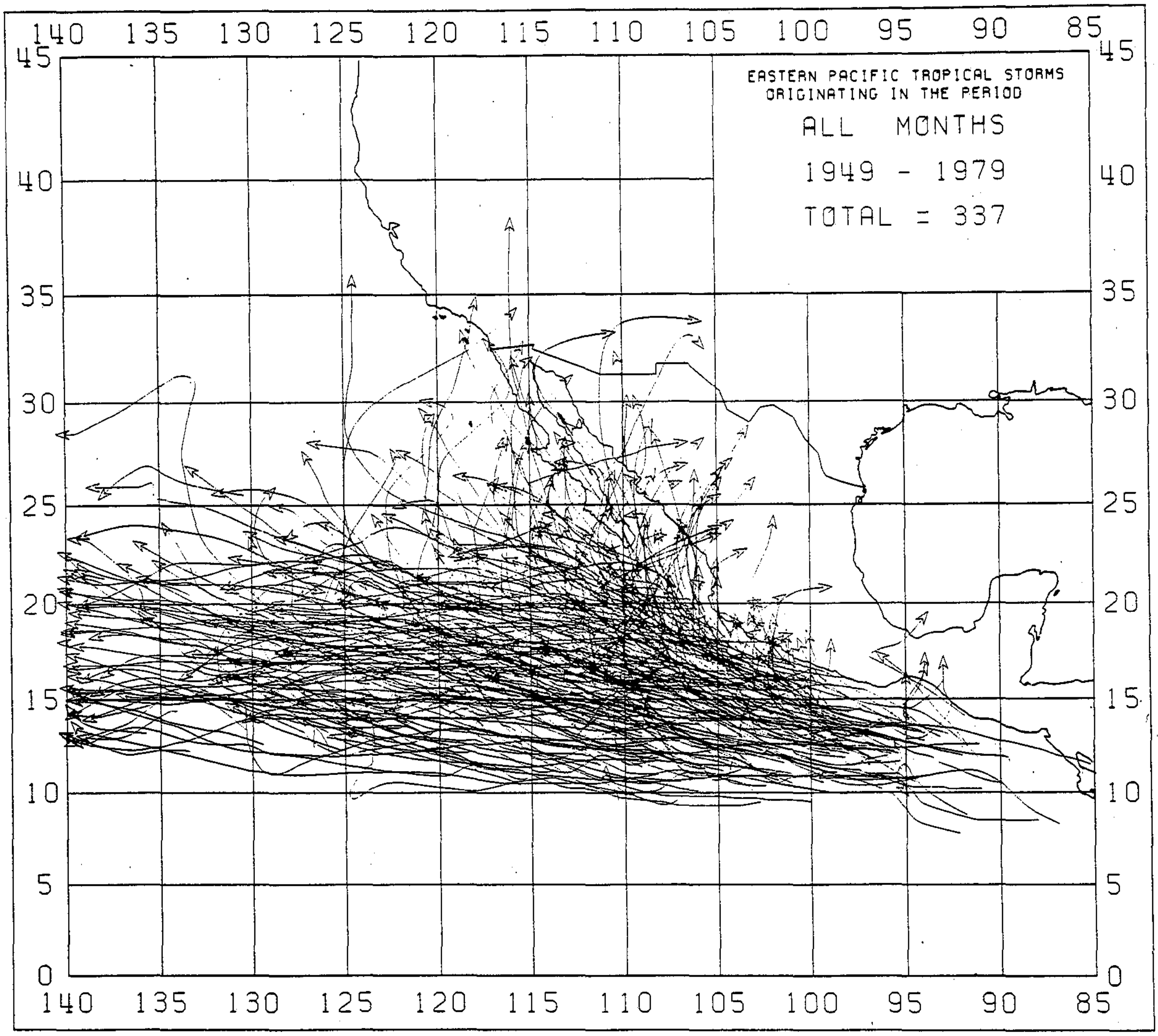


Figure 1. Computer plot of tracks of 337 Eastern North Pacific tropical cyclones during the 31-year period 1949 through 1979.

Figure 2 presents frequencies of storm occurrence for each year from 1949 to 1979. Prior to 1954, no distinctions were made between hurricanes and tropical storms. Storms reaching hurricane intensity are counted as tropical storms as well. For example, during 1974, 18 storms reached tropical storm strength and 11 of these also reached hurricane strength. The increase in number of storms observed after 1964 is evident in the graph. Peak tropical storm occurrence was 19 in both 1970 and 1978, and the peak hurricane occurrence was 13 in 1978. Only four tropical storms were recorded in 1953 and one hurricane was recorded in 1955, 1964 and 1965.

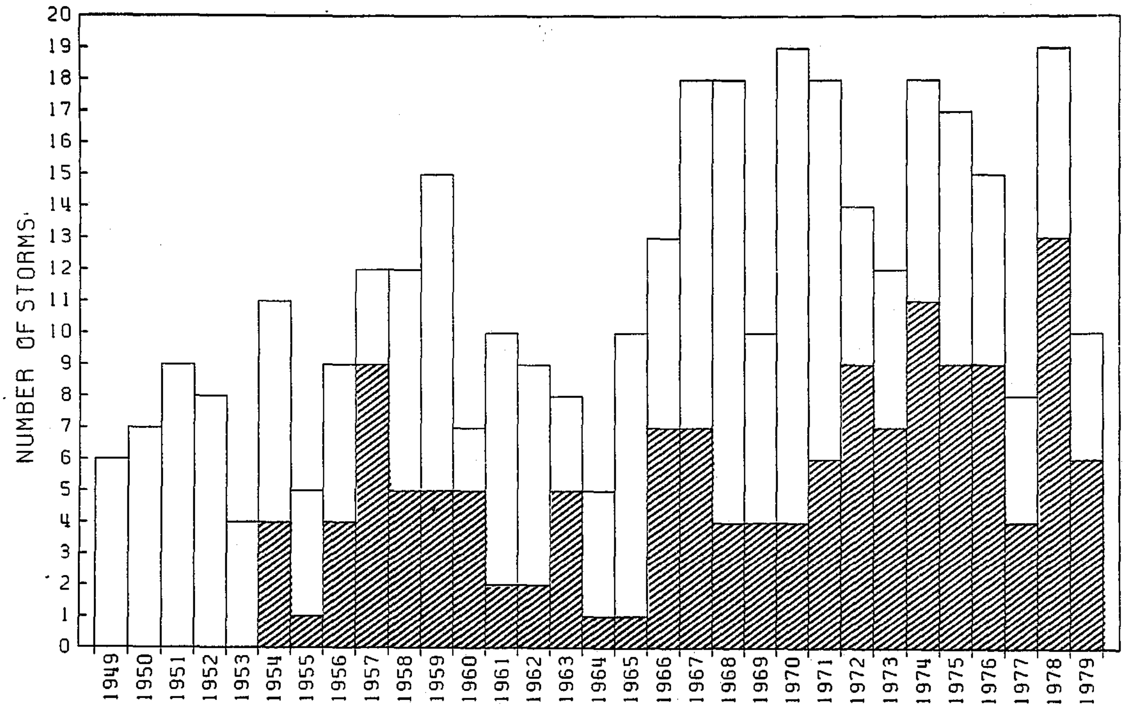


Figure 2. Annual distribution of 337 recorded tropical cyclones reaching at least tropical storm strength (open bar) and hurricane strength (shaded bar), 1949-1979.

Figures 3 and 4 depict the daily incidence of tropical cyclones in the Eastern North Pacific for the eight-month period May-December. If two storms existed on a given day, two storm occurrences were counted for that day. Frequencies have been smoothed (Figure 4) using a 15-day moving average in order to remove much of the "noise" inherent in the original data, but still retain larger-scale cycles. These smoothed frequencies indicate a general increase from mid-May to mid-July, with a slight drop in frequencies during the last half of June. A sharper drop in frequencies occurs during late July before an increase to the seasonal maximum near the end of August. This peak in daily frequencies occurs when both the number of storms and the lengths of

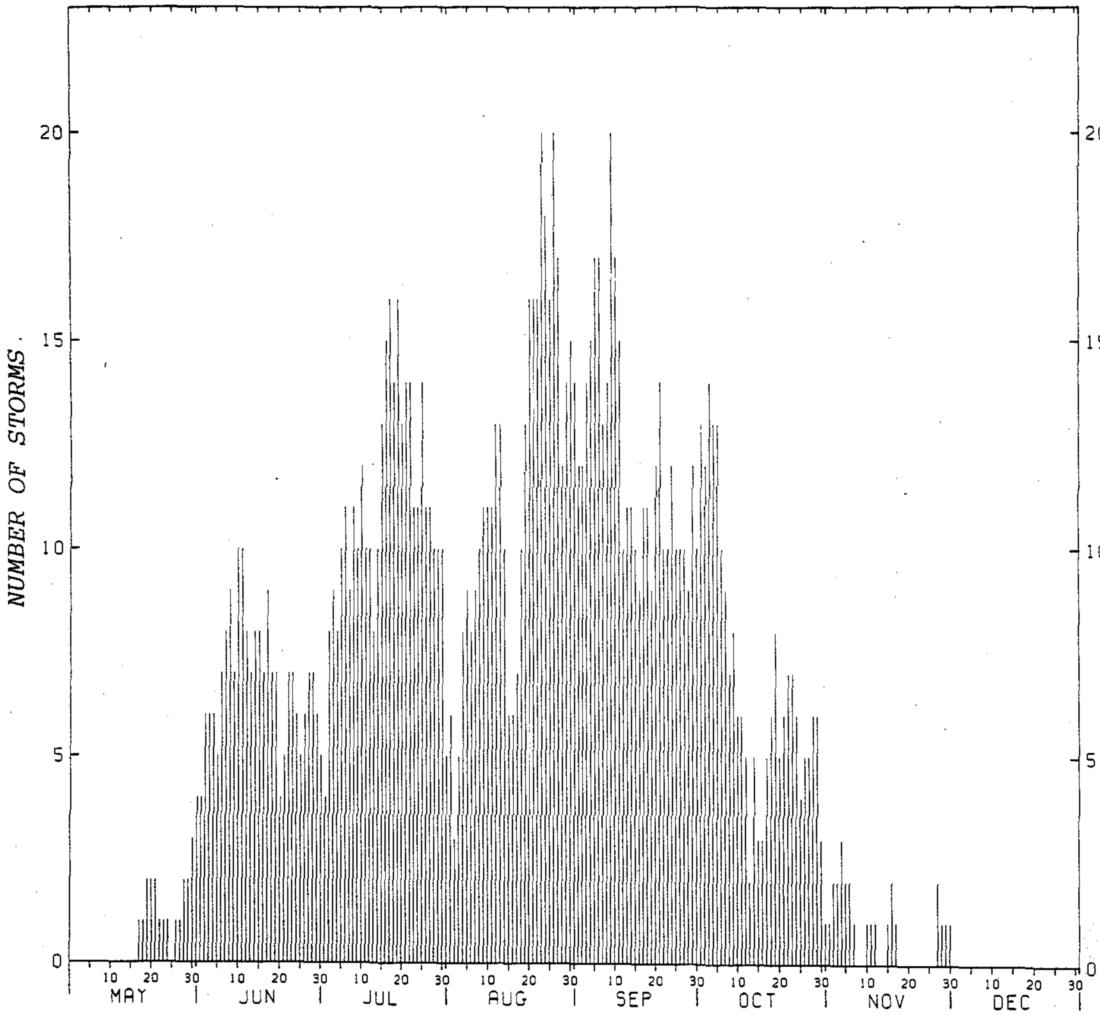


Figure 3. Number of tropical cyclones of at least tropical storm strength observed on each day, May 1 - December 31, 1949-1979.

their tracks are near maxima. Frequencies then show a general decline for the remainder of the season. These data may be compared to similar computations presented by Neumann et al. (1978) for the Atlantic basin.

Figure 5 shows cumulative frequencies of beginning and ending dates of the Eastern North Pacific tropical storm seasons for the period 1949-1979. Data are the first and last days of each year on which at least one tropical storm or hurricane existed. Mean season length is 134 days. A summary of these statistics is given in Table 1.

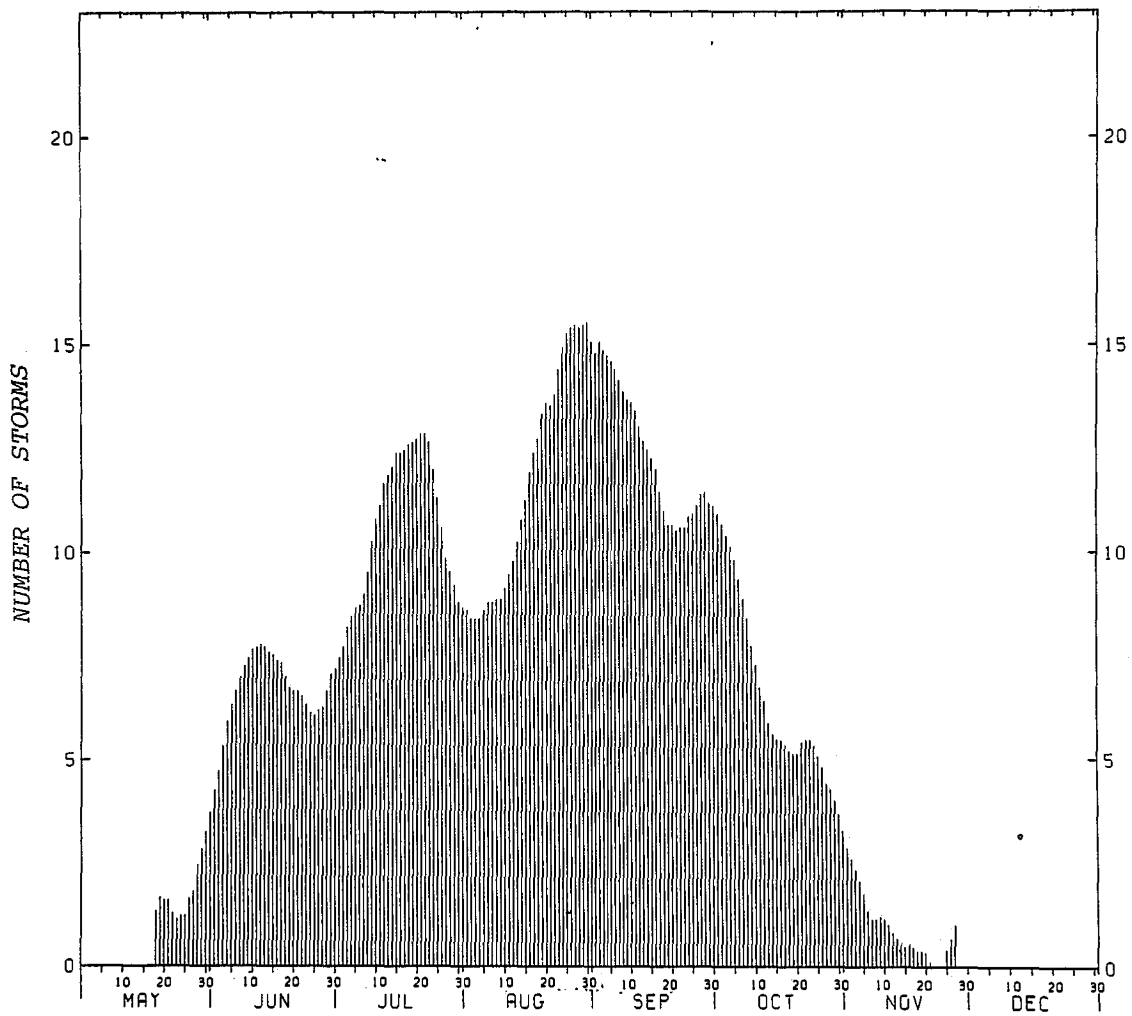


Figure 4. Same as Figure 3, but data smoothed by a 15-day moving average.

Table 1. Statistics concerning beginning and ending dates of Eastern North Pacific tropical cyclone seasons, 1949-1979.

	Beginning Date	Ending Date
Earliest	May 17	September 5
Latest	August 25	November 30
Mean	June 12	October 22
Median	June 7	October 19
Standard Deviation	20 days	18 days

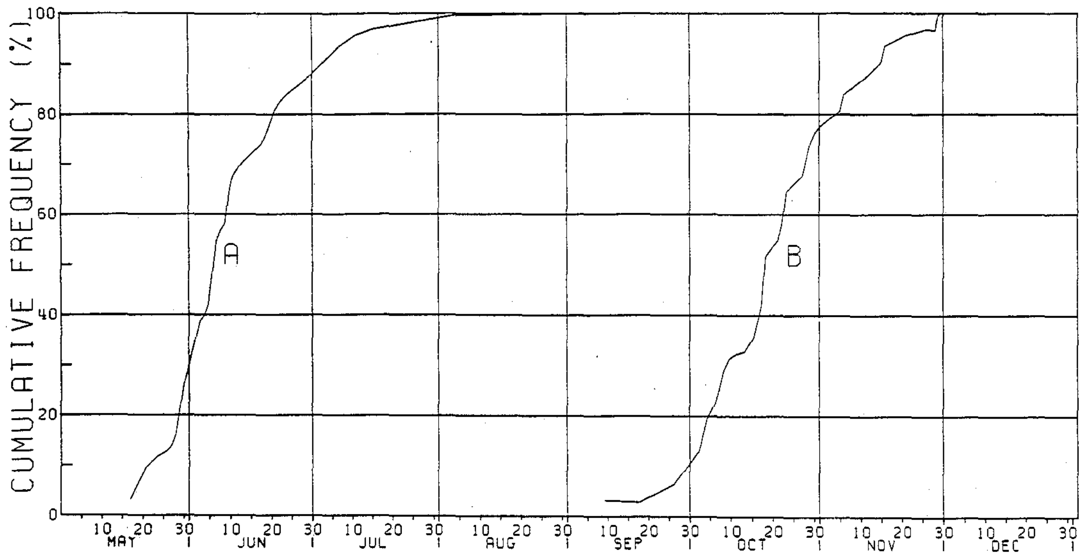


Figure 5. Cumulative frequency distribution of beginning (A) *and ending* (B) *dates of Eastern North Pacific tropical cyclone seasons, 1949-1979.*

4. STORM TRACKS

The various charts on the following pages present tropical cyclone tracks for several intraseasonal periods. These charts were produced on the NOAA FR-80 computer graphics system. Their purpose is graphical depiction of seasonal variations of characteristics of tropical cyclone tracks in the Eastern North Pacific basin. Storms are in the respective periods according to their first day of existence as documented in our compiled data set. No other identification is assigned to individual tracks. Appendix I presents storm tracks for monthly periods from May through November. Similar charts follow for 15-day (Appendix II) and 10-day (Appendix III) periods.

ACKNOWLEDGMENTS

The authors thank Sherri Morris and Brian Jarvinen for help in producing computer plots of storm tracks. Judy Kraus provided technical assistance in production of this report. Charles J. Neumann, Chief of the NHC Research and Development Unit, offered helpful comments.

REFERENCES

Akima, H., 1970: A new method of interpolation and smooth curve fitting based on local procedures. J. Assoc. Computing Mach., 17, 589-602.

Court, A., 1980: Tropical storm landfalls in western North America, 1899-1948. Preprints, Second Conference on Coastal Meteorology, Amer. Meteor. Soc., 30 Jan - 1 Feb 1980, Los Angeles, CA., 198-201.

Crutcher, H. L. and R. G. Quayle, 1974: Mariner's worldwide climatic guide to tropical storms at sea. NOAA/EDS National Climatic Center and Naval Weather Service publication (NAVAIR50-IC-61), 114 pp. plus 312 charts.

Eidemiller, D. I., 1978: The frequency of tropical cyclones in the southwestern United States and northwestern Mexico. Climatological Publications, Scientific Paper No. 1, 41 pp.

Gray, W. M., 1968: Global view of the origin of tropical disturbances and storms. Mon. Wea. Rev., 96, 669-700.

Gray, W. M., 1975: Tropical cyclone genesis. Atmos. Sci. Paper No. 234, Colorado State University, Fort Collins, CO., 121 pp.

Hansen, H. L., 1972: The climatology and nature of tropical cyclones of the Eastern North Pacific Ocean. Master's Thesis, Naval Postgraduate School, Monterey, CA., 178 pp.

Jarvinen, B. R. and E. L. Caso, 1978: A tropical cyclone data tape for the North Atlantic basin, 1886-1977: contents, limitations, and uses. NOAA Technical Memorandum NWS NHC 6, 19 pp.

Jarvinen, B. R. and C. J. Neumann, 1978: Atlantic tropical cyclone tracks by 5-, 10-, 15-, and 30-day periods. NOAA Technical Memorandum NWS NHC 5, 57 pp.

Leftwich, P. W. and C. J. Neumann, 1977: Statistical guidance on the prediction of Eastern North Pacific tropical cyclone motion - part 2. NOAA Technical Memorandum NWS WR-125, 15 pp.

Mull, M. W., 1962: Tropical cyclones in the Eastern North Pacific, 1961. Mar. Wea. Log, 6, 44-46.

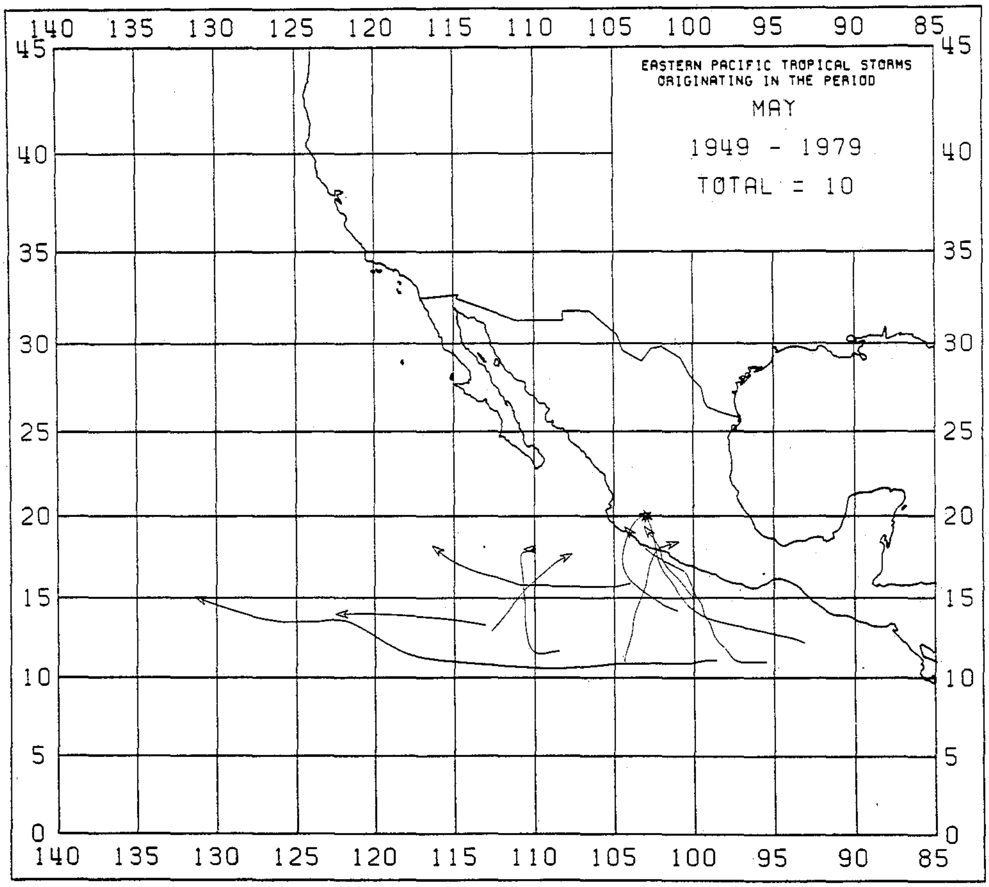
Neumann, C. J., G. W. Cry, E. L. Caso and B. R. Jarvinen, 1978: Tropical cyclones of the North Atlantic Ocean, 1871-1977. National Climatic Center, Asheville, N.C., and National Hurricane Center, Coral Gables, FL., 170 pp.

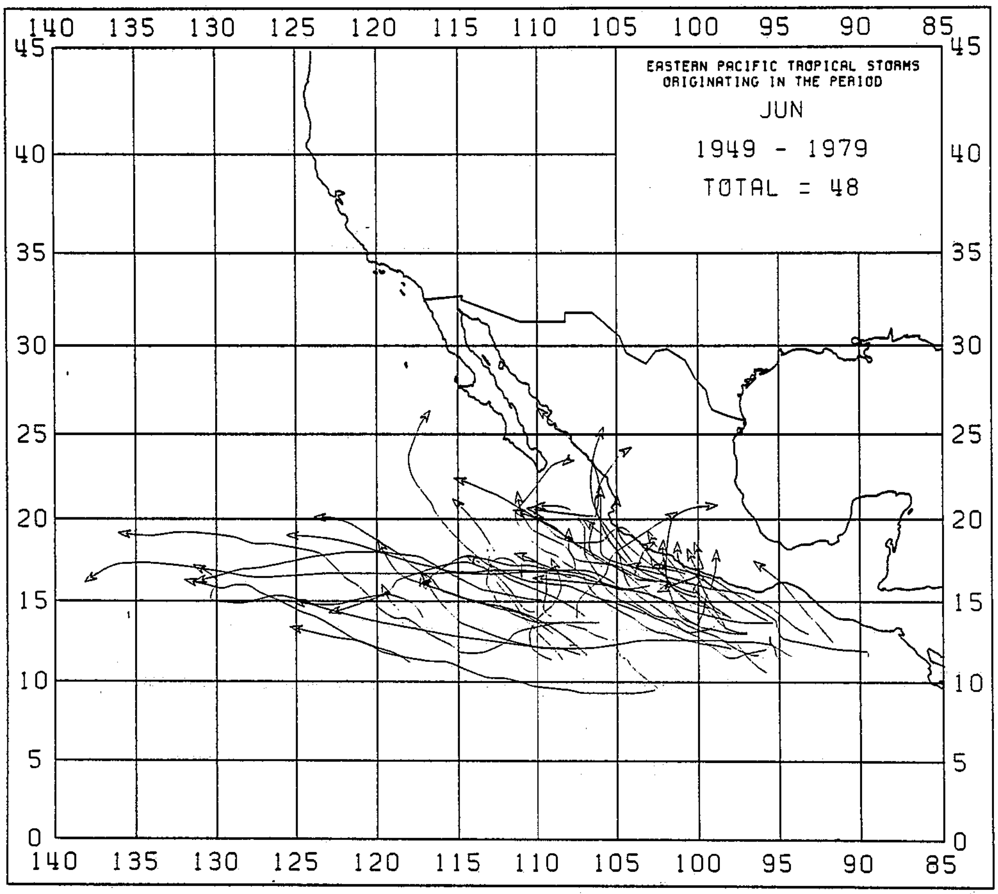
Neumann, C. J. and P. W. Leftwich, 1977: Statistical guidance for the prediction of Eastern North Pacific tropical cyclone motion - part 1. NOAA Technical Memorandum NWS WR-124, 32 pp.

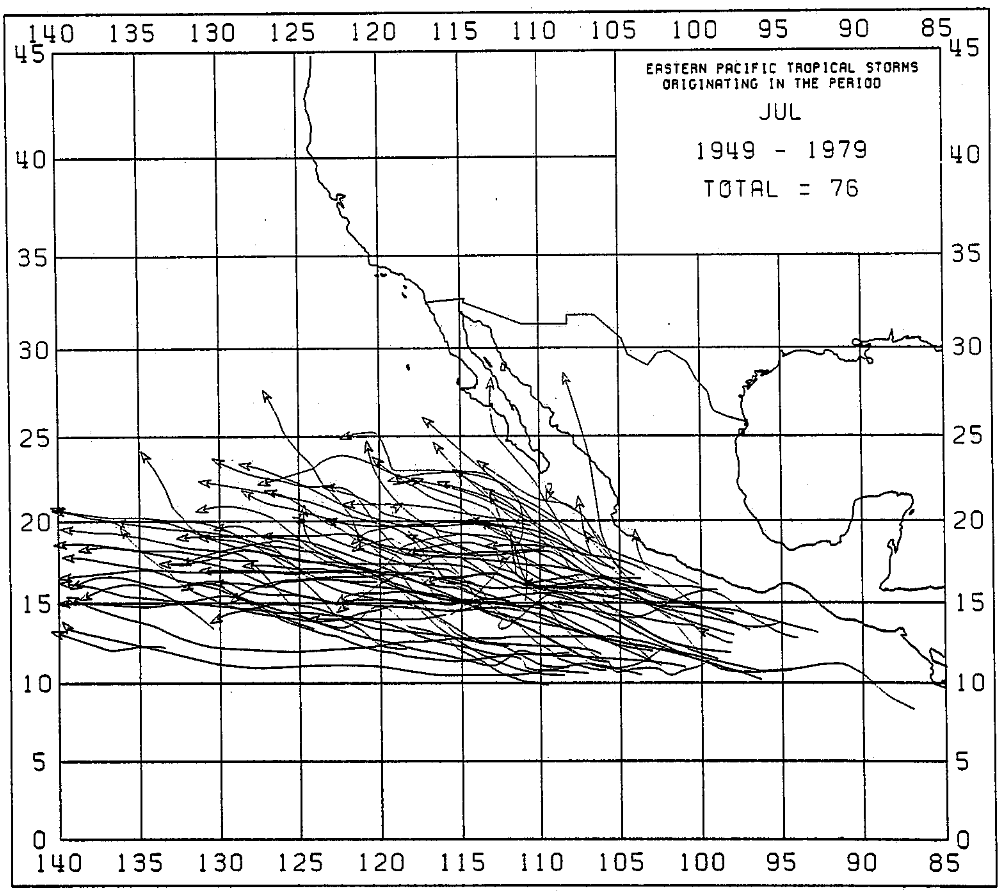
Renard, R. J. and W. N. Bowman, 1976: The climatology and forecasting of Eastern North Pacific Ocean tropical cyclones. NAVENVPREDRSCHFAC Technical Paper No. 7-76, Monterey, CA., 79 pp.

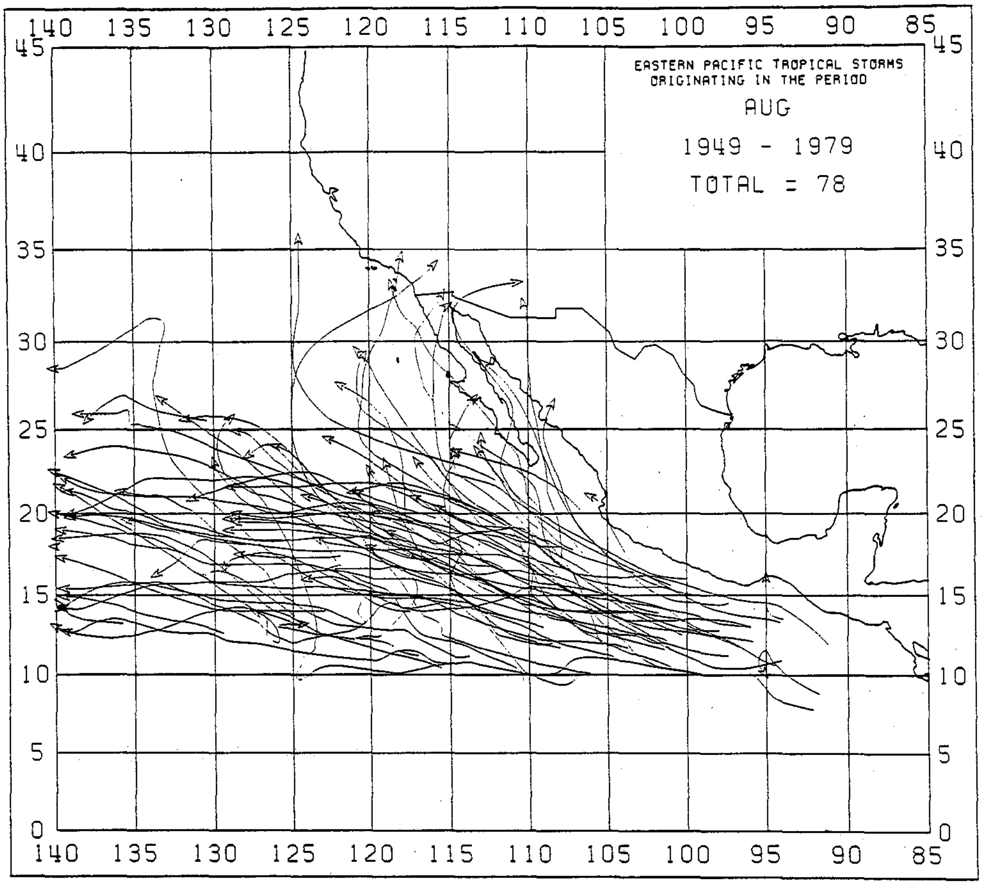
APPENDIX I

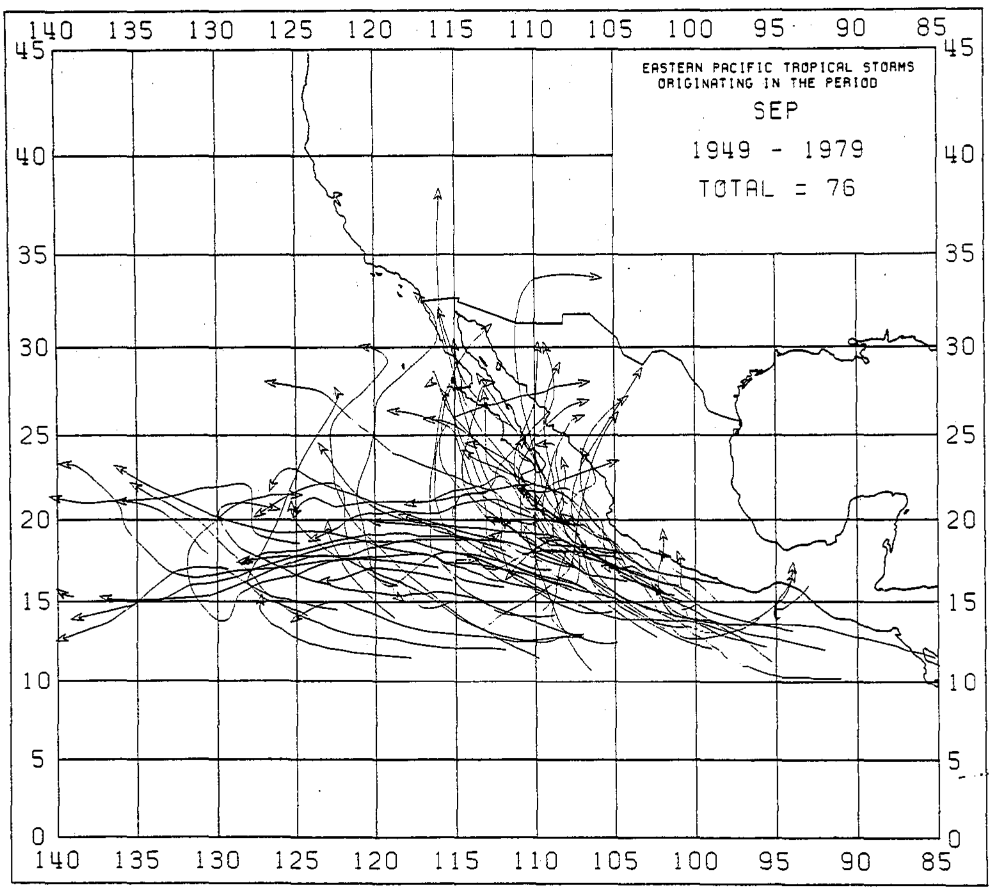
TROPICAL CYCLONE TRACKS BY MONTHLY PERIODS, MAY - NOVEMBER

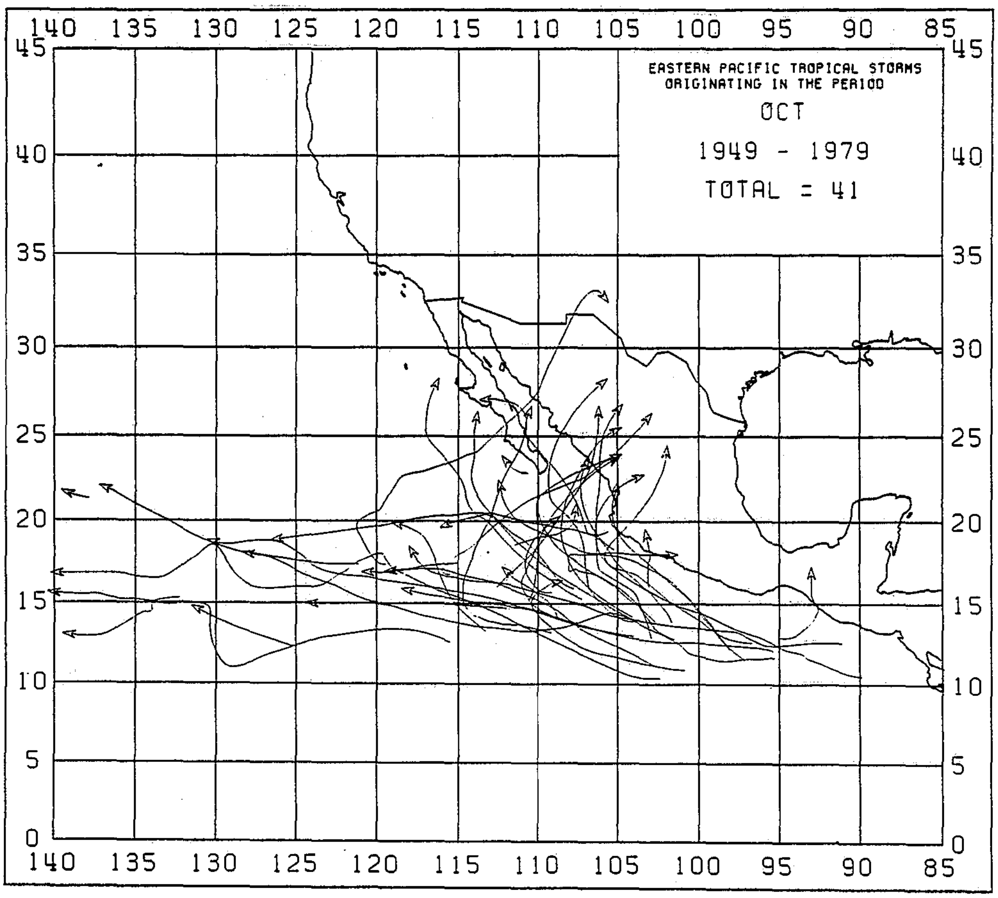


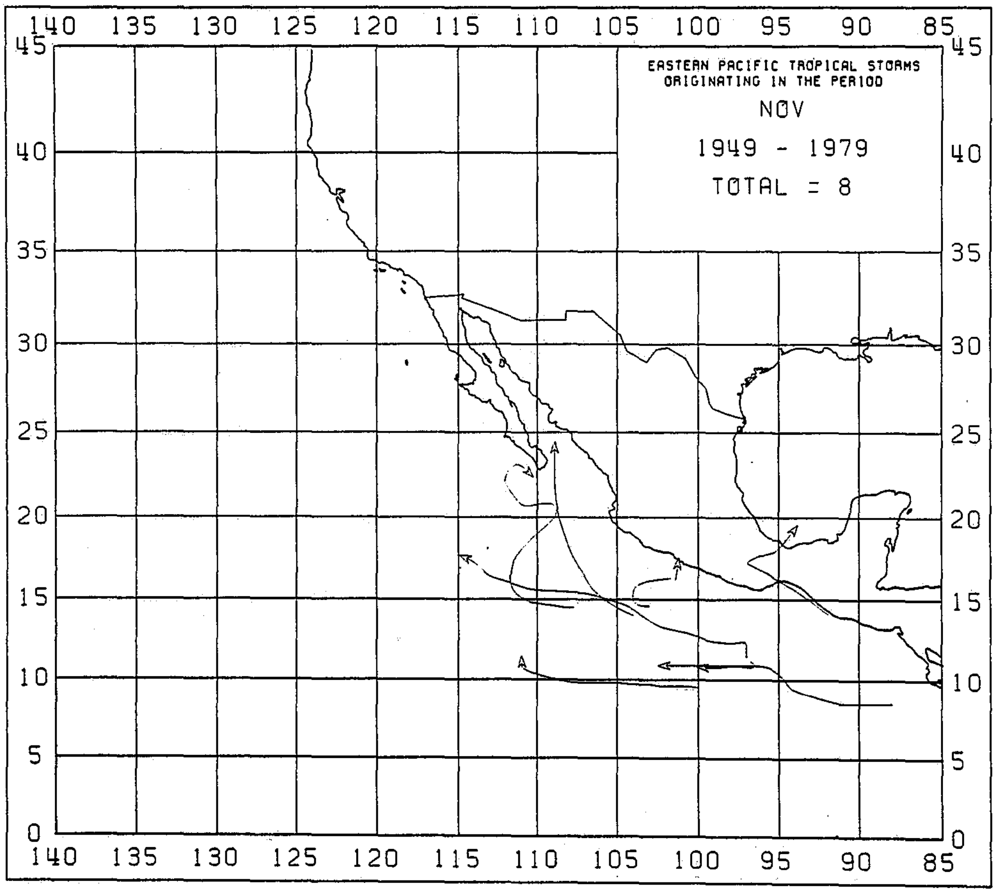

EASTERN PACIFIC TROPICAL STORMS
ORIGINATING IN THE PERIOD
JUN
1949 - 1979
TOTAL = 48


EASTERN PACIFIC TROPICAL STORMS
ORIGINATING IN THE PERIOD
JUL
1949 - 1979
TOTAL = 76


EASTERN PACIFIC TROPICAL STORMS
ORIGINATING IN THE PERIOD
AUG
1949 - 1979
TOTAL = 78

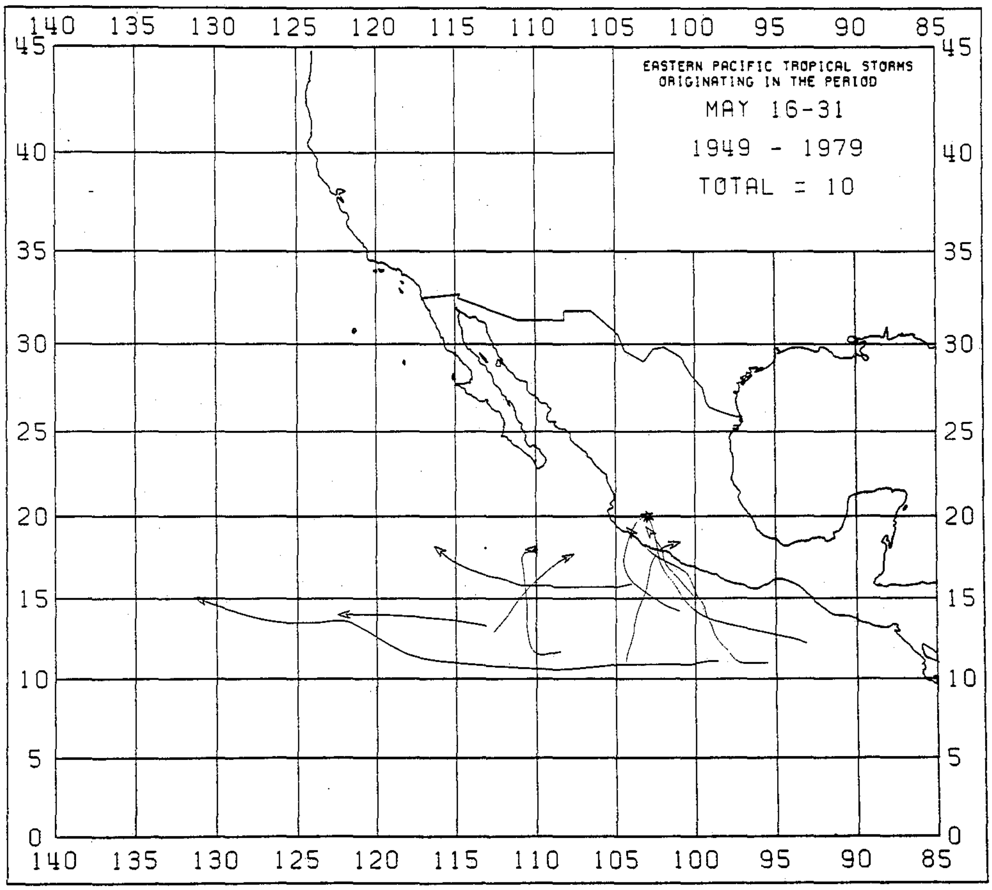

EASTERN PACIFIC TROPICAL STORMS
ORIGINATING IN THE PERIOD
SEP
1949 - 1979
TOTAL = 76

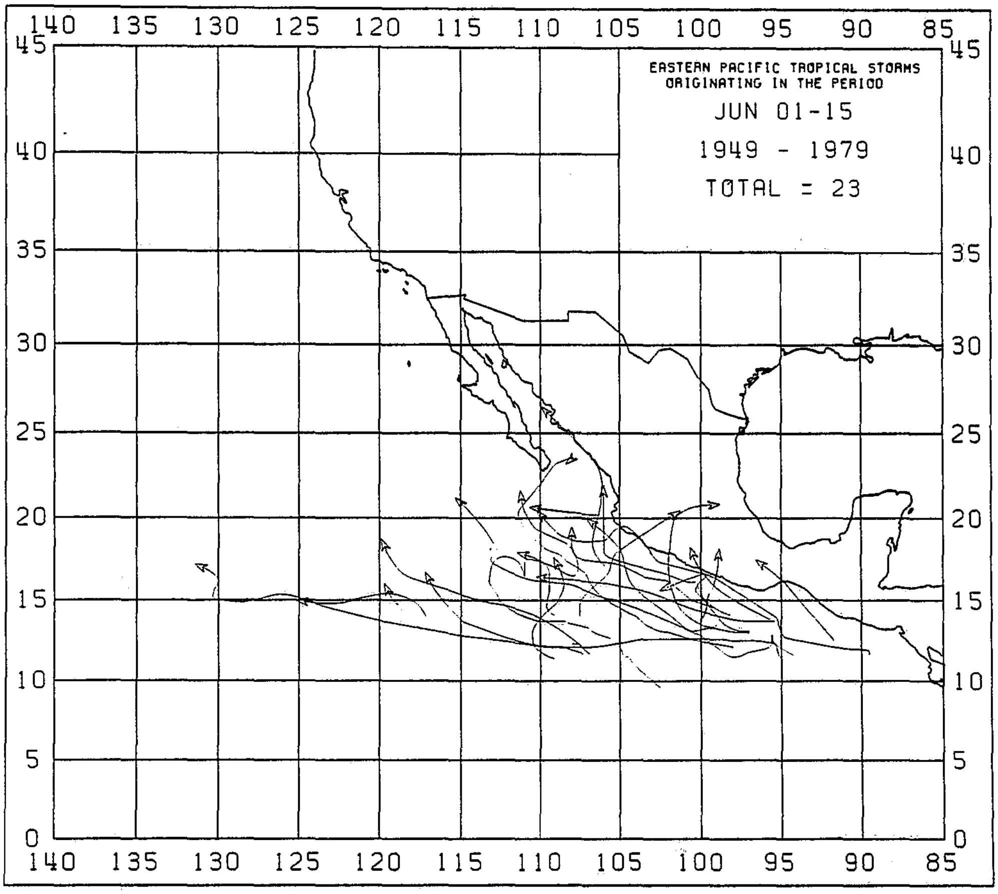

EASTERN PACIFIC TROPICAL STORMS
ORIGINATING IN THE PERIOD
OCT
1949 - 1979
TOTAL = 41
140 135 130 125 120 115 110 105 100 95 90 85
45 40 35 30 25 20 15 10 5 0

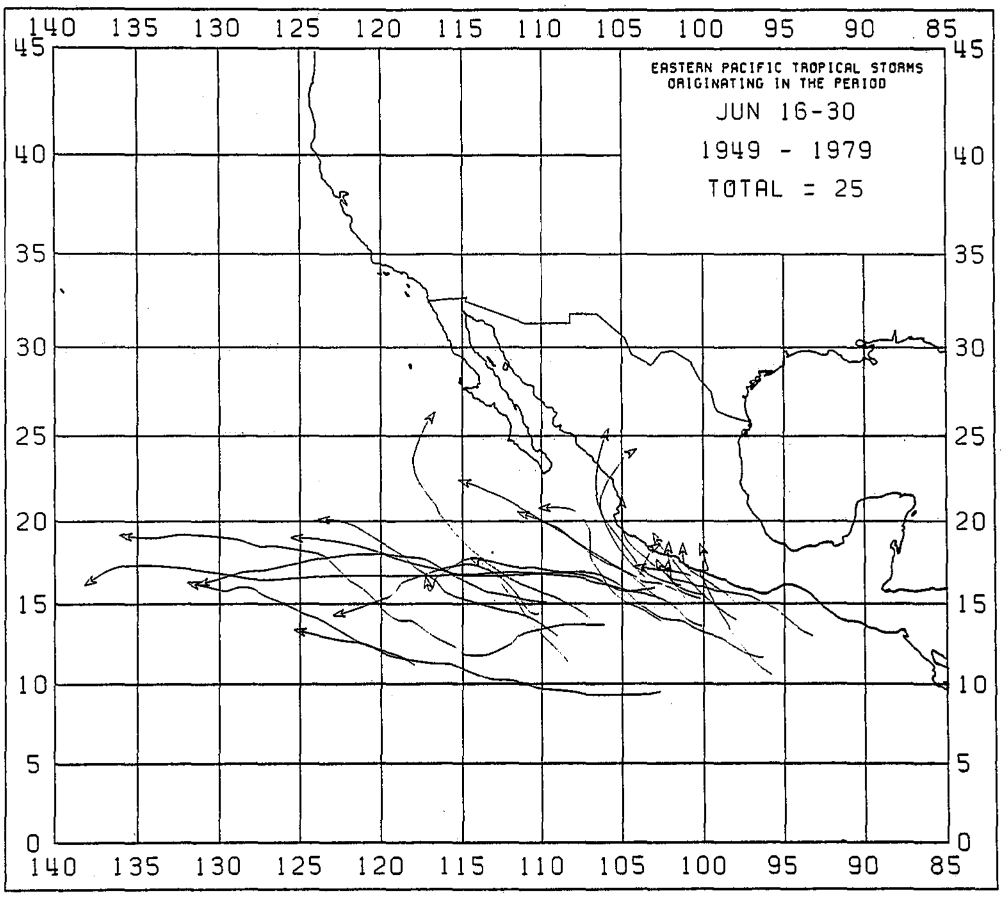

EASTERN PACIFIC TROPICAL STORMS
ORIGINATING IN THE PERIOD
NOV
1949 - 1979
TOTAL = 8
140 135 130 125 120 115 110 105 100 95 90 85
45 40 35 30 25 20 15 10 5 0

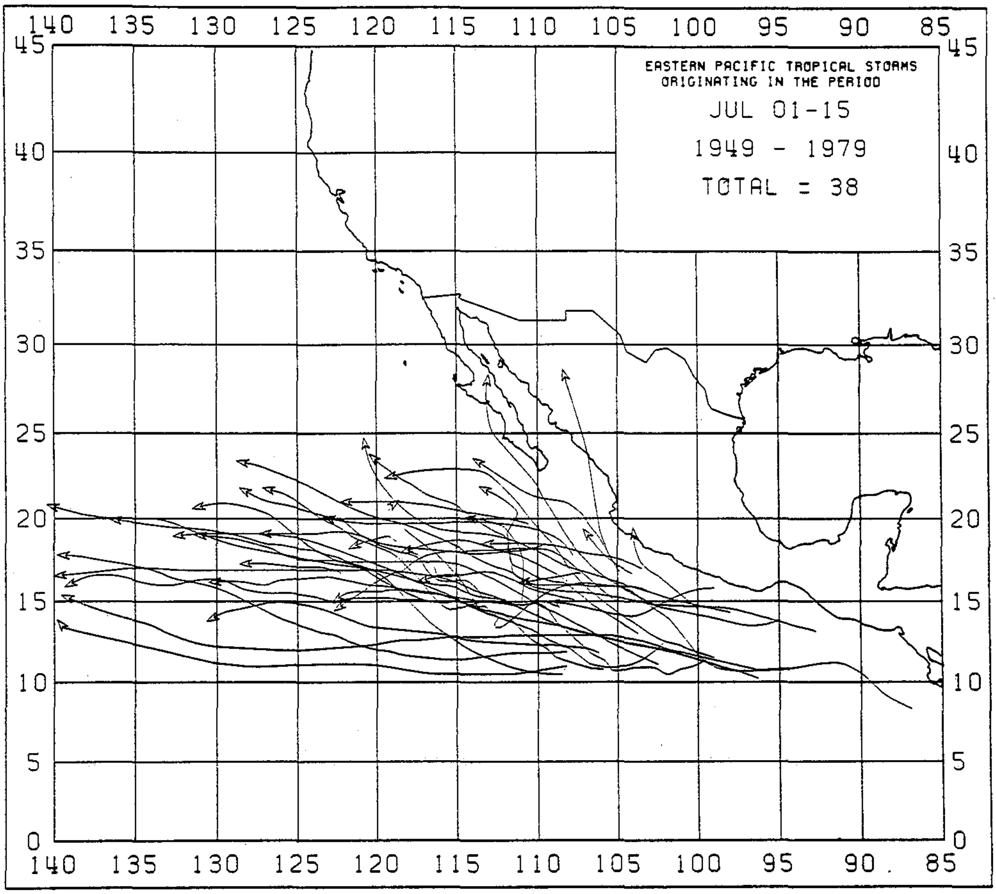
APPENDIX II

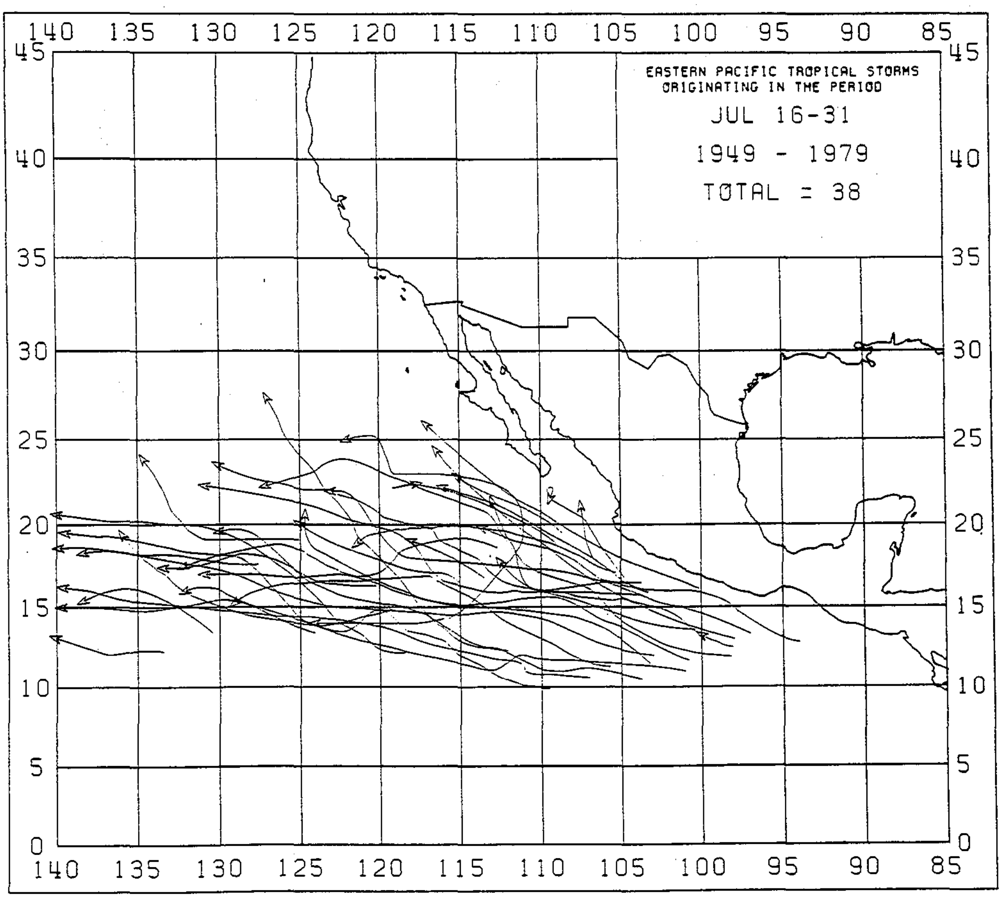
TROPICAL CYCLONE TRACKS BY 15-DAY PERIODS, MAY 16 - NOVEMBER 30

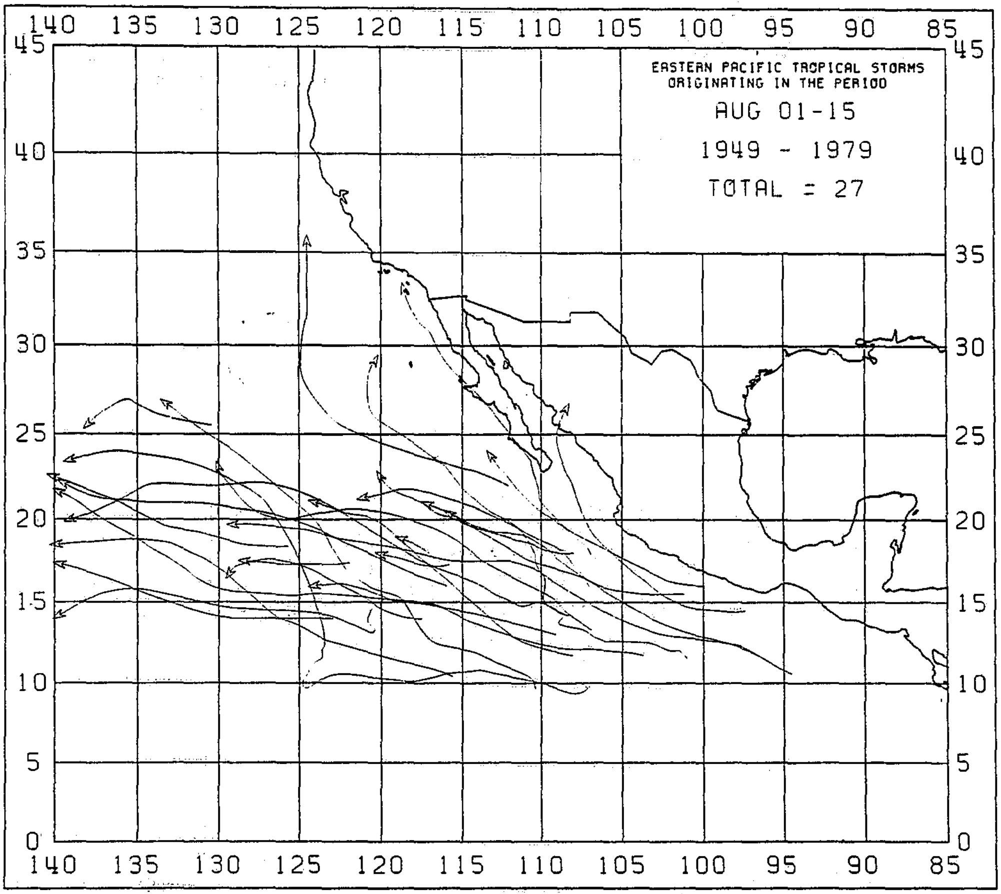


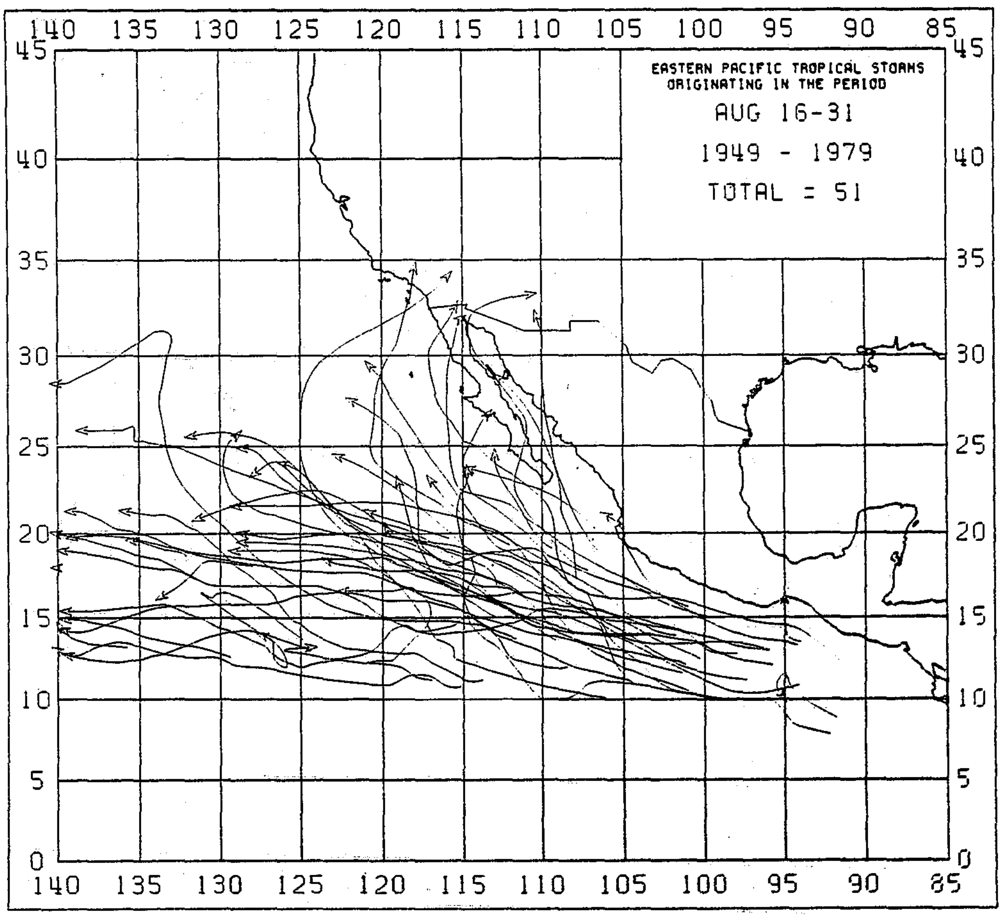

EASTERN PACIFIC TROPICAL STORMS
ORIGINATING IN THE PERIOD
JUN 01-15
1949 - 1979
TOTAL = 23
140 135 130 125 120 115 110 105 100 95 90 85
45 40 35 30 25 20 15 10 5 0

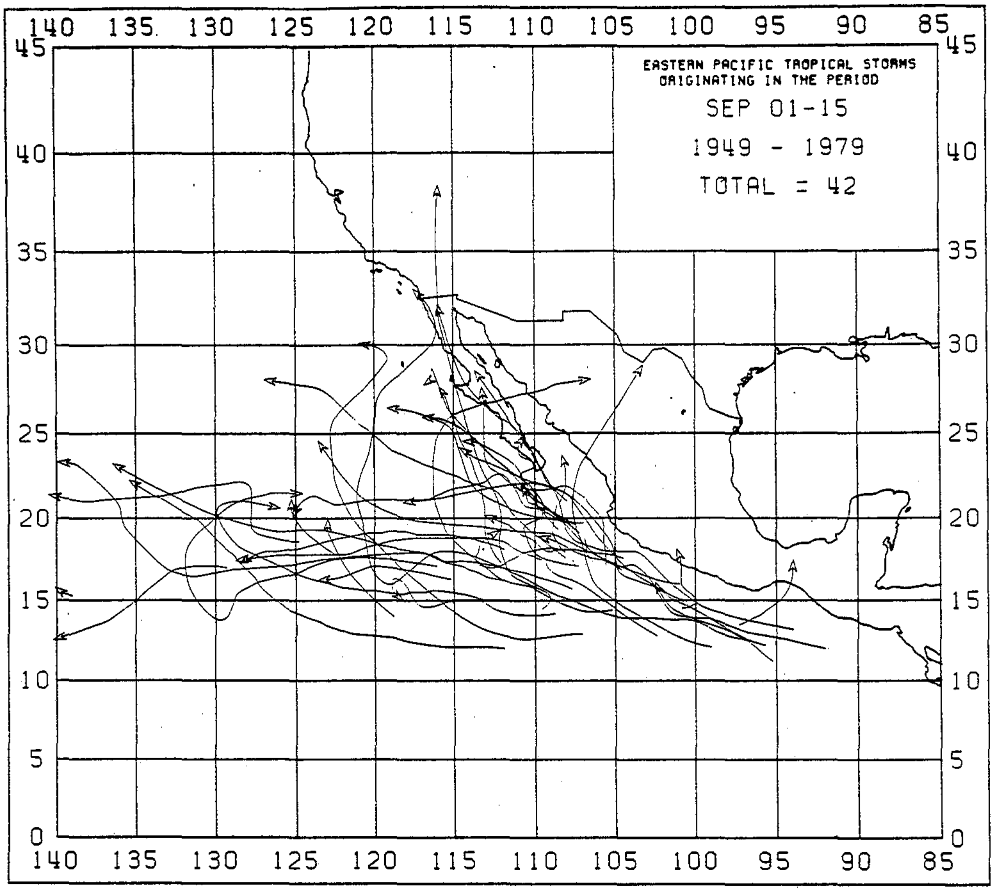

EASTERN PACIFIC TROPICAL STORMS
ORIGINATING IN THE PERIOD
JUN 16-30
1949 - 1979
TOTAL = 25
140 135 130 125 120 115 110 105 100 95 90 85
45 40 35 30 25 20 15 10 5 0

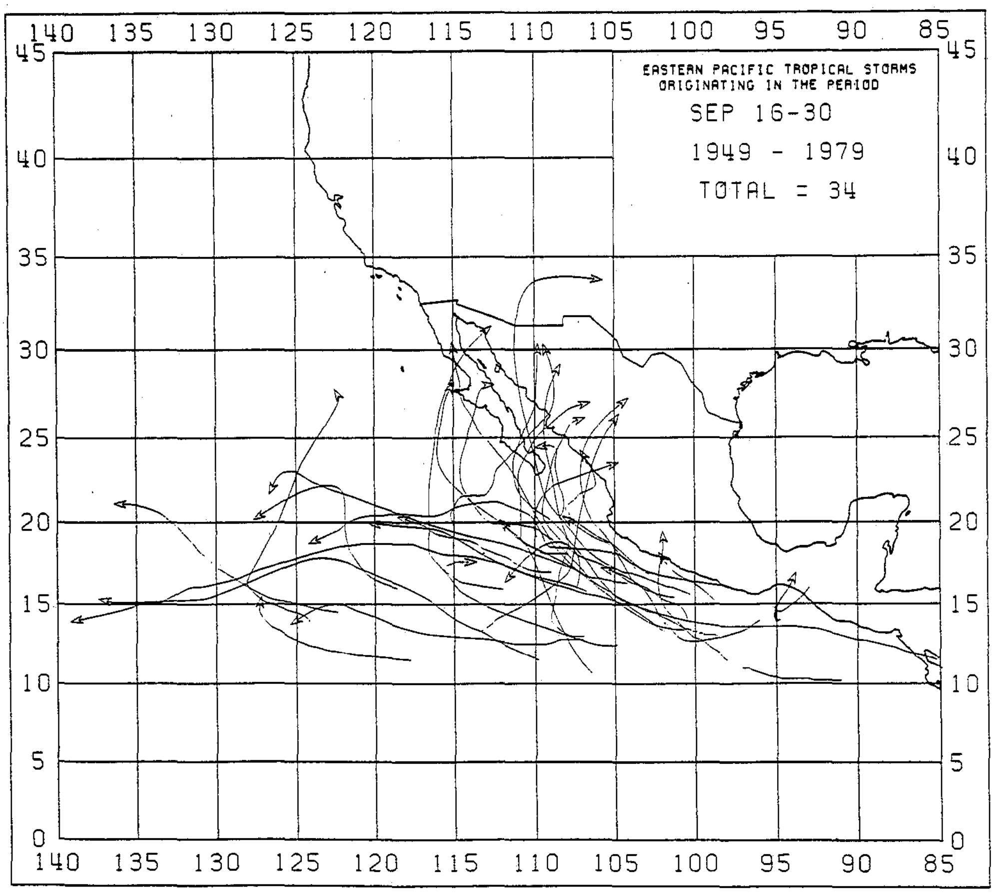

EASTERN PACIFIC TROPICAL STORMS
ORIGINATING IN THE PERIOD
JUL 01-15
1949 - 1979
TOTAL = 38
140 135 130 125 120 115 110 105 100 95 90 85
45 40 35 30 25 20 15 10 5 0

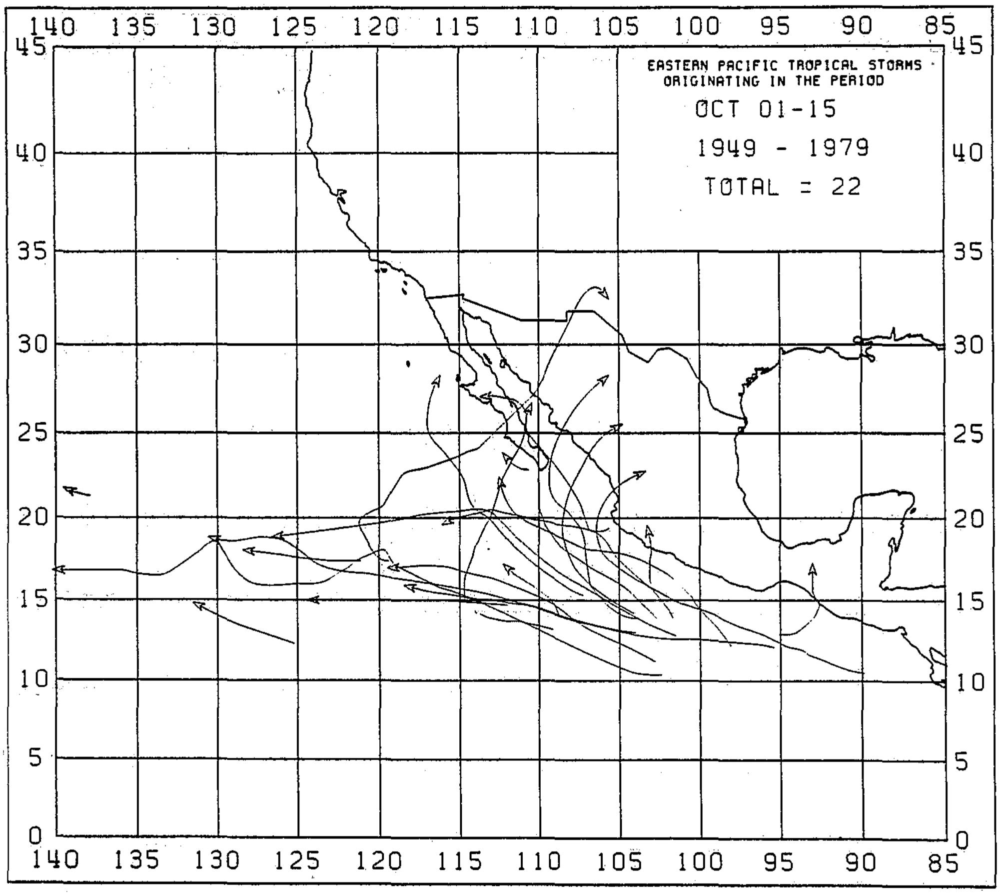

EASTERN PACIFIC TROPICAL STORMS
ORIGINATING IN THE PERIOD
JUL 16-31
1949 - 1979
TOTAL = 38
140 135 130 125 120 115 110 105 100 95 90 85
45 40 35 30 25 20 15 10 5 0

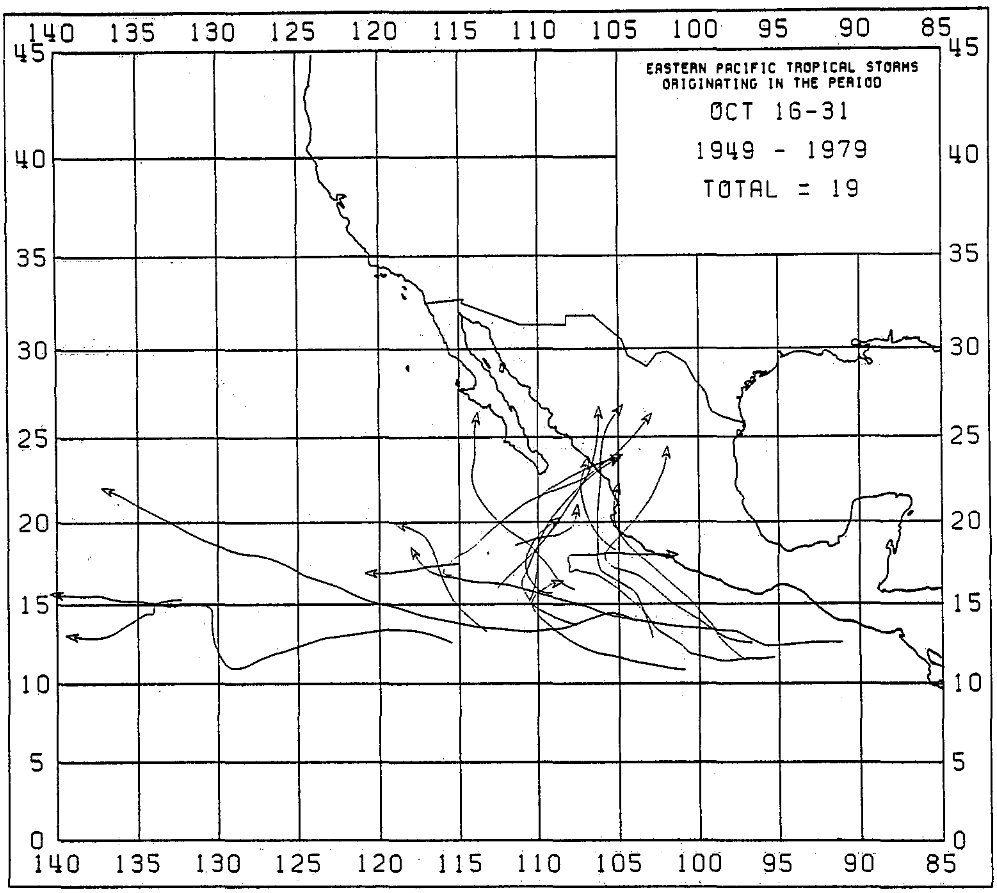

EASTERN PACIFIC TROPICAL STORMS ORIGINATING IN THE PERIOD
AUG 01-15
1949 - 1979
TOTAL = 27
140 135 130 125 120 115 110 105 100 95 90 85
45 40 35 30 25 20 15 10 5 0

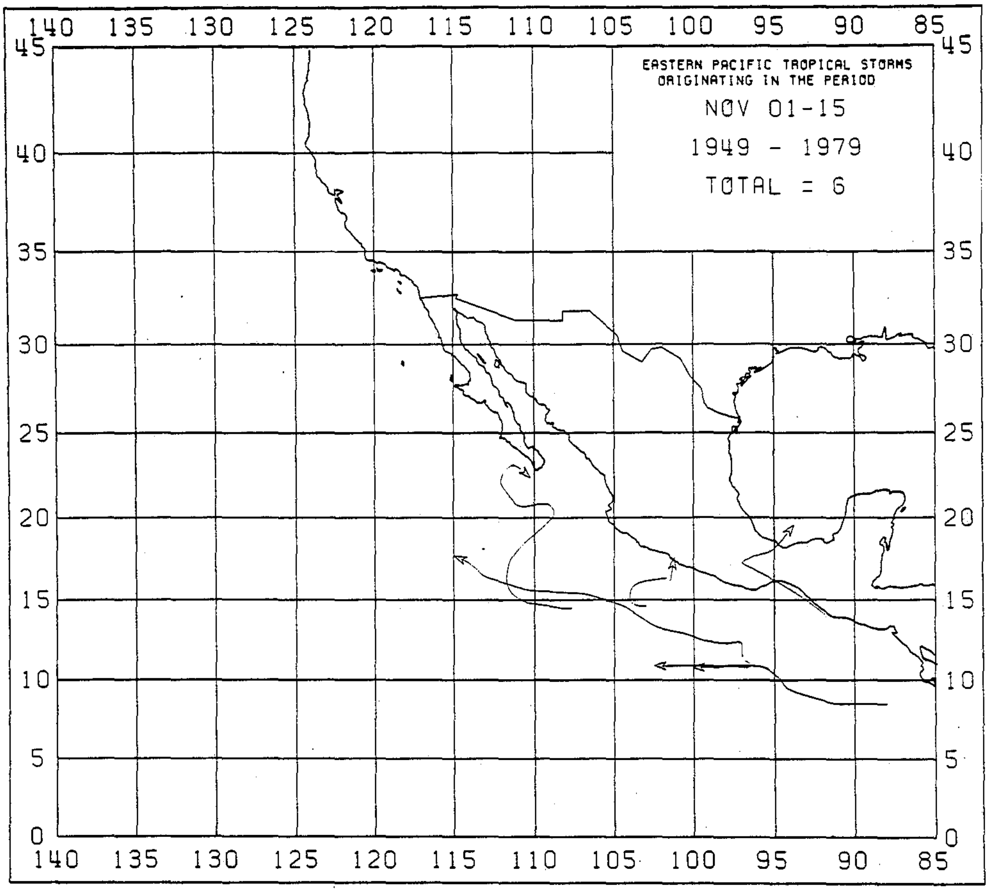

EASTERN PACIFIC TROPICAL STORMS ORIGINATING IN THE PERIOD
AUG 16-31
1949 - 1979
TOTAL = 51
140 135 130 125 120 115 110 105 100 95 90 85
45 40 35 30 25 20 15 10 5 0

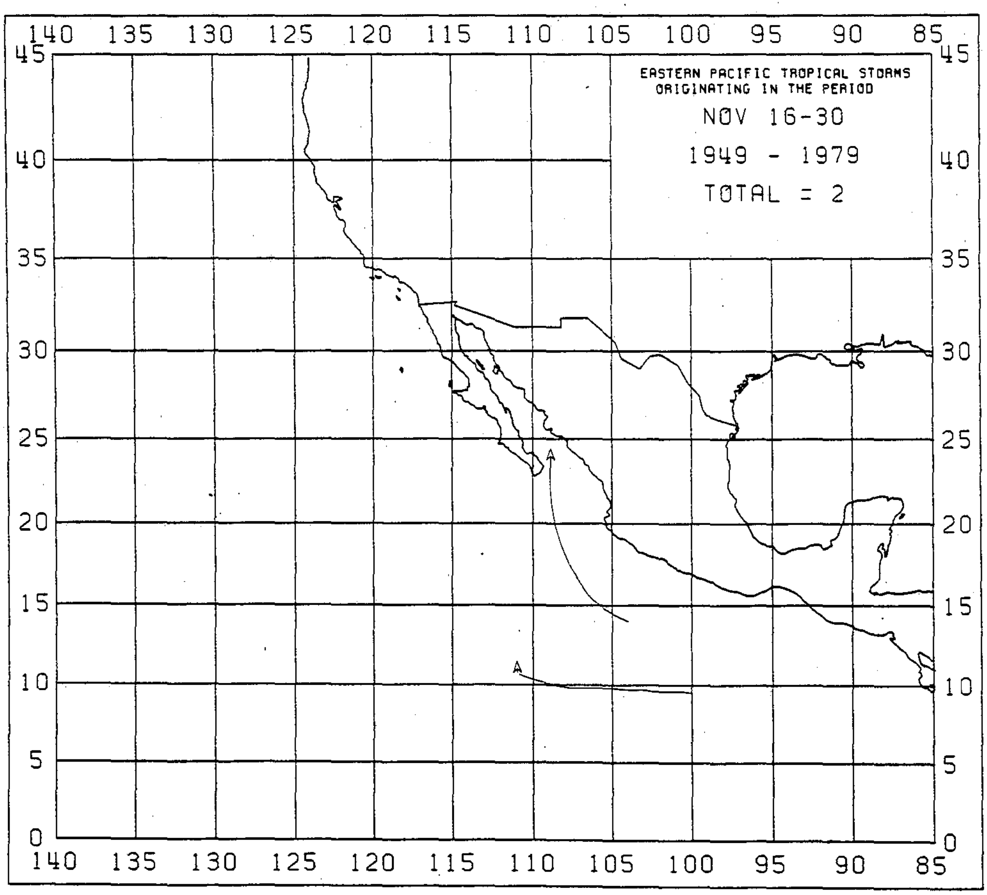

EASTERN PACIFIC TROPICAL STORMS ORIGINATING IN THE PERIOD
SEP 01-15
1949 - 1979
TOTAL = 42
140 135 130 125 120 115 110 105 100 95 90 85
45 40 35 30 25 20 15 10 5 0


EASTERN PACIFIC TROPICAL STORMS ORIGINATING IN THE PERIOD
SEP 16-30
1949 - 1979
TOTAL = 34
140 135 130 125 120 115 110 105 100 95 90 85
45 40 35 30 25 20 15 10 5 0


EASTERN PACIFIC TROPICAL STORMS ORIGINATING IN THE PERIOD
OCT 01-15
1949 - 1979
TOTAL = 22
140 135 130 125 120 115 110 105 100 95 90 85
45 40 35 30 25 20 15 10 5 0

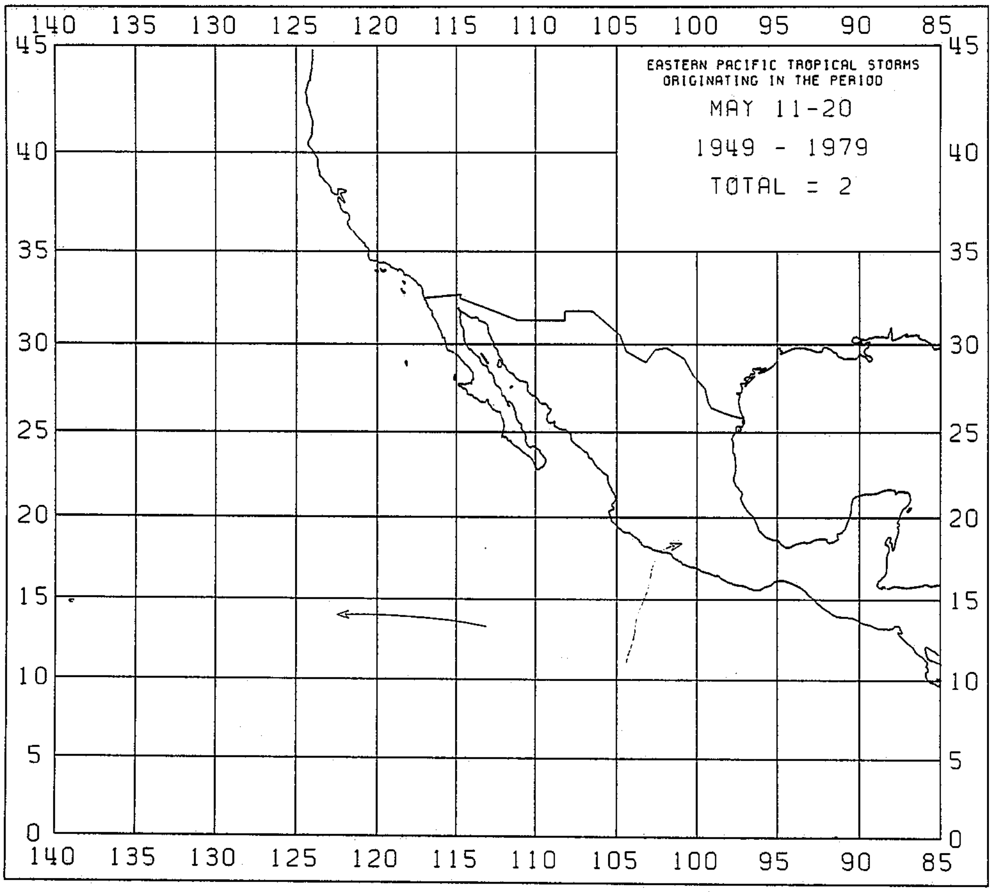

EASTERN PACIFIC TROPICAL STORMS ORIGINATING IN THE PERIOD
OCT 16-31
1949 - 1979
TOTAL = 19
140 135 130 125 120 115 110 105 100 95 90 85
45 40 35 30 25 20 15 10 5 0

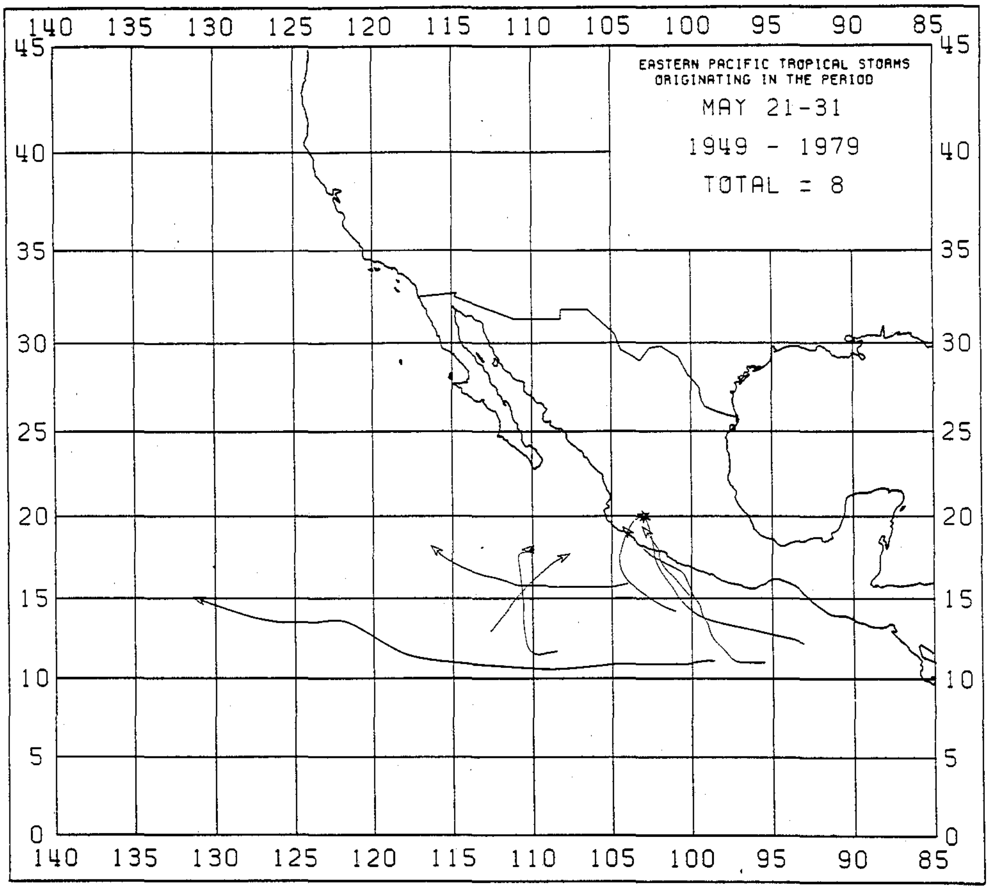

EASTERN PACIFIC TROPICAL STORMS ORIGINATING IN THE PERIOD
NOV 01-15
1949 - 1979
TOTAL = 6
140 135 130 125 120 115 110 105 100 95 90 85
45 40 35 30 25 20 15 10 5 0


EASTERN PACIFIC TROPICAL STORMS ORIGINATING IN THE PERIOD
NOV 16-30
1949 - 1979
TOTAL = 2
140 135 130 125 120 115 110 105 100 95 90 85
45 40 35 30 25 20 15 10 5 0

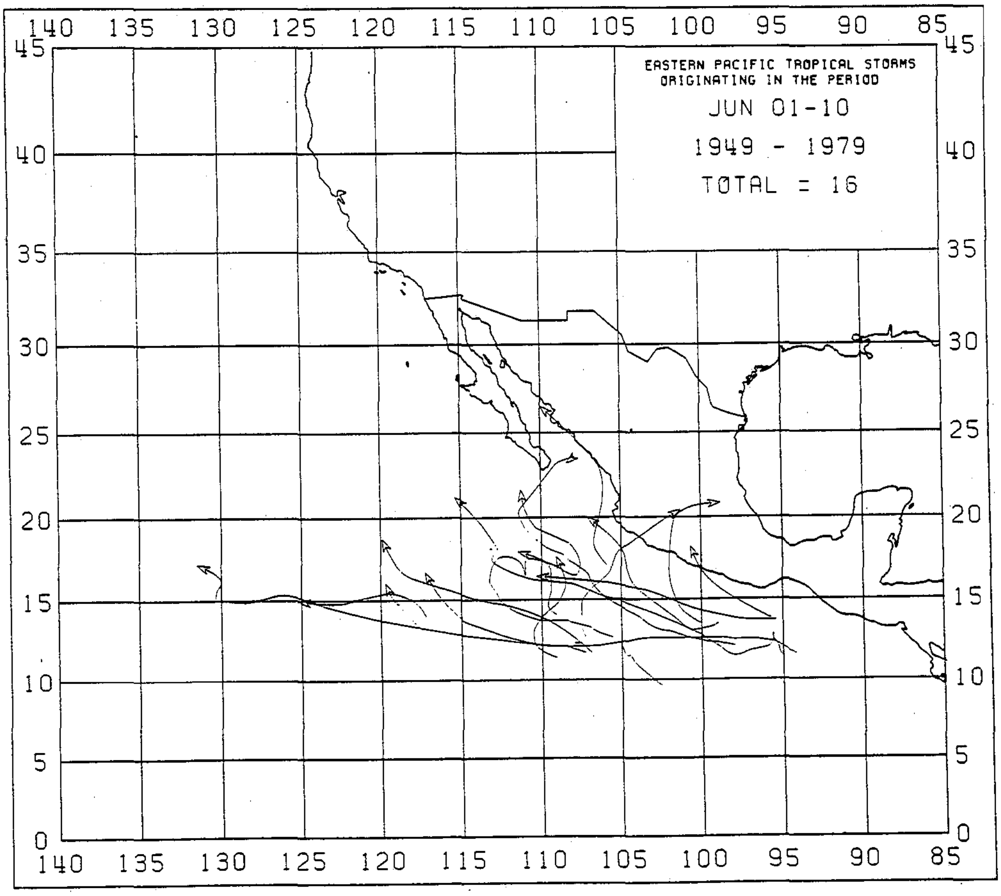
APPENDIX III

TROPICAL CYCLONE TRACKS BY 10-DAY PERIODS, MAY 11 - NOVEMBER 30

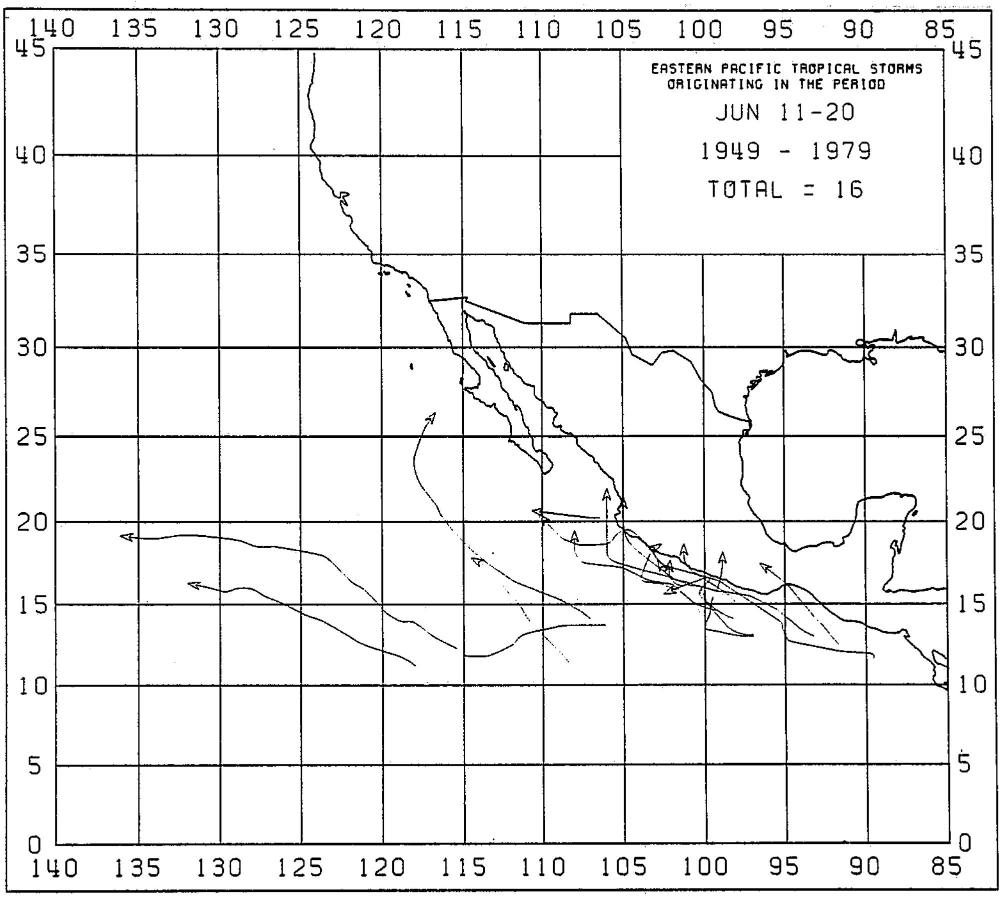


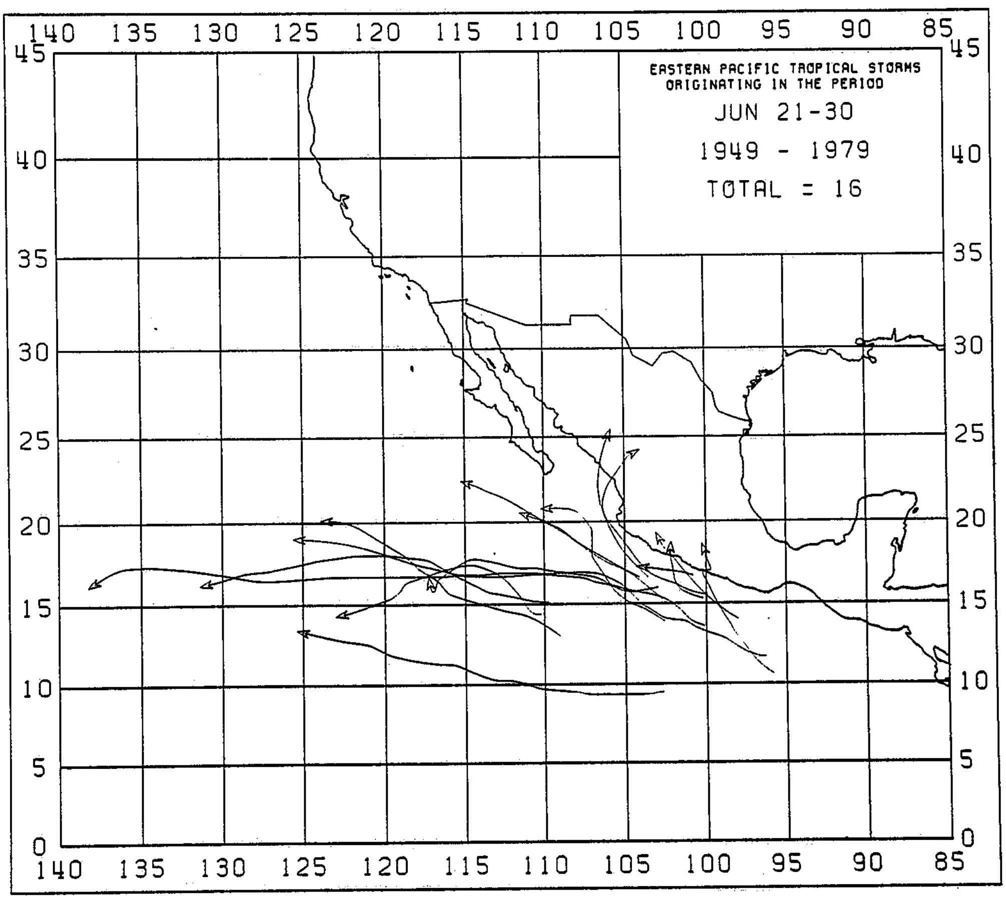


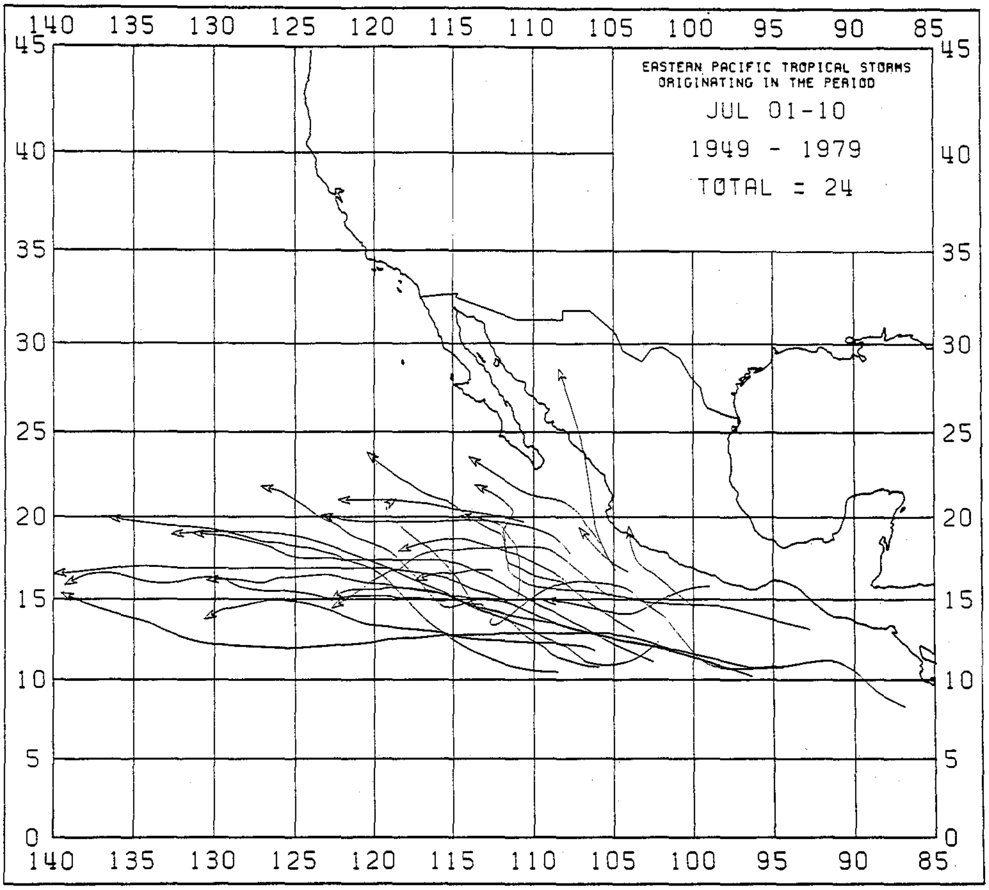
EASTERN PACIFIC TROPICAL STORMS
ORIGINATING IN THE PERIOD
MAY 21-31
1949 - 1979
TOTAL = 8

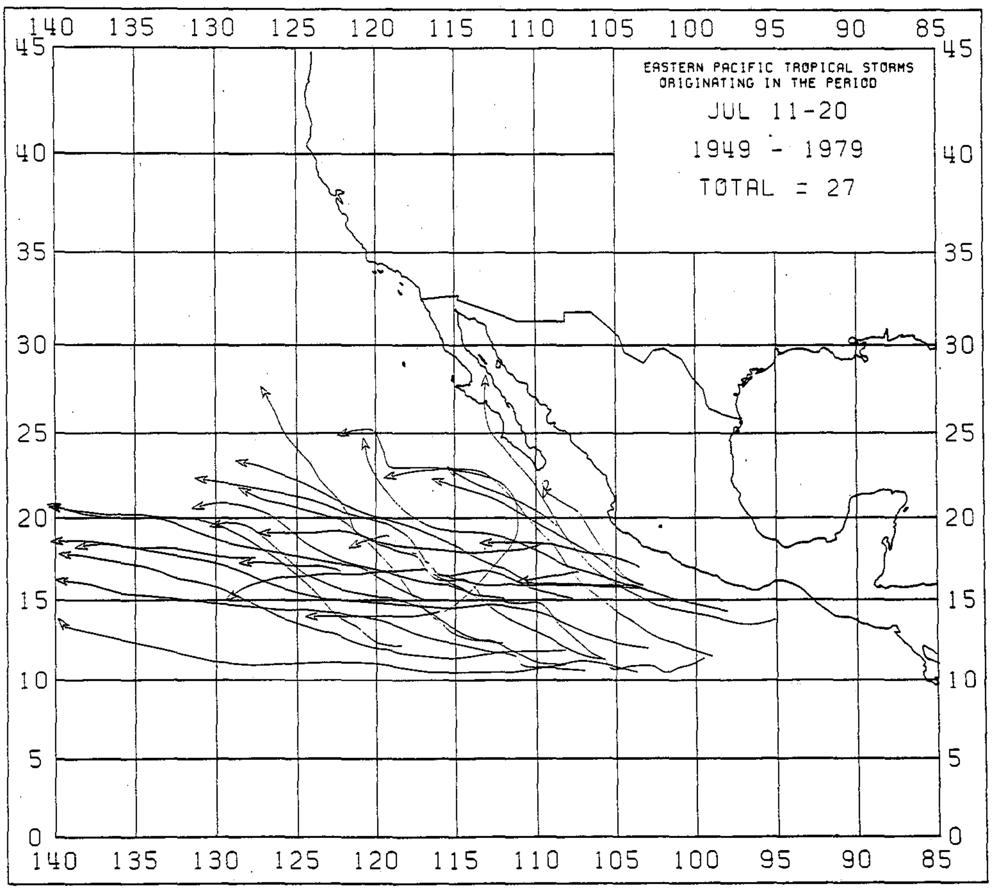


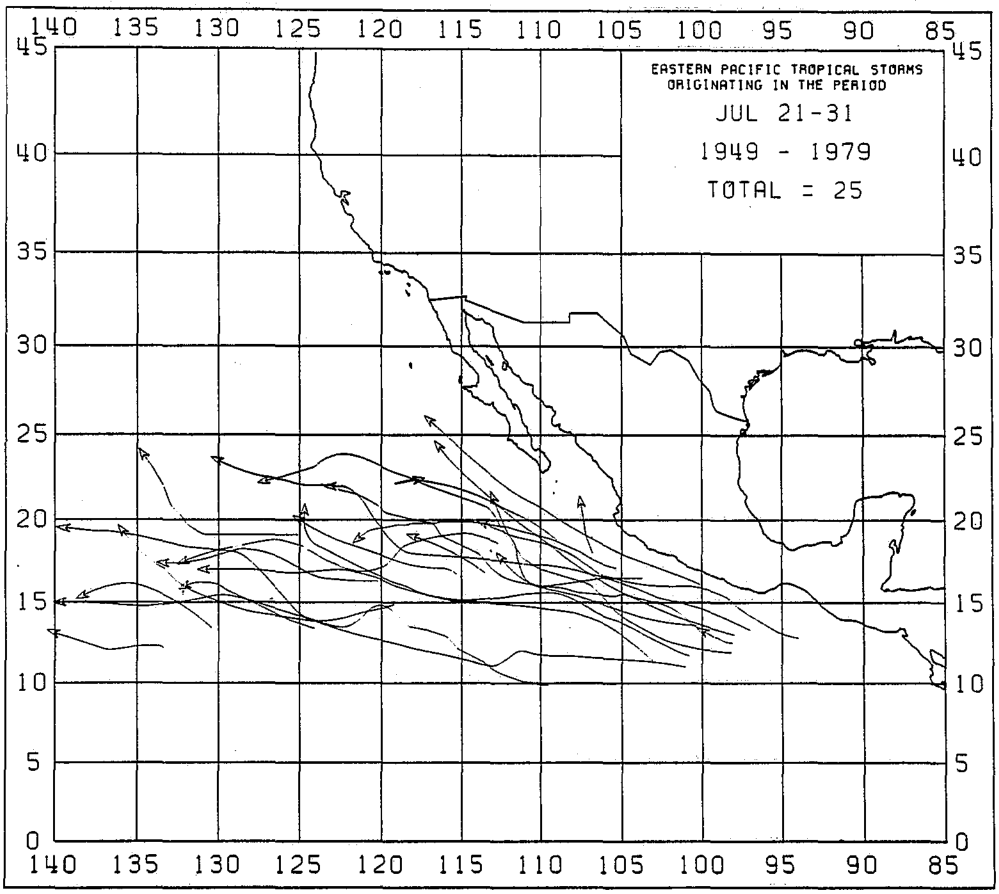
EASTERN PACIFIC TROPICAL STORMS
ORIGINATING IN THE PERIOD
JUN 01-10
1949 - 1979
TOTAL = 16

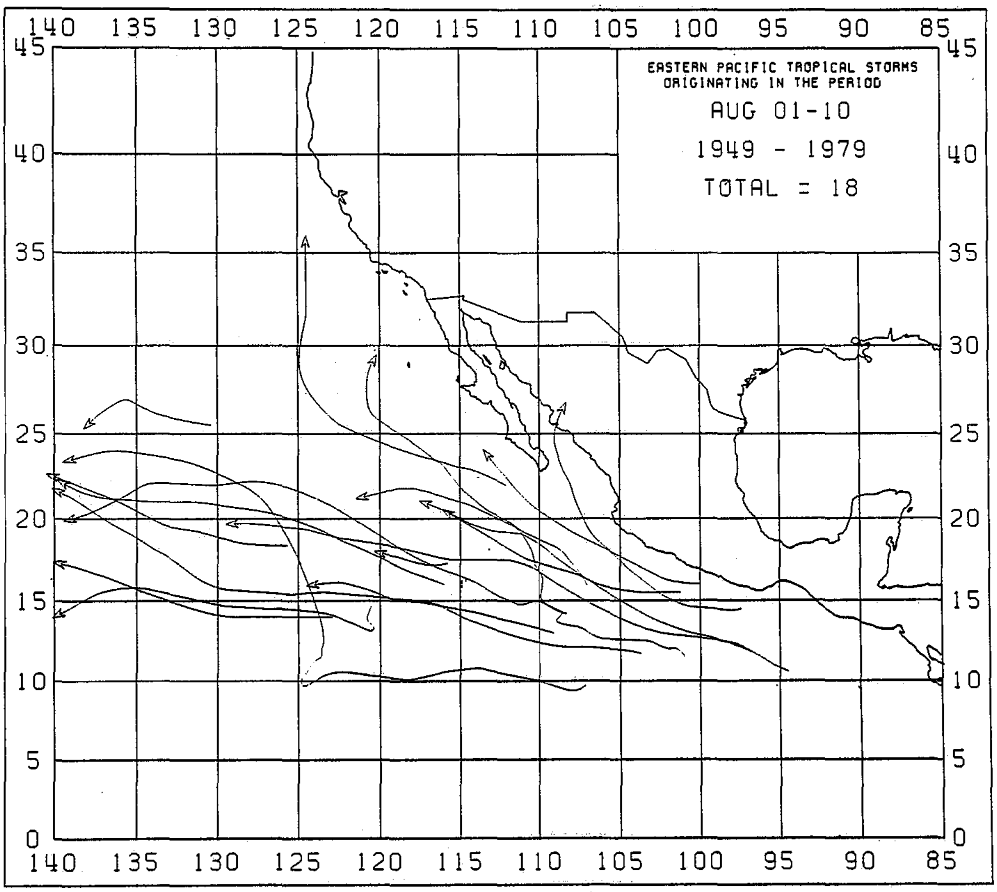

EASTERN PACIFIC TROPICAL STORMS
ORIGINATING IN THE PERIOD
JUN 11-20
1949 - 1979
TOTAL = 16

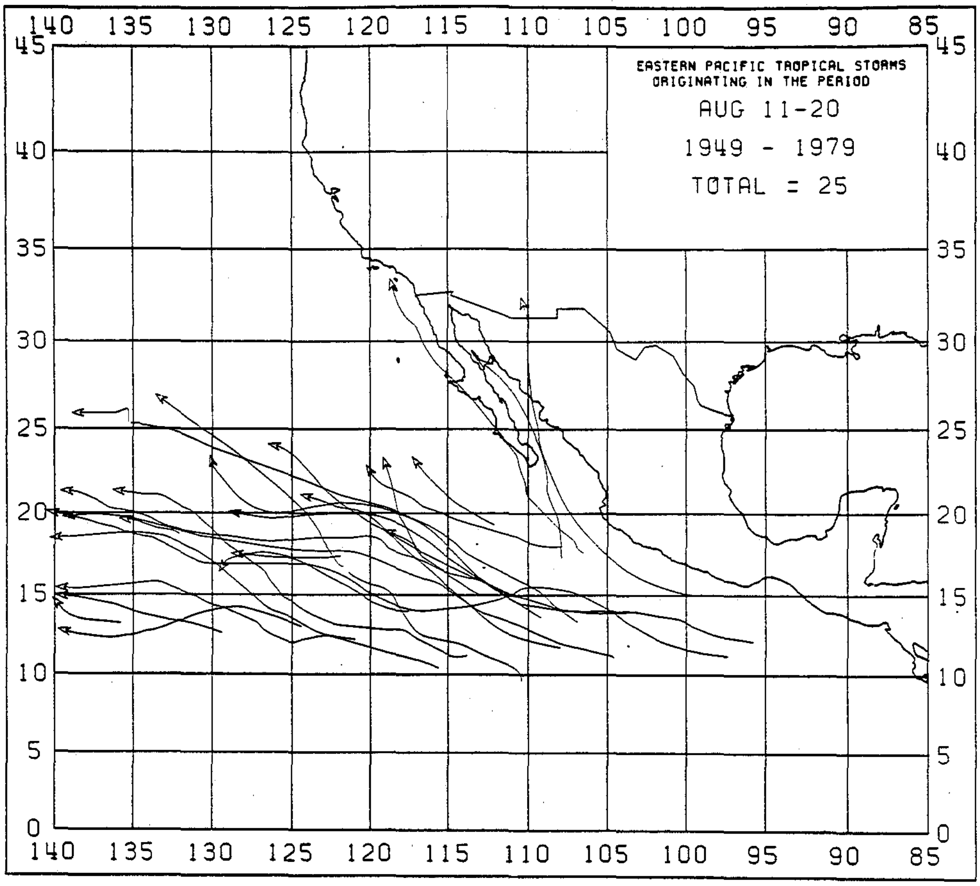

EASTERN PACIFIC TROPICAL STORMS
ORIGINATING IN THE PERIOD
JUN 21-30
1949 - 1979
TOTAL = 16

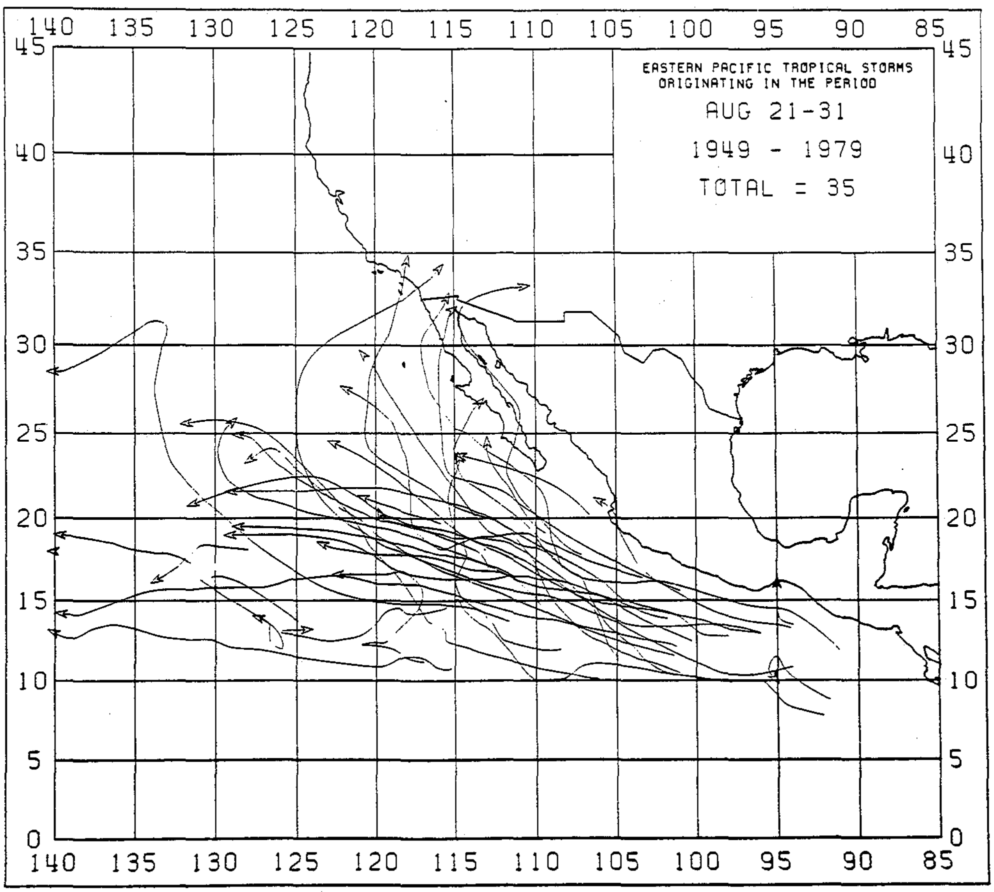

EASTERN PACIFIC TROPICAL STORMS
ORIGINATING IN THE PERIOD
JUL 01-10
1949 - 1979
TOTAL = 24

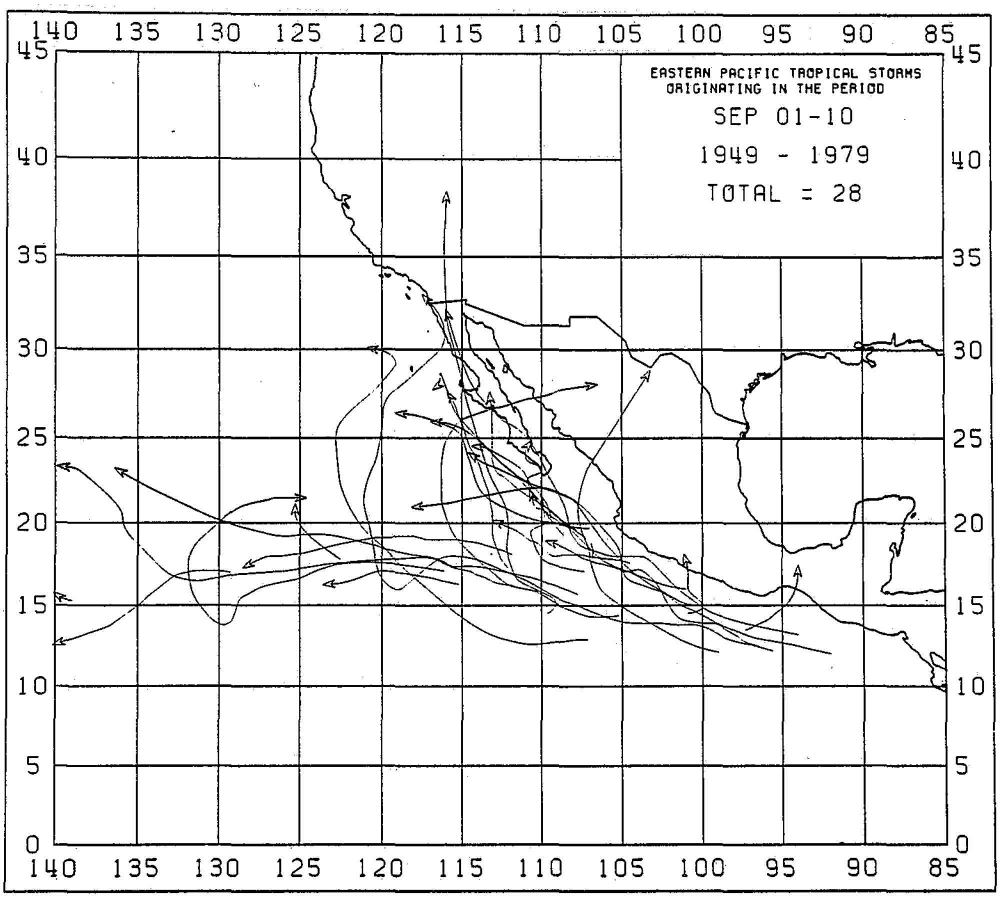

EASTERN PACIFIC TROPICAL STORMS
ORIGINATING IN THE PERIOD
JUL 11-20
1949 - 1979
TOTAL = 27

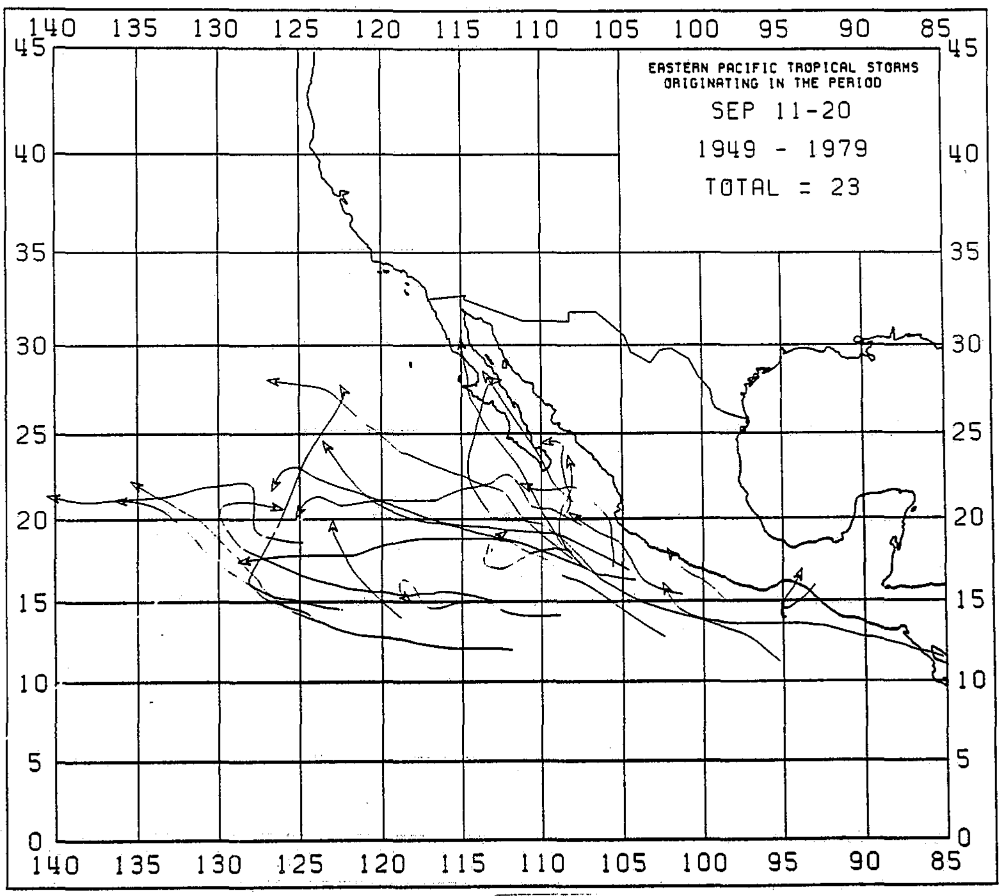

EASTERN PACIFIC TROPICAL STORMS
ORIGINATING IN THE PERIOD
JUL 21-31
1949 - 1979
TOTAL = 25
140 135 130 125 120 115 110 105 100 95 90 85
45 40 35 30 25 20 15 10 5 0

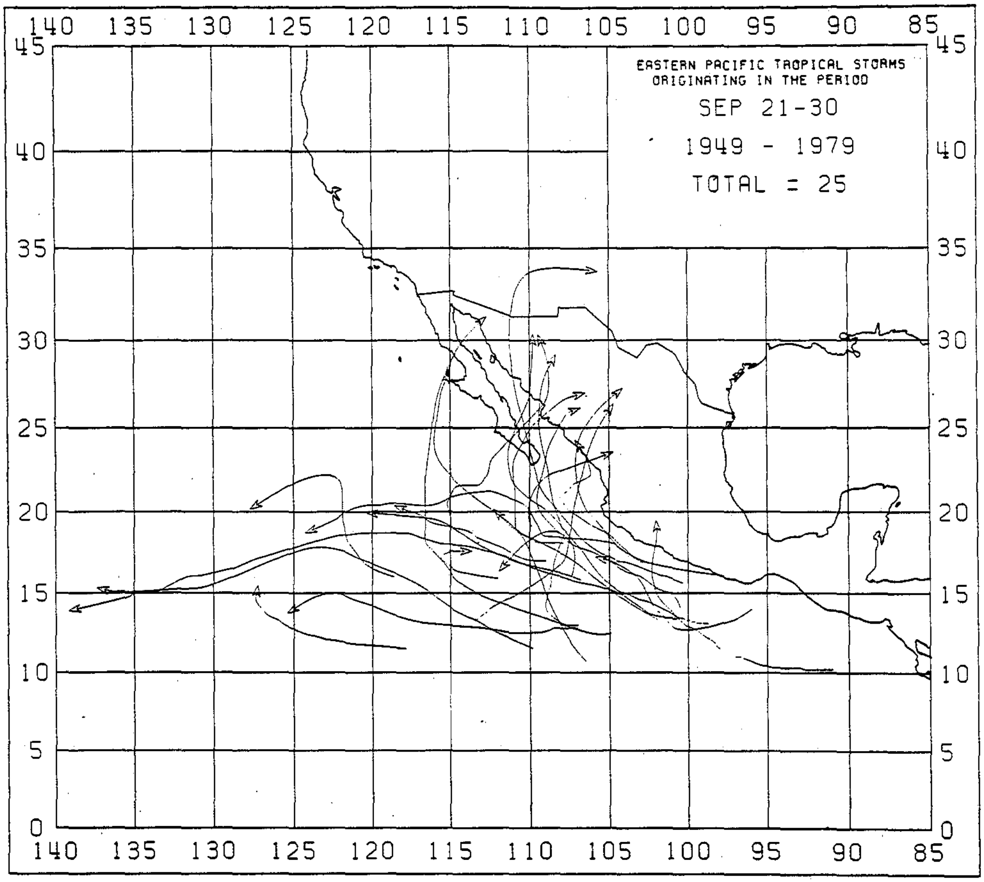

EASTERN PACIFIC TROPICAL STORMS
ORIGINATING IN THE PERIOD
AUG 01-10
1949 - 1979
TOTAL = 18
140 135 130 125 120 115 110 105 100 95 90 85
45 40 35 30 25 20 15 10 5 0

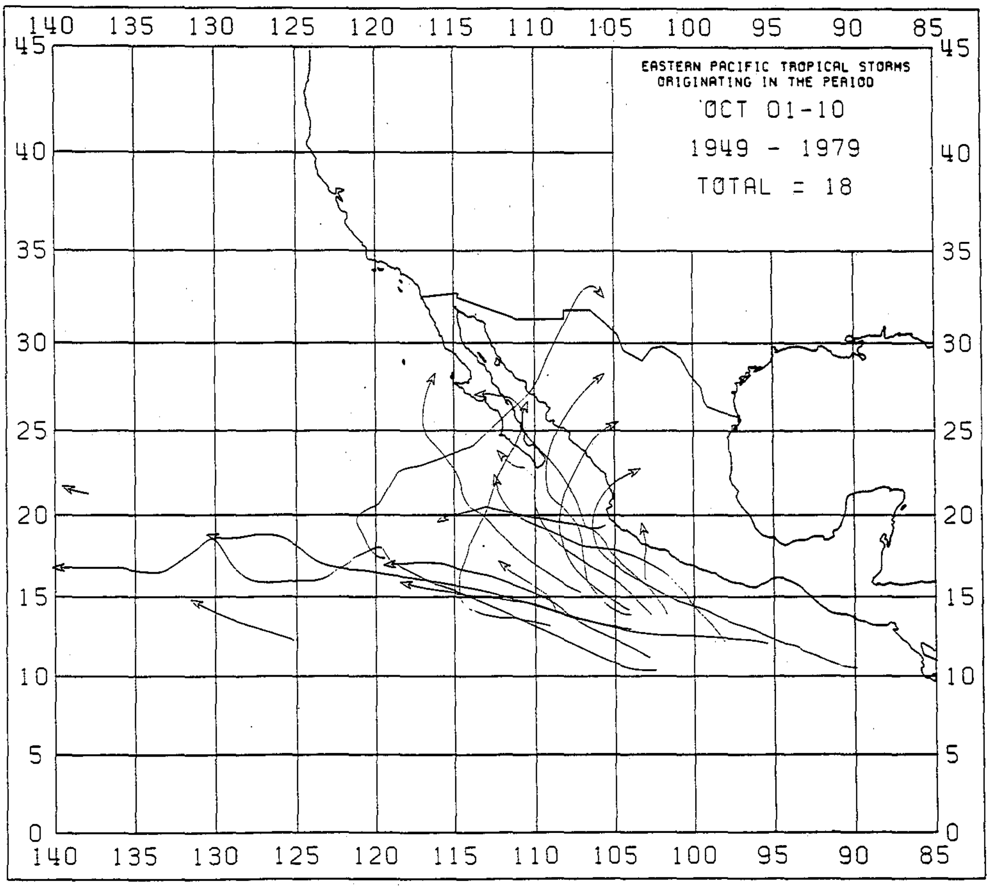

EASTERN PACIFIC TROPICAL STORMS
ORIGINATING IN THE PERIOD
AUG 11-20
1949 - 1979
TOTAL = 25

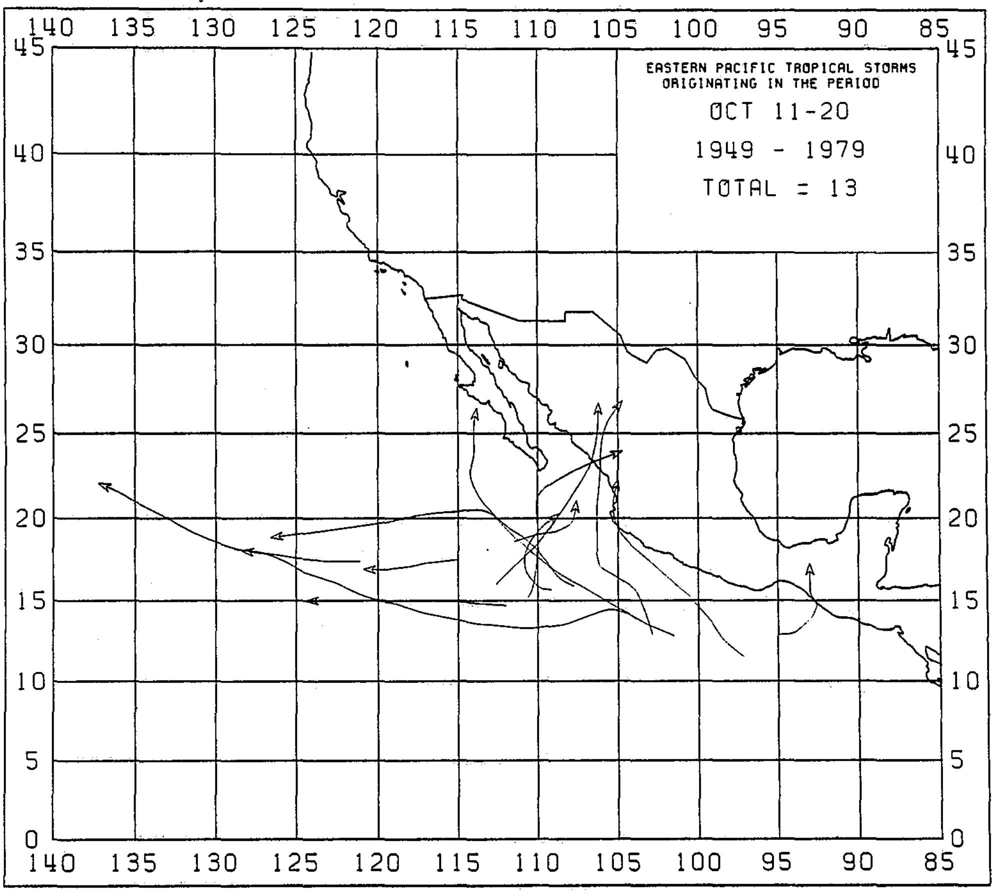

EASTERN PACIFIC TROPICAL STORMS
ORIGINATING IN THE PERIOD
AUG 21-31
1949 - 1979
TOTAL = 35

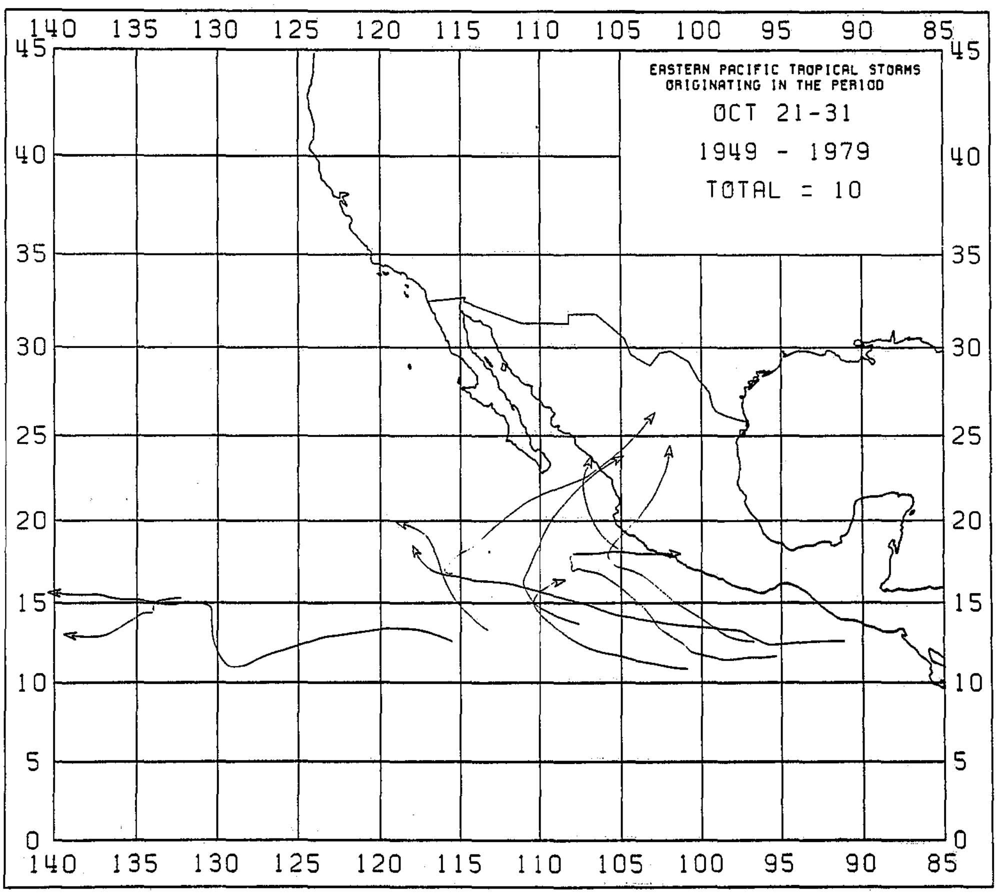

EASTERN PACIFIC TROPICAL STORMS
ORIGINATING IN THE PERIOD
SEP 01-10
1949 - 1979
TOTAL = 28
140 135 130 125 120 115 110 105 100 95 90 85
45 40 35 30 25 20 15 10 5 0

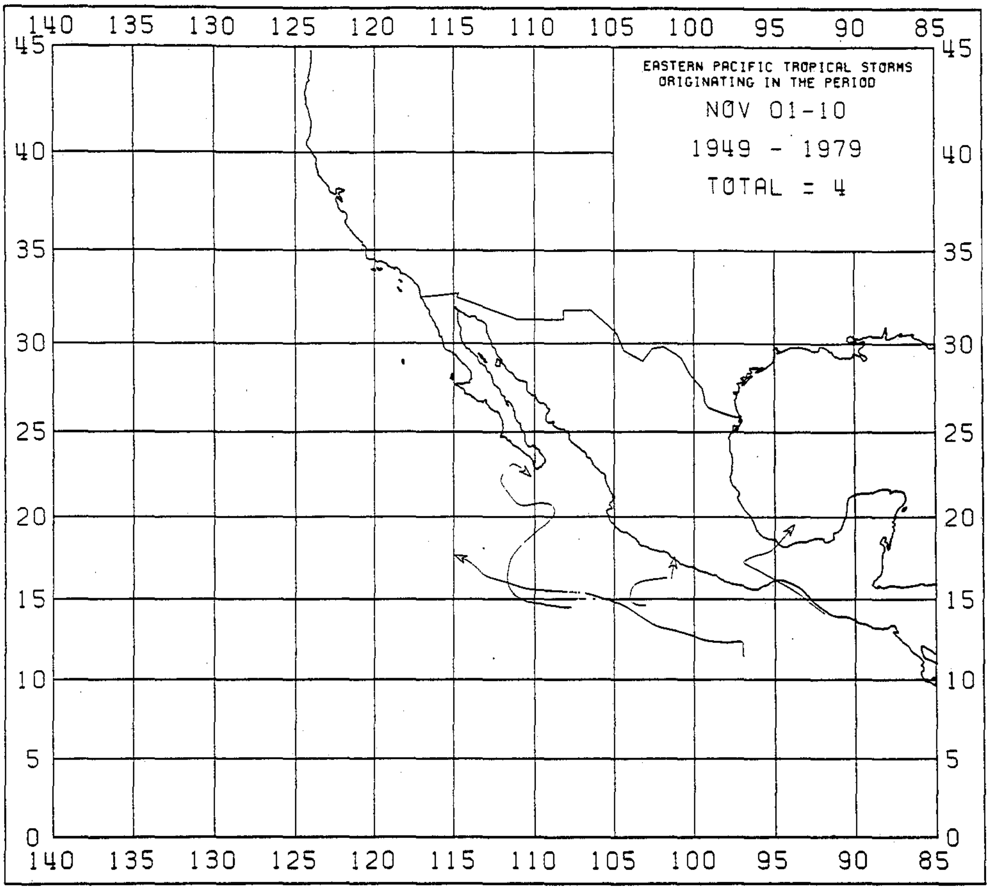

EASTERN PACIFIC TROPICAL STORMS
ORIGINATING IN THE PERIOD
SEP 11-20
1949 - 1979
TOTAL = 23
140 135 130 125 120 115 110 105 100 95 90 85
45 40 35 30 25 20 15 10 5 0

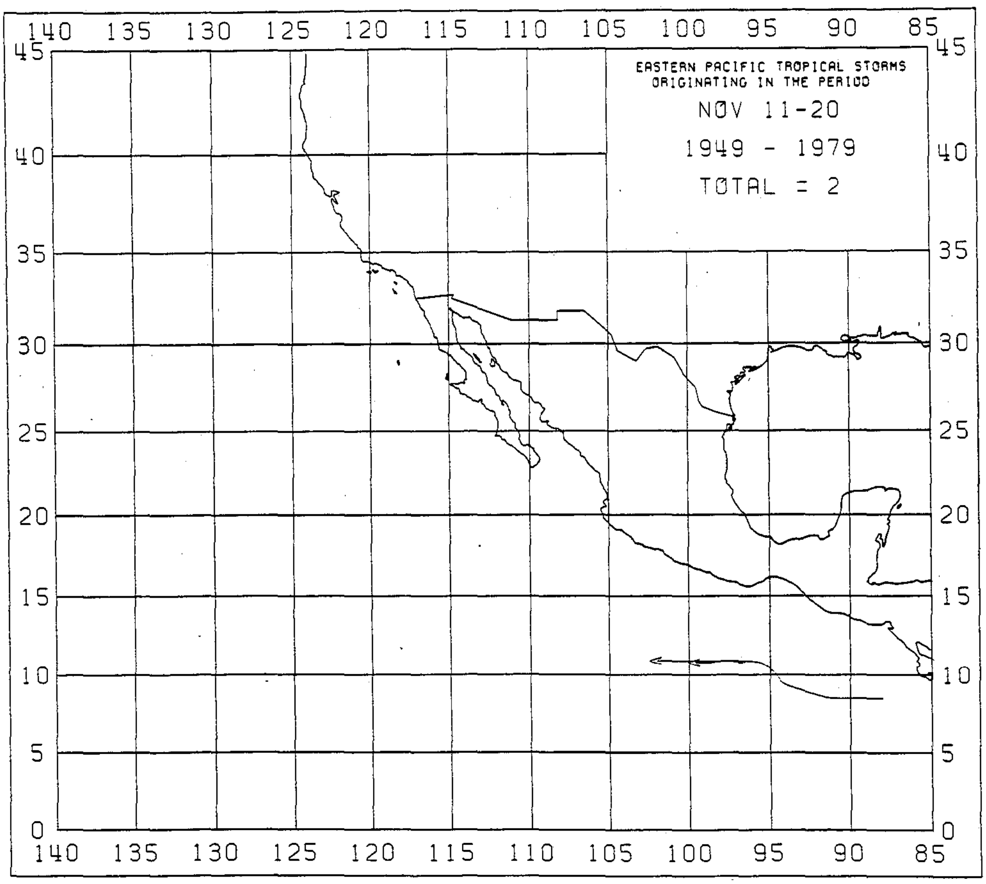

EASTERN PACIFIC TROPICAL STORMS
ORIGINATING IN THE PERIOD
SEP 21-30
1949 - 1979
TOTAL = 25
140 135 130 125 120 115 110 105 100 95 90 85
45 40 35 30 25 20 15 10 5 0

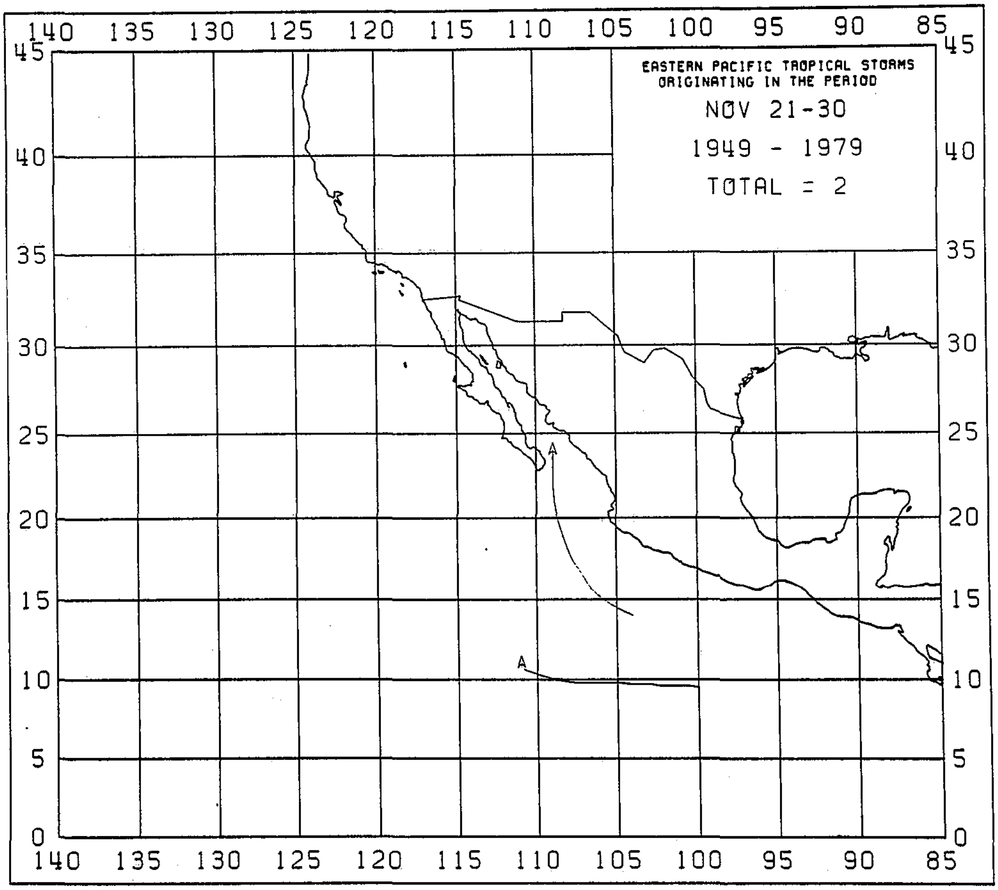

EASTERN PACIFIC TROPICAL STORMS
ORIGINATING IN THE PERIOD
OCT 01-10
1949 - 1979
TOTAL = 18
140 135 130 125 120 115 110 105 100 95 90 85
45 40 35 30 25 20 15 10 5 0


EASTERN PACIFIC TROPICAL STORMS
ORIGINATING IN THE PERIOD
OCT 11-20
1949 - 1979
TOTAL = 13
140 135 130 125 120 115 110 105 100 95 90 85
45 40 35 30 25 20 15 10 5 0


EASTERN PACIFIC TROPICAL STORMS
ORIGINATING IN THE PERIOD
OCT 21-31
1949 - 1979
TOTAL = 10
140 135 130 125 120 115 110 105 100 95 90 85
45 40 35 30 25 20 15 10 5 0


EASTERN PACIFIC TROPICAL STORMS
ORIGINATING IN THE PERIOD
NOV 01-10
1949 - 1979
TOTAL = 4
140 135 130 125 120 115 110 105 100 95 90 85
45 40 35 30 25 20 15 10 5 0


EASTERN PACIFIC TROPICAL STORMS
ORIGINATING IN THE PERIOD
NOV 11-20
1949 - 1979
TOTAL = 2
140 135 130 125 120 115 110 105 100 95 90 85
45 40 35 30 25 20 15 10 5 0


EASTERN PACIFIC TROPICAL STORMS
ORIGINATING IN THE PERIOD
NOV 21-30
1949 - 1979
TOTAL = 2
140 135 130 125 120 115 110 105 100 95 90 85
45
40
35
30
25
20
15
10
5
0
A
A

102 A Set of Rules for Forecasting Temperatures in Napa and Sonoma Counties. Wesley L. Tuft, October 1975. (PB-246-902/AS)

103 Application of the National Weather Service Flash-Flood Program in the Western Region. Gerald Williams, January 1976. (PB-253-053/AS)

104 Objective Aids for Forecasting Minimum Temperatures at Reno, Nevada, During the Summer Months. Christopher D. Hill, January 1976. (PB-252-866/AS)

105 Forecasting the Mono Wind. Charles P. Ruscha, Jr., February 1976. (PB-254-650)

106 Use of MOS Forecast Parameters in Temperature Forecasting. John C. Plankinton, Jr., March 1976. (PB-254-649)

107 Map Types as Aids in Using MOS Pops in Western United States. Ira S. Brenner, August 1976. (PB-259-594)

108 Other Kinds of Wind Shear. Christopher D. Hill, August 1976. (PB-260-437/AS)

110 Cool Inflow as a Weakening Influence on Eastern Pacific Tropical Cyclones. William J. Denney, November 1976. (PB-264-655/

112 The MAN/MOS Program. Alexander E. MacDonald, February 1977. (PB-265-941/AS)

113 Winter Season Minimum Temperature Formula for Bakersfield, California, Using Multiple Regression. Michael J. Oard, February 1977. (PB-273-694/AS)

114 Tropical Cyclone Kathleen. James R. Fors, February 1977. (PB-273-676/AS)

116 A Study of Wind Gusts on Lake Mead. Bradley Colman, April 1977. (PB-268-847)

117 The Relative Frequency of Cumulonimbus Clouds at the Nevada Test Site as a Function of K-value. R.F. Quiring, April 1977. (PB-272-831)

118 Moisture Distribution Modification by Upward Vertical Motion. Ira S. Brenner, April 1977. (PB-268-740)

119 Relative Frequency of Occurrence of Warm Season Echo Activity as a Function of Stability Indices Computed from the Yucca Flat, Nevada, Rawinsonde. Darryl Randerson, June 1977. (PB-271-290/AS)

121 Climatological Prediction of Cumulonimbus Clouds in the Vicinity of the Yucca Flat Weather Station. R.F. Quiring, June 1977. (PB-271-704/AS)

122 A Method for Transforming Temperature Distribution to Normality. Morris S. Webb, Jr., June 1977. (PB-271-742/AS)

124 Statistical Guidance for Prediction of Eastern North Pacific Tropical Cyclone Motion - Part I. Charles J. Neumann and Preston W. Leftwich, August 1977. (PB-272-661)

125 Statistical Guidance on the Prediction of Eastern North Pacific Tropical Cyclone Motion - Part II. Preston W. Leftwich and Charles J. Neumann, August 1977. (PB-272-155/AS)

127 Development of a Probability Equation for Winter-Type Precipitation Patterns in Great Falls, Montana. Kenneth B. Mielke, February 1978. (PB-281-387/AS)

128 Hand Calculator Program to Compute Parcel Thermal Dynamics. Dan Gudgel, April 1978. (PB-283-080/AS)

129 Fire Whirls. David W. Goens, May 1978. (PB-283-866/AS)

130 Flash-Flood Procedure. Ralph C. Hatch and Gerald Williams, May 1978. (PB-286-014/AS)

131 Automated Fire-Weather Forecasts. Mark A. Mollner and David E. Olsen, September 1978. (PB-289-916/AS)

132 Estimates of the Effects of Terrain Blocking on the Los Angeles WSR-74C Weather Radar. R.G. Pappas, R.Y. Lee, and B.W. Finke, October 1978. (PB289767/AS)

133 Spectral Techniques in Ocean Wave Forecasting. John A. Jannuzzi, October 1978. (PB291317/AS)

134 Solar Radiation. John A. Jannuzzi, November 1978. (PB291195/AS)

135 Application of a Spectrum Analyzer in Forecasting Ocean Swell in Southern California Coastal Waters. Lawrence P. Kierulff, January 1979. (PB292716/AS)

136 Basic Hydrologic Principles. Thomas L. Dietrich, January 1979. (PB292247/AS)

137 LFM 24-Hour Prediction of Eastern Pacific Cyclones Refined by Satellite Images. John R. Zimmerman and Charles P. Ruscha, Jr., January 1979. (PB294324/AS)

138 A Simple Analysis/Diagnosis System for Real Time Evaluation of Vertical Motion. Scott Heflick and James R. Fors, February 1979. (PB294216/AS)

139 Aids for Forecasting Minimum Temperature in the Wenatchee Frost District. Robert S. Robinson, April 1979. (PB298339/AS)

140 Influence of Cloudiness on Summertime Temperatures in the Eastern Washington Fire Weather District. James Holcomb,

141 Comparison of LFM and MFM Precipitation Guidance for Nevada During Doreen. Christopher Hill, April 1979. (PB298613/AS)

142 The Usefulness of Data from Mountaintop Fire Lookout Stations in Determining Atmospheric Stability. Jonathan W. Corey, April 1979. (PB298899/AS)

143 The Depth of the Marine Layer at San Diego as Related to Subsequent Cool Season Precipitation Episodes in Arizona. Ira S. Brenner, May 1979. (PB298817/AS)

144 Arizona Cool Season Climatological Surface Wind and Pressure Gradient Study. Ira S. Brenner, May 1979. (PB298900/AS)

145 On the Use of Solar Radiation and Temperature Models to Estimate the Snap Bean Maturity Date in the Willamette Valley. Earl M. Bates, August 1979. (PB80160971)

146 The BART Experiment. Morris S. Webb, October 1979. (PB80155112)

147 Occurrence and Distribution of Flash Floods in the Western Region. Thomas L. Dietrich, December 1979. (PB80160344)

148 A Real-Time Radar Interface for AFOS. Mark Mathewson, January 1980. (PB80157605)

149 Misinterpretations of Precipitation Probability Forecasts. Allan H. Murphy, Sarah Lichtenstein, Baruch Fischhoff, and Robert L. Winkler, February 1980. (PB80174576)

150 Annual Data and Verification Tabulation - Eastern and Central North Pacific Tropical Storms and Hurricanes 1979. Emil B. Gunther and Staff, EPHC, April 1980. (PB80220486)

151 NMC Model Performance in the Northeast Pacific. James E. Overland, PMEL-ERL, April 1980. (PB196033)

152 Climate of Salt Lake City, Utah. Wilbur E. Figgins, June 1980. (PB80225493)

153 An Automatic Lightning Detection System in Northern California. James A. Rea and Chris E. Fontana, June 1980.(PB80225592)

154 Regression Equation for the Peak Wind Gust 6 to 12 Hours in Advance at Great Falls During Strong Downslope Wind Storms. Michael J. Oard, July 1980. (PB81108367)

155 A Raininess Index for the Arizona Monsoon, John H. TenHarkel, July 1980. (PB81106494) /(PB81102501)

156 The Effects of Terrain Distribution on Summer Thunderstorm Activity at Reno, Nevada. Christopher Dean Hill, July 1980.

157 An Operational Evaluation of the Scofield/Oliver Technique for Estimating Precipitation Rates from Satellite Imagery. Richard Ochoa, August 1980. (PB81108227)

158 Hydrology Practicum. Thomas Dietrich, September 1980. (PB81134033)

159 Tropical Cyclone Effects on California. Arnold Court, October 1980. (PB81133779)

NOAA SCIENTIFIC AND TECHNICAL PUBLICATIONS

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

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

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

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

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

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

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

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

Information on availability of NOAA publications can be obtained from:

ENVIRONMENTAL SCIENCE INFORMATION CENTER (D822)
ENVIRONMENTAL DATA AND INFORMATION SERVICE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

6009 Executive Boulevard
Rockville, MD 20852