3B.5 Tropical Cyclones of the Eastern North Pacific Ocean, 1949-2006

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1. INTRODUCTION

The eastern North Pacific basin produces more tropical cyclones (TCs) per square km than any other worldwide basin. The 1971-2006 averages for the number of tropical storms (TS), hurricanes and major (Saffir-Simpson Hurricane Scale 3 or higher) hurricanes in the basin are 15, 8 and 4, respectively. This work is part of a long-term project to reanalyze TC statistics in the eastern Pacific basin. In addition, a track book similar to the Atlantic version (Neumann et al. 1999) is being published and should be ready by the end of the year. This study focuses on intraseasonal variation and landfalls in Mexico. However, the track book covers these topics and others in more detail (Blake et al. 2008) than space allows here.

2. DATA

This study uses the "best-track" file at the National Hurricane Center (NHC) from 1949-2006 (Jarvinen et al. 1984). The origination of the eastern Pacific data is quite different than the Atlantic best track file and requires some explanation. TC data that comprises most of the NHC best track record from 1949-1975 were obtained from the U.S. Navy. Some modifications to that dataset were performed using data found in *Mariner's Weather Log, Monthly Weather Review,* and *Climatological Data*. It is important to note, however, for most of the systems prior to 1970, cyclones were categorized as tropical depressions, tropical storms or hurricanes, and were assigned average intensities of 25, 45, or 75 kt respectively. This categorization helps to explain why there are very few major hurricanes (only significant landfalls) in the dataset before 1971. In addition, routine, high-quality satellite images were first available in the early 1970s for forecaster use. 1971 is considered a good starting point for more reliable records in the eastern Pacific. Consistent, quality satellite imagery were then available for analysis and better satellite intensity estimation techniques were in use by forecasters by that time.

The best track database from 1976-1987 was based on advisories issued by the Eastern Pacific Hurricane Center in Redwood City, California. Some in-house modification of tracks and intensities was performed by Arthur Pike after the NHC assembled the best track database in 1976 (Neumann, personal communication). Other best track files were modified and extended based on a study by Court (1980). Operational responsibility for the eastern Pacific was assumed by the NHC in 1988, and the NHC has maintained the best track database to present day. Annual summaries of storms issued by the NHC and published in *Monthly Weather Review* are the definitive source of information since 1988.

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3. CLIMATOLOGY

Other publications have dealt with the climatology of the eastern Pacific basin (e.g. Allard 1984, Leftwich and Brown 1981), but few updates have been performed over recent years. TC tracks in the basin are tightly clustered southwest of Mexico. Figure 1 shows the frequency of TS tracks from 1949-2006. The maximum concentration of tracks is just offshore of southwestern Mexico, near 17°N, 108°W (approximately 240 n mi southwest of Manzanillo, Mexico). Tropical cyclones (hurricanes) have passed within 60 n mi of this location 133 (59) times over the 58-year period, 1949-2006.

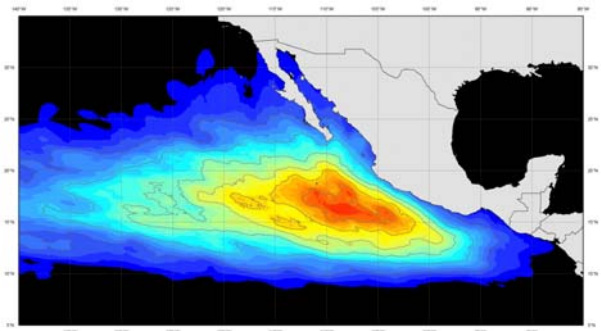

Figure 1: Frequency of TS tracks in the eastern North Pacific, 1949-2006.

Figure 2 shows a year-by-year count of tropical storms, hurricanes and major hurricanes in the eastern Pacific from 1949-2006. There is noticeable jump in the number of named storms after 1966 and hurricanes and major hurricanes after 1971. The largest number of tropical storms in a year occurred in 1992 (24), while the fewest in the geostationary satellite age (post-1966) was 8 in 1977. Sixteen hurricanes were noted in 1990, and only 4 hurricanes were observed in 1977. Only twice, in 1977 and 2003, have no major hurricanes been noted since reliable major hurricane records began in 1971.

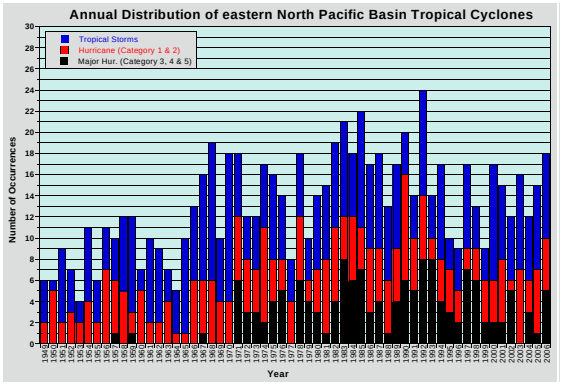

Figure 2: Eastern Pacific TCs by year, 1949-2006.

Another area of interest in the eastern Pacific is the intraseasonal variation of activity. Forecasters from the 1960s have often said that August brings a lull in activity (Gustafson 1969), and Leftwich and Brown (1981) showed this mid-season TS minimum during late July and early August. Figure 3 illustrates the daily frequency of tropical storms, hurricanes and major hurricanes over the eastern Pacific basin for the 8-month period that tropical cyclones have been observed. Note that the mid-seasonal minimum includes a significant reduction in both hurricanes and major hurricanes, in addition to tropical storms.

The daily frequencies in Fig. 3 are useful to define intraseasonal fluctuations in tropical cyclone frequency. These intraseasonal changes include a slight maximum around mid-June, followed by a slight decline until early July. This decline is followed by a steep increase in frequency until mid-July, then a substantial drop in activity is noted through mid-August. A marked increase in activity occurs by the third week in August, attaining a level a little higher than the July peak. The frequency decreases steadily until the end of September, where it drops off rapidly, save a slight increase in activity in the third week of October. It is also of note that the hurricane and major hurricane frequency from early July to late September is rather steady, except for the large drop in activity from late July to mid-August.

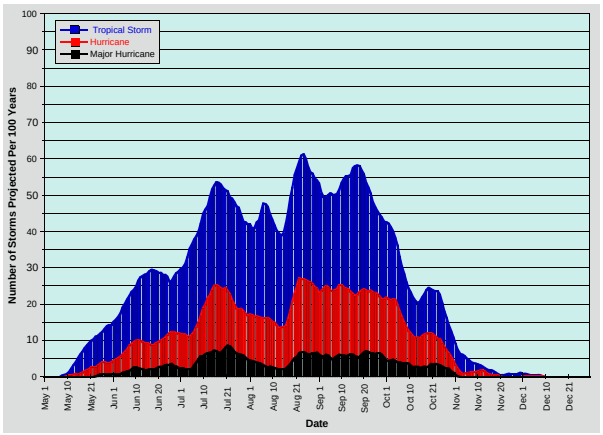

Figure 3: Intraseasonal variations in the 100-year expectancy of TC occurrence. The blue bar is for tropical storms, the red bar is for hurricanes and the black bar is for major hurricanes. The data has been smoothed by a 9-day running mean.

4. LANDFALLING TROPICAL CYCLONES

Of the 769 tropical cyclones of at least tropical storm strength that have been recorded over the eastern Pacific tropical cyclone basin, 1949-2006, a total of 151 or about 20% are estimated to have caused at least tropical storm force winds along the Mexican mainland. These impacts are termed TS strikes, defined as a system estimated to have caused TS winds on the coastline, but does not necessarily make landfall in the area of strong winds. A year-by-year distribution is shown in Fig. 4. For marginal cases, or those systems that brushed the coast, a review of the data along with the tropical cyclone reports or published seasonal summaries in *Monthly Weather Review* were used to make a determination of the maximum wind speeds that likely occurred on the coast.

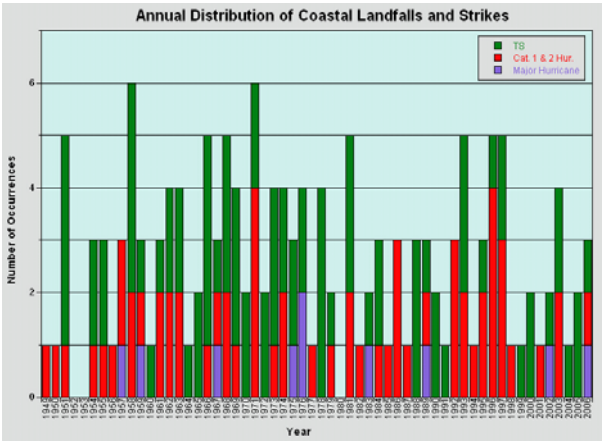

Figure 4: Mexican and Central American landfalls and strikes, 1949-2006.

Four tropical storms affected other areas of the Pacific coast of Central America (Simone 1968, Olivia 1971, Miriam 1988, Adrian 2005). It is noted that Olivia and Miriam were former Atlantic hurricanes that quickly redeveloped after entering the eastern Pacific, rather than a direct hit from the west like Adrian.

Seventy-one hurricane strikes have been noted along with ten landfalling major hurricanes. The maximum number of hurricane strikes was four in 1996, and the minimum observed is zero in numerous years, mostly recently in 2005. Figure 5 shows the landfall points of any hurricanes that crossed the coast. There is a significant clustering of hurricane landfall points in southern Mexico near Manzanillo and in the Mexican state of Sinaloa.

Figure 5: Hurricane and major hurricane landfall points in Mexico, 1949-2006.

It is also of note that most of the hurricane strikes and major hurricane landfalls occur late in the season, with a sharp maximum in September and October (Figure 7). These two months account for about 60% of the seasonal strikes. June has a secondary maximum in hurricane impacts, but the maximum is smaller than either September or October. In terms of major hurricanes, October is by far the most dangerous month for Pacific coastal residents of Mexico, with 8 out of 10 recorded systems observed in that month. These systems have tended to approach Mexico from the south or southwest as the mid-latitude westerlies dip far enough to the south to allow recurvature of the major hurricanes.

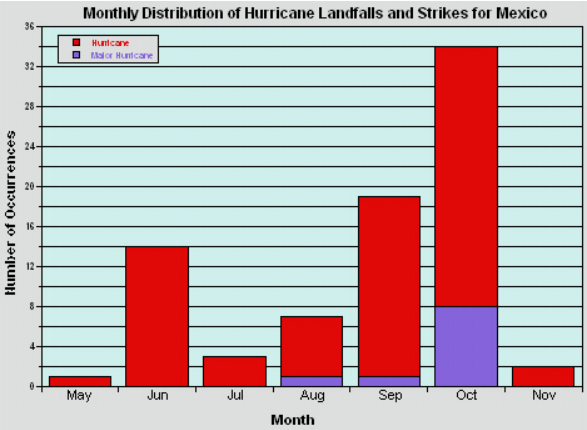

Figure 6: Hurricanes and major hurricanes by month affecting mainland Mexico, 1949-2006.

5. DISCUSSION

This report highlights some of the research contained in the new eastern North Pacific track book. This book is currently in publication and should be released by the end of the year. One other component of the track book is the sequence of yearly maps detailing the position and intensity of all tropical cyclones. Figure 7 shows an example year, displaying the style and colors that are used in the track book. Also contained within the tracks section of the publication are monthly and decadal maps of the basin, in much the same manner as the Atlantic track book.

6. ACKNOWLEDGEMENTS

Richard Pasch and Christopher Landsea made helpful reviews for this document. The past and current authors of the Atlantic track book are also acknowledged as much of the structure of the book is based on their early work. I'd also like to thank my NHC co-authors on the eastern Pacific track book for their critical contributions: Ethan Gibney, Dan Brown, Michelle Mainelli, James Franklin and Todd Kimberlain. Finally Greg Hammer and his team at NCDC provided much support and publication assistance.

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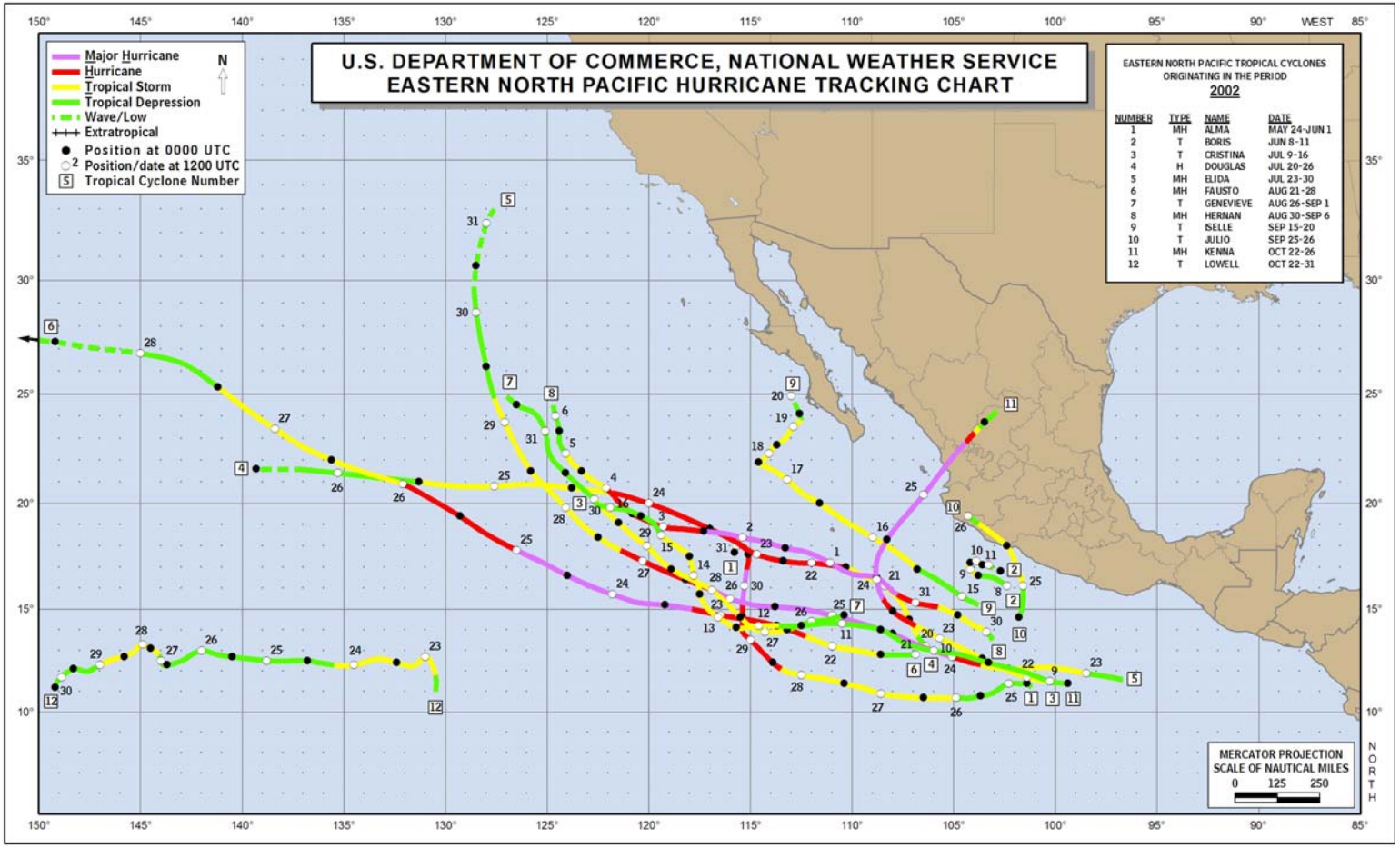

Figure 7: The 2002 hurricane season in the eastern Pacific. This is an example of the map style in the new track book.