1.1 PRECURSOR GLOBAL CLIMATE INFLUENCES ON THE PROBABILITY OF US LANDFALLING HURRICANES

William M. Gray *
Colorado State University, Fort Collins, Colorado

1. INTRODUCTION

It is impossible to predict when or where a hurricane will make landfall in any year or any period of years. But, one can predict the year-to-year and decade-to-decade differences in the probability of such landfall events. On average, active hurricane seasons have many more landfall events than do inactive seasons. The probability of major (Cat. 3-4-5) hurricane landfall along the U.S. East Coast in individual years can vary greatly from the long term average. For example, the probability of U.S. major hurricane landfall during a 4-5 year period when global oceanic and atmospheric climate signals are favorable is much higher than during a similar 4-5 year period when climate signals were unfavorable.

Landfall probability forecasts have been developed from statistics of the last century (1900-1999). Landfall information has been taken from the NOAA Historical Climate Series 6-2 publication titled "Tropical Cyclones of the North Atlantic Ocean 1871-1998" by C. Neumann, B. Jarvinen, C. McAdie and G. Hammer.

Year-to-year and decadal variations in landfall frequency have been statistically related to prior global ocean and atmospheric conditions. Landfall of intense or major hurricanes show the best association with precursor global climate features. There are individual years and multi-decadal periods when the probability of major hurricane landfall and hurricane DP along the U.S. East Coast are many times higher or many times lower than the long period average.

Future landfall probability can be statistically related to the seasonal and decadal variations in Atlantic basin Net Tropical Cyclone Activity (NTC) plus prior one to six year measurements of prior North Atlantic (50-60°N, 10-50°W) Sea Surface Temperature Anomalies (SSTA*). NTC is a percentage average of each of the six seasonal parameters of NS, NSD, H, HD, IH and IHD in comparison to the 1950-1990 mean of 100 units. See our prior papers for the definition and discussion of seasonal NTC variations.

Landfall frequency statistics have been analyzed for the whole U.S. coastline and separately for the Gulf Coast and for the Florida Peninsula and East Coast (FL+EC). These statistics are further broken down into 11 different U.S. coastal sublocations (Fig. 1) based on the frequency of intense or major (Saffir/Simpson 3-4-5) hurricane landfall. Table 1 gives the landfall event breakdown frequency for these 11 U.S. coastal regions by cyclone intensity class. Estimates of the probability of hurricane-spawned Destruction Potential (DP) have also been made for 96 additional U.S. sub-regions based on a combination of cyclone frequency-intensity and coastal population variation. Last century DP values have been developed by normalization by landfall frequency-intensity, population, inflation, and wealth per capita.

Table 1: Number of United States landfall tropical cyclones of tropical storms (TS), and Saffir/Simpson category 1, category 2, category 3, and category 4-5 between 1900-1999.

		Normalized relative destruction by intensity category				
Coast-line Region	Coastal Distance km	TS 0.62	Cat.1 0.25	Cat.2 1	Cat.3 4	Cat.4-5 16
1	503	21	11	9	10	5
2	257	12	4	2	1	1
3	666	36	16	5	16	3
4	382	19	4	4	0	0
5	373	15	4	1	4	0
6	483	11	6	9	8	7
7	574	13	2	3	0	0
8	673	18	13	7	10	2
9	527	5	4	2	0	0
10	426	3	3	1	6	0
11	447	5	3	0	0	0
Total	5311	158	70	43	55	18

Skillful seasonal landfall probability hindcasts can be made by early December, early April, early June and early August. Other papers of this 25th AMS conference show that very skillful hurricane landfall probability forecasts can also be made for the individual months of August (see E. Blake)

*William M. Gray, Colorado State University, Dept. of Atmospheric Science, Fort Collins, CO 80523-1371; e-mail: gray@climo.atmos.colostate.edu

and September (see P. Klotzbach) but from different global precursor signals.

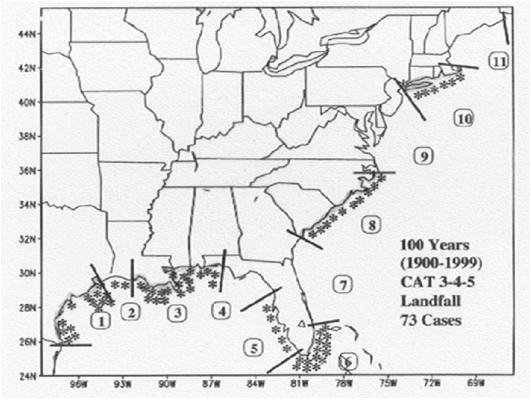

Figure 1: Designation of U.S. coastal regions by the locations of 73 intense or major (category 3-4-5) hurricane landfall events during the period of 1900-1999.

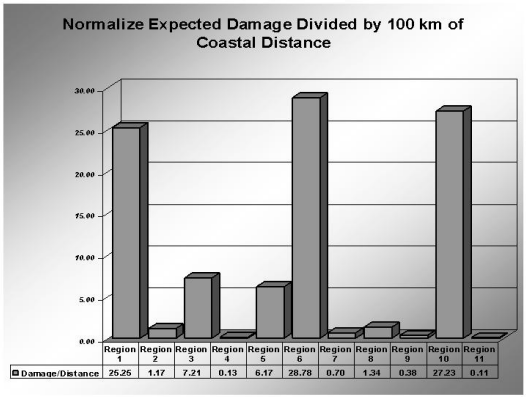

Figure 2: Last century (1900-1999) normalized (by cyclone frequency-intensity, inflation, population and wealth per capita) U.S. coastal Destruction Potential (DP).

Emphasis should be placed on the intense or major (cat. 3-4-5) hurricanes that have caused (on a long period normalized basis (see Pielke, Jr. and Landsea 1999) about 85 percent of all tropical cyclone-spawned damage - even though they account for only about 22 percent of the last century's landfalling named storms.

Florida is currently facing a grave problem in the form of an expected large increase in major hurricane landfall in the next few decades. An unprecedented decrease in landfalling major (cat. 3-4-5) hurricanes has occurred in the southern two-thirds of Florida during the last 35 years. Only one major hurricane (Andrew 1992) has made landfall during the period of 1966-2001 while in the equal period between 1930-1965 there were 11 such major hurricane landfall events in the southern two-thirds of Florida. And Florida's coastal population and damage potential as skyrocketed during the recent period of decreased major hurricane landfall.

This unusual downturn in Florida major hurricane landfall events has been a rare combination of unfavorable multi-decadal global climate trends and unusual luck. A number of major hurricanes have followed near-miss tracks. This remarkable decrease in Florida landfalling major hurricanes is unlikely to continue. When it changes Florida is going to experience unprecedented hurricane-spawned destruction.

Figure 2 shows that there exists a great variability in U.S. coastal DP. The Texas coast, Southeast Florida, and the coastal area from New York City to Cape Cod have a long-period destruction potential (due to a combination of population density and frequency-intensity) that is 5-20 times higher than at most other U.S. coastal locations. A major hurricane coming into one of these densely populated areas could cause up to $50-75 billions in losses. Fortunately, the annual probability of such an event is quite low. But such events are on the horizon.

2. ACKNOWLEDGEMENT

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3. REFERENCES

Pielke, Jr., R. A. and C. W. Landsea, 1998: Normalized Atlantic hurricane damage, 1925-1995. *Wea. Forecasting*, 13, 621-631.