EXTENDED RANGE FORECAST OF ATLANTIC SEASONAL HURRICANE ACTIVITY AND US LANDFALL STRIKE PROBABILITY FOR 2003

The recent upturn in Atlantic basin hurricane activity which began in 1995 is expected to continue in 2003. We anticipate an above average probability for Atlantic basin tropical cyclones and U.S. hurricane landfall.

(as of 6 December 2002)

This forecast is based on new research by the authors,
along with current meteorological information through November 2002

By

William M. Gray,[1] Philip J. Klotzbach,[2] and Christopher W. Landsea[3]

with assistance from William Thorson[4] and Jason Connor[5]

[This forecast as well as past forecasts and verifications are available via the World Wide Web: http://tropical.atmos.colostate.edu/forecasts/index.html] - also,

Brad Bohlander and Thomas Milligan, Colorado State University Media Representatives (970-491-6432) are available to answer various questions about this forecast.

Department of Atmospheric Science

Colorado State University

Fort Collins, CO 80523

email: barb@tutt.atmos.colostate.edu

ATLANTIC BASIN SEASONAL HURRICANE FORECAST FOR 2003

Forecast Parameter and 1950-2000 Climatology (in parentheses)	6 December 2002 Forecast for 2003
Named Storms (NS) (9.6)	12
Named Storm Days (NSD) (49.1)	65
Hurricanes (H)(5.9)	8
Hurricane Days (HD)(24.5)	35
Intense Hurricanes (IH) (2.3)	3
Intense Hurricane Days (IHD)(5.0)	8
Hurricane Destruction Potential (HDP) (72.7)	100
Net Tropical Cyclone Activity (NTC)(100%)	140

PROBABILITIES FOR AT LEAST ONE MAJOR (CATEGORY 3-4-5) HURRICANE LANDFALL ON EACH OF THE FOLLOWING COASTAL AREAS:

1) Entire U.S. coastline - 68% (average for last century is 52%)

2) U.S. East Coast Including Peninsula Florida - 48% (average for last century is 31%)

3) Gulf Coast from the Florida Panhandle westward to Brownsville - 38% (average for last century is 30%)

4) Expected above-average major hurricane landfall risk in the Caribbean

DISTINCTION BETWEEN CSU SEASONAL HURRICANE FORECASTS VERSUS THOSE ISSUED BY NOAA

Seasonal hurricane forecasts have now been issued for 20 years by the tropical meteorology research group of Prof. William Gray of the Department of Atmospheric Science, Colorado State University (CSU). The forecasts, which are issued in December of the prior year, and in April, June, and August of the current year, have steadily improved through continuing research. These forecasts now include predictions of Atlantic basin activity and U.S. hurricane landfall probabilities for seasonal as well as individual monthly periods.

The National Oceanic and Atmospheric Administration (NOAA) has also recently begun to issue Atlantic basin seasonal hurricane forecasts. The NOAA forecasts are independent of our CSU forecasts although they utilize prior CSU research augmented by their own insights. The NOAA and the CSU forecasts will typically differ in some aspects and details. Chris Landsea and Eric Blake, former CSU project members presently employed by NOAA, have made important contributions to both forecasts.

DEFINITIONS

ABSTRACT

Information obtained through November 2002 indicates that the 2003 Atlantic hurricane season will be an active one. We estimate that 2003 will have about 8 hurricanes (average is 5.9), 12 named storms (average is 9.6), 65 named storm days (average is 49), 35 hurricane days (average is 24.5), 3 intense (category 3-4-5) hurricanes (average is 2.3), 8 intense hurricane days (average is 5.0) and a Hurricane Destruction Potential (HDP) of 100 (average is 71). The probability of U.S. major hurricane landfall is estimated to be 30 percent above the long-period average. We expect Atlantic basin Net Tropical Cyclone (NTC) activity in 2003 to be about 140 percent of the long-term average. This forecast is based on our recently developed 6-11 month extended range statistical forecast procedure which utilizes 52 years of past data. Both statistical and analog predictors have been utilized. These include five selective measures of September-November North Atlantic and Pacific surface pressure and 500 mb height fields and a 10-month extrapolation of the stratospheric QBO. The influence of El Niño conditions are implicit in these six predictor fields, and therefore we do not utilize a specific ENSO forecast as a predictor. Our predictors indicate that the current moderate El Niño will be largely dissipated by next summer.

1 Introduction

This is the 20th year in which the first author has made forecasts of the coming season's Atlantic basin hurricane activity. Our Colorado State University research project has shown that a sizable portion of the year-to-year variability of Atlantic tropical cyclone (TC) activity can be hindcast with skill significantly exceeding climatology. The forecasts are based on a statistical methodology derived from 52 years of past data and a separate study of analog years which have similar precursor circulation features. Qualitative adjustments are added to accommodate additional processes which may not be explicitly represented by our statistical analyses. These evolving forecast techniques are based on a variety of climate-related global and regional predictors previously shown to be related to the forthcoming seasonal Atlantic tropical cyclone activity and landfall probability.

2 December Forecast Methodology

We believe that seasonal forecasts must be based on methods showing significant hindcast skill in application to long periods of prior data. It is only through hindcast skill that one can demonstrate that seasonal forecast skill is possible. This is a valid methodology provided the atmosphere continues to behave in the future as it has in the past. We have no reason for thinking that it will not. Our initial 6-11 month early December seasonal hurricane forecast scheme (Gray et al. 1992) demonstrated hindcast skill for the period of 1950-1990. Our new, recently developed forecast scheme uses more hindcast years (1950-2001) and shows improved hindcast skill and better physical insights into why such precursor relationships have an extended period memory.

Through extensive analyses of NOAA-NCEP reanalysis products, Phil Klotzbach of our forecast team has developed a new set of 6-11 month extended range predictors which shows superior hindcast prediction skill over our previous 1 December forecast scheme. The location of each of these new predictors is shown in Fig. 1. The pool of six predictors for this new extended range forecast is given in Table 1. Strong statistical relationships can be extracted via combinations of these predictors (which are available by 1 December) and the Atlantic basin hurricane activity occurring the following year.

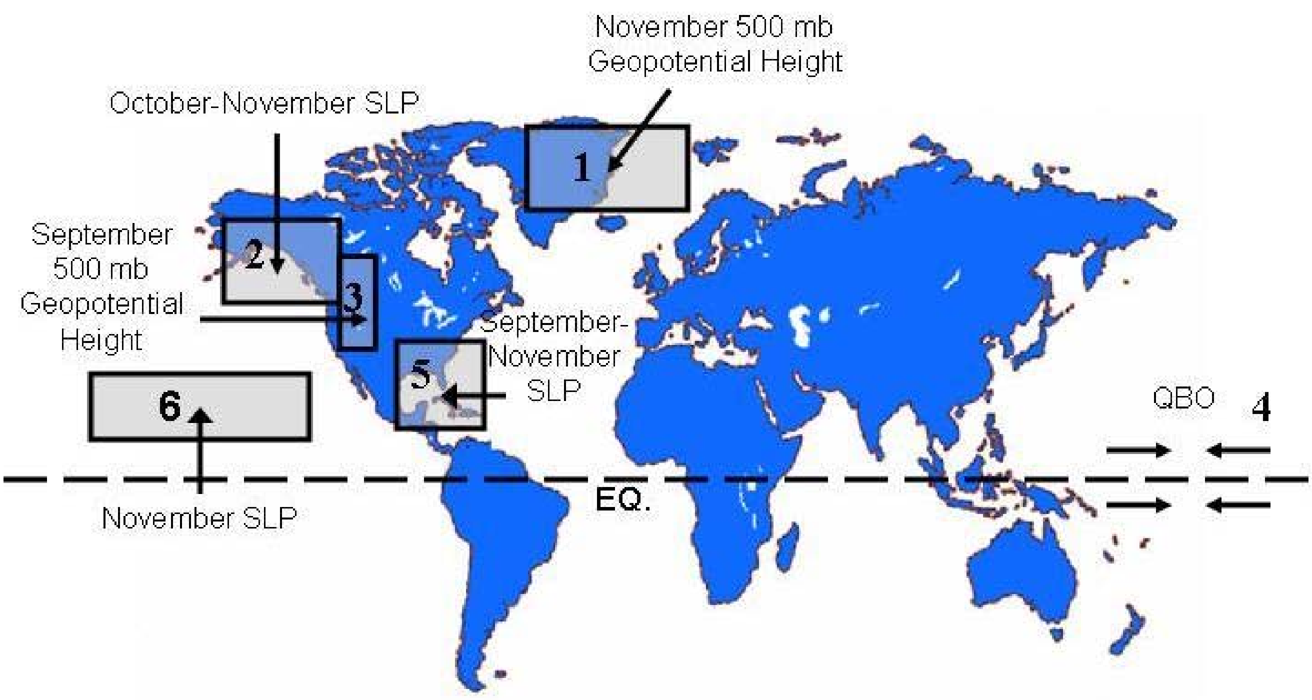

Figure 1: Location of the new predictors for our early December extended range prediction for the 2003 hurricane season.

Table 1: Listing of 1 December 2002 predictors for next year's hurricane activity. A plus (+) means that positive values of the parameter indicate increased hurricane activity the following year, and a minus (-) means that positive values of the parameter indicate decreased hurricane activity the following year.

	2002 Values for 2003 Forecast
(1) - November 500 mb geopotential height (67.5-85° N, 10E-50°W) (+)	+1.7SD
(2) - October-November SLP (45-65°N, 120-160° W) (-)	-0.3SD
(3) - September 500 mb geopotential height (35-55°N, 100-120° W) (+)	-0.2SD
(4) - July 50 mb U (5°S-5°N, 0-360) (-)	+1.5SD
(5) - September-November SLP (15-35°N, 75-95° W) (-)	-1.5SD
(6) - November SLP (7.5-22.5°N, 125-175°W) (+)	-0.3SD

2.1 Physical Associations among Predictors Listed in Table 1

The locations and brief descriptions of our 6-11 month predictors are as follows:

Predictor 1. November 500 MB Geopotential Height in the far North Atlantic (+)

(67.5-85° N, 10E-50°W)

Positive values of this predictor correlate very strongly (r = -0.7) with negative values of the Arctic Oscillation (AO) and the North Atlantic Oscillation (NAO). Negative AO and NAO values imply more ridging in the central Atlantic and a likely warm north Atlantic Ocean (50-60°N, 10-50°W). Also, on decadal timescales, weaker zonal winds in the subpolar areas are indicative of a relatively strong thermohaline circulation which is favorable for hurricane activity. Positive values of this November index are negatively correlated with both 200 mb zonal winds and trade winds the following September in the tropical Atlantic. The associated reduced tropospheric vertical wind shear enhances conditions for TC development. Other features that are directly correlated with this predictor are low sea level pressure in the Caribbean and a warm North and Tropical Atlantic. Both of the latter are also hurricane-enhancing factors.

Predictor 2. October-November SLP in the Gulf of Alaska (-)

(45-65°N, 120-160°W)

Negative values of this predictor are strongly associated with a positive Älaskan pattern" (Renwick and Wallace 1996) as well as a positive "Pacific North American Pattern" (PNA) which implies reduced blocking over the central Pacific with increased heights over the western United States. The negative mode of this predictor is typically associated with current warm eastern Pacific equatorial SST conditions which usually lead to cool ENSO conditions the following year. Low sea level pressure is observed to occur in the Gulf of Alaska with a decaying El Niño event, and anomalously high pressure is observed with a weakening La Niña event (Larkin and Harrison 2002). Negative values of this predictor indicate La Niña conditions the following year which tend to enhance Atlantic hurricane activity.

Predictor 3. September 500 MB Geopotential Height in Western North America (+)

(35-55°N, 100-120°W)

Positive values of this predictor correlate very strongly (r = 0.8) with positive values of the PNA. PNA values are usually positive in the final year of an El Niño event (Horel and Wallace 1981). Therefore, cooler ENSO conditions are likely during the following year. Significant lag correlations exist between this predictor and enhanced geopotential height anomalies in the subtropics during the following summer. High heights in the subtropics reduce the height gradient between the tropics and subtropics resulting in easterly anomalies at 200 mb throughout the tropics which favor hurricane development.

<u>Predictor 4. July 50 MB Equatorial U (-)</u>

(5°S-5°N, 0-360)

Easterly anomalies of the QBO during the previous July indicate that the QBO will likely be in the west phase during the following year's hurricane season. The west phase of the QBO has been shown to provide favorable conditions for development of tropical cyclones in the deep tropics according to Gray et al. (1992, 1993, 1994) and Shapiro (1989). Hypothetical mechanisms for how the QBO affects hurricanes are as follows: a) Atlantic TC activity is inhibited during easterly phases of the QBO due to enhanced lower stratospheric wind ventilation and increased upper-troposphere-lower-stratosphere wind shear, and b) for slow moving systems, the west phase of the QBO has a slower relative wind (advective wind relative to the moving system) than does the east phase. This allows for greater coupling between the lower stratosphere and the troposphere.

<u>Predictor 5. September-November SLP in the Gulf - SE USA (-)</u>

(15-35°N, 75-95°W)

This feature is used to predict the following year's August-September sea level pressure in the tropical and subtropical Atlantic. August-September SLP in the tropical Atlantic is one of the most important predictors for seasonal activity, that is, lower-than-normal sea level pressure is favorable for more TC activity. Low pressure in this area during September-November correlates quite strongly with the positive phase of the PNA. In addition, low sea level pressure in the tropical Atlantic and easterlies at 200 mb are typical during the following year's August-September period with low values of this predictor.

<u>Predictor 6. November SLP in the Subtropical NE Pacific (+)</u>

(7.5-22.5°N, 125-175°W)

This feature is also used to predict the following year's August-September sea level pressure in the tropical and subtropical Atlantic. High pressure in this area correlates with low sea level pressure in the tropical Atlantic and easterly anomalies at 200 mb during the following August through September period. According to Larkin and Harrison (2002), high pressure in this area appears during most winters preceding the development of a La Niña event. High pressure in this region forces stronger trade winds in the east Pacific which increases upwelling and helps initiate La Niña conditions which eventually enhance Atlantic hurricane activity during the following summer. In addition, this predictor correlates with low geopotential heights at 500 mb throughout the tropics the following year which is also favorable for more hurricane activity in the Atlantic.

2.2 Hindcast Skill

Table 2 shows the degree of 1 December precursor (i.e. hindcast) variance explained by the best single predictor, the best two predictors, the best three predictors, etc. for each of our eight forecast parameters based on the 52-year period of 1950-2001. To reduce overfitting, we use no more than four predictors. Note that there is substantial skill for the following year's predictions of NTC and HDP. Predictors 5 and 6 are combined to obtain a predictor for the following year's August-September sea level pressure; the combination is referred to as Predictor 5 in Table 2.

The 1 December forecast picks the best combination of four predictors from a pool of five predictors or until the jackknife variance explained no longer increases. All predictands utilize four predictors except for named storms which utilizes three predictors.

Table 2: Amount of hindcast variance explained (r^2) from the pool of five predictors shown in Table 1 for the 52 -year period of 1950-2001. Calculations of the best single predictor is shown in box A, the best two predictors in box B, the best three predictors in box C and the best four predictors in box D. The second column gives the amount of variance explained when each of the years being forecast are not in the training data set (jackknife method).

A-Best Single Predictor			**B-Best Two Predictors**		
	Variance Explained	**Jackknife**		**Variance Explained**	**Jackknife**
NS - 1	0.248	0.196	NS - 1, 2	0.367	0.304
NSD - 5	0.232	0.177	NSD - 1, 5	0.354	0.283
H - 2	0.286	0.237	H - 1, 2	0.452	0.389
HD - 5	0.285	0.234	HD - 1, 5	0.417	0.348
IH - 1	0.320	0.259	IH - 1, 3	0.472	0.401
IHD - 5	0.251	0.193	IHD - 1, 3	0.364	0.284
HDP - 5	0.301	0.247	HDP - 1, 5	0.428	0.354
NTC - 1	0.320	0.263	NTC - 1, 2	0.473	0.403
C-Best Three Predictors			**D-Best Four Predictors**		
	Variance Explained	**Jackknife**		**Variance Explained**	**Jackknife**
NS - 1, 2, 3	0.403	0.318	NS - 1, 2, 3, 5	0.420	0.312
NSD - 1, 3, 5	0.410	0.306	NSD - 1, 3, 4, 5	0.445	0.311
H - 1, 2, 5	0.489	0.414	H - 1, 2, 3, 5	0.519	0.424
HD - 1, 3, 5	0.488	0.384	HD - 1, 3, 4, 5	0.521	0.398
IH - 1, 2, 3	0.541	0.455	IH - 1, 3, 4, 5	0.572	0.463
IHD - 1, 3, 5	0.463	0.365	IHD - 1, 3, 4, 5	0.501	0.390
HDP - 1, 3, 5	0.521	0.418	HDP - 1, 3, 4, 5	0.566	0.451
NTC - 1, 3, 5	0.573	0.486	NTC - 1, 3, 4, 5	0.614	0.513

3 Analog Based Predictors for 2003 Hurricane Activity

Certain years in the historical record have global oceanic and atmospheric trends which are substantially similar to 2002/2003. These years also provide useful clues as to likely trends in activity that the forthcoming 2003 hurricane season may bring. For this (1 December) extended range forecast, we project atmospheric and oceanic conditions for August through October 2003 and determine which of the prior years in our database have distinct trends in key environmental conditions which are similar to current October-November 2002 conditions. Table 3 lists our analog selections.

Analog Years. We have found five prior hurricane seasons since 1949 which appear to be similar to current November 2002 conditions and projected 2003 August-October conditions. Specifically, we expect the North Atlantic (50-60°N, 10-50°W) warm SST anomalies to remain warm for the 2003 hurricane season due to current negative AO and NAO values and hence that the strong Atlantic thermohaline circulation will persist through the next hurricane season. Also, it is assumed that the conditions of the Northern Hemisphere NAO, PNA, PDO, and AO of six of the last eight years will persist through 2003. The latter assumptions carry the implication that the recent global atmosphere and ocean circulation regimes which have been present in all but two of the last eight years will continue to be present in 2003. In addition, we look for years that had warm ENSO conditions the previous fall and winter with cooling sea surface temperatures in the eastern and central Pacific observed during the summer of the year being selected. Finally, years that tended to be in the east phase of the QBO were selected.

There were five hurricane seasons since 1949 with characteristics similar to what we observe in November 2002 and what we anticipate for the summer/fall 2003 period. These best analog years are 1952, 1958, 1964, 1970, and 1984 (Table 3). We anticipate that the 2003 seasonal hurricane conditions will be somewhat above the average values for these five analog years due to an anticipated active thermohaline circulation. Thus, based on this analysis, we expect 2003 to be an active hurricane season and in line with the average of six of the last eight years (1995, 1996; 1998-2001). We anticipate 2003 to be considerably more active than the average season during the inactive 1970-1994 period.

Table 3: Best analog years for 2003 with the associated hurricane activity listed for each year.

	NS	NSD	H	HD	IH	IHD	HDP	NTC
1952	7	40	6	23	3	4.00	70	93
1958	10	56	7	30	4	8.25	94	133
1964	12	71	6	43	5	9.75	139	160
1970	10	23	5	7	2	1.00	18	62
1984	12	51	5	18	1	0.75	42	74
Mean	10.2	48.2	5.8	24.2	3.0	4.75	72.6	104.4
2003 Forecast	12	65	8	35	3	8	100	140

Table 4 shows our final adjusted 1 December forecast for the 2003 season which is a combination of our derived full 52-year statistical forecast and our five analog year forecast. We foresee an active 2003 hurricane season.

Table 4: Summary of our new 1 December statistical forecast, our analog forecast, and our adjusted final forecast for this year.

Forecast Parameter and 1950-2000 Climatology (in parentheses)	New Statistical Scheme	Analog Scheme	Adjusted Final Forecast
Named Storms (9.6)	12.3	10.2	12
Named Storm Days (49.1)	61.3	48.2	65
Hurricanes (5.9)	8.1	5.8	8
Hurricane Days (24.5)	33.3	24.2	35

Intense Hurricanes (2.3)	3.2	3.0	3
Intense Hurricane Days (5.1)	7.2	4.8	8
Hurricane Destruction Potential (72.7)	97.8	72.6	100
Net Tropical Cyclone Activity (100%)	132.4	104.4	140

4 Discussion

Our analysis of the current and projected global atmospheric and oceanic circulation patterns indicates that Atlantic tropical cyclone activity should be above average during the 2003 Atlantic basin hurricane season. We anticipate a termination of the current moderate-intensity El Niño conditions and a continuation of warm sea surface temperatures in the North and tropical Atlantic as has occurred in most years since 1995. High pressure has been developing in the northern tropical Pacific indicative that stronger trade winds are reestablishing themselves. Stronger trades increase upwelling in the eastern Pacific and usually signal the end of warm ENSO conditions.

Sea surface temperatures throughout the Atlantic basin cooled considerably this past spring and summer but have warmed again this fall. The cooling of the Atlantic this past year was attributed to a stronger Arctic Oscillation (AO) and North Atlantic Oscillation (NAO). This increased the strength of the zonal winds throughout the north Atlantic, enhanced evaporation, and subsequently cooled sea surface temperatures in the Atlantic. We hypothesize that this January to July 2002 cooling was likely associated with a 6-8 month weakening of the Atlantic thermohaline circulation (ATC). See our 21 November 2002 summary and verification of our 2002 hurricane forecast for more discussion of the 2002 season. A strong AO and NAO are also associated with a strong ridge in the subtropical Atlantic which strengthens trade winds and cools sea surface temperatures in the tropical Atlantic. Current values of the AO and NAO are trending negative, and therefore we are not anticipating an Atlantic cooling event similar to what happened last year.

5 Landfall Probabilities for 2003

A significant focus of our recent research involves efforts to develop forecasts of the probability of hurricane landfall along the U.S. coastline. Whereas individual hurricane landfall events cannot be accurately forecast months in advance, the total seasonal probability of landfall can be forecast with statistical skill. With the observation that, statistically, landfall is a function of varying climate conditions, a probability specification has been developed through statistical analyses of all U.S. hurricane and named storm landfall events during the last 100 years (1900-1999). Specific landfall probabilities can be given for all cyclone intensity classes for a set of distinct U.S. coastal regions.

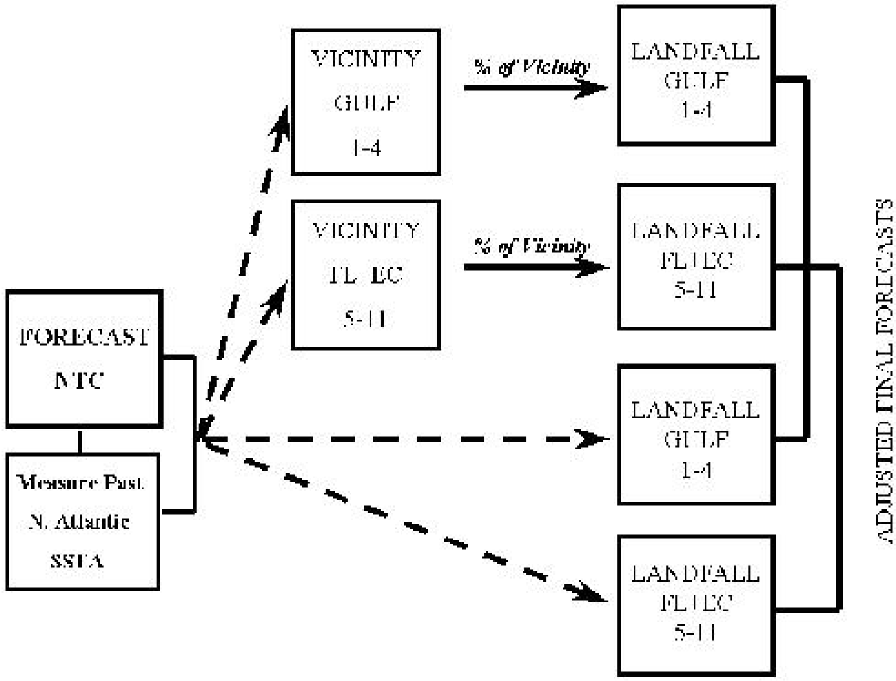

Figure 2: Flow diagram illustrating how forecasts of U.S. hurricane landfall probabilities are made. Forecast NTC values and an observed measure of recent North Atlantic (50-60°N, 10-50°W) SSTA* are used to develop regression equations from U.S. hurricane landfall measurements of the last 100 years. Separate equations are derived for the Gulf and for Florida and the East Coast (FL+EC).

Figure 2 provides a flow diagram showing how these forecasts are made. Net landfall probability is shown linked to the overall Atlantic basin Net Tropical Cyclone activity (NTC; see Table 5) and to climate trends linked to multi-decadal variations of the Atlantic Ocean thermohaline circulation as inferred from recent past years of North Atlantic SSTA*.

Higher values of SSTA* generally indicate greater Atlantic hurricane activity, especially for intense or major hurricanes. Atlantic basin NTC can be skillfully hindcast, and the strength of the Atlantic Ocean thermohaline circulation can be inferred as SSTA* from North Atlantic SST anomalies in the current and prior years. These relationships are then utilized to make probability estimates for U.S. landfall. The current (November 2002) value of SSTA* is 30. Hence, in combination with a prediction of NTC of 140 for 2003, a combination of NTC + SSTA* of (140 + 30) yields a value of 170.

As shown in Table 5, NTC is a combined measure of the year-to-year mean of six indices of hurricane activity, each expressed as a percentage difference from the long-term average. Whereas many active Atlantic hurricane seasons feature no landfalling hurricanes, some inactive years have experienced one or more landfalling hurricanes. Long-term statistics show that, on average, the more active the overall Atlantic basin hurricane season is, the greater the probability of U.S. hurricane landfall. For example, landfall observations during the last 100 years show that a greater number of intense (Saffir-Simpson category 3-4-5) hurricanes strike the Florida and U.S. East Coast during years of (1) increased NTC and (2) above-average North Atlantic SSTA* conditions.

Table 5: NTC activity in any year consists of the seasonal total of the following six parameters expressed in terms of their long-term averages. A season with 10 NS, 50 NSD, 6 H, 25 HD, 3 IH, and 5 IHD, would then be

the sum of the following ratios: 10/9.6 = 104, 50/49.1 = 102, 6/5.9 = 102, 25/24.5 = 102, 3/2.3 = 130, 5/5.0 = 100, divided by six, yielding an NTC of 107.

	1950-2000 Average	
1)	**Named Storms (NS)**	9.6
2)	**Named Storm Days (NSD)**	49.1
3)	**Hurricanes (H)**	5.9
4)	**Hurricane Days (HD)**	24.5
5)	**Intense Hurricanes (IH)**	2.3
6)	**Intense Hurricane Days (IHD)**	5.0

Table 6 lists strike probabilities for different TC categories for the entire U.S. coastline, the Gulf Coast and Florida, and the East Coast for 2003. The mean annual probability of one or more landfalling systems is given in parentheses. Note that Atlantic basin NTC activity in 2003 is expected to be greater than the long-term average (140), and North Atlantic SSTA* values are measured to be above average (30 units). U.S. hurricane landfall probability is thus expected to be above average owing to both a higher NTC and above-average North Atlantic SSTAs. During periods of positive North Atlantic SSTA, a higher percentage of Atlantic basin major hurricanes cross the Florida and eastern U.S. coastline for a given level of NTC.

Table 6: Estimated probability (expressed in percent) of one or more U.S. landfalling tropical storms (TS), category 1-2 hurricanes (HUR), category 3-4-5 hurricanes, total hurricanes and named storms along the entire U.S. coastline, along the Gulf Coast (region 1-4), and along the Florida and the East coastline (Regions 5-11) for 2003. The long-term mean annual probability of one or more landfalling systems during the last 100 years is given in parentheses.

Coastal Region	**TS**	**Category 1-2 HUR**	**Category 3-4-5 HUR**	**All HUR**	**Named Storms**
Entire U.S. (Regions 1-11)	85% (80)	79% (68)	68% (52)	93% (84)	99% (97)
Gulf Coast (Regions 1-4)	66% (59)	51% (42)	38% (30)	70% (61)	90% (83)
Florida plus East Coast (5-11)	56% (51)	56% (45)	48% (31)	77% (62)	90% (81)

6 The 1995-2002 Upswing in Atlantic Hurricanes and Global Warming

Various groups and individuals have suggested that the recent large upswing in Atlantic hurricane activity (since 1995) may be in some way related to the effects of increased man-made greenhouse gases such as carbon dioxide (CO_2). There is no reasonable scientific way that such an interpretation of this recent upward shift in Atlantic hurricane activity can be made. Please see our recent 21 November 2002 verification report for more discussion on this subject.

[http://tropical.atmos.colostate.edu/forecasts/index.html]

7 Forecast Theory and Cautionary Note

Our forecasts are based on the premise that those global oceanic and atmospheric conditions which precede comparatively active or inactive hurricane seasons in the past provide meaningful information about similar trends in future seasons. It is important that the reader appreciate that these seasonal forecasts are based on statistical schemes which, owing to their intrinsically probabilistic nature, will fail in some years. Moreover, these forecasts do not specifically predict where within the Atlantic basin these storms will strike. The probability of landfall for any one location along the coast is very low and reflects the fact that, in any one season, most US coastal areas will not feel the effects of a hurricane no matter how active the individual season is. However, it must also be emphasized that a low landfall probability does not insure that hurricanes will not come ashore. Regardless of how active the 2003 hurricane season is, a finite probability always exists that one or more hurricanes may strike along the US coastline or the Caribbean Basin and do much damage.

8 Forthcoming Update Forecasts of 2003 Hurricane Activity

We will be issuing seasonal updates of our 2003 Atlantic basin hurricane activity forecast on Friday 4 April, Friday 30 May (to coincide with the official start of the 2003 hurricane season on 1 June), Thursday 7 August and Wednesday 3 September 2003. The 7 August forecast will include separate forecasts for 2003 August-only and September-only activity and probabilities of U.S. landfall during these individual months. The 3 September update will include a separate updated forecast for 2003 September-only activity and an outlook for the October-November period. All these forecasts will be available at our web address given on the front cover (http://tropical.atmos.colostate.edu/forecasts/index.html).

9 Acknowledgments

Eric Blake and John Knaff have made many important contributions to the conceptual and scientific background for these forecasts. The authors are indebted to a number of meteorological experts who have furnished us with the data necessary to make this forecast or who have given us valuable assessments of the current state of global atmospheric and oceanic conditions. We are particularly grateful to Arthur Douglas, Richard Larsen, Ray Zehr and Mark DeMaria for very valuable climate discussions and input data. We thank Colin McAdie and Jiann-Gwo Jiing for furnishing us with data. In addition, Barbara Brumit and Amie Hedstrom have provided excellent manuscript, graphical, and data analysis assistance. We have profited over the years from many indepth discussions with most of the current NHC hurricane forecasters. These include Lixion Avila, Miles Lawrence, Richard Pasch, Jack Beven, James Franklin and Stacy Stewart. The first author would further like to acknowledge the encouragement he has received for this type of forecasting research application from Neil Frank, Robert Sheets, Robert Burpee, Jerry Jarrell, former directors of the National Hurricane Center (NHC), and from the current director, Max Mayfield. We also thank Bill Bailey of the Insurance Information Institute for his sage advice and encouragement.

The financial backing for the issuing and verification of these forecasts has in part been supported by the National Science Foundation, but this NSF support is insufficient. We are very grateful to the Research Foundation of the United Services Automobile Association (USAA) and to the Lexington Insurance Company (a memeber of the American International Group) for providing support to the first author's research project. It is this support which is allowing our seasonal predictions to continue and expand.

10 Citations and Additional Reading

11 Verification of Previous Forecasts

Table 7: Summary verifications of the authors' four previous years of seasonal forecasts of Atlantic TC activity between 1999-2002.

1999	5 Dec 1998	Update 7 April	Update 4 June	Update 6 August	Obs.
No. of Hurricanes	9	9	9	9	8
No. of Named Storms	14	14	14	14	12
No. of Hurricane Days	40	40	40	40	43
No. of Named Storm Days	65	65	75	75	77
Hurr. Destruction Potential(HDP)	130	130	130	130	145
Major Hurricanes (Cat. 3-4-5)	4	4	4	4	5
Major Hurr. Days	10	10	10	10	15
Net Trop. Cyclone (NTC) Activity	160	160	160	160	193

2000	8 Dec 1999	Update 7 April	Update 7 June	Update 4 August	Obs.
No. of Hurricanes	7	7	8	7	8
No. of Named Storms	11	11	12	11	14
No. of Hurricane Days	25	25	35	30	32
No. of Named Storm Days	55	55	65	55	66
Hurr. Destruction Potential(HDP)	85	85	100	90	85
Major Hurricanes (Cat. 3-4-5)	3	3	4	3	3
Major Hurr. Days	6	6	8	6	5.25
Net Trop. Cyclone (NTC) Activity	125	125	160	130	134

2001	7 Dec 2000	Update 6 April	Update 7 June	Update 7 August	Obs.
No. of Hurricanes	5	6	7	7	9
No. of Named Storms	9	10	12	12	15
No. of Hurricane Days	20	25	30	30	27
No. of Named Storm Days	45	50	60	60	63
Hurr. Destruction Potential(HDP)	65	65	75	75	71
Major Hurricanes (Cat. 3-4-5)	2	2	3	3	4
Major Hurr. Days	4	4	5	5	5
Net Trop. Cyclone (NTC) Activity	90	100	120	120	142

2002	7 Dec 2001	Update 5 April	Update 31 May	Update 7 August	Update 2 Sept	Obs.
No. of Hurricanes	8	7	6	4	3	4
No. of Named Storms	13	12	11	9	8	12
No. of Hurricane Days	35	30	25	12	10	11
No. of Named Storm Days	70	65	55	35	25	54
Hurr. Destruction Potential(HDP)	90	85	75	35	25	31
Major Hurricanes (Cat. 3-4-5)	4	3	2	1	1	2
Major Hurr. Days	7	6	5	2	2	2.5
Net Trop. Cyclone (NTC) Activity	140	125	100	60	45	80

Footnotes:

[1]Professor of Atmospheric Science

[2]Research Associate

[3]Dr. Landsea, a former project member, is an employee of the NOAA Atlantic Oceanographic and Meteorological Laboratory. As part of his research to improve NOAA's climate forecasting ability, he collaborates with researchers at Colorado State University on our CSU seasonal hurricane forecasts (see page 3). The CSU hurricane forecast is independent of the NOAA forecast and should not be construed as an official NOAA forecast.

[4]Research Associate

[5]Research Associate

File translated from TEX by TTH, version 3.12.
On 5 Dec 2002, 17:17.