11C.1 UPDATED 6-11 MONTH PREDICTION OF ATLANTIC BASIN SEASONAL HURRICANE ACTIVITY

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1. INTRODUCTION

Skillful extended-range seasonal forecasts can be issued on 1 December of the prior year for Atlantic basin seasonal hurricane activity. Gray et al. (1992) found that 1 December cross-validated hindcast skill explaining approximately 50 percent of the variance in Atlantic basin seasonal hurricane activity could be obtained based on the hindcast period of 1950-1990. This original 1 December forecast scheme utilized predictors involving West African rainfall and the QBO (Quasi-Biennial Oscillation). Although this statistical scheme showed promising hindcast skill explaining up to about 50 percent of the variance, it has explained only 3-5 percent of the variance for tropical cyclone measures such as hurricane days or Hurricane Destruction Potential (HDP) in real-time forecasts since 1992. This is due in large part to the unexplained failure of the West African rainfall predictors. We have recently used the new NCEP/NCAR reanalysis dataset (Kalnay et al. 1996) for the period 1950-2001 to further research this 1 December extended range forecast.

2. METHODOLOGY

The predictor selection process began by examining what the September-November period looked like in the year prior to an active or an inactive year. Years were classified as being active or inactive based upon the Net Tropical Cyclone (NTC) activity parameter (Gray et al. 1994) which is an aggregate measure of the tropical cyclone activity for a particular year. Linear correlation maps between global reanalysis data fields such as sea level pressure and 200 mb zonal wind and tropical cyclone activity time series were constructed to see which areas provided the most useful hindcast signals in forecasting seasonal tropical cyclone activity. After thorough analyses of these correlation maps, we selected several large-scale areas that seem to possess meaningful precursor signals for the upcoming hurricane season.

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3. RESULTS

We have been able to hindcast up to approximately 50 percent of the cross-validated variance explained for seasonal hurricane activity by 1 December of the previous year based on the hindcast period of 1950-2001. Figure 1 displays the locations of the predictors utilized to forecast seasonal activity, and Table 1 describes these predictor locations. Most of these predictors are related to either the North Atlantic Oscillation (NAO) or a slightly eastward-shifted Pacific North American Pattern (PNA). A negative NAO implies weaker winds across the Atlantic which reduces evaporation and upwelling and keeps the Atlantic warmer during the following summer. A positive PNA is frequently associated with a warm ENSO event (Horel and Wallace 1981), and since a wave train propagates poleward and eastward from an area of thermal forcing (Hoskins and Karoly 1981), the eastward shift of the PNA implies that warm anomalies are concentrated in the eastern Pacific. These types of El Niño events shift to neutral or cool La Niña conditions during the following summer more frequently then events where warm anomalies are concentrated in the central Pacific. Our other predictor is a measure of the QBO which has been shown in previous work to be related to tropical cyclone activity (Gray et al. 1984). Table 2 displays the cross-validated variance explained for eight measures of seasonal Atlantic basin tropical cyclone activity. A plot of cross-validated hindcast NTC activity versus observed NTC from 1950-2001 is shown in Figure 2. We are able to show significant skill in hindcasting utilizing these new December predictors.

Table 1: Predictors used in the early December forecast. The sign of the predictor associated with increased tropical cyclone activity the next year is in parentheses.

Predictor Name	Location
1) Nov. 500 MB Geo Ht. (+)	(67.5-85°N, 10°E-50°W)
2) Oct.-Nov. SLP (-)	(45-65°N, 120-160°W)
3) Sep. 500 MB Geo Ht. (+)	(35-55°N, 100-120°W)
4) Jul. 50 MB U (-)	(5°S-5°N, 0-360°)
5) Sep.-Nov. SLP (-)	(15-35°N, 75-95°W)
6) Nov. SLP (+)	(7.5-22.5°N, 125-175°W)

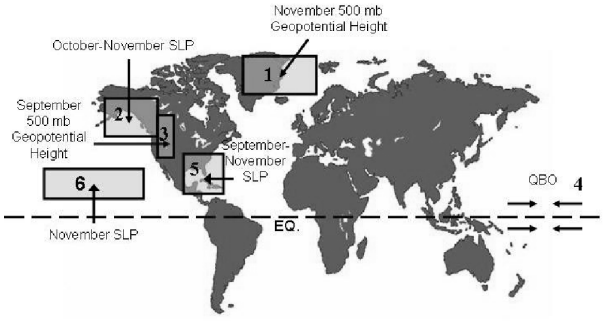

Figure 1: Map of predictors used in the early December statistical forecast.

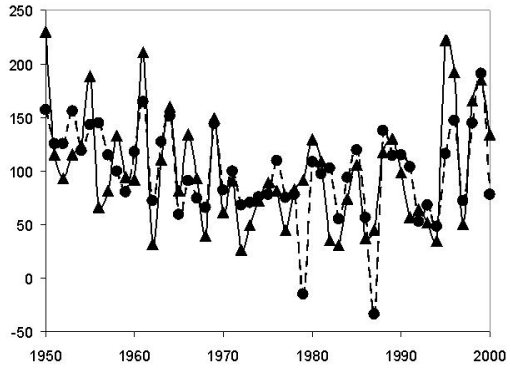

Figure 2: Actual Net Tropical Cyclone activity (solid line) versus early December cross-validated hindcast (dashed line). Cross-validated variance explained is 46 percent.

4. CONCLUSION

Significant hindcasting ability exists for the following year's Atlantic basin tropical cyclone activity as early as 1 December of the previous year. The predictors utilized to forecast seasonal activity are global in nature and are related to the NAO, the PNA and the QBO. This new statistical scheme has been utilized to issue real-time forecasts for the past two seasons with considerable success. Our statistical forecasts issued in early April, late May and early August are also being revised utilizing a methodology similar to that which was outlined in this paper.

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REFERENCES

Horel, J. D., and J. M. Wallace, 1981: Planetary-scale atmospheric phenomena associated with the Southern Oscillation. *Mon. Wea. Rev.*, **109**, 813-829.

Hoskins, B. J., and D. J. Karoly, 1981: The steady linear response of a spherical atmosphere to thermal and orographic forcing. *J. Atmos. Sci.*, **38**, 1179-1196.

Gray, W. M., 1984: Atlantic seasonal hurricane frequency. Part II: Forecasting its variability. *Mon. Wea. Rev.*, **112**, 1669-1683.

—, C. W. Landsea, P. W. Mielke, and K. J. Berry, 1992: Predicting Atlantic seasonal hurricane activity 6-11 months in advance. *Wea. Forecasting*, **7**, 440-455.

—, —, P. W. Mielke, Jr., and K. J. Berry, 1994: Predicting Atlantic basin seasonal tropical cyclone activity by 1 June. *Wea. Forecasting*, **9**, 103-115.

Kalnay, E., and Coauthors, 1996: The NCEP/NCAR Reanalysis 40-year project. *Bull. Amer. Meteor. Soc.*, **77**, 437-471.

Table 2: Predictors chosen, hindcast variance explained and jackknife variance explained for each TC activity parameter in the early December forecast of the following year's tropical cyclone activity.

Forecast Parameter	No. of Predictors	Hindcast R^2 (1950-2001)	Jackknife R^2 (1950-2001)
NS	3	0.40	0.29
NSD	5	0.45	0.28
H	5	0.53	0.38
HD	5	0.53	0.35
IH	5	0.69	0.57
IHD	5	0.51	0.41
HDP	5	0.57	0.37
NTC	5	0.62	0.46