US Cooling Degree Day (CDD) Forecasts for Summer 2000

Issued 14th March, 2000

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Forecast Summary

New York and Philadelphia Cooling Degree Days are expected to be 10-15% above average during July-August 2000

We present an extended range forecast for the Summer 2000 Cooling Degree Days (CDDs) expected at four US weather stations. These are located in two cities, both of which are included in the Chicago Mercantile Exchange's new CDD weather futures market. Our forecasts span the main US CDD degree season from 1st July to 31st August. They are based on information available through the end of January 2000. Predictions are given for total CDD numbers and for probability of exceedance. Rigorous hindcast testing shows that these forecasts have a skill better than climatology of ~ 40 CDDs per year. Our model is based on new statistical techniques and teleconnections, developed in-house, which have not yet appeared in the scientific literature.

1. CDD Forecasts (65°F base) for July-August 2000

		New York Central Park (WBAN 94728)	New York Laguardia (WBAN 14732)	New York JFK Airport (WBAN 94739)	Philadelphia Intl. Airport (WBAN 13739)
Forecast (±SD)	2000	782 (±82)	838 (±65)	717 (±85)	874(±94)
Actual	1999	838	881	733	884
Average (±SD)	1976-1999	713 (±110)	724 (±99)	636 (±94)	752(±111)

2. CDD Model Hindcast Skill for July-August 1990-1999

Our model achieves the following mean annual improvements over climatology in predicting July and August CDDs, at a lead of 4.5 months, over the last 10 years:

	New York	New York	New York	Philadelphia
	Central Park	Laguardia	JFK Airport	Intl. Airport
	(WBAN 94728)	(WBAN 14732)	(WBAN 94739)	(WBAN 13739)
Mean Annual Improvement Over Climatology (CDDs)	39	48	39	36



New York Central Park (WBAN 94728)

Probability of Exceedance Forecast for Jul-Aug 2000 CDDs



Model Hindcast Performance for Jul-Aug 1990-1999 CDDs

How would the model have done had it been available in previous years? Each hindcast is based on climate data available only through the end of the January prior to the summer being predicted. The hindcasts are thus robust and provide the skill level of the CDD forecast at a lead of 4.5 months.



New York Laguardia (WBAN 14732)

Probability of Exceedance Forecast for Jul-Aug 2000 CDDs



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New York JFK Airport (WBAN 94789) **Probability of Exceedance Forecast for Jul-Aug 2000 CDDs** 1 Probability of Exceedance Forecast Probabilities 0.9 Average Probabilities 0.8 (1976 - 1999)0.7 0.6 0.5 0.4 0.3 0.2 0.1 0 600 750 1050 300 450 900 1200 Cooling Degree Days

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Philadelphia (WBAN 13739)

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Methodology

The forecast model builds on our experience in forecasting seasonal Atlantic hurricane, NW Pacific typhoon, and UK winter gale activity. It is statistical, using January lagged sea surface temperature predictors, and includes innovative features for testing model stability. A fundamental principle underlying our approach is to forecast probability distributions for CDD occurrence. In this way, imperfection in the forecast is recognised while still providing quantitative information. Forecast errors are given as the standard deviation of the hindcast errors for 1990-1999.

A Gaussian distribution is used to model the CDD random variability. Lagged correlation predictors are identified using stringent random, field significance, and model stability tests. Three predictors are used in the CDD forecasts. In selecting predictors we applied the Chow parameter stability test, as used in economics, to ensure persistence and stability. This involves running the same regression over subsections of the data to test the hypothesis that the regression parameters obtained for the subsets are not significantly different from those found for the whole regression, against the alternative that one or more are different. This hypothesis must be satisfield at the 95% level for a predictor to prove stable and acceptable.

The CDD forecast skill is assessed by rigorous hindcast testing over the period 1990-1999. We use only prior years in identifying the predictors and in calculating the regression relationship for each future year to be forecast - ie the hindcasts are performed in strict 'forecast' mode. Thus 1990 is forecast using 1976-1989 data, 1991 using 1976-1990 data, etc. We do not employ the jack-knife method of cross-validation which inflates skill, nor do we identify predictors using the whole data set which again inflates skill. The hindcast values are compared (pages 2 to 5) against verification, and the model skill is quantified using the following standard measures:

- MAE (<u>Mean Absolute Error</u>) defined as the mean absolute difference between the predicted and actual values. The lower this value, the more skilful the model.
- PAC (<u>Percentage Agreement Coefficient</u>) defined as the mean absolute difference between the predicted and actual values relative to the level expected under the model. A PAC of 100% indicates perfect skill, a PAC value of 0% indicates no forecast skill.
- PVE (Percentage of Variance Explained) defined as the percent of the actual variance explained by the forecast. A PVE of 100% indicates perfect skill, a PVE of 0% indicates no skill.

The initial model training period and the CDD 'average' values are both based on data back to 1976. Earlier CDD data are not included as our tests indicate they are problematic. In particular, correlating the CDD values with contemporaneous NCEP/NCAR gridded temperatures gives significantly lower values prior to 1976 than after.

We believe that the CDD forecast skill will be further improved by the use of forecast SSTs. Our next CDD forecasts will benefit from new long-range statistical SST forecast models currently under development in-house.

Verification and Future US Forecasts

A verification of our US CDD 2000 seasonal forecasts will be available in September 2000.

Extended range forecasts for the US Winter 2000/01 Heating Degree Days (HDDs) for cities on the Chicago Mercantile Exchange's Weather Futures Listing will be announced in early October 2000.

Our pre-season forecast for Atlantic seasonal hurricane activity and US hurricane strike probability in 2000 will be issued at the end of May 2000.