JP1.3 Evaluation of Seasonal Climate Outlooks for the United States

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1 INTRODUCTION

Decision-making processes influenced by climate variation can potentially be improved by incorporating the information contained in the long-lead seasonal climate outlooks issued by the Climate Prediction Center (CPC). However, these seasonal climate outlooks must be assessed to determine their validity on both a temporal and spatial scale. The objectives of this study are to evaluate the accuracy of CPC's seasonal climate outlooks for temperature and precipitation and to assess the percent confidence to place in the outlooks based on: location within the United States; three-month season under consideration; lead time; the CPC-assigned probability anomaly; and for above-normal, near-normal, or below-normal predictions.

2 DATA AND METHODOLOGY

Observed temperature data; tercile thresholds for above-normal, near-normal, and below-normal temperature; and all seasonal climate outlooks were courtesy of CPC. A logistic regression was used to evaluate CPC's climate outlooks from JFM (January, February, March) 1995 through OND (October, November, December) 2000. CPC consolidates the 344 climate divisions in the contiguous U.S. into 102 aggregated divisions. Spatially, these aggregated divisions are of roughly equal size (Tinker, 1999; Unger, 1999).

The climate outlooks are published online via the Web during the middle of each month for the 13 subsequent running 3-month seasons. Lead times range from 0.5 months to 12.5 months (Briggs and Wilks, 1996). For example, an outlook produced in mid-January will give a 0.5 month lead time for February, March, and April (FMA), an outlook with a 1.5 month lead time for March, April, and May (MAM), and so on. Thus the outlooks produced in mid-January will extend out to the February, March, and April (FMA) season of the following year for a lead time of 12.5 months. Climate outlooks are divided into three categories: above-normal, near-normal, and below-normal. Each category has an equal probability of occurring (33.3%) based on the 30-year climate normals (1961-1990). When CPC assigns a probability anomaly, the near-normal category usually stays in the 33.3% range while the above- and below-normal categories rise and fall inversely (CPC, 1995). In other words, if the probability of the above-normal category increases to 43.3%, then the below-normal category decreases to 23.3% and the near-normal category remains at 33.3%. The probability anomaly in this case would be a 10% likelihood of above-normal temperature. However, if the CPC feels strongly that an area will be normal, it can assign a higher probability to the normal category at the expense of the above-normal and below-normal categories. When the models used by CPC cannot produce satisfactory skill for an outlook, or when the models are in disagreement, outlook divisions are assigned an equal probability (33.3% above-normal, 33.3% near-normal, and 33.3% below-normal) and are then designated as "Climatology" (CL) (Briggs and Wilks, 1996).

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A logistic regression was performed because it keeps the estimated probabilities of a dependent variable between zero and one (Kleinbaum, 1994). Therefore, because the dependent variable in this study (the seasonal climate outlook) is discrete (either 0 for an incorrect outlook or 1 for a correct outlook) a logistic regression was used to test the hypothesis that correct predictions do not depend on lead time, year, outlook division, or season. The logistic regression was conducted on all outlooks regardless of their probability anomaly. Logistic regression was used to find the probability of a correct outlook (PCO) using variable (temperature/precipitation), lead time, season, outlook division, and the CPC-assigned probability anomaly as input. Results were returned as a PCO and the 95% confidence interval.

It must be noted that the results described next are for the averages that encompass all values within a year, an outlook division, a season, or a lead time, and may obscure the affect of other factors that are acting on the outlooks. The averages must be viewed as trends and not absolutes.

3 TEMPERATURE RESULTS

A logistic regression conducted on temperature outlooks for 1995-2000 showed that outlook division was the most important determinant for a correct outlook. Division had the highest chi-square value, followed by season, prediction (above-normal, near-normal, or below-normal), year, probability anomaly, and lead time.

When temperature outlooks for all 5 years (1995-2000), all lead times (0.5-12.5 months), and all seasons are considered, the average PCO was 59.1% for above-normal outlooks, 29.2% for near-normal outlooks, and 24.5% for below-normal outlooks. For temperature outlooks, there was more than a 30% difference in average PCOs between an above-normal outlook and a below-normal outlook. While the average PCO for temperature outlooks as a function of year increased from 1995 (41.4%) to 1997 (51.8%), decreased to 41.4% in 1999, and increased to 63.6% in 2000, the analysis showed that correct temperature outlooks did not depend heavily on year. This may be an indication that temperature is not significantly dependent on ENSO events while CPC's models depend heavily on ENSO teleconnections. Although temperature outlooks are highly dependent on season and any ENSO teleconnection may be hidden in the seasonal signal, year significance is low enough that this does not seem to be the case.

Outlook divisions were the major determinants for correct temperature outlooks. Two outlook divisions had average PCOs over 75%, sixteen outlook divisions had average PCOs over 60%, and thirty outlook divisions had average PCOs over 50%. Average PCOs for outlook divisions were greatest for Utah and in the southern regions of Texas, New Mexico, Arizona, California, and Florida. Lower average PCOs occurred in parts of North Dakota, South Dakota, Montana, Colorado, and the states of Wyoming and Maine.

Following a plateau during winter (NDJ, DJF, JFM, FMA) of average PCOs greater than 50%, the rest of the year saw average PCOs of under 50% with a low of 35.4% in AMJ. The anomalously low value for the AMJ season may be due to the transitional nature of late spring/early summer season.

Average PCOs based on lead times were constant, exhibiting neither steadily increasing nor steadily decreasing average PCOs as the target season neared. This is contrary to what might be expected, as the average PCOs would logically increase as the target season draws nearer since more information is available to the model. Lead time was the least significant factor in the logistic model for contributing to correct outlooks. The average PCO for a 0.5 month lead time was 51.9 %.

For all temperature outlooks, average PCOs for above-normal outlooks were significantly higher than below-normal or near-normal PCOs and more outlooks were made for above-normal temperatures than for below- or near-normal temperature outlooks combined. Overall the average PCO for temperature outlooks was 50.1%.

4 PRECIPITATION RESULTS

The logistic regression conducted on precipitation outlooks for 1995-2000 showed that outlook divisions was the most important determinant for a correct outlook, followed by year, prediction, season, lead time and probability anomaly.

Precipitation outlooks for all 5 years, at all lead times, and for all seasons revealed that the average PCO was 42% for above-normal outlooks, 24.7% for near-normal outlooks, and 31.5% for below-normal outlooks. For precipitation prediction, there was less than an 11% difference in average PCOs between an above-normal outlook and a below-normal outlook.

The average PCO for precipitation outlooks as a function of year showed that average PCOs peaked in 1997 (53.8%) and had shifted up again in 2000 (39.7%). Correct precipitation outlooks did depend heavily on year possibly indicating the dependence of precipitation outlooks on ENSO events.

Outlook divisions were the major determinants for correct precipitation outlooks. One outlook division had average PCOs over 75%, five outlook divisions had average PCOs over 60%, and nine outlook divisions had average PCOs over 50%. In general, average PCOs for outlook divisions were greatest in the areas around the Gulf of Mexico and the southwest corner of California. The lowest average PCOs occurred along coastal Maine, some areas surrounding Lake Michigan and Lake Superior, and northwest Wyoming.

The average PCOs as a function of season was highly erratic. Peaks occurred in JFM (43.1%), MJJ (45.1%), and DJF (45.1%) and the lowest average PCO took place in MAM (18%).

Average PCOs as a function of lead time slightly increased as the shortest lead time approach. However, the increase was so small as to be negligible. The average PCO for a 0.5 month lead time was 38.6 %.

Unlike temperature outlooks, average PCOs for precipitation outlooks showed little distinction between above-normal outlooks and below-normal outlooks even though more outlooks were made for above-normal precipitation outlooks than for below- or near-normal outlooks combined. The overall average PCO for precipitation outlooks was 37.6%.

5 SUMMARY AND CONCLUSIONS

This study used a logistic regression analysis to assess the spatial and temporal accuracy of CPC's long-lead seasonal climate outlooks at each of the 13 lead times for the United States. The analyses established that temperature outlooks are statistically better than precipitation outlooks and could be used as a tool in the decision-making process. Precipitation prediction is statistically poor and less frequently predicted (out of a possible 84,864 outlooks, CPC issued 38,265 non-"CL" temperature outlooks and 19,333 non-"CL" precipitation outlooks). Future studies should be undertaken to calculate the economic and social risks and benefits of these outlooks.

6 REFERENCES

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