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# AUTOMATED PREDICTION OF THE PROBABILITY OF PRECIPITATION (PoP) FOR ALASKA--FALL SEASON

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Automated Prediction of Probability of Precipitation (PoP) in Alaska--Fall Season

by

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## 1. INTRODUCTION

As part of TDL's effort to develop an automated guidance forecast package for the Alaskan Region of the National Weather Service, we have derived a set of probability of precipitation (PoP) equations for the fall season of September, October, November. These equations based on Model Output Statistics (MOS), are quite similar to the ones for the summer season (June, July, and August) described by Gilhousen (1977).

## 2. DEVELOPMENT OF PREDICTION EQUATIONS

Using the MOS approach (Glahn and Lowry, 1972), we generated one set of prediction equations for the 0000 GMT runs and another for the 1200 GMT runs of the Primitive Equation (PE) model (Shuman and Hovermale, 1968). Each set includes equations to predict the occurrence of measurable precipitation (.01 in. or greater) for the 6-h periods ending at 18, 24, 30, and 36 hours and 12-h periods ending at 24, 36, 48, and 60 hours after model run time. Separate equations were developed for each of the 14 stations shown in Table 1.

The forecasts were produced through the use of multivariate logit model (Brelsford and Jones, 1967). Our logit program doesn't have a screening option; up to 10 independent variables can be included in the program, but they must be selected subjectively. Therefore, we gave our logit program the first 10 predictors selected by our screening regression program. We realize that these 10 predictors may not be the best 10 for the logit model.

Table 1. Fourteen stations used to develop an automated surface wind forecasting system for Alaska.

| | |
|---|---|
| Anchorage | Juneau |
| Annette | King Salmon |
| Barrow | Kotzebue |
| Barter Island | McGrath |
| Bethel | Nome |
| Cold Bay | St. Paul Island |
| Fairbanks | Yakutat |

## 3. PREDICTORS

Table 2 shows the potential predictors we screened. In addition to the PE model output, we screened surface observations (available 6 hours after the PE model run time) at the forecast site for all projections of 24 hours or less. Backup equations which don't use surface observations were also derived for these projections. The only new predictors we screened were the observed U and V wind components.

Table 3 is a summary of the predictors selected most frequently by the screening process for both the fall and summer season equations. The forecast periods are the 12-24 h first period and the 24-36 h second period. Various humidity forecasts, precipitation amount forecasts, and wind component forecasts are still the key predictors for fall. However, note that the fall equations have more predictors at the 850-mb level than at the 500-mb level. This makes sense because most fall precipitation falls from lower stratification clouds that are produced by low-level advection and lifting processes. Also, a more stable atmosphere has less coupling of systems with height.

The developmental data sample for most of our equations consisted of the periods September through November of 1970 through 1976. However, for the 0000 GMT model run, we developed 12-h PoP forecasts for the 36-48 h third period and the 48-60 h fourth period using only fall 1972 through 1976 data. This enabled us to screen PE fields beyond 48 hours, plus those fields marked by an asterisk in Table 2. Due to model slowness, 48-60 h precipitation occurrence is better correlated with 60- and 72-h forecast fields than with 48-h fields. The 1200 GMT PE model produced forecasts only out to 48 hours. Therefore, third and fourth period forecasts from the 0000 GMT model run should be better than those from the 1200 GMT run.

## 4. FORECASTS ON DEPENDENT DATA

Table 4 shows the Brier scores[1], the relative frequency of precipitation, and the range of the forecasts on the dependent data for 1200 GMT first period forecasts. The range shows the highest and lowest PoP forecasts that the MOS equations gave in the dependent sample. The wider the range of the forecasts, the better the quality and utility of the product. Notice that at all but four stations, the full range of forecast values from 0 to 100% were produced for first period forecasts. The differences in Brier score between summer and fall season varies considerably by station. The Brier scores were generally higher for the fall season for Northwest, North Slope, and Aleutian stations. This means that our logit model explained less of the variance in measurable precipitation. The Brier scores were generally lower for the fall season for Interior and Panhandle stations. These differences in Brier score don't appear to be related to changes in the relative frequency of precipitation.

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[1] The Brier score is defined to be one-half the score proposed by Brier (1950).

## 5. FUTURE WORK

We will continue to use this same approach to develop Alaskan PoP prediction equations for the winter and spring seasons. However, we may be forced to group data from several stations together because of the low wintertime frequency of precipitation in northern Alaska.

## REFERENCES

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Glahn, H. R., and D. A. Lowry, 1972: The use of model output statistics (MOS) in objective weather forecasting. J. Appl. Meteor., 11, 1203-1211.

Shuman, F. G., and J. B. Hovermale, 1968: An operational six-layer primitive equation model. J. Appl. Meteor., 7, 525-547.

Table 2. Potential predictors available to the screening regression program for the fall season. Certain predictors have been space smoothed by 5, 9, or 25 points to eliminate small scale noise. Predictors at 60 and 72 hours are available for the 0000 GMT run only. An asterisk indicates that the field is only available starting October 1, 1972 (see text for details).

| Field | Smoothing[1] (Points) | Time (Hours from model run time) | Form[2] |
|---|---|---|---|
| (a) PE Model Output | | | |
| Mean Rel. Humidity | 1,5,9,25 | 12,18,24,30,36,42,48,60,72 | B,C |
| Boundary Layer Humidity | 1,5,9,25 | 12,24,36,48,60,72 | B,C |
| Precipitation Amount | 1,5,9 | 12,24,36,48,60,72 | B |
| 850-mb Height | 5,9 | 12,24,36,48,60,72 | B |
| 850-mb Temperature | 1 | 24,36,48,60,72 | B,C |
| 850-mb Temperature Advection | 5 | 24,36,48,60,72 | B,C |
| 500-mb Minus 850-mb Temp. Difference | 1,5 | 24,36*,48*,60*,72* | B |
| 500-mb Geostrophic Vorticity Advection | 5 | 12,24,36,48,60,72 | B,C |
| 850-mb Vertical Velocity | 5 | 12,24,48*,60*,72* | B,C |
| 650-mb Vertical Velocity | 5 | 12,24 | B,C |
| Boundary Layer Moist. Convergence | 1,5 | 12,24,36,48,60,72 | B,C |
| Boundary Layer U,V Wind | 5 | 12,24,36,48,60,72 | B,C |
| 850-mb U,V Wind | 1,5 | 24,36,48,60,72 | B,C |
| 500-mb U,V Wind | 1,5 | 24,36,48,60,72 | B,C |
| Mean Rel. Humidity[3], Δτ12 | 5 | 48 | B,C |
| (b) Other Predictors | | | |
| Sine and Cosine Day of year | -- | -- | C |
| Observed Ceiling | -- | 06 | B |
| Observed Sky Cover | -- | 06 | B |
| Observed Weather | -- | 06 | B |
| Observed Dew Point | -- | 06 | B |
| Observed U, V Wind | -- | 06 | B,C |

1 A one in this column means no smoothing.
2 B = binary form, C = continuous form.
3 12-hr trend ending at time shown.

Table 3. PE forecast and 0600 GMT observed predictors listed according to the total number of times they are used in the Alaskan summer and fall season PoP equations for the 0000 GMT forecast cycle. The number following the predictor indicates its projection. (Note: geo.=geostrophic, conv.= convergence, adv.=advection, S5=five-point smoothing to eliminate small scale noise.)

| Rank | First Period (12-24 hr) | Second Period (24-36 hr) |
|---|---|---|
| | **Summer Season Equations** | |
| 1 | Mean Rel. Humidity S5 30 | Mean Rel. Humidity S5 36 |
| 2 | Bound. Layer U S5 24 | Precip. Amount S5 36 |
| 3 | Mean Rel. Humidity S5 24 | 500-mb Geo. V 36 |
| 4 | Observed Sky Cover | Bound. Layer U S5 36 |
| 5 | 500-mb Geo. Vorticity Adv. S5 12 | Mean Rel. Humidity S5 42 |
| 6 | Precip. Amount S5 24 | Bound. Layer V S5 36 |
| 7 | Observed Weather | 850-mb. Temp. Adv. S5 36 |
| 8 | Bound. Layer Moist. Conv. S5 12 | Mean Rel. Humidity S5 30 |
| 9 | Bound. Layer Rel. Humidity S5 24 | Bound. Layer Rel. Humidity S9 36 |
| 10 | Bound. Layer Moist. Conv. S5 24 | 500-mb Geo. U 36 |
| 11 | 500-mb Geo. U S5 24 | 850-mb Geo. V 36 |
| 12 | Bound. Layer V S5 24 | 850-mb Temperature 36 |
| | **Fall Season Equations** | |
| 1 | Mean Rel. Humidity S5 24 | Mean Rel. Humidity S5 36 |
| 2 | Precip. Amount S5 24 | Mean Rel. Humidity S5 30 |
| 3 | Observed Weather | Precip. Amount S5 36 |
| 4 | Mean Rel. Humidity S5 18 | 850-mb Geo. U |
| 5 | Bound. Layer Moist. Conv. S5 24 | Bound. Layer Humidity S5 36 |
| 6 | Bound. Layer Humidity S5 24 | 850-mb Temp. Adv. S5 36 |
| 7 | 850-mb Vertical Velocity S5 24 | Bound. Layer U S5 36 |
| 8 | Bound. Layer U S5 12 | Mean Rel. Humidity S5 42 |
| 9 | Observed Sky Cover | 850-mb Height S5 36 |
| 10 | Bound. Layer U S5 24 | Bound. Layer V S5 36 |
| 11 | 500-mb Geo. Vorticity Adv. S5 24 | Bound. Layer Moist. Conv. S5 36 |
| 12 | 500-mb Geo. U S5 24 | 850-mb Temperature 36 |

Table 4. The Brier scores, the relative frequency of precipitation, and the range of the forecasts on the dependent data for 1200 GMT first period forecasts.

| Station | Summer | | | Fall | | |
|---|---|---|---|---|---|---|
| | Brier Score | Range | Relative Frequency of Precipitation | Brier Score | Range | Relative Frequency of Precipitation |
| Annette | .146 | 100 00 | .379 | .142 | 100 00 | .528 |
| Juneau | .139 | 100 00 | .433 | .143 | 100 00 | .547 |
| Yakutat | .160 | 100 00 | .464 | .108 | 100 00 | .622 |
| King Salmon | .176 | 90 02 | .310 | .148 | 100 00 | .310 |
| Cold Bay | .180 | 90 02 | .316 | .207 | 90 02 | .492 |
| St. Paul Island | .159 | 100 02 | .282 | .208 | 100 10 | .488 |
| Fairbanks | .146 | 90 02 | .249 | .125 | 100 00 | .219 |
| Anchorage | .108 | 100 00 | .176 | .143 | 100 00 | .264 |
| McGrath | .183 | 90 02 | .310 | .133 | 100 00 | .307 |
| Bethel | .176 | 100 02 | .340 | .135 | 100 00 | .310 |
| Katcekue | .076 | 100 00 | .138 | .121 | 100 00 | .252 |
| Nome | .112 | 100 00 | .228 | .115 | 100 00 | .264 |
| Barter Island | .102 | 90 00 | .142 | .127 | 90 00 | .202 |
| Barrow | .126 | 100 00 | .196 | .154 | 90 00 | .232 |