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# User's Guide to the Weather Model: A Component of the Western Spruce Budworm Modeling System

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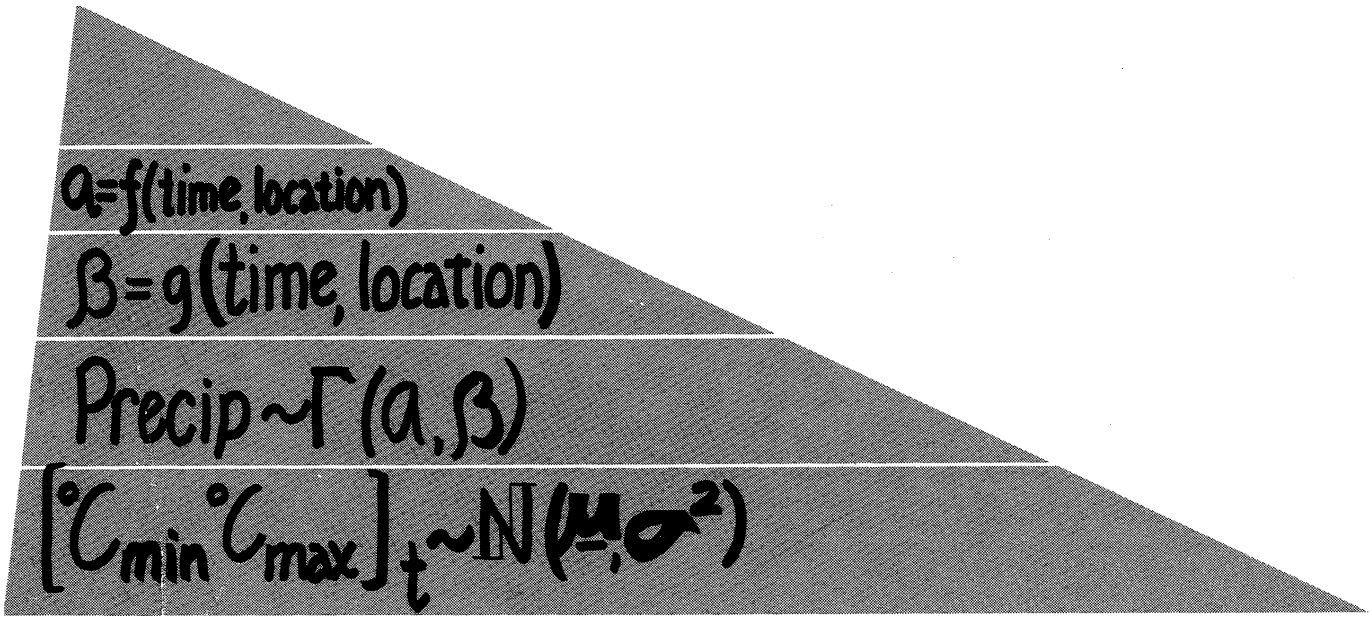


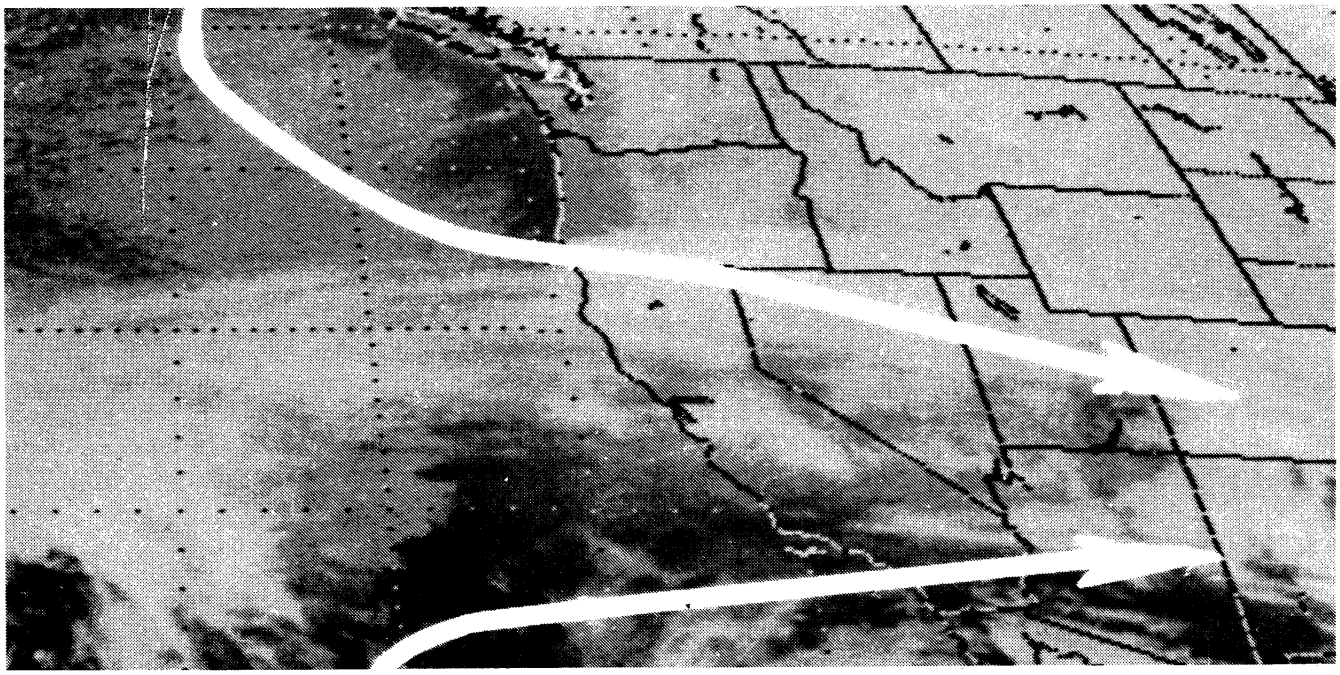

## Authors

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## Abstract

**Kemp, WIlliam P.; Crookston, Nicholas L.; Thomas, Paul W. 1989.** Users guide to the weather model: a component of the western spruce budworm modeling system. Gen. Tech. Rep. PNW-GTR-235. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 25 p.

A stochastic model useful in simulating daily maximum and minimum temperature and precipitation developed by Bruhn and others has been adapted for use in the western spruce budworm modeling system. This document describes how to use the weather model and illustrates some aspects of its behavior.

Keywords: Western spruce budworm, *Choristoneura occidentalis,* temperature, temperature simulation, stochastic weather model.

## Contents

# Introduction

## What Does the Weather Model Do?

The Weather Model provides the daily maximum and minimum temperatures needed by the Budworm Model. The Budworm Model represents the population dynamics of budworms and the development of new foliage in the spring, partly as a function of daily temperature. Actually, in both models, daily temperatures are used to compute degree-days, which are cumulated throughout the growing season. The methods used to compute degree-days and an explanation of their role in the budworm and host-phenology components of the Budworm Model are explained by Sheehan and others (1987).

The Weather Model is based on the model developed by Bruhn (1980) and Bruhn and others (1979). In fact, the model used here includes much of Bruhn's original computer program. We have changed the random-number generator to one of our own choosing, removed relative humidity and solar radiation calculations, and changed the technical details on how to use the model. These changes provide necessary additional control over the model and make its use conform to the command structure of the Prognosis Model.

## What Is the Budworm Modeling System?

A model that describes the population dynamics of the western spruce budworm *(Choristoneura occidentalis* Freeman) provides forest managers and entomologists with a tool for assessing pest-related impacts. The model is called the Budworm Model and is a major component of the Budworm Modeling System. The Budworm Model structure and development is described by Sheehan and others (1987), and its use is described by Crookston and others (in preparation).

Another component of the system is the Prognosis Model (Stage 1973, Wykoff and others 1982). The Prognosis Model is a distant-independent individual-tree stand-growth model. The Prognosis Model is used to simulate growth of stands given various management plans or policies. The Budworm Model and the Prognosis Model are linked together through a set of linkage routines. This linkage translates statistics carried within the Prognosis Model into stand attributes used by the Budworm Model and translates estimated defoliation into reduced tree growth and increased tree mortality.

## How To Use This Guide

This guide is intended for those working with the Budworm Model. Others may find it confusing because some terms and concepts used in the Budworm and Prognosis Models are used here without detailed explanation.

First-time readers should scan the complete text once. Thereafter, Weather Model users should use the text as a reference guide. To aid in finding the keyword you need, appendix II lists the available keywords with a summary of the parameter fields and a page reference to the main text.

# How To Use the Weather Model

The Weather Model is actually "used" directly by the Budworm Model. The Budworm Model will automatically call the Weather Model to estimate the appropriate temperatures; however, the model will mimic the weather at McCall, Idaho, unless a different station is designated. The rest of this section describes how to control the model.

## Keyword Structure

The Weather Model is controlled by using a set of keywords formatted the same way as Prognosis Model and Budworm Model keywords are formatted. The keyword field is the first eight columns of the record; the keyword must be left-justified in this field. Seven numeric fields follow; each is 10 columns wide and the first one starts in column 11. Only numbers may be coded in numeric fields, or the fields may be left blank. Blank fields imply that the default value for this field is desired; you must enter zeros if you want them. Numeric data should be coded with a decimal and placed anywhere within the field; if the decimal is omitted, you must right-justify the number in the field.

Sometimes more data are needed to implement an option than can be entered in seven fields; then, one or more supplemental data records are used. The formats of these differ; they will be described case by case.
Weather Model keywords cannot be mixed in with Prognosis or Budworm Model keywords. You must first enter a WEATHER keyword to alert the Budworm Model that Weather Model keywords follow. The Budworm Model will then call the Weather Model so it can read its own keywords. Note that you cannot enter a WEATHER keyword as a Prognosis Model keyword. You must first enter WSBW to call the Budworm Model. An END keyword signals that all Weather Model options have been entered and returns control to the Budworm Model.

| | |
|---|---|
| WEATHER | Signals that Weather Model keywords follow. |
| END | Signals the end of Weather Model keywords and that Budworm Model keywords follow. |

## Simulated Weather

To better understand how to use the Weather Model, you must understand the model as developed by Bruhn and others (1979). Bruhn's model consists of two computer programs. The first is a parameter-estimation program used to develop a set of statistics or parameters to describe temperature and precipitation each month for a given string of weather data. The second computer program modified for this application is the weather simulator. It uses statistical procedures to estimate daily maximum and minimum temperatures and precipitation. Refer to Bruhn (1980) and Bruhn and others (1979) for further details.

**Selecting a weather station**—The Weather Model stores four parameter data sets; anyone can be used to generate daily weather during a Budworm Model simulation. These parameter data sets were developed by using procedures outlined in Bruhn and others (1979) from historical data from the weather stations listed in table 1. (Other stations may be used as described below.)

Table 1—Parameter sets are stored In the Weather Model for representative stations In Idaho, Montana, and Oregon

| Internal station number | NOAA station number[a] | Weather station |
|---|---|---|
| 1 | 105708 | McCall, Idaho |
| 2 | 107386 | Priest River Experiment Station, Idaho |
| 3 | 244558 | Kalispell, Montana |
| 4 | 350412 | Baker, Oregon |

[a] NOAA = National Oceanic and Atmospheric Administration.

To select one of the four stations in table 1, use the USESTA keyword. Notice that the stations are selected by using internal station numbers.

| | | |
|---|---|---|
| USESTA | Field 1: | The internal station number; default is 1, McCall, Idaho. |

### Example 1: Changing the Weather Model Station Number

Let us say that you want to run the Prognosis-Budworm Model on a stand near Baker, Oregon; here is a part of the necessary keyword file:

| Reference line | Keyword record | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Keyword | Field 1 | Field 2 | Field 3 | Field 4 | Field 5 | Field 6 | Field 7 |
| 1 | STANDID | | | | | | | |
| 2 | EXAMPLE1 A STAND NEAR BAKER, OREGON | | | | | | | |
| 3 | INVYEAR | 1982. | | | | | | |
| 4 | NUMCYCLE | 5. | | | | | | |
| 5 | WSBW | | | | | | | |
| 6 | CALLBW | 1982. | | | | | | |
| 7 | WEATHER | | | | | | | |
| 8 | USESTA | 4. | | | | | | |
| 9 | END | | | | | | | |
| | . | | | | | | | |
| | . | | | | | | | |
| | . more Budworm Model keywords | | | | | | | |
| | . | | | | | | | |
| | . | | | | | | | |
| 10 | END | | | | | | | |
| | . | | | | | | | |
| | . | | | | | | | |
| | . more Prognosis Model keywords | | | | | | | |
| | . | | | | | | | |
| | . | | | | | | | |
| 11 | PROCESS | | | | | | | |
| 12 | STOP | | | | | | | |

Lines 1 to 2: Enter the stand identification.

Lines 3 to 4: Specify the inventory year and that the projection will last five cycles.

Line 5: Signal that Budworm Model options follow.

Line 6: CALLBW is a Budworm Model option that specifies that Budworm Model should be started in 1982.

Line 7: Signal that Weather Model options follow.

Line 8: Specify Weather Model internal station number 4 (Baker, Oregon) be used.

Line 9: Signal the end of Weather Model keywords.

Between lines 9 and 10, more Budworm Model options could be entered.

Line 10: Signal the end of Budworm Model keywords.

Line 11: Signal that all options have been entered and that the projection should start.

Line 12: Stop the program.

**Lapse rates**—The temperatures predicted for Baker, Oregon, and the temperatures for the stand (example 1) are probably different. Therefore, a lapse rate of 6.3 °C (11.3 of) per 1000 m in elevation (Barry 1981) is used on temperature data for each stand to adjust for temperature differences resulting from the change in elevation from weather station to the forest stand.

The Weather Model does not allow more than one weather station to be used during a Budworm Model run. When several stands are being simulated in the Budworm Model, the lapse rate adjustment is made independently for each stand. No adjustments are made to precipitation because these data are not used by the Budworm Model at this time.

**Using stations other than those contained in the Weather Model**—Programming considerations prevented the storage of a large number of weather-station parameter data sets. We recognize that four stations do not offer the variations in weather that may be required. To alleviate this problem, 14 additional weather stations were selected (fig. 1), and parameter data sets were generated for each of these stations as described previously and by Bruhn and others (1979). The parameter data sets are listed in appendix I and are distributed in machine-readable form with the Budworm Model source code. Contact your system support staff for help in accessing these files. Because of the complexity of the generation of and interpretation of parameters contained in appendix I, we refrain from detailed discussion of parameter sets here. Refer to Bruhn (1980) and Bruhn and others (1979) for further information.

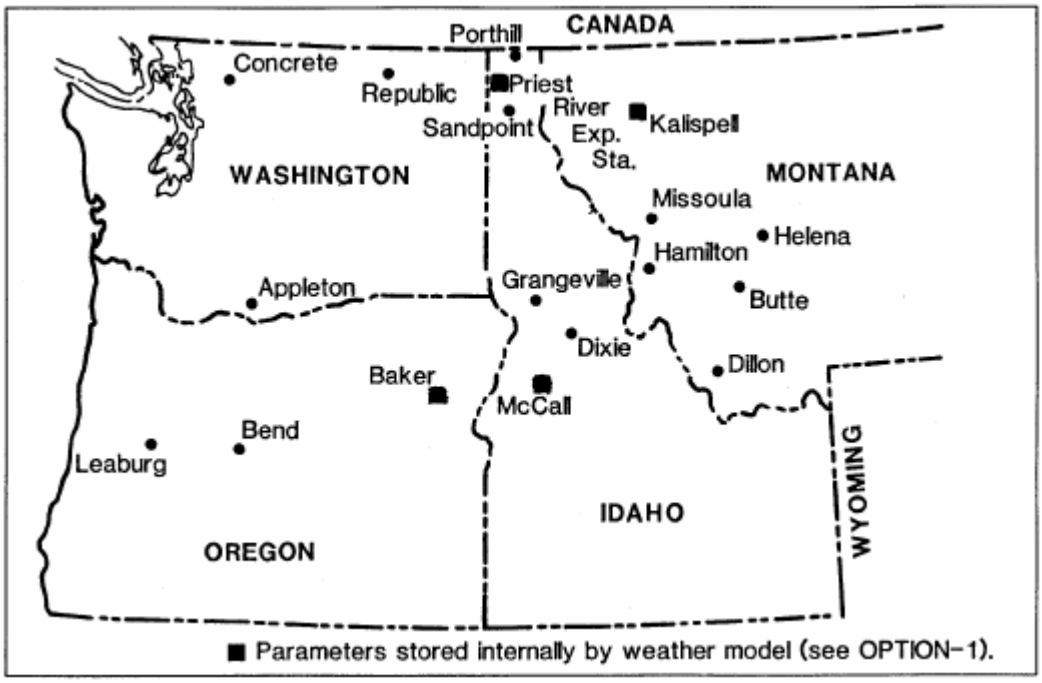


Figure 1—Map of Weather Model stations available to users of the combined Budworm Prognosis Models.

The parameter data sets may replace those already stored in the Weather Model by using the REDEFINE keyword.

| | |
|---|---|
| REDEFINE | Redefine the parameter for a specific internal station number. |
| Field 1: | Internal station number for which new parameters are being entered, default = 1. |
| Field 2: | The data set reference number used to read the new parameter. If blank, the parameters follow in the keyword file. |
| Field 3: | Starting month (1-12) for weather parameter redefinition; default is 1 (January). |
| Field 4: | Ending month for weather parameter redefinition; default is 12 (December). |

When supplemental data records follow this keyword, their format is controlled by the parameter-generating program so you need not be concerned with it. [1] Simply include all the parameter data records for the station you have selected.

[1] The parameter-generating program requires a long (about 10 years) run of data with no missing observations. The program we used to generate the parameters can be obtained from the Forestry Sciences Laboratory, Moscow, Idaho 83843.

Example 2: Entering a New Weather Station's Parameter File

| Reference line | Keyword | Field 1 | Field 2 | Field 3 | Field 4 | Field 5 | Field 6 | Field 7 |
|---|---|---|---|---|---|---|---|---|
| | . | | | | | | | |
| | . | | | | | | | |
| | . Budworm Model keywords | | | | | | | |
| | . | | | | | | | |
| | . | | | | | | | |
| 1 | WEATHER | | | | | | | |
| 2 | REDEFINE | | | | | | | |
| 3 | 450217 APPLETON, WASHINGTON | | | | | 710.00 | | |
| 4 | | 0.774 | 0.333 | 0.864 | 0.460 | | | |
| 5 | | 35.344 | 8.727 | 25.149 | 9.992 | 0.767 | 0.868 | |
| 6 | | 34.680 | 9.436 | 21.193 | 10.317 | 0.815 | 0.760 | |
| 7 | | 0.638 | 0.264 | 0.886 | 0.261 | | | |
| 8 | | 41.384 | 6.256 | 29.493 | 6.410 | 0.623 | 0.643 | |
| 9 | | 41.945 | 8.212 | 26.701 | 6.811 | 0.796 | 0.609 | |
| 10 | | 0.659 | 0.250 | 0.994 | 0.234 | | | |
| 11 | | 42.530 | 5.817 | 28.896 | 5.570 | 0.645 | 0.496 | |
| 12 | | 49.462 | 7.645 | 28.543 | 5.814 | 0.834 | 0.448 | |
| 13 | | 0.476 | 0.200 | 1.301 | 0.115 | | | |
| 14 | | 49.086 | 5.744 | 31.190 | 5.162 | 0.297 | 0.346 | |
| 15 | | 55.373 | 7.517 | 32.667 | 5.043 | 0.656 | 0.258 | |
| 16 | | 0.522 | 0.109 | 1.007 | 0.160 | | | |
| 17 | | 57.348 | 7.309 | 36.725 | 5.838 | 0.516 | 0.238 | |
| 18 | | 66.092 | 9.735 | 38.967 | 6.416 | 0.76 | 5 0.468 | |
| 19 | | 0.377 | 0.104 | 1.207 | 0.093 | | | |
| 20 | | 64.151 | 8.601 | 42.717 | 5.861 | 0.682 | 0.378 | |
| 21 | | 72.221 | 9.813 | 45.303 | 6.030 | 0.740 | 0.446 | |
| 22 | | 0.174 | 0.057 | 0.750 | 0.148 | | | |
| 23 | | 70.304 | 7.262 | 45.435 | 5.640 | 0.416 | 0.033 | |
| 24 | | 30.186 | 9.234 | 48.868 | 5.954 | 0.751 | 0.446 | |
| 25 | | 0.410 | 0.072 | 0.798 | 0.204 | | | |
| 26 | | 87.462 | 6.786 | 46.641 | 4.440 | 0.538 | 0.097 | |
| 27 | | 79.637 | 9.227 | 49.108 | 5.860 | 0.746 | 0.379 | |
| 28 | | 0.548 | 0.094 | 0.717 | 0.316 | | | |
| 29 | | 60.500 | 6.278 | 42.226 | 5.868 | 0.523 | 0.216 | |
| 30 | | 71.493 | 8.734 | 43.406 | 6.800 | 0.784 | 0.350 | |
| 31 | | 0.541 | 0.192 | 0.898 | 0.315 | | | |
| 32 | | 51.045 | 6.031 | 35.414 | 6.103 | 0.638 | 0.475 | |
| 33 | | 58.845 | 8.212 | 36.207 | 6.584 | 0.803 | 0.397 | |
| 34 | | 0.758 | 0.393 | 0.967 | 0.296 | | | |
| 35 | | 42.702 | 5.528 | 32.070 | 5.222 | 0.603 | 0.634 | |
| 36 | | 43.428 | 7.448 | 30.097 | 5.693 | 0.811 | 0.548 | |
| 37 | | 0.762 | 0.362 | 1.031 | 0.361 | | | |
| 38 | | 36.332 | 8.190 | 26.574 | 9.861 | 0.759 | 0.862 | |
| 39 | | 35.000 | 8.883 | 23.221 | 9.578 | 0.808 | 0.794 | |
| 40 | END | | | | | | | |

Line 1: Signal that Weather Model keywords follow.

Line 2: Signal that you are redefining the station elevation and identification for internal station 1.

Line 3: The new identification (co!. 1-40) and station elevation (cols. 41-50) are entered on a supplemental data record.

Lines 4 to 39: Enter new monthly parameters on supplemental data records.

Line 40: Signal the end of the Weather Model keywords.

### Using Actual Weather Data

Rather than using the Weather Model to simulate weather, you can enter actual weather data from an external data file. These data are then used by the Budworm Model in the yearly simulations. This option is invoked by using the FIXWEATH keyword:

| | | |
|---|---|---|
| FIXWEATH | Field 1: | Data set reference number of file with weather data (no default). |

Table 2 shows the format requirements of the data referenced in field 1 of the FIXWEATH keyword. Records for months with fewer than 31 days are simply truncated. The sequence of five records (table 2) is repeated for each month of every year in the data string; for example, a 1 O-year weather string would have (5)(12)(10) = 600 records. All input data are assumed to be in of and lapse rates are not applied. If a data set is shorter than needed by the Budworm Model simulation, the Weather Model will substitute simulated weather by using the currently set internal station. The substitution starts as soon as the first incomplete year is detected. You may, therefore, have fixed weather data for a few years followed by simulated weather.

**Table 2—Required formatting of the data file referenced in field 1 of FIXWEATH keyword**

| Record | Description | Columns | Format |
|---|---|---|---|
| 1 | Month number | 1-2 | 12 |
| | Comment field | 3-74 | 18A4 |
| 2 | Maximum temperatures oF for days 1-20 | 1-80 | 20F4.0 |
| 3 | Maximum temperatures oF for days 21-31 | 1-80 | 11F4.0 |
| 4 | Minimum temperatures oF for days 1-20 | 1-80 | 20F4.0 |
| 5 | Minimum temperatures oF for days 21-31 | 1-80 | 11F4.0 |

## Other Keywords

Several additional keywords may be used in the Weather Model: DEBUG, NODEBUG, RANNSEED, TESTGEN, DISPRMS, and INITPRMS.

If you need to troubleshoot certain portions of the Weather Model system, you may use the DEBUG keyword. Enter a DEBUG keyword after a WEATHER keyword and before the END keyword. This option may be turned off by entering the NODEBUG keyword. The RANNSEED keyword can be used to change the random sequence of weather for a given station.

| | | |
|---|---|---|
| RANNSEED | Field 1: | The new random number seed used by the Weather Model's random number generator (default = 55329). |

| | | |
|---|---|---|
| TESTGEN | The Weather Model will generate and print weather when this keyword is entered. | |
| | Field 1: | The internal station number, default is 1. |
| | Field 2: | The first month you want the simulated weather generated, default is 3. |
| | Field 3: | The last month you want the weather simulated, default is 10. |
| | Field 4: | The year associated with the first month, default is 1. The year is useful if you want your output correctly labeled as to the year and in computing leap years. |

The DISPRMS keyword allows you to examine the parameters of any of the four weather stations stored internally in the Weather Model. The parameters are printed after the DISPRMS keyword in the keyword table.

| | | |
|---|---|---|
| DISPRMS | Field 1: | Internal station number (default = 1). |

## How Well Does the Model Work?

A complete description of the validation of the Weather Model is beyond the scope of this paper and has been reported elsewhere (Bruhn 1979, 1980; Bruhn and others 1979). To give an illustration of how well the model works, we have provided comparisons between actual and simulated cumulative frequency distributions for daily maximum and minimum temperatures (°F) and precipitation (inches) for the four weather stations during a 5-year test (figs. 2-5). These results together with those reported previously (Bruhn 1980, Bruhn and others 1979) indicate that simulated weather data agree favorably with actual weather data in mean response, dispersion, and sequential pattern of daily events.

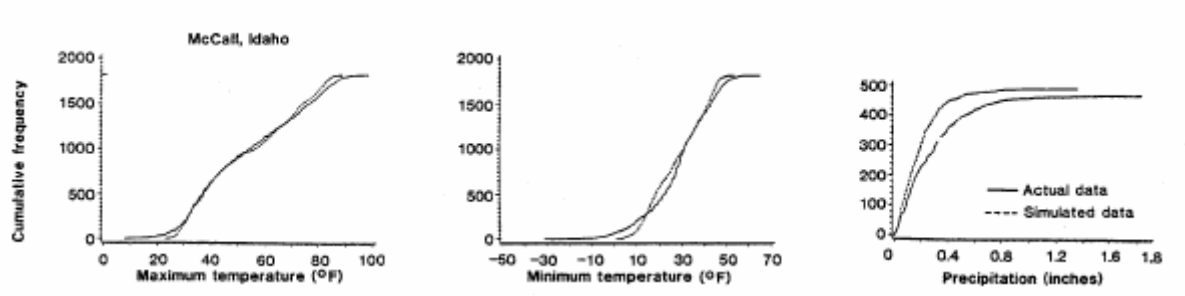


Figure 2—Comparison of simulated vs. actual temperature (°F) and precipitation (inches) data for a 5-year test period, McCall, Idaho.

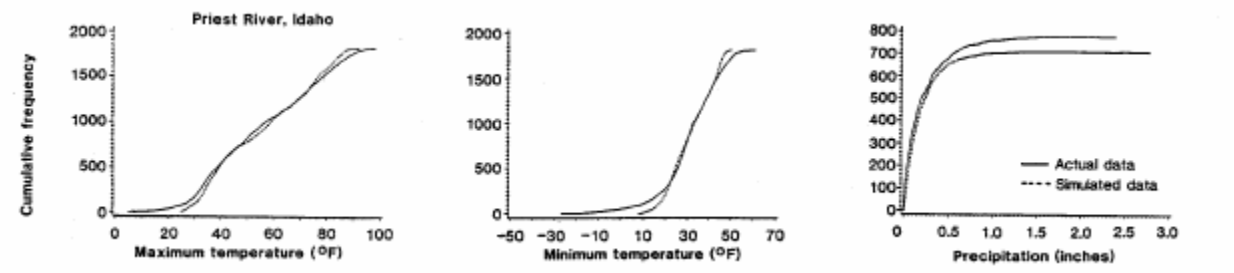


Figure 3—Comparison of simulated vs. actual temperature (°F) and precipitation (inches) data for a 5-year test period, Priest River Experiment Station, Idaho.

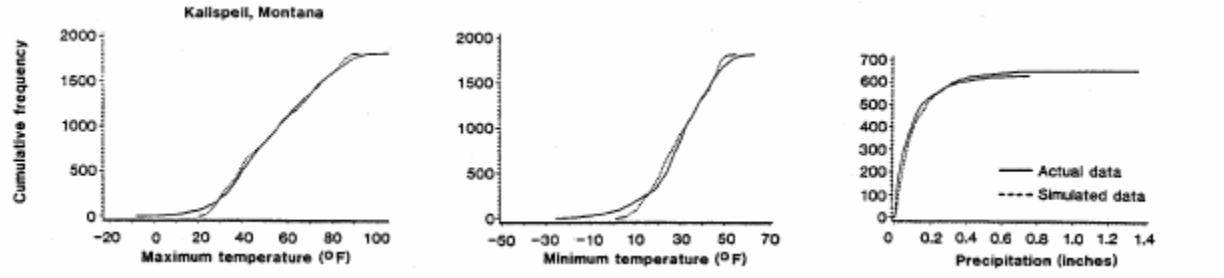


Figure 4—Comparison of simulated vs. actual temperature (°F) and precipitation data (inches) for a 5-year test period, Kalispell, Montana.

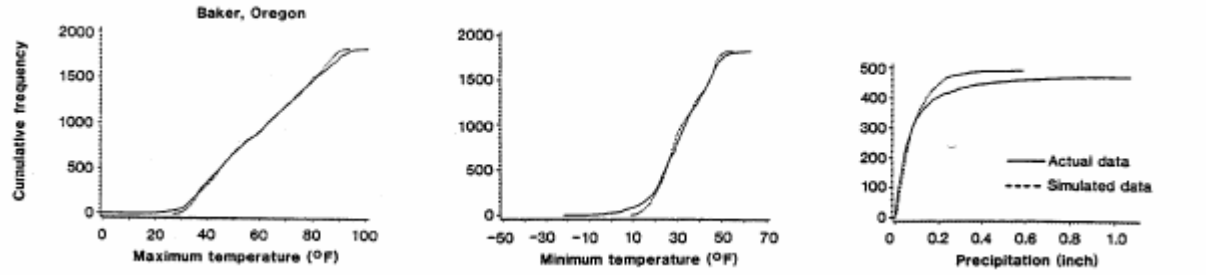


Figure 5—Comparison of simulated vs. actual temperature (°F) and precipitation (inches) data for a 5-year test period, Baker, Oregon.

## Acknowledgments

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## Appendix I

### Additional Weather Station Parameter Files

```
STATION NAME : DIXIE, IDAHO
STATION NUMBER : 102575
STATION ELEVATION : 1708 METERS.
START OF SAMPLE INTERVAL : JANUARY 1, 1962
END OF SAMPLE INTERVAL : DECEMBER 31, 1976

COLUMN LOCATION
>...|....1....|....2....|....3....|....4....|....5....|....6....|....7
102575 DIXIE, IDAHO                        1708.00
     0.780     0.370     1.283     0.220
    28.952     7.224     8.601    16.240     0.614     0.738
    28.879    10.236    -0.613    15.578     0.880     0.660
     0.609     0.330     1.530     0.142
    32.599     6.910    10.000    12.982     0.752     0.535
    37.485     8.107     4.185    12.602     0.770     0.380
     0.591     0.359     1.569     0.139
    34.245     6.028     9.641    12.118     0.546     0.567
    41.159     8.507    10.118    12.660     0.821     0.476
     0.581     0.333     1.316     0.148
    39.732     5.654    18.247     8.186     0.297     0.383
    48.849     7.860    21.103     7.097     0.598     0.181
     0.546     0.275     1.443     0.128
    49.477     8.575    26.356     6.076     0.579     0.437
    61.038     9.323    27.560     5.407     0.762     0.389
     0.627     0.268     1.332     0.182
    59.052     9.246    34.078     5.469     0.663     0.384
    69.584     8.842    34.907     6.113     0.714     0.513
     0.354     0.133     1.285     0.132
    71.073     8.074    37.329     5.605     0.483     0.234
    77.862     6.830    36.614     5.883     0.648     0.435
     0.419     0.178     0.850     0.218
    67.419     9.199    35.714     5.658     0.550     0.228
    78.542     7.582    34.664     5.895     0.683     0.334
     0.538     0.153     1.339     0.168
    55.470    10.146    30.009     6.306     0.559     0.262
    69.736     9.436    27.916     6.231     0.732     0.396
     0.541     0.194     1.014     0.252
    44.222     8.581    22.956     8.476     0.507     0.500
    57.652    10.281    21.733     6.144     0.787     0.223
     0.632     0.332     1.271     0.168
    35.804     6.544    16.306    11.578     0.613     0.697
    42.685     8.507    15.141    10.510     0.805     0.495
     0.675     0.384     1.216     0.202
    30.124     6.639     8.723    14.046     0.617     0.723
    32.620     9.072     3.935    14.200     0.846     0.660
```

STATION NAME: GRANGEVILLE, IDAHO
STATION NUMBER: 103771
STATION ELEVATION: 1,021 METERS.
START OF SAMPLE INTERVAL: JANUARY 1, 1933.
END OF SAMPLE INTERVAL: DECEMBER 31, 1949.

COLUMN LOCATION
>...|....1....|....2....|....3....|....4....|....5....|....6....|....7
103771 GRANGEVILLE, IDAHO 1021.00

| | | | | | |
|---|---|---|---|---|---|
| 0.421 | 0.233 | 1.062 | 0.127 | | |
| 33.664 | 10.638 | 19.408 | 13.672 | 0.780 | 0.888 |
| 36.155 | 9.782 | 20.150 | 11.690 | 0.824 | 0.846 |
| 0.456 | 0.264 | 0.868 | 0.199 | | |
| 37.399 | 8.651 | 22.392 | 10.731 | 0.707 | 0.797 |
| 40.214 | 8.917 | 24.267 | 9.630 | 0.788 | 0.791 |
| 0.472 | 0.323 | 0.859 | 0.216 | | |
| 44.477 | 7.166 | 27.492 | 7.403 | 0.604 | 0.684 |
| 49.272 | 9.162 | 29.716 | 6.507 | 0.722 | 0.569 |
| 0.522 | 0.320 | 1.175 | 0.190 | | |
| 51.720 | 7.901 | 32.386 | 5.108 | 0.485 | 0.467 |
| 59.822 | 10.726 | 36.172 | 6.346 | 0.645 | 0.531 |
| 0.570 | 0.243 | 0.914 | 0.299 | | |
| 59.452 | 7.892 | 38.489 | 5.601 | 0.511 | 0.448 |
| 67.906 | 9.926 | 41.900 | 6.381 | 0.603 | 0.531 |
| 0.601 | 0.258 | 1.022 | 0.250 | | |
| 66.005 | 7.982 | 44.034 | 4.703 | 0.605 | 0.387 |
| 73.096 | 9.125 | 46.656 | 5.966 | 0.555 | 0.432 |
| 0.337 | 0.114 | 1.110 | 0.167 | | |
| 76.262 | 8.677 | 48.875 | 5.728 | 0.676 | 0.511 |
| 83.718 | 7.832 | 52.492 | 5.239 | 0.606 | 0.518 |
| 0.283 | 0.096 | 0.911 | 0.162 | | |
| 75.417 | 8.399 | 46.683 | 5.156 | 0.525 | 0.340 |
| 83.126 | 7.601 | 50.713 | 5.423 | 0.552 | 0.495 |
| 0.469 | 0.154 | 0.819 | 0.281 | | |
| 63.973 | 9.951 | 41.903 | 6.851 | 0.643 | 0.478 |
| 74.892 | 10.187 | 44.814 | 6.480 | 0.687 | 0.552 |
| 0.536 | 0.197 | 0.902 | 0.275 | | |
| 52.338 | 8.288 | 35.596 | 6.489 | 0.539 | 0.614 |
| 62.444 | 10.192 | 38.040 | 6.674 | 0.711 | 0.562 |
| 0.538 | 0.238 | 1.343 | 0.120 | | |
| 42.368 | 7.625 | 28.736 | 7.347 | 0.644 | 0.750 |
| 46.607 | 8.290 | 28.893 | 7.211 | 0.783 | 0.661 |
| 0.486 | 0.270 | 1.024 | 0.151 | | |
| 37.642 | 7.608 | 25.374 | 9.016 | 0.635 | 0.783 |
| 39.238 | 8.598 | 24.606 | 9.752 | 0.796 | 0.796 |

STATION NAME : SANDPOINT EXPERIMENTAL STATION, IDAHO
STATION NUMBER: 108137
STATION ELEVATION: 644 METERS.
START OF SAMPLE INTERVAL: JANUARY 1, 1948.
END OF SAMPLE INTERVAL: DECEMBER 31, 1977.

COLUMN LOCATION

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>...|....1....|....2....|....3....|....4....|....5....|....6....|...7
108137 SANDPOINT EXP. STATION, IDAHO    644.00
     0.668     0.342     0.967     0.323
    34.330     7.883    23.842    10.562     0.740     0.848
    27.926     9.787    14.965    13.885     0.878     0.882
     0.613     0.299     1.046     0.266
    38.792     6.111    26.483     9.125     0.668     0.705
    37.456     7.432    21.351    10.723     0.802     0.679
     0.605     0.242     1.185     0.195
    42.365     6.463    28.515     7.177     0.699     0.636
    45.494     7.732    25.524     7.805     0.810     0.512
     0.565     0.223     0.934     0.223
    51.201     5.875    34.018     5.216     0.543     0.380
    57.591     7.710    32.788     6.105     0.700     0.218
     0.526     0.210     1.170     0.191
    59.250     7.629    38.843     5.740     0.562     0.253
    69.031     8.365    40.727     6.637     0.768     0.314
     0.538     0.235     1.119     0.199
    67.222     6.895    45.731     5.679     0.368     0.160
    76.019     7.552    46.812     6.389     0.755     0.337
     0.364     0.113     1.165     0.162
    73.295     7.443    47.969     5.442     0.577     0.132
    82.576     6.405    48.468     5.682     0.732     0.223
     0.447     0.111     0.888     0.276
    70.947     7.352    47.235     5.402     0.596     0.056
    82.119     6.856    47.201     6.192     0.753     0.134
     0.460     0.148     1.066     0.244
    61.920     6.897    41.414     6.274     0.557     0.079
    72.369     8.193    41.420     7.307     0.810     0.296
     0.598     0.188     0.946     0.321
    51.544     5.996    36.567     6.603     0.517     0.458
    57.757     7.810    33.399     6.964     0.831     0.279
     0.634     0.306     0.880     0.386
    42.209     6.414    31.510     6.954     0.637     0.727
    40.660     7.817    26.732     8.149     0.825     0.699
     0.670     0.384     1.035     0.285
    35.991     6.147    26.582     8.226     0.676     0.800
    31.488     8.394    20.688    10.998     0.814     0.862
```

STATION NAME: BUTTE, MONTANA
STATION NUMBER: 241318
STATION ELEVATION: 1,684 METERS.
START OF SAMPLE INTERVAL: JANUARY 1, 1964.
END OF SAMPLE INTERVAL: DECEMBER 31, 1975.

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COLUMN LOCATION
>...|....1....|....2....|....3....|....4....|....5....|....6....|....7
241318 BUTTE, MONTANA                    1684.00
     0.391     0.266     0.942     0.078
    24.739    13.562     2.235    17.900     0.618     0.856
    29.820    13.246     7.988    18.421     0.822     0.888
     0.311     0.204     0.887     0.058
    27.824    10.356     2.797    15.503     0.566     0.778
    34.479     8.992    10.581    13.600     0.740     0.741
     0.438     0.285     1.181     0.056
    31.085     9.861     8.600    13.844     0.619     0.717
    41.616     9.657    17.182    12.028     0.740     0.677
     0.450     0.247     0.784     0.142
    40.367     8.954    21.734     8.482     0.538     0.555
    50.179     9.530    26.072     6.883     0.584     0.446
     0.520     0.265     0.748     0.194
    52.118     9.997    32.102     6.558     0.693     0.578
    63.669    10.605    33.592     6.417     0.711     0.415
     0.596     0.294     0.950     0.214
    61.827     9.533    40.929     5.533     0.644     0.404
    73.525     9.626    42.098     6.199     0.707     0.483
     0.448     0.188     0.850     0.147
    75.177     8.473    45.656     5.047     0.599     0.399
    82.355     6.434    46.217     5.017     0.477     0.196
     0.402     0.193     0.829     0.195
    71.685    10.294    44.011     5.284     0.697     0.276
    80.646     8.462    43.843     5.586     0.620     0.350
     0.443     0.180     0.897     0.161
    54.557    10.364    33.591     6.844     0.619     0.496
    68.930    10.679    34.669     7.159     0.640     0.382
     0.342     0.172     0.743     0.177
    43.776     8.380    25.434     7.365     0.564     0.617
    56.902    11.517    26.243     7.065     0.712     0.346
     0.424     0.205     0.977     0.065
    33.761     9.958    14.696    12.673     0.628     0.741
    42.272     9.174    18.851     9.572     0.738     0.581
     0.412     0.277     1.378     0.038
    25.202    11.840     2.975    15.364     0.638     0.826
    31.336    12.139     7.937    15.434     0.790     0.824
```

STATION NAME: DILLON, MONTANA
STATION NUMBER: 242404
STATION ELEVATION: 1,586 METERS.
START OF SAMPLE INTERVAL: JANUARY 1, 1959.
END OF SAMPLE INTERVAL: DECEMBER 31, 1972.

COLUMN LOCATION

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>...|....1....|....2....|....3....|....4....|....5....|....6....|....7
242404 DILLON, MONTANA                    1586.00
     0.284     0.153     0.928     0.050
    21.986    14.844     0.716    17.296     0.680     0.913
    33.744    12.300    12.894    14.189     0.757     0.893
     0.238     0.132     2.496     0.019
    29.810    11.471     9.016    12.341     0.717     0.897
    39.288     9.629    17.174    10.876     0.778     0.853
     0.337     0.161     0.865     0.082
    35.372    10.600    13.674    11.502     0.670     0.828
    45.095    11.331    20.284    10.224     0.806     0.833
     0.406     0.201     0.656     0.187
    47.248     8.178    26.040     5.592     0.511     0.656
    55.009     9.904    27.978     7.224     0.599     0.649
     0.526     0.207     1.060     0.161
    56.704     8.685    33.696     5.998     0.486     0.513
    67.729     9.430    37.612     6.287     0.680     0.644
     0.608     0.260     0.864     0.230
    66.753     9.340    43.012     5.120     0.638     0.533
    77.575     8.684    46.094     5.698     0.639     0.545
     0.268     0.143     0.912     0.179
    80.169     9.090    48.986     4.725     0.585     0.612
    85.063     6.592    50.022     4.965     0.510     0.468
     0.318     0.163     1.038     0.176
    75.271     9.591    47.024     5.671     0.595     0.671
    83.794     7.903    49.152     5.638     0.614     0.575
     0.484     0.151     0.947     0.153
    60.705    11.414    37.653     7.167     0.665     0.750
    70.711    10.953    39.837     7.843     0.688     0.660
     0.328     0.111     1.469     0.087
    47.656     9.771    28.297     6.405     0.634     0.760
    59.022    11.488    31.511     8.384     0.711     0.750
     0.275     0.171     0.858     0.107
    36.688     9.026    17.188    10.878     0.529     0.880
    44.382     8.918    22.835     9.083     0.664     0.758
     0.352     0.173     1.025     0.038
    24.136    13.767     5.705    14.658     0.705     0.944
    34.460    10.404    14.118    11.644     0.775     0.835
```

STATION NAME: HAMILTON, MONTANA
STATION NUMBER: 243885
STATION ELEVATION: 1,073 METERS.
START OF SAMPLE INTERVAL: JANUARY 1, 1960.
END OF SAMPLE INTERVAL: DECEMBER 31, 1975.

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COLUMN LOCATION
>...|....1....|....2....|....3....|....4....|....5....|....6....|....7
243885 HAMILTON, MONTANA                1073.00
     0.596     0.257     0.827     0.161
    33.947    13.436    18.330    15.937     0.736     0.908
    34.420    13.728    16.609    15.392     0.834     0.894
     0.386     0.177     1.037     0.102
    40.228    10.768    23.089    11.280     0.673     0.846
    42.487     9.346    22.971     9.660     0.765     0.762
     0.403     0.224     1.294     0.064
    43.043     8.984    23.331     8.961     0.682     0.768
    49.406    10.494    26.308     8.880     0.808     0.692
     0.493     0.192     0.935     0.128
    49.963     7.002    29.779     5.122     0.355     0.310
    58.395     8.826    32.108     6.052     0.687     0.409
     0.510     0.242     0.804     0.166
    60.459     7.704    36.841     5.153     0.580     0.407
    68.752     9.525    39.670     6.008     0.700     0.524
     0.554     0.226     0.866     0.197
    67.910     7.802    44.199     5.253     0.534     0.269
    78.229     9.026    47.277     5.389     0.744     0.552
     0.369     0.131     0.853     0.147
    78.298     7.211    48.214     4.868     0.535     0.356
    85.852     6.112    50.337     5.195     0.659     0.466
     0.364     0.166     0.747     0.222
    74.545     8.469    46.657     5.716     0.666     0.386
    84.191     7.947    49.111     5.084     0.663     0.499
     0.416     0.166     1.197     0.132
    63.788     9.215    39.354     6.338     0.602     0.529
    72.488     9.265    40.482     6.943     0.759     0.546
     0.462     0.166     0.838     0.179
    51.675     8.163    31.111     7.436     0.609     0.518
    60.984     9.645    32.317     7.364     0.747     0.488
     0.464     0.261     0.728     0.163
    42.377     7.978    26.278     7.889     0.526     0.716
    45.793     8.728    25.617     8.404     0.689     0.598
     0.467     0.264     0.953     0.112
    36.245    10.516    21.012    11.824     0.710     0.884
    35.529    11.893    18.489    13.102     0.783     0.869
```

STATION NAME: HELENA, MONTANA
STATION NUMBER: 244055
STATION ELEVATION: 1,183 METERS.
START OF SAMPLE INTERVAL: JANUARY 1, 1958.
END OF SAMPLE INTERVAL: DECEMBER 31, 1975.

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COLUMN LOCATION
>...|....1....|....2....|....3....|....4....|....5....|....6....|....7
244055 HELENA, MONTANA                  1183.00
     0.449     0.219     1.074     0.074
    19.859    18.217    -0.212    18.061     0.673     0.888
    33.254    14.397    12.940    15.851     0.797     0.871
     0.388     0.186     0.952     0.074
    28.250    12.576     9.414    14.412     0.684     0.825
    38.844    11.371    18.163    12.164     0.779     0.810
     0.427     0.199     1.154     0.064
    35.127    11.123    16.667    11.444     0.716     0.785
    46.431    11.965    22.850    10.386     0.775     0.745
     0.403     0.233     0.853     0.148
    47.275     9.690    27.940     6.847     0.555     0.558
    55.962    10.331    30.031     6.881     0.572     0.431
     0.472     0.259     0.721     0.235
    58.722     9.316    38.733     5.864     0.612     0.577
    67.828    10.385    39.275     6.297     0.700     0.473
     0.554     0.252     0.886     0.212
    67.026     8.170    46.067     5.221     0.516     0.316
    77.157     9.235    48.194     5.880     0.648     0.504
     0.355     0.173     1.020     0.129
    78.734     8.433    50.661     4.782     0.630     0.434
    85.138     7.194    52.763     5.185     0.555     0.357
     0.426     0.182     0.705     0.266
    75.202     8.893    49.806     5.007     0.615     0.388
    84.138     8.503    50.807     5.406     0.622     0.350
     0.421     0.155     1.155     0.094
    60.091    11.248    38.669     7.388     0.618     0.604
    71.673    10.786    40.511     7.340     0.674     0.474
     0.313     0.153     0.720     0.182
    48.566    10.396    29.343     8.817     0.637     0.675
    60.351    10.516    32.026     7.327     0.678     0.460
     0.376     0.188     0.956     0.084
    33.672    12.644    15.416    14.226     0.710     0.890
    45.239     9.879    22.369     9.004     0.680     0.708
     0.454     0.204     1.072     0.068
    24.980    15.114     6.184    15.711     0.736     0.874
    35.670    11.656    15.724    12.612     0.736     0.837
```

STATION NAME : MISSOULA, MONTANA
STATION NUMBER: 245741
STATION ELEVATION: 970 METERS.
START OF SAMPLE INTERVAL: JANUARY 1, 1953.
END OF SAMPLE INTERVAL: DECEMBER 31, 1975.

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COLUMN LOCATION
>...|....1....|....2....|....3....|....4....|....5....|....6....|....7
245741 MISSOULA, MONTANA                  970.00
     0.663     0.366     0.937     0.102
    30.276    12.177    15.420    14.565     0.727     0.902
    29.209    12.490    13.391    14.232     0.834     0.913
     0.523     0.304     1.081     0.070
    35.938     7.990    20.244    10.169     0.605     0.817
    36.895     8.886    18.895    10.419     0.768     0.767
     0.496     0.300     1.270     0.056
    41.144     9.331    22.648     9.375     0.653     0.780
    46.623     9.999    24.546     8.347     0.803     0.631
     0.475     0.313     0.882     0.107
    51.078     6.920    31.227     5.092     0.427     0.316
    57.685     9.131    31.083     5.707     0.589     0.211
     0.592     0.234     0.789     0.161
    59.914     8.863    38.031     6.093     0.527     0.468
    69.216    10.229    38.461     6.579     0.724     0.435
     0.536     0.276     0.879     0.202
    67.540     8.541    44.791     4.872     0.526     0.299
    77.649     9.729    45.576     6.207     0.683     0.343
     0.388     0.155     0.911     0.145
    78.932     9.539    48.850     5.774     0.598     0.394
    86.779     7.522    49.951     5.765     0.616     0.300
     0.488     0.156     0.825     0.163
    74.278     9.788    47.901     5.619     0.621     0.368
    85.528     8.401    48.397     5.251     0.628     0.250
     0.485     0.164     1.031     0.135
    62.281     9.653    40.661     6.165     0.643     0.454
    73.724    10.332    39.684     6.980     0.743     0.411
     0.471     0.192     0.814     0.141
    49.872     7.127    31.973     5.716     0.552     0.424
    58.825     9.760    30.987     6.499     0.777     0.363
     0.478     0.303     1.052     0.077
    39.722     9.106    24.847     8.644     0.601     0.817
    41.547     9.752    23.395     8.504     0.773     0.710
     0.523     0.359     0.885     0.102
    32.914     8.667    19.043    10.722     0.575     0.818
    31.641    10.918    17.198    11.508     0.784     0.886
```

STATION NAME: BEND, OREGON
STATION NUMBER: 350694
STATION ELEVATION: 1,110 METERS.
START OF SAMPLE INTERVAL : JANUARY 1, 1964.
END OF SAMPLE INTERVAL: DECEMBER 31, 1975.

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COLUMN LOCATION
>...|....1....|....2....|....3....|....4....|....5....|....6....|....7
350694 BEND, OREGON                    1110.00
     0.614     0.243     0.714     0.290
    37.352     9.397    21.821    12.425     0.743     0.833
    43.066     9.480    22.305    11.127     0.722     0.705
     0.358     0.165     0.799     0.127
    41.910     7.254    22.134     8.168     0.418     0.625
    48.051     7.984    24.408     6.795     0.680     0.347
     0.377     0.153     0.966     0.160
    45.052     6.870    24.156     7.963     0.489     0.673
    52.136     9.026    24.044     7.325     0.723     0.510
     0.362     0.123     0.969     0.089
    50.448     6.358    25.897     5.536     0.259     0.547
    57.030     8.633    26.679     6.774     0.599     0.568
     0.326     0.095     0.697     0.189
    60.848     8.670    33.239     6.538     0.717     0.677
    67.126     9.854    34.067     8.036     0.698     0.730
     0.462     0.115     0.750     0.236
    66.400     9.277    40.262     6.685     0.743     0.587
    75.068     9.523    41.071     7.714     0.742     0.675
     0.282     0.084     0.987     0.134
    78.256     8.631    45.128     7.747     0.818     0.747
    82.799     7.550    44.736     6.747     0.703     0.714
     0.389     0.071     0.655     0.198
    71.611     7.653    42.972     5.703     0.801     0.645
    82.253     7.759    43.193     6.081     0.723     0.711
     0.294     0.071     1.135     0.068
    62.941     7.495    36.441     7.849     0.516     0.658
    74.494     8.867    35.816     7.145     0.679     0.601
     0.414     0.142     0.886     0.136
    50.700     6.569    29.829     7.593     0.442     0.457
    65.000    10.192    29.755     7.720     0.720     0.499
     0.427     0.230     0.765     0.227
    46.718     6.566    28.971     7.008     0.556     0.554
    50.187     8.431    26.475     7.929     0.645     0.481
     0.531     0.293     0.762     0.232
    39.888     8.150    22.406    11.800     0.677     0.786
    42.017     9.251    22.419    10.999     0.707     0.716
```

STATION NAME: LEABURG, OREGON
STATION NUMBER: 354811
STATION ELEVATION: 705 METERS.
START OF SAMPLE INTERVAL: JANUARY 1, 1966.
END OF SAMPLE INTERVAL : DECEMBER 31, 1975.

COLUMN LOCATION

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>...|....1....|....2....|....3....|....4....|....5....|....6....|....7
354811 LEABURG, OREGON                  705.00
     0.817     0.444     0.934     0.543
    45.936     6.603    34.822     5.963     0.612     0.712
    45.022     7.193    28.856     7.276     0.737     0.746
     0.749     0.387     1.016     0.344
    49.854     6.229    35.316     4.548     0.513     0.474
    55.865     8.528    33.910     4.216     0.729     0.549
     0.793     0.333     1.193     0.319
    51.974     6.380    35.870     4.886     0.410     0.507
    60.966     7.667    35.530     5.193     0.582     0.443
     0.680     0.358     1.303     0.207
    55.061     5.762    36.333     3.876     0.214     0.324
    64.163     7.731    38.228     4.834     0.473     0.408
     0.657     0.176     0.907     0.322
    62.143     7.225    41.962     4.753     0.443     0.379
    72.278     8.880    43.298     4.653     0.524     0.542
     0.614     0.151     0.925     0.273
    66.398     6.805    47.307     4.561     0.302     0.293
    78.250     8.952    49.090     4.622     0.565     0.349
     0.345     0.064     1.143     0.112
    72.379     8.189    49.724     4.059     0.320     0.267
    83.907     7.807    50.310     4.096     0.662     0.368
     0.622     0.062     0.806     0.414
    71.189     6.600    50.973     3.672     0.423    -0.205
    84.930     7.705    49.429     4.286     0.656     0.353
     0.614     0.117     1.084     0.381
    66.514     5.884    47.543     4.600     0.324     0.032
    80.383     7.816    46.713     4.565     0.606     0.191
     0.708     0.265     0.927     0.405
    59.028     6.474    41.750     4.908     0.529     0.323
    68.157     8.140    40.988     4.984     0.603     0.263
     0.818     0.451     0.766     0.615
    51.904     5.653    38.727     4.872     0.511     0.477
    56.077     8.358    37.670     5.084     0.777     0.565
     0.837     0.535     0.954     0.479
    46.444     6.227    35.406     5.920     0.593     0.709
    45.239     7.243    30.704     7.206     0.738     0.761
```

STATION NAME : APPLETON, WASHINGTON
STATION NUMBER: 450217
STATION ELEVATION: 710 METERS.
START OF SAMPLE INTERVAL: JANUARY 1, 1962.
END OF SAMPLE INTERVAL: DECEMBER 31, 1973.

COLUMN LOCATION
>...|....1....|....2....|....3....|....4....|....5....|....6....|....7
450217 APPLETON, WASHINGTON 710.00

| | | | | | |
|---|---|---|---|---|---|
| 0.774 | 0.333 | 0.864 | 0.460 | | |
| 35.344 | 8.727 | 25.149 | 9.992 | 0.767 | 0.868 |
| 34.680 | 9.436 | 21.193 | 10.317 | 0.815 | 0.760 |
| 0.638 | 0.264 | 0.886 | 0.261 | | |
| 41.384 | 6.256 | 29.493 | 6.410 | 0.623 | 0.643 |
| 41.945 | 8.212 | 26.701 | 6.811 | 0.796 | 0.609 |
| 0.659 | 0.250 | 0.994 | 0.234 | | |
| 42.530 | 5.817 | 28.896 | 5.570 | 0.645 | 0.496 |
| 49.462 | 7.645 | 28.543 | 5.814 | 0.834 | 0.448 |
| 0.476 | 0.200 | 1.301 | 0.115 | | |
| 49.086 | 5.744 | 31.190 | 5.162 | 0.297 | 0.346 |
| 55.373 | 7.517 | 32.667 | 5.043 | 0.656 | 0.258 |
| 0.522 | 0.109 | 1.007 | 0.160 | | |
| 57.348 | 7.309 | 36.725 | 5.838 | 0.516 | 0.238 |
| 66.092 | 9.735 | 38.967 | 6.416 | 0.765 | 0.468 |
| 0.377 | 0.104 | 1.207 | 0.093 | | |
| 64.151 | 8.601 | 42.717 | 5.861 | 0.682 | 0.378 |
| 72.221 | 9.813 | 45.303 | 6.030 | 0.740 | 0.446 |
| 0.174 | 0.057 | 0.750 | 0.148 | | |
| 70.304 | 7.262 | 45.435 | 5.640 | 0.416 | -0.033 |
| 80.186 | 9.234 | 48.868 | 5.954 | 0.751 | 0.446 |
| 0.410 | 0.072 | 0.798 | 0.204 | | |
| 67.462 | 6.786 | 46.641 | 4.440 | 0.538 | -0.097 |
| 79.637 | 9.227 | 49.108 | 5.860 | 0.746 | 0.379 |
| 0.548 | 0.094 | 0.717 | 0.316 | | |
| 60.500 | 6.278 | 42.226 | 5.868 | 0.523 | 0.216 |
| 71.493 | 8.734 | 43.406 | 6.800 | 0.784 | 0.350 |
| 0.541 | 0.192 | 0.898 | 0.315 | | |
| 51.045 | 6.031 | 35.414 | 6.103 | 0.638 | 0.475 |
| 58.854 | 8.212 | 36.207 | 6.584 | 0.803 | 0.397 |
| 0.758 | 0.393 | 0.967 | 0.296 | | |
| 42.702 | 5.528 | 32.070 | 5.222 | 0.603 | 0.634 |
| 43.428 | 7.448 | 30.097 | 5.693 | 0.811 | 0.548 |
| 0.762 | 0.362 | 1.031 | 0.361 | | |
| 36.332 | 8.190 | 26.574 | 9.861 | 0.759 | 0.862 |
| 35.000 | 8.883 | 23.221 | 9.578 | 0.808 | 0.794 |

STATION NAME: CONCRETE, WASHINGTON
STATION NUMBER: 451679
STATION ELEVATION: 59 METERS.
START OF SAMPLE INTERVAL: JANUARY 1, 1966.
END OF SAMPLE INTERVAL: DECEMBER 31, 1975.

COLUMN LOCATION

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>...|....1....|....2....|....3....|....4....|....5....|....6....|....7
451679 CONCRETE, WASHINGTON                59.00
     0.846     0.420     1.001     0.565
    39.996     6.158    31.645     6.178     0.728     0.787
    37.877     5.815    26.383     7.802     0.787     0.702
     0.797     0.343     1.071     0.376
    45.288     5.515    34.130     4.247     0.645     0.410
    49.571     7.791    32.019     5.012     0.790     0.270
     0.828     0.318     1.013     0.380
    48.493     5.826    35.025     4.104     0.650     0.242
    56.065     6.974    34.299     4.998     0.803     0.225
     0.720     0.348     0.952     0.291
    54.327     6.366    37.381     3.803     0.462     0.066
    60.515     6.998    38.152     4.363     0.506     0.084
     0.649     0.235     0.971     0.216
    62.038     7.453    42.855     4.065     0.499     0.204
    70.598     9.042    44.955     4.420     0.656     0.411
     0.619     0.253     0.864     0.243
    66.932     7.151    48.890     3.486     0.490     0.381
    73.170     8.326    50.275     4.322     0.686     0.396
     0.551     0.120     0.930     0.288
    69.507     6.340    51.101     3.328     0.400    -0.059
    78.137     6.842    52.100     3.790     0.711     0.352
     0.525     0.129     0.723     0.346
    70.787     6.678    52.000     3.635     0.648    -0.005
    77.574     7.516    52.024     3.608     0.702     0.282
     0.680     0.168     0.903     0.427
    64.087     5.937    48.049     4.464     0.593     0.010
    74.721     7.467    49.614     4.808     0.649     0.281
     0.758     0.356     0.769     0.565
    55.944     6.115    42.910     4.787     0.602     0.418
    62.879     8.232    42.318     5.818     0.773     0.317
     0.812     0.460     1.005     0.459
    47.634     5.126    38.427     5.034     0.665     0.690
    49.908     6.961    37.000     5.600     0.842     0.551
     0.863     0.493     1.057     0.520
    42.311     5.220    34.589     5.748     0.566     0.774
    38.116     5.960    28.551     7.270     0.816     0.781
```

STATION NAME: REPUBLIC, WASHINGTON
STATION NUMBER: 456974
STATION ELEVATION: 2,610 METERS.
START OF SAMPLE INTERVAL: JANUARY 1, 1962.
END OF SAMPLE INTERVAL: DECEMBER 31, 1972.

COLUMN LOCATION

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>...|....1....|....2....|....3....|....4....|....5....|....6....|....7
456974 REPUBLIC, WASHINGTON              2610.00
     0.535      0.282      1.029      0.159
    30.260      9.598     12.890     13.504      0.802      0.752
    28.446      9.611     11.535     13.153      0.779      0.779
     0.373      0.191      1.548      0.083
    39.053      6.505     19.920     12.115      0.766      0.648
    39.068      7.159     17.055      9.687      0.663      0.587
     0.465      0.215      1.006      0.123
    42.323      6.030     22.828      8.355      0.682      0.514
    46.442      8.250     20.975      7.915      0.776      0.589
     0.436      0.183      0.851      0.185
    51.128      6.035     28.103      5.156      0.384      0.241
    56.377      7.282     29.044      5.928      0.657      0.477
     0.489      0.193      1.127      0.117
    57.913      6.730     34.522      6.468      0.306      0.334
    68.643      8.383     36.209      6.178      0.770      0.531
     0.518      0.232      1.325      0.124
    66.227      5.842     41.345      5.496      0.212      0.236
    75.782      8.332     42.941      6.059      0.741      0.493
     0.340      0.110      0.831      0.171
    73.480      8.166     43.020      5.406      0.540      0.364
    82.206      8.246     44.959      5.549      0.743      0.587
     0.500      0.106      0.806      0.323
    69.328      7.778     43.483      5.167      0.539     -0.020
    83.625      8.145     44.763      5.950      0.725      0.518
     0.478      0.137      0.939      0.148
    61.910      7.401     36.090      7.307      0.527      0.469
    72.985      9.909     38.080      6.874      0.776      0.600
     0.415      0.138      1.007      0.148
    51.231      6.356     30.215      6.588      0.533      0.440
    57.685      9.264     28.895      6.907      0.802      0.488
     0.407      0.288      0.947      0.164
    40.611      5.861     26.546      8.230      0.650      0.428
    40.419      6.788     24.905      7.457      0.689      0.472
     0.549      0.367      1.192      0.152
    32.222      7.010     18.621     11.839      0.715      0.731
    28.250     10.749     13.723     13.774      0.805      0.849
```

## Appendix II

### Keyword Summary

Summary of keywords (listed alphabetically):

| Keyword | Description | Page reference |
|---|---|---|
| DEBUG | Debug output is printed. NODEBUG stops this output. | 8 |
| DISPRMS | Display parameters for an internal station.<br>Field 1: Internal station number (default = 1). | 8 |
| END | End of Weather Model keywords. | 2 |
| FIXWEATH | Read fixed weather file.<br>Field 1: Data set reference number (no default). | 7 |
| RANNSEED | Enter new random number generator seed in field 1,<br>Default = 55329. | 8 |
| REDEFINE | Read a parameter file for a weather station.<br>Field 1: Internal station number, default = 1.<br>Field 2: Data set reference number, default = keyword file.<br>Field 3: First month, default = 1.<br>Field 4: Last month, default – 12. | 5 |
| TESTGEN | Generate weather for a specified period.<br>Field 1: Internal station number.<br>Field 2: First month, default is 3.<br>Field 3: Last month, default is 10.<br>Field 4: Year associated with the first month, default is 1. | 8 |
| USESTA | Specify the internal station number in field 1, default is 1. | 3 |
| WEATHER | Signal Weather Model keywords follow. | 2 |

The source code for the Weather Model and machine-readable copies of the parameter files can be obtained by writing to anyone of the following:

Nicholas L. Crookston
Intermountain Forest and Range Experiement Station
Forestry Sciences Laboratory
1221 South Main
Moscow, 10 83843 (208) 882-3557

J.J. Colbert
Northeastern Forest Experiment Station
Forestry Sciences Laboratory
180 Canfield Street
Morgantown, WV 26505 (304) 291-4613

Forest Pest Management
Methods Application Group
3825 East Mulberry, Rm. 228
Fort Collins, CO 80528 (303) 224-1785

**Kemp, William P.; Crookston, Nicholas L.; Thomas, Paul W. 1989.**
Users guide to the weather model: a component of the western spruce budworm modeling system. Gen. Tech. Rep. PNW-GTR-235. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 25 p.

A stochastic model useful in simulating daily maximum and minimum temperature and precipitation developed by Bruhn and others has been adapted for use in the western spruce budworm modeling system. This document describes how to use the weather model and illustrates some aspects of its behavior.

Keywords: Western spruce budworm, *Choristoneura occidentalis,* temperature, temperature simulation, stochastic weather model.



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