Environment Canada Imaging Cover Page

Report N.: *TEC-877*

SKP Box Number: 672572429

Environment Canada / Environnement Canada

Atmospheric Environment Service / Service de l'environnement atmosphérique

Technical Memoranda

AUTOMATED WEATHER ELEMENT INPUT TO FOREST FIRE SEVERITY FORECASTING

by

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Published under the authority of the Assistant Deputy Minister

Publication autorisée par le sous-ministre adjoint

UDC 551.509.58:632.187
ISSN 0708-2878

TEC 877
2 APRIL 1982

Available in French
Disponible en français

ENVIRONMENT CANADA - ATMOSPHERIC ENVIRONMENT SERVICE
4905 Dufferin Street, North York
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ABSTRACT

Across Manitoba and Saskatchewan appropriate weather element forecasts for each forestry station are automatically derived from grid-point output from the Canadian Meteorological Centre Spectral Model assuming a well-mixed planetary boundary layer. After modification, as required, by the Forestry Meteorologist, these forecasts are used to calculate Fire Weather Index values, which are entirely a function of weather, to predict the short-term potential forest fire severity.

Verification statistics for 1980 and 1981 indicate that the forecasts of temperature, humidity and wind speed were correct about two thirds of the time, and the forecasts of precipitation about 80 per cent of the time.

INTRODUCTION AUTOMATIQUE DES ÉLÉMENTS MÉTÉOROLOGIQUES POUR LA PRÉVISION DE LA GRAVITÉ DES INCENDIES DE FORÊT

par

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RÉSUMÉ

En faisant appel aux données de points de grille provenant du modèle spectral du Centre météorologique canadien, on obtient, sous réserve d'un bon mélange de la couche limite planétaire, des prévisions automatiques de certains éléments météorologiques correspondant à chaque station forestière à travers le Manitoba et la Saskatchewan. Une fois que le spécialiste de la météorologie forestière y a apporté les modifications nécessaires, on utilise ces prévisions pour calculer des valeurs de l'indice forêt-météo basées exclusivement sur les conditions météorologiques, ainsi que pour prévoir la gravité potentielle des incendies de forêt à courte échéance.

D'après les statistiques de vérification pour 1980 et 1981, les prévisions de température, d'humidité et de vitesse du vent étaient exactes dans les deux-tiers des cas environ, et les prévisions des précipitations étaient justes à 80%.

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(Manuscript received 17 October 1980; in revised form 29 January 1982)

1. Introduction

The fire danger in a forested area results from the complex interaction of many factors that affect the inception, spread, and difficulty of control of fires and the damage they cause. Climate, topography and property values are normally assumed constant while fuel moisture and weather combine to produce short-term fluctuations in the fire danger (Brown and Davis, 1973). Across Canada, the variable factors are normally monitored through the daily calculation of a composite index referred to as the Fire Weather Index (FWI). The FWI provides a scale for rating potential fire severity and is useful for evaluating the total fire danger. Since the FWI is entirely a function of weather, the actual and forecast indices may be calculated from observed and predicted values of the appropriate weather elements. The resultant FWI values indicate the intensity or severity of a potential fire, i.e., the potential energy output rate per unit length of fire front in a standard fuel type.

The Fire Weather Indices are used by forestry protection agencies to rate the potential fire severity for today and tomorrow. This information helps them to deploy their manpower and equipment in the most effective manner.

For a brief explanation of the components of the FWI, see Appendix 1; for a more detailed description, see Van Wagner (1970).

Environment Canada has entrusted the Atmospheric Environment Service (AES) with the responsibility of providing provincial fire control agencies with FWI values. Computer facilities at the AES regional centres are routinely used for this purpose. Indices, based on weather elements observed daily at 1200 LST, are calculated for a network of forestry stations. Forecast FWI values are also provided using forecast weather elements subjectively derived by AES meteorologists. Six-hour forecasts are made for 1200 LST today and 24-hour forecasts are produced for 1200 LST tomorrow. The "point" forecast approach is employed where weather elements forecast for specific reference stations are used to represent a particular area or weather zone. There are approximately 80 forestry stations across Manitoba and Saskatchewan.

AES Central Region provides a service that allows the forestry protection agencies of Manitoba and Saskatchewan to communicate directly with the computer system at the Prairie Weather Centre (PRWC). Direct assess, via the Trans-Canada Telephone System's TWX network, was implemented at the start of the 1979 season. The forestry protection agencies input weather observations and automatically receive actual and forecast FWI values. Beginning in 1980, the subjectively-produced forecasts of the weather elements were replaced by surface wind, temperature and relative humidity values automatically derived from grid-point data forecast by the Canadian Meteorological Centre (CMC) Hemispheric Spectral Model. The Forestry Meteorologist scrutinizes these weather element predictions and makes adjustments based on his assessment of their accuracy, thereby retaining control over the final product. Precipitation forecasts must still be subjectively produced.

This paper outlines the automated forecasting of weather element data input to Manitoba's and Saskatchewan's Fire Weather Indices, which are used in the short-term prediction of the potential fire severity. A brief description of the direct access procedure is also included.

2. Direct Computer Access by Forestry Protection Agencies

The forestry protection agencies of Manitoba and Saskatchewan are allowed direct access to PRWC's computer system. Access is initiated by dialing the PRWC's computer via TWX; identification is through a prearranged password. The forestry program has two user access time-slots. When accessed in the morning (1300-1500 GMT), the system responds with a request for data. The user then enters the precipitation accumulated at each forestry station over the 18-h period ending at 1200 GMT. The program then calculates and outputs the FWI values forecast for noon LST today based on the actual rainfall and forecast values of surface wind speed, temperature and relative humidity. Predicted 1200 LST values for these weather elements would normally have been input to the computer system by the procedure to be outlined in Section 3. The afternoon user time-slot (1830-1930 GMT) provides for direct entry of the 1200 LST observations of dry- and wet-bulb temperatures and wind speed plus the rainfall accumulated over the preceding 24 h. The computer outputs the actual FWI values based on today's observations and the predicted values for 1200 LST tomorrow based on the weather elements forecast for noon tomorrow. These weather element forecasts would previously have been input to the system by the procedure outlined in the next section.

3. Automated Forecast Input to the FWI

Surface weather element predictions, used in the calculation of forecast Fire Weather Indices, are automatically derived from grid-point output from CMC's operational Spectral Model.

3.1 Data Source

Grid-point data for a "Prairie window" are being received from the operational Spectral Model for times t = 0 to t = 36 h at 6-h intervals. The 6 x 6 window is defined by the CMC grid-points (20, 16), (25, 16), (25, 21) and (20, 21). Data, coded and converted to base 36 for brevity, are received via teletype twice daily at approximately 0430 and 1630 GMT. The fields transmitted by CMC include heights, temperatures and dew-point depressions for the 100-, 85-, 70- and 50-kPa levels. At the PRWC, the data are automatically decoded and stored on disc (Raddatz, 1978).

3.2 Selective Access to Data

A data acquisition routine provides selective time and location access to the stored data fields. The forestry station's locations (latitude and longitude) are accessed from a second data file and converted to Prairie window coordinates. The forecast period is controlled by two "forecaster access time-slots" that precede the "user access time-slots" discussed in Section 2. Spectral grid-point forecasts for 1800 GMT today, based on yesterday's 0000 GMT observations, are read from the storage file during the morning time-slot (1230-1300 GMT). Bessel's central difference scheme (Haltiner, 1971) is then used to interpolate the data from the grid-mesh to the station. Forecast surface weather elements for each forestry station are then derived by the methods outlined in Section 3.3. These values are then used to predict the Fire Weather Indices for "noon" today. During the afternoon time-slot (1700-1830 GMT), Spectral grid-point forecasts for 1800 GMT tomorrow, based on today's 1200 GMT observations, are read from the data file. The data are interpolated for the stations and used to derive surface weather elements and subsequently FWI values for noon tomorrow.

3.3 Automatically Derived Forecasts of the Surface Weather Elements

Forecast weather elements for each forestry station are automatically derived from grid-point upper-air data predicted by CMC's operational Spectral Model. Surface weather elements are derived assuming a well-mixed planetary boundary layer (PBL), typical of summer midday conditions. Therefore, the forecast surface temperature, relative humidity and wind speed can only be used when the assumption of a fair-weather boundary layer applies.

Wind

The forecast surface (i.e. 10-m or anemometer-level) wind is derived in the following manner:

a) The 100-kPa level geostrophic wind for each forestry location is calculated from a station-centred grid of 100-kPa heights interpolated from the Prairie window grid. This wind is used to approximate the free atmosphere wind, i.e., the wind unaffected by surface fluxes.

b) The depth of the PBL is assumed to be equal to the greater of the mechanical boundary layer (MBL) depth and the thermal or convective boundary layer (TBL) depth. The MBL (m) is approximated by:

$$MBL = V_g \times 125$$

where V_g (m/s), the 100-kPa geostrophic wind, is used to approximate the 10-m or anemometer-level wind. This is an adaptation of the equation suggested by Benkley and Shulman (1979) for calculating the depth of the mechanical boundary layer from historical meteorological data. The above formulation assumes $MBL = 0.185U_*/f$, where the Coriolis parameter $f = 10^{-4}\ s^{-1}$, and the value of the friction velocity U_* is derived assuming a logarithmic wind profile in the lowest 10 m, the von Kármán constant of 0.35 and a roughness length of 5 cm. Since the depth of the

MBL is subsequently used to calculate the forecast summer midday surface temperature and the depth of the thermal boundary layer it was limited to the range, 500 to 1000 m.

The TBL (m) is given by Danard, (1977):

$$TBL = (T_o - T_f)/(\gamma_d - \gamma_f)$$

where γ_d (°C/m) is the dry-adiabatic lapse rate, γ_f is the free atmosphere lapse rate computed from the 85- and 70-kPa data, T_o (°C) is the surface temperature, derived by assuming a dry-adiabatic lapse rate in the MBL consistent with the well-mixed assumption, and T_f (°C) is the temperature that the surface would have, assuming a free atmosphere lapse rate.

c) The drag coefficient is given by (Cressman, 1960):

$$C_D = C_t + C_s$$

where C_t is the terrain drag due to the rolling nature of the topography, assumed constant at 5×10^{-3} (Sawyer, 1959), and C_s is the skin drag given by $C_s = (1 + 0.21\ V_g) \times 10^{-3}$ (Deacon and Webb, 1962).

The 100-kPa geostrophic wind, V_g, the drag coefficient, C_D and the deeper of MBL and TBL are used to calculate the surface wind by assuming an Ekman balance and solving the horizontal equations of motion by the iterative method. Then, in keeping with the well-mixed PBL assumption, and the accompanying downward transport of horizontal momentum, the Ekman solution is modified by the 85-kPa geostrophic wind to derive the forecast surface wind speed using the empirical formula $V_o = (2V_E + V_{85})/3$ where V_E is the Ekman solution wind speed and V_{85} is the 85-kPa geostrophic wind speed.

<u>Temperature</u>

The noon surface temperature is forecast in the following manner:

a) The temperature at the top of the MBL is calculated from the height of the MBL and the 100-85 kPa lapse rate. (The assumption of a well-mixed boundary layer dictates a dry-adiabatic lapse rate within the MBL.) This lapse rate in conjunction with the depth of the MBL is used to convert the temperature at the top of the MBL into a first approximation of the surface temperature.

b) The first-guess surface temperature is then used to calculate the depth of the TBL as outlined above. If the TBL is greater than the MBL then the deeper PBL and the dry-adiabatic assumption are used to calculate a new surface temperature. This temperature is then increased by 1°C to approximate a slightly superadiabatic lapse rate in the lowest 100 m of the PBL (i.e., the Prandtl layer).

Relative Humidity

The surface relative humidity (RH_o) is derived by inserting the 100-kPa dew point and the forecast surface temperature into the Clausius-Clapeyron equation. A modified surface relative humidity was then calculated using the empirical formula:

$$RH_o = [(RH_o + RH_{85})/2] \times 0.75$$

where the subscripts "o" and "85" refer to the surface and the 85- kPa level, respectively. This calculation is consistent with the assumption of a well-mixed PBL and with experience.

Precipitation

The 6-h precipitation forecasts for noon today are not required, since the measured rainfall from 1800 GMT yesterday to 1200 GMT today is used to approximate the 1200-1200 LST rainfall. The 24-h precipitation forecasts for the period 1200 LST today to 1200 LST tomorrow are still subjectively derived by the Forestry Meteorologist.

3.4 Final Product

The surface wind speed, temperature and relative humidity automatically derived from the Spectral grid-point output are presented to the forecaster to be accepted, modified or rejected. An assessment of the current synoptic situation allows the forecaster to determine: (1) whether the assumption of a well-mixed PBL is applicable: and (2) whether the Spectral Model's solution is appropriate. If either the well-mixed assumption or the Spectral solution is rejected, the meteorologist must reject the automatically derived weather element forecasts and subjectively derive the final product.

3.5 Operational Procedure

The operational program F1, employed by the Forestry Meteorologist to automatically access the appropriate Spectral Model output and to derive the surface weather element forecasts, is outlined in the block diagram, Appendix 2. The program includes the option of bypassing the automated procedure and manually inputting subjectively-derived forecasts of surface weather elements.

4. Verification of Final Product - 1980 and 1981

4.1 Data Sample and Verification Procedure

During the 1980 fire weather season observed and forecast weather elements were saved for 20 locations across Saskatchewan and Manitoba for three months, June, July and August. This resulted in a verification sample of 1840 observations of temperature, relative humidity, wind speed and precipitation for comparison with data from the two forecasts, one forecast with a lead time of

24 h and the updated forecast with a lead time of 6 h. Two error statistics were calculated by stations over the "summer" season:

absolute error = |forecast - observed|
bias error = forecast - observed

A mean value of each statistic averaged over the 20 stations was then derived (see Tables 1 and 2). In 1981, weather elements were saved for 19 locations* for May through September, producing a verification sample of 2907 observations of each weather element for comparison with the two forecasts. Statistics were again calculated by station for the "summer" season. Mean values averaged over the 19 stations were derived and compared with the 1980 values. For brevity, only the broad picture illustrated by the station-averaged values and the 1980-1981 comparisons will be discussed.

4.2 Verification statistics for 1980 (Table 1) and 1981 (Table 2)

a) The 24- and 6-h temperature forecasts both had an average absolute error of 2-3°C in 1980, and just over 3°C in 1981. Bias calculations indicated that the 24-h forecast tended to be a little low while the 6-h forecast tended to be a little high. This bias "oscillation" may be attributed to the Spectral Model output, from which the forecasts are derived. The temperature values for the lower levels of the atmosphere, as predicted by the Spectral Model, show this same oscillation between forecasts based on 1200 and 0000 GMT data.

b) The relative humidity forecasts averaged 14-15% in absolute error and the predicted values were generally too low. This, in part, may be caused by the empirical formula used to derive the surface relative humidity forecasts from the 100- and 85-kPa relative humidities predicted by the Spectral Model. Gimli data are excluded from the 1981 average since they had an unusually strong negative bias; RH values were persistently underforecast by 15 to 20%, an anomaly attributed to a local lake effect.

c) The wind speed forecasts averaged 7-8 km/h in absolute error in 1980 and 7 km/h in 1981. Winds were generally forecast to be stronger than the observed winds.

d) The precipitation forecasts averaged 2-3 mm in absolute error in 1980 and 1-2 mm in 1981. Precipitation was generally underforecast. As indicated earlier, this weather element is still a subjective product of the Forestry Meteorologist, the only one without an automated first-guess field.

4.3 Comparison of 1980 and 1981 Statistics

Comparison with the average absolute errors obtained in 1980 indicate that slight improvements were made in 1981's forecast of wind and precipitation. The

*Data for The Pas were not saved in 1981 because of a programming error.

RH average absolute error was about the same as in 1980 and the temperature forecast was marginally poorer. The slight reduction in temperature forecasting accuracy may be attributed to the extension of the verification sample to include the transitional months of May and September.

4.4 Percentage Correct Forecasts for 1980 and 1981

A correct forecast was defined as one falling within the following bias error limits:

Temperature: ± 3°C RH: ± 15%
Wind Speed : ± 8 km/h Precipitation: ± 3 mm

a) In Table 3 each weather element was accurately predicted about two thirds of the time. Favourable exceptions to this were the temperature forecast with a 6-h lead time, which were correct on an average of 73% of the time, and both precipitation forecasts, which were correct 80-83% of the time.

b) In 1981, (Table 4) each weather element with a 6-h lead time was also accurately predicted on about two thirds of the days. Slightly poorer accuracy was achieved for the 24-h lead time. Exceptions were the wind and precipitation forecasts, which were correctly forecast 69-70% of the time and 88-89% of the time, respectively.

c) A station-by-station examination of the verification statistics appears to indicate that at some sites, local effects act to reduce the accuracy of the forecasts. This is illustrated by Gimli data, where the relative humidity was consistently underforecast by a larger than average amount, and was likely attributable to Gimli's location on the shores of Lake Winnipeg.

5. Discussion and Conclusion

Surface weather element forecasts for each forestry station in Manitoba and Saskatchewan are automatically derived from CMC's Spectral Model grid-point output. The procedure assumes a well-mixed PBL typical of summer midday conditions. The forecast surface wind speed, temperature and relative humidity data, after scrutinization by the Forestry Meteorologist, are used to calculate Fire Weather Indices, which are used in the short-term prediction of potential forest fire severity.

Automatically derived surface weather element forecasts provide for uniform interpretation of Spectral Model output while producing a spatially consistent product. When the assumption of a well-mixed PBL applies, automation frees the forecaster from the task of producing numerous point forecasts. The forecaster's role is elevated to "model analyst" interpreting the applicability of the Spectral output and the well-mixed PBL assumption.

Verification statistics indicate that the weather element forecasts produced in the manner outlined in this paper were correct about two thirds of the time.

APPENDIX 1

Fire Weather Index (FWI)

The FWI is composed of six components, three moisture codes representing the drying rates of the main classes of forest fuel, two intermediate indices representing fire spread rate and amount of fuel available and the FWI itself representing the intensity of a single fire in a standard fuel type. The Fire Weather Index is calculated once per day to represent the fire danger during the afternoon peak period, assuming a normal diurnal pattern. The FWI, based on observed or forecast surface weather elements, effectively rates potential fire severity.

The moisture codes and fire behaviour indices according to Turner and Lawson (1978) are:

a) Moisture codes:

   i. Fine fuel moisture code (FFMC) is a numerical rating of moisture content of litter and other cured fine fuels in a forest stand.

   ii. Duff moisture code (DMC) represents moisture content of loosely composed organic (duff) layers of moderate depth.

   iii. Drought code (DC) represents moisture content of deep compact organic layers.

b) Intermediate indices:

   i. Initial Spread Index (ISI), a combination of wind speed and FFMC, representing fire spread rate without the influence of variable fuel quantity.

   ii. Buildup Index (BUI), a combination of DMC and DC that represents total amount of fuel available to the spreading fire.

c) Fire Weather Index:

   i. A combination of ISI and BUI that represents the intensity of a spreading fire as energy output rate per unit length of fire front. The components of the Canadian FWI are summarized in Figure 1.

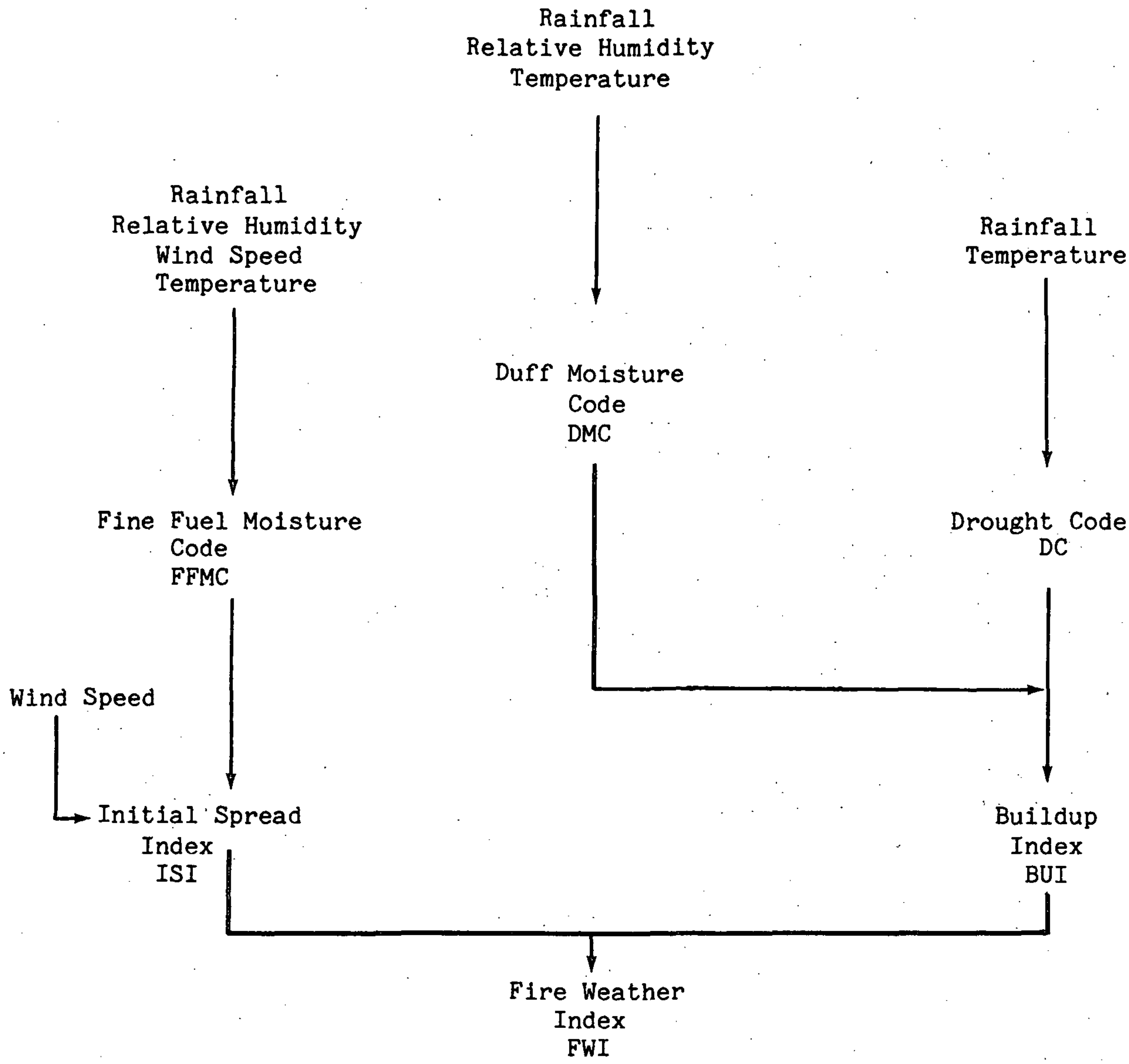

Figure 1

Components of the Canadian Fire Weather Index
(after Turner and Lawson, 1978).

APPENDIX 2

Block Diagram for Program F1

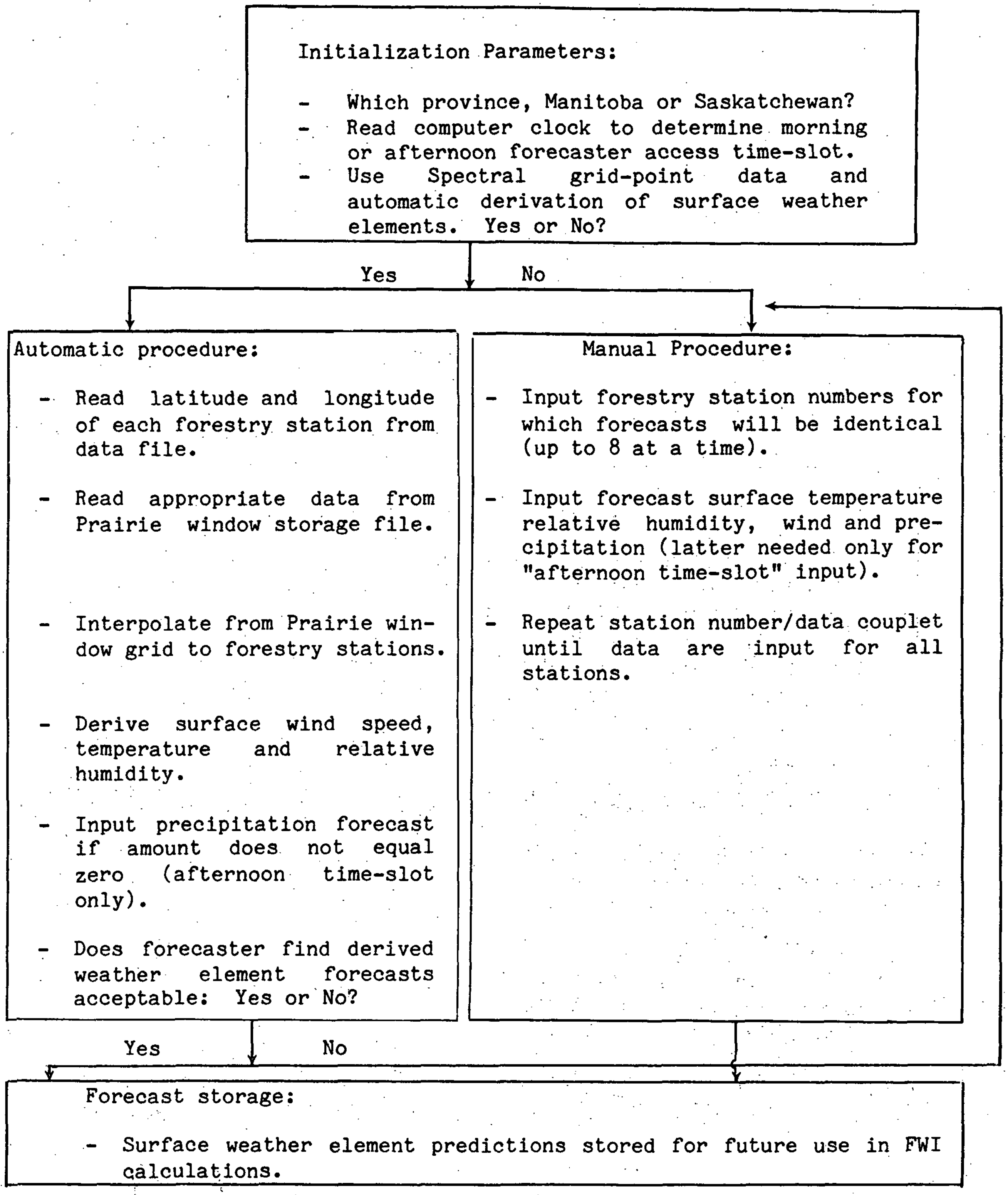

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Table I

Average Absolute Error (A) and Bias Error (B) 1980
(See section 4.1 for definitions)

Station	Lead Time (h)	Temperature (°C)		RH (%)		Wind Speed (km/h)		Precipitation (mm)	
		A	B	A	B	A	B	A	B
Lynn Lake	24	3.4	-0.5	13.7	+4.2	8.0	+2.7	2.9	-2.0
	6	2.5	+0.9	10.9	-1.0	7.3	+2.3	2.8	-2.4
Bissett	24	3.5	-0.2	14.9	-2.9	7.2	+1.9	2.3	-0.3
	6	2.9	+1.4	14.5	-7.7	7.0	+2.6	1.8	-1.5
Island Lake	24	2.7	-0.4	14.6	-7.3	6.6	-0.5	2.2	-0.8
	6	2.8	+0.8	15.0	-11.0	5.8	-2.0	2.0	-1.6
Gillam	24	3.4	-0.1	14.9	-4.8	5.9	-1.1	3.4	-2.8
	6	3.1	+1.4	14.2	-8.2	5.8	-2.1	3.8	-3.3
Winnipeg	24	2.9	-0.7	13.9	-2.7	9.4	-5.4	1.7	-0.7
	6	2.8	+1.1	12.6	-8.0	8.0	-4.3	1.8	-1.4
Gimli	24	2.8	-1.0	17.7	-13.5	6.8	+1.1	2.1	-1.0
	6	3.4	+2.5	19.8	-18.4	6.4	+2.5	2.4	-2.1
Thompson	24	3.8	-0.9	13.9	-0.4	7.9	+1.1	2.7	-1.6
	6	2.5	+0.0	10.9	-3.7	7.8	+0.2	2.6	-2.2
Dauphin	24	2.6	-0.1	15.4	-8.8	9.8	-1.7	3.4	-2.0
	6	2.6	+1.5	15.5	-13.3	8.4	-0.6	3.3	-2.9
The Pas	24	2.7	-0.2	14.0	-6.4	6.8	-0.8	2.2	-0.1
	6	2.2	+1.1	12.9	-10.2	5.8	-0.6	1.8	-1.2
Fort Chipewyan	24	3.1	-1.1	15.2	-1.4	8.3	+4.0	3.1	-1.5
	6	3.0	-0.3	15.2	-4.3	6.9	+2.3	2.5	-2.2
Uranium City	24	2.9	-1.0	12.5	+3.9	8.1	+6.5	1.6	-0.4
	6	2.4	-0.2	11.7	+1.5	6.2	+4.4	0.6	-0.4
Cree Lake	24	2.9	-0.2	15.0	-1.9	7.7	+3.9	1.6	-0.3
	6	2.7	+1.0	14.3	-5.3	6.4	+2.8	1.4	-1.2
Collins Bay	24	3.2	-0.8	15.2	-2.4	6.1	+1.5	2.4	-1.1
	6	3.0	+1.5	15.2	-5.7	5.6	+1.2	2.5	-2.2
Fort McMurray	24	2.8	-0.3	16.3	-4.1	7.4	+5.1	2.3	-0.9
	6	2.4	+0.7	16.1	-7.0	6.4	+4.8	2.1	-1.9
Buffalo Narrows	24	3.1	-0.5	19.5	-7.8	7.5	+3.8	2.5	-0.5
	6	2.7	+1.5	18.0	-10.9	6.8	+2.9	2.0	-1.8
Cold Lake	24	2.4	-0.8	14.2	-8.2	8.3	+2.4	2.4	-1.2
	6	2.3	+1.6	14.2	-10.4	7.7	+2.2	2.5	-2.3
La Ronge	24	2.8	-0.8	14.3	-1.8	6.5	+1.2	2.5	-0.4
	6	2.5	+0.2	12.6	-5.0	6.8	+1.9	1.9	-1.8
Prince Albert	24	2.3	-0.7	11.5	-0.6	8.1	-1.0	1.9	-0.3
	6	2.2	+0.3	12.1	-3.9	7.6	-0.8	1.6	-1.6
Nipawin	24	2.5	-1.2	11.0	-1.7	8.0	+0.7	2.2	-0.4
	6	2.0	-0.1	11.7	-5.5	8.2	+1.4	2.1	-1.8
Hudson Bay	24	2.4	-0.3	13.9	-7.7	8.5	+2.4	2.6	-0.5
	6	2.3	+0.8	19.4	-10.7	8.6	+3.0	2.3	-1.9
STATION AVERAGE	24	2.9	-0.6	14.6	-3.8	7.6	+1.4	2.4	-0.9
	6	2.6	+0.9	14.3	-7.4	7.0	+1.2	2.2	-1.7

Table 2

Average Absolute Error (A) and Bias Error (B) 1981
(See section 4.1 for definitions)

Station	Lead Time (h)	Temperature (°C) A	Temperature (°C) B	RH (%) A	RH (%) B	Wind Speed (km/h) A	Wind Speed (km/h) B	Precipitation (mm) A	Precipitation (mm) B
Lynn Lake	24	3.8	-0.5	17.9	+5.3	7.1	-0.3	2.3	-1.5
	6	3.4	+1.2	14.1	-1.2	7.4	+0.3	2.4	-1.9
Bissett	24	3.1	-0.8	12.6	-4.1	7.3	+3.6	1.7	-0.5
	6	3.2	+0.9	15.8	-9.5	7.9	+4.4	1.7	-1.1
Island Lake	24	3.7	-0.2	16.0	-4.0	7.4	+0.2	1.7	-0.8
	6	3.3	+1.2	16.4	-8.2	7.4	+0.5	1.8	-1.5
Gillam	24	3.9	+0.6	16.5	-6.3	5.8	-0.3	1.7	-1.0
	6	3.5	+1.6	16.1	-9.4	6.3	+0.2	1.8	-1.1
Winnipeg	24	2.7	-0.8	11.9	-2.7	7.9	-2.9	1.8	-0.7
	6	3.1	+1.1	15.1	-9.3	7.7	-1.9	2.1	-1.1
Gimli	24	2.5	+0.5	17.1	-12.5	5.6	+1.2	1.9	-1.0
	6	3.4	+2.5	20.9	-18.6	6.2	+2.3	2.2	-1.4
Thompson	24	3.7	-1.2	15.2	+4.2	6.4	+0.0	1.5	-0.6
	6	3.6	+0.3	13.7	-1.5	6.5	-0.0	1.6	-1.0
Dauphin	24	3.2	-1.0	12.9	-2.9	8.7	-2.3	2.3	-1.1
	6	3.3	+1.5	15.9	-9.7	8.8	-2.5	2.4	-2.0
Fort Chipewyan	24	3.4	-1.0	15.0	+0.1	6.5	+0.7	0.9	-0.0
	6	3.3	+0.9	14.7	-5.4	5.9	+0.3	0.6	-0.5
Uranium City	24	3.0	-0.8	14.2	+1.4	5.9	+3.5	0.9	-0.2
	6	2.8	+0.6	13.2	-2.7	6.5	+3.4	0.8	-0.7
Cree Lake	24	3.3	-0.6	15.7	+4.3	5.9	+0.8	1.2	-0.1
	6	3.1	+0.8	14.9	-1.8	6.2	+0.5	0.9	-0.8
Collins Bay	24	3.6	+0.3	16.8	-3.2	6.2	+0.9	1.6	-0.7
	6	3.5	+1.4	17.2	-7.9	6.1	+0.4	1.5	-1.3
Fort McMurray	24	3.4	-1.2	17.4	+4.1	6.9	+3.1	1.5	-0.5
	6	2.9	+0.4	16.1	-2.0	6.3	+2.4	1.2	-1.1
Buffalo Narrows	24	3.1	-1.0	14.2	+0.9	5.8	+0.5	1.2	-0.2
	6	2.6	-0.7	16.1	-5.5	5.7	-0.4	1.0	-0.9
Cold Lake	24	2.6	-0.3	14.9	+2.2	6.9	+0.1	1.5	-0.5
	6	2.9	+0.3	15.1	-3.4	6.5	-1.1	1.4	-1.2
La Ronge	24	3.1	-0.9	12.6	+5.4	6.0	-0.6	1.2	-0.1
	6	2.6	+0.5	11.8	-0.3	6.2	-1.0	1.1	-1.0
Prince Albert	24	2.9	-0.9	13.5	+4.8	6.9	-1.4	1.1	-0.2
	6	2.6	+0.4	13.0	-1.3	6.8	-2.2	1.1	-1.0
Nipawin	24	2.6	-0.8	12.5	-0.1	7.8	-1.5	1.7	-0.5
	6	2.8	+0.8	13.6	-5.8	7.5	+0.9	1.6	-1.5
Hudson Bay	24	2.7	-1.0	12.6	-1.1	7.3	+2.8	2.0	-0.9
	6	2.5	+0.5	13.8	-6.5	7.3	+1.7	2.1	-1.9
STATION AVERAGE	24	3.2	-0.6	14.7	-0.0*	6.8	+0.4	1.6	-0.6
	6	3.1	+1.0	14.1	-5.1*	6.8	+0.4	1.5	-1.2
STATION AVERAGE 1980	24	2.9	-0.6	14.6	-3.8	7.6	+1.4	2.4	-0.9
	6	2.6	+0.9	14.3	-7.4	7.0	+1.2	2.2	-1.7

*Gimli not included.

Table 3

Percentage of forecasts for each weather element falling within a range of bias error indicated: June through August 1980.

Station	Lead Time (h)	Temperature (±3°C)	RH (±15%)	Wind Speed (±8 km/h)	Precipitation (±3 mm)
Lynn Lake	24	56	64	63	78
	6	73	77	66	78
Bissett	24	60	64	67	79
	6	74	63	67	85
Island Lake	24	77	60	63	81
	6	71	62	77	85
Gillam	24	62	63	76	79
	6	68	65	77	74
Winnipeg	24	64	69	53	84
	6	70	70	58	86
Gimli	24	73	46	67	79
	6	59	40	66	76
Thompson	24	48	65	68	77
	6	72	82	66	79
Dauphin	24	71	56	59	74
	6	72	60	59	74
The Pas	24	69	63	74	77
	6	82	61	75	78
Fort Chipewyan	24	64	66	61	89
	6	66	61	65	95
Uranium City	24	65	75	65	85
	6	77	75	73	96
Cree Lake	24	66	62	70	84
	6	73	64	70	85
Collins Bay	24	64	62	78	76
	6	63	61	85	80
Fort McMurray	24	70	65	61	83
	6	72	61	70	83
Buffalo Narrows	24	66	53	68	79
	6	71	58	67	87
Cold Lake	24	68	64	57	82
	6	79	64	64	83
La Ronge	24	68	65	71	75
	6	70	72	72	80
Prince Albert	24	75	74	60	82
	6	86	66	58	86
Nipawin	24	74	73	60	82
	6	85	68	57	86
Hudson Bay	24	79	68	54	78
	6	79	62	51	78
STATION AVERAGE	24	67	64	65	80
	6	73	65	67	83

Table 4

Percentage of forecasts for each weather element falling within a range of bias error indicated: May through September 1981.

Station	Lead Time (h)	Temperature (±3°C)	RH (±15%)	Wind Speed (±8 km/h)	Precipitation (±3 mm)
Lynn Lake	24	53	51	64	90
	6	64	64	63	87
Bissett	24	64	66	64	86
	6	70	56	66	86
Island Lake	24	57	52	64	90
	6	61	53	64	88
Gillam	24	49	52	78	90
	6	64	58	75	89
Winnipeg	24	68	70	64	85
	6	70	61	66	83
Gimli	24	75	51	75	86
	6	65	36	73	86
Thompson	24	55	63	70	88
	6	59	68	72	90
Dauphin	24	59	60	53	81
	6	63	61	57	81
Fort Chipewyan	24	55	63	71	94
	6	70	65	76	94
Uranium City	24	64	63	77	93
	6	69	53	70	91
Cree Lake	24	59	62	77	90
	6	62	63	74	94
Collins Bay	24	54	54	71	90
	6	56	52	72	94
Fort McMurray	24	57	54	67	89
	6	70	55	76	93
Buffalo Narrows	24	61	67	77	87
	6	69	58	78	90
Cold Lake	24	69	65	68	88
	6	69	61	73	90
La Ronge	24	60	71	71	89
	6	74	70	73	92
Prince Albert	24	65	65	66	88
	6	73	69	69	89
Nipawin	24	71	73	61	85
	6	77	55	65	88
Hudson Bay	24	66	66	65	82
	6	76	61	65	84
STATION AVERAGE	24	61	61*	69	88
	6	67	65*	70	89
STATION AVERAGE 1980	24	67	64	65	80
	6	73	65	67	83

*Gimli not included.

TEC 877 UDC: 551.509.58:632.187
2 April 1982 ISSN: 0708-2878
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ABSTRACT Across Manitoba and Saskatchewan appropriate weather element forecasts for each forestry station are automatically derived from grid-point output from the Canadian Meteorological Centre Spectral Model assuming a well-mixed planetary boundary layer. After modification, as required, by the Forestry Meteorologist, these forecasts are used to calculate Fire Weather Index values, which are entirely a function of weather, to predict the short-term potential forest fire severity.

Verification statistics for 1980 and 1981 indicate that the forecasts of temperature, humidity and wind speed were correct about two thirds of the time, and the forecasts of precipitation about 80 per cent of the time.

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