Prometheus Data I/O Standards Manual

Version 5.2

CWFGM Data I/O Standards Technical Sub-Committee

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Prometheus - the Canadian Wildland Fire Growth Simulation Model
Version 5.2
Data I/O Standards

March, 2009

1. Purpose

This document describes the data input and output (I/O) standards used for *Prometheus* - the Canadian Wildland Fire Growth Simulation Model Version 5.2. Later versions of *Prometheus* may include enhanced data I/O functionality. These future considerations are summarized in Appendix E.

2. Data Input

There are two ways to input data into *Prometheus*: import a file or interactively input data from the screen.

Fire ignition point(s), fire ignition line(s), fire ignition polygon(s), weather stream(s), and fuel break(s) can be entered interactively from the screen or input as files. This document focuses on the format of files for input and output.

3. Data Output

Data can be output graphically (i.e. display) or as a file. Prometheus uses ESRI Generate, Shapefile and MapInfo file formats.

4. Data Size and Raster Cell Alignment

To run a fire growth simulation, most users will need to clip a small area of data (i.e. area of interest) from a larger database. No maximum data size has been determined at this time. However, the larger the area, and size of the data, the longer it will take to import the file. As well, program performance may be compromised if very large fires are run using a very large landscape.

Prometheus uses a raster data format to input fuel and topography data. Any cell size can be used. Users must ensure that all of the raster data use the same coordinate system and cell size to ensure cell alignment between the grids.

5. **Projection**

Prometheus requires a projection file. FBP fuel type, DEM, slope and aspect grids can be input using any projection as long as they all use the same projection. Sponsoring agencies were contacted to determine which projections to support for vector input. The supported projections include:

- Albers Conic Equal-Area (Albers)
- Universal Transverse Mercator (UTM)
- 10 Degree Transverse Mercator (10 TM)
- Lambert Conformal Conic (Lambert)
- New Zealand Map Grid

Version 5.2 uses the PROJ.4 cartographic projections and datum library. This library supports many additional projections than the five listed above. However, they have not been tested. Users should exercise caution when using these projections.

If no projection file corresponding to the vector data is provided, Prometheus will assume the same projection as that used for the FBP fuel-type grid.

The *Prometheus* application allows users to input fire ignitions and vector data in any of these five projections. These data will be re-projected on the "fly" to the projection used by the *Prometheus* project (i.e. the projection applied to the FBP fuel-type grid).

Ignition points, lines and polygons can be input interactively as X and Y geographic coordinates when New Ignition is selected in the Component View. Although Decimal Degrees (DD) is the default format for the Geographic Coordinate System, users can also select the Degree Decimal Minutes or Degree Minutes Seconds format. The ignition location in the Component View is always displayed in Relative Distance. In Relative Distance, the lower left corner point is represented as 0,0.

The North American Datum of 1983 (NAD83) is the recommended Datum. The Canadian method (CNT) is the recommended transformation method between NAD27 and NAD83. Datum conversion is not provided in Prometheus.

ESRI's projection file formats are the standard formats used in *Prometheus* to provide projection information. *Prometheus* accepts two different projection file formats. The coverage or Grid projection file, and the shapefile projection file. A coverage or a grid projection file is the prj.adf file hidden in the coverage or the grid folder. A shapefile projection file is named as shapefile-name.prj. Regardless of the format used, the projection file used in Prometheus must have the *.prj extension. If a projection file does not accompany a Shapefile when importing vector data, the *Prometheus* application will assume the Shapefile is in the same projection as the FBP fuel type grid.

Example projection files are included in Appendix B, for five of the standard projections that are supported and have been tested in Prometheus.

The Universal Transverse Mercator System (UTM) is a specialized Transverse Mercator Projection. The globe is divided into 60 UTM zones. Each UTM zone covers a 6 degree area (spanning 3 degrees west and 3 degrees east of its central meridian). The origin of each zone is the equator and its central meridian. To eliminate negative coordinates, the projection alters the coordinate values at the origin. The value given to the central meridian is the false easting, and the value assigned to the equator is the false northing. Central meridians west of Greenwich have negative values, and east of Greenwich the central meridians have positive values.

Some agencies using the UTM projection have more than one UTM zone. To overcome this problem, one UTM zone (usually the eastern zone) is "pushed" and extended into the other zone. Some agencies modify the standard UTM to meet their own needs. In this case, a modified projection file is required to include the new parameters. This practice is a "trade-off" between increased distortion, and increased area coverage using one projection system. 10TM projection is a typical example.

6. Data Catalogue

6.1 Required Input Data

This is the minimal input data required to run a *Prometheus* simulation.

- FBP fuel type grid (Grid ASCII file)
  - FBP fuel type lookup table (ASCII text file)
- Projection file (ESRI file format) for the FBP fuel type.
- Fire ignition point, fire ignition line or fire ignition polygon (interactive screen input, Generate ASCII file or Shapefile)
- Weather stream (manual or ASCII data file import)

6.2 Optional Input Data

- Green up grid (ASCII file)
- Elevation grid (ASCII file)
- Slope grid (ASCII file)
- Aspect grid (ASCII file)
- Wind speed grid (ASCII file)
- Wind direction grid (ASCII file)
- Fuel breaks (input interactively, or assigned from vector data)
- Vector data (Generate ASCII file, Shapefile)

6.3 Output Data

- Fire perimeter (Graphical/Map, Statistics View, Generate ASCII file, Shapefile, MapInfo file)
- Fuel breaks (Generate ASCII file, Shapefile, MapInfo file)
- Modified FBP fuel type Grid (Grid ASCII file)
- FBP fuel type lookup table (ASCII text file)
- Statistics View (ASCII text file)
- Weather Stream (ASCII text file)
- Weather and Fire Behaviour Prediction System Raster output (ASCII Grids)

7. Data Format

ESRI's Generate ASCII and Shapefile formats are used to input and output vector data. ESRI has included in their document library, a white paper documenting the format of the Shapefile. It can be obtained at the following address:

http://www.esri.com/library/whitepapers/pdfs/shapefile.pdf

The document is entitled: "ESRI Shapefile Technical Description". This format documentation provides the information needed to allow programmers to read and write Shapefiles.

Most agencies use the Shapefile format. The Generate ASCII file format is provided as an alternate format that can be used independent of the type of GIS software used. The ESRI Generate ASCII file formats can be found in Appendix C.

Although the vector Generate ASCII file format cannot be imported directly into ArcView, the ESRI website provides an Arcscript to add a theme from a Generate format ASCII file. This script is located at:

http://arcscripts.esri.com/details.asp?dbid=10606

Attributes cannot be included in the Generate ASCII files. As a result, separate ASCII data files are required to input/link any attribute data.

If a Shapefile is chosen, all of the attributes can be included in either the associated DBF file or in the comma delimited ASCII text file. The item requirements and definitions of the ASCII file also apply to the *.dbf file.

ESRI’s generated ASCII file is the format used for raster files. This format consists of header information containing a set of keywords, followed by cell values in row-major order.

Detailed information on the ESRI Generate ASCII file format is provided in Appendix C. Note that Prometheus only accepts integer raster files with the LLCORNER option.

8. Data Descriptions

This section provides a detailed description and example of the data sets described in Section 6 - Data Catalogue. Input and output data are separated in this session. If not described in the output it means the description in the input applies.

8.1 Input Data

FBP fuel type grid

The ESRI Generate ASCII file is the standard format used to input the FBP fuel type data layer into *Prometheus*. The ASCII file is a standard format used to transfer raster ASCII data between various applications. The detailed description of this data format can be found in Appendix C. Prometheus only uses an integer raster with LLCORNER options for the FBP fuel-typ[e grid.

The following is an example of an ASCII raster file:

```
ncols         480
nrows         450
xllcorner     378923
yllcorner     4072345
cellsize      30
nodata_value  -9999
43 3 45 7 3 56 2 5 23 65 34 6 32 etc
35 45 65 34 2 6 78 4 38 44 89 3 2 7 etc
.
.
<data in row n>
```

The rows are entered sequentially starting at the top; i.e. the first value in row 1 is located in the upper left corner. Cell values should be delimited by spaces. No carriage returns are necessary at the end of each row in the data set. The number of columns in the header is used to determine when a new row begins. The total number of cells in the file must be exactly equal to the product of the specified number of rows and columns.

No comment statements are allowed in the Grid file.

The unit of measure for xllcorner and yllcorner are the same. However, the units for cellsize may be different than the units used for xllcorner and yllcorner. The units that apply are read from the corresponding .PRJ file.

Prometheus users must specify the integer grid values for the FBP fuel types in the FBP fuel type lookup table.

FBP Fuel Type Lookup Table

The contents and format of the FBP fuel-type lookup table are as shown below:

grid_value,export grid_value,agency fuel type,FBP fuel type,R,G,B,hue,sat,lum
--- --- ---

where:	grid_value	-	integer value in the Grid ASCII file
	export grid_value	-	integer value used when the Grid is exported
	agency fuel_type	-	agency name (alpha-numeric) for the fuel type
	FBP fuel type	-	FBP fuel type used by *Prometheus*
	R	-	display color red
	G	-	display color greeen
	B	-	display color blue
	hue	-	display hue
	sat	-	display saturation
	lum	-	display luminence

Users need to provide a FBP fuel type Grid ASCII file, and the corresponding projection file and FBP fuel-type lookup table to run the program. The FBP fuel-type lookup table allows the user to create new FBP fuel types and to export modified FBP fuel type grids with the associated fuel type information. Users can then import the modified grid into other applications.

Prometheus uses a national default FBP fuel type lookup table. Listed below is the application level default file used when the Prometheus application is first installed.

grid_value,export grid_value,agency fuel type,FBP fuel type,R,G,B,hue,sat,lum
1,1,C-1,C-1,0,205,219,130,255,220
2,2,C-2,C-2,192,63,153,212,122,120
3,3,C-3,C-3,167,255,166,84,90,255
4,4,C-4,C-4,191,0,255,202,255,255
5,5,C-5,C-5,255,0,0,0,255,255
6,6,C-6,C-6,0,219,0,85,255,220
7,7,C-7,C-7,99,0,96,214,255,100
11,11,D-1,D-1a,255,251,0,42,255,255
12,12,D-2,D-2a,186,161,0,37,255,186
13,13,D-1/D-2 (greenup-grid),D-1/D-2,255,251,0,42,255,255
21,21,S-1,S-1,179,255,0,55,255,255

22,22,S-2,S-2,146,173,47,52,186,174
23,23,S-3,S-3,0,130,0,85,255,130
31,31,O-1a,O-1a,255,198,173,13,81,255
32,32,O-1b,O-1b,255,170,0,28,255,255
40,40,M-1 (pc-grid),M-1a,161,100,50,19,175,161
405,405,M-1 (5%S),M-1b,161,100,50,19,175,161
410,410,M-1 (10%S),M-1c,161,100,50,19,175,161
415,415,M-1 (15%S),M-1d,161,100,50,19,175,161
420,420,M-1 (20%S),M-1e,161,100,50,19,175,161
425,425,M-1 (25%S),M-1f,161,100,50,19,175,161
430,430,M-1 (30%S),M-1g,161,100,50,19,175,161
435,435,M-1 (35%S),M-1h,161,100,50,19,175,161
440,440,M-1 (40%S),M-1i,161,100,50,19,175,161
445,445,M-1 (45%S),M-1j,161,100,50,19,175,161
450,450,M-1 (50%S),M-1k,161,100,50,19,175,161
455,455,M-1 (55%S),M-1l,161,100,50,19,175,161
460,460,M-1 (60%S),M-1m,161,100,50,19,175,161
465,465,M-1 (65%S),M-1n,161,100,50,19,175,161
470,470,M-1 (70%S),M-1o,161,100,50,19,175,161
475,475,M-1 (75%S),M-1p,161,100,50,19,175,161
480,480,M-1 (80%S),M-1q,161,100,50,19,175,161
485,485,M-1 (85%S),M-1r,161,100,50,19,175,161
490,490,M-1 (90%S),M-1s,161,100,50,19,175,161
495,495,M-1 (95%S),M-1t,161,100,50,19,175,161
50,50,M-2 (pc-grid),M-2a,99,0,0,0,255,100
505,505,M-2 (5%S),M-2b,99,0,0,0,255,100
510,510,M-2 (10%S),M-2c,99,0,0,0,255,100
515,515,M-2 (15%S),M-2d,99,0,0,0,255,100
520,520,M-2 (20%S),M-2e,99,0,0,0,255,100
525,525,M-2 (25%S),M-2f,99,0,0,0,255,100
530,530,M-2 (30%S),M-2g,99,0,0,0,255,100
535,535,M-2 (35%S),M-2h,99,0,0,0,255,100
540,540,M-2 (40%S),M-2i,99,0,0,0,255,100
545,545,M-2 (45%S),M-2j,99,0,0,0,255,100
550,550,M-2 (50%S),M-2k,99,0,0,0,255,100
555,555,M-2 (55%S),M-2l,99,0,0,0,255,100
560,560,M-2 (60%S),M-2m,99,0,0,0,255,100
565,565,M-2 (65%S),M-2n,99,0,0,0,255,100
570,570,M-2 (70%S),M-2o,99,0,0,0,255,100
575,575,M-2 (75%S),M-2p,99,0,0,0,255,100
580,580,M-2 (80%S),M-2q,99,0,0,0,255,100
585,585,M-2 (85%S),M-2r,99,0,0,0,255,100
590,590,M-2 (90%S),M-2s,99,0,0,0,255,100
595,595,M-2 (95%S),M-2t,99,0,0,0,255,100
60,60,M-1/M-2 (greenup-grid/pc-grid),M-1/M-2a,99,0,0,0,255,100
605,605,M-1/M-2 (5%S),M-1/M-2b,161,100,50,19,175,161

610,610,M-1/M-2 (10%S),M-1/M-2c,161,100,50,19,175,161
615,615,M-1/M-2 (15%S),M-1/M-2d,161,100,50,19,175,161
620,620,M-1/M-2 (20%S),M-1/M-2e,161,100,50,19,175,161
625,625,M-1/M-2 (25%S),M-1/M-2f,161,100,50,19,175,161
630,630,M-1/M-2 (30%S),M-1/M-2g,161,100,50,19,175,161
635,635,M-1/M-2 (35%S),M-1/M-2h,161,100,50,19,175,161
640,640,M-1/M-2 (40%S),M-1/M-2i,161,100,50,19,175,161
645,645,M-1/M-2 (45%S),M-1/M-2j,161,100,50,19,175,161
650,650,M-1/M-2 (50%S),M-1/M-2k,161,100,50,19,175,161
655,655,M-1/M-2 (55%S),M-1/M-2l,161,100,50,19,175,161
660,660,M-1/M-2 (60%S),M-1/M-2m,161,100,50,19,175,161
665,665,M-1/M-2 (65%S),M-1/M-2n,161,100,50,19,175,161
670,670,M-1/M-2 (70%S),M-1/M-2o,161,100,50,19,175,161
675,675,M-1/M-2 (75%S),M-1/M-2p,161,100,50,19,175,161
680,680,M-1/M-2 (80%S),M-1/M-2q,161,100,50,19,175,161
685,685,M-1/M-2 (85%S),M-1/M-2r,161,100,50,19,175,161
690,690,M-1/M-2 (90%S),M-1/M-2s,161,100,50,19,175,161
695,695,M-1/M-2 (95%S),M-1/M-2t,161,100,50,19,175,161
70,70,M-3 (pdf-grid),M-3a,124,166,152,113,64,167
705,705,M-3 (5%pdf),M-3b,124,166,152,113,64,167
710,710,M-3 (10%pdf),M-3c,124,166,152,113,64,167
715,715,M-3 (15%pdf),M-3d,124,166,152,113,64,167
720,720,M-3 (20%pdf),M-3e,124,166,152,113,64,167
725,725,M-3 (25%pdf),M-3f,124,166,152,113,64,167
730,730,M-3 (30%pdf),M-3g,124,166,152,113,64,167
735,735,M-3 (35%pdf),M-3h,124,166,152,113,64,167
740,740,M-3 (40%pdf),M-3i,124,166,152,113,64,167
745,745,M-3 (45%pdf),M-3j,124,166,152,113,64,167
750,750,M-3 (50%pdf),M-3k,124,166,152,113,64,167
755,755,M-3 (55%pdf),M-3l,124,166,152,113,64,167
760,760,M-3 (60%pdf),M-3m,124,166,152,113,64,167
765,765,M-3 (65%pdf),M-3n,124,166,152,113,64,167
770,770,M-3 (70%pdf),M-3o,124,166,152,113,64,167
775,775,M-3 (75%pdf),M-3p,124,166,152,113,64,167
780,780,M-3 (80%pdf),M-3q,124,166,152,113,64,167
785,785,M-3 (85%pdf),M-3r,124,166,152,113,64,167
790,790,M-3 (90%pdf),M-3s,124,166,152,113,64,167
795,795,M-3 (95%pdf),M-3t,124,166,152,113,64,167
80,80,M-4 (pdf-grid),M-4a,16,130,92,130,225,130
805,805,M-4 (5%S) (pdf-grid),M-4b,16,130,92,130,225,130
810,810,M-4 (10%S)(pdf-grid),M-4c,16,130,92,130,225,130
815,815,M-4 (15%S)(pdf-grid),M-4d,16,130,92,130,225,130
820,820,M-4 (20%S)(pdf-grid),M-4e,16,130,92,130,225,130
825,825,M-4 (25%S)(pdf-grid),M-4f,16,130,92,130,225,130
830,830,M-4 (30%S)(pdf-grid),M-4g,16,130,92,130,225,130
835,835,M-4 (35%S)(pdf-grid),M-4h,16,130,92,130,225,130

840,840,M-4 (40%S)(pdf-grid),M-4i,16,130,92,130,225,130
845,845,M-4 (45%S)(pdf-grid),M-4j,16,130,92,130,225,130
850,850,M-4 (50%S)(pdf-grid),M-4k,16,130,92,130,225,130
855,855,M-4 (55%S)(pdf-grid),M-4l,16,130,92,130,225,130
860,860,M-4 (60%S)(pdf-grid),M-4m,16,130,92,130,225,130
865,865,M-4 (65%S)(pdf-grid),M-4n,16,130,92,130,225,130
870,870,M-4 (70%S)(pdf-grid),M-4o,16,130,92,130,225,130
875,875,M-4 (75%S)(pdf-grid),M-4p,16,130,92,130,225,130
880,880,M-4 (80%S)(pdf-grid),M-4q,16,130,92,130,225,130
885,885,M-4 (85%S)(pdf-grid),M-4r,16,130,92,130,225,130
890,890,M-4 (90%S)(pdf-grid),M-4s,16,130,92,130,225,130
895,895,M-4 (95%S)(pdf-grid),M-4t,16,130,92,130,225,130
90,90,M-3/M-4 (greenup-grid/pdf-grid),M-3/M-4a,16,130,92,130,225,130
905,905,M-3/M-4 (5%pdf)(greenup-grid),M-3/M-4b,16,130,92,130,225,130
910,910,M-3/M-4 (10%pdf)(greenup-grid),M-3/M-4c,16,130,92,130,225,130
915,915,M-3/M-4 (15%pdf)(greenup-grid),M-3/M-4d,16,130,92,130,225,130
920,920,M-3/M-4 (20%pdf)(greenup-grid),M-3/M-4e,16,130,92,130,225,130
925,925,M-3/M-4 (25%pdf)(greenup-grid),M-3/M-4f,16,130,92,130,225,130
930,930,M-3/M-4 (30%pdf)(greenup-grid),M-3/M-4g,16,130,92,130,225,130
935,935,M-3/M-4 (35%pdf)(greenup-grid),M-3/M-4h,16,130,92,130,225,130
940,940,M-3/M-4 (40%pdf)(greenup-grid),M-3/M-4i,16,130,92,130,225,130
945,945,M-3/M-4 (45%pdf)(greenup-grid),M-3/M-4j,16,130,92,130,225,130
950,950,M-3/M-4 (50%pdf)(greenup-grid),M-3/M-4k,16,130,92,130,225,130
955,955,M-3/M-4 (55%pdf)(greenup-grid),M-3/M-4l,16,130,92,130,225,130
960,960,M-3/M-4 (60%pdf)(greenup-grid),M-3/M-4m,16,130,92,130,225,130
965,965,M-3/M-4 (65%pdf)(greenup-grid),M-3/M-4n,16,130,92,130,225,130
970,970,M-3/M-4 (70%pdf)(greenup-grid),M-3/M-4o,16,130,92,130,225,130
975,975,M-3/M-4 (75%pdf)(greenup-grid),M-3/M-4p,16,130,92,130,225,130
980,980,M-3/M-4 (80%pdf)(greenup-grid),M-3/M-4q,16,130,92,130,225,130
985,985,M-3/M-4 (85%pdf)(greenup-grid),M-3/M-4r,16,130,92,130,225,130
990,990,M-3/M-4 (90%pdf)(greenup-grid),M-3/M-4s,16,130,92,130,225,130
995,995,M-3/M-4 (95%pdf)(greenup-grid),M-3/M-4t,16,130,92,130,225,130
100,100,Not-Available,Not Available,255,255,255,0,0,0
101,101,Non-fuel,Non-fuel,120,120,120,0,0,120
102,102,Water,Water,22,0,219,174,255,220
103,103,Unknown,Unknown,0,0,0,0,0,0
104,104,Unclassified,Unclassified,166,166,166,0,0,165
105,105,Bog,Bog,0,255,170,113,255,255

D-1 is leafless aspen. D-2 is leafed aspen. There is a no rate of spread in D-2 unless a BUI threshold of 80 is reached. When the BUI is >= 80, the rate of spread in D-2 is $1/5^{th}$ the rate of spread in D-1. Areas in the FBP fuel-type grid identified as D-1 will remain as leafless aspen regardless of whether the green-up setting is on.

It is therefore possible to have both D-1 (integer value 11) and D-2 (integer value 12) in the same FBP fuel type Grid. It is also possible to have D-1/D-2 (integer value 13). A Grid of value of 13

indicates that the fuel type is either D-1 or D-2. In this case, the program will first look for a green-up Grid. If available, it will assign D-1 or D-2 based on whether the green-up Grid indicates it is green-up or not green-up. If there is no green-up Grid, the program will use the application FBP default green-up setting (on or off).

It is possible to have both M-1 (integer value 40, 405 - 495) and M-2 (integer value 50, 505 - 595) in the same FBP fuel type Grid. M-1 is boreal mixedwood – leafless and M-2 is boreal mixedwood – green. It is also possible to have M-1/M-2 (integer value 60, 605 - 695). A Grid value of 60 or 605 – 695 indicates the fuel type is either M-1 or M-2. The program will first look for a green-up Grid and assign M-1 or M-2 based on the status of green up in the Grid.

The M-1 and M-2 mixedwood fuel types require an additional input of per cent softwood (conifer) and per cent hardwood (deciduous). Again, the program will first look for a per cent conifer Grid. If there is no per cent conifer Grid, it will use the application FBP default per cent conifer (50 %). The user can change this setting manually by editing the fuel type properties for M-1/M-2.

M-3 is dead balsam fir/mixedwood – leafless, and M-4 is dead balsam fir/mixedwood – green. It is possible to have both M-3 (integer 70, 705 – 795) and M-4 (integer value 80, 805 – 895) in the same FBP fuel type Grid. It is also possible to have M-3/M-4 (integer value 90, 905 – 995). A Grid value of 90 or 905 – 995 indicates the fuel type is either M-3 or M-4. The program will first look for a green-up Grid and assign M-3 or M-4 based on the status of greenup in the Grid.

The M-3 and M-4 mixedwood fuel types require an additional input of per cent dead fir. The program will first look for a per cent dead fir Grid. If there is no Grid, it will use the application default per cent dead fir (50%). The user can change this setting manually by editing the fuel type properties for M-3/M-4.

Not available, non-fuel, water, unknown, unclassified and bog are additional fuel types in the FBP fuel type lookup table. Although they can be displayed individually by colour, the program considers all of these types as non-fuel type. Agencies can assign as many non-fuel types as desired.

Fire Ignition Point

Ignition points can be input using geographic coordinates. *Prometheus* will re-project these ignition points to any of the five supported projection coordinates specified by the FBP fuel-type grid projection file. Ignition points can also be input using the same coordinate system applied to the FBP fuel-type grid.

Ignition points can be input interactively, or as an ESRI Generate ASCII file or Shapefile.

Fire Ignition Line

Ignition lines can be input interactively, or as an ESRI's Generate ASCII or Shapefile. If the Generate ASCII format file is used, attributes can be input using a separate comma delimited ASCII text file.
Projection coordinate system requirements and support are the same as described in 8.1.

Fire Ignition Polygon (Perimeter)

Ignition polygons (perimeters) can be inputted interactively, or as an ESRI's Generate ASCII or Shapefile. If the Generate ASCII format file is used, attributes can be input using a separate comma delimited ASCII text file.

Projection coordinate system requirements and support are the same as described in 8.1.

Hourly Weather Stream Data File

A comma, space, tab or semi-colon delimited ASCII text file format can be used for weather files. To successfully run a simulation, a weather stream must be assigned to the weather station.

The first line of the hourly weather stream data file contains weather data header information. This line is formatted as:

hourly,hour,temp,rh,wd,ws,precip

hourly - required
hour - required
temp - required
rh - required
wd - required
ws - required
precip - required
FFMC - optional
DMC - optional
DC - optional

hourly	Denotes that the file is an hourly weather file and records the date as DD/MM/YY e.g. 25/9/2001
hour	Hour recorded using the 24 hr format, 0 – 23, 0 is midnight
temp	Temperature recorded in degrees Celsius (integer or real, negative values acceptable)
rh	Relative Humidity recorded in per cent (integer or real)
wd	Wind direction recorded in degrees (1– 360, 360 is north, 0 is no wind.)
ws	Wind speed recorded in km/hr (integer or real)
precip	Precipitation recorded in mm (integer or real)

The header information can be comma, space, tab or semi-colon delimited. The weather data begins on the second line. It should be delimited in the same format as the header information. The first data element must be Hourly. The remaining weather data elements can be arranged in any order. The header information can be in upper or lower case.

An example of a comma delimited hourly weather stream data file (without FFMC) is as follows:

hourly,hour,temp,rh,wd,ws,precip
25/9/2001,0,1.1,96,360,2.00,0
25/9/2001,1,-0.3,98,90,1.00,0
25/9/2001,2,-0.7,98,90,3.00,0
25/9/2001,3,-0.3,94,0,0.00,0
25/9/2001,4,1.8,82,36,2.00,0

Daily Weather Stream Data File

The first line of the daily weather stream data file contains weather data header information. This line is formatted as:

daily,min_temp,max_temp,rh,precip,min_ws,max_ws,wd

daily	- required
min_temp	- required
max_temp	- required
rh	- required
precip	- required
min_ws	- required
max_ws	- required
wd	- required

daily	Denotes that the file is a daily hourly weather file and records the date as DD/MM/YY e.g. 25/9/2001
min_temp	Minimum temperature recorded in degrees Celsius (integer or real, negative values acceptable)
max_temp	Maximum temperature recorded in degrees Celsius (integer or real, negative values acceptable)
rh	Minimum relative humidity recorded in per cent (integer or real)
precip	Precipitation recorded in mm (integer or real)
min_ws	Minimum wind speed recorded in km/hr (integer or real)
max_ws	Maximum wind speed recorded in km/hr (integer or real)
wd	Wind direction recorded in degrees (1– 360, 360 is north, 0 is no wind)

The header information can be comma, space, tab or semi-colon delimited. The weather data begins on the second line. It should be delimited in the same format as the header information.

The first data element must be Daily. The remaining weather data elements can be arranged in any order.

An example of a comma delimited daily weather stream data file is as follows:

daily,min_temp,max_temp,rh,precip,min_ws,max_ws,wd
25/9/2001,15,25,25,0,12,25,90
26/9/2001,17,27,22,2,12,25,180
27/9/2001,18,28,30,0,10,25,180

Green-up

Green-up is the period when leaf growth occurs. Green-up is used to switch the D-1 fuel type (Leafless Aspen) to the D-2 fuel type (Leafed Aspen), the M-1 fuel type (Boreal Mixedwood-Leafless) to the M-2 fuel type and the M-3 fuel type (Dead Balsam Fir/Mixedwood-Leafless) to the M-4 fuel type (ead Balsam Fire/Mixedwood-Green). No other fuel types are affected by the green-up state. The green up grid is a binary ASCII grid where the value 0 equates to no green-up and the value of 1 equates to green-up. Multiple green-up grids can be imported into Prometheus but only one of these grids can be assigned to a scenario at a time.

Elevation (DEM)

The ASCII grid file format is used to input Elevation (DEM) data. Projection, cell size, and xllcorner/yllcorner should be the same as those used in the FBP fuel-type grid. The integer values in the ASCII Elevation (DEM) grid file represent actual elevation values in metres. Typically, a GIS application, such as ArcView or ArcGIS, will be used to create this file. Float or integer values for elevation can also be used. Float values will be rounded internally in the program. You can import elevation data by selecting LANDSCAPE > IMPORT ELEVATION GRID DATA from the main menu bar.

Slope

The ASCII grid file format is used to input slope data. The projection, cell size, and xllcorner/yllcorner should be the same as those used in the FBP fuel-type grid. The integer values in the ASCII slope grid file represent percent slope values. Typically, a GIS application, such as ArcView, will be used to create this file. You can import slope data by selecting Landscape > Import Elevation Grid Data from the main menu bar.

The slope Grid values are recorded in per cent.

Aspect

The ASCII grid file format is used to input aspect data. Projection, cell size, and xllcorner/yllcorner should be the same as those used in the FBP fuel-type grid. The integer values in the ASCII aspect grid file represent degree values. Typically a GIS application, such as ArcView, will be used to create this file. You can import aspect data by selecting LANDSCAPE > IMPORT ELEVATION GRID DATA from the main menu bar.

The value for no data is specified in the ASCII grid header. However, the *Prometheus* program reclassifies no data to –1. Values of aspect data are as follows:

-1 = No Data
0 = Flat
1-22 = North
22-67 = Northeast
67-112 = East
112-157 = Southeast
157-202 = South
202-247 = Southwest
247-292 = West
292-337 = Northwest
337-360 = North

**WARNING: Geographic information systems usually assign flat to a value of -1; therefore it is necessary to reclassify the dataset before using it in Prometheus. All 0 values (North) need to become 360 values, and all -1 values (Flat) need to become 0 values.

Wind Speed

The format of the ASCII wind speed grid file is the Grid ASCII file format. Projection, cell size, and xllcorner/yllcorner should be the same as those used in the FBP fuel type grid.

The value unit in the wind speed grid is km/hr. They can be integer or float, however, float values are rounded to integer values that are subsequently used for fire behaviour prediction calculations.

Wind Direction

The format of the ASCII Wind Direction Grid file is the Grid ASCII file format. Projection, cell size, and xllcorner/yllcorner are same as those used in the FBP fuel type grid. The Wind direction unit is degree. The wind direction grid can be integer or float, however, float values are rounded to integer values that are subsequently used for FBP calculations. 0 represents no wind (calm), and 360 represents a north wind. Wind direction means at what direction the wind came from.

Fuel Breaks

Fuel breaks are input interactively or as Generate ASCII files or Shapefiles. They are considered as static inputs (i.e. they do not grow or have a temporal component).

Projection coordinate system requirements and support are the same as described in 8.1.

Vector Data

Base data layers (e.g. hydrography, roads) can be input as Generate ASCII files or Shapefiles. The projection coordinate system requirements and support are the same as described in 8.1.

8.2 Output Data

Modified Fire Boundary

Fire perimeters can be output as a Generate ASCII file or Shapefile.

Modified FBP Fuel Type

FBP fuel-type grids can be exported in Grid ASCII file format. The FBP fuel type lookup table must also be output with this file. The same projection should be used as the source FBP fuel-type grid.

Statistics View

The simulation output can be displayed in the Statistics View when the scenario is run. The Statistics View can then be printed and/or exported. Users have the option to select which outputs to include in the Statistics View. The order can also be re-arranged. The Statistics View can display the following outputs:

- Date and Time
- Elapsed Time
- Time to Completion
- Temperature (^{o}C)
- Dew Point (^{o}C)
- Relative humidity (%) (RH)
- Wind direction (WD)
- Wind speed (WS)

- Precipitation (mm)
- Hourly Fine Fuel Moisture Code (HFFMC)
- Hourly Initial Spread Index (HISI)
- Hourly Fire Weather Index (HFWI)
- Temporally calculated Fine Fuel Moisture Code ($_t$FFMC)
- Temporally calculated Initial Spread Index ($_t$ISI)
- Temporally calculated Fire Weather Index ($_t$FWI)
- Daily standard Fine Fuel Moisture Code (FFMC)
- Daily standard Duff Moisture Code (DMC)
- Daily standard Drought Code (DC)
- Daily standard Buildup Index (BUI)
- Time Step Area (ha)
- Active Perimeter (km)
- Active Perimeter Growth Rate (km/h)
- Perimeter (km/h)
- Perimeter Growth Rate (km/h)
- FI (%) 10 kW/m
- FI (%) 10 - 500 kW/m
- FI (%) 500 - 2000 kW/m
- FI (%) 2000 - 4000 kW/m
- FI (%) 4000 - 10000 kW/m
- FI (%) > 10000 kW/m
- ROS (%) 0 – 1 m/min
- ROS (%) 2 – 4 m/min
- ROS (%) 5 – 8 m/min
- ROS (%) 9 – 14 m/min
- ROS (%) 15+ m/min
- Time Step Duration
- Area Growth Rate (ha/hr)
- Maximum ROS (m/min) – Rate of Spread
- Maximum FI (kW/m) – Fire Intensity
- Maximum CFB (%) – Crown Fraction Burned
- Maximum CFC (kg/m^2) – Crown Fuel Consumption
- Maximum SFC (kg/m^2) – Surface Fuel Consumption
- Maximum TFC (kg/m^2) – Total Fuel Consumption
- Active Points
- Number Points
- Cumulative Number Points
- Active Fronts
- Number Fronts

Export Burned Grid

After a simulation has completed or been stopped, a Burned Grid can be exported as an ESRI ASCII Grid file. The Burned Grid is an integer value grid. 0 represents unburned and 1 represents burned.

Weather and Fire Behaviour Prediction System Raster Outputs

The FBP system generates a number of primary and secondary outputs that can be output and exported as raster. Users can select and export any or all of following outputs:

- temperature
- dew point
- relative humidity
- wind direction
- wind speed
- precipitation
- FFMC (temporally interpolated Fine Fuel Moisture Code)
- ISI (temporally interpolated Initial Spread Index)
- fire intensity (FI)
- rate of spread (ROS)
- surface fuel consumption (SFC)
- crown fuel consumption (CFC)
- total fuel consumption (TFC)
- crown fraction burned (CFB)
- net effective spread direction (RAZ)
- burned status (i.e. burned or not burned)

9. Appendices

Appendix A -- Projection Algorithms.

John P. Snyder: Map Projections -- A Working Manual.

Appendix B -- Projection File Formats

The ESRI projection file contains all parameters for the projection used by Arc/Info coverages, ESRI grids or shapefiles. The projection file, commonly referred to as a ".PRJ file", is named either **prj.adf** or <shapefile **_name>.prj** depending on how the data are stored. The latter format, e.g. ***.prj**, is the preferred filename format for use in *Prometheus*.

The .PRJ file may contain comment statements. The comments start with the string **/*** and ends at the end of the line.

An example of Albers projection file in the coverage/grid format is:

```
PROJECTION ALBERS
UNITS FEET
PARAMETERS
37 10 00        /* 1st standard parallel
37 50 00        /* 2nd standard parallel
-123 00 00      /* Central meridian
0 0 0           /* Latitude of projection's origin
0.0             /* False easting
0.0             /* False northing
```

An example of UTM projection file in the coverage/grid format is:

```
/*  Projection definition for UTM Projection, Zone 12, NAD83
/*
projection utm
zone 12
datum nad83 cnt
unit meters
parameters
end
```

There are 60 UTM Zones encompassing the Earth with each being 6° of longitude wide and numbered sequentially eastward from the Date Line. The origin of the UTM map project is located at the intersection of the Equator and the Central Meridian (C.M.) of each zone, thus each zone extends 3° of longitude east and west of the Central Meridian. Central Meridians west of Greenwich have negative values and thus east of Greenwich have positive values. The UTM Zone number can be calculated from the equation:

Zone = 1 + (177 + C.M.) / 6

For example, if the C.M. is 117° W then the Zone number = 1 + (177 - 117) / 6 = 11. Similarly, if the C.M. is 3° E then the Zone number = 1 + (177 + 3) / 6 = 31.

The .PRJ file contains several keywords followed by some valid words that, in turn, define the values to be used for projection calculations. The sequence of the keyword entries before the word "Parameters" is not critical but the sequence shown above is the traditional sequence that all GIS analysts are fully familiar with. The keywords and their valid entries for the most common projections that can be expected in Canada are listed below:

KEYWORD	**VALID ENTRY**	**DESCRIPTION**
Projection	UTM	Universal Transverse Mercator Projection (international)
	ALBERS	Albers Projection (used in British Columbia)
Zone	*zone number*	Zone is used only when Projection UTM is specified in the .PRJ file. For Canada, the valid *zone numbers* are through
Datum	NAD83	North American Datum of 1983
	NAD27	North American Datum of 1927
		NOTE: Both NAD83 and NAD27 may be followed by the word "CNT" for Canadian National Transformation. For practical reasons, this can be ignored by the CWFGM.
Zunits	NO	No unit specified for the vertical dimension
	METERS	The vertical values are in metres; e.g. in an elevation grid
	FEET	The vertical values are in feet; e.g. in an elevation grid
Units	METERS	The horizontal (eastings and northings) are in metres
	FEET	The horizontal (eastings and northings) are in feet
Sphereoid	GRS1980	a = 6,378,137.0 b = 6,356,752.31414
	CLARKE1866	a = 6,378,206.4 b = 6,356,583.8
	GWS84	a = 6,378,137.0 b = 6,356,752.31424
Xshift	*a value*	
Yshift	*a value*	

Alberta uses a modified UTM projection called 10TM. One zone covers 10 degrees rather than the standard 6 degree UTM zone. An example of the projection file in the coverage/grid format is as follows:

```
Projection transverse
Datum nad83 cnt
Units meters
Parameters
0.9992
-115 0 0.0
0 0 0.0
500000.0
0.0
```

An example of Lambert projection file in the coverage/grid format is:

```
PROJECTION LAMBERT
UNITS FEET
PARAMETERS
37 10 00        /* 1st standard parallel
37 50 00        /* 2nd standard parallel
-123 00 00      /* Central meridian
0 0 0           /* Latitude of projection's origin
0.0             /* False easting
0.0             /* False northing
```

An example of New Zealand Map Grid projection file in the coverage/grid format is:

```
Projection     New_Zealand_Map_Grid
Datum          D_New_Zealand_1949
Spheroid       International_1924
Units          METERS
Zunits         NO
Xshift         0.0
Yshift         0.0
Parameters
173 0 0.0 /*longitude of central meridian
-41 0 0.0 /* latitude of origin
2510000 /* false easting (meters)
6023150 /* false northing (meters)
```

Appendix C -- ESRI Generate ASCII File Format

Background

The ESRI GENERATE format is an open space separated value (space delimited) ASCII file format. As the file format has been openly published, has a simple structure and has been incorporated into a large number of GIS and GPS software, the GENERATE file format is one of the most widely used ASCII file formats for spatial data exchange.

There may be more than one space delimiting the data. As well, there is not a standard number of spaces used (i.e. it varies).

The GENERATE file format includes file structures for point, line and polygon features. The three formats are described below.

GENERATE Grid ASCII file format is described in 7.1.

Point Features

The point data is stored with one record per line in the format **ID, x, y**, where **ID** is a unique numeric identifier, **x** is the location of the point in the x-direction and **y** is the location of the point in the y-direction. The end of the GENERATE file is indicated by the word END. For example,

301 565600 5578900	ID and location of first point
302 566732 5678321	ID and location of first point
303 496751 5731456	ID and location of first point
.	.
.	.
.	.
406 496751 5731456	ID and location of last point in file
END	end of file

Line Features

Line features are stored by line segment and the end of the file is indicated by the word **END**. The first record of each segment contains a unique numeric identifier (**ID**) and end of each line segment is indicated by the word **END**. The alignment of the each line segment is defined by a sequence of map co-ordinate locations. For example,

435	ID of first line segment
489349 5587623	start location (x,y) of first line segment
489349 5587623	intermediate location (x,y) in first line segment
489349 5587623	intermediate location (x,y) in first line segment
.	.

.	.
.	.
489349 5587623	end location (x,y) for first line segment
END	end of records for first line segment
.	.
.	.
.	.
463	ID for last line segment
489349 5587623	start location (x,y) of last line segment
489349 5587623	intermediate location (x,y) of last line segment
489349 5587623	intermediate location (x,y) of last line segment
.	.
.	.
.	.
489349 5587623	end location (x,y) of last line segment
END	end of records for last line segment
END	end of file

Polygon Features

Polygon features are stored by polygon and the end of the file is indicated by the word **END**. The first record of each polygon contains a unique numeric identifier (**ID**) and the location of the polygon label (**x,y** in map co-ordinates) and the last record of each polygon contains the word **END**. The perimeter of the each polygon is defined by a sequence of map co-ordinate locations. For example,

434 456789 5467345	ID and location (x,y) of the polygon label
455895 5466435	start location (x,y) of first polygon perimeter
456300 5467981	intermediate location (x,y) in first polygon perimeter
457451 5468002	intermediate location (x,y) in first polygon perimeter
.	.
.	.
.	.
455895 5466435	end (=start) location (x,y) in first polygon perimeter
END	end of records for first polygon
.	.
.	.
.	.
567 435791 5457324	ID and location (x,y) of the last polygon label
435895 5456435	start location (x,y) of last polygon perimeter
436300 5457981	intermediate location (x,y) in last polygon perimeter
437451 5458002	intermediate location (x,y) in last polygon perimeter
.	.
.	.

```
.                                                    .
435895  5456435              end (=start) location (x,y) in last polygon perimeter
END                    end of records for last polygon
END                    end of file
```

The examples of the Generate file format show fixed floating point numbers. However, the default when using UNGENERATE is exponential. The model will accept either format.

If you select the polygon option during the UNGENERATE process, you should remove the first point (the polygon label ID). Although you will be able to import the file into the model, the label ID point results in an extra "run away" line. The next version of the model will address this problem. To avoid the problem of deleting the polygon label ID points from the file, it is suggested that you use the line option during the UNGENERATE process.

Raster

- The ASCII file consists of header information containing a set of keywords, followed by cell values in row-major order. The file format is:

  NCOLS xxx - number of columns in the data set
  NROWS xxx - number of rows in the data set
  XLLCCORNER xxx | XLLCORNER xxx - - x coordinate of the center or lower left corner of the lower left cell. Prometheus uses XLLCORNER.
  LLCORNER xxx | YLLCORNER xxx - y coordinate of the center or lower left corner of the lower left cell. Prometheus uses YLLCORNER.
  CELLSIZE xxx - size for the data set. Prometheus can use any cell size.
  NODATA_VALUE xxx - value in the file assigned to cells whose value is unknown. The nodata_value defaults to -9999. This value is used for NODATA cell values in all other raster output files.
  row 1
  row 2
  .
  .
  .
  row n

  where xxx is a number and the keyword NODATA_VALUE is optional and defaults to -9999.
  ESRI's raster to ASCII tool will only generate files where the location of the raster is based off the lower left corner (LLCORNER). Note that the raster to ASCII tool in ArcTool box supports both LLCENTER and LLCORNER. Prometheus only accepts the LLCORNER option.

- The NODATA_VALUE is the value in the ASCII file that will be assigned to the NoData cells in the input raster. This value is normally reserved for those cells whose true value is unknown.
- The end of each row of data from the raster is terminated with a carriage return in the file.
- Both integer and floating point rasters can be converted to an ASCII format. Prometheus only accept integer raster.
- The output will be an ASCII text file.

Appendix D – Hourly Weather Stream Data File

An example of an hourly weather stream data file:

```
hourly,hour,temp,rh,wd,ws,precip
25/9/2001,0,1.1,96,360,2.00,0
25/9/2001,1,-0.3,98,90,1.00,0
25/9/2001,2,-0.7,98,90,3.00,0
25/9/2001,3,-0.3,94,90,0.00,0
25/9/2001,4,1.8,82,360,2.00,0
25/9/2001,5,2.5,78,270,9.00,0
25/9/2001,6,2.1,80,90,5.00,0
25/9/2001,7,2.8,78,135,2.00,0
25/9/2001,8,4.9,78,90,6.00,0
25/9/2001,9,12.1,43,270,11.00,0
25/9/2001,10,16.9,33,270,18.00,0
25/9/2001,11,21.3,24,225,5.00,0
25/9/2001,12,23.3,14,135,4.00,0
25/9/2001,13,24.2,14,90,9.00,0
25/9/2001,14,25.1,14,135,12.00,0
25/9/2001,15,26.9,10,90,13.00,0
25/9/2001,16,27.3,10,180,7.00,0
25/9/2001,17,25.1,14,135,15.00,0
25/9/2001,18,22.1,20,180,6.00,0
25/9/2001,19,12.1,47,0,0.00,0
25/9/2001,20,8.8,57,0,0.00,0
25/9/2001,21,7.8,65,270,3.00,0
25/9/2001,22,7.1,67,315,3.00,0
25/9/2001,23,6,73,315,3.00,0
```

Appendix E – New Zealand FBP Fuel Type Lookup Table

grid_value,export grid_value,agency fuel type,FBP fuel type,R,G,B,hue,sat,lum
1,1,C-1,C-1,0,205,219,130,255,220
2,2,O-1a (percent cure-grid),O-1a,255,198,173,13,81,255
3,3,C-3,C-3,167,255,166,84,90,255
4,4,O-1a (percent cure-grid),O-1a,255,198,173,13,81,255
5,5,C-5,C-5,255,0,0,0,255,255
10,10,O-1a (percent cure-grid),O-1a,255,198,173,13,81,255
11,11,D-1,D-1a,255,251,0,42,255,255
12,12,D-2,D-2a,186,161,0,37,255,186
13,13,D-1/D-2 (greenup-grid),D-1/D-2,255,251,0,42,255,255
14,14,O-1a (percent cure-grid),O-1a,255,198,173,13,81,255
15,15,O-1b (percent cure-grid),O-1b,255,170,0,28,255,255
20,20,O-1a (percent cure-grid),O-1a,255,198,173,13,81,255
21,21,O-1a (percent cure-grid),O-1a,255,198,173,13,81,255
22,22,O-1a (percent cure-grid),O-1a,255,198,173,13,81,255
30,30,O-1b (percent cure-grid),O-1b,255,170,0,28,255,255
31,31,O-1a (percent cure-grid),O-1a,255,198,173,13,81,255
32,32,O-1a (percent cure-grid),O-1a,255,198,173,13,81,255
40,40,O-1a (percent cure-grid),O-1a,255,198,173,13,81,255
41,41,O-1a (percent cure-grid),O-1a,255,198,173,13,81,255
43,43,O-1b (percent cure-grid),O-1b,255,170,0,28,255,255
44,44,O-1b (percent cure-grid),O-1b,255,170,0,28,255,255
45,45,C-4,C-4,191,0,255,202,255,255
46,46,O-1b (percent cure-grid),O-1b,255,170,0,28,255,255
47,47,C-4,C-4,191,0,255,202,255,255
50,50,O-1b (percent cure-grid),O-1b,255,170,0,28,255,255
51,51,C-4,C-4,191,0,255,202,255,255
52,52,C-4,C-4,191,0,255,202,255,255
53,53,O-1b (percent cure-grid),O-1b,255,170,0,28,255,255
54,54,M-2 (pc-grid),M-2a,99,0,0,0,255,100
55,55,C-4,C-4,191,0,255,202,255,255
56,56,C-4,C-4,191,0,255,202,255,255
57,57,C-4,C-4,191,0,255,202,255,255
61,61,C-6,C-6,0,219,0,85,255,220
62,62,O-1b (percent cure-grid),O-1b,255,170,0,28,255,255
63,63,O-1b (percent cure-grid),O-1b,255,170,0,28,255,255
64,64,S-1,S-1,179,255,0,55,255,255
65,65,O-1b (percent cure-grid),O-1b,255,170,0,28,255,255
66,66,C-6,C-6,0,219,0,85,255,220
67,67,C-6,C-6,0,219,0,85,255,220
68,68,D-1,D-1a,255,251,0,42,255,255
69,69,M-2 (pc-grid),M-2a,99,0,0,0,255,100