

MULTI-MODEL EXTRACTION
UTILITY 2 (MMEU2) &
2015-2019 ALBERTA
METEOROLOGICAL
DATA SET
USER'S GUIDE

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Background

In 2020 RWDI created a unique software solution called “Multi-Model Extraction Utility 2” for Alberta Environment and Parks (RWDI Project No. 2004851). This tool is an upgrade to the existing MMEU tool and is referred to as MMEU2. The purpose of the MMEU2 software is to generate standardized land use, digital terrain, meteorological data sets along with template model input files for the CALMET/CALPUFF and AERMET/AERMOD regulatory air quality models. An option exists to generate template model input files for MCIP; however, a separate meteorological data set will be required (see section on MCIP).

General

The MMEU2 application comes bundled with the 2015-2019 AEP meteorological data set which is delivered on an external USB 12 TB hard drive. The MMEU2 application can be found in the MMEU2 directory on the hard drive.

MMEU2 is a 64-bit application developed using the Microsoft .NET Framework version 4.8. The application was designed for the 64-bit version of Microsoft Windows 10; however, it can be run on any 64-bit edition of Microsoft Windows that supports .NET Framework 4.8.

MMEU2 has been designed to work exclusively with the 2015-2019 Alberta Environment and Parks Meteorological Dataset provided on the external USB Hard Drive.

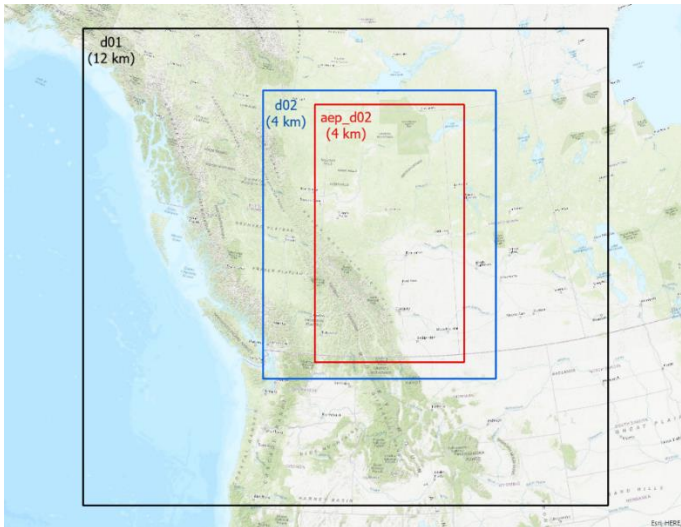
For optimal performance, it is recommended that the 2015-2019 AEP external hard drive be connected via USB3 connection to the computer where the MMEU2 executable will be run. The “MMEU2”, “MET”, “DEM”, and “LANDUSE” folders can be copied to your local hard drive, or a network share; however, the speed of MMEU2 will depend on the speed of your network as MMEU2 is I/O intensive and uses large datasets that are stored on the USB drive. This means that the time required to extract the various datasets will depend on the type of USB connection (ie. USB3 vs USB2), or if installed on a network drive, the speed of your network. For example, MMEU2 running on a workstation class computer with a USB3 connection and generating the output to a local drive will take approximately 4 and one-half hours to extract 1 year of meteorological data. The process will take longer to build 3D.dat files for CALMET as an additional CALWRF processing step is required.

2015 – 2019 AEP Meteorological Dataset

The 2015 - 2019 Alberta Environment Meteorological Dataset was created by applying WRF in a series of 5 and one-half day simulations to span the 5 years. The first 12 hours of each 5 and one-half day simulation was used as a spin-up period to let the model equilibrate to the initial and boundary conditions for the run. This spin-up was discarded and the final 5 full days of each run was used to build the longer period. The model was then 'backed-up' 12 hours and restarted for the next 5 and one-half day simulation period. This process is repeated to cover the full 5-year model period. This allows the retained 5 days from each run to be appended end-to-end to create the longer data set. The discarded 12-hr spin-up time of a given run is always a repeat of the last 12 hours of the previous run, and the retained 5-day pieces are appended in time to cover the period with no gaps. The resulting constructed dataset is saved as one WRF file per day, with each year in a separate folder.

WRF Domain Extents

The meteorological dataset covers the period from January 1, 2015 through December 31, 2019. The meteorological data is stored on the hard drive in NetCDF format as daily meteorological files by year and is to be used for regulatory modelling applications. MMEU2 provides the ability to easily extract the data for modelling domains through intuitive wizards. Users can specify a date range and subdomain to extract the WRF data in NetCDF format; SAMSON and TD6201 upper air files for use within AERMOD; and, as a 3D.dat file for use within CALMET.



The above image depicts the WRF 12km outer domain denoted as “d01”, and the 4km nested inner domain noted as “d02”. To fit the 4km meteorological dataset on a 12TB drive, the 4km “d02” inner domain was clipped to cover the province of Alberta and is called “aep_d02”. The data found in the MET directory on the external USD drive is the daily output from the “aep_d02” domain. Raw NetCDF data from the “d01” and “d02” domain can be ordered separately for MCIP processing.

The “aep_d02” domain is 740km x 1280km (or 185 x 320 grid cells) at 4km resolution with a minimum of 20km (or 5 grid cells) buffer on all sides.

All spatial inputs to MMEU2 must fall within the “aep_d02” domain as indicated in the table below. This table is also included in the application wherever spatial information is required.

Domain	CORNER	I	J	LATITUDE (Decimal Degrees, WGS84)	LONGITUDE (Decimal Degrees, WGS84)
aep_d02	Lower Left	1	1	48.6869926	-119.791763
aep_d02	Upper Left	1	321	60.1612129	-121.3497
aep_d02	Lower Right	186	1	48.664608	-109.7319
aep_d02	Upper Right	186	321	60.1316261	-108.020782

Special care must be taken when specifying the lower left and upper right coordinates if they occur at, or near the WRF boundary. The WRF projection is in Lambert Conformal whereas most modelling domains are in UTM (Universe Traverse Mercator). A situation can arise where the specified lower left and upper right coordinates are within the WRF modelling domain, but due the different projections the resulting upper left or lower right coordinates may fall outside the WRF domain. This condition will be highlighted in MMEU2 as depicted in the image below. “Check Marks” indicate that the user specified coordinates all fall within the WRF modelling domain and an “Exclamation Mark” along with a warning will indicate if one of the coordinates fall outside the WRF domain.

LOWER LEFT CORNER
(Decimal Degrees, WGS84)

Latitude (Y)
48.6635039

Longitude (X)
-119.8148194

UPPER RIGHT CORNER
(Decimal Degrees, WGS84)

Latitude (Y)
-119.65

Longitude (Y)
-119.65

The given Lower Left/Upper Right coordinates result in the Lower Right corner exceeding the WRF domain.

Width: 12 km Height: 20 km

ALBERTA WRF DOMAIN EXTENTS (DECIMAL DEGREES, WGS84)

CORNER	LATITUDE	LONGITUDE	CORNER	LATITUDE	LONGITUDE
UPPER LEFT	60.177616	-121.384774	UPPER RIGHT	60.148799	-108.005183
LOWER LEFT	-119.816457	48.662263	LOWER RIGHT	48.640427	-109.722108

< BACK NEXT > CANCEL

WRF Precipitation

By default, the WRF model saves precipitation (mm) as the accumulated value from the beginning of each simulation, which means that each grid cell value only grows with each time step. This means that every five days there will be a discontinuity in the WRF accumulated precipitation as the model goes from the last hour of one segment (that will represent a 5 and one-half day cumulative precipitation total) to the first hour of the subsequent segment (that will represent the cumulative precipitation from the 12 hour spin-up that has been discarded). However, starting with version 3.2, the WRF model also allows precipitation to be output at a user specified interval using the 'prec_acc_dt' option. This was set to 60 minutes, so in addition to the default cumulative precipitation variables, the WRF files also contain hourly precipitation values in the output fields prec_acc_c, prec_acc_nc and snow_acc_nc.

Unfortunately, current versions of regulatory processes such as CALWRF, read the cumulative precipitation variables in WRF only. As such this discontinuity will also be present in the precipitation in CALWRF files derived from the AEP WRF data set.

Directory Structure

The USB hard drive comes formatted with MMEU2 application; high-resolution DEM; high-resolution Land Use and meteorological data sets. The following directory structure will be available once the USB drive is connected to a computer:

- **DEM**
 - cdem_aster_mosaic_25m.asc
 - cdem_aster_mosaic_25m.prj
- **LANDUSE**
 - lc2015_nlcd_mosaic_30m.asc
 - lc2015_nlcd_mosaic_30m.prj
- **MET**
 - **2015**
 - wrfout_aep_d02_2015-01-01.nc
 - wrfout_aep_d02_2015-01-02.nc
 - (...)
 - **2016**
 - wrfout_aep_d02_2016-01-01.nc
 - wrfout_aep_d02_2016-01-02.nc
 - (...)
 - **2017**
 - wrfout_aep_d02_2017-01-01.nc
 - wrfout_aep_d02_2017-01-02.nc
 - (...)
 - **2018**
 - wrfout_aep_d02_2018-01-01.nc
 - wrfout_aep_d02_2018-01-02.nc
 - (...)
 - **2019**
 - wrfout_aep_d02_2019-01-01.nc
 - wrfout_aep_d02_2019-01-02.nc
 - (...)
 - **2020**
 - wrfout_aep_d02_2020-01-01.nc

- **MMEU2**
 - **calwrf**
 - calwrf.exe
 - libgcc_s_dw2-1.dll
 - libgfortran-5.dll
 - libnetcdf-0.dll
 - libquadmath-0.dll
 - netcdf.h
 - **Configuration**
 - landuse.csv
 - geo_dat.csv
 - **de**
 - (*.*)
 - **gdal**
 - (*.*)
 - **gdal-data**
 - (*.*)
 - **man**
 - MMEU2_UserManual.pdf
 - **ms**
 - (*.*)
 - **nco**
 - ncks.exe
 - **proj**
 - (*.*)
 - **proj7**
 - (*.*)
 - **Templates**
 - CALMET_Template_v2.2.inp
 - CALPUFF_Template_v7.0.inp
 - calwrf.inp
 - grid.nc
 - run_mcip.csh
 - Template_AERMET_Stage1.inp
 - Template_AERMET_Stage2.inp
 - Template_AERMET_Stage3.inp
 - Template_AERMOD.inp
 - (...)
 - MMEU2.exe
 - MMEU2.exe.config
 - MMEU2.Foundation.dll
 - MMEU2.Foundation.dll.config
 - MMEU2.Lib.dll
 - MMEU2.Lib.dll.config
 - (...)

The Land Use directory contains rasterized data resampled at 30-meter resolution from the 2015 Land Cover of Canada dataset issued by Natural Resources Canada (NRCAN) and is used for all Land Use data extraction within MMEU2. More information on this data set can be found in the Appendix.

The DEM directory contains rasterized 25-meter resolution CDEM data sourced from GeoBase and is used for all DEM data extraction within MMEU2. More information on this data set can be found in the Appendix.

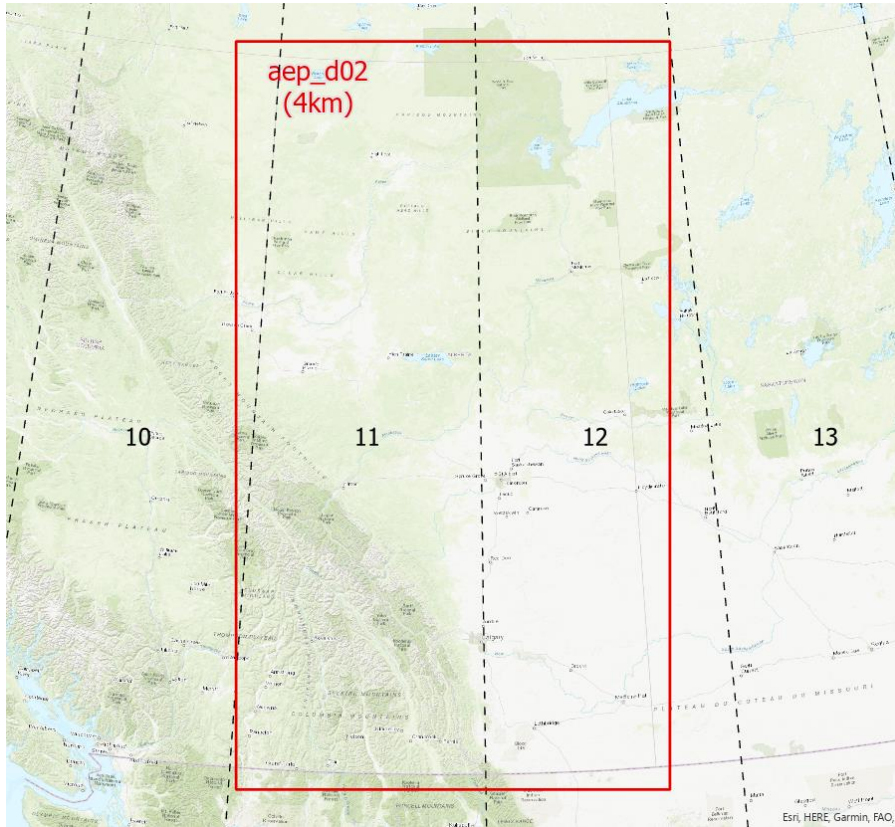
The MET directory contains the 2015-2019 AEP meteorological data.

The MMEU2 directory contains the MMEU2.exe and all required libraries and DLL's. MMEU2 is the graphical user interface discussed in this document.

The DEM, LANDUSE, MET and MMEU2 folders can optionally be moved to separate locations; however, when copying to alternative directories the contents of each folder must retain the exact file names and directory structure as shown above.

UTM Zones

The “aep_d02” domain spans UTM Zones 11N and 12N (see image below).



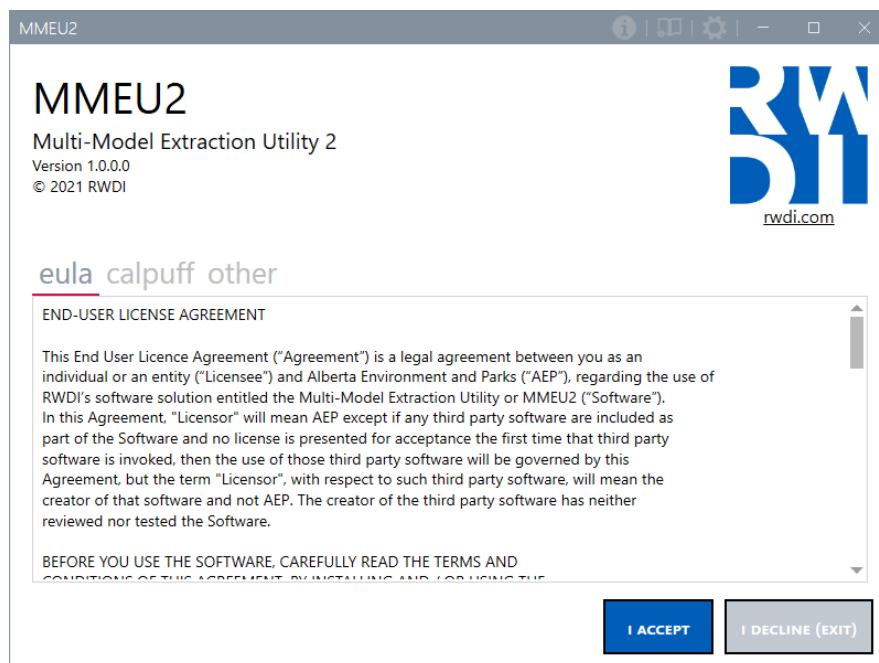
When specifying an output coordinate system, please select the UTM zone that is closest to center of your study area to avoid distortion.

Note that the native land use and DEM data provided in the Land Use and DEM directory is stored using the Alberta 10TM Forest (NAD83) projection and can be extracted with the MMEU2 Land Use and DEM wizards.

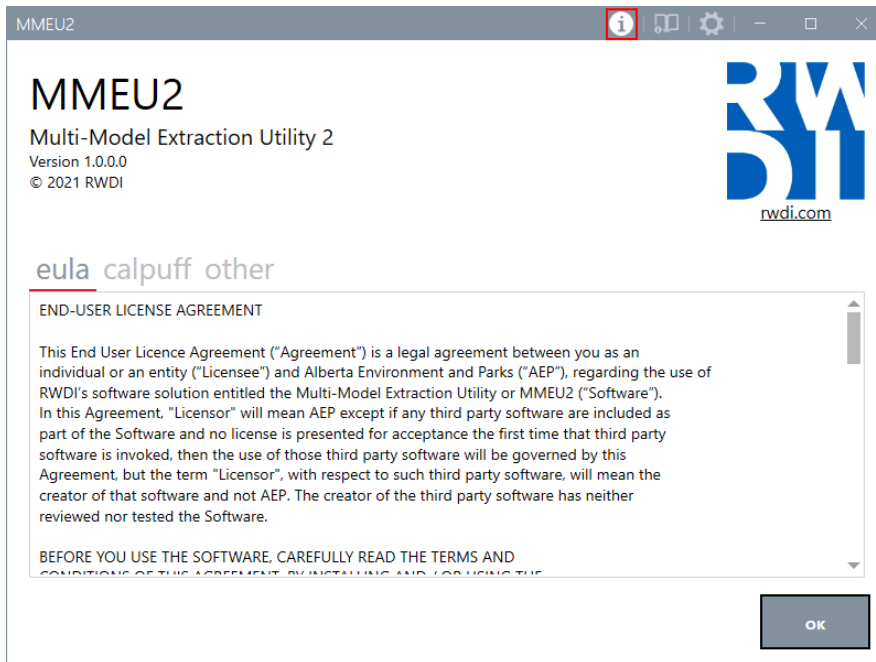
End User License Agreement

An End User License Agreement is included with the MMEU2 application. Any individual or entity that runs the MMEU2 application is consenting to be bound by the End User License Agreement. A copy of the terms and conditions of the End User License Agreement is provided in the Appendix for reference.

The End User License Agreement is presented to the user on each launch of the MMEU2 application. The agreement must be accepted by pressing the “I ACCEPT” button. If the agreement is declined by pressing the “I DECLINE” button the application is closed.



The End User License Agreement can also be viewed by clicking the “Information” button on the main application window as shown below.



The “CALPUFF” link contains attributions to Exponent for permission to include and run the CALWRF tool within the MMEU2 application.

The “Other” link contains attributions to 3rd party tools that are included within the MMEU2 distribution.

Help Manual

This Help Manual can be found by selecting the book icon located in the top right corner of the main screen. A PDF version of the manual can be found in the MMEU2\man subdirectory located on the external USB drive.

Settings

Upon first invocation the Settings dialog will be displayed once the EULA is accepted. The settings dialog is used to store the location of the MET, Land Use and DEM datasets as well as the standard output directory. The settings specified on this screen only need to be entered once and will persist for subsequent invocations.

MMEU2

Settings

MET DATA FOLDER

Location of the "Met" folder on the AEP 2015-2019 external hard drive.

DEM FILE

Location of the DEM data file found in the "DEM" folder on the AEP 2015-2019 external hard drive.

LAND USE FILE

Location of the Land Use data file found in the "Land Use" folder on the AEP 2015-2019 external hard drive.

DEFAULT OUTPUT FOLDER

Default output location of all MMEU2 outputs.

MMEU2 works best when the above files & folders are on a local drive.

The directories specified in the Settings dialog can be modified at any by selecting the Settings Gear located in the upper right-hand corner of the application.

Met Data Folder

The “MET DATA FOLDER” setting tells MMEU2 where the “MET” data folder is located on your computer. Users should specify the “MET” folder on the 2015-2019 Meteorological Dataset external hard drive.

Within this directory is a folder for each year between 2015 and 2019. Each of these folders contains one NetCDF file per day for the “aep_d02” domain as described in the [WRF Domain Extents](#) section of this document.

DEM File

The “DEM FILE” setting tells MMEU2 where the DEM data file is located on your computer. This should be set to the “cdem_aster_mosaic_25m.asc” located in the “DEM” folder on the 2015-2019 Meteorological Dataset hard drive.

Land Use File

The “LAND USE FILE” setting tells MMEU2 where the Land use data file is located on your computer. This should be set to the “lc2015_nlcd_mosaic_30m.asc” located in the “LANDUSE” folder on the 2015-2019 Meteorological Dataset hard drive.

Default Output Folder

The “DEFAULT OUTPUT FOLDER” setting is the folder MMEU2 will use as a default location of all outputs.

Land Use Wizard

The Land Use Wizard allows the user to export land use raster data compatible with CALMET/CALPUFF and AERMET/AERMOD preprocessors. It is recommended that the MMEU2 AERMOD and CALUFF wizards be used to extract Land Use data for use within those modelling applications, whereas this wizard allows additional flexibility to extract and preprocess the land use data.

Fractional land use can be obtained by selecting 30m (native resolution) and importing the resulting raster into a GIS tool. To generate a GENERIC ASCII land use file for CTGPROC, select the output coordinate system Lat/Long (WGS84) and then the CTGPROC Generic land Use output file type.

Please see [Land Use](#) in the appendices for more information on the Land Use dataset.

The Land Use Wizard guides the user through:

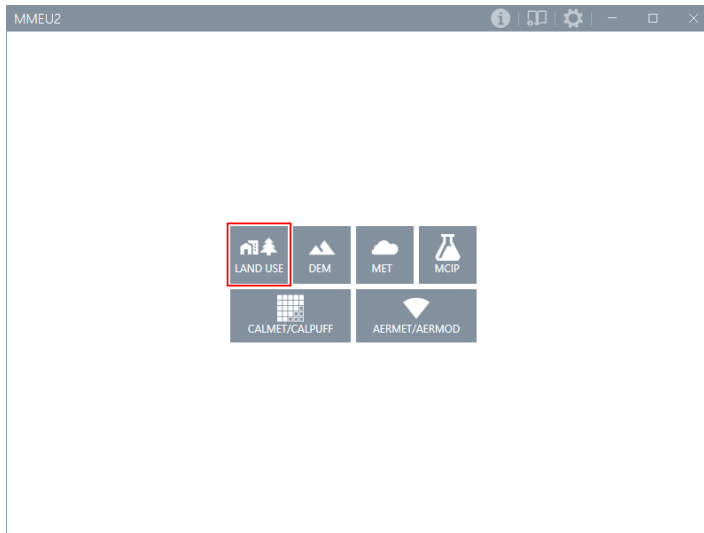
- Selecting a spatial extent
- Selecting an output resolution
 - 30 Meter (native resolution)
 - 250 Meter
 - 500 Meter
 - 1 Kilometer
 - 4 Kilometer
- Selecting an output coordinate system
 - UTM Zone 11N (WGS84)
 - UTM Zone 11N (NAD83)
 - UTM Zone 12N (WGS84)
 - UTM Zone 12N (NAD83)
 - Lat/Lon (WGS84)
 - Alberta 10-TM Forest (NAD83)
- Selecting an output file type
 - GeoTIFF (*.tif)
 - Arc/Info ASCII Grid (*.asc)
 - CTGPROC Generic land Use (*.dat)¹

Notes:

- ¹ The CTGPROC Generic Land Use option is only available when the Lat/Lon (WGS 84) coordinate system is selected.

Launch

To launch the Land Use Wizard, press the “LAND USE” button on the main screen as shown below:



Spatial Extent

The spatial extent screen is used to specify the extents of the region.

The screenshot shows the LANDUSE WIZARD window. At the top, it says "Please specify a spatial extent." Below this, there are two sections for defining the spatial extent:

LOWER LEFT CORNER (Decimal Degrees, WGS84)

Latitude (Y)	Longitude (X)
48.6683687	-119.8069753

UPPER RIGHT CORNER (Decimal Degrees, WGS84)

Latitude (Y)	Longitude (X)
48.844	-119.65

Width: 12 km Height: 20 km

Below these, there is a dashed box representing the spatial extent, with green checkmarks at each corner. Inside the dashed box, the text "ALBERTA WRF DOMAIN EXTENTS (DECIMAL DEGREES, WGS84)" is displayed. Below this text is a table with the following data:

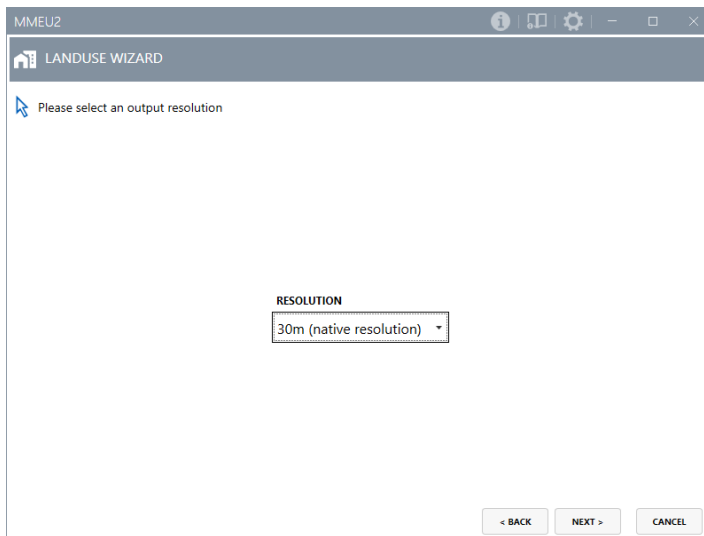
CORNER	LATITUDE	LONGITUDE
UPPER LEFT	60.177616	-121.384774
UPPER RIGHT	60.148799	-108.005183
LOWER LEFT	-119.816457	48.662263
LOWER RIGHT	48.640427	-109.722108

At the bottom of the window, there are three buttons: "< BACK", "NEXT >", and "CANCEL".

Resolution

This stage of the Land Use Wizard allows the user to select the resolution (cell size) of the exported land use raster. The 30m (native resolution) is selected by default.

Selecting a lower resolution (larger cell size) will result in resampling using the “Mode” resampling method. Mode resampling selects the value which appears most often of all the sampled points with the cell.



Coordinate System

This screen is used to specify which coordinate system (UTM, GEODETIC) and datum that will be used to generate the gridded output file.

The screenshot shows the 'MMEU2 LANDUSE WIZARD' window. The title bar includes the text 'MMEU2' and standard window controls. The window header is 'LANDUSE WIZARD'. The main instruction is 'Please select an output coordinate system'. Below this, there is a dropdown menu labeled 'COORDINATE SYSTEM' with the selected option 'UTM Zone 11N (WGS84)'. At the bottom right, there are three buttons: '< BACK', 'NEXT >', and 'CANCEL'.

Output File

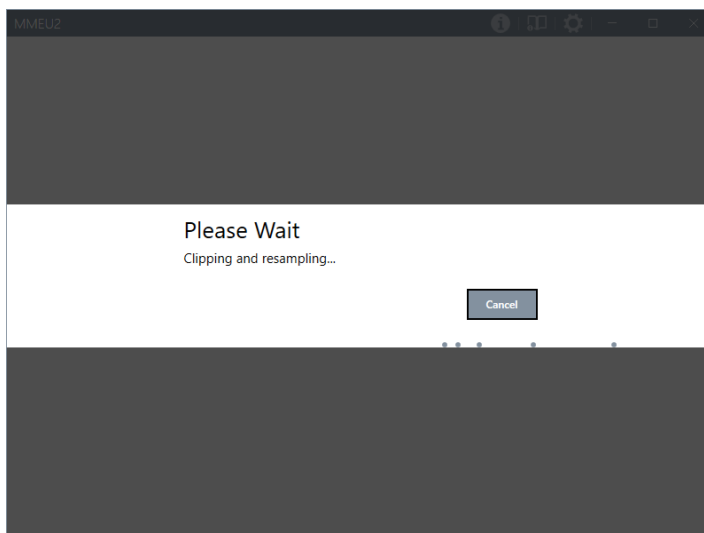
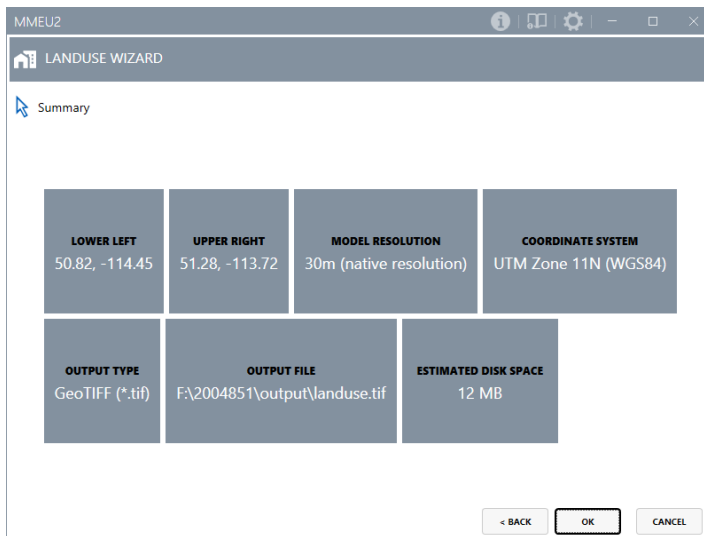
This screen is used to specify the output location and format.

The screenshot shows the 'MMEU2 LANDUSE WIZARD' window. The title bar includes the text 'MMEU2' and standard window controls. The window header is 'LANDUSE WIZARD'. The main instruction is 'Please specify the output format and location'. Below this, there are two input fields: 'OUTPUT FORMAT' with a dropdown menu showing 'GeoTIFF (*.tif)' and 'OUTPUT FILE' with a text box and a file selection button (represented by a folder icon). At the bottom right, there are three buttons: '< BACK', 'NEXT >', and 'CANCEL'.

Summary

The Land Use Wizard can be time consuming and depending on the options selected may require significant disk space. The Summary view displays the details of the options selected to ensure that the inputs are correct and that there is sufficient disk space available.

The “OK” button is used to complete the Wizard and start the extraction.



Progress messages are displayed as the wizard processes data and generates the selected output files. The process can be cancelled at any point by pressing the “Cancel” button. Note that when cancelling the process there may be incomplete files in the output directory that will need to be cleaned up.

DEM Wizard

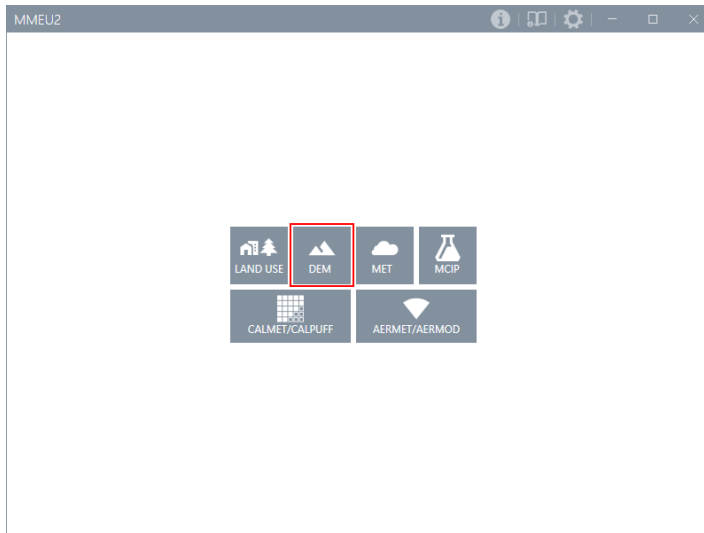
The DEM Wizard allows the user to export DEM raster data compatible with CALMET/CALPUFF and AERMET/AERMOD preprocessors. It is recommended that the AERMOD and CALUFF wizards be used to extract data for use within those modelling applications, whereas this wizard allows additional flexibility to extract and preprocess the DEM data. Please see [DEM](#) in the appendices for more information on the DEM dataset.

The DEM Wizard guides the user through:

- Selecting a spatial extent
- Selecting an output resolution
 - 25 Meter (native resolution)
 - 250 Meter
 - 500 Meter
 - 1 Kilometer
 - 4 Kilometer
- Selecting a resampling method
 - Average (default)
 - Bilinear
 - Cubic Spline
 - Mode
 - Nearest Neighbour
- Selecting an output coordinate system
 - UTM Zone 11N (WGS84)
 - UTM Zone 11N (NAD83)
 - UTM Zone 12N (WGS84)
 - UTM Zone 12N (NAD83)
 - Lat/Lon (WGS84)
 - Alberta 10-TM Forest (NAD83)
- Selecting an output file type
 - GeoTIFF (*.tif)
 - Arc/Info ASCII Grid (*.asc)

Launch

To launch the DEM, press the “DEM” button on the main screen as shown below:



Spatial Extent

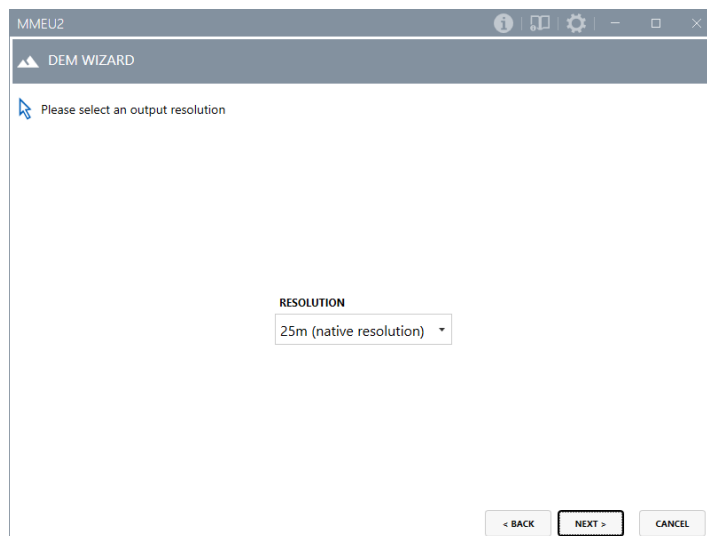
The spatial extent screen is used to specify the extents of the region.

The screenshot shows the 'DEM WIZARD' screen in the MMEU2 application. It prompts the user to 'Please specify a spatial extent.' The screen is divided into two main sections for defining the spatial extent: 'LOWER LEFT CORNER (Decimal Degrees, WGS84)' and 'UPPER RIGHT CORNER (Decimal Degrees, WGS84)'. Each section has input fields for Latitude (Y) and Longitude (X). Below these, it shows 'Width: 12 km' and 'Height: 20 km'. At the bottom, there is a table titled 'ALBERTA WRF DOMAIN EXTENTS (DECIMAL DEGREES, WGS84)' with columns for CORNER, LATITUDE, and LONGITUDE. The table lists the coordinates for the four corners of the domain. Navigation buttons '< BACK', 'NEXT >', and 'CANCEL' are at the bottom right.

CORNER	LATITUDE	LONGITUDE
UPPER LEFT	60.177616	-121.384774
LOWER LEFT	-119.816457	48.662263
UPPER RIGHT	60.148799	-108.005183
LOWER RIGHT	48.640427	-109.722108

Resolution

This screen is used to select the resolution of the output file. Note the 25m native resolution is the highest resolution of the raw data and no interpolation is performed. All other resolutions will resample the data using a resampling method described in the next section.



Resampling Method

This stage of the DEM Wizard is only presented when the user selects a non-native output resolution in the Resolution stage of the DEM Wizard.

The user may select one of five resampling methods:

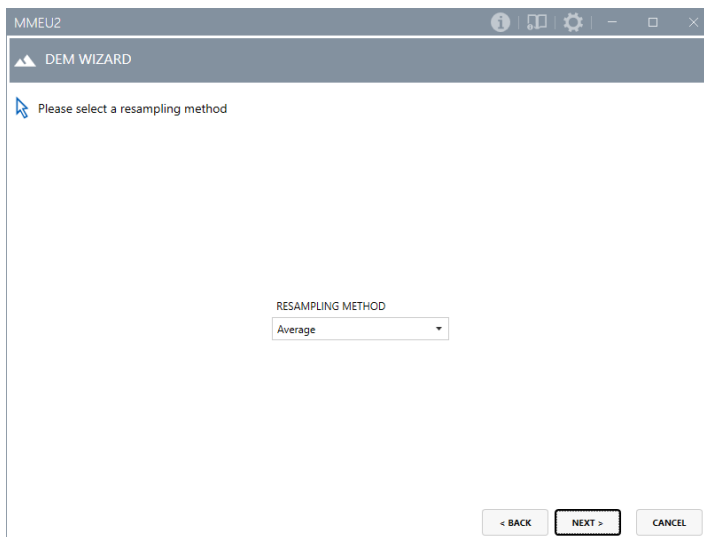
Average: average resampling computes the weighted average of all non-NODATA contributing pixels. This is the recommended resampling method for DEM data.

Bilinear: Bilinear interpolation calculates the value of each pixel by averaging (weighted for distance) the values of the surrounding four pixels. It is suitable for continuous data.

Cubic Spline: cubic spline resampling applies a B-Spline convolution kernel.

Mode: mode resampling selects the value which appears most often of all the sampled points.

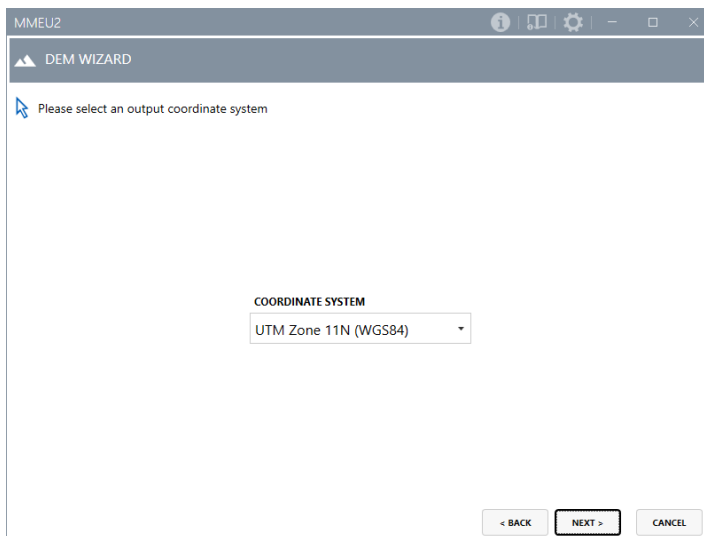
Nearest Neighbour: nearest neighbour resampling is a method in which each pixel in the resampled raster acquires the same value as its nearest neighbor in the original raster (fastest algorithm, worst interpolation quality).



The screenshot shows the 'DEM WIZARD' window within the MMEU2 application. The window title bar includes 'MMEU2' and standard OS controls. The header bar contains a mountain icon and the text 'DEM WIZARD'. Below the header, a message reads 'Please select a resampling method'. In the center, there is a dropdown menu labeled 'RESAMPLING METHOD' with 'Average' selected. At the bottom right, there are three buttons: '< BACK', 'NEXT >', and 'CANCEL'.

Coordinate System

This screen is used to specify which coordinate system (UTM, GEODETIC) and datum that should be used for extraction.



The screenshot shows the 'DEM WIZARD' window within the MMEU2 application. The window title bar includes 'MMEU2' and standard OS controls. The header bar contains a mountain icon and the text 'DEM WIZARD'. Below the header, a message reads 'Please select an output coordinate system'. In the center, there is a dropdown menu labeled 'COORDINATE SYSTEM' with 'UTM Zone 11N (WGS84)' selected. At the bottom right, there are three buttons: '< BACK', 'NEXT >', and 'CANCEL'.

Output File

This screen is used to specify the output location and format.

MMEU2

DEM WIZARD

Please specify the output format and location

OUTPUT FORMAT: GeoTIFF (*.tif)

OUTPUT FILE: [Text Box] [Browse]

< BACK NEXT > CANCEL

Summary

The DEM Wizard can be time consuming and depending on the options selected may require significant disk space. The Summary view displays the details of the options selected to ensure that the inputs are correct and that there is sufficient disk space available.

Press the “OK” button to complete the Wizard.

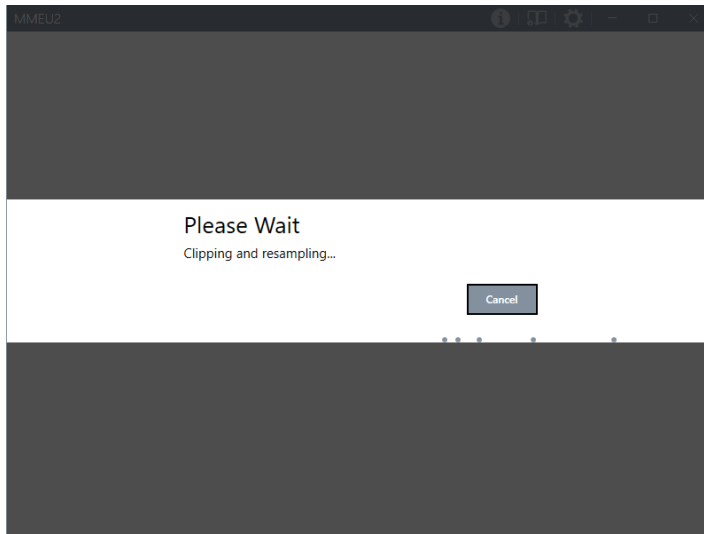
MMEU2

DEM WIZARD

Summary

LOWER LEFT 50.82, -114.45	UPPER RIGHT 51.28, -113.72	MODEL RESOLUTION 25m (native resolution)	COORDINATE SYSTEM UTM Zone 11N (WGS84)
OUTPUT TYPE GeoTIFF (*.tif)	OUTPUT FILE F:\2004851\output\dem.tif	ESTIMATED DISK SPACE 17 MB	

< BACK OK CANCEL



Progress messages are displayed as the wizard processes data and generates the selected output files. The process can be cancelled at any point by pressing the “Cancel” button. Note that when cancelling the process there may be incomplete files in the output directory that will need to be cleaned up.

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Met Wizard

The Met Wizard allows the user to specify a spatial extent and period to export a subset of the raw meteorological data. The Met Wizard outputs daily data (i.e. 1 file per day). It is recommended that the AERMOD and CALUFF wizards be used to extract Meteorological data for use within those modelling applications, whereas this wizard allows access to raw NetCDF WRF output for a user specified domain.

The file naming convention used follows the source data:

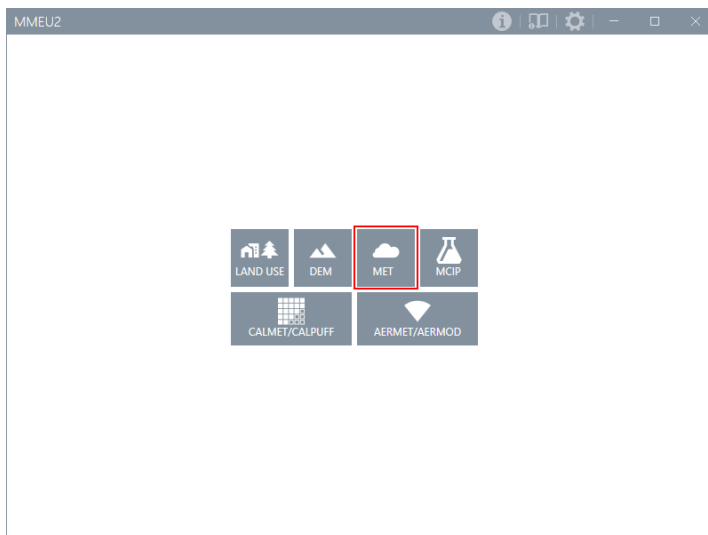
`{output directory}/{yyyy}/wrfout_aep_d02_{yyyy}-{MM}-{dd}.nc`

{output directory}	The selected output directory
wrfout	Model (WRF)
aep_d02	The name of the domain
{yyyy}	4-digit year
{MM}	2-digit month
{dd}	2-digit day
.nc	NetCDF file extension

Note that the global attribute section within the NetCDF files will refer to the “d02” domain and not the “aep_d02” domain. Refer to the CALWRF on Windows section in the Appendix if the intent is to use the extracted NetCDF files with CALWRF.

Launch

To launch the MET Wizard, press the “MET” button on the main screen as shown below:



Spatial Extent

The spatial extent screen is used to specify the extents of the region.

The screenshot shows the 'MET WIZARD' screen in the MMEU2 application. It prompts the user to 'Please specify a spatial extent.' The screen is divided into two main sections for defining the spatial extent: 'LOWER LEFT CORNER (Decimal Degrees, WGS84)' and 'UPPER RIGHT CORNER (Decimal Degrees, WGS84)'. Each section has input fields for Latitude (Y) and Longitude (X). Below these, it shows 'Width: 12 km' and 'Height: 20 km'. At the bottom, there is a table titled 'ALBERTA WRF DOMAIN EXTENTS (DECIMAL DEGREES, WGS84)' with columns for CORNER, LATITUDE, and LONGITUDE. The table lists coordinates for UPPER LEFT, LOWER LEFT, UPPER RIGHT, and LOWER RIGHT corners. The screen also includes '< BACK', 'NEXT >', and 'CANCEL' buttons.

CORNER	LATITUDE	LONGITUDE
UPPER LEFT	60.177616	-121.384774
LOWER LEFT	-119.816457	48.662263
UPPER RIGHT	60.148799	-108.005183
LOWER RIGHT	48.640427	-109.722108

Period

This screen is used to specify the start and end date and time for the meteorological data set.

The screenshot shows a window titled "MMEU2" with a "MET WIZARD" header. Below the header, a message says "Please specify a start and end date between 1/1/2015 0:00 and 12/31/2019 23:00 (MST)". The main area contains two date selection fields. The first is labeled "START DATE (MST)" and shows "1/1/2015" with a calendar icon and a time field set to "0" with plus/minus buttons. The second is labeled "END DATE (MST)" and shows "12/31/2019" with a calendar icon and a time field set to "23" with plus/minus buttons. At the bottom right are three buttons: "< BACK", "NEXT >", and "CANCEL".

Output Folder

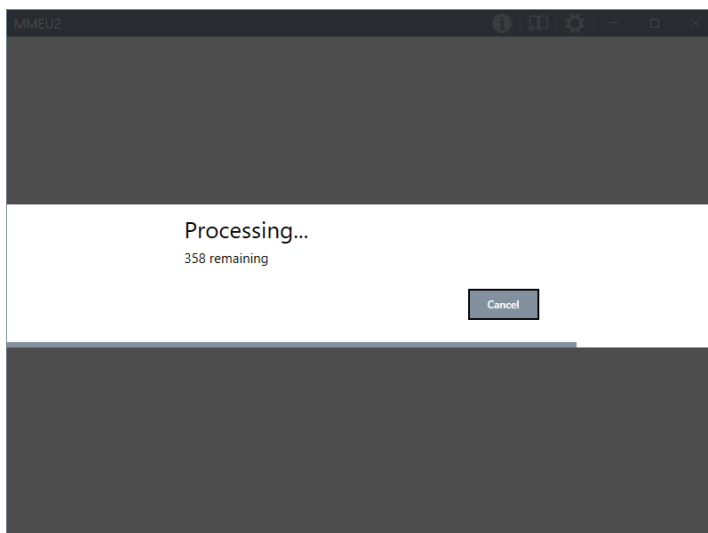
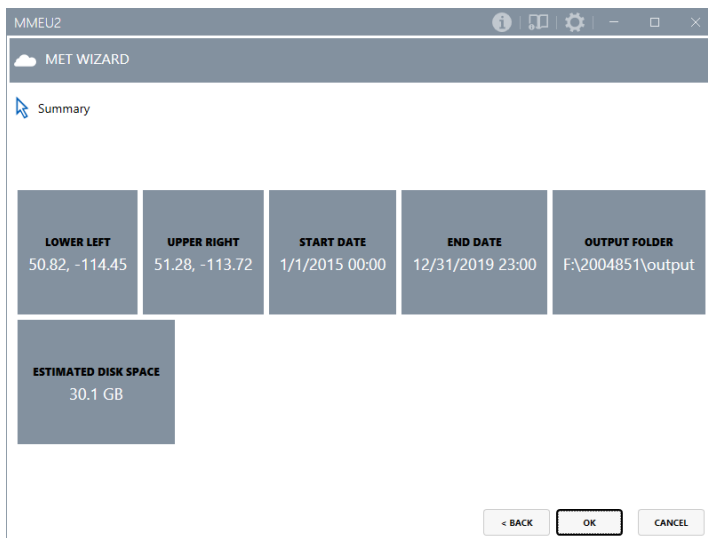
This screen is used to specify the output location.

The screenshot shows a window titled "MMEU2 (BETA1)" with a "MET WIZARD" header. Below the header, a message says "Please specify an output folder." The main area contains a text input field labeled "OUTPUT FOLDER" with the value "F:\2004851\output" and a folder selection icon to its right. At the bottom right are three buttons: "< BACK", "NEXT >", and "CANCEL".

Summary

The Met Wizard can be time consuming and depending on the options selected may require significant disk space. The Summary view displays the details of the options selected to ensure that inputs are correct and that there is sufficient disk space.

Press the “OK” button to complete the Wizard.



Progress messages are displayed as the wizard processes data and generates the selected output files. The process can be cancelled at any point by pressing the “Cancel” button. Note that when cancelling the process there may be incomplete files in the output directory that will need to be cleaned up.

MCIP Wizard

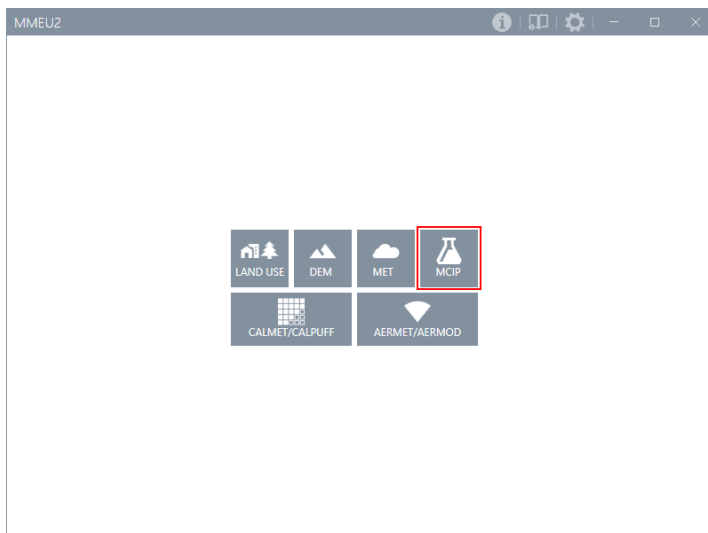
The meteorological data included on the external hard drive are a subset meant for regulatory dispersion modelling using CALMET/CALUFF and AERMET/AERMOD modelling tools. The meteorological dataset required for MCIP contains the same data but is a larger domain with the correct mapping coordinates in the global attribute section within each NetCDF file.

To run MCIP, you will need to order the full 2015-2019 meteorological dataset that is compatible with MCIP from Alberta Environment and Parks.

Since MCIP doesn't natively run in a Windows environment the MCIP Wizard will create a template Linux/Unix shell script pre-populated with settings that match the Alberta Environment and Parks 2015-2019 meteorological dataset. Once you have exported the template shell script, you will need to modify it to match the configuration of your Linux/Unix environment. This modified shell script can then be used to create additional shell script files for MCIP.

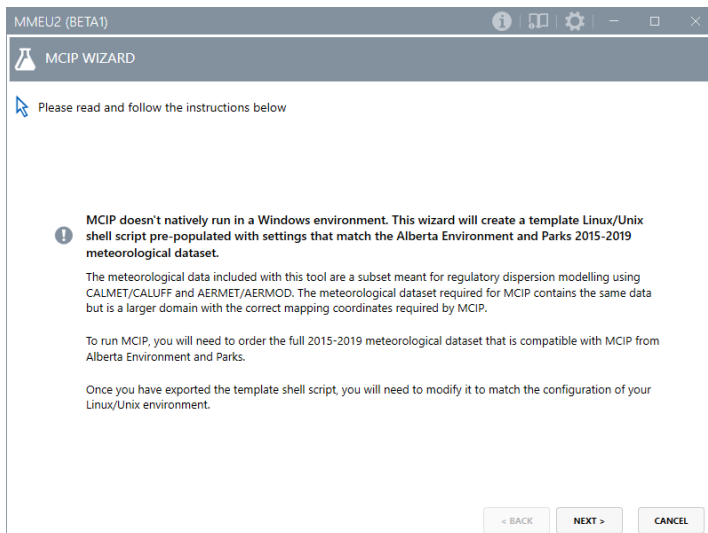
Launch

To launch the MCIP Wizard, press the “MCIP” button on the main screen as shown below:



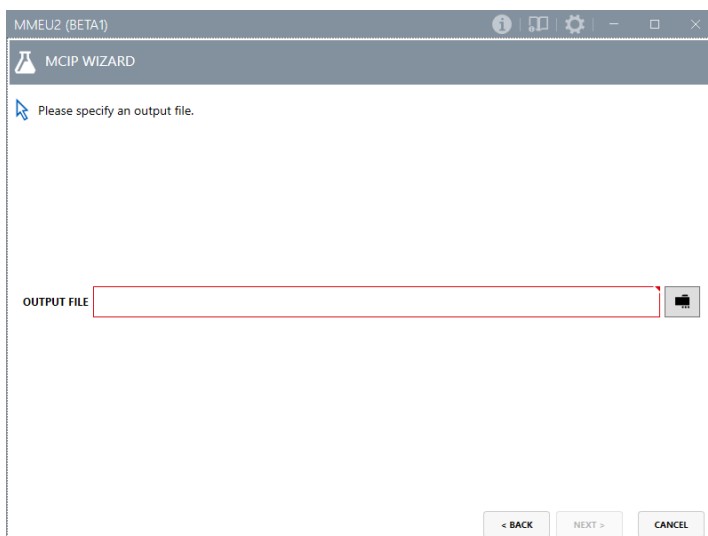
Instructions

The Instructions screen provides some guidance on the MCIP generation process.



Output File

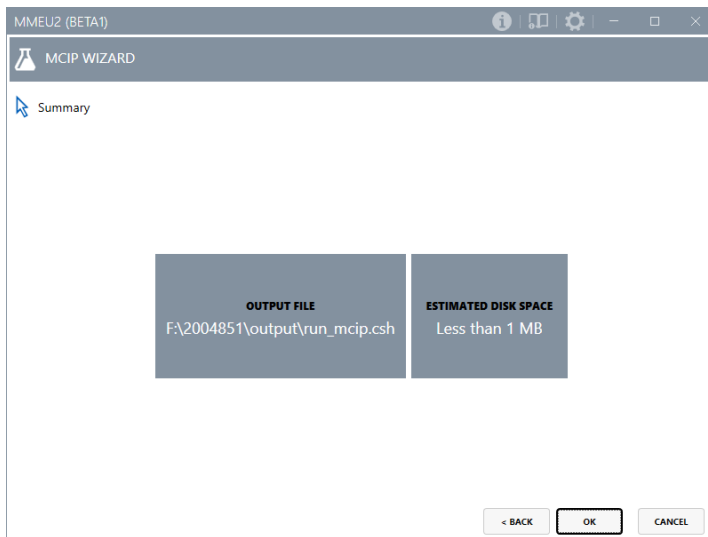
This screen is used to specify the output location and format.



Summary

The Summary view displays the details of the options selected to ensure that the inputs are correct and that there is sufficient disk space available.

The “OK” button is used to complete the Wizard and start the extraction.



CALMET/CALPUFF Wizard

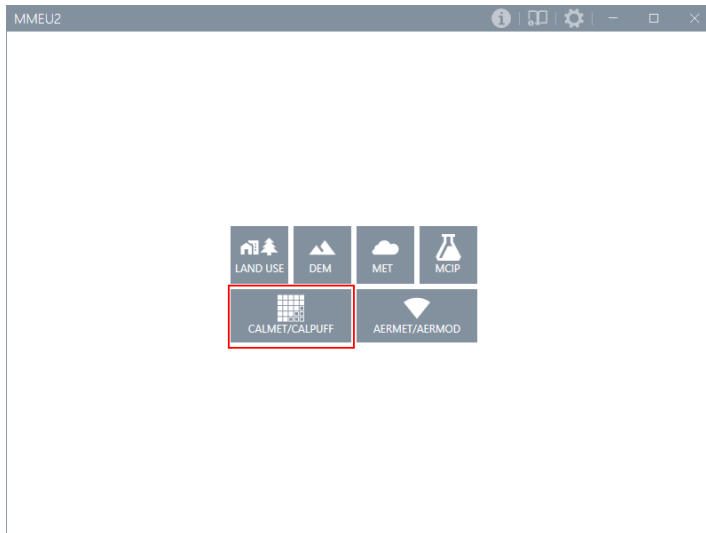
The CALMET/CALPUFF Wizard is used to simplify the generation of geo.dat and meteorological files. The following files will be generated:

- Daily Met Data
 - {yyyy}/wrfout_aep_d02_{yyyy}-{MM}-{dd}.nc
- Monthly CALWRF input files
 - calwrf_{yyyy}-{MM}.inp
- Monthly CALWRF output files
 - wrf_aep_d02_{yyyy}-{MM}.lst
 - wrf_aep_d02_{yyyy}-{MM}.m2d
 - wrf_aep_d02_{yyyy}-{MM}.m3d
- Monthly CALMET input files
 - calmet_{yyyy}-{MM}.inp
- Land Use and DEM GeoTiff files use to create seasonal GEO.dat files
 - landuse.tif
 - dem.tif
- Yearly CALPUFF input files
 - calpuff_{yyyy}.inp
- Seasonal GEO.dat files
 - geo_fall.dat
 - geo_spring.dat
 - geo_summer.dat
 - geo_winter.dat

Note: the wizard will extract the correct meteorological data from the MET directory specified in the settings dialog and will run CALWRF to generate proper 3D.dat files. Similarly, the land use and DEM data found in the Land Use and DEM directories specified in the settings dialog are used to build seasonal geo.dat files. The seasons and various factors within the geo.dat files can be found in the Appendix.

Launch

To launch the CALMET/CALPUFF Wizard, press the “CALMET/CALPUFF” button on the main screen as shown below:



Spatial Extent

The spatial extent screen is used to specify the extents of the CALMET/CALPUFF modelling domain.

The screenshot displays the 'CALMET/CALPUFF WIZARD' window with the instruction 'Please specify a spatial extent.' The interface includes input fields for the 'LOWER LEFT CORNER' and 'UPPER RIGHT CORNER' coordinates (Latitude and Longitude in Decimal Degrees, WGS84). Below these, it shows 'Width: 12 km' and 'Height: 20 km'. A dashed box represents the spatial extent, with green checkmarks at its corners. At the bottom, there is a table titled 'ALBERTA WRF DOMAIN EXTENTS (DECIMAL DEGREES, WGS84)' and navigation buttons: '< BACK', 'NEXT >', and 'CANCEL'.

CORNER	LATITUDE	LONGITUDE
UPPER LEFT	60.177616	-121.384774
LOWER LEFT	-119.816457	48.662263

CORNER	LATITUDE	LONGITUDE
UPPER RIGHT	60.148799	-108.005183
LOWER RIGHT	48.640427	-109.722108

Period

This screen is used to specify the start and end date and time for the modelling run.

The screenshot shows the 'CALMET/CALPUFF WIZARD' window in MMEU2. The title bar reads 'MMEU2'. Below the title bar, there is a header 'CALMET/CALPUFF WIZARD'. The main area contains a message: 'Please specify a start and end date between 1/1/2015 0:00 and 12/31/2019 23:00 (MST)'. Below this message, there are two sets of input fields. The first set is for the 'START DATE (MST)' with a date picker showing '1/1/2015' and a 'HOUR' spinner set to '0'. The second set is for the 'END DATE (MST)' with a date picker showing '12/31/2019' and a 'HOUR' spinner set to '23'. At the bottom right, there are three buttons: '< BACK', 'NEXT >', and 'CANCEL'.

Resolution

This screen is used to select the resolution of the CALMET modeling domain. All resolutions will resample the native DEM data using the average method (see DEM extraction) and the native Land Use data using mode (see Land Use extraction).

The screenshot shows the 'CALMET/CALPUFF WIZARD' window in MMEU2. The title bar reads 'MMEU2'. Below the title bar, there is a header 'CALMET/CALPUFF WIZARD'. The main area contains a message: 'Please select a CALMET model resolution'. Below this message, there is a 'RESOLUTION' label and a dropdown menu showing '250m'. At the bottom right, there are three buttons: '< BACK', 'NEXT >', and 'CANCEL'.

Coordinate System

This screen is used to specify which UTM zone and datum that should be used for extraction.

The screenshot shows the 'CALMET/CALPUFF WIZARD' window in MMEU2. The title bar includes the text 'MMEU2' and standard window controls. The window header is 'CALMET/CALPUFF WIZARD'. The main area contains the instruction 'Please select an output coordinate system'. Below this is a dropdown menu labeled 'COORDINATE SYSTEM' with 'UTM Zone 11N (WGS84)' selected. At the bottom are three buttons: '< BACK', 'NEXT >', and 'CANCEL'.

Output Properties

This screen is used to specify the output location and options. The user can specify whether to generate a GEO.dat, the meteorological levels to be used when running CALWRF, and whether to generate template CALMET and CALPUFF input files.

The screenshot shows the 'CALMET/CALPUFF WIZARD' window in MMEU2. The title bar includes the text 'MMEU2' and standard window controls. The window header is 'CALMET/CALPUFF WIZARD'. The main area contains the instruction 'Please specify output location & extraction options.' Below this is an 'OUTPUT FOLDER' text box containing 'F:\2004851\output' and a folder icon button. Underneath are four checked checkboxes: 'GENERATE GEO.DAT (4 Seasons)', 'EXTRACT MET DATA', 'GENERATE CALMET.INP', and 'GENERATE CALPUFF.INP'. The 'EXTRACT MET DATA' checkbox is followed by a slider labeled 'EXTRACTION LEVELS' with values '1' and '39'. Below the slider are four radio buttons for 'Urban - Open Space', 'Urban - Low Intensity', 'Urban - Medium Intensity' (which is selected), and 'Urban - High Intensity'. At the bottom are three buttons: '< BACK', 'NEXT >', and 'CANCEL'.

Generate GEO.DAT (4 Seasons)

Selecting this option instructs MMEU2 to create seasonal GEO.dat files (see [Seasons](#) in the appendix for information on seasons). DEM and land use data are clipped to the user specified spatial extent, resampled to the specified CALMET resolution, and re-projected to the selected coordinate system. Land use data are resampled using the “Mode” resampling method. DEM data are resampled using the “Average” resampling method.

The resulting DEM file is used to create the terrain heights section of the GEO.dat file.

The resulting Land Use file is used to create gridded land use, albedo, bowen ratio, surface roughness, leaf area index, latent heat flux and anthropogenic heat flux sections of the GEO.dat (see the Appendix for the lookup values).

Extract Met Data

The Extract Met Data option functions similarly to the Met Wizard in that it extracts meteorological data for a specified spatial extent and period. This option will also run CALWRF to generate 3d.dat files. Due to an issue identified with CALWRF on Windows, the parameters exported from the meteorological data in this wizard have been limited to a subset that allows CALWRF to run on Windows. See [CALWRF on Windows](#) for more information.

Please note that hourly precipitation rate between WRF simulations is not handled by CALWRF correctly. Please refer to the discussion on WRF precipitation at the start of this document.

Generate CALMET.inp

This option creates monthly CALMET input files with 2020 Alberta Air Quality Model Guideline options selected by default. In each of the monthly output files:

- GEODAT is set to either geo_summer.dat, geo_spring.dat, geo_winter.dat, or geo_fall.dat according to the month (as defined in [Seasons](#)).
- M3DDAT is set to the corresponding monthly CALWRF 3D output
- IBYR, IBMO, IBDY, IBHR, IBSEC are set to the start of the month
- IEYR, IEMO, IEDY, IEHR, IESEC are set to the end of the month
- DATUM is set to either NAR-C or WGS-84 depending on the selected coordinate system
- IUTMZN is set to either 11, or 12, depending on selected coordinate system
- XORIGKM, YORIGKM are set to the lower left coordinate of the selected domain
- NX, NY are set to the number of grid cells
- DGRIDKM is set to the selected CALMET resolution

Generate CALPUFF.inp

This option creates yearly CALPUFF input files with 2020 Alberta Air Quality Model Guideline options selected by default. In each of the yearly output files:

- IBYR, IBMO, IBDY, IBHR, IBMIN, IBSEC are set to the start of the year
- IEYR, IEMO, IEDY, IEHR, IEMIN, IESEC are set to the end of the year
- DATUM is set to either NAR-C or WGS-84 depending on the selected coordinate system
- IUTMZN is set to either 11, or 12, depending on selected coordinate system
- XORIGKM, YORIGKM are set to the lower left coordinate of the selected domain
- NX, NY are set to the number of grid cells
- DGRIDKM is set to the selected CALMET resolution
- NMETDAT is set to the number of CALMET outputs specified for the year
- METDAT1, METDAT2, (...), NMETDAT in Subgroup (0a) are set to the file names of all monthly CALMET outputs for the year.

It is up to the user to create source input parameters and receptor data.

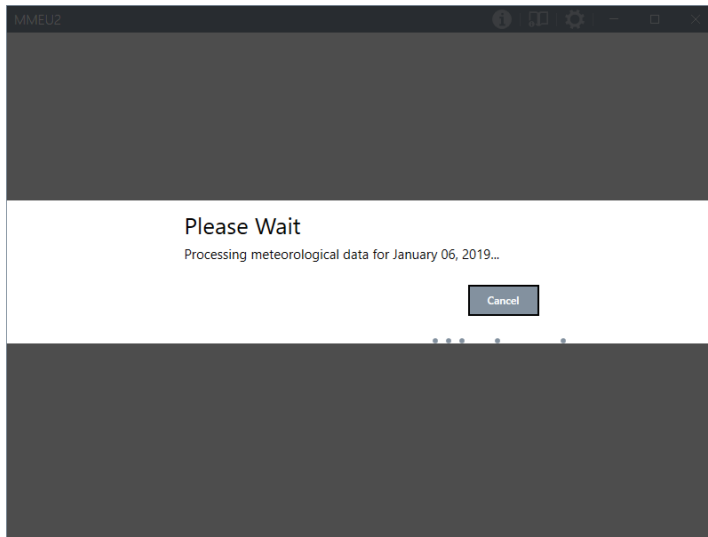
Summary

Running the CALMET/CALPUFF Wizard may be time consuming and requires significant disk space. The Summary view displays the details of the options selected to ensure that the inputs are correct and that there is sufficient disk space.

Press the “OK” button to complete the Wizard.

LOWER LEFT	UPPER RIGHT	START DATE	END DATE	CALPUFF RESOLUTION
50.82, -114.45	51.28, -113.72	1/1/2015 00:00	12/31/2019 23:00	250m
OUTPUT DIRECTORY	GEO.DAT	URBAN	EXTRACTION LEVELS	CALMET INPUT FILE
F:\2004851\output	Yes	Medium Intensity	1-39	Yes
CALPUFF INPUT FILE	ESTIMATED DISK SPACE			
Yes	21.0 GB			

< BACK OK CANCEL



Progress messages are displayed as the wizard processes data and generates the selected output files. The process can be cancelled at any point by pressing the “Cancel” button. Note that when cancelling the process there may be incomplete files in the output directory that will need to be cleaned up.

AERMET/AERMOD Wizard

The AERMET/AERMOD Wizard is used to simplify the meteorological file generation for AERMET/AERMOD. The following files will be generated:

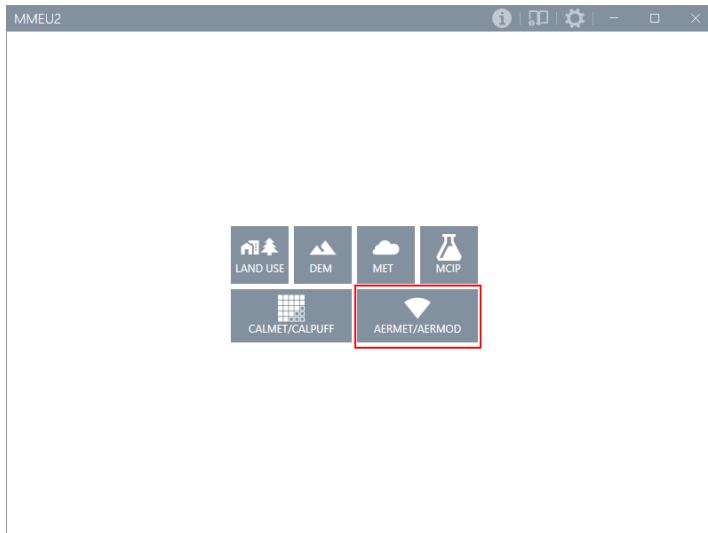
- [SAMSON](#) formatted surface station file at 10-meter height
 - samson.sam
- [RAOBS \(NCDC TD6201\)](#) formatted upper air file
 - upperair.ua
- Template yearly AERMET Stage 1, Stage 2, and Stage 3 input files
 - aermet_stage1_{yyyy}.inp
 - aermet_stage2_{yyyy}.inp
 - aermet_stage3_{yyyy}.inp
- Template yearly AERMOD input files
 - aermod_{yyyy}.inp

The AERMET Stage 1, Stage 2, Stage 3 and AERMOD template files will require some modification before they can be used with AERMET and AERMOD. The DEM and Land Use wizards can generate the raw data that will be necessary to finalize the editing of the files.

Note that using the SAMSON and RAOBS file for the SURFACE and UPPERAIR pathways in AERMET generates an AERMET output profile (.pfl) file with 10-meter data. The user has the option to create a vertical AERMET profile with multiple heights which can be achieved by using the MET option within MMEU2 to extract the raw WRF data and using the result with MMIF to create an ONSITE file.

Launch

To launch the AERMET/AERMOD, press the “AERMET/AERMOD” button on the main screen as shown below:



Coordinate

The coordinate screen is used to specify the source coordinates.

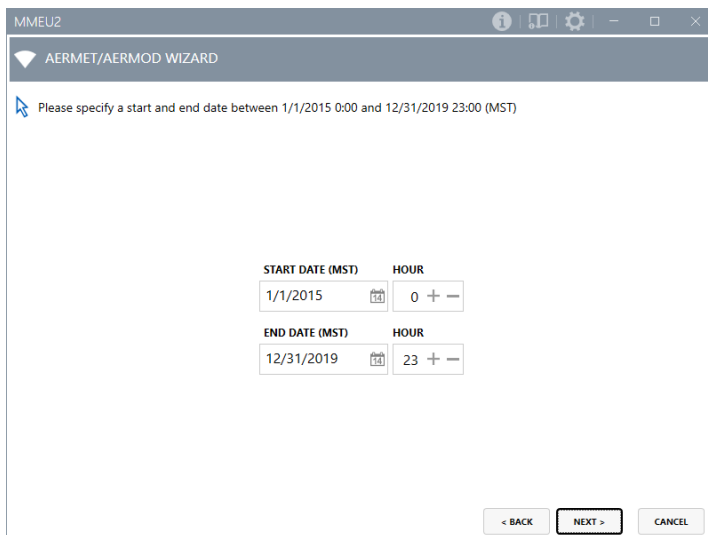
The screenshot shows the 'AERMET/AERMOD WIZARD' window. It prompts the user to 'Please enter a coordinate to extract.' Below this, there are two input fields: 'Latitude (Y)' and 'Longitude (X)', each with a red border and a small 'X' icon for clearing the field. Below the input fields, there is a table titled 'ALBERTA WRF DOMAIN EXTENTS (DECIMAL DEGREES, WGS84)' showing the coordinates for the four corners of the domain.

CORNER	LATITUDE	LONGITUDE	CORNER	LATITUDE	LONGITUDE
LOWER LEFT	48.6869926	-119.791763	LOWER RIGHT	48.664608	-109.7319
UPPER LEFT	60.1612129	-121.3497	UPPER RIGHT	60.1316261	-108.020782

At the bottom of the window, there are three buttons: '< BACK', 'NEXT >', and 'CANCEL'.

Period

This screen is used to specify the start and end date and time for the meteorological data set.



The screenshot shows a software window titled "MMEU2" with a standard Windows interface. Below the title bar is a dark header with a Wi-Fi icon and the text "AERMET/AERMOD WIZARD". The main content area has a light blue background with a message: "Please specify a start and end date between 1/1/2015 0:00 and 12/31/2019 23:00 (MST)". Below this message are two sets of input fields. The first set is for the "START DATE (MST)" with a date picker showing "1/1/2015" and a "HOUR" spinner set to "0". The second set is for the "END DATE (MST)" with a date picker showing "12/31/2019" and a "HOUR" spinner set to "23". At the bottom right of the window are three buttons: "< BACK", "NEXT >", and "CANCEL".

START DATE (MST)	HOUR
1/1/2015	0

END DATE (MST)	HOUR
12/31/2019	23

Interpolation

This screen is used to select the interpolation method for the meteorological data.

Selecting **"No Interpolation"** instructs the application to extract all necessary meteorological parameters from the 4km WRF grid cell closest to the user specified coordinate.

Selecting **"Interpolate"** instructs the application to extract all necessary meteorological parameters from the four 4km WRF grid cells closest to the user specified coordinate and compute the distance weighted average for each meteorological parameter.

MMEU2

AERMET/AERMOD WIZARD

Please select an interpolation method.

☒ No Interpolation
Use the closest 4km grid cell

☐ Interpolate
Use the 4 closest 4km grid cells

< BACK NEXT > CANCEL

Output Properties

This screen is used to specify the output location and options. The user can user whether to extract meteorological data, template AERMET input file or a template AERMOD input file. Please note that existing files will be overwritten in the output folder.

MMEU2

AERMET/AERMOD WIZARD

Please specify output location & extraction ptions.

OUTPUT FOLDER: F:\2004851\output

☒ EXTRACT MET
 SAMSON FILE NAME: samson.sam
 UPPER AIR FILE NAME: upperair.ua

☒ GENERATE AERMET.INP

☒ GENERATE AERMOD.INP

< BACK NEXT > CANCEL

Summary

Running the AERMOD Wizard can be time consuming and may use significant disk space. The Summary view displays the details of the options selected to ensure that the inputs are correct and that there is sufficient disk space.

Press the “OK” button to complete the Wizard.

The screenshot shows the 'Summary' window of the MMEU2 AERMOD Wizard. The window title is 'MMEU2' and the subtitle is 'AERMOD WIZARD'. The 'Summary' tab is selected. The summary is displayed in a grid of eight boxes:

COORDINATE	START DATE	END DATE	INTERPOLATION
50.82, -114.45	1/1/2015 00:00	12/31/2019 23:00	None (Closest Cell)

OUTPUT FOLDER	SAMSON FILE	UPPER AIR FILE	ESTIMATED DISK SPACE
F:\2004851\output	samson.sam	upperair.ua	15 MB

At the bottom of the window are three buttons: '< BACK', 'OK', and 'CANCEL'.

The screenshot shows a 'Please Wait' dialog box from the MMEU2 application. The title bar is 'MMEU2'. The main text reads 'Please Wait' followed by the file path 'F:\2004851\Deliverable\MET\2019\wrfout_aep_d02_2019-01-09_12.nc'. A 'Cancel' button is located at the bottom right of the dialog box.

Progress messages are displayed as the wizard processes data and generates the selected output files. The process can be cancelled at any point by pressing the “Cancel” button. Note that when cancelling the process there may be incomplete files in the output directory that will need to be cleaned up.

APPENDICES

End User License Agreement

MMEU2

This End User License Agreement ("Agreement") is a legal agreement between you as an individual or an entity ("Licensee") and Alberta Environment and Parks ("AEP"), regarding the use of RWDI's software solution entitled the Multi-Model Extraction Utility or MMEU2 ("Software").

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Multi-Model Extraction Utility 2 & 2015-2019 Alberta Meteorological Data

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CALPUFF

This distribution contains a copy of the CALWRF preprocessor developed by Exponent.

CALWRF is part of the CALPUFF modelling system and has a separate End User License Agreement which can be found here:

http://www.src.com/calpuff/calpuff_eula.htm

Exponent has granted Alberta Environment and Parks permission to distribute and use a compiled version of CALWRF as part of the MMEU distribution. A copy of CALWRF and it's associated licenses can be found in the MMEU2/calwrf directory located on the external hard drive(s).

Other

NetCDF Operators

<http://nco.sourceforge.net>

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SDSLite (Microsoft Scientific Dataset)

<https://github.com/predictionmachines/sdslite>

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Seasons

All seasonal outputs from MMEU2 conform to the following definition of season:

Season	Months
Winter	November-March
Spring	April-May
Summer	June-August
Fall	September-October

Land Use Lookup Tables

MMEU2 uses lookup tables derived from the [2020 Alberta Air Quality Model Guideline](#) and the [2015 British Columbia Air Quality Dispersion Modelling Guideline](#). The values in these lookup tables are stored in the same directory as MMEU2.exe called configuration\Landuse.csv and configuration\geo_dat.csv. The CSV files are read each time the MMEU2 application is executed, which means that the default values can be overridden by modifying the CSV files. Please justify your reasoning to AEP when overriding these values.

Land Use

Land Use Classification	FGP Code	CALPUFF LUC
Temperate or sub-polar needleleaf forest	1	42
Sub-polar taiga needleleaf forest	2	42
Temperate or sub-polar broadleaf deciduous forest	5	41
Mixed Forest	6	43
Temperate or sub-polar shrubland	8	32
Temperate or sub-polar grassland	10	30
Sub-polar or polar shrubland-lichen-moss	11	32
Sub-polar or polar grassland-lichen-moss	12	30
Wetland	14	60
Cropland	15	20
Barren	16	70
Urban - Open Space	17	10
Urban - Low Intensity	17	10
Urban - Medium Intensity	17	10
Urban - High Intensity	17	10
Water	18	51
Snow and Ice	19	90

Albedo

2020 Alberta Air Quality Model Guideline

Land Use Classification	FGP Code	CALPUFF LUC	Albedo			
			Winter	Spring	Summer	Fall
Evergreen Forest Land Temperate	1	42	0.35	0.12	0.12	0.12
Evergreen Forest Land Subpolar	2	42	0.35	0.12	0.12	0.12
Deciduous Forest Land	5	41	0.5	0.16	0.16	0.16
Mixed Forest Land	6	43	0.42	0.14	0.14	0.14
Temperate or Subpolar Shrubland	8	32	0.5	0.18	0.18	0.18
Temperate or subpolar Grassland	10	30	0.6	0.18	0.18	0.18
Subpolar or polar Shrubland Lichen Moss	11	32	0.5	0.18	0.18	0.18
Subpolar or Polar Grassland Lichen Moss	12	30	0.6	0.18	0.18	0.18
Wetland	14	60	0.3	0.14	0.14	0.14
Agricultural Land Unirrigated	15	20	0.6	0.14	0.2	0.2
Barren Land	16	70	0.25	0.2	0.2	0.2
Urban - Open Space	17	10	0.7	0.6	0.6	0.6
Urban - Low Intensity	17	10	0.6	0.15	0.15	0.15
Urban - Medium Intensity	17	10	0.45	0.16	0.16	0.16
Urban - High Intensity	17	10	0.18	0.18	0.18	0.18
Water	18	51	0.1	0.1	0.1	0.1
Perennial Snow or Ice	19	90	0.7	0.6	0.6	0.6

Bowen Ratio

2020 Alberta Air Quality Model Guideline

Land Use Classification	FGP Code	CALPUFF LUC	Bowen Ratio			
			Winter	Spring	Summer	Fall
Evergreen Forest Land Temperate	1	42	0.5	0.7	0.3	0.8
Evergreen Forest Land Subpolar	2	42	0.5	0.7	0.3	0.8
Deciduous Forest Land	5	41	0.5	0.7	0.3	1
Mixed Forest Land	6	43	0.5	0.7	0.3	0.9
Temperate or Subpolar Shrubland	8	32	0.5	1	1	1.5
Temperate or subpolar Grassland	10	30	0.5	0.4	0.8	1
Subpolar or polar Shrubland Lichen Moss	11	32	0.5	1	1	1.5
Subpolar or Polar Grassland Lichen Moss	12	30	0.5	0.4	0.8	1
Wetland	14	60	0.5	0.2	0.2	0.2
Agricultural Land Unirrigated	15	20	0.5	0.3	0.5	0.7
Barren Land	16	70	0.5	1.5	1.5	1.5
Urban - Open Space	17	10	0.5	0.3	0.5	0.7
Urban - Low Intensity	17	10	0.5	0.8	0.8	1
Urban - Medium Intensity	17	10	0.5	1.1	1.1	1.2
Urban - High Intensity	17	10	0.5	1.5	1.5	1.5
Water	18	51	0.1	0.1	0.1	0.1
Perennial Snow or Ice	19	90	0.5	0.5	0.5	0.5

Surface Roughness (z0)

2020 Alberta Air Quality Model Guideline

Land Use Classification	FGP Code	CALPUFF LUC	Surface Roughness			
			Winter	Spring	Summer	Fall
Evergreen Forest Land Temperate	1	42	1.3	1.3	1.3	1.3
Evergreen Forest Land Subpolar	2	42	1.3	1.3	1.3	1.3
Deciduous Forest Land	5	41	0.5	1	1.3	1.3
Mixed Forest Land	6	43	0.8	1.1	1.3	1.3
Temperate or Subpolar Shrubland	8	32	0.15	0.3	0.3	0.3
Temperate or subpolar Grassland	10	30	0.005	0.05	0.1	0.1
Subpolar or polar Shrubland Lichen Moss	11	32	0.05	0.1	0.1	0.1
Subpolar or Polar Grassland Lichen Moss	12	30	0.005	0.05	0.1	0.1
Wetland	14	60	0.3	0.5	0.5	0.5
Agricultural Land Unirrigated	15	20	0.014	0.04	0.2	0.2
Barren Land	16	70	0.01	0.05	0.05	0.05
Urban - Open Space	17	10	0.02	0.03	0.04	0.03
Urban - Low Intensity	17	10	0.05	0.09	0.1	0.09
Urban - Medium Intensity	17	10	0.2	0.3	0.3	0.3
Urban - High Intensity	17	10	0.7	0.7	0.7	0.7
Water	18	51	0.001	0.001	0.001	0.001
Perennial Snow or Ice	19	90	0.002	0.002	0.002	0.002

Soil Heat Flux (HCG)

British Columbia 2015 Dispersion Modelling Guideline

Land Use Classification	FGP Code	CALPUFF LUC	Soil Heat Flux			
			Winter	Spring	Summer	Fall
Evergreen Forest Land Temperate	1	42	0.15	0.15	0.15	0.15
Evergreen Forest Land Subpolar	2	42	0.15	0.15	0.15	0.15
Deciduous Forest Land	5	41	0.15	0.15	0.15	0.15
Mixed Forest Land	6	43	0.15	0.15	0.15	0.15
Temperate or Subpolar Shrubland	8	32	0.15	0.15	0.15	0.15
Temperate or subpolar Grassland	10	30	0.15	0.15	0.15	0.15
Subpolar or polar Shrubland Lichen Moss	11	32	0.15	0.15	0.15	0.15
Subpolar or Polar Grassland Lichen Moss	12	30	0.15	0.15	0.15	0.15
Wetland	14	60	0.3	0.3	0.3	0.3
Agricultural Land Unirrigated	15	20	0.15	0.15	0.15	0.15
Barren Land	16	70	0.15	0.15	0.15	0.15
Urban - Open Space	17	10	0.15	0.25	0.25	0.25
Urban - Low Intensity	17	10	0.15	0.25	0.25	0.25
Urban - Medium Intensity	17	10	0.15	0.25	0.25	0.25
Urban - High Intensity	17	10	0.15	0.25	0.25	0.25
Water	18	51	0.15	1	1	1
Perennial Snow or Ice	19	90	0.15	0.15	0.15	0.15

Anthropogenic Heat Flux (QF)

British Columbia 2015 Dispersion Modelling Guideline

Land Use Classification	FGP Code	CALPUFF LUC	Anthropogenic Heat Flux			
			Winter	Spring	Summer	Fall
Evergreen Forest Land Temperate	1	42	0	0	0	0
Evergreen Forest Land Subpolar	2	42	0	0	0	0
Deciduous Forest Land	5	41	0	0	0	0
Mixed Forest Land	6	43	0	0	0	0
Temperate or Subpolar Shrubland	8	32	0	0	0	0
Temperate or subpolar Grassland	10	30	0	0	0	0
Subpolar or polar Shrubland Lichen Moss	11	32	0	0	0	0
Subpolar or Polar Grassland Lichen Moss	12	30	0	0	0	0
Wetland	14	60	0	0	0	0
Agricultural Land Unirrigated	15	20	0	0	0	0
Barren Land	16	70	0	0	0	0
Urban - Open Space	17	10	17	15	8	12
Urban - Low Intensity	17	10	17	15	8	12
Urban - Medium Intensity	17	10	17	15	8	12
Urban - High Intensity	17	10	17	15	8	12
Water	18	51	0	0	0	0
Perennial Snow or Ice	19	90	0	0	0	0

Leaf Area Index (XLAI)

British Columbia 2015 Dispersion Modelling Guideline

Land Use Classification	FGP Code	CALPUFF LUC	Leaf Area Index			
			Winter	Spring	Summer	Fall
Evergreen Forest Land Temperate	1	42	5	5	5	5
Evergreen Forest Land Subpolar	2	42	5	5	5	5
Deciduous Forest Land	5	41	0	0.8	3.4	1.9
Mixed Forest Land	6	43	2.3	3.3	4.5	3.5
Temperate or Subpolar Shrubland	8	32	0	0	0	0
Temperate or subpolar Grassland	10	30	1	1	1	1
Subpolar or polar Shrubland Lichen Moss	11	32	0	0	0	0
Subpolar or Polar Grassland Lichen Moss	12	30	1	1	1	1
Wetland	14	60	0	0.1	0.2	0.2
Agricultural Land Unirrigated	15	20	0	1	2	1.5
Barren Land	16	70	0.05	0	0	0
Urban - Open Space	17	10	0	0.2	0.3	0.2
Urban - Low Intensity	17	10	0	0.2	0.3	0.2
Urban - Medium Intensity	17	10	0	0.2	0.3	0.2
Urban - High Intensity	17	10	0	0.2	0.3	0.2
Water	18	51	0	0	0	0
Perennial Snow or Ice	19	90	0	0	0	0

Land Use

The Land Use data used by MMEU2 is the “2015 Land Cover of Canada” dataset from Natural Resources Canada (NRCAN):

https://ftp.maps.canada.ca/pub/nrcan_rncan/Land-cover_Couverture-du-sol/canada-landcover_canada-couverture-du-sol/

It can be found on the accompanying hard drive here: /LANDUSE/lc2015_nlcd_mosaic_30m.asc

Documentation about this dataset can be found on the Open Data Canada website:

<https://open.canada.ca/data/en/dataset/4e615eae-b90c-420b-adee-2ca35896caf6>

DEM

DEM data was sourced from GeoBase.

It can be found on the accompanying hard drive here: /DEM/cdem_aster_mosaic_25m.asc

Documentation about this dataset can be found here:

https://ftp.maps.canada.ca/pub/nrcan_rncan/elevation/cdem_mnec/doc/CDEM_en.pdf

CALWRF on Windows

The CALWRF 2.03 Windows binary included with this distribution along with the CALWRF Windows binary included in the CALPUFF distribution will not run work with NetCDF files exported with the Met wizard. This is due to an incompatibility between the different NetCDF libraries used with the current version of WRF and those that were used for CALWRF. To use CALWRF on windows it is necessary to remove the unnecessary WRF parameters from the NetCDF. This can be accommodated by using the NCO tool ncks to generate NetCDF files that only contain the following parameters:

Parameter		
GLW	QGRAUP	U
HFX	QICE	U10
HGT	QRAIN	UST
ITIMESTEP	QSNOW	V
LH	QVAPOR	V10
LU_INDEX	RAINC	W
P	RAINNC	XLAT
PB	SNOWC	XLAT_U
PBLH	SST	XLAT_V
PH	SWDOWN	XLONG
PHB	T	XLONG_U
PSFC	T2	XLONG_V
Q2	Times	ZNU
QCLOUD	TSK	

The CALMET/CALPUFF Wizard within MMEU2 takes this into account when generating the meteorological files for CALWRF.

This incompatibility does not exist for CALWRF compiled in a linux environment.

RAOBS (NCDC TD6201) Upper Air File Format

A) FORMAT (VARIABLE RECORD)

The first seven fields constitute the ID PORTION and occur at the beginning of each record. The next ten fields of the record contain the DATA PORTION. The DATA PORTION is repeated for each level in the observation. The maximum number of levels is 200.

Each logical record is of variable length with a maximum of 7232 characters. Each logical record contains a station's complete Upper Air Observation for a specific release time. The form of a record is:

ID PORTION (32 characters) Fixed Length

STATION ID	LAT	LAT CODE	LONG	LONG CODE	TIME/DATE	NUMBER VALUES
XXXXXXXX	XXXX	X	XXXXX	X	XXXXXXXXXX	XXX
001	002	003	004	005	006	007

DATA PORTION (36 Characters) repeated Number-Values Times

LVL-QLTY INDCTR	TIME	PRESSURE	HEIGHT	TEMP	RH	WIND DIR	WIND SPD
X	XXXX	XXXXX	XXXXXX	XXXX	XXX	XXX	XXX
008	009	010	011	012	013	014	015

Field Descriptions

TAPE FIELD	TAPE RECORD POSITION	ELEMENT DESCRIPTION	CODE DEFINITIONS AND REMARKS
001	001-008	STATION IDENTIFICATION	STATION IDENTIFICATION-For U.S. controlled and cooperative stations, this is a WBAN number. For stations received through GTS, it is the WMO number. This field may contain alphabetic characters for ships and remote sensed observations. Numeric station numbers are right justified and zero filled, while alphanumeric station identifiers are left justified and blank filled. If unknown, this field contains "99999999". If the station identification is unknown, both latitude and longitude must be present.
002	009-012	LATITUDE	LATITUDE-The station latitude in degrees and minutes. When unknown, this field contains "9999". Latitude will not normally appear for land stations.

TAPE FIELD	TAPE RECORD POSITION	ELEMENT DESCRIPTION	CODE DEFINITIONS AND REMARKS
003	013	LATITUDE CODE N/S	LATITUDE CODE - CODE used to indicate the Northern (N) or Southern (S) latitudes.
004	014-018	LONGITUDE	LONGITUDE-The station longitude in degrees and minutes. When unknown, this field contains "99999". Longitude will not normally appear for land stations.
005	019	LONGITUDE CODE E/W	LONGITUDE CODE-CODE used to indicate CODE longitudes East (E) or West (W).
006	020-029	DATE AND TIME (YR/MO/DY/HR)	DATE/TIME-The scheduled time of the observation, as defined by WMO. The format of date/time is YYYYMMDDHH, i.e., year, month, day, hour. This field may never be unknown. YEAR-This is the Year of record. Range of values is 1946-current year processed. MONTH-This is the Month of record. Range of values is 01-12. DAY-This is the Day of record, Range of values is 01 to 31. HOURL-This is the Hour of record. Range of values is 00 to 23. Hour is GMT. Normal scheduled observation times are 00 and 12 GMT. For selected periods and areas observations may have been taken at other times, especially 06 and 18 GMT.
007	030-032	NUMBER OF DATA PORTION GROUPS THAT FOLLOW	NUMBER-OF-REPEATING-GROUPS--This number represents the number of data levels found in the current observation, including edited levels. Range of values is 001-200. Two hundred is the maximum number of levels.

TAPE FIELD	TAPE RECORD POSITION	ELEMENT DESCRIPTION	CODE DEFINITIONS AND REMARKS
008	033	LEVEL QUALITY INDICATOR	LEVEL-QUALITY-INDICATOR--Denotes the results of any quality controls applied to this level. 0 - Original values are correct. 1 - Original values are missing. 2 - Original values doubtful, a corrected level follows. 3 - Original values doubtful, uncorrected. 4 - Original values in error, a corrected level follows. 5 - Original values in error, uncorrected. 6 - Corrected level. 9 - Level not checked. <i>A-Z Indicators supplied by NMC. (A-G, blank) Automatic via computer system.</i> A Passed vertical consistency check with tight limits. B Failed vertical consistency check and has not been recomputed. C Failed vertical consistency check and was recomputed. D Failed vertical consistency check with tight limits and passed with loose limits. E (Not assigned) F Has been checked but did not pass vertical consistency check with loose limits. G (Not assigned) blank (Not specified) <i>(H-P, \$) Manual via Human Intervention</i> H Hold value for next analysis run I (Same as A) J (Same as B) K (Same as C) L (Same as D) M (Same as E) N (Same as F) O (Same as G) P Purge from analysis run MMEU2 sets this field 0
009	034-037	TIME (ELAPSED TIME SINCE RELEASE)	TIME-The elapsed time since the release of the sounding, in minutes and tenths. If the elapsed time is not known, this field contains "9999". Range is 001 through 9999. Available only for U.S. quality-controlled stations beginning January 1981.

TAPE FIELD	TAPE RECORD POSITION	ELEMENT DESCRIPTION	CODE DEFINITIONS AND REMARKS
010	038-042	PRESSURE AT LEVEL	PRESSURE-Atmospheric pressure at the current level in kilopascals and hundredths. If unknown, this field contains "99999". (TD-6201 only - subsurface levels were generated from January 1, 1981 through February 28, 1986. The values were always unknown. This practice was stopped March 1, 1986).
011	043-048	HEIGHT AT LEVEL	HEIGHT-Geopotential height of the current level in whole meters. If unknown, this field contains "-99999". Range of values is -99999 through 99999.
012	049-052	TEMPERATURE AT LEVEL	TEMPERATURE-The free air temperature at the current level in degrees and tenths Celsius. If unknown, this field contains "-999". Range of values is -999 through 999.
013	053-055	RELATIVE HUMIDITY AT LEVEL	RELATIVE-HUMIDITY-The relative humidity at the current level in whole percent. If unknown, this field contains "999". In TD- 6202, relative humidities are derived statistically for RH's not reported originally.
014	056-058	WIND DIRECTION AT LEVEL	WIND-DIRECTION-Direction of the wind in whole degrees (nearest five degrees for observations received through GTS). If unknown, this field contains "999".
015	059-061	WIND SPEED AT LEVEL	WIND-SPEED-Speed of the wind in whole meters per second. If unknown, this field contains "999".

TAPE FIELD	TAPE RECORD POSITION	ELEMENT DESCRIPTION	CODE DEFINITIONS AND REMARKS
016	062-067	FLAG FIELD (QUALITY FLAGS). Format XXXXXX	QUALITY-FLAG -This field contains the results of any quality control procedures, identifying each individual element found in error (see table below). QUALITY CONTROL FLAG 0 Element is correct 1 Element is doubtful 2 Element is in error 3 Replacement value 4 Assumed or estimated value 9 Element not checked A-Z Indicators supplied by NMC Position 62 – Time Quality Flag Position 63 – Pressure Quality Flag Position 64 – Height Quality Flag Position 65 – Temperature Quality Flag Position 66 – Relative Humidity Quality Flag Position 67 – Wind Quality Flag MMEU2 sets the quality flag to 0
017	068	TYPE OF LEVEL.	LEVEL-QUALITY-INDICATOR--Denotes the results of any quality controls applied to this level. Format X 0 Surface 1 Mandatory 2 Significant 3 Generated 4 Tropopause 5 Maximum wind 9 Other/unspecified MMEU2 sets the Type of Level to 2

Note that fields 1 – 8 are the header record and fields 9-17 are repeated for each vertical level.

The following table denotes the historical changes to the TD6201 format.

(1958-1972)	(7125-7160)	DATA GROUPS IN THE SAME FORM AS TAPE FIELDS
(1973-1987)	(7161-7196)	008-017. REPEATED AS MANY TIMES AS NEEDED
(1988-2002)	(7197-7232)	TO COMPLETE ONE UPPER AIR OBSERVATION. A MAXIMUM OF 200 LEVELS ARE POSSIBLE.

SAMSON File Format

Columns	Element	Definition
001	Indicator	~ to indicate a header record
002-006	WBAN Number	Station number identifier
008-029	City	City where station is located
031-032	State	State where station is located
033-036	Time Zone	The number of hours by which the local standard time lags or leads Universal Time.
039-044	Latitude	Station latitude
039		N = north of equator
040-041		Degrees
043-044		Minutes
047-053	Longitude	Station longitude
047		W = west, E = east
048-050		Degrees
052-053		Minutes
056-059	Elevation	Elevation of the station in meters above sea level.

The FORTRAN format of this record is:

(1X,A5,1X,A22,1X,A2,1X,I3,2X,A1,I2,1X,I2,2X,A1,I3,1X,I2,2X,I4)

Each variable is represented by a position number. This position number always corresponds to that variable, no matter how many or how few variables are retrieved. The second record contains the list of variables (by a position number) that appear in the data file. There is no particular format; the variable number appears above the column of data it represents with at least one space (and usually many more) between the position numbers.

The third and subsequent records contain the weather elements retrieved from the SAMSON CD-ROMs. The data are free format, i.e., there is at least one space between each element in the record. The year, month, day, hour and

observation indicator always appear on each record. These are followed by the variables retrieved by the user. If all the variables were retrieved, they would appear in the following order:

Position	Description
	Year, month, day, hour (LST), observation indicator
1	Extraterrestrial horizontal radiation
2	Extraterrestrial direct normal radiation
3	Global horizontal radiation
4	Direct normal radiation
5	Diffuse horizontal radiation
6	Total cloud cover
7	Opaque cloud cover
8	Dry bulb temperature
9	Dew point temperature
10	Relative humidity
11	Station pressure
12	Wind direction
13	Wind speed
14	Visibility
15	Ceiling height
16	Present weather
17	Precipitable water
18	Broadband aerosol optical depth

Position	Description
19	Snow depth
20	Days since last snowfall
21	Hourly precipitation amount and flag