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Meteorological data processing for AERMOD: 2024 updates and user's manual

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1 Introduction

Air dispersion modeling has been used by the Air Program of California Department of Pesticide Regulation (DPR) for human health risk assessments. Meteorological input data is an important component in the applications of air dispersion models. In the early modeling efforts, the Air Program used manual processing to prepare meteorological input data for ISCST (Industrial Source Complex – Short Term) (Segawa, 1997). A standard procedure was later proposed to process CIMIS (California Irrigation Management Information System) data for ISCST (Johnson and Vidrio, 2014; Vidrio and Johnson, 2014). In 2017, a computer program "MetProc" was developed to prepare meteorological input data for AERMOD (American Meteorological Society/Environmental Protection Agency Regulatory Model) (Luo, 2017).

Meteorological data processing in MetProc is based on the AERMET model and its accessories developed by U.S. Environmental Protection Agency (USEPA). With the same model inputs and settings, therefore, MetProc will generate exactly the same results as AERMET or other AERMET-based applications such as AERMET View by Lakes Software. The purpose of MetProc development is to provide a one-click solution for the preparation of meteorological input files and facilitate the configuration and implementation of air dispersion modeling by the Air Program.

With a graphical user interface, MetProc automatically downloads and processes data from the National Weather Service (NWS) and also allows incorporation of user-specified onsite data. This program has been used by Air Program in the modeling studies on both soil and structural fumigations (Tao, 2018a, b; Luo, 2019; Tao, 2019; Tao and Vidrio, 2019). More recently, MetProc was used in the regulatory modeling for 1,3-D rulemaking (DPR, 2023, 2024). The Air Program has continued to enhance and refine the capabilities of the program. This report summarizes the cumulative updates after 2017 for the development, improvement, and integration in MetProc. Section 2 explains the procedures for data preparation and processing, and Section 3 provides instructions to use the program interface of MetProc.

2 Procedures and model settings

2.1 Overview of data and tools used in MetProc

Two primary data sources are used in the preparation of meteorological input data: [1] meteorological observations from National Oceanic and Atmospheric Administration (NOAA) and [2] National Land Cover Database (NLCD) from United States Geological Survey (USGS). In addition, MetProc provides an option to incorporate user-provided onsite meteorological data.

Meteorological observations are updated at hourly or sub-hourly frequency and released to the public via NOAA's web services (with delays from hours to days varying by date type, station, and period). NLCD data are updated less frequently, and the use of NLCD data in air dispersion modeling is also limited by the development of compatible tools for data processing. For example, the 2016 version of NLCD was accepted and processed by AERMET and its accessories only after 2020, and, as of this study, the latest AERMET (24142) accepts NLCD data up to the 2021 version. In MetProc, therefore, meteorological data will be downloaded and processed for each model run according to the user-specified station and period, while the NLCD data for California have been preprocessed and integrated in MetProc.

The latest versions of USEPA models and accessories are incorporated in MetProc (Table 1). In addition, the gzip executable (https://www.gzip.org/) is used by MetProc to extract the data files compressed using the gzip algorithm.

Table 1. USEPA models and accessories incorporated in the MetProc version 2024

Model	Version	Description
AERMET	24142	Processing surface data and upper air data
AERMINUTE	15272	Processing sub-hourly data
AERSURFACE	24142	Processing NLCD data

2.2 Integrated Surface Database (Data set ID: 3505)

NOAA's Integrated Surface Database (ISD) consists of hourly surface observations. ISD includes numerous parameters such as wind speed and direction, wind gust, temperature, dew point, cloud data, sea level pressure, altimeter setting, station pressure, present weather, visibility, precipitation amounts for various time periods, snow depth, and various other elements as observed by each station. Note that all meteorological data released by NOAA are reported in Greenwich Mean Time (GMT), which is 8 hours ahead of the Local Standard Time (LST) of California.

There are about 140 active ISD stations in California. An ISD data file is provide for each station and each year. MetProc uses the 5-digit WBAN (Weather Bureau, Air Force and Navy) code of a station to query meteorological data. The code could be retrieved from the online map of the NOAA stations (Figure 1). More detailed information on each site is available in the station history file (Figure 2).

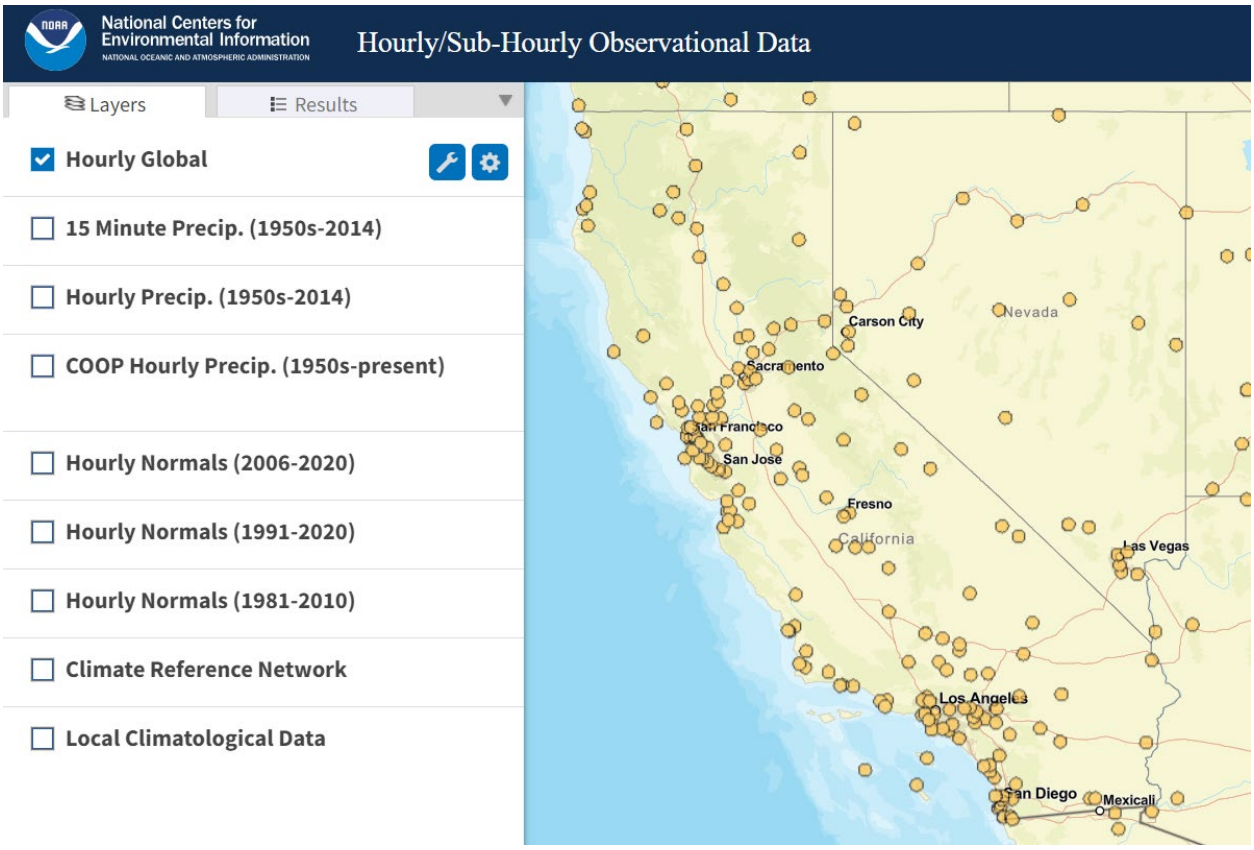

Figure 1. Online map of the NOAA stations for surface observations (https://www.ncei.noaa.gov/maps/hourly/)

A	B	C	D	E	F	G	H	I	J	K
USAF	WBAN	STATION NAME	CTRY	STATE	ICAO	LAT	LON	ELEV(M)	BEGIN	END
723910	93111	POINT MUGU	US	CA	KNTD	34.124	-119.123	3.8	19730101	20231109
722906	93112	NORTH ISLAND NAS	US	CA	KNZY	32.692	-117.21	4.4	19450401	20231109
722909	93115	NAVAL AUXILIARY LANDING FD	US	CA	KNRS	32.568	-117.117	7.2	19730101	20231109
722910	93116	SAN NICOLAS ISLAND NAVAL OUTLYING FIELD	US	CA	KNSI	33.234	-119.456	161.3	19430616	20231109
722925	93117	NALF/F. SHERMAN FLD ARPT	US	CA	KNUC	33.023	-118.588	55.5	19430610	20231109
690150	93121	TWENTY NINE PALMS	US	CA	KNXP	34.294	-116.147	610.5	19900102	20231109
722874	93134	DOWNTOWN L.A./USC CAMPUS	US	CA	KCQT	34.024	-118.291	54.6	20000101	20231109
722868	93138	PALM SPRINGS INTL AIRPORT	US	CA	KPSP	33.822	-116.504	124.7	20060101	20231109
723896	93144	VISALIA MUNICIPAL AIRPORT	US	CA	KVIS	36.317	-119.4	89.9	20060101	20231110
722977	93184	J. WAYNE APT-ORANGE CO APT	US	CA	KSNA	33.68	-117.867	13	19400617	20231109
723890	93193	FRESNO YOSEMITE INTERNATIONAL AIRPORT	US	CA	KFAT	36.78	-119.72	101.9	19411204	20231109
722885	93197	SANTA MONICA MUNI AIRPORT	US	CA	KSMO	34.021	-118.447	53.3	20060101	20231109
725846	93201	TRUCKEE-TAHOE AIRPORT	US	CA	KTRK	39.32	-120.139	1798.3	20060101	20231109

Figure 2. Detailed information for the NOAA ISD stations. Here only shows some of the active stations in California, accessed on 11/10/2023.

Data downloading

With the user-specified WBAN code and years, MetProc automatically downloads the ISD data from the data service provided by NOAA's National Centers for Environmental Information (NCEI). A warning message will be provided if the requested date range are not sufficiently

covered by the available data, i.e., out of the range as defined by the BEGIN and END days (Figure 2) for the corresponding station. As mentioned before, ISD data files are provided on an annual basis (i.e., one file for one year at a station). For the current year, the ISD files are available and continuously updated with a delay of several hours to days varying by stations. The downloaded files are compressed using the standard gzip (GNU zip) algorithm, and MetProc will extract the data after downloading.

Station characteristics

The map (Figure 1) and list (Figure 2) of NOAA stations only provide a rough estimation of the location for each station. MetProc will extract accurate values for the coordinates and elevation from the ISD data file. The data values are retrieved from the first record with the data source flag of "6" or "7". See the documentation for the ISD format for more information (NOAA, 2018).

2.3 Automated Surface Observing System (Data set ID: 6405)

Some of the ISD stations have been equipped with Automated Surface Observing Systems (ASOS) since 2000. In California, there are 74 active ISD stations reporting ASOS data. The ASOS reports 1-minute wind data which can be used to supplement the standard archive of hourly observations and thus reduce the number of calms and missing winds in the surface data.

ASOS data is provide for each station and each month. Similar to ISD, ASOS data are also continuously updated and the data for the current month are available with a delay of several hours to days varying by stations. MetProc will first check if the user-specified ISD station has ASOS data available. If so, MetProc will automatically download and process the ASOS data for the modeling period.

2.4 Radiosonde Observation (Data set ID: IGRA or FSL)

Some weather stations provide upper air data for the radiosonde observations including pressure, temperature, humidity, and wind speed and direction. Upper air observations are taken twice a day at 0000 hours and 1200 hours GMT. There are only 3 active stations in California for upper air data (Table 2), conventionally identified by its World Meteorological Organization (WMO) code.

Table 2. Active stations for air upper data in California

WMO	Name	USAF	WBAN	Station	Longitude	Latitude
72293	NKX	722931	NA	Miramar MCAS	-117.15	32.87
72393	VBG	723930	93214	Vandenberg AFB	-120.57	34.75
72493	OAK	724930	23230	Oakland international airport	-122.22	37.75

The previous version of MetProc (Luo, 2017) uses the upper air data in the Forecast System Laboratory (FSL) format. In December 2021, USEPA (2021) started to accept a new format, the Integrated Global Radiosonde Archive (IGRA), for meteorological data processing. Beginning in autumn of 2024, the FSL data was no longer available online (USEPA, 2024a), while the FSL

data files previously downloaded in local drives still can be processed. In this update of MetProc, therefore, the upper air data is downloaded and processed as follows,

- (Default for any modeling period) Based on the user-specified station and time period, MetProc will automatically retrieve and process the upper air data in the IGRA format.
- (Optional for July 2024 and before) MetProc has an option to integrate the pre-downloaded FSL data for data processing.

The pre-downloaded FLS data files for the three California stations (Table 3) during 2010-2023 and the first 7 months of 2024 are provided in the MetProc package. This option is to generate meteorological data consistent with those used in previous air dispersion modeling studies.

2.5 Onsite data

MetProc accepts user-provided onsite surface data and processes the data together with the NOAA data to build the meteorological input files for AERMOD. The sources of onsite data used in the previous DPR studies including California Irrigation Management Information System (CIMIS, hourly data, https://cimis.water.ca.gov/), Air Quality and Meteorological Information System (AQMIS, hourly data, https://www.arb.ca.gov/aqmis2/aqmis2.php), and DPR's Air Monitoring Network (1-minute or 5-minute data, not publicly available). A user is required to download and format the data for use in MetProc. The required format of the onsite data is described in the user's manual section 3.3. The following paragraph will focus on the algorithms and procedures in onsite data processing.

Based on the input onsite data, MetProc first determines the reporting frequency as the keyword OBS/HOUR, which is the number of observations per hour. AERMET currently allows OBS/HOUR up to 12 (i.e., every 5 minutes). For onsite data with OBS/HOUR ≤ 12, therefore, MetProc will directly send the data to AERMET without any preprocessing.

MetProc provides an option to preprocess sub-hourly onsite data for the following conditions:

- To process onsite data with OBS/HOUR >12,
- To use the Yamartino method for averaging wind directions, and/or
- To calculate the standard deviation of wind directions.

The Yamartino (1984) method is an algorithm for estimate the circular variance of wind direction (θ). The hourly average wind direction (θ_a) is calculated as,

$$\theta_a = \arctan\,(c_a, s_a)$$

where c_a and s_a are the arithmetic averages of sin(θ) and cos(θ) over the hour to be averaged across,

$$s_a = \frac{1}{n}\sum_{i=1}^{n} sin\theta_i$$

$$c_a = \frac{1}{n}\sum_{i=1}^{n}\cos\theta_i$$

with n = OBS/HOUR (number of measurements per hour). The same method is used in AERMINUTE for averaging 1-minute ASOS data (USEPA, 2023). However, AERMET uses a different method by considering wind speed in the calculation of s_a and c_a.

The standard deviation of wind directions (σ_θ) is estimated as,

$$\sigma_\theta = \arcsin(\epsilon)\left[1 + \left(\frac{2}{\sqrt{3}} - 1\right)\epsilon^3\right]$$

where

$$\epsilon = \sqrt{1 - (s_a^2 + c_a^2)}$$

Note that the standard deviation of wind directions is not provided by NOAA meteorological data or calculated by AERMET. To include σ_θ in the meteorological input files for AERMOD, a user needs to either provide onsite data with pre-calculated σ_θ (e.g., hourly data from CIMIS) or use the MetProc option to calculate it from sub-hourly wind directions.

2.6 National Land Cover Database (NLCD)

Two versions (1992 and 2021) of NLCD data have been incorporated into MetProc. Before 2021, AERMET only accepted the NLCD version 1992. Therefore, the meteorological data processed with NLCD 1992 have been used by DPR in regulatory modeling studies, especially for 1,3-dichloropropene (1,3-D) rulemaking. The latest version of AERSURFACE 24142 could process multiple versions of the NLCD data up to 2021. Generally, NLCD 2021 (or the latest version accepted by AERSURACE in the future) should be used for meteorological data processing. In MetProc, NLCD 1992 is also included for the regulatory modeling on 1,3-D in order to generate consistent results with the previous studies (DPR, 2023, 2024).

According to USEPA (2024b) guidance for land surface data access, both versions of NLCD data were downloaded from the USEPA server (https://gaftp.epa.gov/Air/aqmg/nlcd/) and saved in the "nlcd" folder of the MetProc program. The data are provided as a set of GeoTIFF files, which were generated by USEPA's Air Quality Modeling Group (AQMG) based on the nationwide NLCD files available from the MRLC website in ERDAS IMAGINE format. Note that, even for the same version of NLCD, there are different formats and editions available from various online sources, which may generate slightly different results for meteorological data processing compared to those prepared by USEPA's AQMG and incorporated in MetProc.

NLCD data is used to estimate the surface characteristics around the meteorological station, including albedo, surface roughness length, and Bowen ratio. In MetProc, the three variables are extracted as monthly data for 12 directions (called "sectors") within 1 kilometer around the

weather station (see Appendix II for an example of the landscape segmentation). For each station, therefore, there are 432 parameter values extracted from NLCD (432 = 3 variables × 12 months × 12 sectors). MetProc will first extract data for the NOAA site. With user-provided onsite data, in addition, MetProc will repeat the process for the onsite station. In this case, the two sets of extracted surface characteristics, for the NOAA station and the onsite station, will both be used in the subsequent meteorological data processing.

2.7 Data processing

The following procedures are automated in MetProc for meteorological data processing:

1. Prepare a list of data files (for ISD, ASOS, and upper air observations) to be downloaded based on the user-specified stations and period.
2. Download the required data files from the NOAA servers.
3. If ASOS data is available at the NOAA surface station: call AERMINUTE to calculate hourly averages from ASOS data.
4. Call AERSURFACE to extract surface characteristics for the NOAA surface station.
5. If onsite data is provided:
    a. Call AERSURFACE to extract surface characteristics for the onsite station.
    b. If sub-hourly onsite data is provided and the option for "Yamartino method" is selected by the user: Calculate hourly average wind data and standard deviation of wind directions.
6. Call AERMET stage 1 to extract data from downloaded NOAA data and user-provided onsite data.
7. Call AERMET stage 2 to incorporate outputs from AERMINUTE and AERSURFACE and create model input files for AERMOD.

2.8 Annual updating

MetProc will automatically update its internal database during the first model run on or after January 15 of each year. This process updates the NOAA station information for the last calendar year, including the changes on operation status and introduction of new stations.

3 User's manual

3.1 Installation

The package of MetProc is available at the Air Program's network drive (\\dprhq01\Air_Program\Computer Modeling\MetProc). Please copy the entire folder of "MetProc" to a local hard disk of your computer. Figure 3 shows an example of MetProc copied in C:\MetProc\. The package includes the executable file ("MetProc.exe"), PDF file of the user's manual (this document), models and accessories ("bin" folder), files for tutorials ("example" folder), downloaded data and model inputs/outputs ("met" folder), and NLCD data ("nlcd" folder).

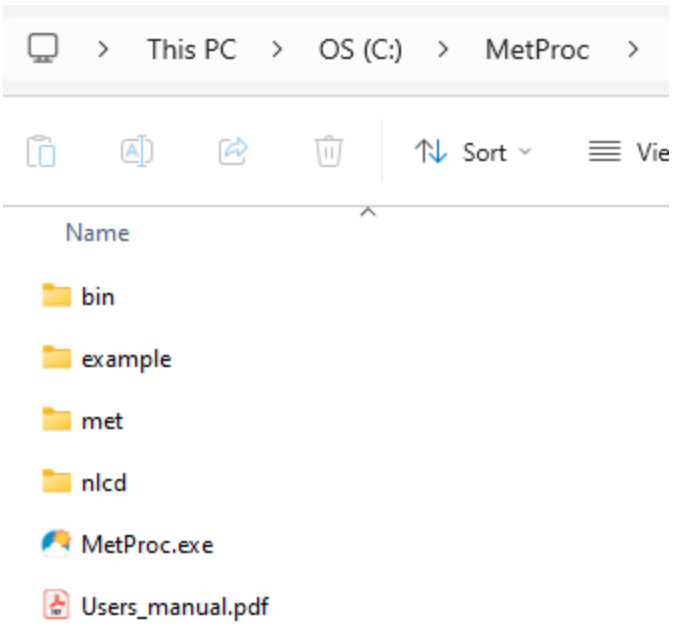

Figure 3. The MetProc package in a local computer

3.2 The graphical user interface and a simple model run

Double click the executable file "MetProc.exe" to start the program (Figure 4). The minimum set of input data include

- Start date and end date for data processing (specified in the format of "MM/dd/yyyy"),
- The surface data station (specified by its WBAN), and
- The upper air station (selected from a dropdown menu).

Figure 4 shows an example of meteorological data processing during 1/1/2022 to 12/31/2022 for the NOAA station at Parlier (WBAN 93193) with the upper air data from Oakland. Press the "Process" button to start data processing. See Section 2.7 for more information on the procedures. Once the data processing has completed, MetProc will pop up a message window and open the folder with the processed data files. The files are provided: the surface file (SFC), the profile file (PFL), and the AERMET stage-1 input file (IN1). The first two files are the meteorological input files for AERMOD, and the last one is to save the information of the weather stations.

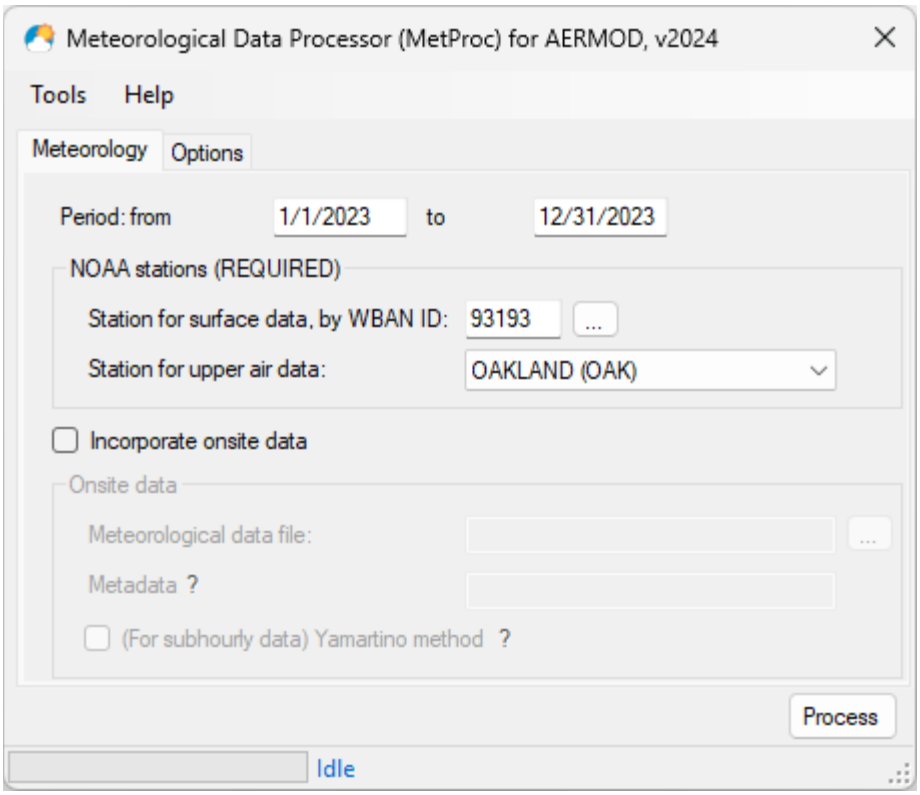

Figure 4. MetProc graphical user interface

3.3 Onsite data

Figure 5 shows the input data and options for onsite data incorporation with the example project in the MetProc package ("MetProc\example\Atwater_Onsite\"). The following three sets of input data are required for the incorporation of onsite data (Figure 5):

- The input data file for the meteorological observations from the onsite station,
- The information on the onsite station: longitude (decimal degree), latitude (decimal degree), elevation (meter), and threshold wind speed (m/s), in comma delimited value. For example, the input string "-120.6637,37.3058,36.88,0.01" characterizes the onsite weather station in a field study at Atwater, California (Figure 5), and
- The option to use the Yamartino method to replace the AERMET built-in algorithm for converting sub-hourly observations to hourly averages (see Section 2.5 for more information on this option).

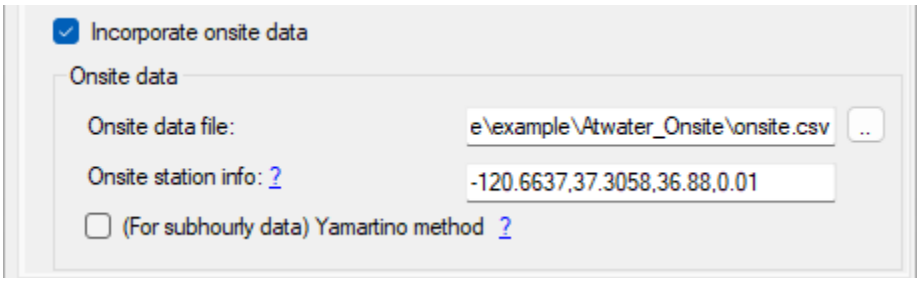

Figure 5. Input data and options to incorporate onsite data in MetProc

Onsite data are downloaded and formatted by a user before it can be used in MetProc. Appendix I provides instructions for data downloading from CIMIS and AQMIS databases. The prepared input file is in a CSV (comma-separated value) format. It's suggested to prepare the input data file in Excel and choose "CVS (Comma delimited) (*.csv)" as the "Save as type" when exporting the data. The CSV file should have a header row that describes the variable names of each column, followed by data rows ordered by date/time of observations (Figure 6). Blank rows are not acceptable. If *all* variables are missing at an observation interval (i.e., a missing hour or minute), just skip this interval and write the next available data row. Blank cells are not acceptable. If *some* of the variables are missing, the missing values should be replaced by the missing indicator (Table 3).

	A	B	C	D	E	F	G	H	I	J
1	OSYR	OSMO	OSDY	OSHR	OSMN	HT01	WS01	WD01	TT01	RH01
2	2021	10	18	13	25	10	3.149	175.7	18.63	39.69
3	2021	10	18	13	30	10	3.191	10.28	18.26	39.39
4	2021	10	18	13	35	10	3.47	332.9	17.62	40.48
5	2021	10	18	13	40	10	3.342	1.522	17.13	40.36
6	2021	10	18	13	45	10	2.946	318.8	17.07	40.98
7	2021	10	18	13	50	10	2.983	0.107	17.11	40.15
8	2021	10	18	13	55	10	4.357	308.7	17.25	38.97
9	2021	10	18	14	0	10	3.129	33.87	17.24	39.33
10	2021	10	18	14	5	10	2.637	350	17.71	38.44
11	2021	10	18	14	10	10	3.758	334.3	18.04	38.55
12	2021	10	18	14	15	10	4.392	341.8	17.63	40.34
13	2021	10	18	14	20	10	3.05	338.9	17.06	40.6

Figure 6. Example of onsite input data prepared for MetProc

The minimum dataset includes year (OSYR), month (OSMO), day (OSDY), hour (OSHR), minute (OSMN, for sub-hourly onsite data), height of the first sensor (HT01), and wind speed (WS01), wind direction (WS01), and temperature (TT01) measured at the corresponding height. Unlike the NOAA data reported in GMT, onsite data should be provided in Local Standard Time (LST). Table 3 summarizes commonly variables for onsite data. Refer to the AERMET user's manual for a full list of the variables.

Table 3. Variables for onsite input file to be prepared

Variable	Description	Missing indicator
OSYR	Year	NA
OSMO	Month	NA
OSDY	Day	NA
OSHR	Hour	NA
OSMN	Minute (for sub-hourly data)	NA
PRES	Station pressure (mbar×10)	99999
HT01	Height (meter)	NA
WS01	Wind speed (m/s)	99
WD01	Wind direction (degree from north)	999
TT01	Temperature (°C)	99
SA01	Standard deviation of horizontal wind (degree)	99
RH01	Relative humidity (whole percent)	999

Notes: NA = missing data is not allowed for the variable. Variables in bold represent the minimum requirement for onsite data in MetProc.

3.4 Additional options

Additional options are provided in MetProc for NLCD data, upper air data, ADJ_U* algorithm, and surface characterization (Figure 7). The general recommendation is to use the latest NLCD data (i.e., version 2021 as of this study) that could be processed by AERSURFACE. The exemption is for the regulatory modeling on 1,3-D, which was initiated in 2018 and developed based on NLCD 1992 (the latest version at that time). In order to generate consistent results, the option to "use NLCD 2021" should be unselected for the modeling studies related to the 1,3-D rulemaking.

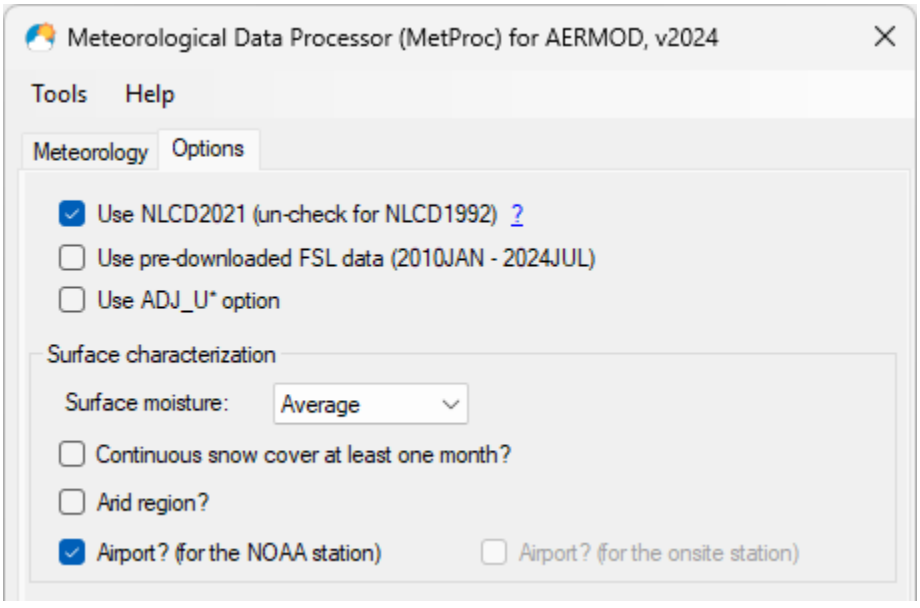

Figure 7. The MetProc advanced options

By default, MetProc will download and process the upper air data in IGRA format. In addition, an option is provided to use the historical FSL data. MetProc package includes the pre-downloaded FSL data files for the three California stations during 1/1/2010 to 7/31/2024. Users can also use their own data by copying the file to the "met" folder and renaming it in the format of "WMO_year.fsl." For example, the file "72493_2006.fsl" is supposed to save the 1-year upper air data at the OAK station (WMO=72493, Table 2) during 2006.

ADJ_U* is an option to adjust the surface friction velocity (U*) for low wind speed stable conditions. Results of the model validation indicated that the predictions for 1,3-D with the ADJ_U* option significantly underpredicted the observed concentrations (Luo, 2019). Based on DPR model validation studies for both long-term averages and high detections of 1,3-D observations (Tao, 2018a, b; Luo, 2019; Tao, 2019; Luo and Uyeda, 2023), it's recommended not to use the ADJ_U* option in the modeling of *soil fumigants*.

For *structural fumigants* such as sulfuryl fluoride, the preliminary results showed that the differences of model predictions with and without ADJ_U* are moderated with the consideration of building washdown in urban area. The previous DPR modeling study on sulfuryl fluoride was based on the meteorological data processed with this option (Tao and Vidrio, 2019). Therefore, the preliminary recommendation for modeling structural fumigation is to include the ADJ_U* option, and the recommendation will be refined with additional modeling studies in the future.

The "Airport" option (also called "highz0" option for high roughness adjustment) is applied to most of the NOAA stations, but should be unchecked for some stations which are not located in an airport (such as the site WBAN93134 in the Los Angeles Downtown USC Campus). For other surface characteristics including moisture, snow cover, and aridity, no changes are need for most of the modeling areas in California for soil or structural fumigants. Refer to the AERSURFACE user's guide for more information (USEPA, 2024c).

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Yamartino, R. J. (1984). A Comparison of Several "Single-Pass" Estimators of the Standard Deviation of Wind Direction. Journal of Applied Meteorology and Climatology 23(9): 1362-1366.

Appendix I. Onsite data from CIMIS and AQMIS

CIMIS hourly data

CIMIS data is available at https://cimis.water.ca.gov/. A user account is needed for full access to download hourly data. Information for the CIMIS stations and sensors are provided at https://cimis.water.ca.gov/Stations.aspx (Figure 8). The longitude, latitude, and elevation (converted from feet to meters) of the station are required input data in MetProc. The wind sensors are installed at 2 m above the ground (HT01 = 2 m).

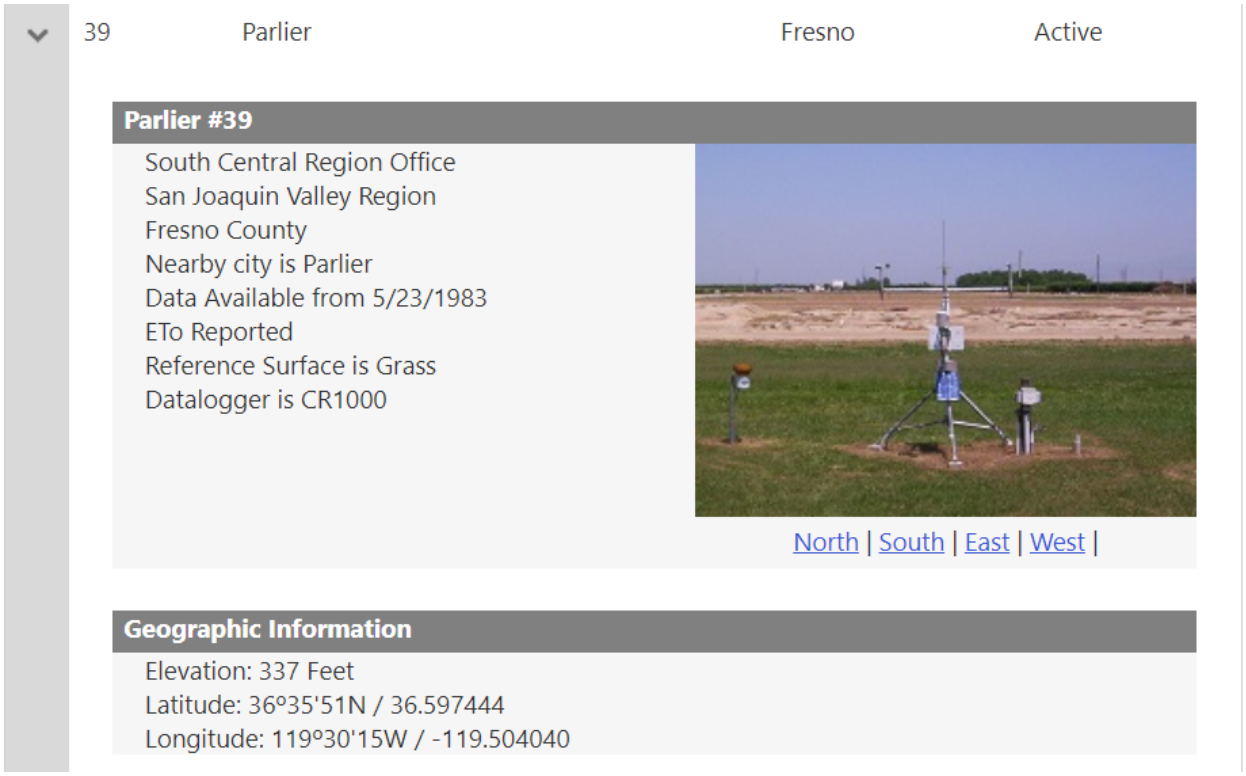

Figure 8. Information for CIMIS stations (showing CIMIS#39 at Parlier as an example)

CIMIS has the option to "Select Sensors" so that one can download multiple observations into one file (Figure 9). Figure 10 shows an example of the downloaded CIMIS data. By changing the variable names (Table *3*) and adding the sensor height (HT01 = 2 m), the downloaded CVS file could be converted to an onsite input file for MetProc (Figure 6).

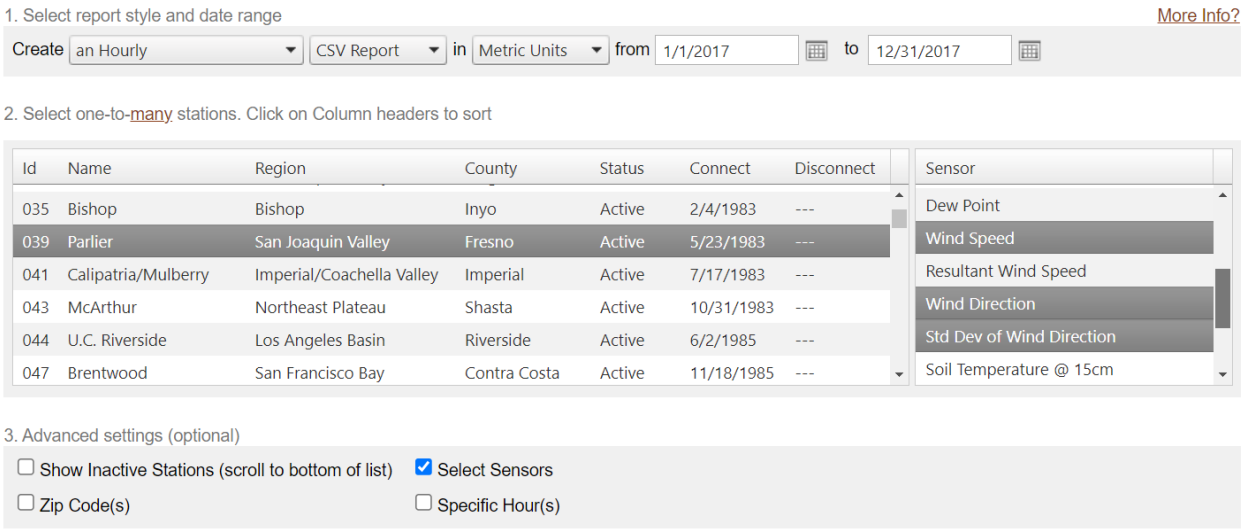

Figure 9. CIMIS option to "Select Sensors"

	A	B	C	D	E	F	G	H	I	J
1	Stn Id	Stn Name	CIMIS Region	Date	Hour (PST)	Jul	Air Temp (C)	Wind Speed (m/s)	Wind Dir (0-360)	Wind Dir Std Dev
2	39	Parlier	San Joaquin Valley	1/1/2017	100	1	5.8	0.8	122	23
3	39	Parlier	San Joaquin Valley	1/1/2017	200	1	5.7	1	113	15
4	39	Parlier	San Joaquin Valley	1/1/2017	300	1	5.6	1.2	133	12
5	39	Parlier	San Joaquin Valley	1/1/2017	400	1	5.4	1.2	130	14
6	39	Parlier	San Joaquin Valley	1/1/2017	500	1	5.2	0.8	120	12
7	39	Parlier	San Joaquin Valley	1/1/2017	600	1	4.8	1.1	130	11
8	39	Parlier	San Joaquin Valley	1/1/2017	700	1	4.9	1.5	125	12
9	39	Parlier	San Joaquin Valley	1/1/2017	800	1	5.1	0.9	168	30
10	39	Parlier	San Joaquin Valley	1/1/2017	900	1	5.5	1.3	121	21
11	39	Parlier	San Joaquin Valley	1/1/2017	1000	1	6.6	1.7	108	15
12	39	Parlier	San Joaquin Valley	1/1/2017	1100	1	7.6	2.1	122	15
13	39	Parlier	San Joaquin Valley	1/1/2017	1200	1	8.8	1.5	113	26
14	39	Parlier	San Joaquin Valley	1/1/2017	1300	1	9.6	0.9	186	55

Figure 10. Downloaded CIMIS data in CSV format (showing temperature, wind speed, wind direction, and wind direction standard deviation as selected sensors)

AQMIS hourly data

AQMIS data is available at https://www.arb.ca.gov/aqmis2/aqmis2.php. A user account is not required for data downloading. AQMIS data is queried by meteorological parameter. For each station and period, therefore, at least two files should be downloaded: one for wind data and the other for temperature. The first step for data query is to specify the parameter and region of interest. Figure 11 shows an example to retrieve the AQMIS stations reporting hourly wind data within Fresno County during 2017. There are 6 stations meeting the criteria (Figure 12). Under the station list, an option is available to "Get Additional Information on Sites" where one can retrieve the coordinates and elevation of each site. The wind sensors are installed at 10 m above the ground (HT01 = 10 m). By selecting a station from the list, a user could download the hourly data for the selected parameter. Figure 13 shows an example for the downloaded AQMIS hourly wind data at the Parlier station during 2017.

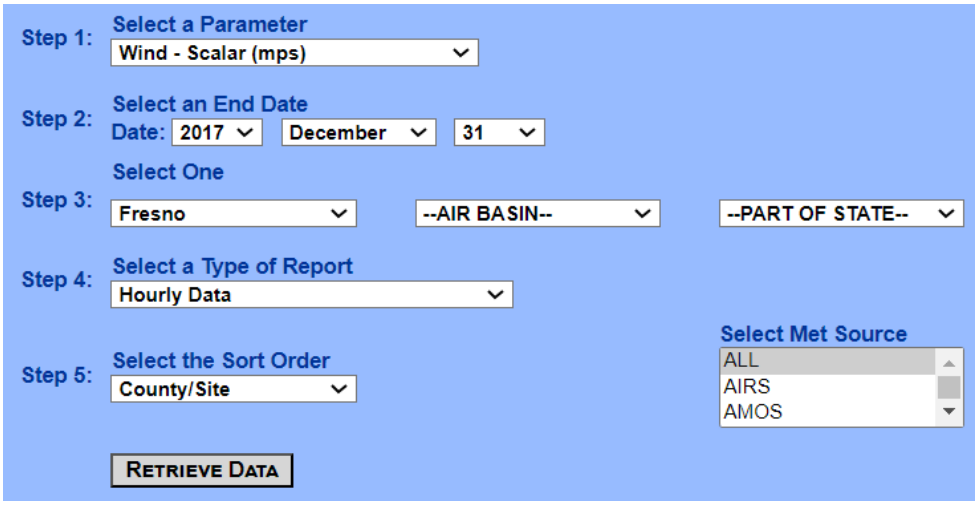

Figure 11. AQMIS data downloading, step 1: select parameter and region

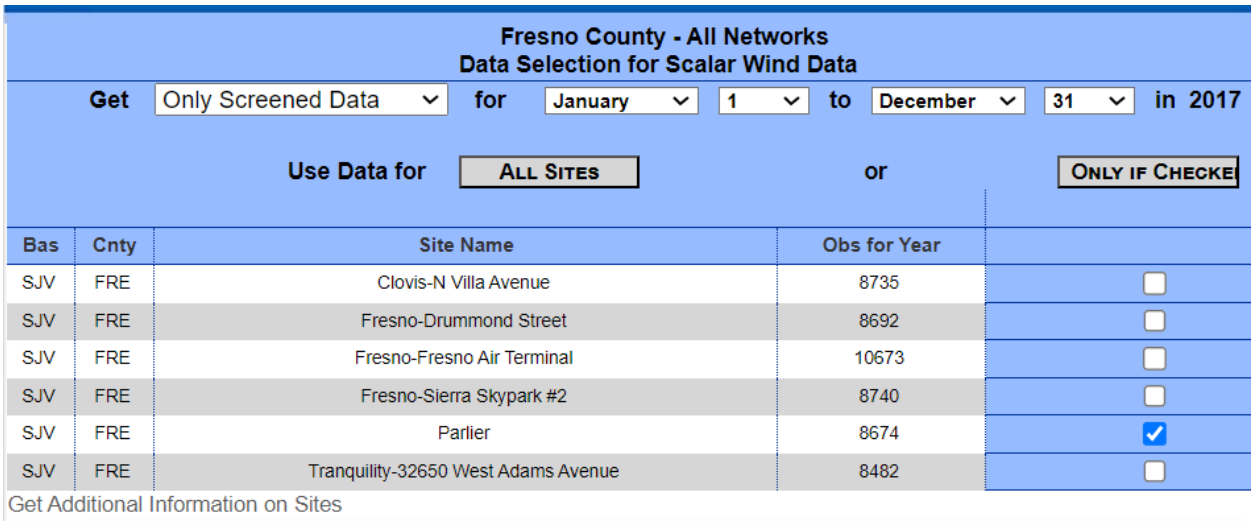

Figure 12. AQMIS data downloading, step 2: select station

	A	B	C	D	E	F
1	site	date	start_hour	value	variable	units
2	2114	1/1/2017	0	138/01.3	SWINSPD_wd/ws	Meters/Second (m/s)
3	2114	1/1/2017	1	120/01.5	SWINSPD_wd/ws	Meters/Second (m/s)
4	2114	1/1/2017	2	145/01.8	SWINSPD_wd/ws	Meters/Second (m/s)
5	2114	1/1/2017	3	143/01.8	SWINSPD_wd/ws	Meters/Second (m/s)
6	2114	1/1/2017	4	129/01.3	SWINSPD_wd/ws	Meters/Second (m/s)
7	2114	1/1/2017	5	142/02.0	SWINSPD_wd/ws	Meters/Second (m/s)
8	2114	1/1/2017	6	136/02.2	SWINSPD_wd/ws	Meters/Second (m/s)
9	2114	1/1/2017	7	186/01.6	SWINSPD_wd/ws	Meters/Second (m/s)
10	2114	1/1/2017	8	131/01.9	SWINSPD_wd/ws	Meters/Second (m/s)
11	2114	1/1/2017	9	120/02.3	SWINSPD_wd/ws	Meters/Second (m/s)
12	2114	1/1/2017	10	132/02.8	SWINSPD_wd/ws	Meters/Second (m/s)
13	2114	1/1/2017	11	123/02.0	SWINSPD_wd/ws	Meters/Second (m/s)
14	2114	1/1/2017	12	230/01.3	SWINSPD_wd/ws	Meters/Second (m/s)

Figure 13. Example of AQMIS hourly wind data

Appendix II. Configurations of Lake's AERMET viewer to generate comparable results as MetProc

Surface data

- Open the input ISD data file in a text editor to verify the coordinates and elevation for the station (Figure 14).
- Check "No" for the question "Is Surface Data Reported in LST", and set the adjustment from GMT to LST as "8 hours".

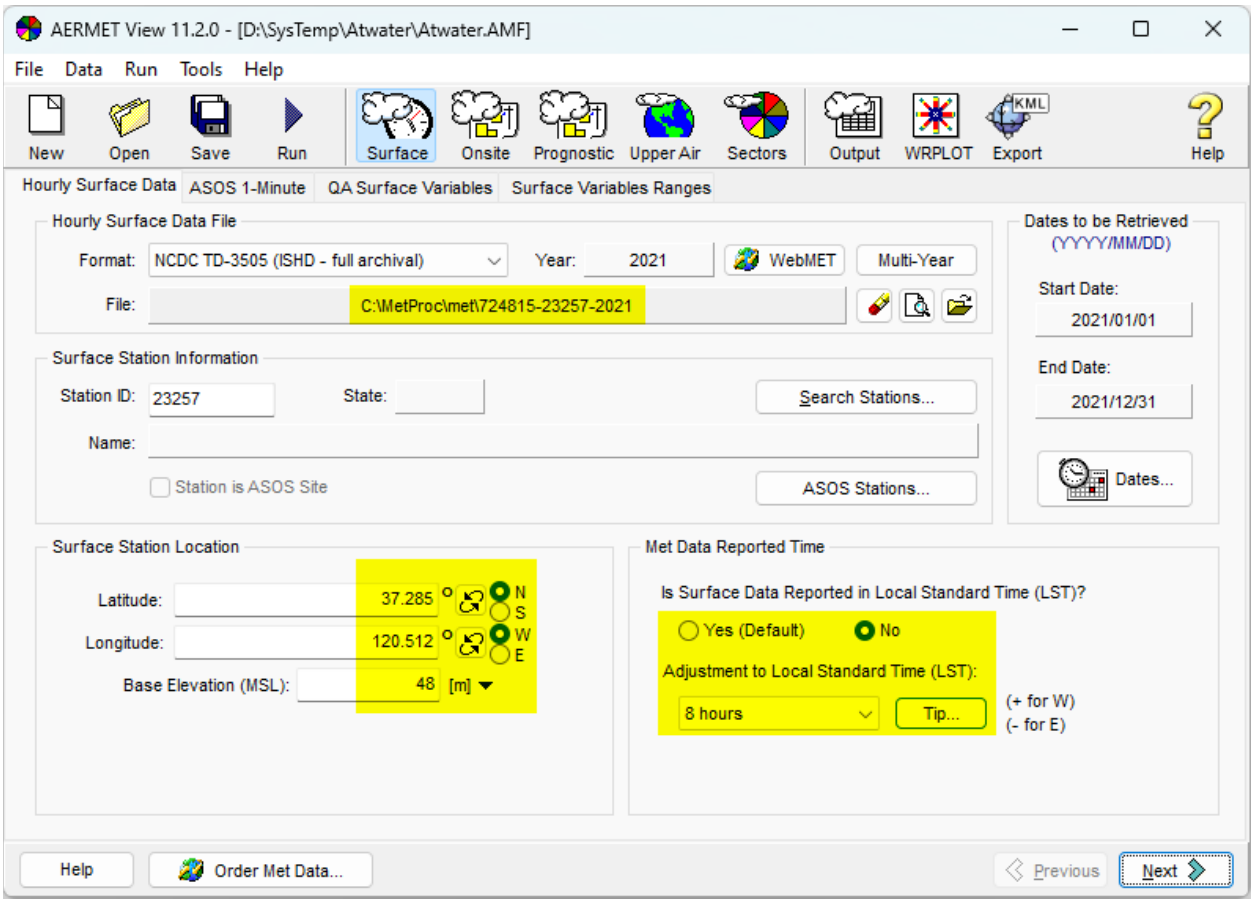

Figure 14. Configurations for ISD data

Onsite data

- Check "Yes (Default)" for the question "Is Surface Data Reported in LST" (Figure 15).

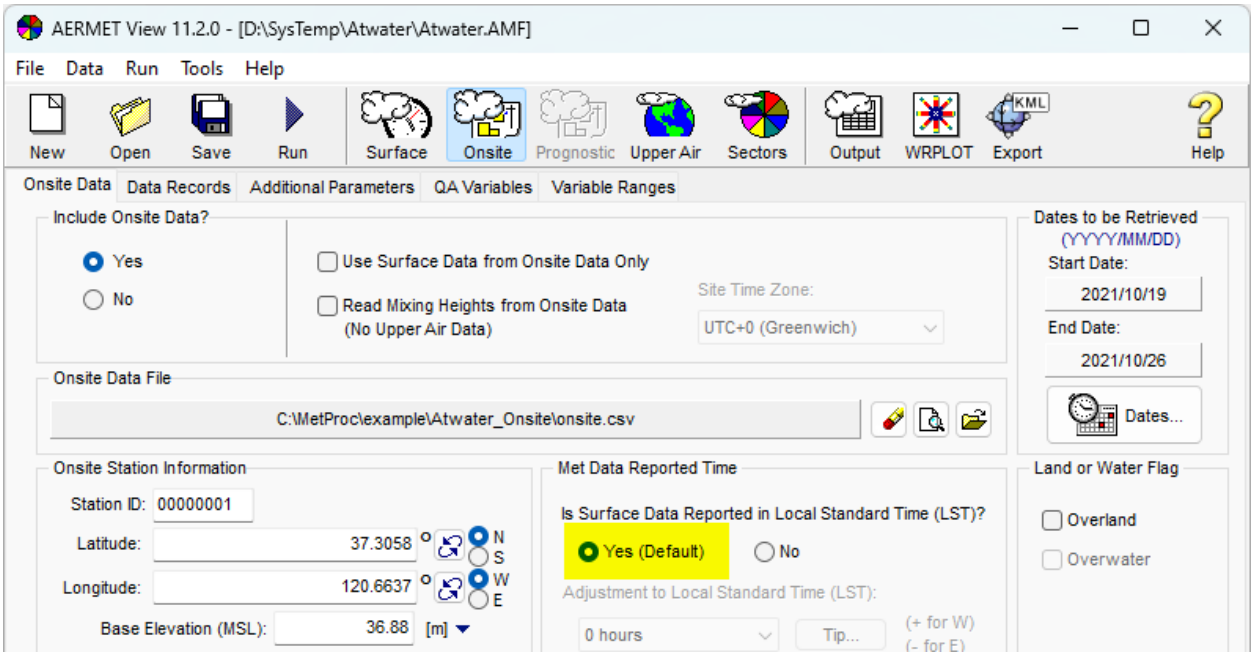

Figure 15. General configurations for onsite data

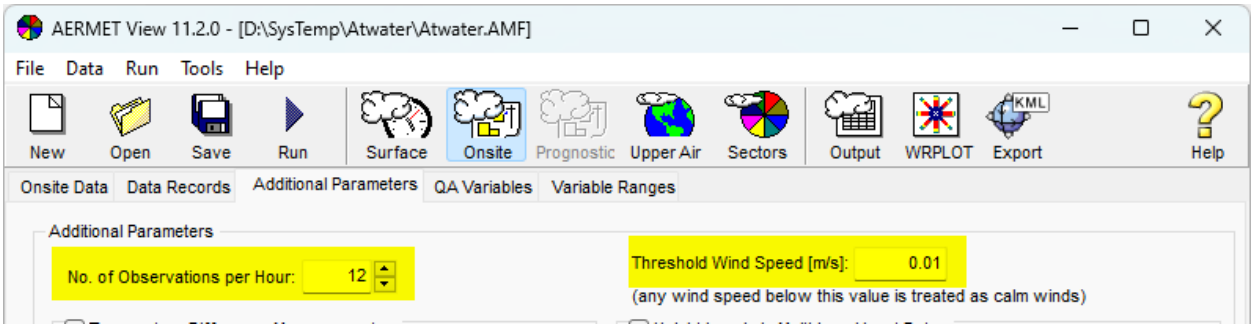

Figure 16. “Additional Parameters” for onsite data

Upper air data

- Check “Yes (Default)” for the question “Is Upper Air Data Reported in GMT”, and set the adjustment from GMT to LST as “8 hours” (Figure 17).

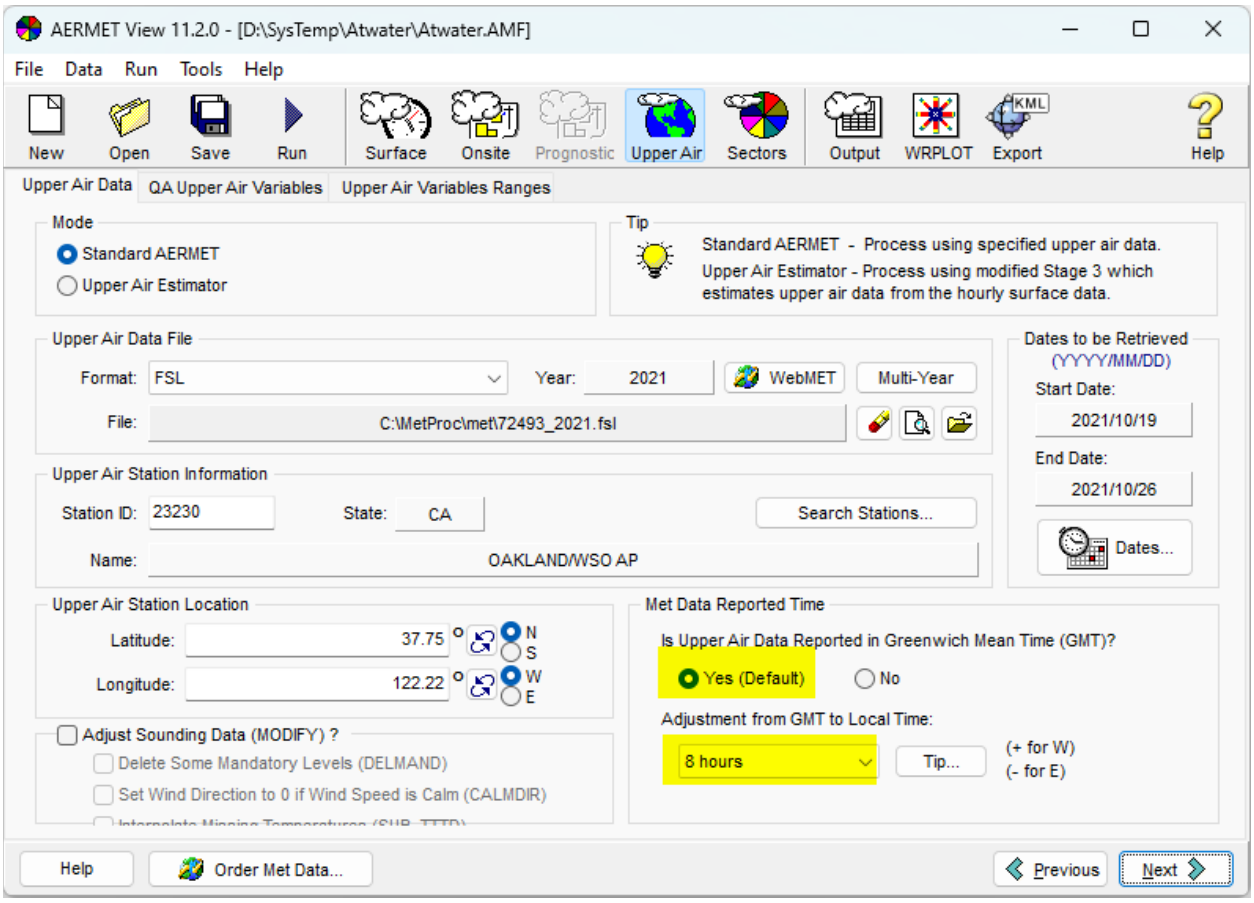

Figure 17. Configurations for upper air data

AERSURFACE

With onsite data, two model runs of AERSURFACE are needed: "Sectors (Onsite)" for the onsite station and "Sectors (Surface)" for the NOAA station. For each model run:

- For consistent modeling results, the NLCD data file provided in MetProc ("nlcd" folder) should be used (Figure 18).
- Double check the coordinates for the corresponding station under the "Location" tab (Figure 18). Specifically, the coordinates for the ISD station should be the same as those in Figure 14, and the coordinates for the onsite station should be the same as those in Figure 15.
- Select "Monthly" as the period under the "Climate Parameters" tab (Figure 19).
- Under the "Surface Roughness" tab, check "Airport Site" for the NOAA station and uncheck it for the onsite station (Figure 20). Do not change the default parameter values for radius (1.0 km) and # sections (12).

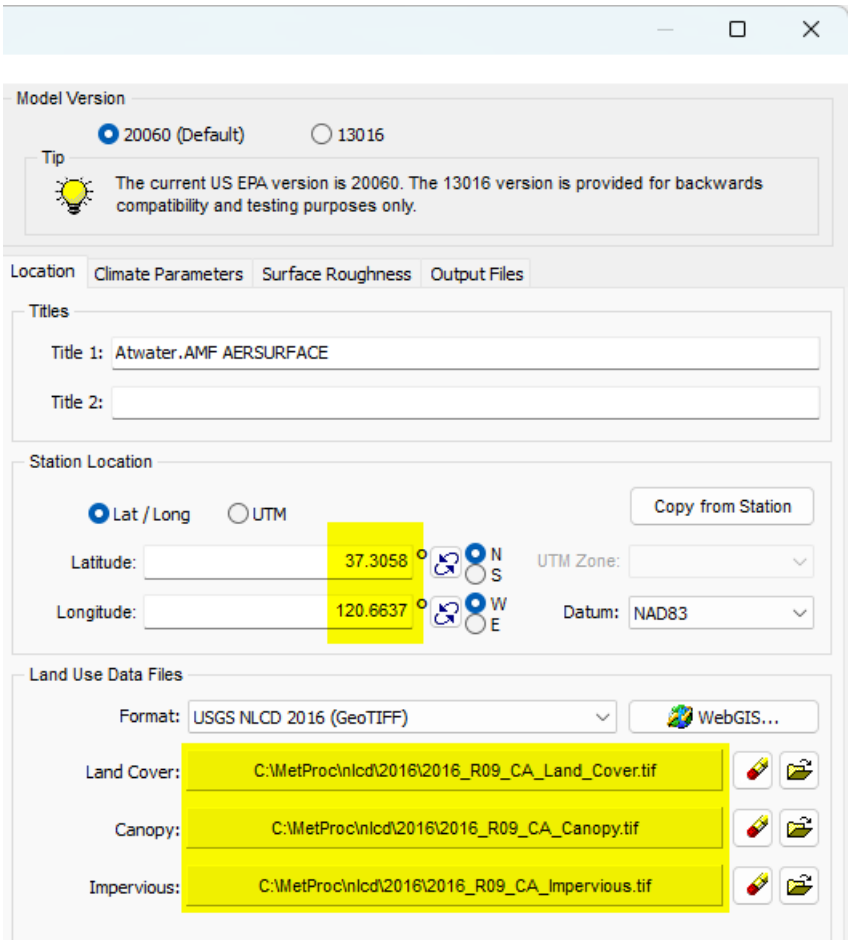

Figure 18. “Location” tab for AERSURFACE (showing the inputs for the onsite station)

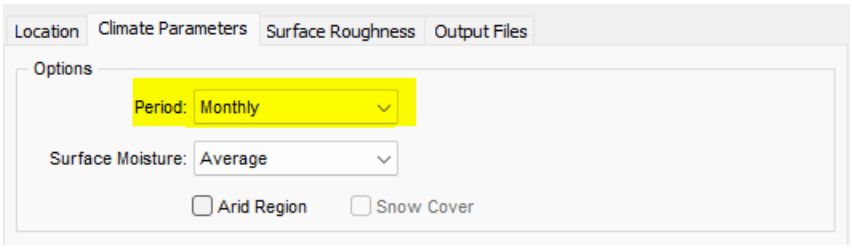

Figure 19. “Climate Parameters” tab for AERSURFACE

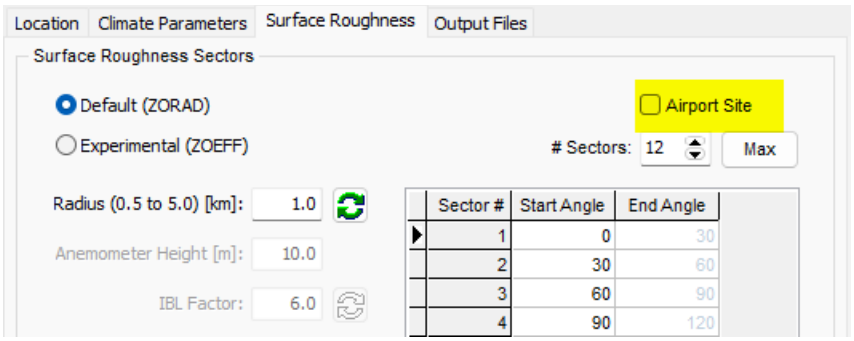

Figure 20. “Surface Roughness” tab for AERSURFACE (check “Airport Site” for the NOAA station and uncheck it for the onsite station)