CV Theis Observatory Plotter

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Overview

This brief overview of the CV Theis Observatory Plotter familiarizes the user with the installation and basic operation of the application which is intended solely for viewing data collected by the CV Theis Groundwater Observatory. The Observatory began operation in February 2017 and is designed to study the interaction of Great Miami River with adjacent outwash-alluvial Great Miami Buried Valley Aquifer, A sole-source aquifer for the c. two million residents of the Great Miami drainage basin. The observatory consists of three sets of paired observation wells: one screened at the top and the other at the bottom of the aquifer and is located on the active Great Miami floodplain immediately adjacent to Great Miami River in Miami-Whitewater Forest, Great Parks of Hamilton County, Ohio (Figure 1).

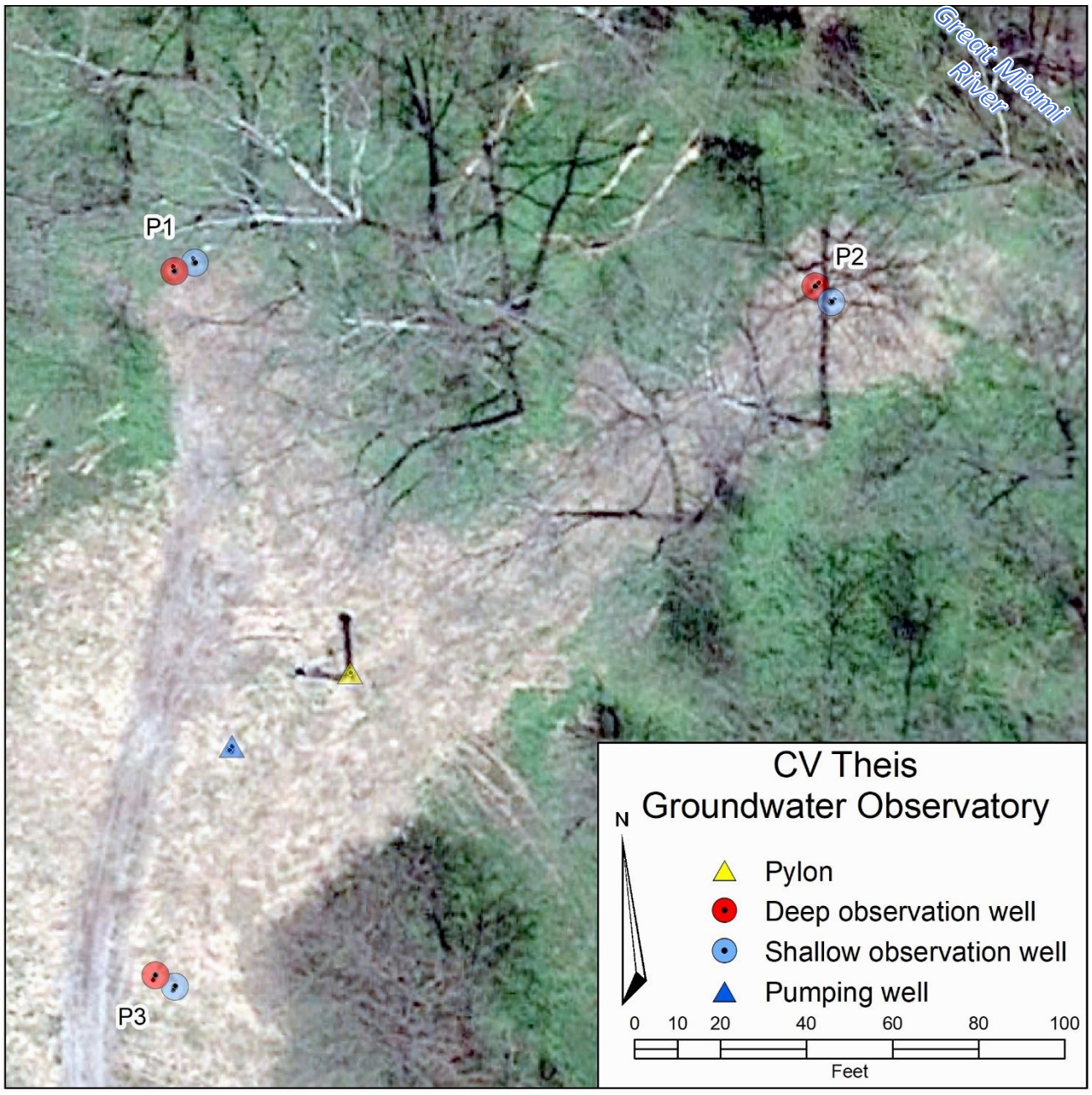

Figure 1. The program is designed to view data collected by the CV Theis Groundwater Observatory.

The program is written for use with Windows computers and is available for free download here. It is not intended for printing data or plots but rather for viewing the data available. Finished plots of the data may be generated by a spreadsheeting program (*e.g.,* Excel) from comma separated data (CSV) or tab-delimited data available online or by writing all or selected portions of the raw data out to a CSV file via the program.

Installation

The program was developed on Microsoft's Visual Studio IDE (Community 2017Edition) and is distributed using that IDE's *Just-in-Time* (JIT) publishing engine. In addition to ease of use, JIT eliminates the necessity of downloading all of the installation files onto the local machine. It informs users of updated versions and permits updates to be installed only on those parts of the program that have changed and does not require that the earlier version be uninstalled before updating.

It is impractical to get Verisign certification for my UC site so installers will be warned that, because the publisher cannot be verified, proceeding with installation is a security risk. Although this is correct, most of us have probably installed software from unverified sources before. I have developed all of the code myself, no components have been taken from other sources (by linking or even copying and pasting). Once installed, no other files are directly written to the local machine (all data are read from the observatory's online data server) unless the ***Output Raw Data*** button is specifically pressed in which case all the raw data collected during the plotted time period will be written to the local machine in the specified comma-delimited file. The installation experience will differ slightly by the installed Windows version and the browser type. Two installation scenarios follow.

Windows 7 with Chrome

When the download button is clicked and the setup program will be downloaded; double-click the file to start installation. After checking that the local machine is connected to the internet, a screen will appear (Figure 2). Click "Install" button to proceed with installation.

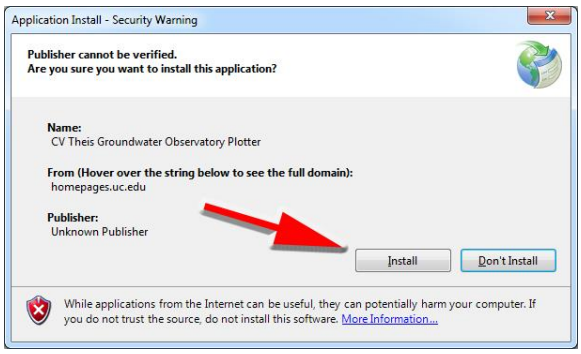

Figure 2. After download the setup file (available here)

Windows 10 with Microsoft Edge

When the download button is clicked, depending on how Edge has been configured, you will likely be given the standard three options (Figure 3)

Figure 3. When the download button is pressed in Edge browser, this dialog appears. The user may run the program directly or save it to a location on the host machine then double-click to run it. It is suggested that the run option is selected.

Chose "Run" to start installation or "Save" to download installer (in which case you'll need to double click the file to launch the installer). After checking that the local machine is connected to the internet, a warning screen will appear (Figure 4).

Figure 4. The user is warned when the setup program is run that the program has not been verified. Click the "More information" link to proceed with installation.

Clicking the "More info" link, will display a new window (Figure 5).

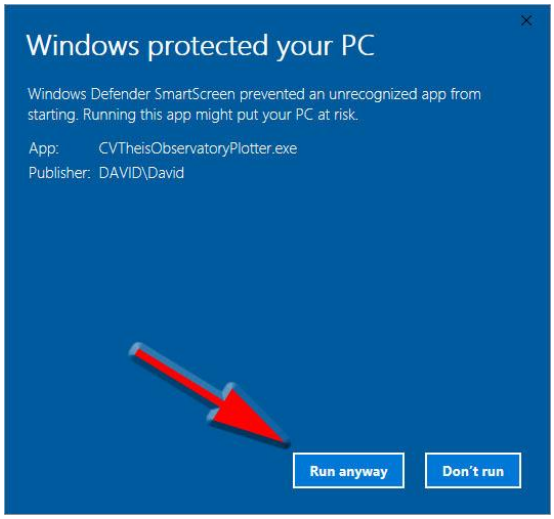

Figure 5. Click the "Run anyway" button to proceed with installation

Click the "Run anyway" button.

Running the program

Startup

When the application is started, it first determines if the host computer is connected to the internet. It next checks to see if the most recent version of the program is installed and, if not, asks the user if he or she wishes to update to the latest version. If the user responds affirmatively, the program is updated using Microsoft's JIT system

Once the application itself starts, it loads the entire collected dataset from the online database. This database is only read once unless the user explicitly directs that it be uploaded again. The database is updated hourly

(although not on the hour). Observations are made at 15-minute intervals. Because the data are stored in a binary format, they are uploaded quickly but an entire calendar year may take several seconds because of the immense amount of data.

The startup screen consists of three panels (Figure 6): The central area in which the data are displayed, a small map display panel in the upper right, and an information panel in the lower right. On startup the map box displays the logos of the CV Theis Groundwater Observatory sponsoring organizations. Clicking on one of the logos will cause the default web browser to go to the corresponding organization's website. On startup the information panel will display very basic instructions for the program.

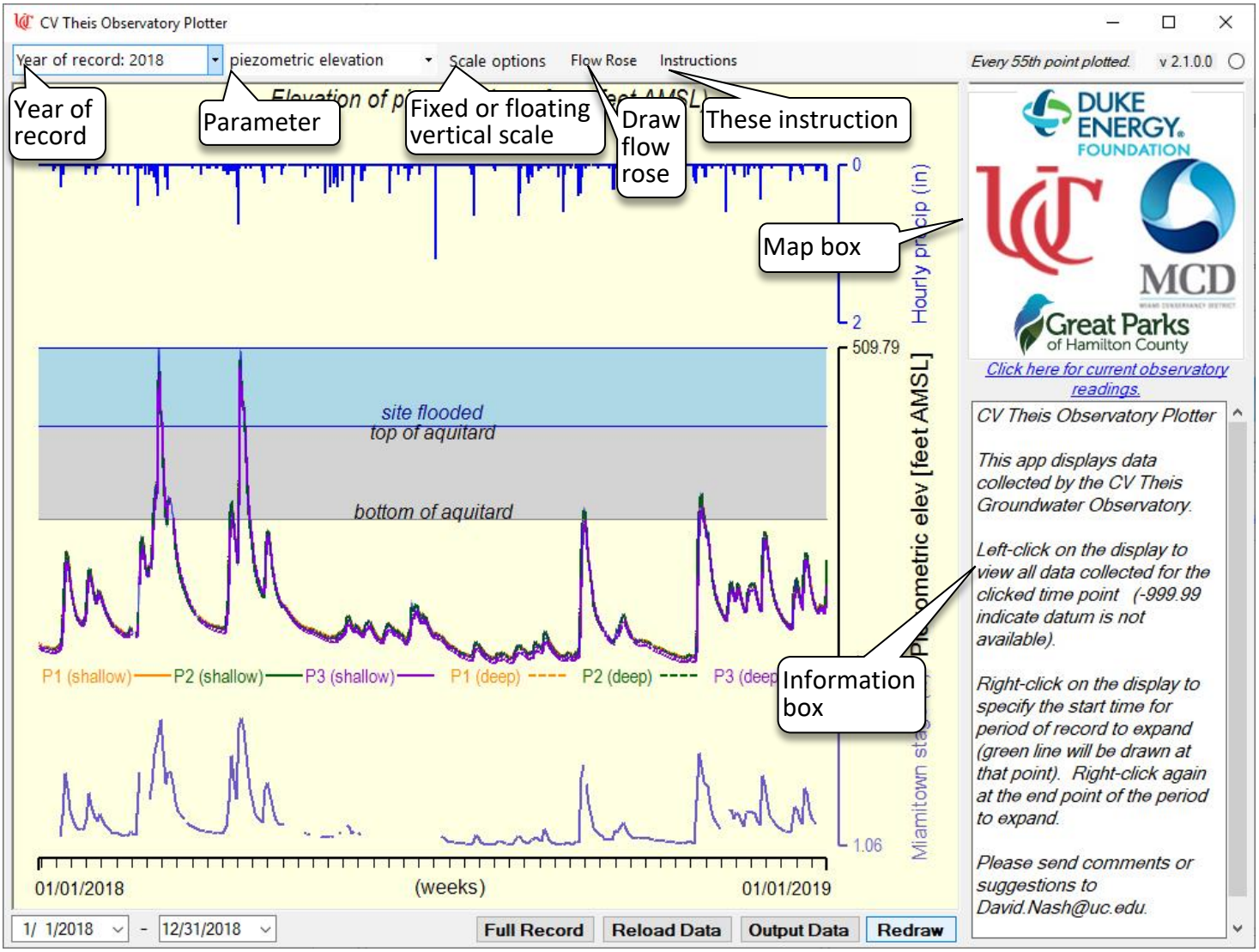

Figure 6 CV Theis Observatory Plotter startup screen.

Displaying Data

Use the *parameter pull-down* to select the dataset to be displayed. Currently the following datasets may be displayed:

- piezometric elevation
- groundwater temp
- specific conductivity
- piezometric gradient

- flow azimuth
- head difference between top and bottom of aquifer (head at top minus head at bottom)
- Hamilton Stage ft
- Hamilton Q cfs
- panel air temp °C[1]
- panel relative humidity (%)[1]
- battery volts

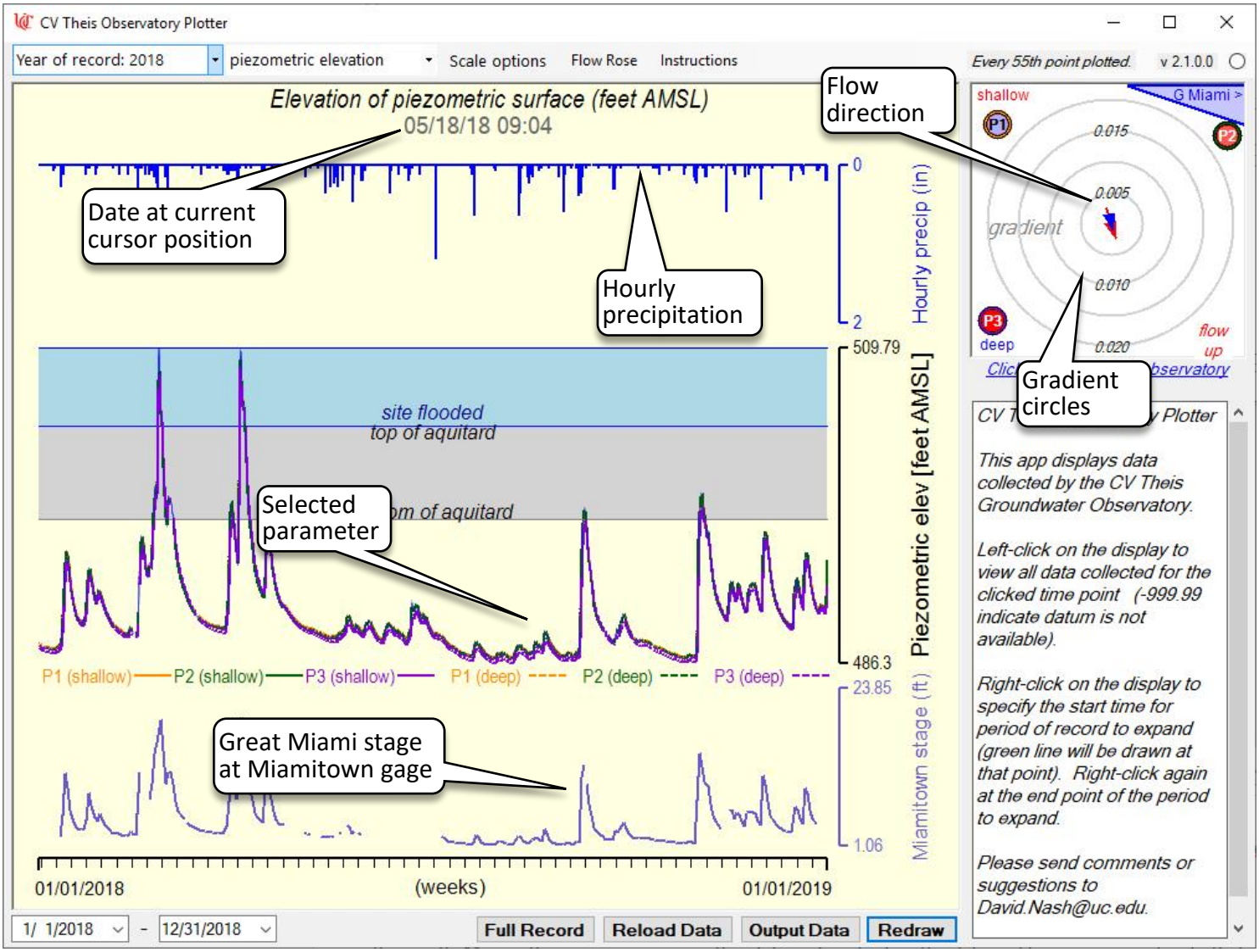

Figure 7. Once the parameter is selected from the pull-down, the data are displayed.

Precipitations in inches/hour is displayed at the top graph in green. The Great Miami Stage at the Miamitown gage (USGS 03274615) is displayed as the bottom graph in brown. The selected parameter is shown by the middle graph. Data for the shallow and deep sondes at *P1*, *P2*, and *P3* are shown for the piezometric elevation, groundwater temp, and specific conductivity datasets with a legend at the bottom of the graph (Figure 7). Moving the mouse curser over the plot window displays the date and time corresponding to that position below the title. The map window shows the flow direction at the top and bottom of the aquifer (red

[1] Panel temperature and relative humidity are measured directly from Campbell CR6 datalogger in the sealed instrument enclosure at the top of the central pylon and therefore do not represent outside conditions.

and blow arrows respectively). The length of the arrow is scaled to the gradient. The spacing between the concentric circles is 0.002; the outer most ring corresponds to a gradient of 0.012. The intensity of the fill colors at each of the wells is proportional to the vertical gradient at that well position; a red color means flow is from the bottom to top of the aquifer (upward) while blue means flow is from the top towards the bottom of the aquifer (downward). The map shows the approximate positions of the three wells relative to each other and to Great Miami River (refer to Figure 1 for exact layout). The function buttons below the graphs are as follows:

- *Full Record:* If only a portion of the data is displayed (using the two methods to be discussed), a plot of the entire dataset for that parameter is displayed.
- *Reload Data:* Reloads the data from the server (using this button is generally unnecessary unless it has been running longer than an hour).
- *Output Raw Data:* Writes all of the parameters for the time period displayed in the plot to a CSV text file. This is the only case in which the application writes anything to the host computer. The operation is quite time consuming so be patient.
- *Redraw:* Redraws the plot. Any "left-click" lines (described in the following paragraph) will be cleared. If the "date pickers" below the chart are changed, the display time interval will be changed to those settings. Resizing, moving, or hiding-displaying the application window will cause an automatic redrawing of the chart.

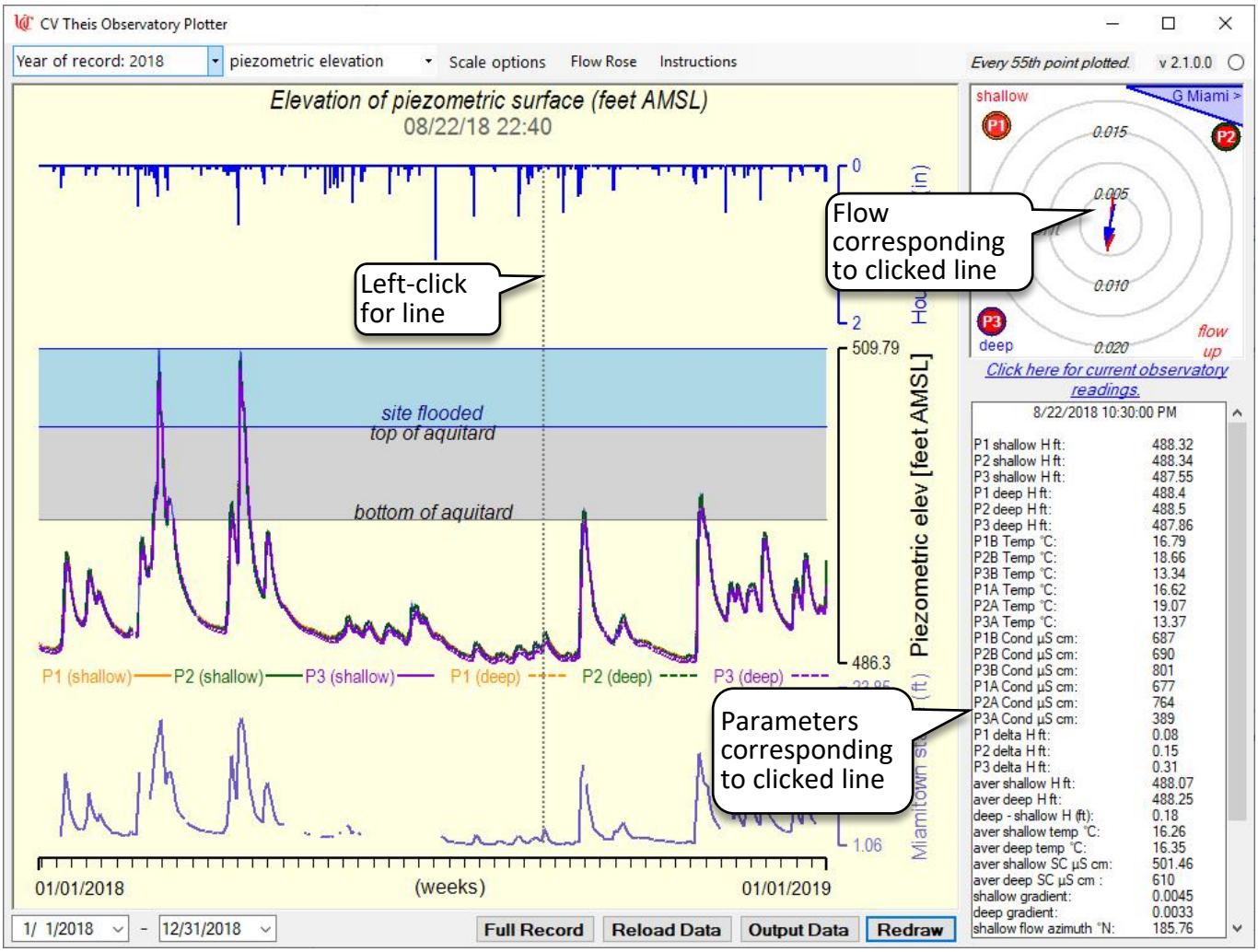

Figure 8 Left-clicking the chart area draws a vertical line at that point and displays the flow dynamics and data corresponding to the clicked point.

Data at Specific Time

As the mouse cursor is moved over the graph area, the date and time corresponding to that position is displayed below the title and the flow dynamics are displayed on the map panel. If the left mouse button is pressed at a point on the chart, a vertical dashed line is drawn at that point, the map displays the flow dynamics at the point, and all of the measured parameters are displayed in the information box (Figure 8).

Displaying Specific Time Interval

The entire period of record is displayed the first time a parameter is selected after boot up. A shorter specific interval of the record may be displayed by either of two methods. Using the first method, the user enters the start and end dates of the interval of interest using the date pickers at the bottom of the application window (Figure 9) either by directly changing the numbers or by using the calendar display invoked by right clicking the picker. After the start and end dates are entered, press the *redraw* button to update the display. The second, easier, method to change the displayed time interval is to right click the chart at the point corresponding to the desired start date. A vertical green line appears at that point (Figure 9). Then, right clicking again at the point corresponding to the end of the desired time interval will immediately display the selected interval (Figure 10). Note that the start date must be earlier than the end date and that the display interval cannot be shorter than one day.

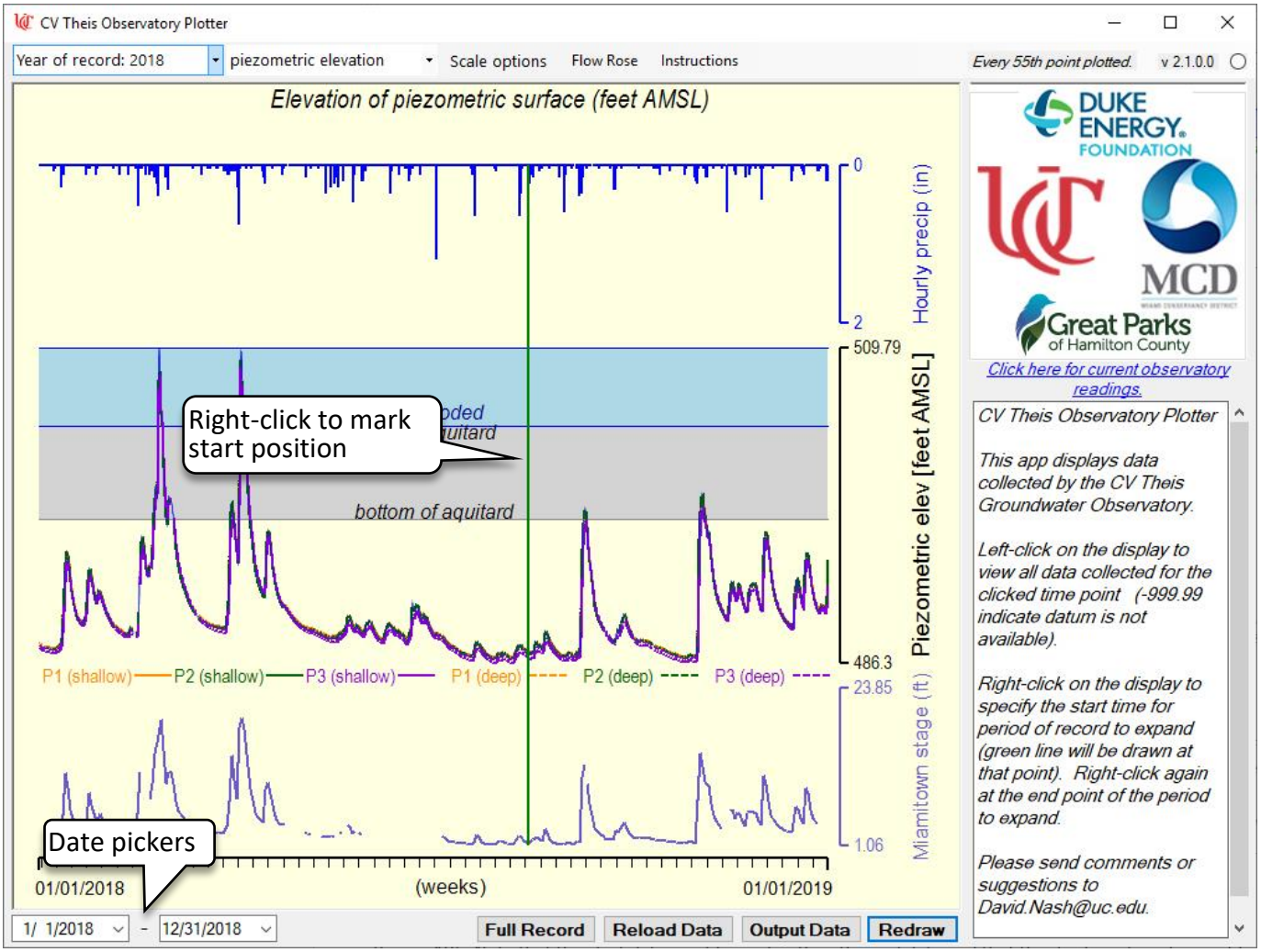

Figure 9 Vertical green line appears at the point the chart is right-clicked at the start date of selected interval. Right clicking at the date corresponding to the end of the selected time period will immediately display the selected interval (*Figure 10*).

The user can move the displayed time interval earlier (if the display is later than February 23, 2017, the date of the earliest record) or later (if the end date earlier than the current date) with the *back* and *forward* buttons respectively (Figure 10).

Vertical Scale Options

By default, the vertical scale of the parameter graph and Maimitown stage graphs is permitted to "float" so that the minimum and maximum values on the vertical axis correspond to the largest and smallest values recorded during the displayed period of record. This may be changed with the Scale Options pull-down at the top of the application window (Figure 3) then clicking to check or uncheck the floating scale option in the pull-down). Unchecking the float option will cause the vertical scale to be set to the smallest and largest values measured during the *entire* period of record rather than for the displayed time interval.

Flow Rose

A radial histogram of the frequency of flow direction (Figure 11) for the displayed period of record may be generated by pressing the Flow Rose menu button. The histogram may be weighted by specific discharge by clicking the *check if weighted by flow* check box (Figure 11). The number of rose "petals" may be changed by entering the number of petals desired (between 10 and 180) in the *Number of petals* text box and then pressing the plot button that appears when the number is changed.

Final Words

This program is a "work in progress" currently undergoing nearly daily revisions as new features are added and bugs are fixed. Any suggestions for how it could be improved or reporting of bugs would be appreciated. Please send them to David.Nash@uc.edu.

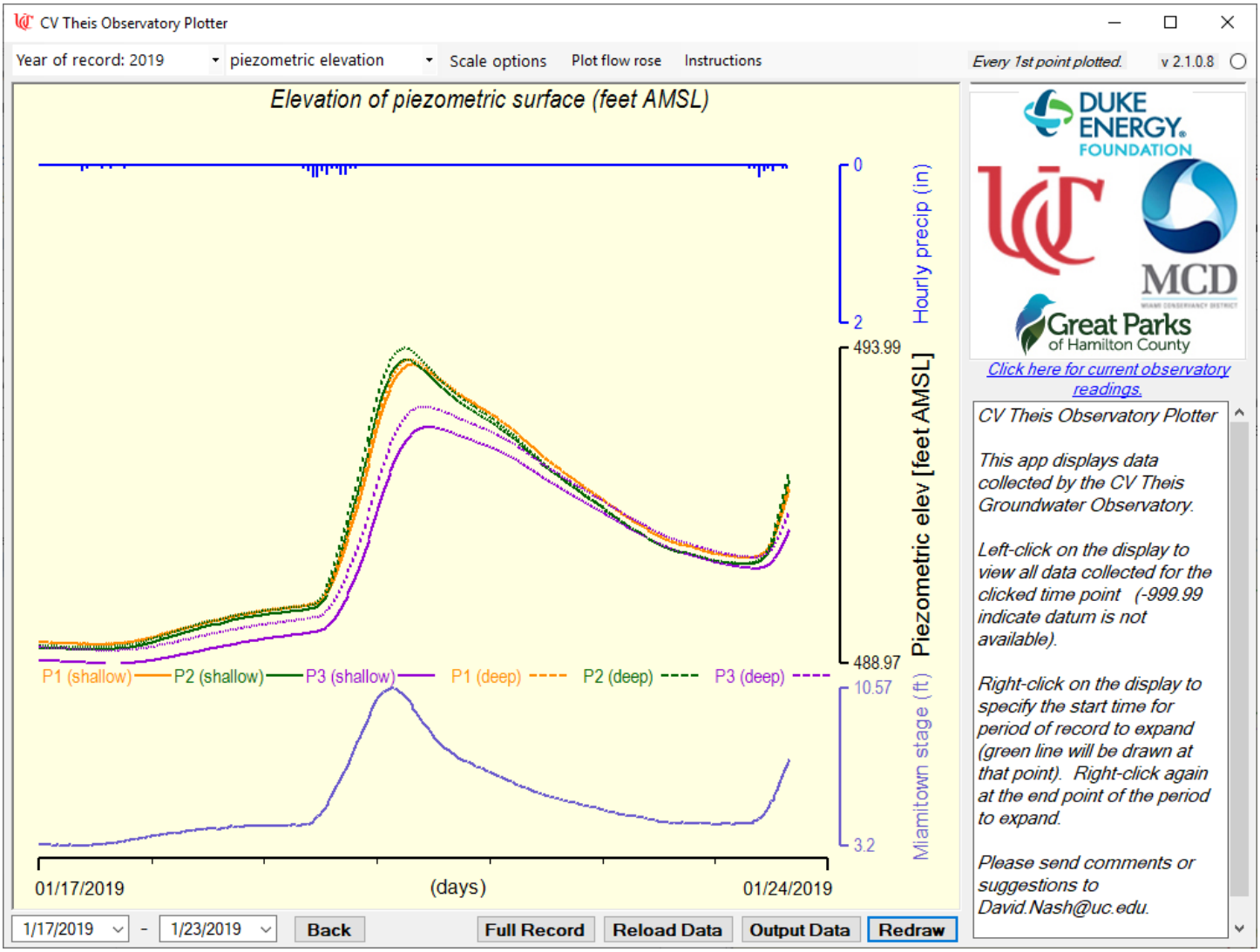

Figure 10 Selected interval is displayed. The user can move forward and backwards using the corresponding buttons.

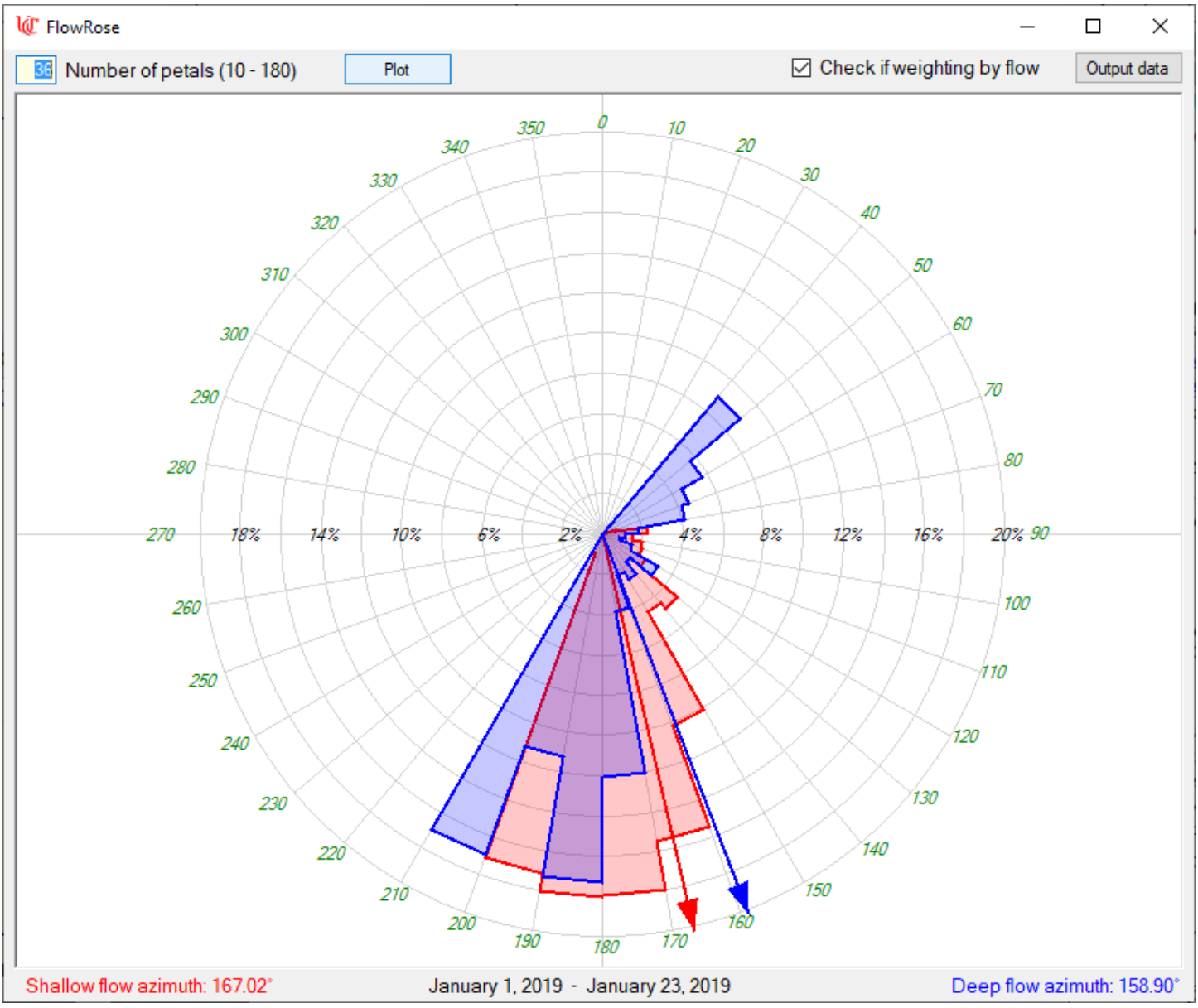

Figure 11. Radial histogram displaying the frequency of flow directions is generated by pressing the Flow Rose menu button. The histogram is for the currently displayed period of record.