

Standard Operating Procedure: US EPA Geospatial Measurement of Air Pollution-Remote Emission Quantification by Direct Assessment (GMAP-REQ-DA) Method: User Interface Software Manual (ver. 8/12)

Scope: The following protocol describes operation of the US EPA Geospatial Measurement of Air Pollution-Remote Emission Quantification-Direct Assessment (GMAP-REQ-DA) user interface software. The software is used for control of instrumentation and acquisition of data in the field. This protocol provides information on all software functions, and guidance for operating the software.

Purpose: To provide specific guidance on operating the US EPA GMAP-REQ-DA user interface software for instrument control and data acquisition in the field.

1.0 Overview

The US EPA Geospatial Measurement of Air Pollution-Remote Emission Quantification by Direct Assessment (GMAP-REQ-DA) advanced mobile measurement system has been developed as a tool to assess emissions of air pollutants from distributed point sources. The system consists of a fast-response Greenhouse Gas Analyzer instrument, global positioning system (GPS), and wind monitors, installed in a measurement vehicle.

As part of the development of the GMAP-REQ-DA method, custom-made user interface software was created for controlling operation of the instrumentation in the field, displaying near real-time data elements including target compound concentrations, GPS data, and wind data, logging manual measurements made in the field at each site, controlling acquisition of all data elements, and initiating the collection of canister samples.

In addition to instrument control and data collection functions, the software contains an emissions source locator tool that is used to verify the location of the source being detected, calculate the atmospheric stability class during the time of the measurements, and analyte emission rate from the site being surveyed.

The software also contains an in-field mapping tool that plots near real-time concentrations in the field onto a Google Earth® base map. The tool is used to identify localized emission hot spots, and as guidance in selecting locations for possible additional monitoring. The user interface software is written in Labview®, and is installed on a field laptop computer. The following sections detail the individual software functions, and provide instructions for operating the software.

2.0 Introduction to the Main User Interface Screen

The main user interface screen (shown in Figure 1) displays the near real-time data elements, a plot of target compound concentrations, and is used to initiate data logging as part of a Mapping or Stationary Monitoring survey. The main user interface screen is also used to verify that the Greenhouse Gas Analyzer instrument, GPS, and wind instrumentation are communicating properly with the software. The emissions source locator and mapping tools, as well as canister sample collection are initiated from the main user interface screen.

After opening the user interface software program, it is important to verify that the Greenhouse Gas Analyzer, GPS unit, and wind monitors are connected properly, and are communicating with the software. This is verified by looking in the lower right hand corner of the main screen. When the instruments are communicating with the software, a green light will be illuminated for the AIO Compact Weather Station (denoted as "WS"), Hemisphere GPS unit ("GPS"), 3-D Sonic Anemometer ("3DS"), and Greenhouse Gas Analyzer instrument (both "RDY" and "CONN" will be illuminated). If any of the green lights are not illuminated, the system is not ready for data collection, and the instrumentation should be reconnected to the laptop computer.

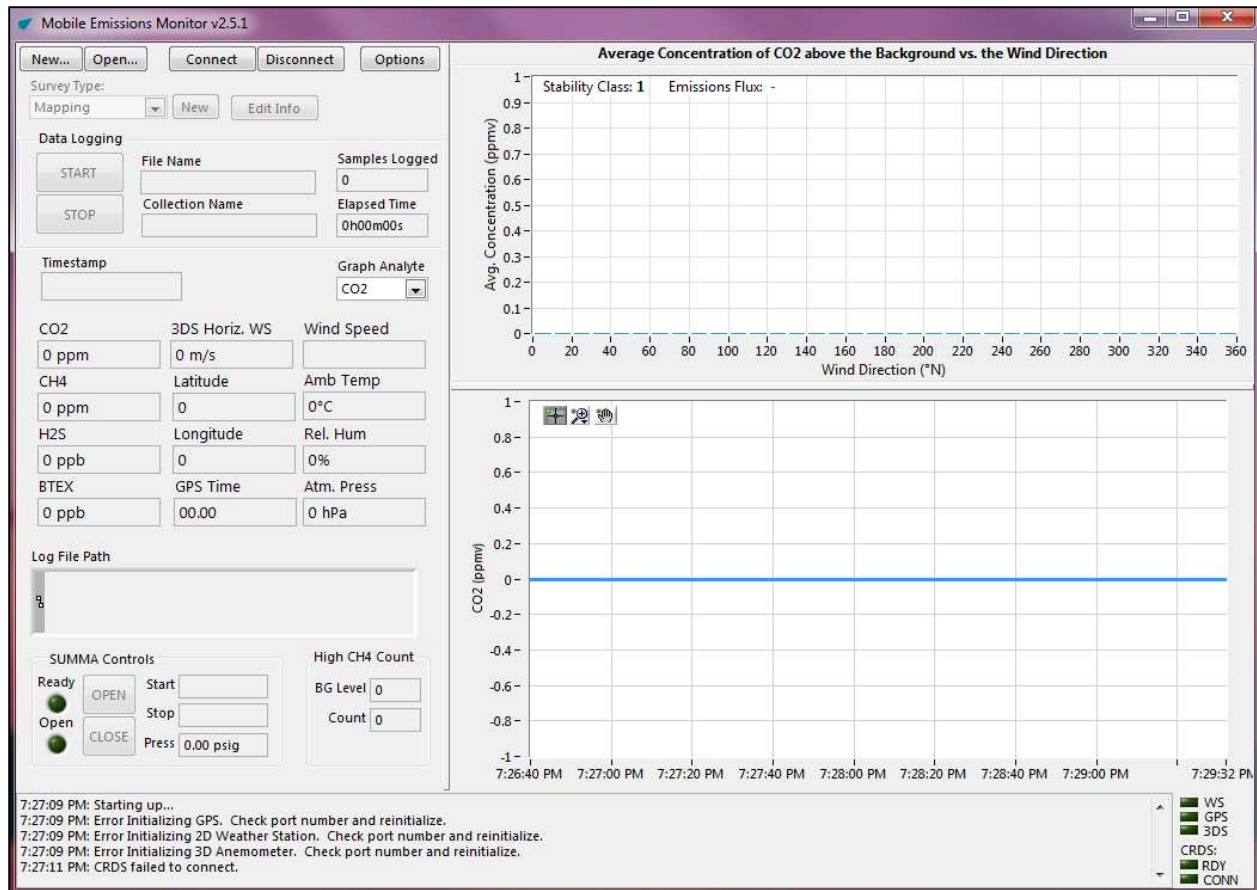


Figure 1. Main Screen of the User Interface Software

If all system instruments are connected properly, the latest data readings from each instrument are displayed on the main screen, even if data is not currently being logged. The far left-center portion of the main screen shows the latest measured carbon dioxide and methane concentrations. Data from the 3-D Sonic Anemometer are displayed directly to the right of the concentration readings, and data from the GPS and AIO Weather Station are displayed directly to the right of the 3-D Sonic Anemometer data. The lower right hand corner of the main user interface screen displays a time series graph of target compound concentrations. The graph begins plotting concentration values when the Greenhouse Gas Analyzer instrument is connected to the user interface software. To display a concentration plot of a particular compound, click on the compound concentration window, located in the far left-center portion of the main screen.

3.0 Conducting Mobile Monitoring and Mapping Surveys

Mobile Monitoring and Mapping surveys are initiated from the user interface software main screen. During Mobile Monitoring surveys, electronic data are not logged by the software. However, the procedures described in Section 2.0 should be followed prior to beginning Mobile Monitoring, to ensure that the instrumentation is functioning. During Mobile Monitoring, real-time analyte concentration values are monitored using the main screen of the software, as shown in Figure 1. Mobile Mapping is initiated by first clicking on the "New" button located in the upper left hand corner of the main screen. After the "New" button has been clicked, a new pop-up window will appear instructing the user to input the location of the folders where the logged mapping data files will be saved, and the name of mapping data file. The first mapping data file should be named "Map1", with subsequent data files from the same day named "Map2", "Map3", etc. Then, click the drop-down menu "Survey Type", which is located at the top left of the main screen, and select "Mapping" as the survey type (see Figure 2).

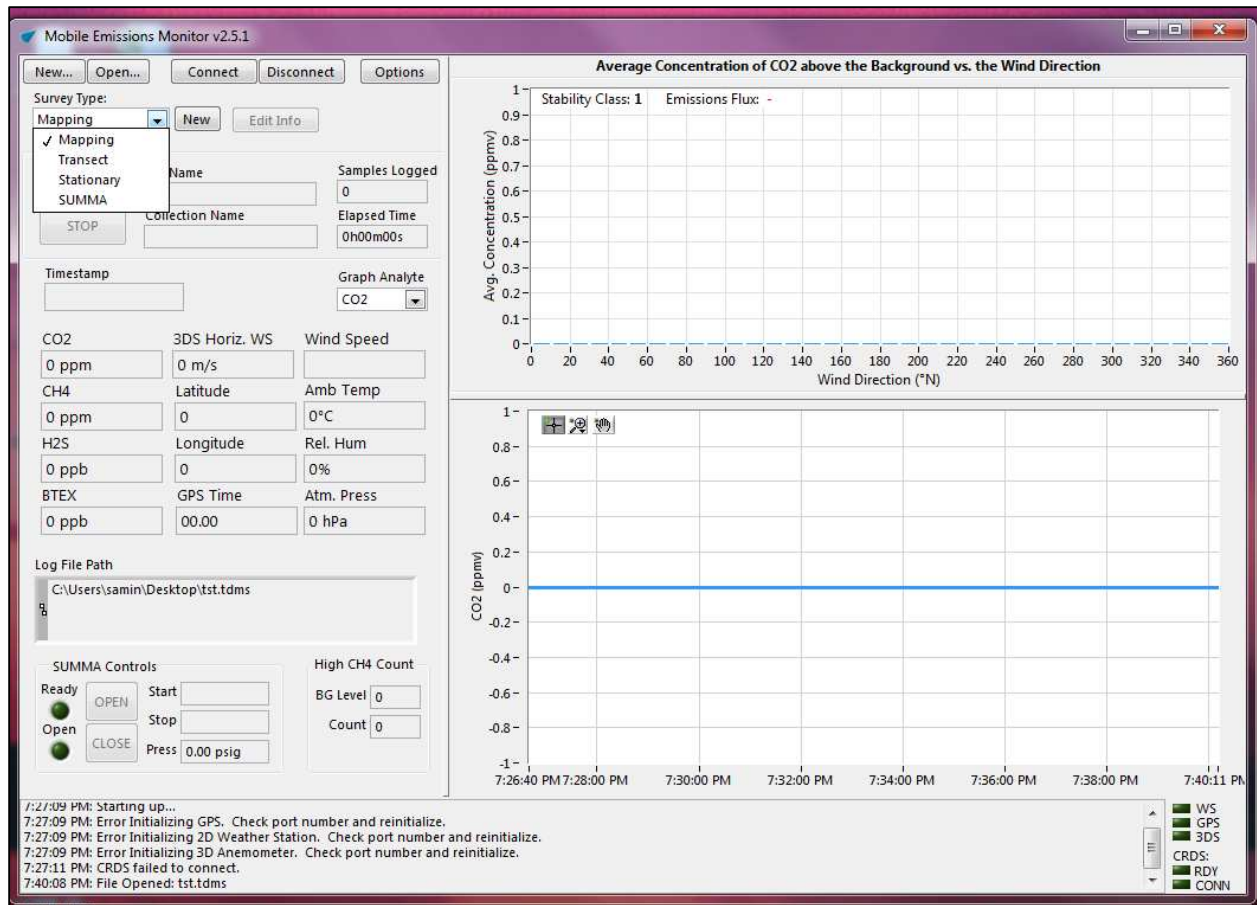


Figure 2: Main Screen of the User Interface showing selection of a Mapping Survey

Next, click the "START" button located in the upper left hand corner of the main screen under the heading "Data Logging", to initiate data collection. After the survey is completed, click the "STOP" button.

4.0 Conducting Stationary Monitoring

Stationary monitoring surveys are conducted by first clicking the "New" button located in the upper left hand corner of the main screen to initiate data logging. After the "New" button has been clicked, a new pop-up window will appear instructing the user to input the location of the folders where the logged Stationary survey data files will be stored, and the name of Stationary survey data file. The first Stationary data file should be named "ST1", with subsequent data files

from the same day named "ST2", "ST3", etc. After the "Save in" location and file name have been selected, click "OK". Next, click the drop-down menu "Survey Type", which located at the top of the main screen, and select "Stationary" as the survey type (see Figure 3).

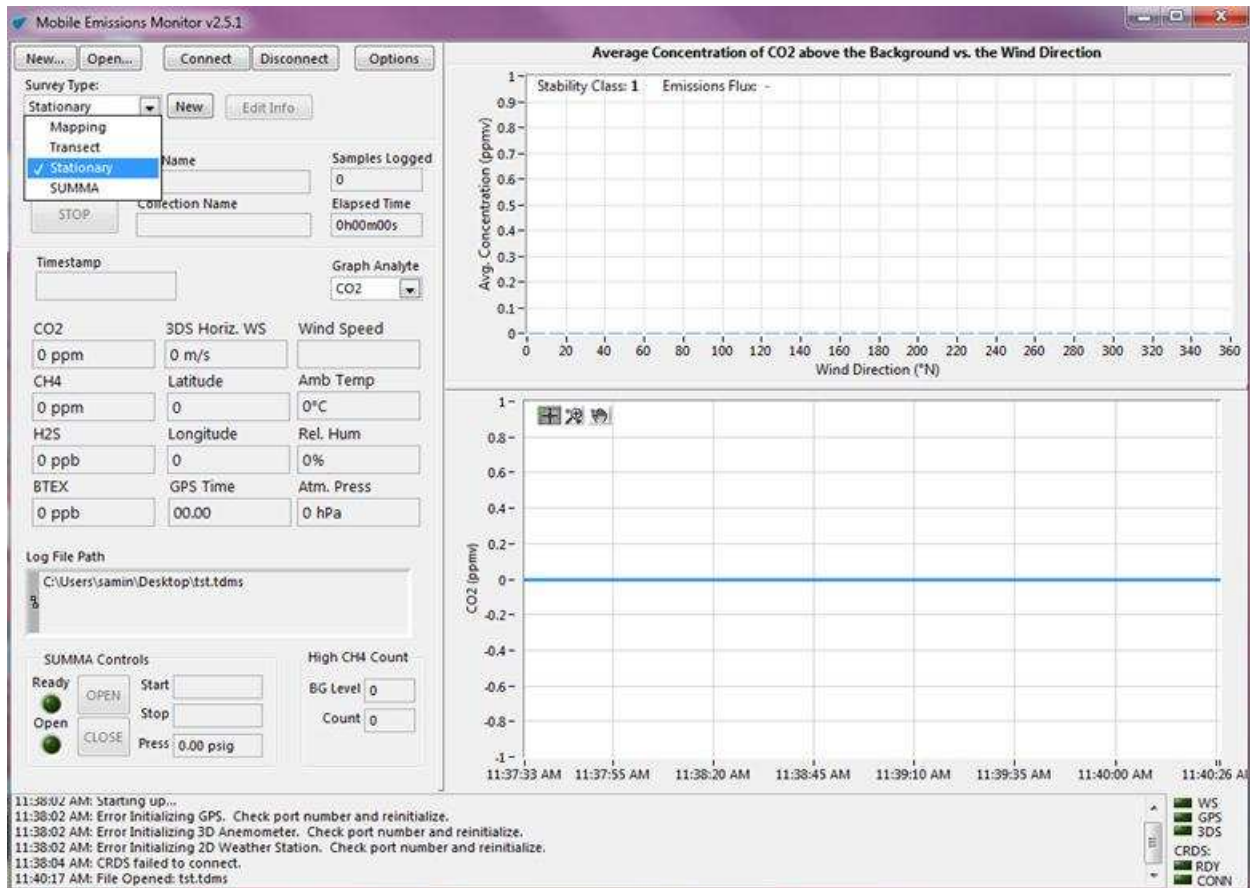


Figure 3. Main Screen of the User Interface Software Showing Selection of a Stationary Survey

After "Stationary" has been selected as the survey type, a new pop-up window will appear, as shown in Figure 4. The window contains fields requesting the user to input several additional data elements, including the results of manual distance and angle measurements collected in the field after the Stationary survey has started (Mast Heading, Distance to Source, Elevation Angle, Height of Elevation Measurement, and Mast Height). Because these measurements are collected during the survey, the fields should be left blank

initially, so that data collection can begin. The fields are populated prior to ending the survey (this step is discussed below). The pop-up window contains fields for entering the name of FLIR infrared camera videos, and site photos, if these data elements are collected at the site during the Stationary Vertical survey. The window also contains fields for entering the background methane concentration, and canister ID number (if a canister sample is collected during the survey), and a site description. After the user has populated the input fields of the pop-up window, click "OK".

The image shows a 'Survey Information' dialog box with the following fields and controls:

- Mast Heading:** Input field with '0' and 'deg' label.
- Distance to Source:** Input field with '0' and 'm' label.
- Elevation Angle:** Input field with '0' and 'deg' label.
- Height of Elevation Measurement:** Input field with '0' and 'm' label.
- Mast Height:** Input field with '0' and 'm' label.
- SUMMA Container ID:** Empty text input field.
- FLIR Image File:** File selection field with a folder icon.
- Camera Photo File:** File selection field with a folder icon.
- Background CH4 Level:** Input field with '0' and 'ppm' label.
- Background CO2 Level:** Input field with '0' and 'ppm' label.
- Background H2S Level:** Input field with '0' and 'ppb' label.
- Background BTEX Level:** Input field with '0' and 'ppb' label.
- Description:** Large empty text area.
- Buttons:** 'OK' and 'Cancel' buttons at the bottom.

Figure 4. Stationary Vertical Pop-up Window Requesting User Input

Next, click the "START" button in the upper left hand corner of the main screen to initiate data logging. The user can ensure that data is

being logged by monitoring the "Samples Logged" window, located in the upper-center of the main screen. The user should also monitor the "Elapsed Time" window, as a typical Stationary survey should last approximately 20 minutes.

As mentioned above, the manual distance and mast heading measurement are collected at the measurement site after the Stationary survey has been initiated, and the values of these measurements must be entered into the software prior to completion of the survey. To enter these values, click on the "Edit Info" button located at the top of the main screen of the software. After this button is selected, the Stationary Vertical pop-up window will appear again, and the user should enter the data and click "OK". When the Stationary survey has been completed, click the "STOP" button, located directly under the "Start" button on the main screen, to stop data logging.

5.0 Collection of Canister Samples

Canister samples are typically collected during Stationary surveys, at select sites when high methane concentrations are observed consistently, indicating that a plume from the site is being captured by the measurement system. The user interface software is used to initiate collection of a canister sample by controlling the canister valve with a digital output signal. The software also displays the canister vacuum pressure, and logs this data to the saved data files. The software includes two methods for initiating collection of a canister sample:

Canister collection can be initiated during the Stationary survey. This method is ideal for canisters collected concurrently with a Stationary Survey, as the canister vacuum pressure data are logged to the Stationary survey data file. To initiate canister collection after the Stationary survey has begun, first connect the canister to the inlet on the sampling mast. When this is done, the green "Ready" light, under the "SUMMA Controls" heading in the lower left hand corner of the main software screen (see Figure 3) should be

illuminated. If the light is not illuminated, the canister is not properly connected, and a canister sample cannot be collected. Click the "OPEN" button located in the upper left hand corner of the main screen to initiate canister collection. The green "Open" light (located below the "Ready" light) should now be illuminated. While canister collection is ongoing, monitor the vacuum pressure of the canister by observing the "Press" window, located in the lower left hand corner of the main screen. When the value in the "Press" window decreases to approximately 2 psi, end canister sample collection by clicking the "CLOSE" button located under the "SUMMA Controls" heading.

In some cases, the field crew may wish to return to a site previously surveyed to collect a canister sample without performing any additional surveys. In this case, collection of the canister sample can be initiated from the user interface software main screen. After the canister is connected to the measurement mast and the field team is ready to collect the sample, use the drop-down menu "Survey Type", which located at the top of the main screen, and select "SUMMA" as the survey type (see Figure 5). Then, click the "New" button in the upper left hand portion of the main screen. A new pop-up window will appear instructing the user to input the location of the folders where the logged canister survey data files will be stored, and the name of canister file. The first canister data file should be named "Canister Collection 1. After the "Save in" location and file name have been selected, click "OK". After returning to the main menu, click the "Start" button in the upper left hand corner of the screen to initiate data logging. Then, follow the instructions presented in the previous paragraph to open the canister valve and collect the sample.

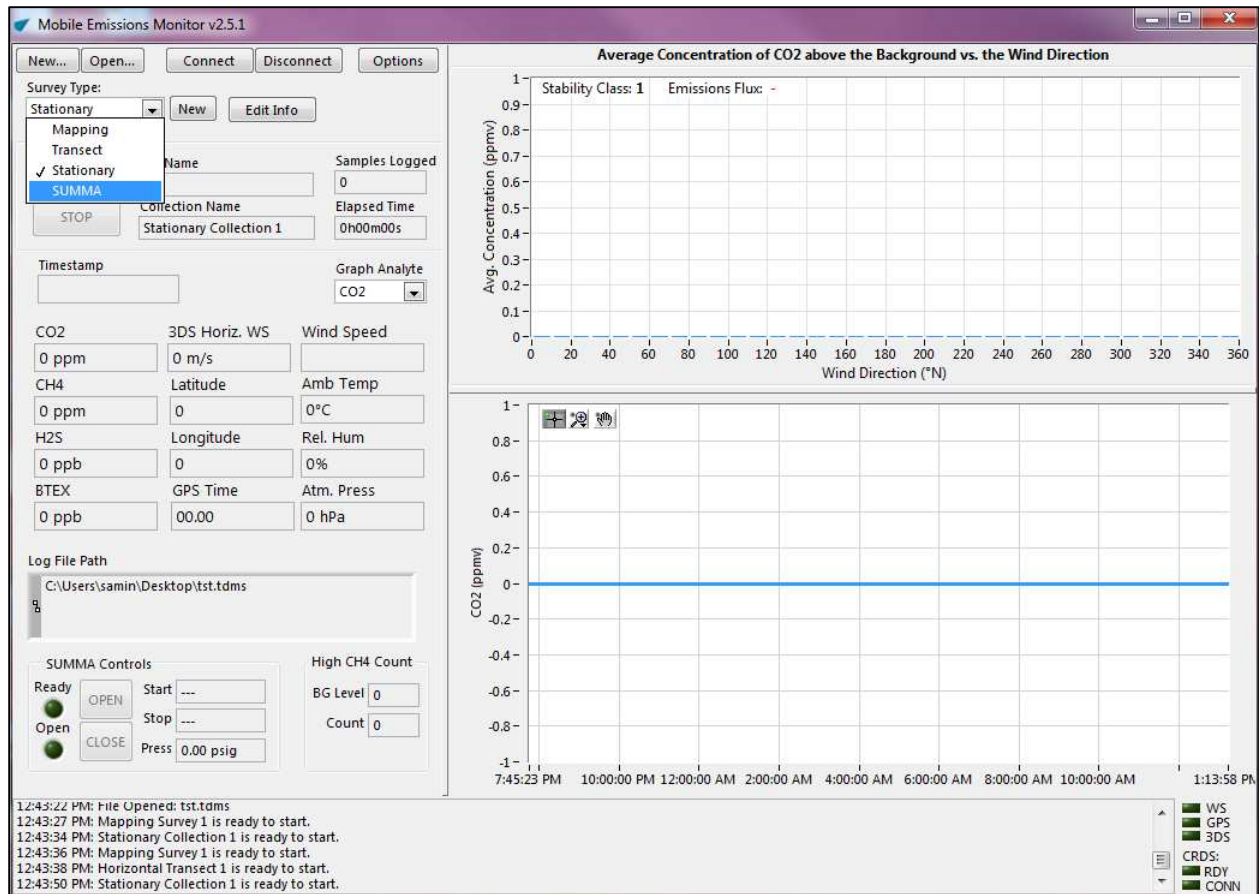


Figure 5. Main Screen of the User Interface Software Showing Selection of Canister Sample Collection

6.0 Using the Emissions Source Locator Tool

The user interface software contains an emissions source locator tool that is used by field personnel to verify the location of the source being detected by the mobile monitoring system. The tool is initiated while Stationary surveys are conducted, and creates a real-time bar plot of the average measured analyte concentration (above the background value entered by the user) as a function of wind direction, as shown in Figure 6. The average analyte concentration is calculated for all observed wind direction bins (grouped in 10° bins), and is updated continuously as additional data is collected. The compass orientation of the source, with respect to the measurement vehicle, is indicated by the wind bin (or bins) containing the highest average analyte concentration. The presence of multiple bin plots having much larger methane concentrations, with respect to other bins, may indicate the presence of multiple emission sources at the same site. The emission source locator tool also calculates the analyte emission rate (updated continuously during monitoring), and calculates the atmospheric stability class during the time of the measurements. The stability class ranging from Stability Class 1 to Stability Class 7 is calculated based on the wind data collected with the 3D Sonic Anemometer.

After the Stationary survey is completed, and before shutting down the software and logging out, save the emission source locator tool plot by right clicking on the image and choosing "Save Image". The image is saved in .png format but can also be saved in other formats.

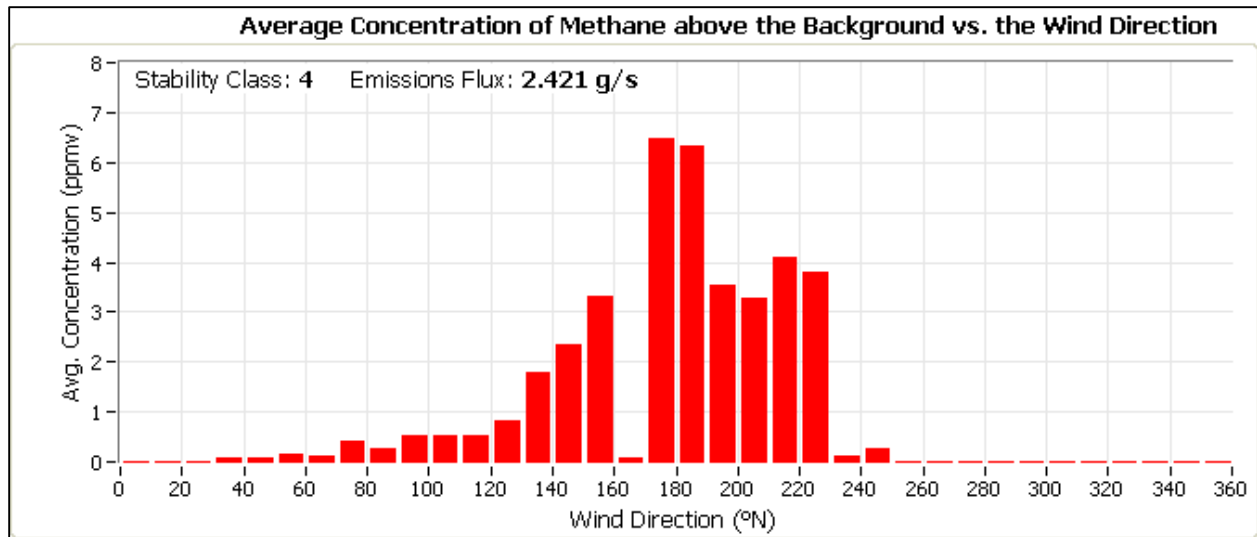


Figure 6: Emission Source Locator Tool Plot Showing Average Methane Concentration as a Function of Wind Direction

7.0 Using the Mapping Tool

After a Stationary or a Mapping survey is completed, the concentration data may be plotted using the mapping tool, which plots the data on a Google Earth® base map. In order to initiate the mapping tool function, click on "Options", located at the top of the software main screen. Next, select the "App Settings" tab, and then click on the "Google Earth" button located at the bottom of the tab. The "Choose Map Plot Options" dialog window will appear, as shown in Figure 7. Click on the folder icon button, located to the right of the "Data File" box to select the source data for the plot. Next, click the drop-down button located to the right of the "Group" box to select the survey type.

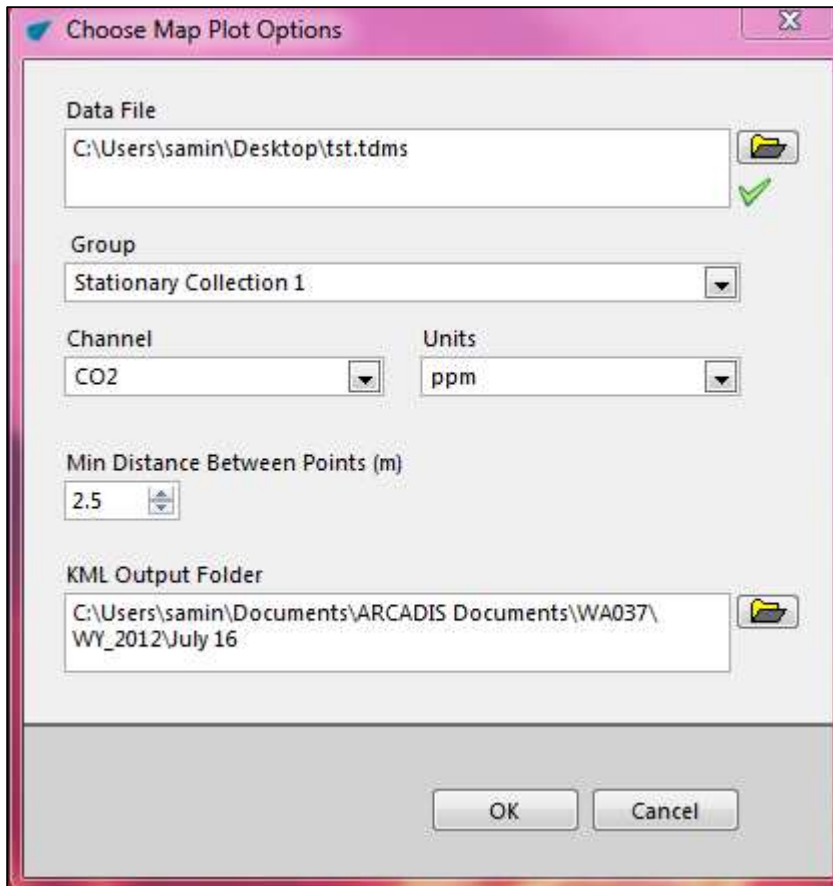


Figure 7. Mapping Tool Dialog Box for Selecting Plot Options

Then, click the drop-down button located to the right of the "Channel" box to select the analyte results that will be plotted, as shown in Figure 8. After the analyte has been chosen, the "Units" field will be populated automatically. Next, select the "Min Distance Between Points" value, using the toggle buttons (default value is 2.5 meters). Then, click on the folder icon button located to the right of the "KML Output Folder" box to specify the location where the output plot file will be saved in .kml format. Once the file location is chosen, click on the "Current Folder" button, as shown in Figure 9.

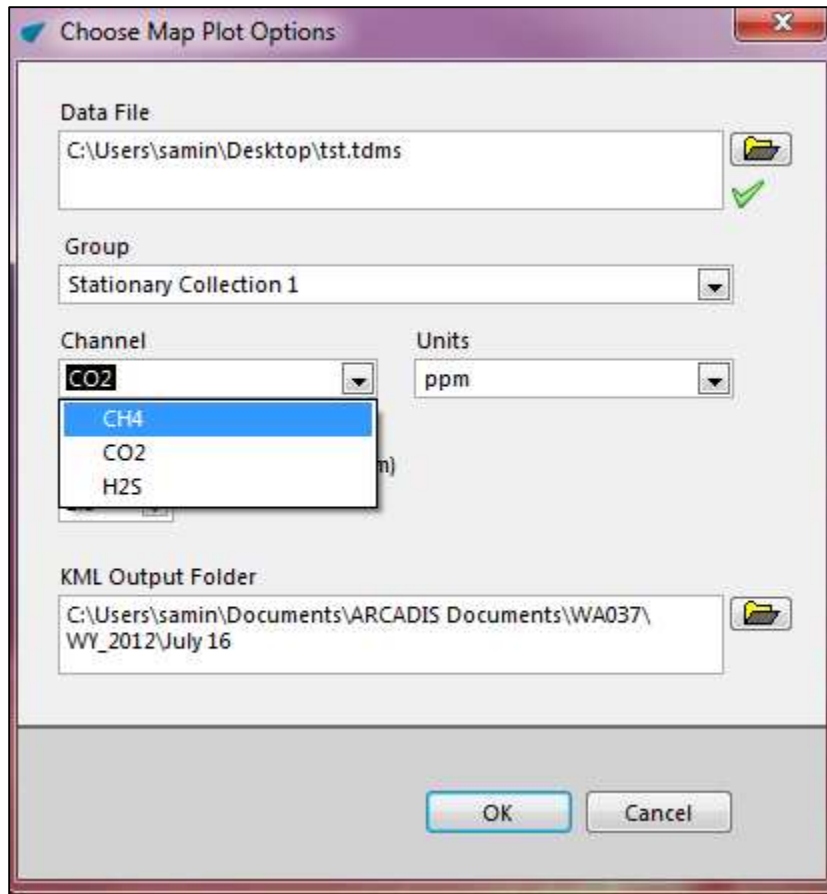


Figure 8. Selection of Analyte for Mapping Tool Plot

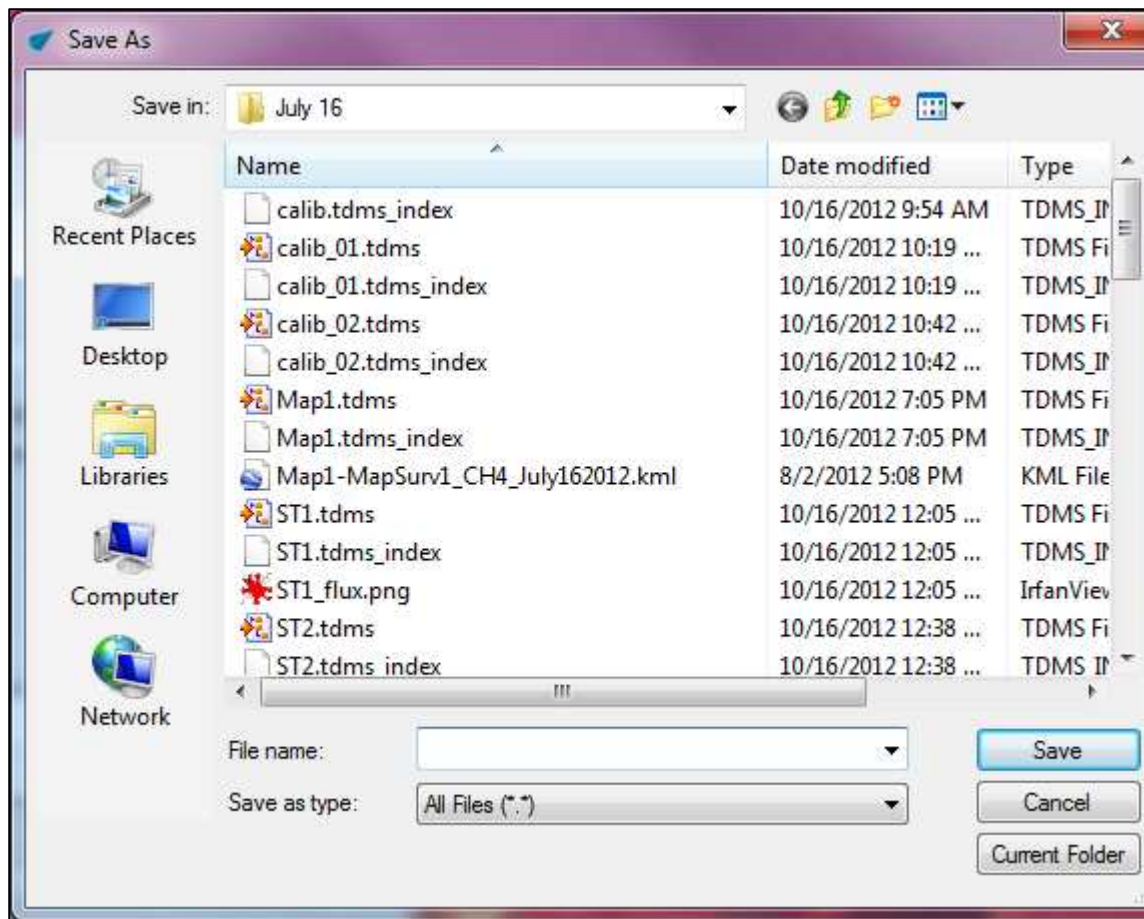


Figure 9. Mapping Tool Dialog Box for Saving the Output Concentration Plot

The file name will be assigned automatically using the following convention: "WWW-XXXXXXXX_YY_ZZZZZZZZZ", where "WWW" is the survey (either Mapping or Stationary) from which the data being plotted was collected, "XXXXXXXX" is the name of the map created from the source survey data, "YY" is the analyte being plotted, and "ZZZZZZZZZZ" is the date that the data was collected. Using the KML file name shown in Figure 9 as an example, "Map 1" indicates that this file uses raw data from the first mapping survey conducted during the particular survey day, "MapSurv1" indicates that this is the first mapping plot created from the raw data, "CH4" indicates that the plot is depicting methane concentrations, and "July162012" indicates that the data was collected on July 16, 2012.

Next, the Google Earth program will open, and the output concentration plot will be displayed, as shown in Figure 10.

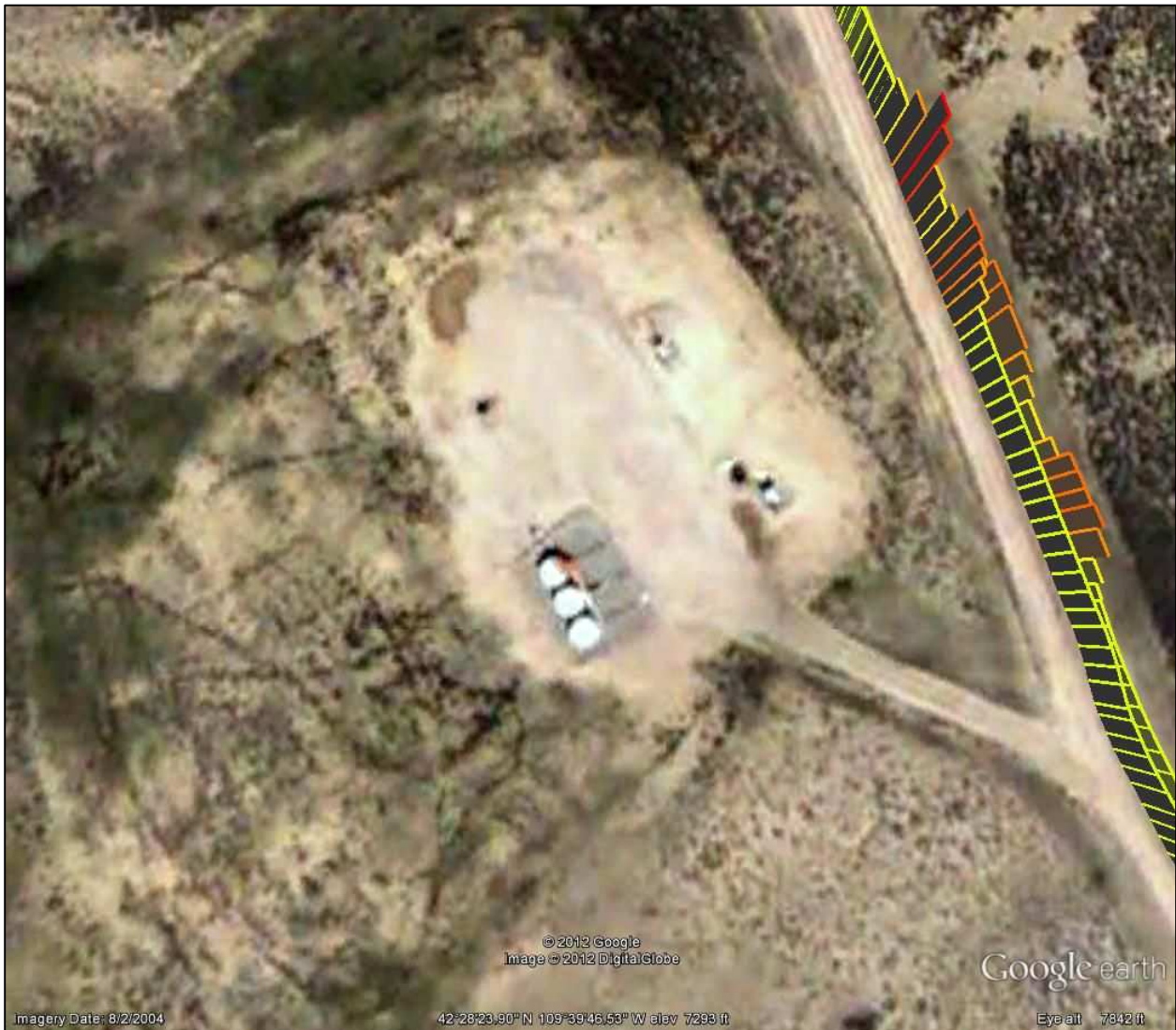


Figure 10. Example Mapping Tool Output Concentration Plot