

NOVAC Explorer

Versions 1.07 and higher

Manual last updated 15 November 2023

Christoph Kern, ckern@usgs.gov

Summary

NOVAC Explorer is a tool for visualizing and exporting data recorded by Scanning DOAS instruments in the Network for Observation of Volcanic and Atmospheric Change (NOVAC, www.novac-community.org). The NOVAC Explorer interfaces directly with output files created by the NOVACProgram. If an internet connection is available, NOVAC Explorer can access data stored on the global NOVAC SFTP server. This allows users to view and export data in close to real time from any computer with an internet connection. In the absence of an internet connection, NOVAC Explorer can be used to plot and export data stored in a local directory.

Table of Contents

1. Software Installation	3
NOVACExplorer Executable	3
Matlab Compiler Runtime (v. 9.8, 2020a).....	3
WinSCP	3
PowerShell script execution policy	3
2. Running NOVAC Explorer for the first time	4
3. Using NOVAC Explorer to visualize or export SO ₂ emission rate data.....	4
Purpose of the software	4
Overview of main dialog	4
Volcano list.....	5
Plot Range	5
Data Stream	6
Data Source	6
Analysis Level	6
Minimum Plume Completeness.....	7
Create/Update Plots	7
Save Image	8
Export Data	8
Automatic Updates	8
Settings Dialog	9
Local Database	9
Emission rate unit	10
NOVAC Server Credentials	10
Automatic Update Tasks	10
4. Future updates.....	11

1. Software Installation

NOVACExplorer Executable

The NOVAC Explorer software itself does not require installation. Simply unzip the NOVACExplorer folder to a location on your hard drive. It is important that you have full read and write permissions to the installation folder. If you wish to use pre-configured settings, it will be easiest to unzip directly to the C:\ drive such that executable is located in `C:\NOVACExplorer_v1.06\NOVACExplorer.exe`

Matlab Compiler Runtime (v. 9.8, 2020a)

NOVACExplorer was developed in MATLAB version 2020a. If this version of MATLAB is not installed on the system, please install the MATLAB Compiler Runtime (**v 9.8, 2020a**). The installer is provided free of charge on the MATLAB website.

<https://www.mathworks.com/products/compiler/matlab-runtime.html>

WinSCP

NOVACExplorer uses sftp data transfer functionality provided by the WinSCP software and therefore requires this software to be installed on the system. WinSCP is free and can be downloaded from the following website:

<https://winscp.net/eng/index.php>

Please install WinSCP in the default directory: **C:\Program Files (x86)\WinSCP**

PowerShell script execution policy

NOVAC Explorer uses Windows PowerShell scripts to interface with WinSCP sftp functionality. In order for these scripts to run, the security settings of the local computer must allow PowerShell scripts to run. To check the current security settings, open a PowerShell terminal by clicking on the Start menu and typing 'PowerShell' until the option to open 'Windows PowerShell' appears and do so. At the command line, type

Get-ExecutionPolicy

The current security settings (script execution policy) will be displayed. NOVAC Explorer has been proven to run on systems with a "RemoteSigned" execution policy. Other, less restrictive policies will also work. However, a "Restricted" execution policy and some other more restrictive policies will block scripts from running. To change the execution policy settings, type

Set-ExecutionPolicy RemoteSigned

If you have permission to change the policy, the computer will ask whether you are sure you wish to change policies. Select 'Y'. If you do not have permission, please contact your IT staff for assistance with changing the PowerShell script ExecutionPolicy.

2. Running NOVAC Explorer for the first time

The first time that NOVAC Explorer is run, the user will be prompted for their SFTP credentials. Even if the software will be used in an offline mode, SFTP credentials must be provided for the software to know which volcanoes to display. If you do not know your SFTP credentials, please contact Christoph Kern (ckern@usgs.gov), Santiago Arellano (santiago.arellano@chalmers.se), or Allan Lerner (alerner@usgs.gov).

NOVAC Explorer may also warn the user that the local database directory does not exist. The local database directory is used to store data for display in the plots on the local computer. Users can ignore this warning the first time that NOVAC Explorer is run. For more information on the local database, see the description of the Settings Dialog below.

3. Using NOVAC Explorer to visualize or export SO₂ emission rate data

Purpose of the software

Although NOVAC Explorer does offer some more advanced features, the basic objective of the software is to provide a simple way to create plots of SO₂ emission rates from data collected by Scanning DOAS instruments in the NOVAC network. While scanning the sky from horizon to horizon, these instruments measure the absorption of scattered solar UV radiation by SO₂ and other gases in volcanic plumes overhead. The data are initially stored on site, then transferred to a local observatory or observation post where a preliminary analysis is performed. In this step, SO₂ column densities are retrieved from the individual spectra and cross-sectional SO₂ burdens are derived for any overhead plumes. Multiplication with the wind speed then yields SO₂ emission rates, typically given in metric tons per day (t/d) or kg/s.

The preliminary data analyses are performed by the official NOVAC software called the NOVACProgram. The results of these analyses are stored in FluxLog files. The user also can perform a manual flux re-analysis during which wind and plume height information may be improved, with the results being stored in PostFluxLog files. These files are in ASCII format and can be opened in any text editor, but as separate files are created for each instrument and day, it can be challenging to plot long time series of emission rates from the FluxLog files alone. The NOVAC Explorer offers a customized solution for this task.

Overview of main dialog

NOVAC Explorer is opened by executing NOVACExplorer.exe. A vertical panel appears with the main plotting controls (Figure 1).

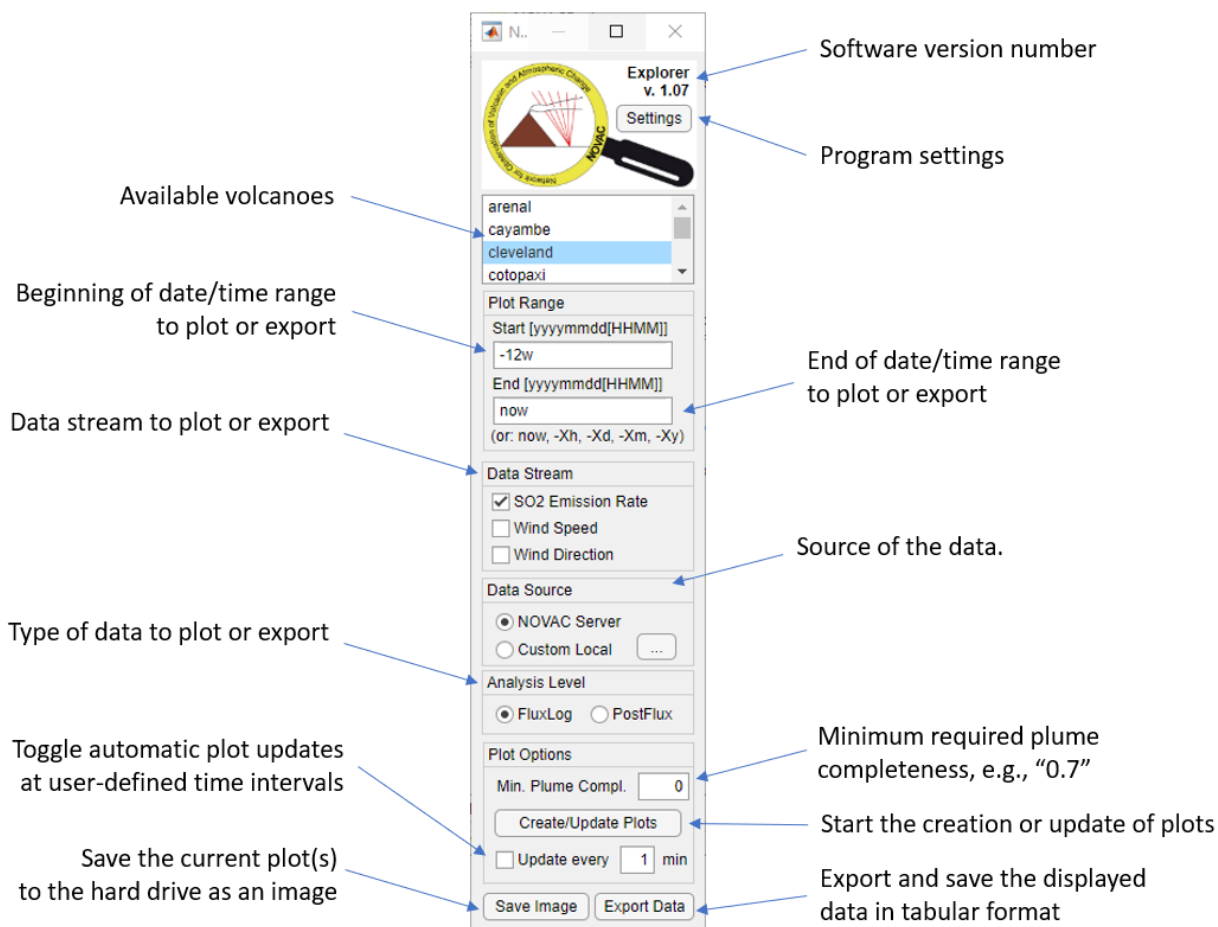


Figure 1 – The main dialog of the NOVAC Explorer provides the user with the ability select data and generate plots.

Volcano list

In a typical workflow, the user first selects one or more volcanoes from the volcano list. The volcanoes available in this list will depend on the SFTP credentials entered by the user on the first start of the application. Only volcanoes affiliated with the entered organization will be shown. Multiple volcanoes can be selected by holding SHIFT and clicking on the volcano names.

Plot Range

The period of interest is entered in the Plot Range panel. The user can either enter a fixed time and date in the indicated format. For example, 17:30 on January 1, 2023, would be entered as 202301011730. Note that the time is optional. 20230101 is also an accepted input format.

Besides fixed time and dates, relative time times are also supported. For example, “-1m” is interpreted as one month before today’s date. Similarly, “-1w” is one week prior to today. The keyword “now” can be entered in the End field to plot data up to the current time and date.

Data Stream

The Data Stream panel specifies the type of data to be plotted. Most users will be interested in the SO₂ emission rate, but other streams (wind speed, wind direction) can also be plotted. Up to 2 streams can be selected at the same time.

Data Source

The Data Source panel defines the source of the data. If NOVAC Server is selected, the NOVAC Explorer will communicate with the global NOVAC SFTP Server and download FluxLog data from there. If the NOVAC Program is running on a computer with access to the internet and is configured correctly, FluxLogs will be uploaded to the NOVAC Server each time a new scan is received and evaluated. In this case, selecting NOVAC Server as a data source will provide the user with the ability to plot data in close to real time from any computer with access to the internet.

Selecting the Custom Local data source allows the user to select a directory on the local computer that contains FluxLog or PostFluxLog data files. This setting can be used to plot data without communicating with the NOVAC Server. However, plots will be limited to data that are available in the local directory and will not be updated in close to real time unless the local data are updated in some other way. Still, this feature provides users with the ability to plot the results of manual Flux analyses which are stored in PostFluxLog data files and not available on the NOVAC Server. Unfortunately, PostFluxLog files do not specify which volcano they are from. Therefore, only a single volcano can be selected when analyzing PostFluxLog files. Users should take care to ensure that only PostFluxLog files from the selected volcano are in the local data directory. The local directory which will be searched for data can be configured either by pushing the Browse button (...) next to the Custom Local Data Source option, or in the Settings Dialog (see below). A checkbox in the Settings Dialog allows users to specify whether subdirectories of the Custom Local directory should also be searched.

Analysis Level

The Analysis Level specifies whether data will be read from FluxLog or PostFluxLog files. FluxLog files are automatically generated by the NOVAC Program and updated each time a new scan is received from a Scanning DOAS instrument in the field. They contain the results of the automatic, preliminary analysis of emission rates.

PostFluxLog files are manually generated by performing a Flux analysis in the NOVAC Program. The data in these files may be more accurate, as updated wind or plume height information may have been used to create them. However, these files are not generated automatically and are not available on the NOVAC Server.

Minimum Plume Completeness

The Plume Completeness parameter is calculated by the NOVAC Program for each scan received from an instrument in the field. The parameter provides a measure for how certain an SO₂ plume was fully captured in a scan. Setting the Min Plume Completeness to 0 plots all collected data. Increasing the Min Plume Completeness to 0.6, 0.7 or even 0.8 filters out scans that did not capture the full plume, leaving only scans with high confidence of capturing a full plume, thus providing a robust measure of emission rate. Remember that numerous factors can lead to a low plume completeness, the most common being that the winds were blowing volcanic gases in a direction away from the scanner. In such cases, the scanner will report a low emission rate with a low plume completeness, but this does not necessarily mean the volcano's emission rate was low at the time.

Create/Update Plots

Pressing the Create/Update plots button starts the data processing. The NOVAC Explorer will first check all available data and attempt to read it to memory. If the Data Source is set to NOVAC Server, the program will connect to the NOVAC Server and check for data from the specified volcano(es). The user will then be asked whether the program should synchronize data with the server. The user will be told how many days of data need to be synchronized to ensure that the plots are fully up to date. If multiple volcanoes are selected for plotting, the user will be asked whether to synchronize each one individually.

If the user chooses to synchronize data, the NOVAC Explorer will begin downloading data from the NOVAC server and storing these in a local database. This may take several 10s of seconds, minutes, or even hours, depending on how much data needs to be downloaded. In tests, downloading one week of data from three Scanning DOAS stations took approximately 1 minute.

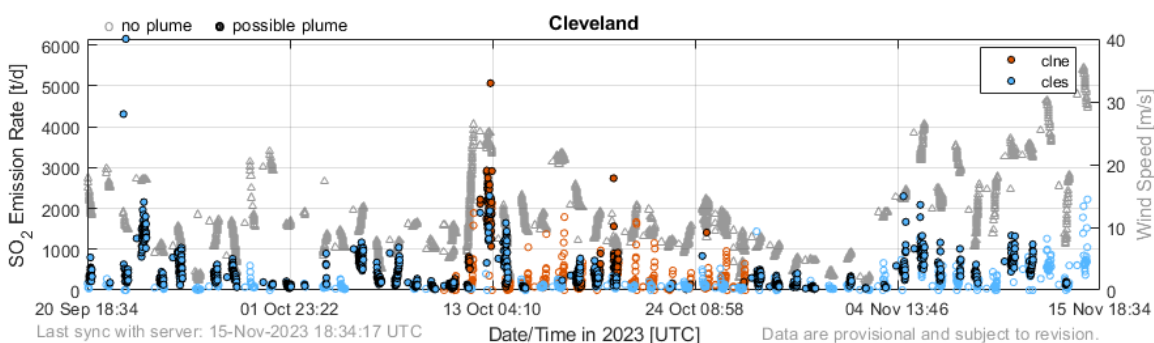


Figure 2 – Example plot of SO₂ emission rates from Cleveland Volcano, Alaska. The colors refer to measurements made by two different Scanning DOAS stations installed on the volcano. Solid circles mark scans in which at least a partial plume was identified.

Once the downloads have been completed, the plot will be created based on the data in the local database, which is now up to date. If the user chose not to synchronize data with the NOVAC Server, the plots will be generated from the data that is already available in the local database, i.e. that had been

previously downloaded. In this case, a small tag will be added to the plot indicating the time and date when the last synchronization with the NOVAC Server occurred. Selecting not to synchronize data with the NOVAC Server can be useful and save time, for example if a user wants to change the minimum plume completeness of a plot of data which had been downloaded only moments earlier.

As the plots are created, they will be brought to the foreground of the display. The plots can be resized and moved around on the screen. If the user updates the plots without closing their respective windows first, then the plot windows' size and location will be preserved and just the plot itself updated.

Save Image

Clicking this button allows the user to save the current plot(s) as an image. The *.pdf, *.png, and *.jpg file formats are supported. The plots are saved exactly as they are displayed on the screen, including any filtering for plume completeness. This feature is useful for creating plots to include in documents, presentations, or displaying on the web. The volcano name is appended to the file name unless it is already included by the user. Selecting an existing file overwrites that file.

Export Data

Clicking this button allows the user to save the data used in the current plot as a table. The *.xlsx, *.csv, and *.txt file formats are supported. The saved data exactly reflects the data displayed in the current plot(s). Data that are filtered out using the minimum plume completeness filter will not be included in the table. To export all data, set the minimum plume completeness to 0, update the plots, then export the data. This feature is useful if the user wants to make a customized plot of the data, e.g., using another software such as Excel. The volcano name is appended to the file name unless it is already included by the user. Selecting an existing file overwrites that file.

Automatic Updates

Activating the checkbox labeled “Update every” starts automatic plot updates (Figure 3). When this setting is enabled, the plot(s) are updated according to the settings defined in the main NOVAC Explorer dialog and the additional “Settings” dialog at user-defined time intervals. The update interval is defined in the edit field at right. Updates begin immediately on activating the checkbox and continue until the checkbox is deactivated or NOVAC Explorer is closed.

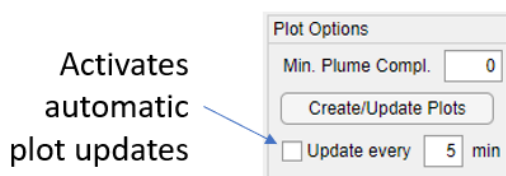


Figure 3- Checking this box starts automatic plot updates at the interval defined at right. (updates every 5 minutes shown here).

When automatic updates are enabled, the use of relative times in the Plot Range is recommended. For example, the user might set the Start time to “-1w” and the end time to “now” to plot the last week of data up to the present time. By then updating the plot every 5 minutes, the window will remain at 1 week but will continuously glide forward to always display the last week of data up to the present time.

Besides simply displaying plots on the local computer, automatic updates can be used to regularly serve updated plots to a website or updated data tables to a database importer. The features are configured in the Settings dialog which is described in the next section.

Settings Dialog

The Settings Dialog can be opened by pressing the “Settings” button on the top of the main NOVAC Explorer dialog. A separate dialog opens and allows additional configuration of the program with the following options.

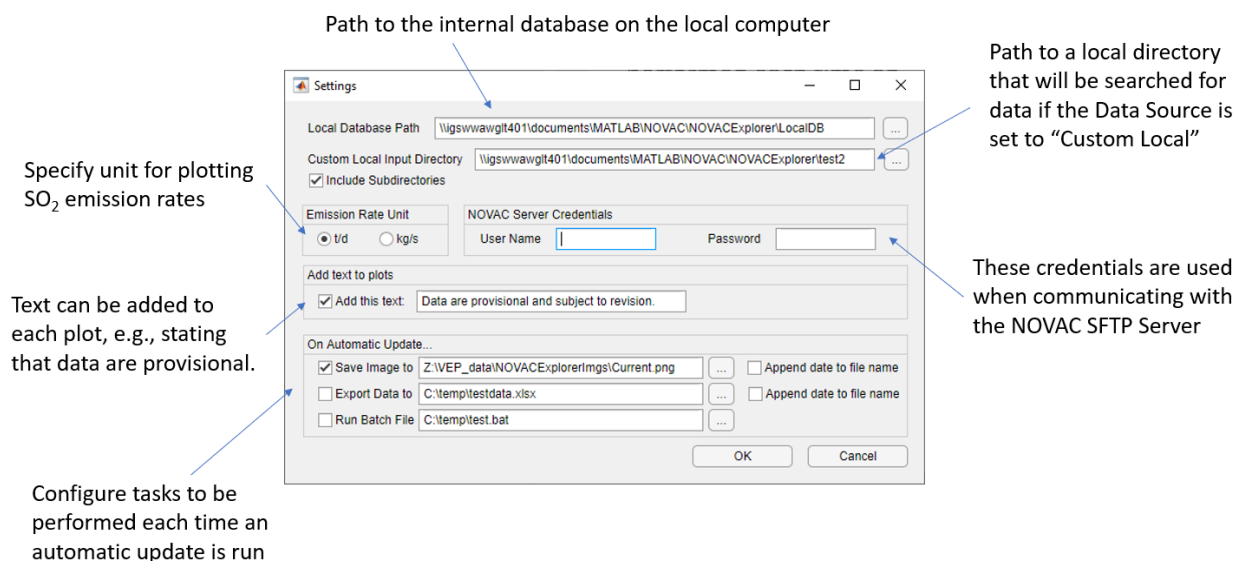


Figure 4 – Overview of the settings configured in the “Settings” dialog.

Local Database

The NOVAC Explorer keeps a local copy of all FluxLog files that have been plotted. Even when the Data Source is set to NOVAC Server, all relevant FluxLog files are downloaded to the local computer and stored there for possible later use. By default, a folder named ‘LocalDB’ is created in the same folder as the NOVAC Explorer program, and the local database is stored there. However, the location of the local database can be customized by changing the path in the Settings dialog. This can be useful, for example if a new version of the NOVAC Explorer is installed but the user wishes to utilize the local database created with a previous version, rather than rebuild everything from scratch.

Custom Local Input Directory

The path from which FluxLog or PostFluxLog files will be read if the Data Source is set to Custom Local in the Main Dialog. If PostFluxLog files are being plotted, note that the software assumes that all PostFluxLog files in this Custom Local directory are from the specified volcano. Selecting multiple volcanoes is not supported when plotting PostFluxLogs. A checkbox allows the user to specify whether FluxLog or PostFluxLog files located in subdirectories of the Custom Local directory should also be included in the plot.

Emission Rate Unit

Emission rates can be plotted either in metric tons per day (t/d) or in kg/s.

NOVAC Server Credentials

Each organization is assigned credentials for accessing the NOVAC SFTP server. These same credentials are also used when populating the list of volcanoes available for plotting. Generally, each institution will only have access to their assigned volcanoes. The credentials only need to be entered once each time the software is installed, typically when it is first run. However, if the user wishes to make changes to the credentials, this can be done in the Settings dialog.

Add text to plots

This feature allows users to specify a short text that will be added to each plot that is created. For example, this can be used to stamp plots with the name of the organization responsible for the data, or to alert viewers that the presented data are provisional and subject to change.

Automatic Update Tasks

As discussed previously, the NOVAC Explorer can be configured to automatically update plots at user-defined time intervals. In this panel, additional tasks can be configured to run each time such an automatic update occurs.

If the checkbox on the first line is activated, the software will save a (separate) image of all plots each time an update occurs. The path and filename of the image(s) are defined in the edit box. The volcano name is automatically appended to the file name. For example, the file “testimg.png” will become “testimg_Cleveland.png” for Cleveland volcano. If the checkbox at right is activated, the date and time will also be appended to the file name, in this case “testimg_Cleveland_2023-01-01T17-35-13.png”. In this way, each file name will be unique, and images will not be overwritten. If, on the other hand, the user chooses not to append the date to the file name, then each successive image will overwrite the last one. This can be useful for serving images of the latest plots to a website or network location, as the address to the image will not change over time.

Activating the second checkbox causes the data contained in each plot to be exported to a data table each time the plots are updated. Volcano names are again automatically appended, so at least one data file will be exported for each volcano. If the user chooses to append dates to the file name, then each successive file will have a unique name and files will not be overwritten. Otherwise, a single data table will be created for each volcano, and this table will be overwritten with each successive update.

The final checkbox allows the user to specify a batch file which will be run after each successful plot update. This feature allows users to perform other tasks not specified here each time the plots are updated. The batch file is executed after the respective image is saved and/or data table is written, so users could, for example, use a batch file to copy the image / table to a different location for viewing.

4. Future updates

NOVAC Explorer is in its infancy, and any ideas for improvements and additional useful features are welcome. If you would like to request a feature or bug fix, please contact Christoph Kern at ckern@usgs.gov.