GRANADA UNIVERSITY (UGR)

Geophysics Andalusian Institute

THEORETICAL PHYSICS AND THE COSMOS DEPARTMENT

ANDALUSIAN INSTITUTE OF GEOPHYSICS AND PREVENTION OF SEISMIC DISASTERS

“Save Records in MSEED and SAC format module”

(Módulo para Convertir y guardar registros en formatos MSEED y SAC)

USER MANUAL: VERSION 1.0

Author:

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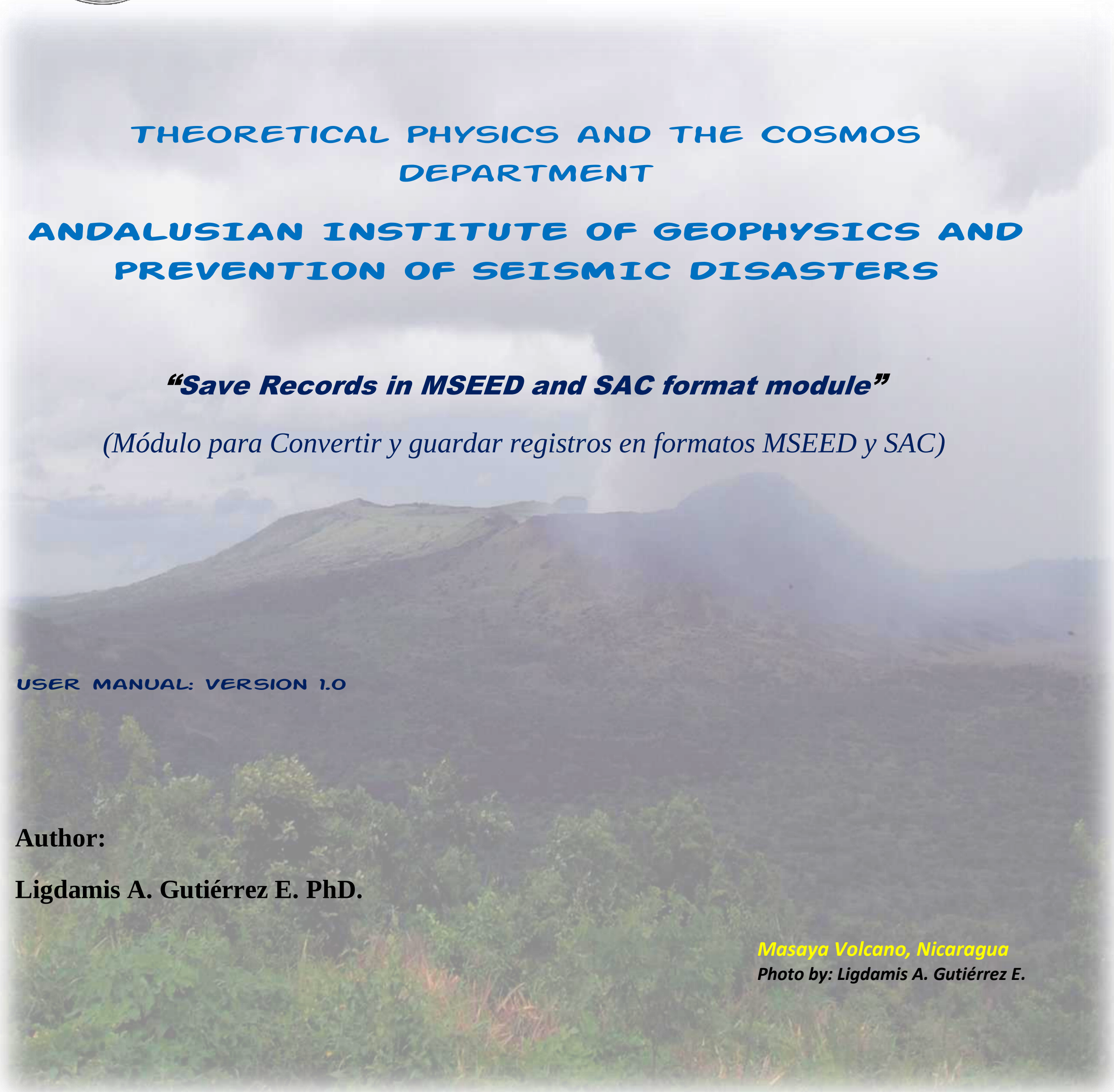

Masaya Volcano, Nicaragua
Photo by: Ligdamis A. Gutiérrez E.

Granada, Spain 2022- 2023

General Index

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1.- Introduction

El "*Save Records in MSEED and SAC format module (Módulo para Convertir y guardar registros en formatos MSEED y SAC)*" It provides a user-friendly interface that allows for easy and efficient management of the conversion of various seismic signal formats, such as SEISAN, GSE2, EVT, and WAV, to the most commonly used observatory formats, such as MSEED and SAC. This process is a practical aid for observatories that require specific software for conversion to these formats and often lack such software or trained personnel to develop the necessary programs. This occurs because observatories frequently acquire data from external sources that they do not manage or that are supplied by other observatories, which use formats different from those that will be processed and analyzed at the receiving observatory. Therefore, it is important and extremely useful to have a converter that performs this step and can obtain a similar record from the original format in MSEED and SAC formats, which can be more easily processed at many observatories and research institutes without the need to create or search for complex code to perform this process.

The application, through its built-in libraries, allows the reading of various seismic formats such as SAC, MSEED, GSE2, EVT, and WAV, among others. The system also provides the ability to store graphical results in various formats, including PNG, JPG, EPS, PS, PDF, RAF, and TIF, automatically adding value to the operator's knowledge.

The module and the entire system have been developed in Python, version 3.8.6. (The set of libraries is compatible with version 3.10.10). Additionally, a series of open-access libraries are included, which, in conjunction with Python, enable the use of graphical and analytical tools, providing ease of use and enhancing computational power for the user. Some of the main elements and libraries used are listed below:

- **Matplotlib**: Used for creating static, animated, and interactive visualizations in Python. (https://matplotlib.org/stable/users/index.html).
- **NumPy**: A library for numerical operations in Python. (https://numpy.org/doc/stable/user/quickstart.html).
- **PyQt5**: A tool that links with the graphical library Qt5 in C++ (https://pypi.org/project/PyQt5/).
- **Obspy**: A Python toolbox for seismology. (https://docs.obspy.org/).
- **Tkinter**: Graphical User Interface (GUI) (https://docs.python.org/3/library/tkinter.html)

Another key feature of the system is its definition as a cross-platform application, meaning it can operate on various platforms or operating systems, such as Windows (7, 8, 10, 11) in both 32-bit and 64-bit versions. It also supports Linux systems, such as Ubuntu and other similar systems (Debian, Red Hat, Fedora, SUSE, etc.), macOS, and Android for tablets and mobile devices (with Python appropriately adapted for these devices).

NOTE: In the appendices of this document (*as well as in the Readme.txt and Initial_requirements.txt files*), you can find general information on installation for Windows and Linux systems, as well as guidelines for installing the main programs and additional libraries required by Python to properly execute the developed programs in its environment.

2.- Initial Screen of the System

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In the appendices of this document and in the “**README.txt**” file included in the “***Documents***” folder, you will find instructions for installing the system on Windows (*the process on Linux systems is similar*). Essentially, you need to perform two actions:

a) Copy the “Set_tools_System_1_1” folder to “My Documents” on Windows.
b) Copy the “Set_tools_System_1_1.bat” file to the Windows desktop.

Additionally, there are instructions for installing the necessary Python libraries on the system. Once “Set_tools_System_1_1.bat” has been copied to the desktop, you need to right-click on it and select “Run as administrator.”

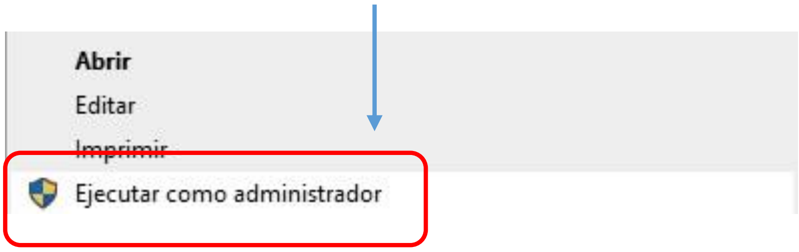
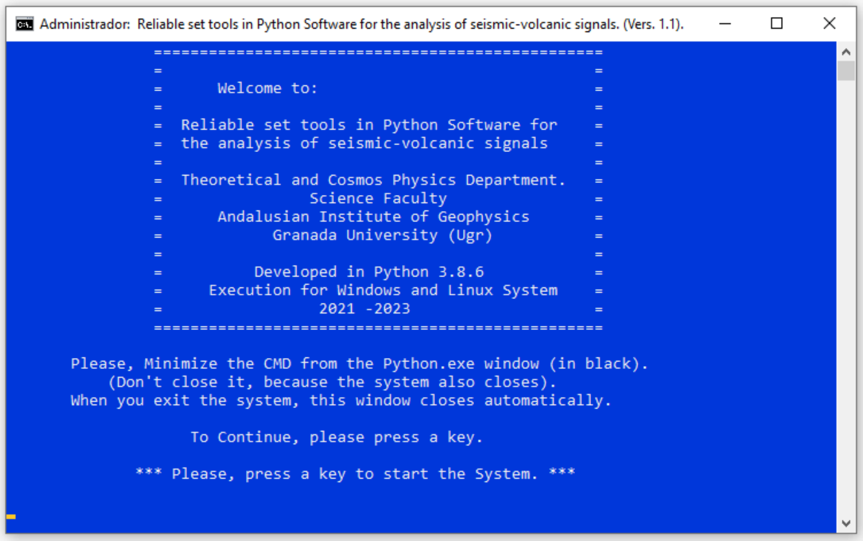


Fig. 1 Popup Window when Right-Clicking on the “Set_tools_System_1_1.bat” File

In the window that opens, click the “Yes” button when prompted with “*Do you want to allow this app to make changes to your computer*?” This is a warning message. However, the application does not make any changes, so you should trust its execution.

Upon clicking “*Yes*,” the following command window opens, welcoming you to the system.



```
Administrador: Reliable set tools in Python Software for the analysis of seismic-volcanic signals. (Vers. 1.1).

                ==================================================
                =                                                =
                =      Welcome to:                               =
                =                                                =
                =   Reliable set tools in Python Software for    =
                =   the analysis of seismic-volcanic signals     =
                =                                                =
                =   Theoretical and Cosmos Physics Department.   =
                =                 Science Faculty                =
                =       Andalusian Institute of Geophysics       =
                =             Granada University (Ugr)           =
                =                                                =
                =           Developed in Python 3.8.6            =
                =      Execution for Windows and Linux System    =
                =                  2021 -2023                    =
                ==================================================

       Please, Minimize the CMD from the Python.exe window (in black).
           (Don't close it, because the system also closes).
       When you exit the system, this window closes automatically.

                    To Continue, please press a key.

              *** Please, press a key to start the System. ***
```

Fig. 2 Welcome Screen and Instructions for Loading the System.

After reading the information in the window, you simply need to press any key to access the system's initial screen. The folder should already be copied to “***My Documents***,” and the “**Set_tools_System_1_1.bat**” file contains all the loading instructions.

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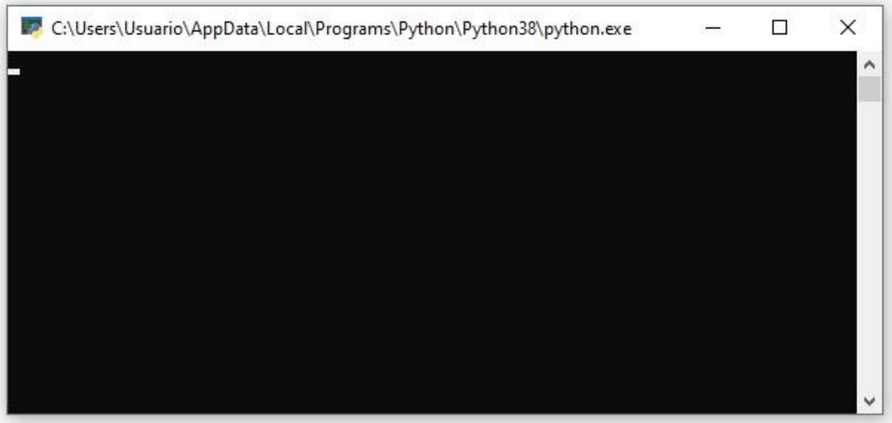
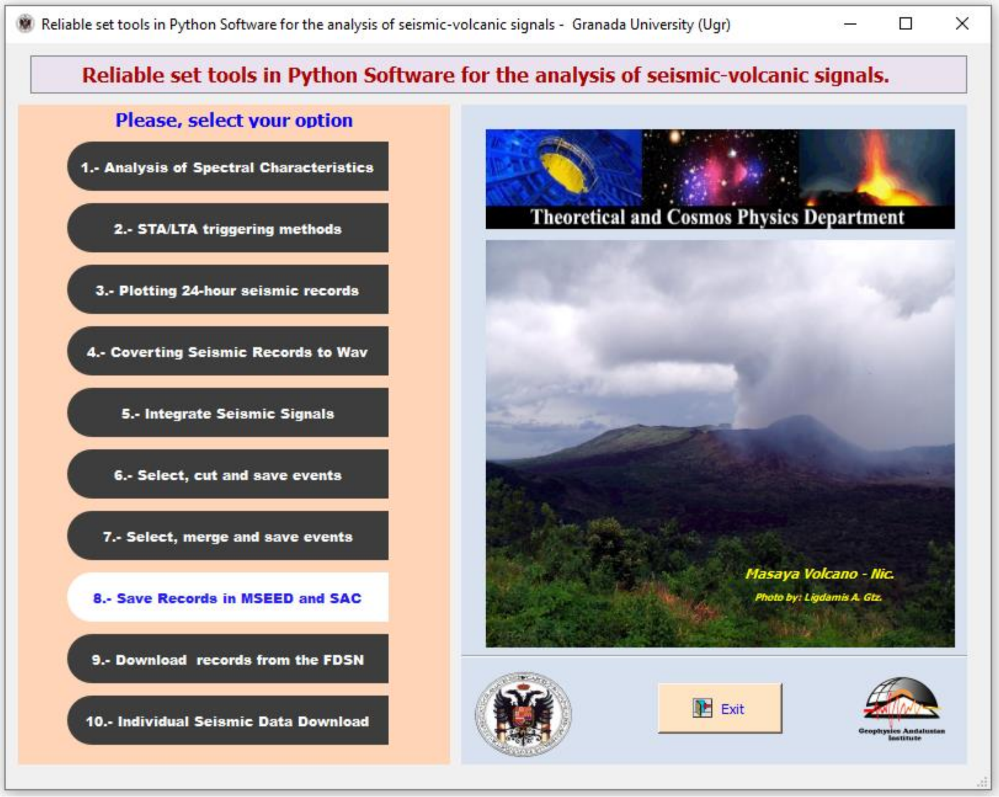
The system's initial screen is "**Menu.py**". It appears when any key is pressed on the Welcome screen. Additionally, the Python command window or console is displayed, similar to the following:



C:\Users\Usuario\AppData\Local\Programs\Python\Python38\python.exe

Fig. 3 Python Console (CMD) Window (*Should be minimized*)

To avoid obstructing the view, you can and should "minimize" this screen. Do **not** close it, as this would also close the system's startup window. Once you have finished working with the system, this window will close automatically. The initial presentation screen of the system (the module menu) "**Menu.py**" is as follows:



Reliable set tools in Python Software for the analysis of seismic-volcanic signals - Granada University (Ugr)

Reliable set tools in Python Software for the analysis of seismic-volcanic signals.

Please, select your option
1.- Analysis of Spectral Characteristics
2.- STA/LTA triggering methods
3.- Plotting 24-hour seismic records
4.- Coverting Seismic Records to Wav
5.- Integrate Seismic Signals
6.- Select, cut and save events
7.- Select, merge and save events
8.- Save Records in MSEED and SAC
9.- Download records from the FDSN
10.- Individual Seismic Data Download
Theoretical and Cosmos Physics Department
Masaya Volcano - Nic.
Photo by: Ligdamis A. Gtz.
Exit
Geophysics Andalusian Institute

NOTE: When pressing or clicking on a module button, the startup window will close and the module window will open (*this may take a little time depending on the PC's memory. It is recommended to have at least 8 GB of memory in the system, with 16 GB being ideal*)

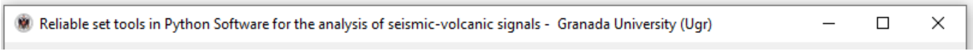
Fig. 4 Main Menu screen. The module to be worked on is highlighted. Module 8 (*Save Records in MSEED and SAC*).

2.1.- Elements of the Initial Screen.

As observed in the previous figure, the initial or presentation screen is a simple window composed of:

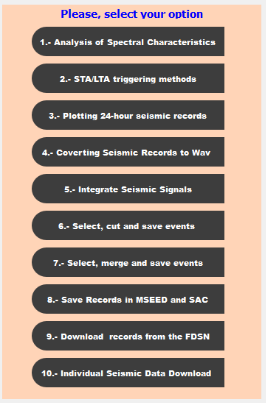
a) A top toolbar with basic information about the module.
b) On the left side, there are 10 execution buttons or command buttons for each module of the system.
c) At the bottom, there is a command button that allows for exiting the system.
d) Additionally, it features a background image representing a volcano (Masaya in Nicaragua), and three images with the logos of the University of Granada, the Andalusian Institute of Geophysics, and the Department of Theoretical and Cosmic Physics.

a) At the top, the icon of the University is visible, along with the module title and a reference to the University of Granada (UGR).

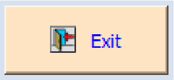


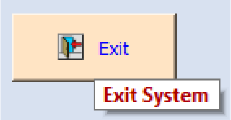
Reliable set tools in Python Software for the analysis of seismic-volcanic signals - Granada University (Ugr)

b) On the left side, there are 10 execution buttons or command buttons for each module of the system. When the mouse pointer is placed over each button, it is highlighted in white to indicate that it is being selected. Clicking on a button closes the startup menu window and opens the window for the indicated module (this may take a little time depending on the PC's memory).

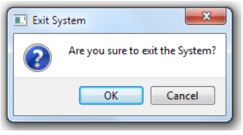

Please, select your option
1.- Analysis of Spectral Characteristics
2.- STA/LTA triggering methods
3.- Plotting 24-hour seismic records
4.- Coverting Seismic Records to Wav
5.- Integrate Seismic Signals
6.- Select, cut and save events
7.- Select, merge and save events
8.- Save Records in MSEED and SAC
9.- Download records from the FDSN
10.- Individual Seismic Data Download

c) At the bottom, there is a command button: **Exit**. When the mouse pointer is placed over each button, a text appears indicating the action of that button (Exit System, Start System).





If you click the “Exit” button, a window will appear asking the user if they are sure they want to leave the system.



Exit System

Are you sure to exit the System?

Fig. 5 Text Box Indicating Whether You Want to Exit the System.

If you click “**OK**,” the screen will close and the system will exit. If you click “Cancel,” you will remain on the initial screen

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3.- Loading and Conversion Interface.

The "load and conversion screen" is the module's main interface, where the activities that comprise the tools for reading records and converting the formats of seismic records are performed. This screen consists of the following parts:

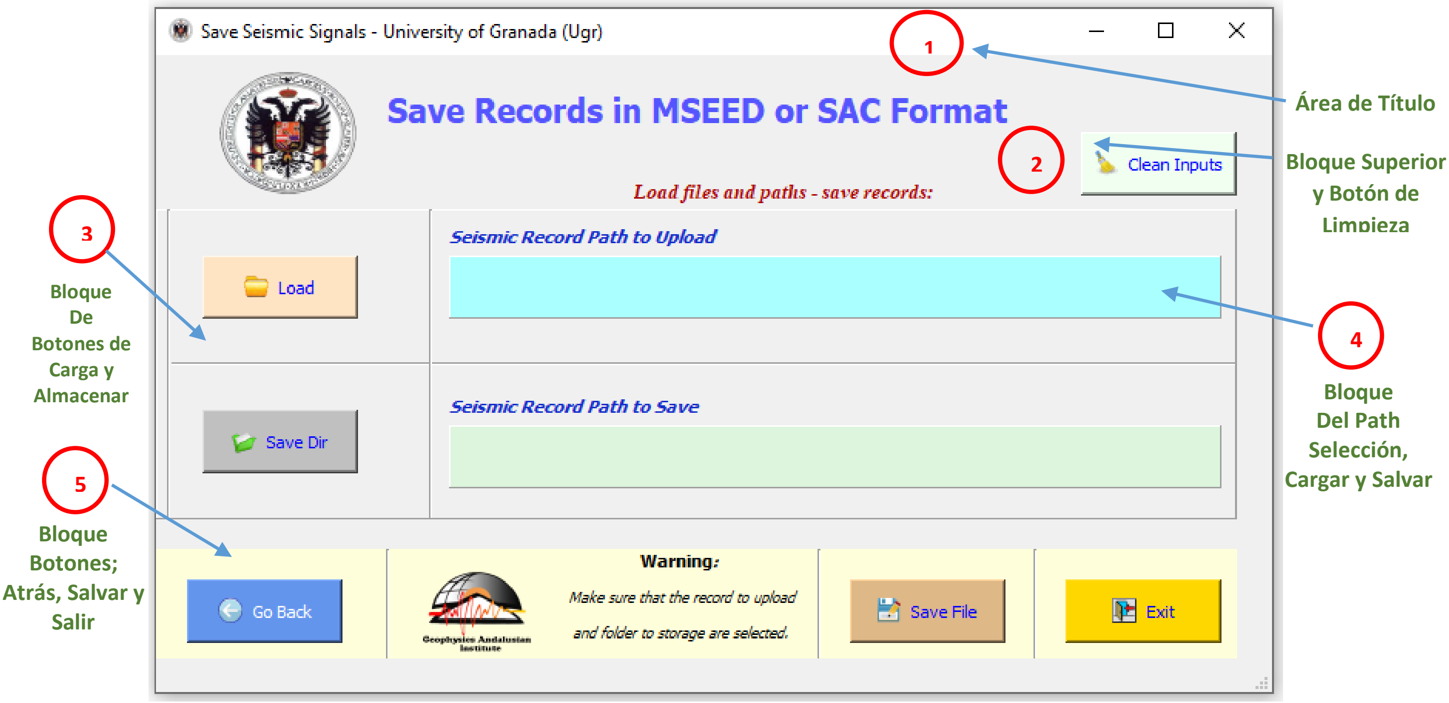

Save Seismic Signals - University of Granada (Ugr)
Save Records in MSEED or SAC Format
Clean Inputs
Load files and paths - save records:
Seismic Record Path to Upload
Load
Seismic Record Path to Save
Save Dir
Warning:
Make sure that the record to upload and folder to storage are selected.
Geophysics Andalusian Institute
Go Back
Save File
Exit
1
Área de Título
2
Bloque Superior y Botón de Limpieza
3
Bloque De Botones de Carga y Almacenar
4
Bloque Del Path Selección, Cargar y Salvar
5
Bloque Botones; Atrás, Salvar y Salir

Fig. 6 Elements of the Loading and Conversion Screen.

1) Title Area.
2) Top Block and Data Entry Clear Button.
3) Load Button Block and Storage Directory Block.
4) Path Block: Physical location of the record to be converted and final storage directory.
5) Command Button Block (Go Back, Save File, Exit).

The screen is made up of various elements for its use. At the top you will see: Program name, icon, University name, and author as the title (1)

The elements that make up the main screen are detailed below.

3.1.- Loading and Conversion Screen Elements.

Apart from item (1), the four elements of the "Charge and Conversion" screen are divided into four main blocks, numbered (2-5) in the red circles.

3.1.1.- Top Block and Cleaning Button. (2)

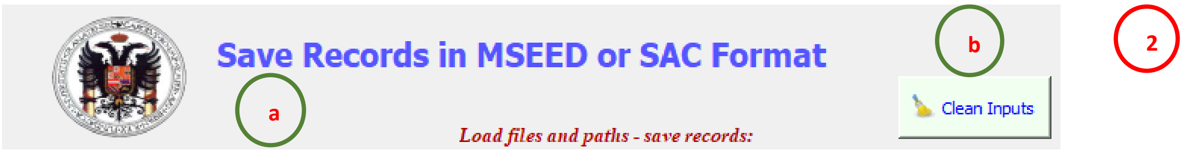
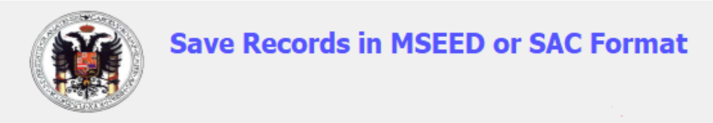
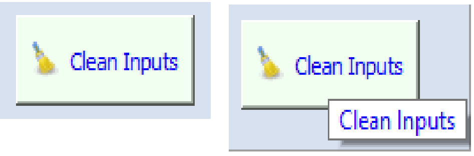

Save Records in MSEED or SAC Format
a
b
Clean Inputs
Load files and paths - save records:
2

Fig. 7 Block of elements from the top block. In the green circles: a) UGR logo and program title, b) Data entry clear button.

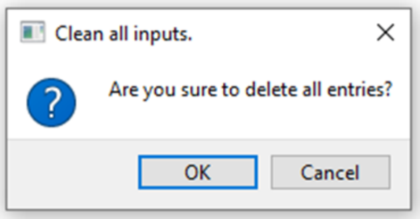
a).- **UGR Logo Area and Program Title**.



b).- **Input cleaning command button** (Clean Inputs).



Clicking this button clears all entries on the screen. It will clean the data entry text boxes and the path or folder where the record to be downloaded will be stored, and it will delete all active entries with data at that moment. It restores the initial values of the main interface (*see Fig. 6*).



Clean all inputs.

Are you sure to delete all entries?

When you place the mouse pointer over it, a message appears indicating its function. Clicking the button opens a window asking the user if they are sure they want to delete the data entries. If confirmed, it clears all entries and returns the interface to its initial state. Otherwise, the current entries remain in the interface.

Fig. 8 Data Clear button. The action message is displayed on the button.

3.1.2.- Upload Button Block and Store Conversion Directory. (3)

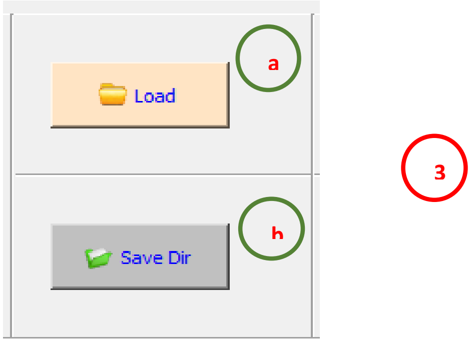


Fig. 9 Block of buttons for loading and saving the conversion directory. In the green circles: a) Load button: Load the seismic file or record to be converted, b) Save Directory button: Indicates the folder where the converted record will be saved in either MSEED or SAC format.

a).- Load button. Allows you to select the record to convert.

Clicking the "***Load*** (Load Registry)" button opens a file explorer window (by default, the path is in the root directory "**C**" of the PC), displaying options for the various file formats to search and allowing you to perform the search within the computer's directory. Hovering the mouse pointer over this button displays a message explaining the action being performed.

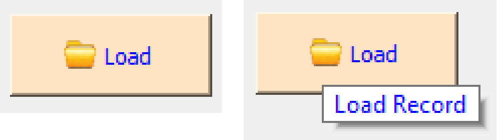


Fig. 10 Load button. The action message is displayed on the button.

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Clicking the button displays the following dialog box.

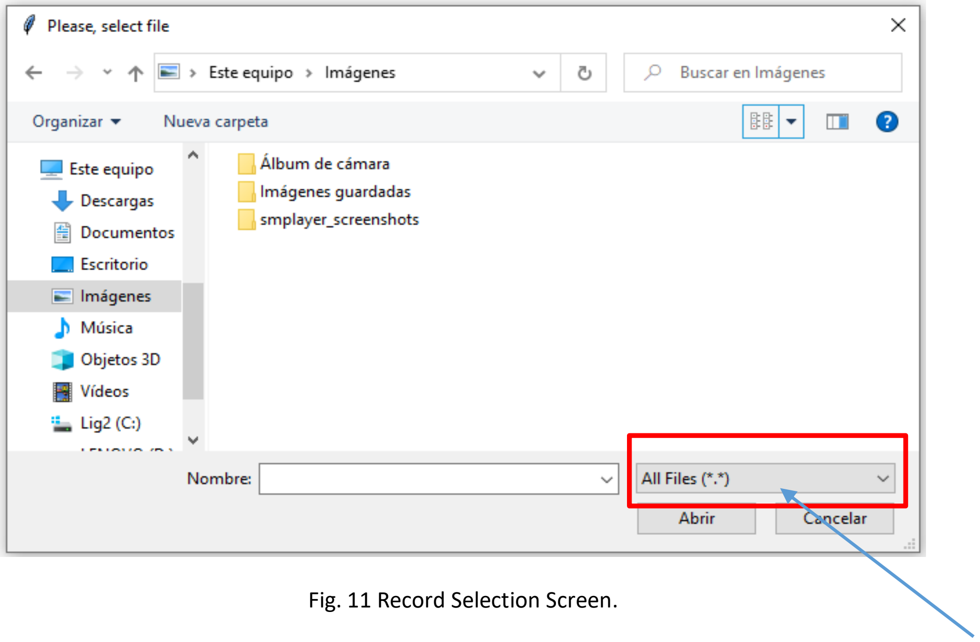


Fig. 11 Record Selection Screen.

On this screen (the language is determined by the operating system), you select the logs according to the desired format (*red box*) (*GSE2*, *EVT*, *WAV*, *SEISAN*, *etc*.). This is possible using the "**Obspy**" seismic format reading library.

Once selected, click the "**Open**" button to load the record onto the analysis screen. Otherwise, click the "**Cancel**" button to return to the analysis screen. The record selection process is shown in the following screenshot.

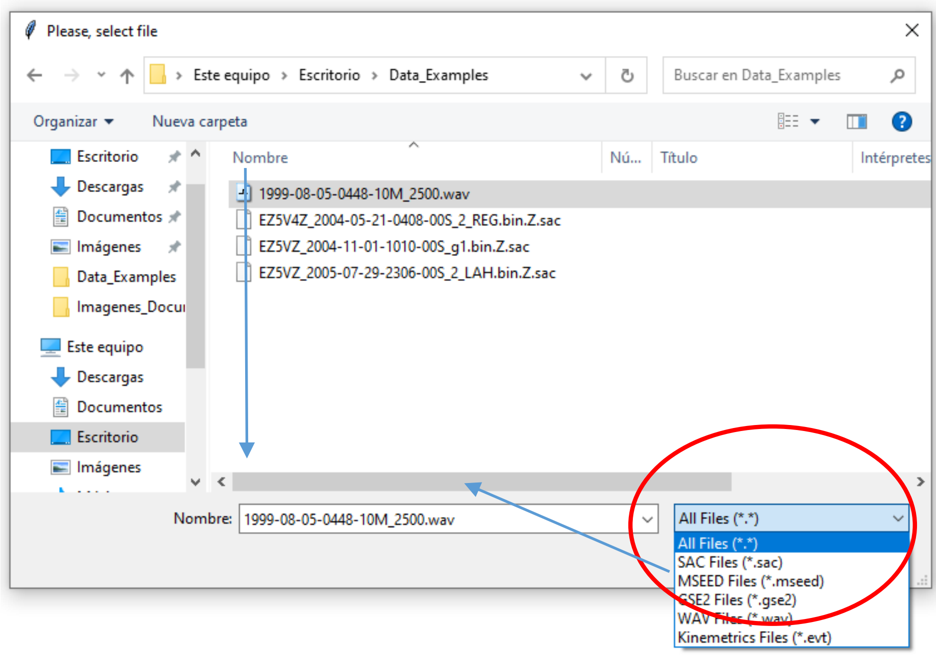


Fig. 12

Example screenshot of selecting a record in “WAV” format.

In the previous screen, in the lower right part, indicated by the red circle and displayed by the arrow, you can see the list of the most general types of seismic formats supported and/or used in observatories and institutes worldwide (*SAC*, *MSEED*, *GSE2*, *WAV*, *EVT*), among others.

Selecting a specific type displays the records according to that format. For example, the “WAV” files stored in “Data_examples”. Clicking on the desired record places it in the “Name” field. At this point, click the “Open” button from the previous screen. This loads the physical location of the record on the system, displaying its path. This path will be shown in the “Seismic Record Path to Upload” field at the bottom of the upload and conversion screen (part of block 4, see Fig. 6).

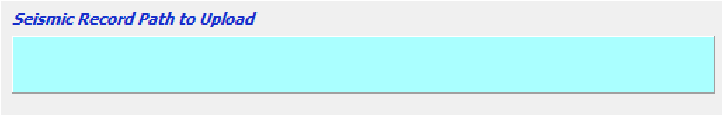


Fig. 13 File path table, which shows the physical location of the record.

This is an important aspect, as it determines whether the physical file where the record is stored on the computer can be located later for analysis. If the file is invalid, cannot be found, or the parameters are incorrect, a validation window will appear indicating this (See Fig. 26, Page 14).

b).- ***Save Dir Button***. Allows you to select the folder or directory where the converted record will be stored. When you hover the mouse pointer over this action button, a message displays the action it performs.

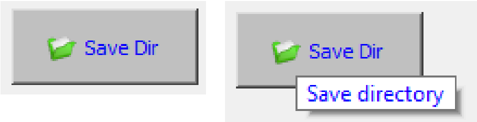
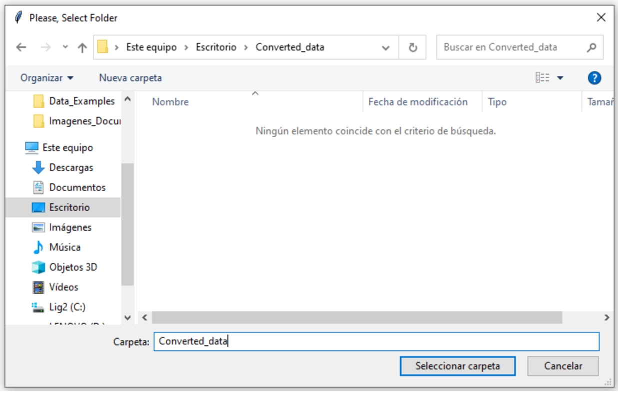


Fig. 14 Botón Save Dir/Salvar Directorio. Se observa el mensaje de acción en el botón.

Clicking this opens a file explorer window (by default, the path is located in the root directory "C" of the PC), allowing you to select the folder or directory on your computer where the registry entry to be converted will be stored. This is shown in the following image.



Ningún elemento coincide con el criterio de búsqueda.

Carpeta: Converted_data

Fig. 15 Select the folder or directory where the converted record will be stored.

The figure above displays the message “Please Select Folder” at the top and two buttons at the bottom: “Select Folder” and “Cancel.” Clicking the “Select Folder” button allows the user to choose the folder or directory on their computer where they want the converted records to be saved, either in MSEED or SAC format. This path will be displayed in the “***Seismic Record Path to Save***” box, located at the bottom of the upload and conversion screen. (*This is part of block 4, see Fig. 6*).

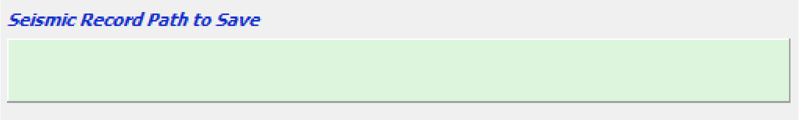


Fig. 16 Directory or folder path, showing the physical location where the converted record will be stored or saved (MSEED or SAC).

3.1.3.- Command Button Block (Go Back, Save File, Exit). (5)

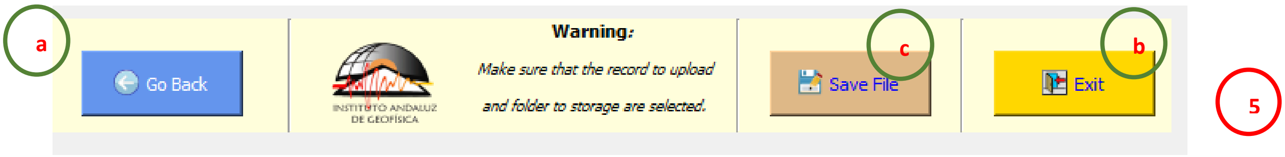

a
Go Back
INSTITUTO ANDALUZ DE GEOFÍSICA
Warning:
Make sure that the record to upload and folder to storage are selected.
c
Save File
b
Exit
5

Fig. 17 Command Button Block. In the green circles: a) Go Back button: Allows you to return to the Home screen (Menu), b) Save File button: Converts the Registry to the selected format (MSEED or SAC), c) Exit button: Indicates program exit.

a).- ***Go Back Button***. Allows you to return to the previous welcome screen (Menu).

The "***Go Back button***” action, when clicked, returns you to the module's initial Welcome screen (**Menu**). When you hover the mouse pointer over this action button, a message displays the action it performs.

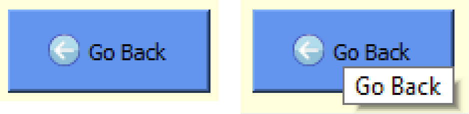


Fig. 18 Go Back button. The action message is displayed on the button.

b).- ***Exit Button***”, allows complete system exit.

(*After displaying the screen asking if you wish to exit the system*). When you hover the mouse pointer over it, a message is displayed indicating its function.

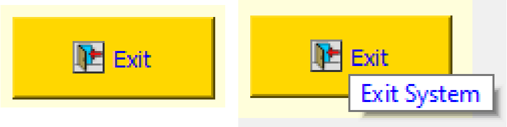
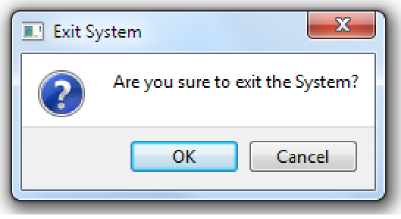


Fig. 19 Exit button. The action message is displayed on the button.

Similarly to the home screen, if you press or click the "***Exit***" button, a window appears asking the user if they are sure they want to leave the system.


Exit System

Are you sure to exit the System?

Fig. 20 Text box indicating whether you wish to exit the system.

Clicking "**OK**" closes the screen and completes the system exit. "Cancel" remains on the analysis screen.

c).- ***Save File Button***".

The "***Save File/Save Record***" button, when clicked, converts the selected record to a specific format (**MSEED** or **SAC**) and saves it to the chosen folder or directory. You must first select both the record to be converted and the folder or directory where it will be saved after conversion. Hovering the mouse pointer over this button displays a message explaining the action it performs.

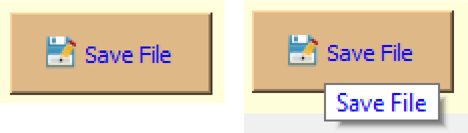
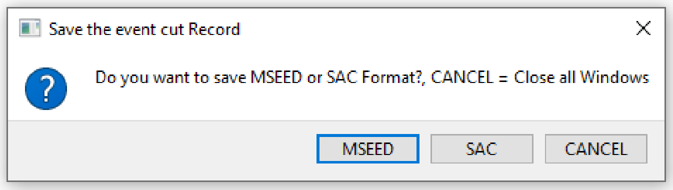


Fig. 21 Save File button. The action message is displayed on the button.

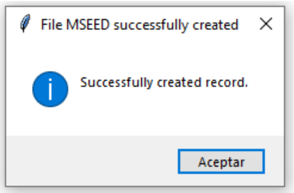
Once you click the "***Save File***" button, a dialog box opens, allowing you to select the desired conversion format. This dialog box is as follows:


Save the event cut Record

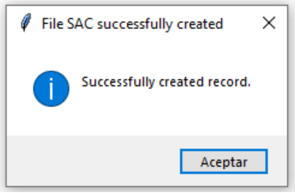
Do you want to save MSEED or SAC Format?, CANCEL = Close all Windows

Fig. 22 Dialog box to select the type of format (MSEED or SAC) to which you want to convert the record.

As shown in the image above, the dialog box asks the user in which format they wish to save the record. It has three action buttons: "**MSEED**", "**SAC**", and "**CANCEL**". The MSEED and SAC buttons will convert the record to the desired format, and the "CANCEL" button will cancel the operation and return to the main screen. The conversion process is automatic and fast. A results window is displayed at the end.


File MSEED successfully created

Successfully created record.


File SAC successfully created

Successfully created record.

Fig. 23 Dialog boxes indicating that the record has been successfully created in the selected format.

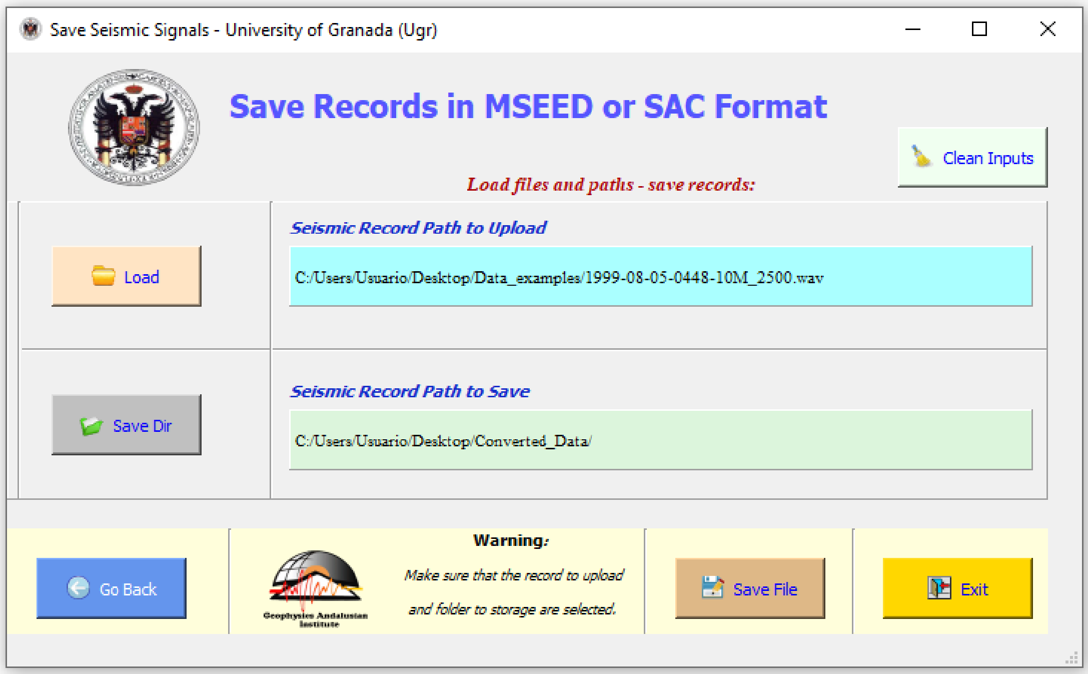
If the entries are not selected and the button is clicked, the validation dialog boxes shown later in this document will appear.

4.- Entries Selection.

The process of selecting entries to perform the conversion of the records is very simple, it consists of the following steps:

I. Select the record to convert using the "Load" button (See Page 8).
II. Select the folder or directory where the record will be stored, using the "Save Dir" button (See Page 10).
III. Proceed to click the "Save File" button and select the type of format you wish to obtain [MSEED or SAC], (See Page 12).

The result of these inputs can be seen in the following image.



Save Seismic Signals - University of Granada (Ugr)

Save Records in MSEED or SAC Format

Load files and paths - save records:

Seismic Record Path to Upload

C:/Users/Usuario/Desktop/Data_examples/1999-08-05-0448-10M_2500.wav

Seismic Record Path to Save

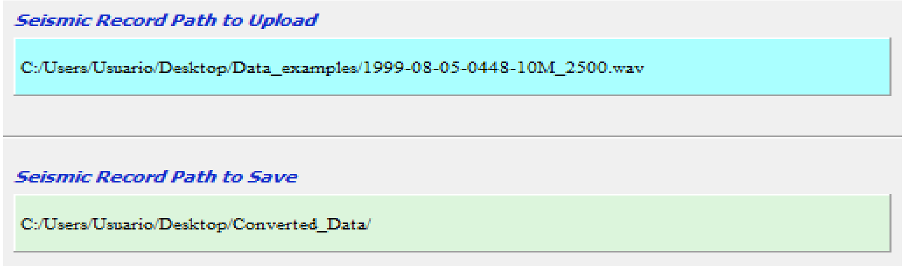
C:/Users/Usuario/Desktop/Converted_Data/

Warning:

Make sure that the record to upload and folder to storage are selected.

Fig. 24 Input elements of the Loading and Conversion Screen.

The figure above shows the data inputs for performing the record conversion. It shows how a file in "WAV" format will be converted to (MSEED or SAC) format and stored in a folder or directory called "*Converted_Data*".



Seismic Record Path to Upload

C:/Users/Usuario/Desktop/Data_examples/1999-08-05-0448-10M_2500.wav

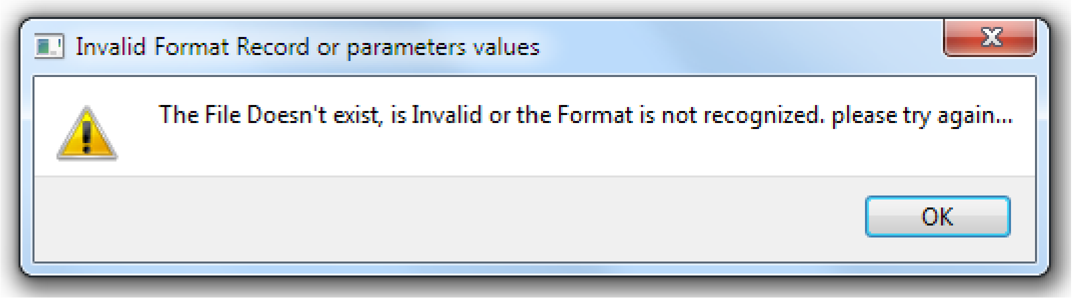
Seismic Record Path to Save

C:/Users/Usuario/Desktop/Converted_Data/

Fig. 25 Registry paths and the folder where it will be stored once converted (MSEED or SAC).

5.- Validation of errors in registration or entries.

Clicking the "***Save File/Guardat Registro***", button will trigger a validation process if an error occurs (invalid entry, non-existent record, or out-of-range format). This validation will be displayed through several dialog boxes, each showing an alert message. This allows the user to modify the entries or select a valid record without the system crashing or stopping. The displayed screens are as follows:



Invalid Format Record or parameters values

The File Doesn't exist, is Invalid or the Format is not recognized. please try again...

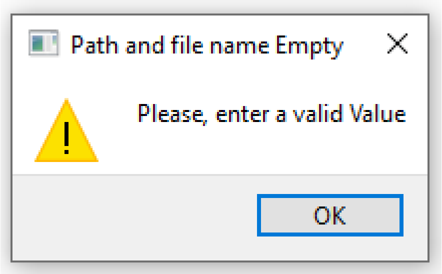
Fig. 26 Validation of invalid entries, incorrect formats or records.

According to the message in the previous figure, an error has occurred because the format is not recognized, the record does not exist, or the merge cannot be performed because the records do not match. Additionally, the parameters or inputs may be outside the allowed range for the signal being analyzed. Pressing the "***OK***" button returns you to the system, allowing you to select a valid file or correct the erroneous inputs. This way, the program continues running without further issues.

5.1.- Validations of the "Save File" button.

When you click the "Save File" button, which performs the conversion and storage of the converted record in the folder that the user has selected for it, if the data entries do not exist, the following validations occur.

a) ***Missing Entry Record***: In this case, the entry record has not been selected, so the Path (see Fig. 13) is empty. The following dialog box appears.



Path and file name Empty

Please, enter a valid Value

Fig. 27 Empty Record Name and Path Validation dialog window.

Click the "OK" button to enter the necessary values and repeat the process. This window prevents the system from crashing or interrupting, allowing it to continue.

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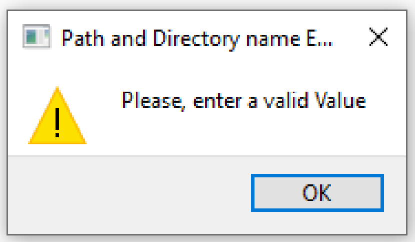
b) ***Missing storage folder***: In this case, the name of the folder or directory where the converted record will be stored is empty, so the following dialog window appears.



Path and Directory name E...

Please, enter a valid Value

Fig. 28 Empty save path and directory or folder name validation dialog window.

As in the previous process, click the "OK" button to enter the necessary values and repeat the process. This window prevents the system from crashing or freezing, allowing it to continue.

CONCLUSION: The system is designed to be an easy-to-use, accessible, and understandable tool. Its user-friendly interface provides reliable technological support to the human operator in the analysis of seismic records, both tectonic and volcanic, enabling the conversion of formats other than those typically used by observatories into more accessible formats such as MSEED or SAC. The simplicity of this first version lies in its single module, which includes the necessary algorithms for reading and converting seismic formats frequently used in the study of a given seismic signal. Subsequent versions or updates to the current version (1.0) will include additional modules containing various types of analysis, functionalities, or different algorithmic methods to enhance the study and research of the scientific community.

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END of the document.

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APPENDIX A

A1.- Installation of Python and Additional Libraries.

A1.1. Package Content.

The main folder "***Analysis_System_1***", It contains two folders with the programs (codes and interfaces in English and documentation in Spanish and English), organized as follows:

a) Folder **"*Reliable_set_tools_system_1*"**: (*seismic analysis system assembly*). This folder must be copied to "*My Documents*". Contains the following elements:

   a. Subfolder: "***Images***" " Images necessary for program interfaces.
   b. Program: ***Menu.py***. Startup program, presentation and calling of individual modules.
   c. Program: "***Convert_1.py***". Main program (interface) for recording and converting seismic records in other formats to MSEED and SAC formats.

b) Folders (*Document_ES and Document_EN, depending on the language; English or Spanish*). For *English* "***Document_EN***": It consists of the following items::

   a. User Manual for the module "***8_Manual_Save_record_MSEED_and_SAC_EN.pdf***" in PDF, written in English, with the necessary documentation for the use of the system interfaces. In addition, the rest of the manuals for the other modules (1-10) that make up the system are found.
   b. "***Initials Requirements.txt***" file. File containing the libraries needed to be installed on Windows through "Pip", once Python is installed.
   c. File "***README.txt***": File with general instructions for system installation.
   d. File "***Set_tools_System_1_1.bat***", batch processing executable file. It must be copied to the desktop, from there by right clicking "run as administrator", it will start the system by calling the main menu. The file will automatically search for the startup program (Menu.py) that is located in the "Set_tools_System_1_1" folder that has been previously copied to "My Documents" and will start Python, executing said program.

The system has all the elements (*programs and interfaces*) in English, except for the user manual, which is written in both Spanish and English. To install on Windows, two main actions should be taken after downloading and extracting the ". Rar" files. The first is to copy the entire folder (a) to the "*My Documents*" folder on the PC.

a) From the main folder (**Analysis_System_1**), copy the subfolder "**Document_EN**" to "**My Documents**" in Windows.

b) Copy the file "**Set_tools_System_1_1.bat**", from the "(Document/Document_ES or Document_EN)", depending on the version (Spanish or English), to the Windows desktop.

This ensures the proper use of the program. Now, we will proceed with the installation of the Python language and additional Python libraries on Windows.

A1.2.- Installing Python on Windows.

Python is an interpreted, multi-platform, and multiparadigm programming language (*it works on various operating systems, including Windows, Linux, and Mac*), utilizing two or more programming paradigms within a program-object-oriented, reflective, imperative, and functional.

In addition, Python can be enriched by a large number of programming modules, libraries, packages, or libraries installed through its package manager, "**Pip**." On Linux, the Python program and its manager "**Pip**" are installed together with the operating system. In Windows systems, however, where Python is not a native language, it is necessary to install this language beforehand by downloading the appropriate version from the Python distribution website at the following address: https://www.python.org/downloads/

On the website, the correct version should be selected based on the type of operating system on the computer, including whether it is 32 or 64 bits.

To be installed on both 32 and 64-bit systems, it is essential to note that this document and the software were created with the version available at that time, which was "Python 3.8.6", and many more versions have emerged since then. A more modern and adaptable version to the software (recommended) is "Python 10.10".

Users need to check if more advanced versions do not interfere with some of the installed libraries, such as "*Obspy*," for example. This is because everything related to Linux systems is constantly changing with updates that Python and Linux-based systems make. It is advisable to visit the website and download the most stable or tested updated version of Python that works well with this software.

Once downloaded, run it as an administrator (*right-click and "**run as administrator**"*), and the software installation wizard will guide you through the necessary steps (*just follow the instructions*).

The process takes only a few minutes. It is "recommended" to indicate during the process, when asked, to include an access path in the system's "**Path**" so that Python can be accessed from any location in Windows. If this is not done during the installation process, it must be done manually by modifying the environment variables (*more complicated*) to include the path from where Python is installed. This will not be necessary (*if indicated at the beginning*) through the installation wizard.

A1.3.- Installation of Additional Libraries.

The next step is to ensure that Python and its file manager or package manager (**Pip**) have been installed correctly. "**Pip**" (*file and library manager*) is crucial because it allows the installation of additional libraries that Python needs to run the created programs. To do this, open the Windows console window, or "*CMD*." The CMD, or command prompt, is a command-line interpreter.

Accessing the CMD is possible by typing, searching for the Windows logo key (a window), located between the "Ctrl" and "Alt" keys at the bottom left of the keyboard. Pressing this key, plus (+) the letter "**R**" key, will open a "Run" program window, similar to the following.

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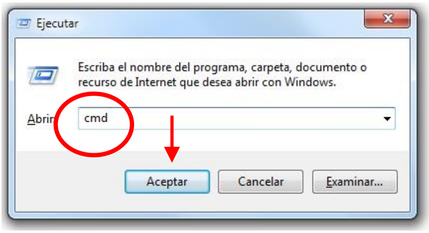


Escriba el nombre del programa, carpeta, documento o recurso de Internet que desea abrir con Windows.

Abrir: cmd

Fig. A1 Screen run in Windows. In the red circle, type "cmd" and click "OK."

As seen in the figure above, type "cmd," click "OK," which will open the Windows command prompt window.

Another way to do this is at the bottom of the desktop, in (W7) or next to (W10) the Windows "Start" button. There is the search section, indicated by the magnifying glass icon. This indicates a search for programs, similar to the following.

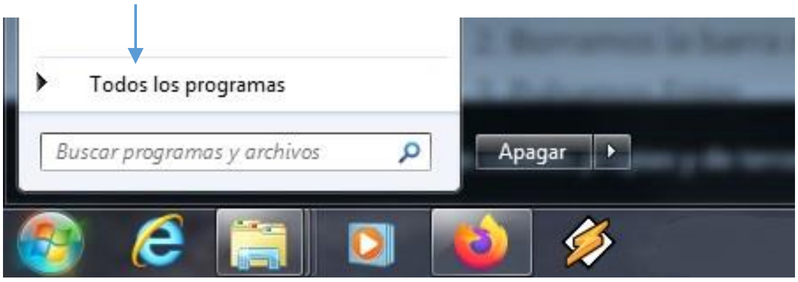
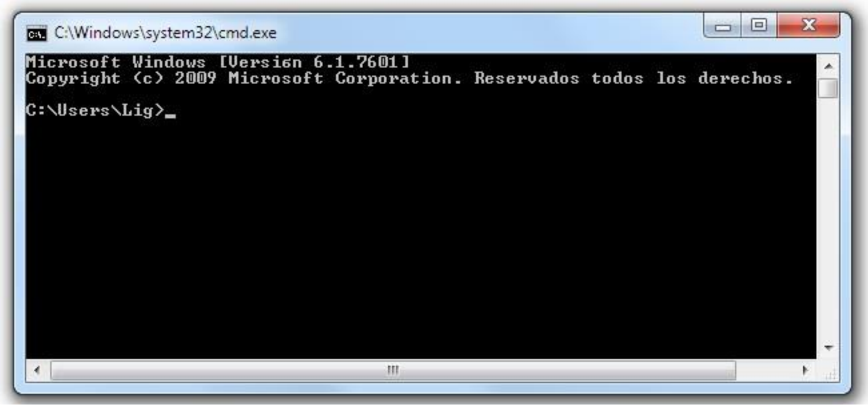


Fig. A2 Windows Program Search Screen.

In the box that says "Search programs and files" (Windows 7) or "*Type here to search*" (Windows 10), type "cmd" as well. This action or the previous one will bring up the Windows command prompt (CMD), similar to the following (W7).



```
Microsoft Windows [Versión 6.1.7601]
Copyright (c) 2009 Microsoft Corporation. Reservados todos los derechos.

C:\Users\Lig>_
```

Fig. A3 Windows 7 Command Prompt (CMD) Screen.

The same applies to versions: Windows 10 (W10) or Windows 11 (W11).

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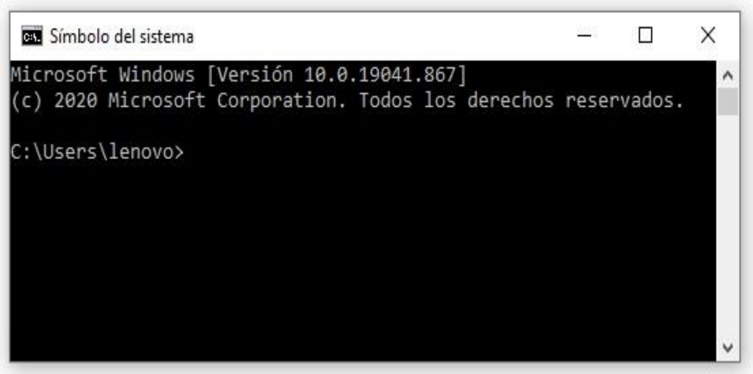
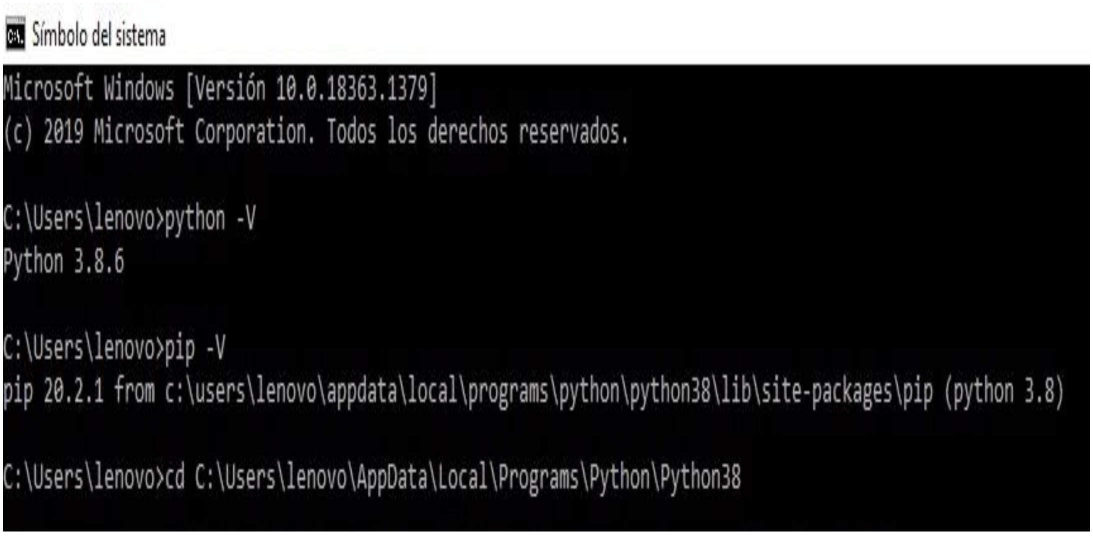


```
Microsoft Windows [Versión 10.0.19041.867]
(c) 2020 Microsoft Corporation. Todos los derechos reservados.

C:\Users\lenovo>
```

Fig. A4 Command Prompt (CMD) Screen in Windows 10.

Once on this screen, to verify that both Python and its package manager "pip" have been installed correctly, type the following commands: Python -V, and to check "pip," type: pip -V. This is shown in the following figure.



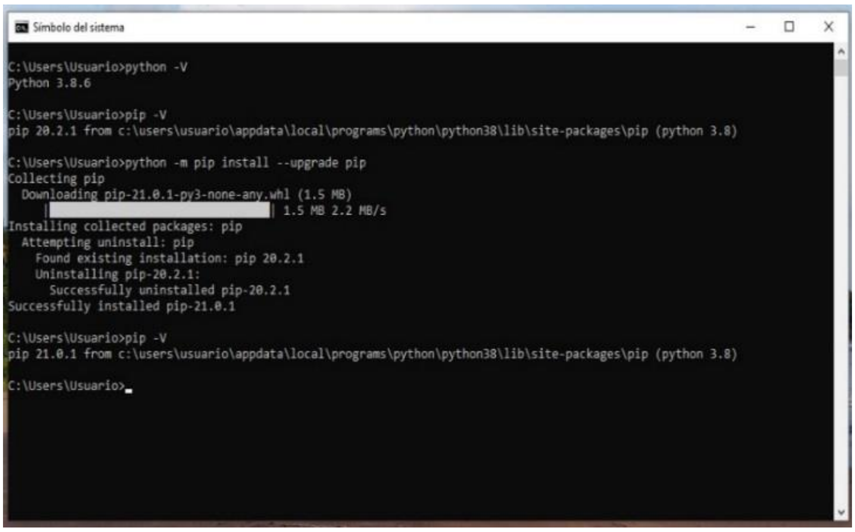
```
Microsoft Windows [Versión 10.0.18363.1379]
(c) 2019 Microsoft Corporation. Todos los derechos reservados.

C:\Users\lenovo>python -V
Python 3.8.6

C:\Users\lenovo>pip -V
pip 20.2.1 from c:\users\lenovo\appdata\local\programs\python\python38\lib\site-packages\pip (python 3.8)

C:\Users\lenovo>cd C:\Users\lenovo\AppData\Local\Programs\Python\Python38
```

Fig. A5 CMD Screen, indicating Python and pip versions in Windows.

The output of typing "-V" in Python indicates invoking the installed version. In this case, it can be seen that it is "3.8.6" (*The library set is compatible with 3.10.10 version*). This has been possible from any location in the system because the Python script has been installed, remember, in the "**path**" or route found in the system's environment variables. Also, after typing "pip -V", it can be seen that the Pip version is "*20.2.1*." At this point, it is recommended to update this version since, by default, "Pip" is installed along with "Python", but it does not install the latest or most up-to-date version. To do this, in the CMD window or console, type the following command (*Windows/Linux*): On Windows, type "python," and on Linux, type "python3".

Windows: > python –m pip install –upgrade pip | Linux: $ sudo python3 –m pip install –upgrade pip

This indicates that "Pip" will be updated to its most recent version (*On Linux, as a "superuser," i.e., with "sudo" at the beginning*). It is shown in the following screen.



```
C:\Users\Usuario>python -V
Python 3.8.6

C:\Users\Usuario>pip -V
pip 20.2.1 from c:\users\usuario\appdata\local\programs\python\python38\lib\site-packages\pip (python 3.8)

C:\Users\Usuario>python -m pip install --upgrade pip
Collecting pip
  Downloading pip-21.0.1-py3-none-any.whl (1.5 MB)
     |████████████████████████████████| 1.5 MB 2.2 MB/s
Installing collected packages: pip
  Attempting uninstall: pip
    Found existing installation: pip 20.2.1
    Uninstalling pip-20.2.1:
      Successfully uninstalled pip-20.2.1
Successfully installed pip-21.0.1

C:\Users\Usuario>pip -V
pip 21.0.1 from c:\users\usuario\appdata\local\programs\python\python38\lib\site-packages\pip (python 3.8)

C:\Users\Usuario>_
```

Fig. A6 Screen showing the update and verification of the new version of pip in Windows.

As can be seen, when typing again (**pip -V**), once Pip is updated, the version is 21.0.1. With this, Python and Pip are already installed and updated. Pip, as mentioned, is very important because with this manager, all the necessary libraries and packages are installed so that Python applications can be executed correctly and without errors. To use the system, you must proceed to install the necessary packages or libraries through Pip.

Next, we will proceed to explain how, in a simple and completely automatic way, the most commonly used and general libraries that Python needs will be installed on the system. Libraries such as, for example, "*obspy*," which is the open-source library or software based on Python for processing seismological data. Also, "***matplotlib***," which is a library for generating graphics from data contained in lists or arrays in Python and its mathematical extension "***NumPy***," among others, which the system needs for its execution (*See Annex B*).

A1.4 Automatic Installation of Libraries on Windows and Linux from PIP.

The advantage of having already installed and updated Pip in Windows is that you can install all the libraries that Python needs to run the system.

Additionally, in the "***Document***" folder, the "***Readme.txt***" file contains instructions for this installation. So the user only needs to follow the instructions, and the necessary packages will be installed on the computer (PC) automatically by Pip, both on Windows and Linux. The required libraries are in the file called "***Initial_requirements.txt***", included in the "***Document***" folder of the downloaded installation files and in **Annex B**.

In a Windows Command Prompt (**Cmd**) window, actions are taken for each of the commands indicated in the file, following the instructions. The installation should not present problems on Windows and Linux systems. If any library encounters an error during installation (*shown in red in CMD*), you should consult the documentation for that library or check if the correct or recommended version of Python is being installed (*version 3.8.6 and/or 3.10.10*). The installation on Linux systems (*See README.txt*) is similar and simpler. Copy the main folder to the desktop, the personal folder, etc. From that location, open a command prompt, and simply type:

"***$ python3 Menu.py***" to start the system.

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APPENDIX B:

INSTALL PYTHON LIBRARIES FOR THE CORRECT FUNCTIONING OF THE SYSTEM.

1.- **PIP**: The **Pip** (*Preferred Installer Program*) is the package or package management manager used to install and manage software packages written in Python. When installing Python, Pip is installed by default. To check the version of Python or PIP, type the following in a console or CMD:

python - V / pip – And to see the list of installed pip packages: -> pip list

Usually, you need to update the version of pip with which Python is installed. For this, type the following command in the command prompt (CMD). In Linux and Mac systems, "**sudo**" is placed at the beginning to indicate super-user permissions.

```
Python –m pip install - - upgrade pip   / (LINUX) -> sudo python –m pip install - - upgrade pip
```

Once downloaded and installed, you can check the version again with the first command, and you will see that the version has changed and been updated. Now that pip is updated, we will proceed to install the necessary packages for Python to work correctly with the applications.

2.- .- **PyQt Installation**: This is a Python binding for the Qt library written in the C++ language. It is used for creating and using graphical user interfaces (GUI) in Python. Type the following in the command prompt (CMD).

```
pip install PyQt5     / (LINUX & Mac) -> sudo python install PyQt5
```

3.- **Matplotlib library Installation**. Matplotlib is the library that allows the creation and visualization of graphics. Type the following:

```
pip install matplotlib   / (LINUX & Mac) -> sudo python install matplotlib
```

4.- Install the **Obspy** library. This library is for handling seismic signals. Type the following:

```
pip install obspy     / (LINUX & Mac) -> sudo python install obspy
```

5.- Install **Thinter**: Thinter is a graphical user interface (GUI). Type the following:

```
pip install tk     / (LINUX & Mac) -> sudo python install tk
```

6.- Install **quantecon**: This library is used for spectrum estimation, Periodogram, Fourier transform. Type the following:

```
pip install - - upgrade quantecon   / (LINUX & Mac) -> sudo python install - - upgrade quantecon
```

7.- Update a library for **matplotlib**. To avoid problems with graphics, install the following:

```
pip install msvc-runtime   / (LINUX & Mac) -> sudo python install msvc-runtime
```

8.- Install **easygui** for the graphical interface:

```
pip install easygui    / (LINUX & Mac) -> sudo python install easygui
```

9 Install **PyWavelets** for CWT handling.

```
pip install PyWavelets   / (LINUX & Mac) -> sudo python install PyWavelets
```

10.- Install **plotly** for handling and assisting with graphics along with Matplotlib.

```
pip install plotly   / (LINUX & Mac) -> sudo python install plotly
```

11.- Install "**pyaudio**", for audio management. Python bindings for PortAudio v19, the cross-platform audio I/O library

```
python -m pip install pyaudio / (LINUX & Mac) -> sudo apt-get install python3-pyaudio
```

Finally, type "pip list" to see the installed libraries. Optionally, you can create a file called "***requirements.txt***" that will contain all the libraries that the PC will use. The "***requirements.txt***" file must be in the current directory. The instruction to do this is as follows:

```
pip freeze > requirements.txt
```