Q-Str2-Models 1.0

USER GUIDE

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“Q-Str2-Models” Windows Installation

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1. Q-Str2-Models information:

Q-Str2-Models (Strain-Stress App) is a complementary software or plugin for QGIS developed under the "PyQGIS" API of the Python language, it is published under the free software license GPL (General Public License) and multiplatform, it allows us to obtain in a semi-automated way the values resulting from the maximum geodetic deformation, shear deformation, rotation and dilatation in geodynamically active areas, from the horizontal velocities (East, North) of a series of GNSS stations (points), also allows us to create Stress-Strain tensors from of a regular grid.

2. Hardware & Software Requirements:

The minimum hardware required is a computer with a dual core processor, 2GB Memory RAM, 3GB of free hard disk space, software required is QGIS 3.22 or later LTR version, the main programming language used for development was Python3 With PyQGIS API, program size is 350KB approximately and source code from: https://lagc.uca.es/servicios-homologados/software/ (official website of the Astronomy, Geodesy and Cartography Laboratory) & https://github.com/lagc-uca/Q-Str2-Models (Official GitHub Repository of the LAGC--UCA). The operating system it “Q-Str2-Models” was tested is “Ubuntu 22.04 LTS” (64-bits).

3. Installation Instructions:

Initially, the Python3 libraries required to run the application are "Basemap Toolkits, Numpy and Scipy". The commands to execute from the Linux console for its installation are:

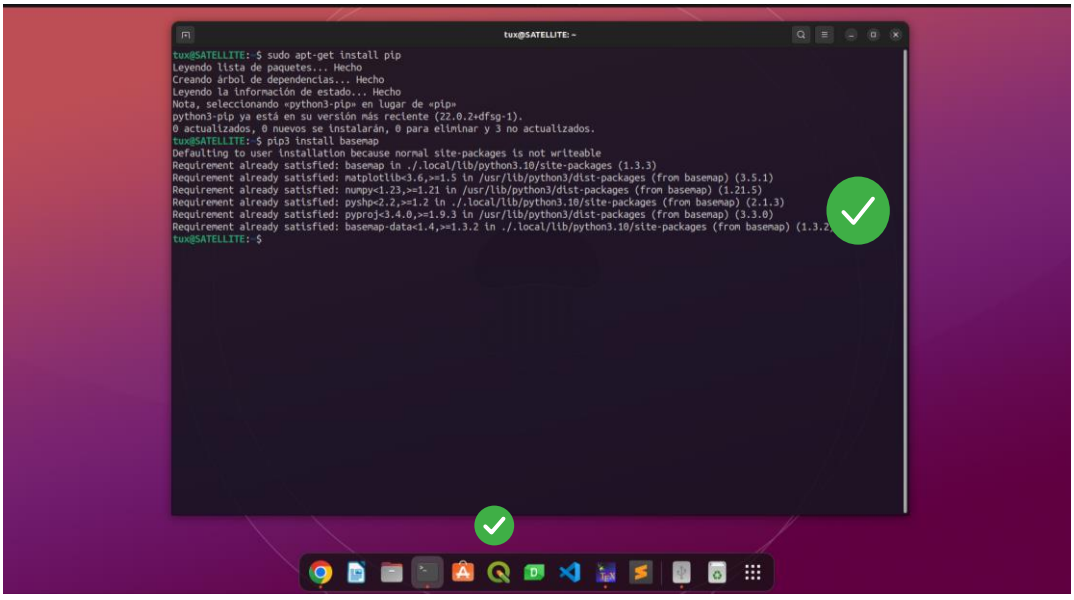
sudo apt-get install pip

pip3 install basemap

Optional libraries:

sudo apt-get install python3-numpy python3-scipy

sudo apt install python3-mpltoolkits.basemap



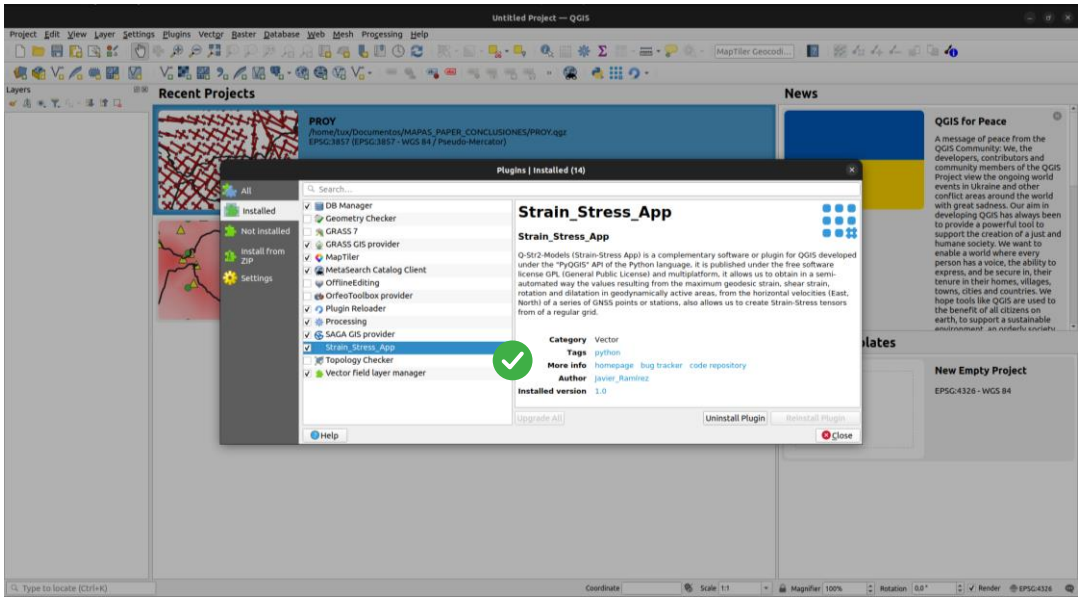
- Later we download and install the corresponding version of QGIS 3 LTR (https://www.qgis.org/es/site/forusers/alldownloads.html#debian-ubuntu), the minimum required version of QGIS is 3.16 LTR.

3.1 Download the application:

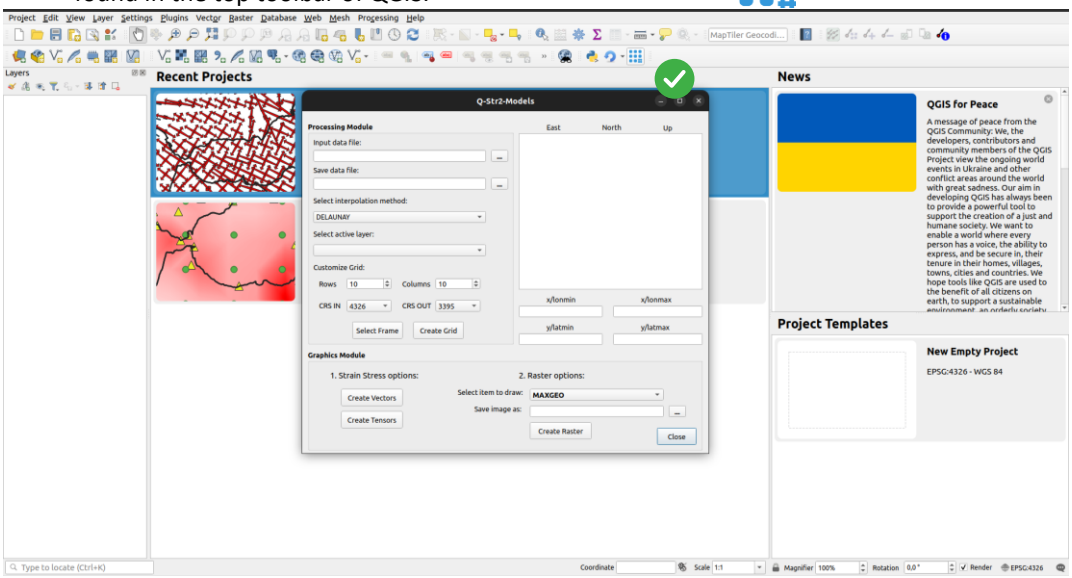
- The next step is to download the Strain_Stress_App.zip file from the followings webpages: https://lagc.uca.es/servicios-homologados/software/

https://github.com/lagc-uca/Q-Str2-Models (mirror 2)

- Next we will install the **Strain_Stress_App.zip** file in QGIS: Plugins → Manage and Install plugins → Install from ZIP → Install Plugin. Do not unzipped the **Strain_Stress_App.zip** file as QGIS required an .zip file to install a new application. Then Verify the app is well installed: Plugins → Manage and Install plugins → Installed → Strain_Stress_App "checked". If needed, please restart QGIS software.

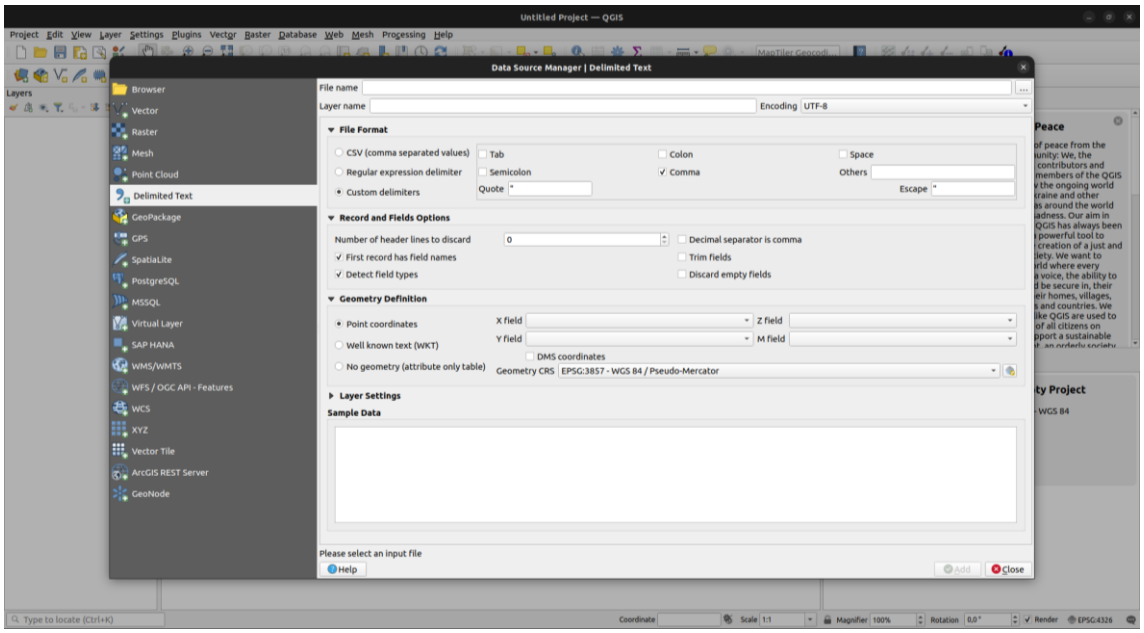


Later we will run the application by selecting the new icon (blue grid) found in the top toolbar of QGIS.



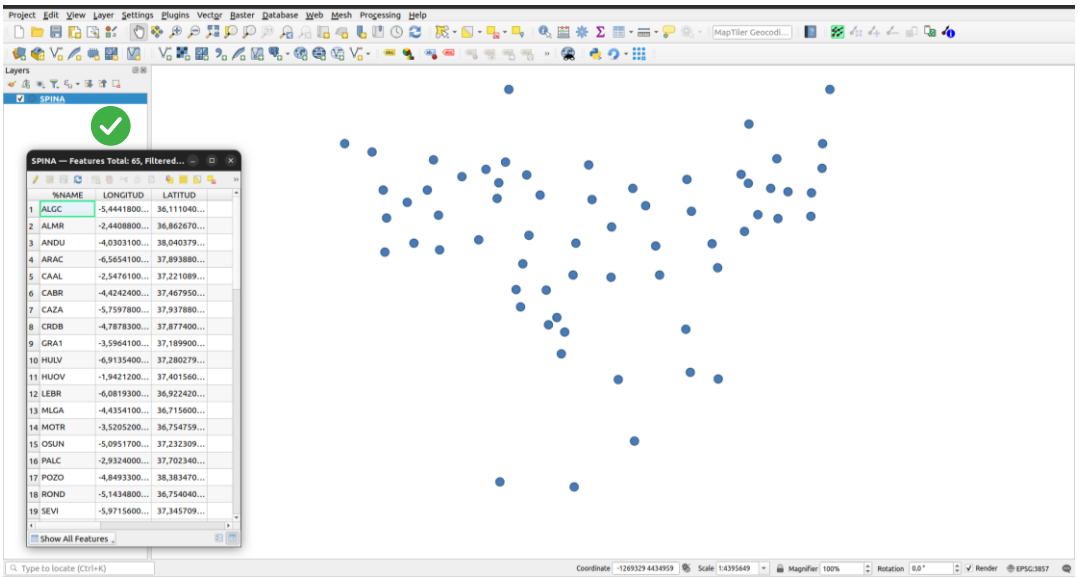
4. Input & Output Data

For the Q-Str2-Models (Strain_Stress_App) application to work correctly, we must initially have a QGIS layer (shapefile) with the points to analyze. (Previously to create a shapefile from a text file we can use the QGIS tool: Layer → Add Layer → Add Delimited Text Layer).

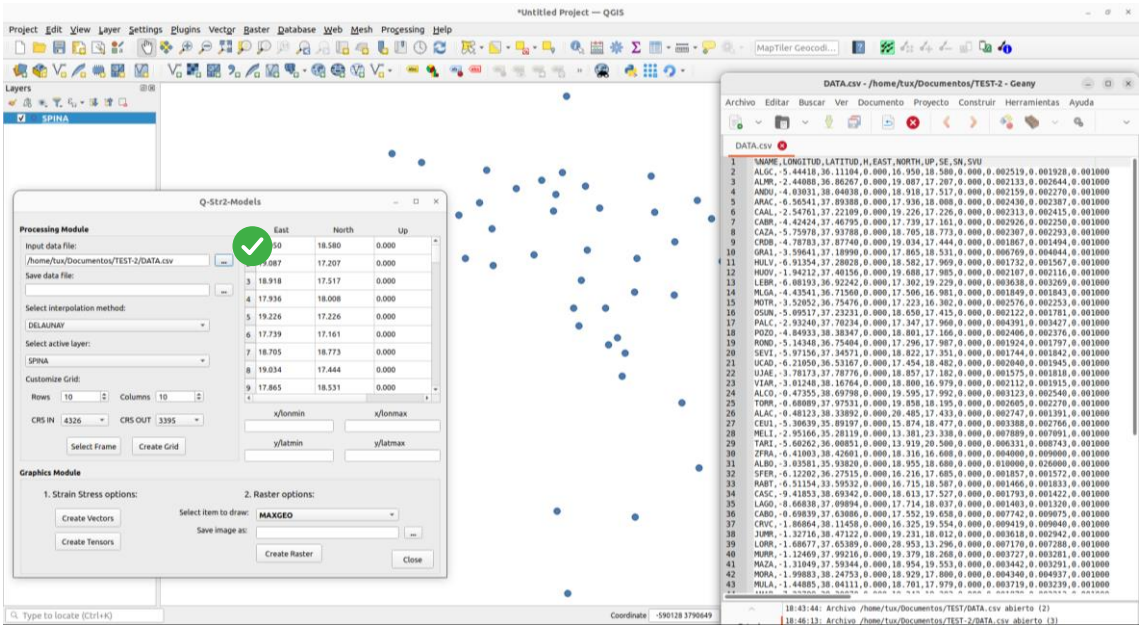


- Once the shapefile is created, we add it to the Qgis layers box, located on the side of Qgis (main environment). This file only contains the points to be analyzed (coordinates in latitude and longitude). Initially in this example, the input objects contain a coordinate reference system (CRS) of type "EPSG:3857

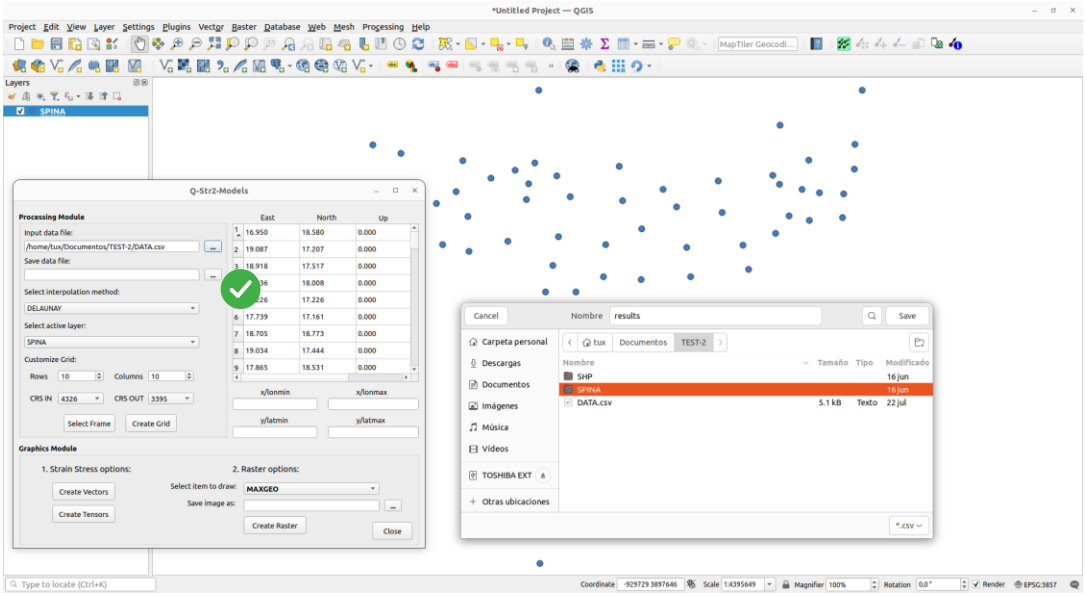
- WGS 84 / Pseudo-Mercator". An optimal CRS should be used for the different possible scenarios. As we mentioned in the article associated with this application, for the testing of this software we used 65 GNSS stations from the SPINA region (South of the Iberian Peninsula and North Africa).



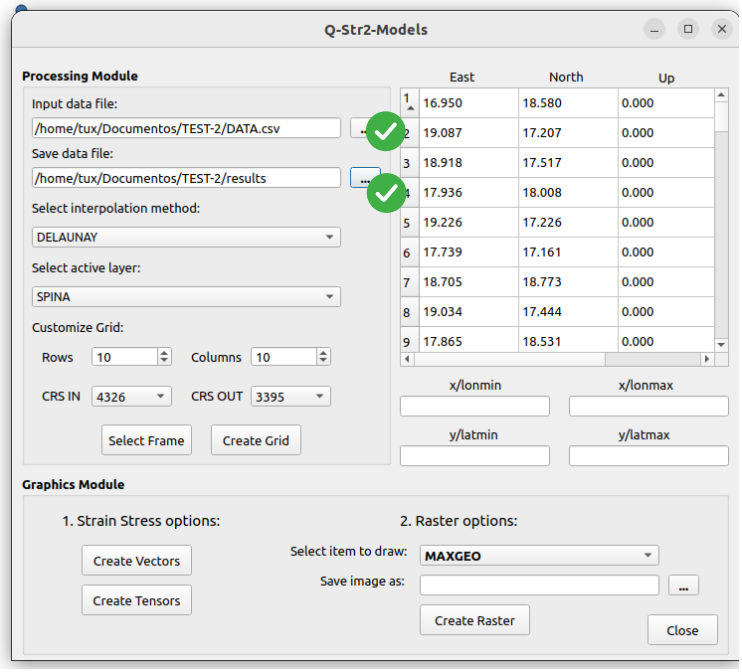
- The second required input file is a CSV or simple text file containing the same coordinates of the stations to be analyzed with the horizontal velocities (East, North) of the same points, these velocities are essential to know the objective parameters of the developed software (maximum geodetic deformation, shear deformation, dilatation, rotation, and Strain-Stress tensors parameters). This CSV file is added by selecting the "Input Data File" option located at the beginning of the Q-Str2-Models processing module.



- Later we will select the "Save Data File" option, which will open a destination folder selection window on our local disk, where the file (CSV) with the results will be saved (maximum geodetic deformation, shear deformation, dilatation, rotation, and Strain-Stress tensors parameters), remember to name this file.

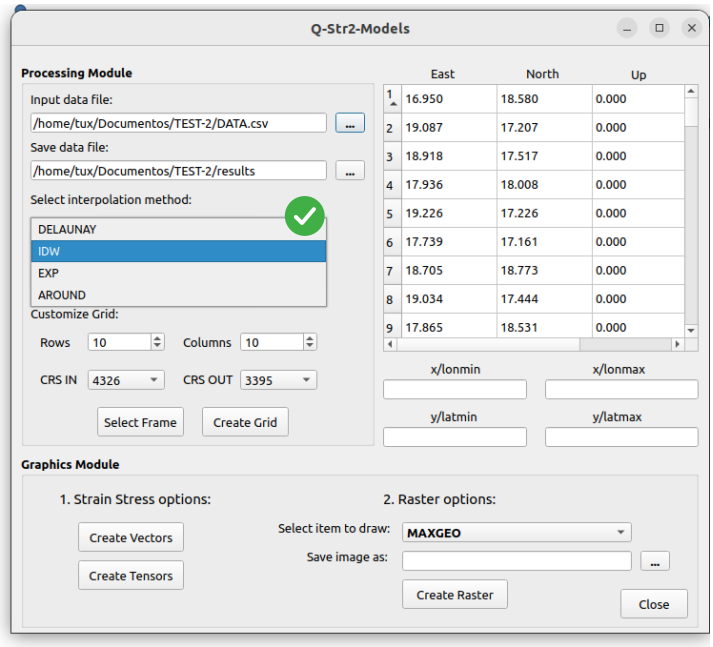


- In this step, we already have the data entry and output path required to apply the following application options. On the right side of the application, we can see a display box with the content (horizontal velocities) of the data file (CSV) introduced initially.

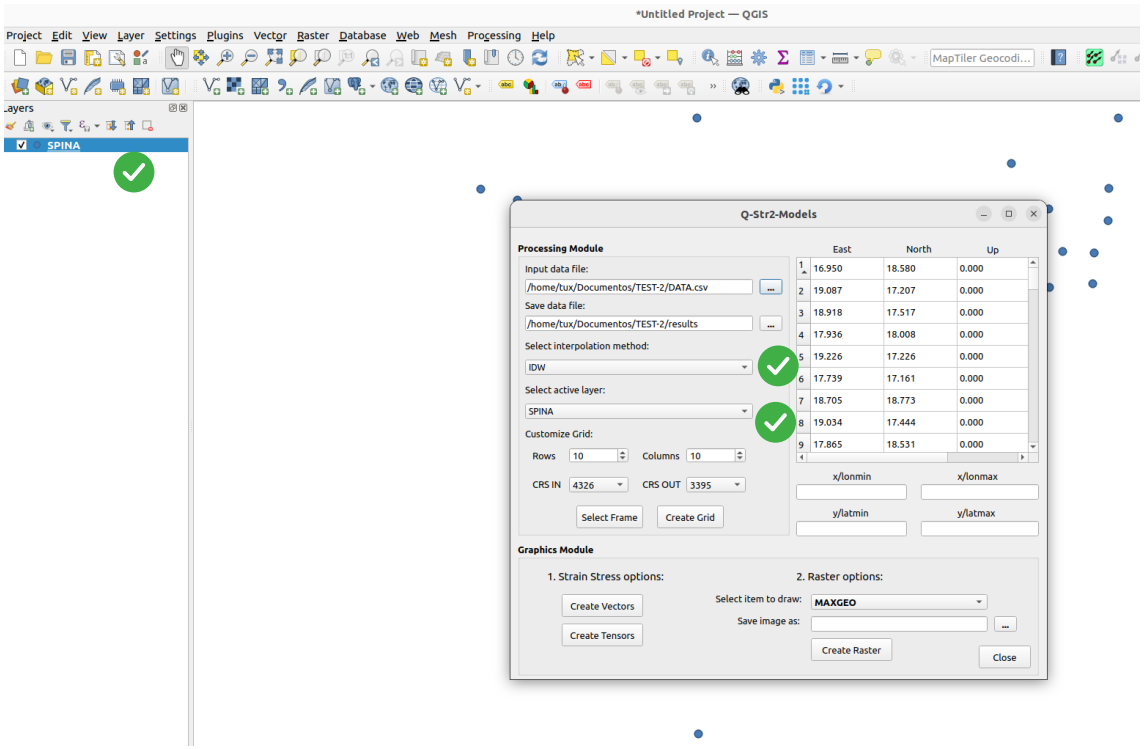


5. Selection Interpolation Method:

As we have defined in the associated article, to obtain the results we must first apply an interpolation method to the data under study, this application offers us the following: IDW, Delaunay, Exponential and Around. For this example, we will use the IDW method since it is the most optimal in our study scenario (SPINA Region). The selection of the most optimal method often depends on the number of GNSS stations used and the quality of their data.

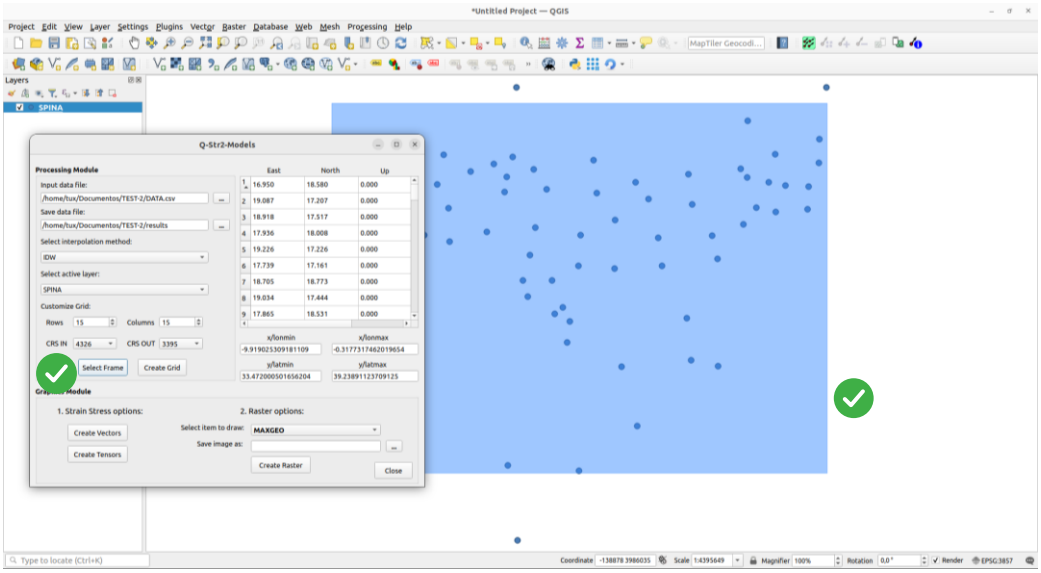


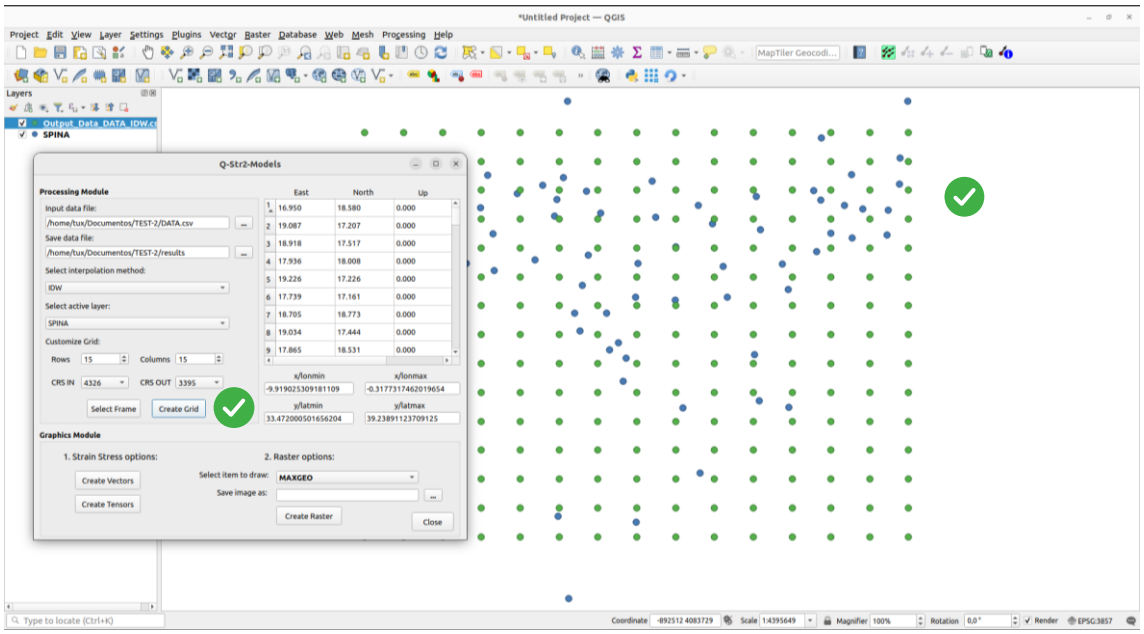
- We will also select the active layer or QGIS object to which we will apply the selected interpolation method. We added this active layer to QGIS in the first few steps.



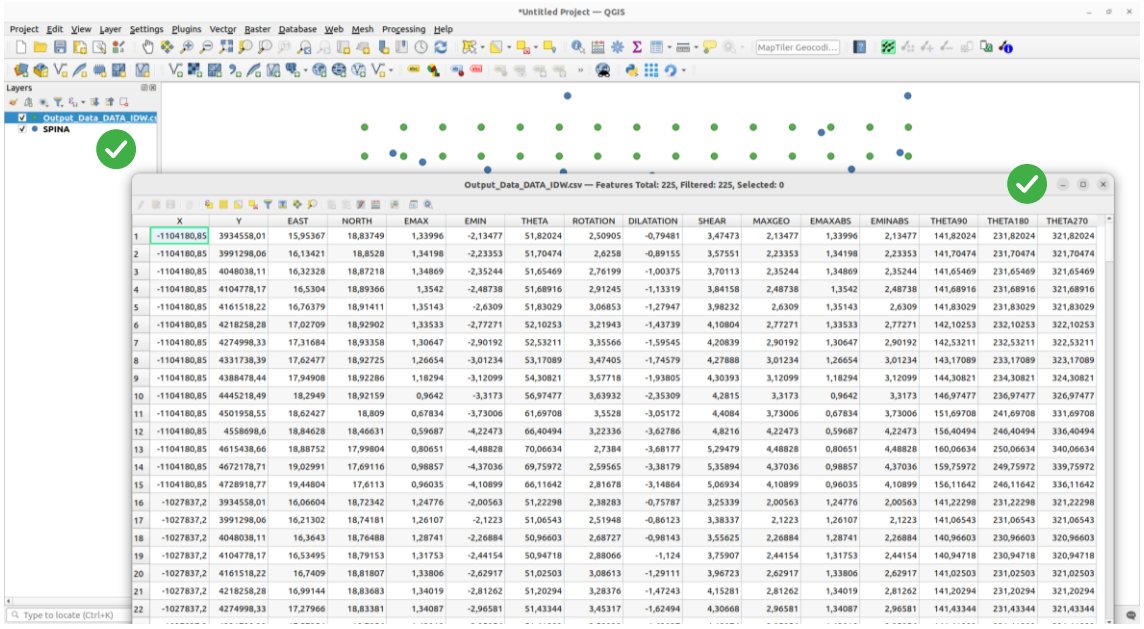
6. Select Frame & Create Grid:

Continuing with the options that Q-Str2-Models provides us, we will find the "Customize Grid" section in which we will indicate the number of rows and columns required for the creation of a temporary grid used by the interpolation method selected, and the CRS to use. The "Select Frame" button allows us (by clicking on the points and dragging the mouse) to create a study area where the custom grid will be located. With the "Create Grid" button, we execute the options described above. Remember that the results will be saved in the destination folder (on the local disk) previously selected.





- Once the grid (15 x 15 in this case) has been created in our area of interest and the final results have been generated (Output_Data_???.csv), we will import it into the QGIS layer box to use the options of the next module (Graphics Module) of the application. Below we show the generated results.

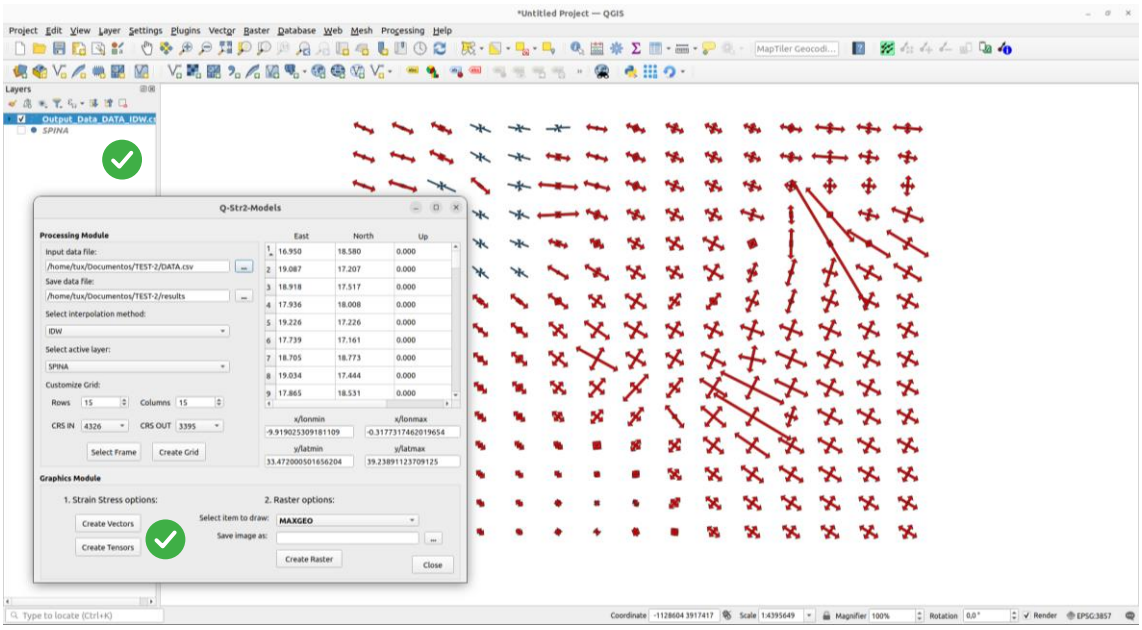


	X	Y	EAST	NORTH	EMAX	EMIN	THETA	ROTATION	DILATATION	SHEAR	MAXGEO	EMAXABS	EMINABS	THETA90	THETA180	THETA270
1	-1104180,85	3934558,01	15,95367	18,83749	1,33996	-2,13477	51,82024	2,50905	-0,79481	3,47473	2,13477	1,33996	2,13477	141,82024	231,82024	321,82024
2	-1104180,85	3991298,06	16,13421	18,8528	1,34198	-2,23353	51,70474	2,6258	-0,89155	3,57551	2,23353	1,34198	2,23353	141,70474	231,70474	321,70474
3	-1104180,85	4048038,11	16,32328	18,87218	1,34869	-2,35244	51,65469	2,76199	-1,00375	3,70113	2,35244	1,34869	2,35244	141,65469	231,65469	321,65469
4	-1104180,85	4104778,17	16,5304	18,89366	1,3542	-2,48738	51,68916	2,91245	-1,13319	3,84158	2,48738	1,3542	2,48738	141,68916	231,68916	321,68916
5	-1104180,85	4161518,22	16,76379	18,91411	1,35143	-2,6309	51,83029	3,06853	-1,27947	3,98232	2,6309	1,35143	2,6309	141,83029	231,83029	321,83029
6	-1104180,85	4218258,28	17,02709	18,92902	1,33533	-2,77271	52,10253	3,21943	-1,43739	4,10804	2,77271	1,33533	2,77271	142,10253	232,10253	322,10253
7	-1104180,85	4274998,33	17,31684	18,93358	1,30647	-2,90192	52,53211	3,35566	-1,59545	4,20839	2,90192	1,30647	2,90192	142,53211	232,53211	322,53211
8	-1104180,85	4331738,39	17,62477	18,92725	1,26654	-3,01234	53,17089	3,47405	-1,74579	4,27888	3,01234	1,26654	3,01234	143,17089	233,17089	323,17089
9	-1104180,85	4388478,44	17,94908	18,92286	1,18294	-3,12099	54,30821	3,57718	-1,93805	4,30393	3,12099	1,18294	3,12099	144,30821	234,30821	324,30821
10	-1104180,85	4445218,49	18,2949	18,92159	0,9642	-3,3173	56,97477	3,63932	-2,35309	4,2815	3,3173	0,9642	3,3173	146,97477	236,97477	326,97477
11	-1104180,85	4501958,55	18,62427	18,809	0,67834	-3,73006	61,69708	3,5528	-3,05172	4,4084	3,73006	0,67834	3,73006	151,69708	241,69708	331,69708
12	-1104180,85	4558698,6	18,84628	18,46631	0,59687	-4,22473	66,40494	3,22336	-3,62786	4,8216	4,22473	0,59687	4,22473	156,40494	246,40494	336,40494
13	-1104180,85	4615438,66	18,88752	17,99804	0,80651	-4,48828	70,06634	2,7384	-3,68177	5,29479	4,48828	0,80651	4,48828	160,06634	250,06634	340,06634
14	-1104180,85	4672178,71	19,02991	17,69116	0,98857	-4,37036	69,75972	2,59565	-3,38179	5,35894	4,37036	0,98857	4,37036	159,75972	249,75972	339,75972
15	-1104180,85	4728918,77	19,44804	17,6113	0,96035	-4,10899	66,11642	2,81678	-3,14864	5,06934	4,10899	0,96035	4,10899	156,11642	246,11642	336,11642
16	-1027837,2	3934558,01	16,06604	18,72342	1,24776	-2,00563	51,22298	2,38283	-0,75787	3,25339	2,00563	1,24776	2,00563	141,22298	231,22298	321,22298
17	-1027837,2	3991298,06	16,21302	18,74181	1,26107	-2,1223	51,06543	2,51948	-0,86123	3,38337	2,1223	1,26107	2,1223	141,06543	231,06543	321,06543
18	-1027837,2	4048038,11	16,3643	18,76488	1,28741	-2,26884	50,96603	2,68727	-0,98143	3,55625	2,26884	1,28741	2,26884	140,96603	230,96603	320,96603
19	-1027837,2	4104778,17	16,53495	18,79153	1,31753	-2,44154	50,94718	2,88066	-1,124	3,75907	2,44154	1,31753	2,44154	140,94718	230,94718	320,94718
20	-1027837,2	4161518,22	16,7409	18,81807	1,33806	-2,62917	51,02503	3,08613	-1,29111	3,96723	2,62917	1,33806	2,62917	141,02503	231,02503	321,02503
21	-1027837,2	4218258,28	16,99144	18,83683	1,34019	-2,81262	51,20294	3,28376	-1,47243	4,15281	2,81262	1,34019	2,81262	141,20294	231,20294	321,20294
22	-1027837,2	4274998,33	17,27966	18,83381	1,34087	-2,96581	51,43344	3,45317	-1,62494	4,30668	2,96581	1,34087	2,96581	141,43344	231,43344	321,43344

7. Create Vectors & Stress-Strain Tensors options:

The graphic module is divided into two sub-modules: Stress-Strain options and Raster options, in the first we can graph horizontal displacement vectors of the points by clicking the "Create vectors" button as well as the Stress-Strain tensors by clicking the button "Create tensors" in the active layer that we want to analyze.

Remember that this active layer must contain the horizontal velocities to create the corresponding vectors and Stress-Strain tensors. In this case, we will create the vectors and/or Stress-Strain tensors, on the active layer (results mentioned in the previous step) of the layers box of the main QGIS environment. Further customizations and creation of legends or scale bars will be done with the QGIS "Create Print Layout" tool.

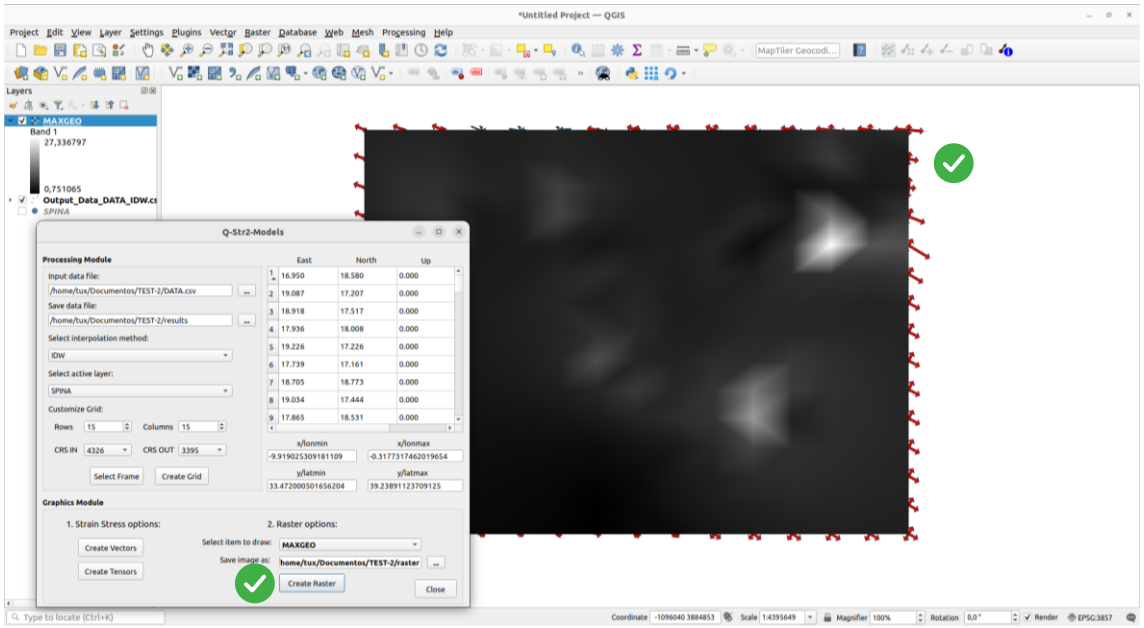


8. Create Rasters options:

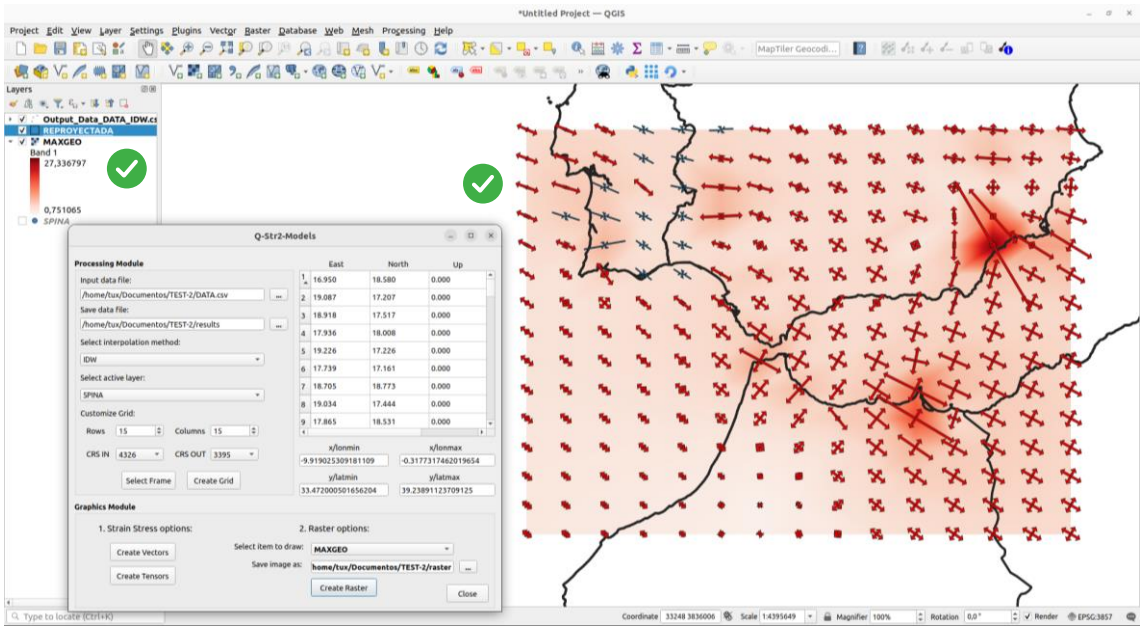
In the second graphic submodule (Raster Options) we initially have a "Select element to draw" combo box that allows us to select one of the four available options (Maximum Geodesic Deformation "MAXGEO", Rotation, Dilation and Shear Deformation "SHEAR"), later we have a button that allows us to save our raster image (.tiff format) in a folder on the local disk.

When executing the "Create Raster" button, the QGIS process will start, which will last approximately 8 seconds (this depends on the performance of the hardware used, the number of points to study and the number of points assigned to the grid), then this raster will be automatically imported into the layers box of the QGIS environment.

Before doing "Create Raster" it is recommended to have only the layer with the results active (QGIS environment layers box) to avoid conflicts with the project's CRS and/or other QGIS objects.



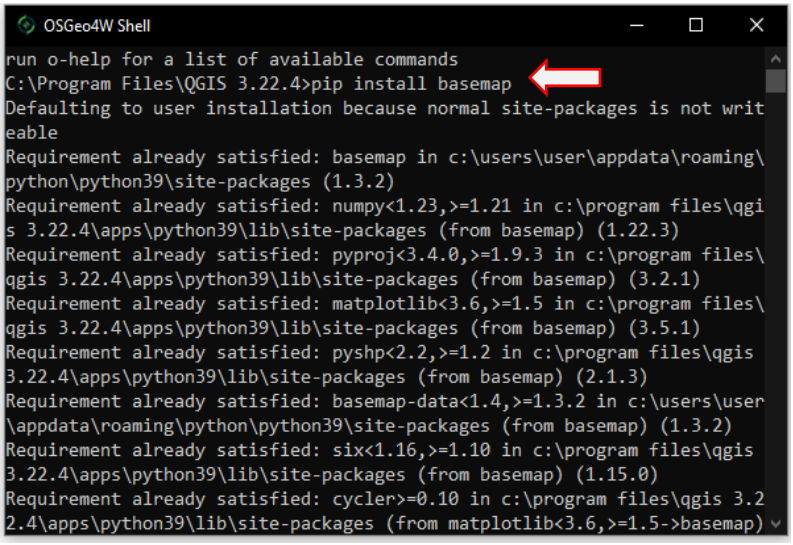
The subsequent customization of the raster images (in styles, colors, transparencies, etc.) will depend on the user's preference.



9. “Q-Str2-Models” Windows Installation

- For a correct installation of the "Q-Str2-Models" application in QGIS under the Windows platform (Windows 10 Pro 22H2 was used in this section), we must initially make sure that QGIS has the Python "basemap" library installed, for this, run the QGIS shell or terminal called; "OSGeo4W Shell", this tool will be added automatically when we install an LTR version of QGIS. We must make sure that we have the corresponding user permissions to run this application.

- When we execute the "OSGeo4W Shell" we must insert the command: ***pip install basemap*** so that the package manager can verify and/or install the indicated library *(remember to have an internet connection before carrying out this step*), at the end, this manager will show us a message with the description of the installation. You can optionally install other major python libraries (numpy, scipy, etc) or upgrade the pip package manager using the command: ***pip install --upgrade pip***



If the previous steps were executed successfully, you can continue installing the "Q-Str2-Models" plugin in section **3.1** (*Download the application “page 3”*) of this guide, otherwise, it is very likely that QGIS will show the following error when starting: