Scientific Visualization

1MD140 11617 HT2021

Project Report

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1. Introduction

The main objective of this project is to visualize earthquakes from the last 365 days in Italy. To implement this, the last 365 days earthquake dataset is downloaded from the *http://cnt.rm.ingv.it/*. This project consists of two parts: creating multiple vtk files for necessary tasks indicated in the project description and making visualization for these vtk files. The dataset contains information about the magnitude, the geographical location and the depth of each earthquake that occurred in the searched period of time. It also contains information about the time and the name of the location where the event took place.

2. Code refactoring

After downloading the earthquake dataset, some required operations are performed. Firstly, in the python file named as "ReadPoints3.py", for reading a dataset and creating vtk files, two methods are implemented. The first method is "readPoints_magnitude_scale", which is useful for collecting the earthquakes according to their magnitudes and then producing a vtk file. It takes a parameter, "magnitude_scaling", for obtaining earthquakes with a magnitude greater than or equal to the value of this parameter. Second method is "readPoints_earthquake_occurences", which is useful for loading the earthquakes according to their occurrences based on the earthquake location (by grouping them attribute called "EventLocationName") and producing a vtk file. It takes a parameter, "quake_number", for taking earthquakes greater than or equal to the value of this parameter. In this method, after grouping the earthquakes based on their locations, the average depth of the grouped earthquake is calculated and it is given as the 3rd parameter of the pre-defined function "InsertNextPoint". After that, the necessary implementations for using those methods are done in the "ExportPoints.py" python file.

- Example Commands:
    - **python ExportPoints.py –input_file=data_365days.txt –magnitude=0 –occurences=1 –output_file=earthquake_365_occurence_gte_1.vtk**
      (This command is for exporting points according to occurences of the earthquake based on their locations.)
    - **python ExportPoints.py –input_file=data_365days.txt –magnitude=4 –output_file=earthquake_with_mag_gt4.vtk**
      (This command is for exporting points according the magnitude of the earthquake greater than or equal to given value.)

For more information about code: *https://github.com/sihabbayraktar/project/tree/sub-master*.

3. Data visualization

This project used ParaView software to load data, make visualizations and produce state files. Paraview is an open-source multiple-platform application developed by Kitware Inc., Sandia

National Laboratories and Los Alamos National Laboratory **[1].** After downloading the dataset and the map, vtk and png file formats have been loaded in the software. The aim of the visualization task is to give information mainly of which earthquakes that happened over the last 365 days from 27 December 2021 (the day the data was downloaded), the magnitude of each earthquake (highlighting the magnitude of four and more), the location of the earthquakes on the map and where the earthquakes are most likely to occur. To answer these questions, we used volume rendering and display of each point data according to the coordinates (latitude, longitude and depth representing x, y and z coordinates respectively), colormap and size of spheres or circles to highlight the magnitude of earthquake, and opacity adjustment to combine data points and map on same visualization. This project also visualized the depth of each earthquake using spheres with diameters set to depth values and colormaping. Decadic (common) logarithmic scale was used to convert depth values (originally given in kilometers).

To generate volume from data points the glyph filter and Gaussian Resampling filter have been used. Glyph filter was useful to visualize points data and give 3D shape (sphere) and 2D shape (circle) on data points. Gaussian Resampling filter was useful to produce a splat value on nearby voxels. With both filters, we performed scaling of scalar values and color mapping. We used combinations of two color maps for data points and an image of location map. Jet colormap for data and Black, Blue, White colormap for map image were chosen since they provide enough contrast between colors and blue color is often used to represent sea or rivers. Other combinations include Jet and Cool to Warm colormaps, blot and linear blue colormaps, and Jet and Grayscale colomaps. Jet colormap was mostly chosen as it gives a wide range of color spectrum, which is beneficial to represent a broad range of scalar values. In order to visualize data in a more clear way, data sampling was used by selecting option 'Uniform Spatial Distribution (Bounds Based)' that is available on Glyph filter. The figures in appendix show the results of our visualization task.

Fig. 1 shows all the quakes, their locations on the map and their magnitude (size and color of the sphere). Fig. 2 and Fig. 3 displays sampled data in 2D and 3D respectively. Fig. 4 highlights earthquakes with magnitude greater than or equal to four. Locations at which quakes are most likely to occur are shown in Fig. 5 and Fig. 6, and the depth of each quake is displayed on Fig. 7.

4. Conclusion

This project tried to answer questions of which earthquakes happened in Italy during the last 365 days since 27 December 2021, what are the sizes and the location of each quake, and which locations where earthquakes are most likely to occur using data visualization techniques. It used python coding to generate and process the dataset and ParaView software to produce visualization state files and images.

APPENDIX

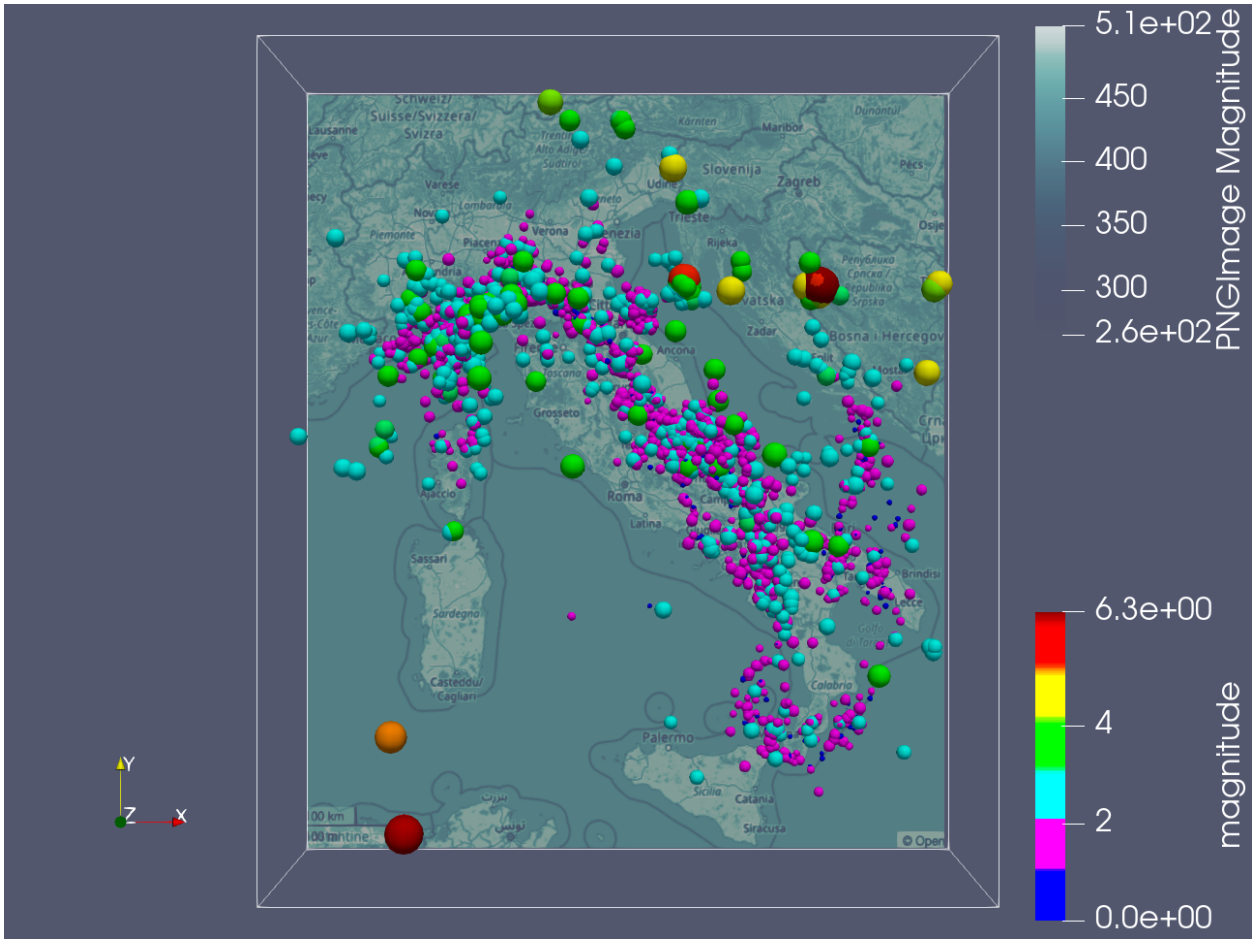

Fig.1 Earthquakes and their location on map (all points, blot and linear blue colormaps)

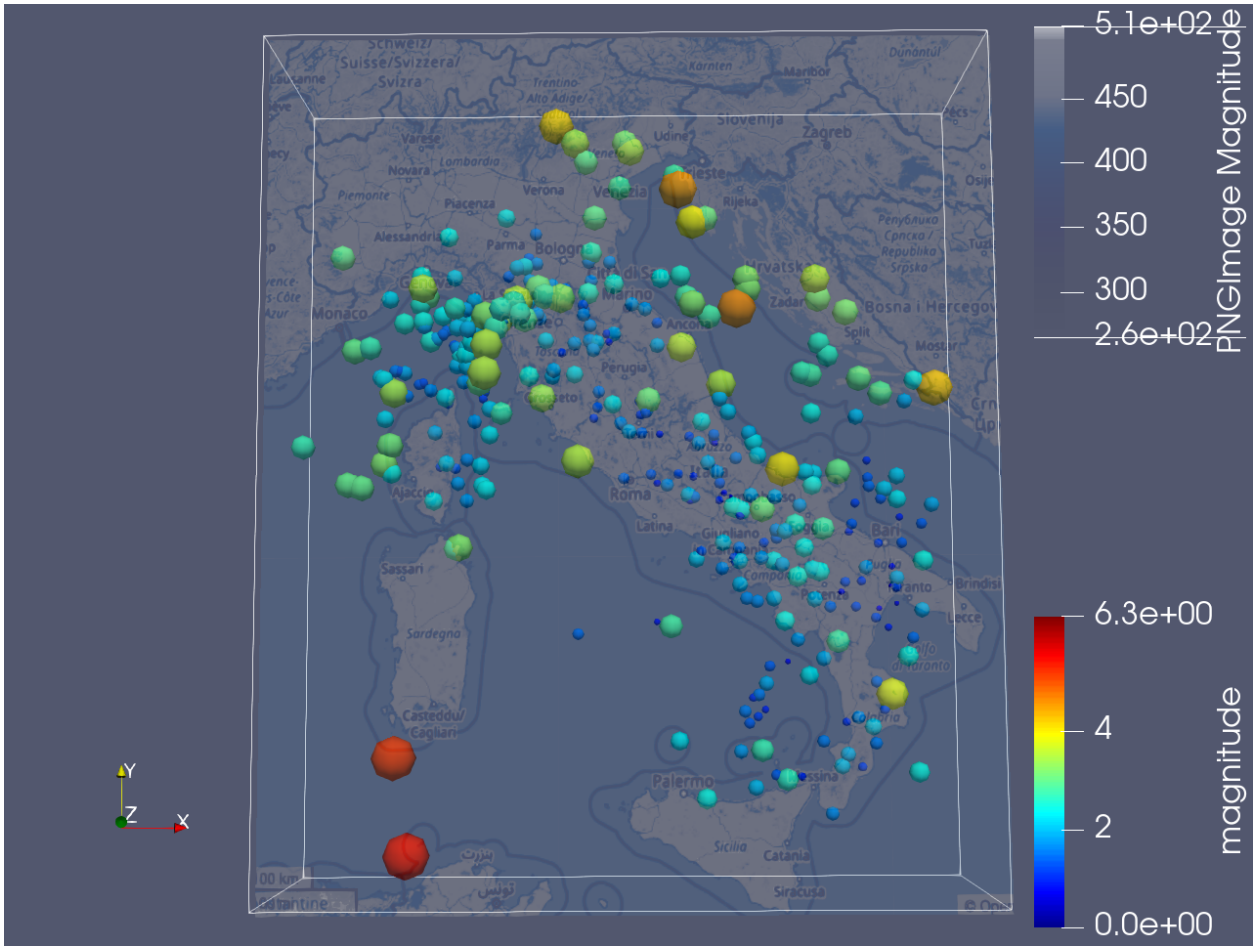

Fig. 2 Earthquakes and their location 3D - sampled with Uniform Spatial Distribution (Bounds Based)

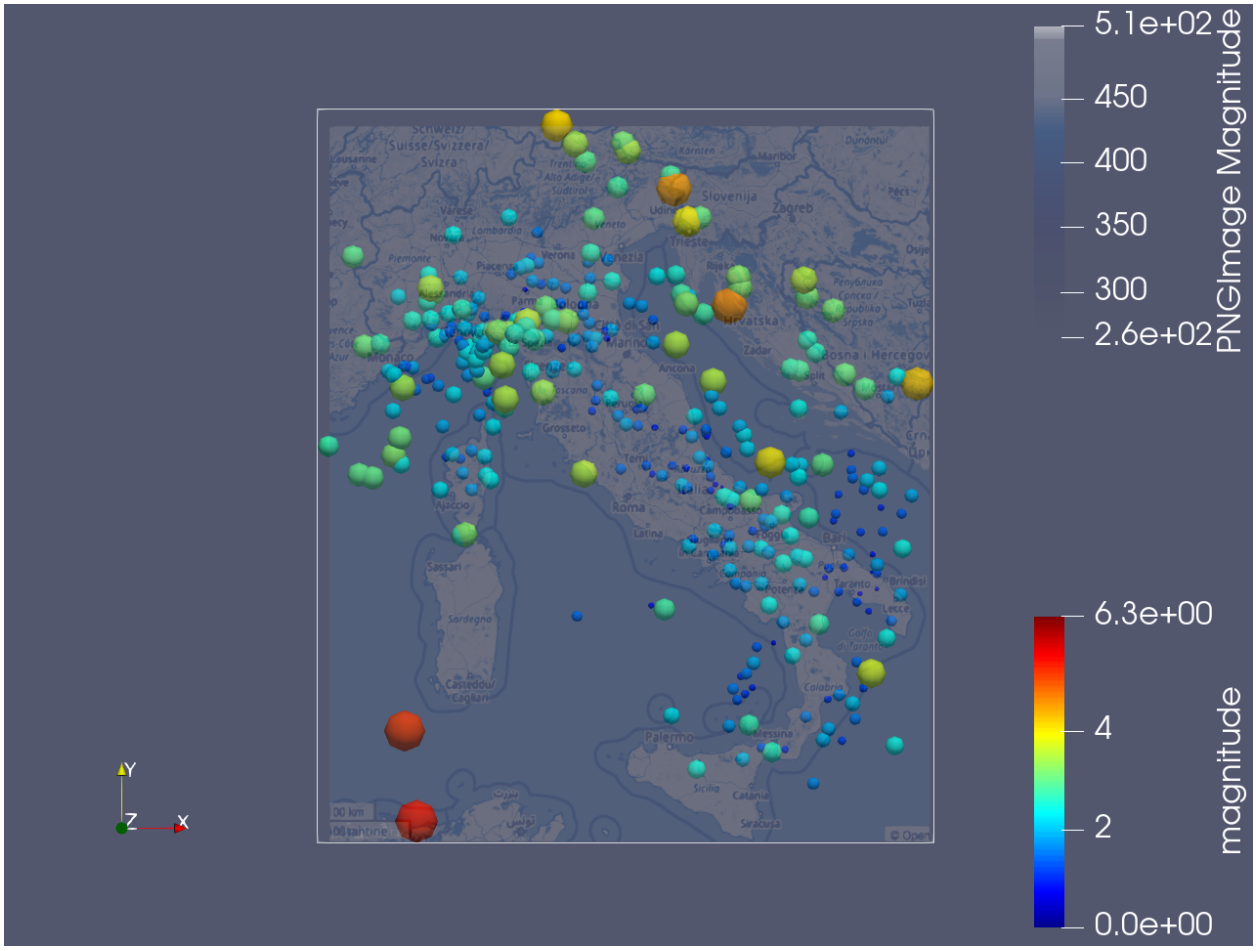

Fig. 3 Earthquakes and their location 2D - sampled with Uniform Spatial Distribution (Bounds Based)

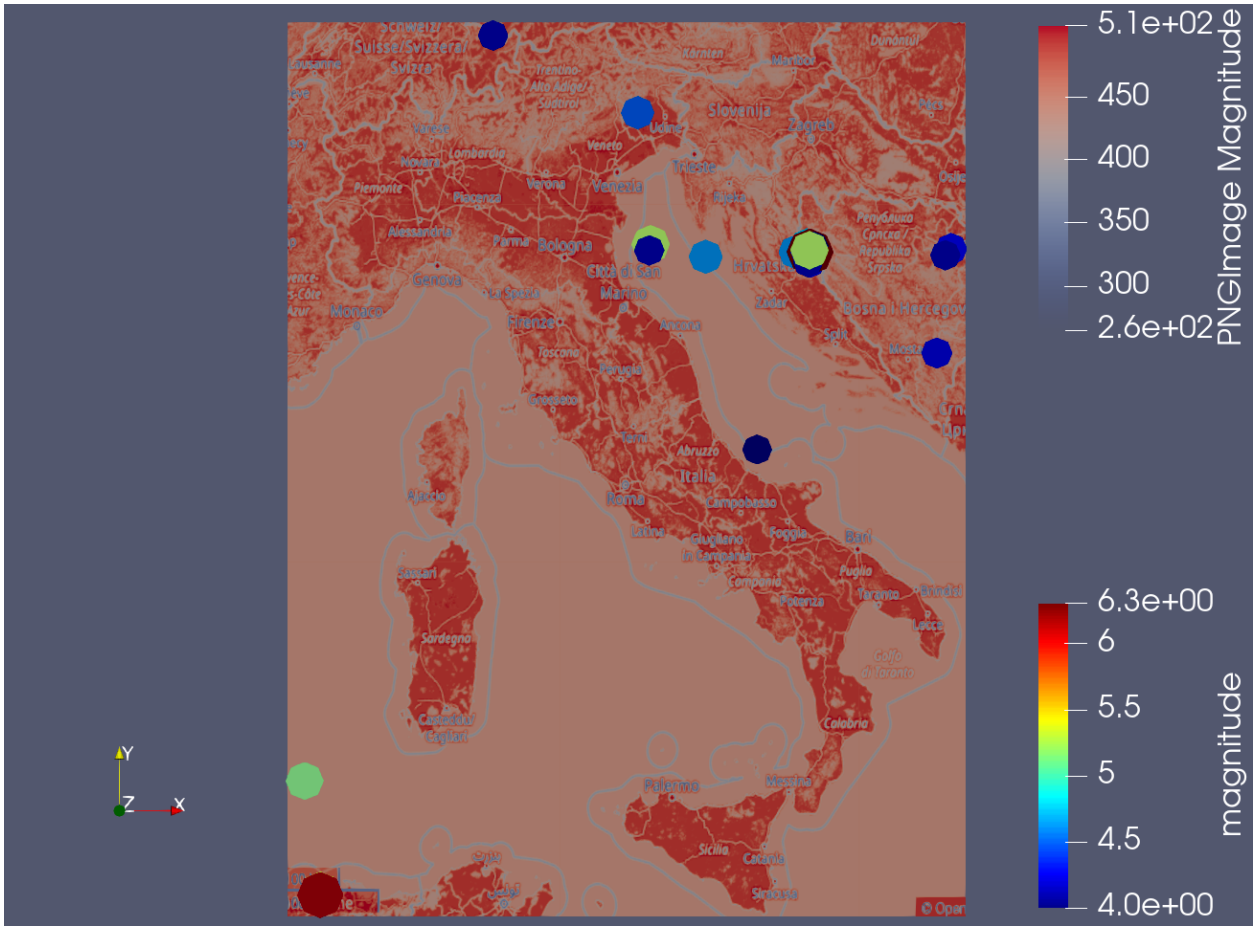

Fig. 4 Earthquakes with magnitude greater than or equal to four

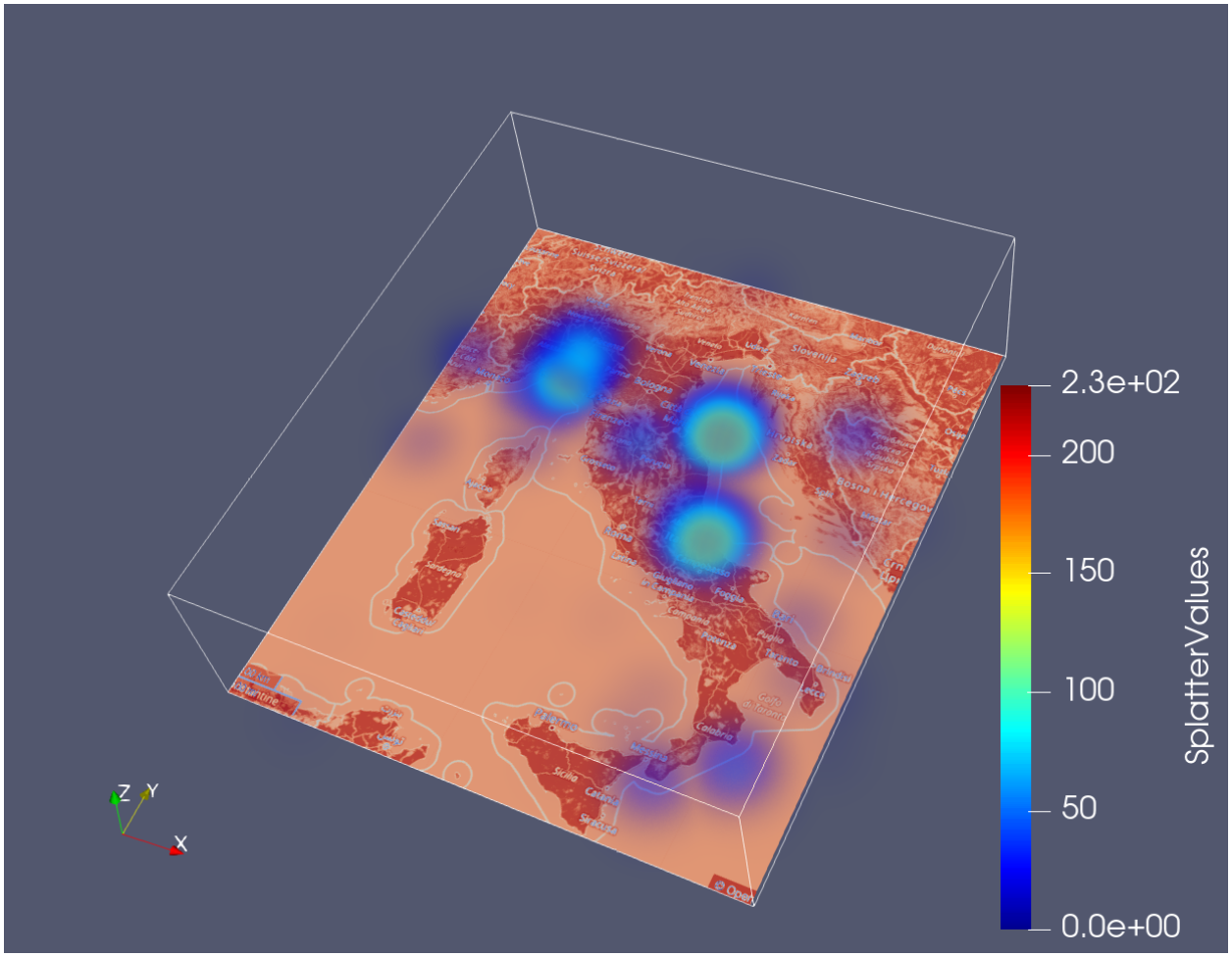

Fig. 5 Locations at which quakes are most likely to occur (with Gaussian Resampling filter)

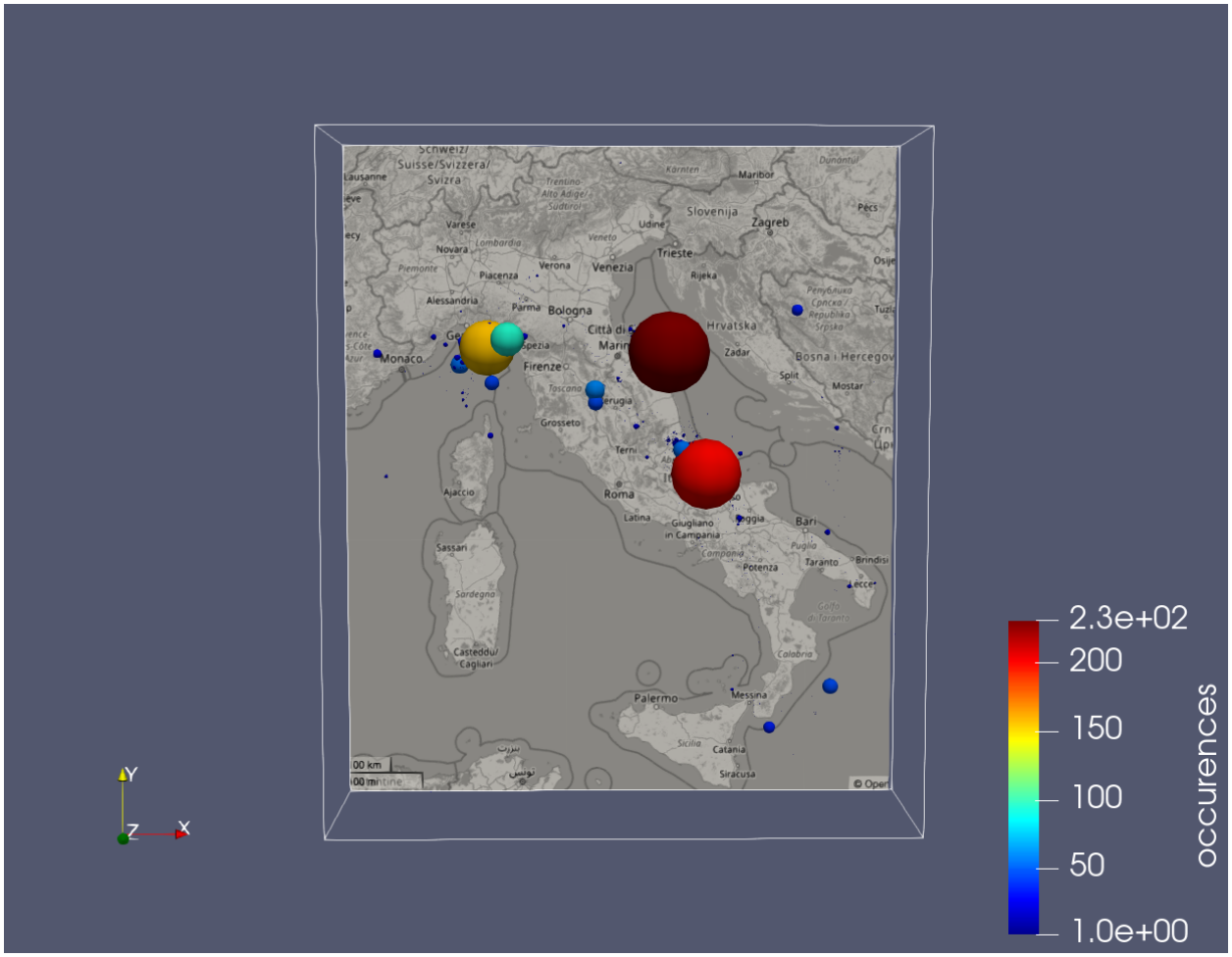

Fig. 6 Locations at which quakes are most likely to occur (with Glyph filter)

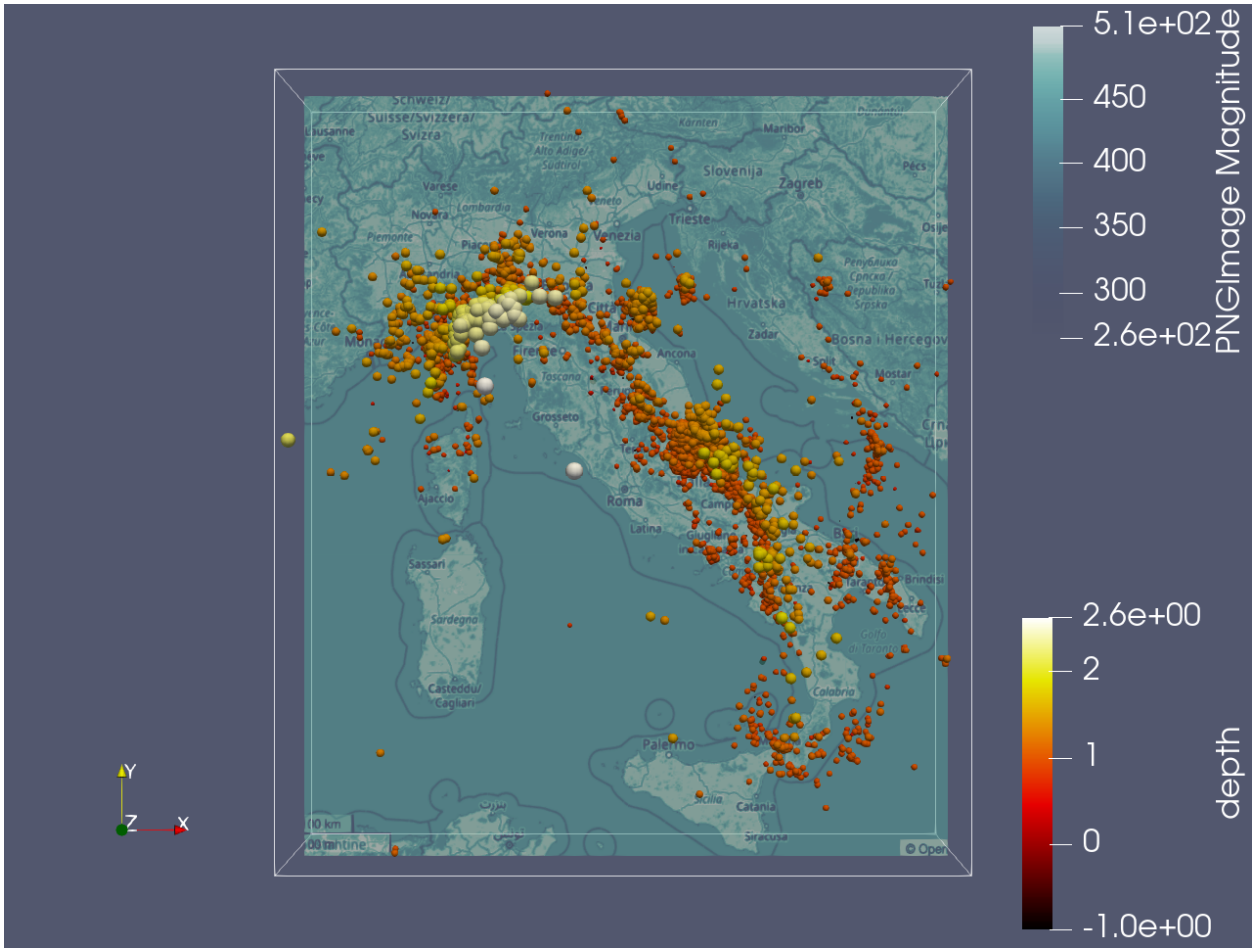

Fig. 7 Depth values of the earthquakes

References:

[1]. ParaView. (n.d.). ParaView. Accessed December 29, 2021, from https://www.paraview.org/