

AdriaArray

explanation to the scripts and files for plotting the maps of stations

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idea

Whenever there is an update of either any permanent or temporary station, we like to quickly update the maps too. Station information is stored in the excel sheets, one for temporary, the other for permanent stations [InventoryPermanent.ods and InventoryTemporary.ods in the GitHub AdA/ folder]. A Python script `extract.py` reads the sheets and sorts the stations by the selected properties into text files with coordinates (and station names). A GMT4 script `plotAdA.sh` uses these text files to plot maps where stations are colored by their properties. Maps with various layers of properties and of various complexity are produced. The Python script also produces *.kml files which can be viewed in GoogleEarth. Hence, once there is a change of any station property in the sheet, updated maps are produced by running the two scripts. After that, the maps, as well as all other updated files, are pushed to GitHub. AdriaArray webpage links to the GitHub repository so that the maps on the AdriaArray webpage are always the most recent ones.

purpose

Beside the obvious purpose to share the information about the station distribution, their corner periods, about who operates them, if they send data to EIDA and so on, the reason to share the scripts and input files is to allow everybody to plot his own maps. By modification of the GMT script using the already prepared text files, different combinations of properties can be plotted into a new map. By modification of the Python script, files with different properties can be produced and then plotted, both for GMT as well as for GoogleEarth. Often, the research will focus on a particular region which can again be easily reflected in modification of the GMT script. Provided files and scripts can be freely used for any purpose, as well as obviously one can use his own tools to process and plot the information from the inventory sheets.

main input files [for `extract.py`]

There are two files (inventories) with almost the same structure to store the information about the permanent and temporary stations. These are classical "excel" sheets, which are handled by LibreOffice and saved in the *.ods format. These are read by `pandas pd.read_excel()` in Python. The sheets have 24 and 27 columns, most of them are the same in both, and are labeled in the header. The sheets differ in the first column "A", which in the temporary sheet has a flag "1" for stations already deployed, "0" for stations planned but not deployed yet and "3" for stations, which were operational during the AdriaArray periods since May 2022, but are closed already now. In the permanent sheet, the same first column is used for the flag "1" stating that the station is inside the AdriaArray region and "0" when outside. The other difference is the column "M", which in the temporary sheet lists "type of spot" (malfunctioning BB sensor, existing permanent station considered as temporary for AdA, new place to be scouted, existing PACASE station, SP/SM station to be upgraded with BB sensor, unequipped spot where there was a station in the past). In the permanent sheet, the same column has one of flags, valid only for stations with corner period 30 s and shorter. Flag "0" means the station is not available or suitable for upgrade, flag "1" means, it is suitable and agreed by the local operator for upgrade. Empty cell means, the station is not needed for upgrade (usually in areas already covered by BB permanent stations sufficiently). Flag "2" is used for permanent stations planned to be deployed in the near future, in this case, the corner period is not given (not known yet). Flag "3" is – similarly as in the case of the temporary inventory – for stations, which were operational during the AdriaArray periods since May 2022, but are closed already now. The temporary sheet contains additional three columns after the "comments" column, with respect to the permanent sheet.

The network codes in the permanent sheet have sometimes non-standard format. "ZZZ" represents the "unequipped spots", simply so that when sorted by this column, these are at the end of the sheet. "CSNU" is used for the Ukrainian Carpathian network, but is not registered as a valid code by FDSN. Then, there are many stations, where network code is non-existent (or not found).

The permanent sheet includes stations between 1° west and 33° east and between 34° - 51.5° north. Meaning, way far around the AdriaArray region. There are two reasons for that: first, the outline of the experiment was not set beforehand, but emerged as a result of covering the region with available mobile stations and hence permanent stations were added or removed from the AdA region when the outline moved. Second, using the AdA stations for research does not exclude the use of permanent stations outside of the AdA region, so in some of the maps, all the stations are shown. Research focused on a given region can easily

make use of the stations both inside and outside. The meaning of the outline is to show the area, where the backbone coverage is homogeneous (as homogeneous as it gets).

Even the backbone consists of BB stations, we list all stations including SM and SP. First, those sites could be potentially used for deployment (upgrade) by BB mobile station. Second, for a specific research, SP/SM stations can be used and hence they are shown in the maps too.

Note, that there is a significant difference between the purposes of the two sheets: while the permanent inventory was made to gather the information about existing stations, the temporary inventory is used to plan the location of the mobile stations. Hence it is being updated frequently, discussed with the local and mobile pool operators, shared online with the field teams, updated after stations are deployed. Lines are often added or removed in this sheet. This is also the reason why these inventories were not shared earlier, even being built since summer 2019. In early 2023, we reached somehow a stable state of the plan and the modifications are expected to be minor only.

Moreover, all the stations, both permanent as well as temporary, within the AdriaArray region, will be sharing the data via the EIDA nodes and the metadata will be accessible for all these stations. Once this happens, these “manually-made” inventories will not be needed. However, at the moment, not only the temporary stations are not all in EIDA yet, but also several tens (~30) of the permanent stations are not sharing data via EIDA. There is anyways significant progress in this, as three years ago, when we started the planning, more than 100 permanent stations were missing in EIDA.

Thanks to the fact, that many entries in the permanent inventory were obtained “manually”, by discussion with the network operators, the sheet includes information independent of the metadata in EIDA. This is currently being used to check the discrepancies between the two. It might help to discover potential errors in the metadata.

Although the properties of the stations can be (should be) obtained from the metadata, there is still one property, which we found crucial, and which is not that easily readable from any of the online tools. It is the corner period of the sensors. There is no mandatory field in the StationXML to list the value. Many operators give the information in the description entries. One can obviously also get the corner period value from the Poles and Zeros set. The permanent (and when deployed, then also the temporary) inventory lists the corner periods and it was the most important and most frequently used information while planning the AdriaArray deployment. For SP/SM stations, some dummy values like “1” or “0.1” are used in the “corner period” column just to mark them as “shorter” than those of the BB stations.

These two inventories are the only two files read by the script `extract.py`.

auxiliary input files [for plotAdA.sh]

These are only used by the GMT4 script `plotAdA.sh`. They are stored in `AdA/AUXI/` and contain information about the past experiments (AlpArray, PACASE), polygons outlining the experiments, and some other data used for plotting the maps (topography, borders). These files are to be changed manually, and are expected not to be changed frequently. The exception are the files listing the institutions, which are also to be updated manually and this was happening frequently during 2022 and 2023, as more and more groups were joining the AdA initiative. Also note, that the `AUXI/` folder contains in addition some other files produced by the `extract.py` script.

folder structure

We provide `AdA/` folder, which contains two input inventories, two scripts and two “manuals”, one of them being this text. It also includes five subfolders. The folders `AUXI/` and `GOOG/` must exist before the python script is used. One file with the triangle icon is needed in the `GOOG/` folder. The subfolders `PERM/` and `TEMP/` are created (if not existing) by the python script. Files are saved into all these four folders by the Python script. Every run of the `extract.py` overwrites these files. The last folder `MAPS/` must exist before running the GMT script `plotAdA.sh` and is used for the output maps. The GMT script also saves some files into `AUXI/`, `TEMP/` and `PERM/` folders.

extract.py

It needs `pandas` and `simplekml` to be installed. This script reads the two sheets and splits them in many small text files, saved into `AUXI/`, `GOOG/`, `PERM/` and `TEMP/` folders. The script has some little documentation inside. Based on the values in different columns of the sheets, it groups the stations by desired properties and saves their coordinates into text files to be later used by the GMT script, and also in `*.kml` files to be displayed by GoogleEarth.

plotAdA.sh

This is GMT4 script for plotting the maps. You might need to modify it for using it with more recent versions of GMT. It also has some little comments inside. After adding all the layers to the postscript, pdf and png files are produced as well. The topography is taken from https://www.ngdc.noaa.gov/mgg/global/relief/ETOPO1/data/bedrock/grid_registered/netcdf/ and cut off for the region needed for the maps. The corresponding *.grd file is in AUX1/. The grey-shaded color palette was customized for the needs of the topography of Europe for these AdA maps.

GoogleEarth

The folder GOOG/ contains several *.kml files, which corresponds to the text files for GMT. The colors used for displaying the triangles in GoogleEarth are the same as used for respective maps in GMT, mainly the map 01AdriaTotal. The *.kml file names start either with “perm” or “temp” to show, if it contains information about permanent or temporary stations. For permanent, it is followed by “BB” if containing broadband stations. In case of temporary, all stations are broadband. Files are split by corner period in five bands. For permanent stations, there is a file containing also the stations outside around the region [permBBoutside.kml]. There is also a file containing all permanent stations inside the region [permBBAllIn.kml], as well as one with all temporary stations [tempAll.kml]. For temporary ones, there are two files showing which stations are already deployed [tempDeployed.kml] and which are not deployed yet [tempNotDepl.kml]. Then, there are several other files with SP/SM stations for upgrade [permUPGR.kml], SP/SM stations not available for upgrade [permNOSP.kml], stations not needed for upgrade [permWHIT.kml], unequipped spots [permSPOT.kml], stations with unknown corner period [permUNKN.kml] and stations already closed [permBBClosed.kml, tempClosed.kml]. All these files correspond to the deaggregation of the stations according to the map 01, with respective colors. Note, that the stations will only show up as triangles in GoogleEarth, if the file triangle.png is in the same folder as the *.kml files (which is the case for GOOG/). The file triangle.png is not needed to run the Python extract.py script, it is only read when displaying the *.kml files.

For suggesting the locations of temporary stations, the “coverage” maps of the permanent stations were needed. These are shown in the GMT maps 04 and 05. However, the planning was done in GoogleEarth. For this, I needed the same circles around the permanent stations, which are shown in the GMT maps, also as *.kml files. The extract.py script saves *.csv files in the GOOG/ folder. When these *.csv files are uploaded here: <https://www.freemaptools.com/radius-around-point.htm>, one can produce the corresponding *.kml file. The *.csv files already include the radius of the circles. There are two versions for each period band for 30 and 40 km radius, so one can adjust the colors in the online tool and get then the coverage in GoogleEarth as shown in the presentations and posters about the AdA Seismic Network over the last 4 years. pBB30-30.csv means broadband stations with 30 s corner period, radius is 30 km. pBB30-40.csv contains the same stations with circles of radius of 40 km and so on for the other period bands.

working with the maps

I suggest, you download the AdA/ folder from the GitHub repository to your local machine. After executing extract.py and plotAdA.sh you should get the maps as provided in the repository. I expect the needs of each researcher to be different, so modify the whole thing as you wish. I do not expect any extensive community development here, however, if you feel like you have upgraded the codes to something what could be of any use by others, let me know. I especially encourage everyone to report to me any errors in the inventories, as well as in any other file, when found.

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