AdriaArray

seismic network, temporary stations and legend to the maps

The planning of the seismic station distribution consisted of two parts: first, finding which permanent stations (of all types) and stations of ongoing temporary experiments were already deployed; second, suggesting a mobile station distribution.

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permanent stations

We gathered information from online sources (FDSN, EIDA/ORFEUS, Orfeus StationBook, ISC, webpages of all the institutions involved, EPOS, CE3RN, webpages of previous temporary experiments [AlpArray, PACASE, LiSARD, ...], ...). However, this investigation was mainly based on discussion and information exchange with the local network operators directly. As a result, we have a table, which lists ~2500 stations. A 24 columns sheet lists [see InventoryPermanent.ods in the GitHub AdA/ folder] properties of interest of every station. The table contains stations between 1° west and 33° east and between 34° - 51.5° north. The main focus was to identify, what is the sensor type at each station. This is later shown in (some of the) maps by different color. In addition to permanent stations, we also listed the spots, where there was a station in the past. Usually, these were temporary installations from previous experiments. These spots can be potentially used again for the mobile station deployment. We also list places, where there will be a new permanent station in the near future, if reported by the local network operators.

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temporary stations

Before the planning, we did not set any apriori station spacing as well as we did not decide strictly for the region to be covered. Moreover, we did not apply any strict rule for the corner periods of the backbone stations. All these three parameters (spacing, region, corner period) were obtained as a result of negotiation with mobile pools operators willing to join the project and as a result of the suggested temporary station distribution.

We divided the region into five geographical subgroups, each including selected mobile pools. Stations of these mobile pools were then arranged only within the given subgroup area. The mobile pool operators first suggested the number of stations they could provide. Hence we got the total number of stations for each subgroup. Based on these numbers, based on the permanent station distribution, on the ongoing temporary experiments (PACASE) and on the scientific interests of both mobile and local network operators, we roughly delineated the outer boundary of AdriaArray. Within each subgroup, we tested the station spacing which would uniformly cover the subgroup area with the given number of mobile stations. For the easternmost part of subgroup EAST, the spacing was obtained to be "40 km". It means, no place in the region would be more than 40 km distant from the nearest BB station. In the rest of the AdriaArray subgroups, which is the vast majority of the covered region, the spacing is "30 km", the same as it was for the AlpArray network. The transition between the two regions of "30 km" and "40 km" spacing is smooth. After distributing the given number of stations with the respective spacing in the given regions, we draw the final outer boundary of the covered area. Then, together with the mobile pool operators, it has been decided, which of the mobile stations would be deployed/operated by which mobile pool.

We gathered a pool of 450+ available mobile stations, selected 447 locations for deployment, and agreed on the institutions deploying the stations, and on the local network operator supporting the deployment.

After the outer boundary of the AdriaArray region has been delineated around the region covered with temporary stations, we checked, which of the permanent stations are inside and outside. It resulted in 1694 permanent stations being inside the AdriaArray region, of which, 1006 are broadband with the corner period >= 30 s and considered as part of the backbone.

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planning

Technically, the mobile station distribution was suggested using GoogleEarth. Permanent stations were imported to the map with circles (of 30 and 40 km in radius) corresponding to their coverage. Mobile stations represented by the same 30- and 40-km circles were manually moved over the region to cover it. We tried to place as many of the mobile BB stations as possible to existing SP/SM stations or to already known but currently unequipped spots, so that the scouting of new places could be minimized. As there was no strict limit of what was the corner period of the backbone, the virtual "deployment" of the temporary stations was done so, that after filling the gaps in coverage of the permanent stations, we were successively replacing the shorter-

period permanent (mostly SP/SM and shorter-period BB) stations with the longer-period temporary BB stations. As a result, we ended up engaging all the mobile stations at hand having replaced as many shorter-period permanent stations as possible. This gave us the best "quality" of the given coverage in the given subgroup, although the lowest corner period of each subgroup differs. In the subgroup EAST and partly in the subgroup CENTER, there are several stations with 30 s corner period used for the backbone, everything else is covered by stations with 40 s and longer corner period.

As a result of the above mentioned procedure, the AdriaArray backbone only includes permanent and temporary stations with sensors with the corner period of 30 s and longer. In addition to the backbone, there is a virtual network _ADARRAY. All broadband stations in the region with HH* and BH* channels are included in _ADARRAY. According to the SEED convention, H** and B** channels are assigned for sensors with corner period of ≥ 10 s. _ADARRAY virtual network hence includes more stations than the AdriaArray backbone network. The backbone is a subset of _ADARRAY.

Several local experiments have been suggested in addition to the backbone. These are to be considered as a local densification of the backbone, either with BB or SP/SM stations (or a combination of them) in the regions of particular interest. So far, we have seven local experiments suggested, out of which four are deployed.

The maps are distilled from the two tables (permanent and mobile, maintained using LibreOffice, see InventoryPermanent.ods and InventoryTemporary.ods in the AdA/ folder). We have a Python script, which runs on both the permanent-station and temporary-station sheets and groups the stations according to selected properties to text files, which are later plotted by GMT with another script. We work with 18 maps (including one for GPS stations) showing different station properties and their combinations. There is also a map showing the institutions, not the stations. Some of the maps are quite complex, the others very simplified. The Python script also produces *.kml files for GoogleEarth. Details about the scripts and files is to be found in the accompanying document maps-manual.pdf in the GitHub AdA/ folder.

01AdriaTotal

This map shows the permanent stations located both inside and outside the AdA region, grouped by the corner period (red: corner period of 60 s and longer, orange: corner period between = 40 and < 60 s, yellow: corner period = 30 s). Dark blue are the PACASE stations planned to stay in place for the whole length of the AdriaArray deployment. Light green are the stations which were agreed by the local network operators as a suitable spots for deployment of mobile BB station. These include short-period stations, accelerometers and BB stations with corner period < 30 s. Light blue are the locations where there was a station before, so called "unequipped spots". White is the same category as green, but these spots were in the end not needed for the backbone. Gray are the stations not available or suitable for upgrade. Dark green are BB stations to be build in near future (about 1 year). Black are the stations (both permanent and temporary), which were operational during the AdA time period (since May 2022), but are closed now. Triangles colored by the five different pink grades show the mobile stations for the respective subgroups; the triangles are empty inside, showing that such a mobile station is sometimes suggested to be placed at an already existing station location, and color coded as: light blue (unequipped spots), green (< 30 s, SP/SM stations) as well as yellow (= 30 s stations).

Station names: For permanent stations, their respective names are shown in the map In case of mobile stations to be placed at the permanent spot, the permanent name is shown. If it is a PACASE spot, the given PACASE temporary name is used. If it is a former AlpArray spot, the given temporary AlpArray name is used. If it is an unequipped spot where there was a name found for that spot, this name is used (e.g. CASE stations). Sometimes, the name of the village is shown. In Romania, the "unequipped spots" are named as ZROxx, where xx is a number. When the mobile station is suggested at a new place, which needs to be scouted for, the name is created using two characters showing the country of deployment plus two digits with a numbering in the respective country.

Permanent stations outside of the AdriaArray region are shown by empty triangles with respective color as in the legend. Big white and blue ellipses show schematically the planned local experiments.

The station colors of this map are reflected in the *.kml files, and hence one can reproduce almost the same layout in GoogleEarth. In the 01AdriaTotal map, all stations with corner period of 60 s and longer are shown by red triangles. The *.kml files have additional two bands corresponding to the map 17AdAcorners, see below.

02AdriaBBonl

This map does not show the stations with corner period < 30 s, SP and SM. Colors for the stations with corner period >= 30 s are the same as above. Mobile stations have now different colors by subgroups. This map is meant to show the backbone and its corner periods (of permanent stations) without the details about the short period stations and without the details on what spots are occupied by the mobile stations.

03AdriaBBsub
Simplification of the previous map. Permanent stations have all the same color (red). Mobile stations have the colors by subgroups, the same as above. Only the stations inside the AdriaArray region are shown.

04AdriaCrc30
This map shows circles of 30 km radius around the station locations (60 km in diameter). Colors for permanent stations are the same as in the map 02AdriaBBonl (by corner period), colors for mobile stations are the same as in the previous two maps.

05AdriaCrc40
The same as previous, for circles of 40 km radius (80 km in diameter).

06AdriaBBovr
Highly simplified map showing only the permanent and mobile stations regardless of their type.

07AdriaMobile
The same as 03AdriaBBsub (all BB permanent in red), with circles around mobile stations showing the mobile pools suggested. The circles denote the pools providing the main equipment for the given station. Map 13AdriaDploy shows more detailed color-coding for stations where the equipment is shared by two mobile pools.

08AdriaGPS
GNSS stations split into two colored categories inside the AdriaArray region. Gray ones are outside. Used for the COST proposal in 2020. Not maintained since then, not published on GitHub.

09AdriaCOST
Simplified map with the layout as used for the COST proposal in 2020 and updated further after the COST proposal was submitted. Similar to 06AdriaBBovr, showing in addition also other permanent stations outside the AdriaArray region by gray triangles.

10AdriaTotPR
A subset of the map 01AdriaTotal showing now only the permanent stations and unequipped spots.

11AdriaEIDA
Shows permanent stations which are / are not connected to EIDA. This maps shows only permanent BB stations (>= 30 s), hence (part of) the backbone, to see, what permanent stations needs to be connected to EIDA to make AdriaArray operational.

12AdriaMobRG
The same as 07AdriaMobil, but all mobile stations are in light green, so this map does not show the subgroup division. The circles denote the pools providing the main equipment for the given station. Map 13AdriaDploy shows more detailed color-coding for stations where the equipment is shared by two mobile pools.

13AdriaDploy
Broadband permanent stations are shown in gray, mobile stations have their respective colors as in 07 and 12. Empty triangles are suggested locations, full triangles are stations already deployed. This applies to both permanent and mobile stations – there are also the future permanent stations shown by empty gray triangles, see also the dark green symbols in almost all the other maps. The title of the map read the number of deployed stations. Some stations share the equipment from two mobile pools. This is shown by dot in the triangles, see also the legend. The triangle always has the color of the pool with the main contribution to the equipment. The dot shows the color of the additional pool. Time-lapse collection of this 13AdriaDploy map can be later used to produce animation of the deployment.

14AA+AdA+PCS
Map shows also the temporary stations of previous experiments, the AlpArray and the PACASE, together with outlines of all three large-scale deployments.

15AdAmembers
Map showing the member institutions, the institutions that have applied and their membership is pending, and institutions interested being possible candidates for the membership. Some institutions joined the AdriaArray initiative together as one member. The map shows the individual institutions and branches, hence there are more symbols then is the number of the members. EIDA nodes storing data from the AdriaArray temporary and permanent stations are also shown.

16AdAnetwork
Map shows temporary stations colored by network codes. EIDA nodes storing the respective network data are shown in the legend.

17AdAcorners
Map shows both permanent and temporary stations (backbone) split by five corner period ranges. Note, that in the previous maps, the red color denoted all corner periods of 60 s and longer, while here, red is used for 60 s up to 120 s only. Longer corner periods have then additional colors for 120 – 240 s range and for 240 and longer.

18AdAEIDAall
Similar to 11AdriaEIDA, showing now all stations, meaning both permanent as well as temporary stations. This map was added in December 2023, when 93% of temporary stations were deployed and hence the check if they are or are not in EIDA made sense. In addition, the map emphasizes the stations, which are not deployed yet.

Each map has a date stamp to track the versions. In the moment, *.pdf, *.png and *.ps are produced, see AdA/MAPS/ in the GitHub repository.

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