Minimum 1-D P-wave velocity reference model for Northern Iran

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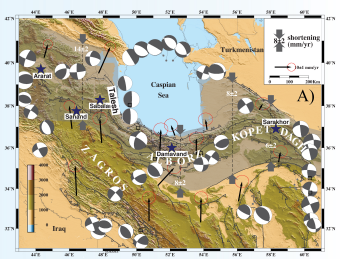
Introduction

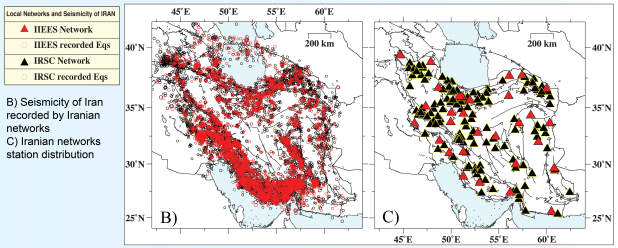
Uniform high-precision earthquake location is of importance in a seismically active area like northern Iran, where a consistent earthquake catalogue is a required for seismic hazard assessment and tectonic interpretation. We compile a complete and consistent local earthquake data set for magnitude >3 for the northern Iran region, using information from two independently operating seismological networks. Iran Seismological Center (IRSC) network, administered by the Geophysical Institute of Tehran University, and Iran Broadband network administered by the International Institute of Engineering Earthquake and Seismology (IIEES). Special care is taken on the merging process to reduce the number of inconsistensies in the data, including station parameters, event pairing, phase identification, and the assessment of quantitative observation uncertainties. The derived P-wave 1D-velocity model for Northern Iran may serve for consistent routine high-precision earthquake location and as an initial reference model for regional 3D seismic

Tectonics of Northern Iran



- Seismicity seems to outline boundaries of stable blocks.
- Large magnitude earthquakes occur in uppermost part of crust.
- Historical destructive earthquakes have occured near large cities.
- Post-collisional Quaternary volcanos
- Tectonic evolution of the collision between Arabian-Iran-Eurasian Plates
- Very active seismic belt.

Iranian Networks



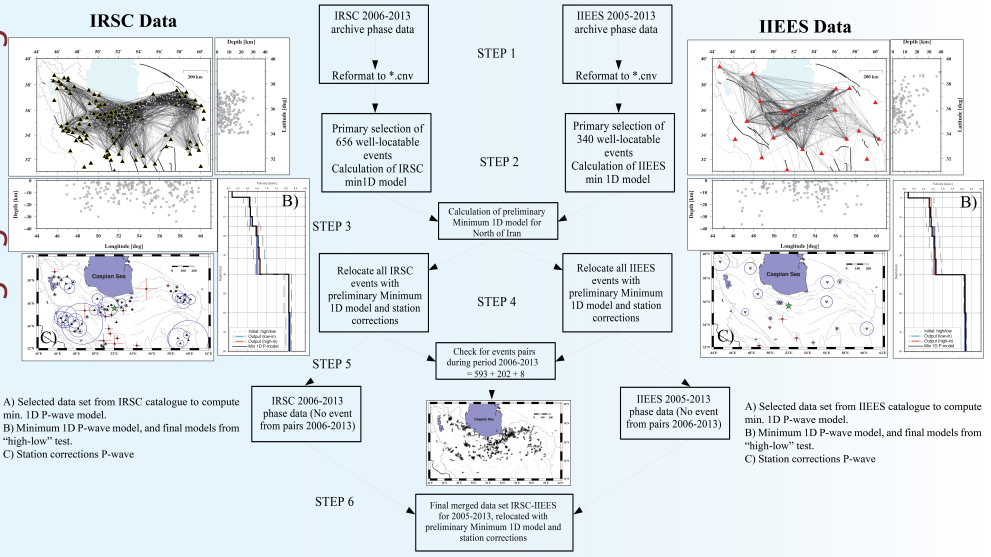
B) Seismicity of Iran recorded by Iranian networks
C) Iranian networks station distribution

Resolution and reliability of travel-time-based inversion techniques, like tomography and hypocenter determination, depend strongly on the consistency of the available arrival times (e.g. Diehl, 2009). To improve location and velocity model in Northern Iran, events with adequate number of arrival times (including consistent picking uncertainties) of both networks are required. To provide such a consistent data set merging of both catalogues is required.

The main gooal of the merging was to provide adequate number of arrival times of both netwroks to calculate the 1D velocity model and station corrections for Northern Iran to improve the earthquake locations.

Merging two catalogues

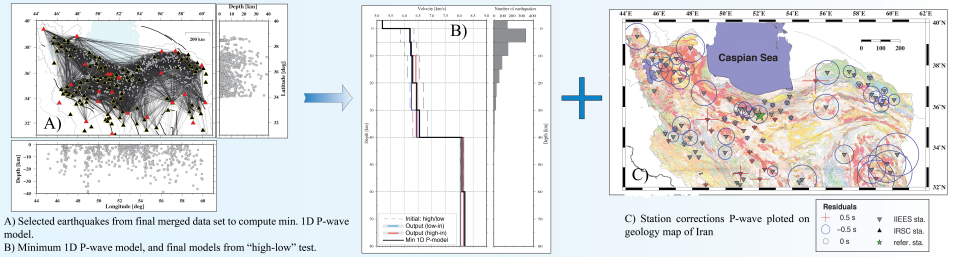
We followed a strategy similar to Solarino et al (1997) using min 1D model to merge two catalogues.
Consistency and quality of the P-wave observations have been given the first priority during the merging process!



A) Selected data set from IRSC catalogue to compute min. 1D P-wave model.
B) Minimum 1D P-wave model, and final models from "high-low" test.
C) Station corrections P-wave

A) Selected data set from IIEES catalogue to compute min. 1D P-wave model.
B) Minimum 1D P-wave model, and final models from "high-low" test.
C) Station corrections P-wave

Minimum 1D model merged data set



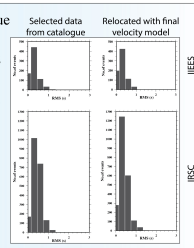
A) Selected earthquakes from final merged data set to compute min. 1D P-wave model.
B) Minimum 1D P-wave model, and final models from "high-low" test.

C) Station corrections P-wave ploted on geology map of Iran

Residuals

Comparing RMS of catalogue data and relocated events:

- Single event RMS and average RMS decreased for both IRSC and IIEES data set after relocation with final P-wave model and station corrections.

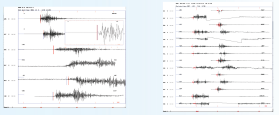


Inconsistancy in data set:

- The picking uncertaity in the catalogue data is not clear and it is different between the two networks
- mispicking and misidentification present in routine phase data
- Inconsistancy in station coordinates identified

Future work

To improve consistency of arrival time data for tomography inversion, we will apply automated repicking of seismograms using softwares like MPX (Alderson, 2005).



Conclusion

The merging of local earthquake travel time data sets reported by the two seismic networks IRSC and IIEES results in a data set for Northern Iran for the period 2005 to 2013 consisting of 1321 events with 64852 P-wave observations. With 853 well-locatable events this represents a prime data set for future local earthquake tomography studies.

The minimum 1D P-velocity model for Northern Iran allows locating earthquakes within the combined seismic station network of IRSC and IIEES with uniform accuracy. In addition, the usage of this velocity model for routine hypocenter location improves consistency in phase identifications. The station delays obtained with the minimum 1D P-velocity model, indicate lateral velocity variations near the surface and probably throughout the crust and, in general, correlate well with surface geology. Thus, the station delays demonstrate the need for using a minimum 1D model for high-precision earthquake location (Kissling et al., 1994) but also document the potential and the need for 3D seismic tomography applications with a consistent data set.

Acknowledgements

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