Moho depths beneath the European Alps from receiver functions of the AlpArray Seismic Network

Konstantinos Michailos[1], Matteo Scarponi[1,2], Josip Stipčević[3], György Hetényi[1], Katrin Hannemann[4], Dániel Kalmár[5,6], Stefan Mroczek[7], Anne Paul[8], Jaroslava Plomerová[2], Frederik Tilmann[7], Jerôme Vergne[9], and the AlpArray Receiver Function Research Group, AlpArray Working Group

1) Institute of Earth Sciences, University of Lausanne, Lausanne, Switzerland
2) Institute of Geophysics, Czech Academy of Sciences, Prague, Czechia
3) Department of Geophysics, Faculty of Science, University of Zagreb, Zagreb, Croatia
4) Westfälische Wilhelms Universität Münster, Institut für Geophysik, Münster, Germany
5) Kövesligethy Radó Seismological Observatory, Institute of Earth Physics and Space Science, Budapest, Hungary
6) MTA EK Lendület Pannon LitH2Oscope Research Group, Institute of Earth Physics and Space Science, Budapest, Hungary
7) Helmholtz-Zentrum Potsdam, Deutsches GeoForschungsZentrum, Potsdam, Germany
8) Institut des Sciences de la Terre, Université Grenoble Alpes, France
9) Institut Terre & Environnement de Strasbourg, University of Strasbourg, France

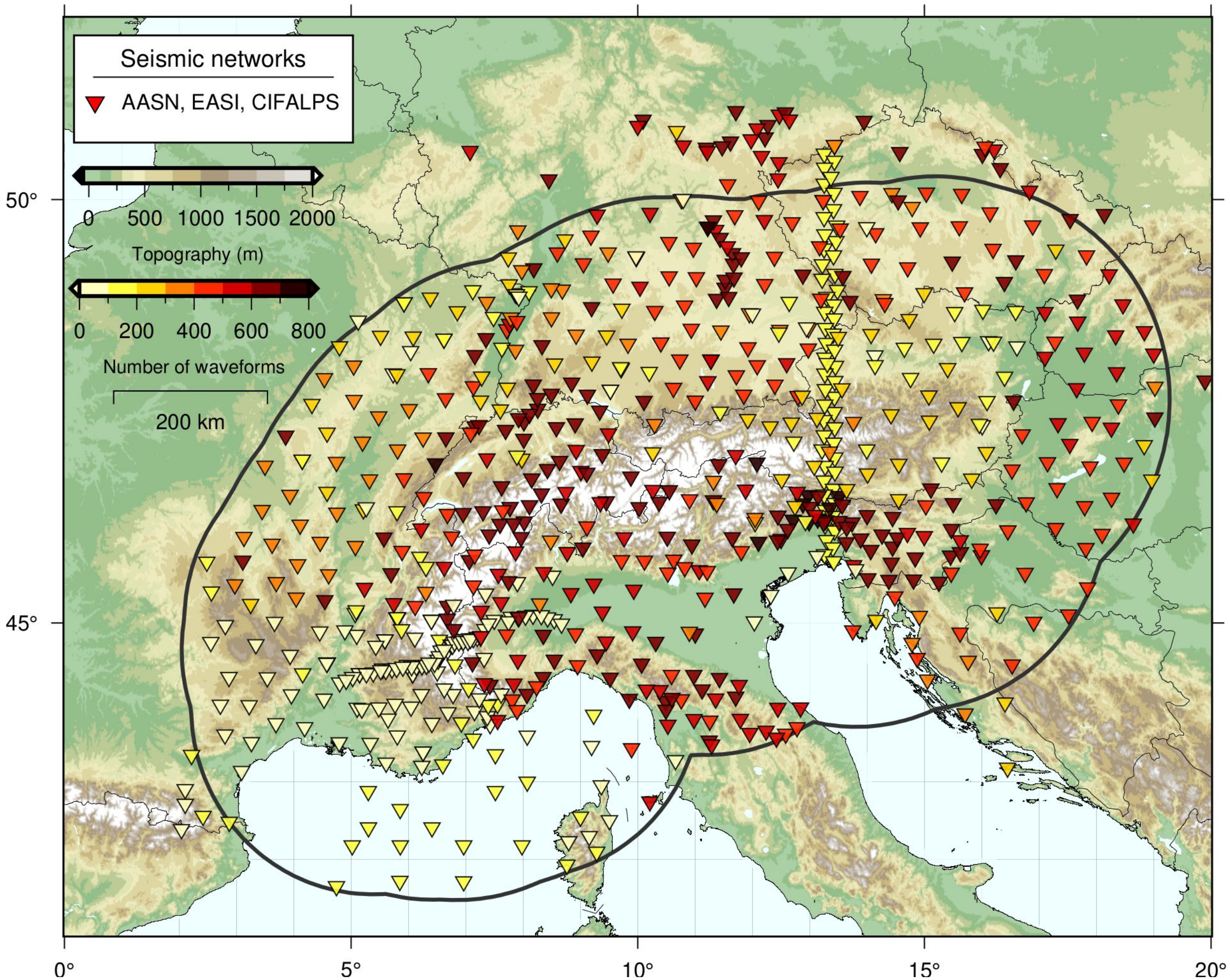
Motivation

We seek to construct a new Moho depth map for the European Alps using:

1. high resolution 3D geophysical imaging (**receiver function analysis and time-to-depth migration**)
2. dense seismic networks (e.g., **AlpArray seismic network, AASN**)

This analysis can help provide new clues on open questions on the present-day structure of the Alps and potentially on reconstructions of its geological history.

Data



We use raw continuous waveform data from the 1) **AASN**, 2) **EASI** and 3) **CIFALPS** seismic networks.

And more than 900 teleseismic earthquakes (M>5.5; epicentral distances 30-90º).

271,722 Z-N-E waveform triplets in total.

Figure 1. *Distribution of three component broadband seismometers of the AlpArray Seismic Network (AASN), the Eastern Alpine Seismic Investigation (EASI) and the China-Italy-France Alps seismic transect (CIFALPS) used in this study. Seismic sites shown as inverted triangles are colored according to their number of waveforms.*

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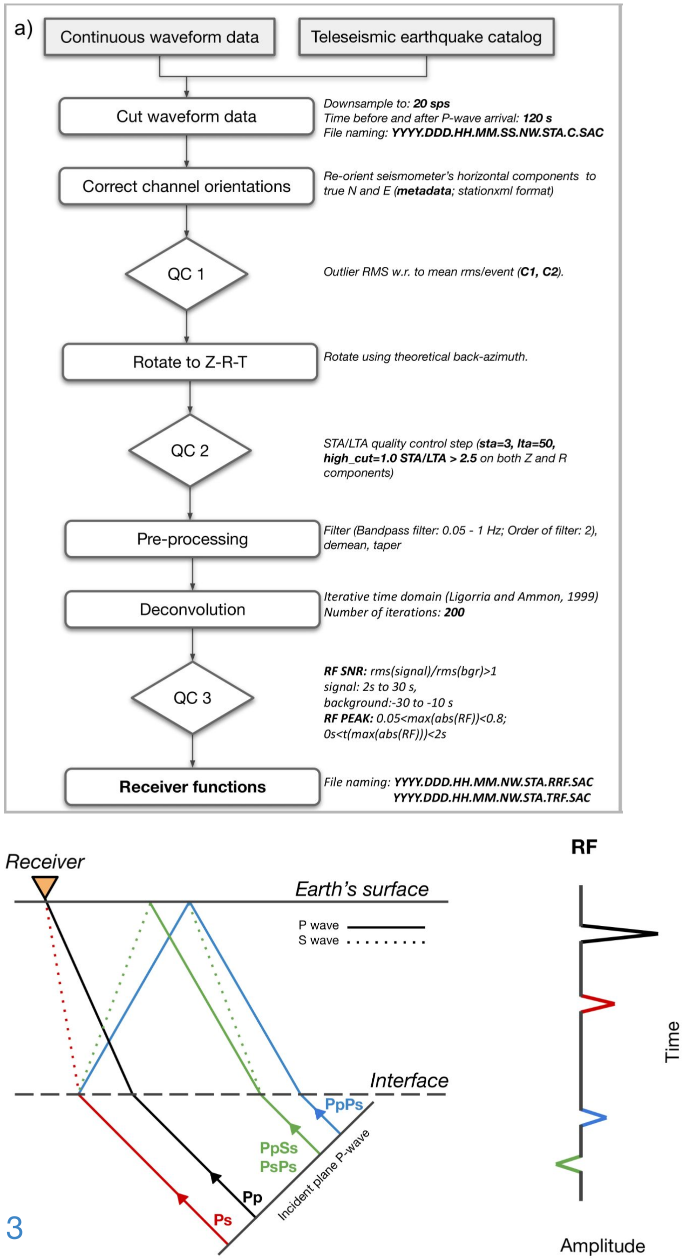
Methods



We start from continuous waveform data and implement a workflow set up by the AlpArray receiver function workgroup.

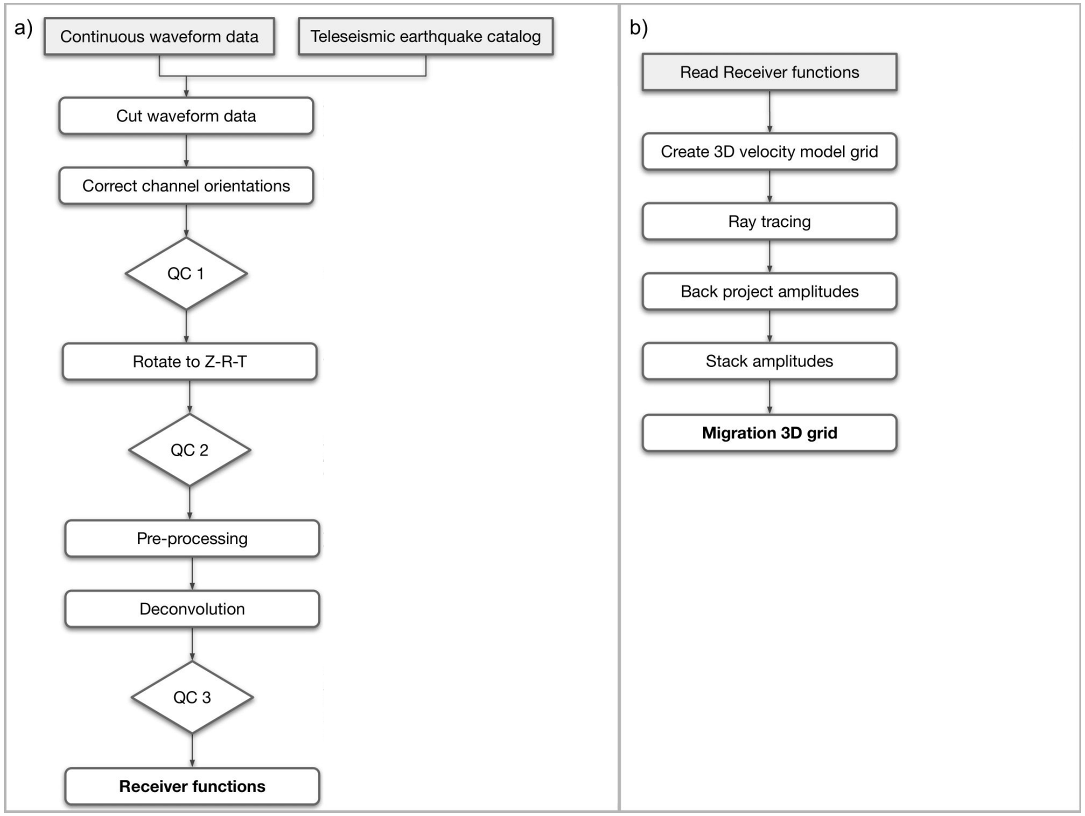
Quality control:

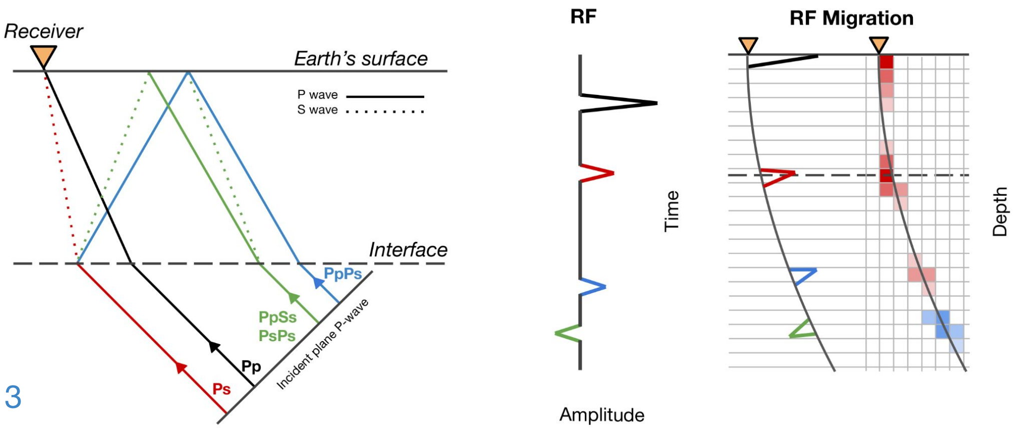
- Remove noisy waveforms
- Keep waveforms with clear P-wave onsets

Deconvolve using the iterative time domain method (*Ligorria and Ammon, 1999*).

Figure 2. *Steps followed for the receiver function calculations.*

Methods





Three dimensional grid using the iasp91 velocity model (*Kennett and Engdahl, 1991*).

Implementation of ray tracing in spherical coordinates.

2D profiles of RF migration images of the crust.

Figure 2. *Steps followed for a) the receiver function calculations and b) for the time-to-depth migration.*

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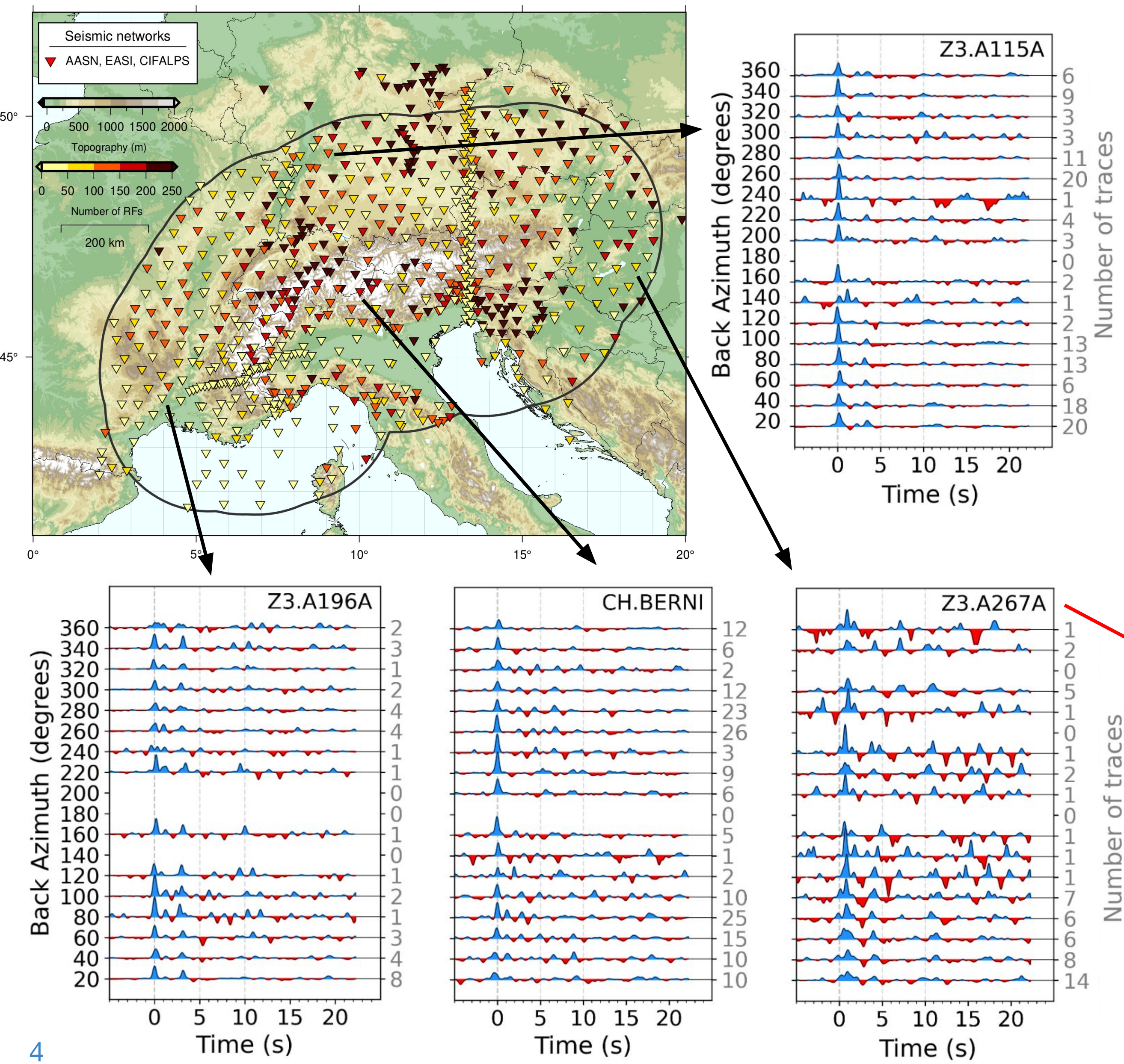
Preliminary results



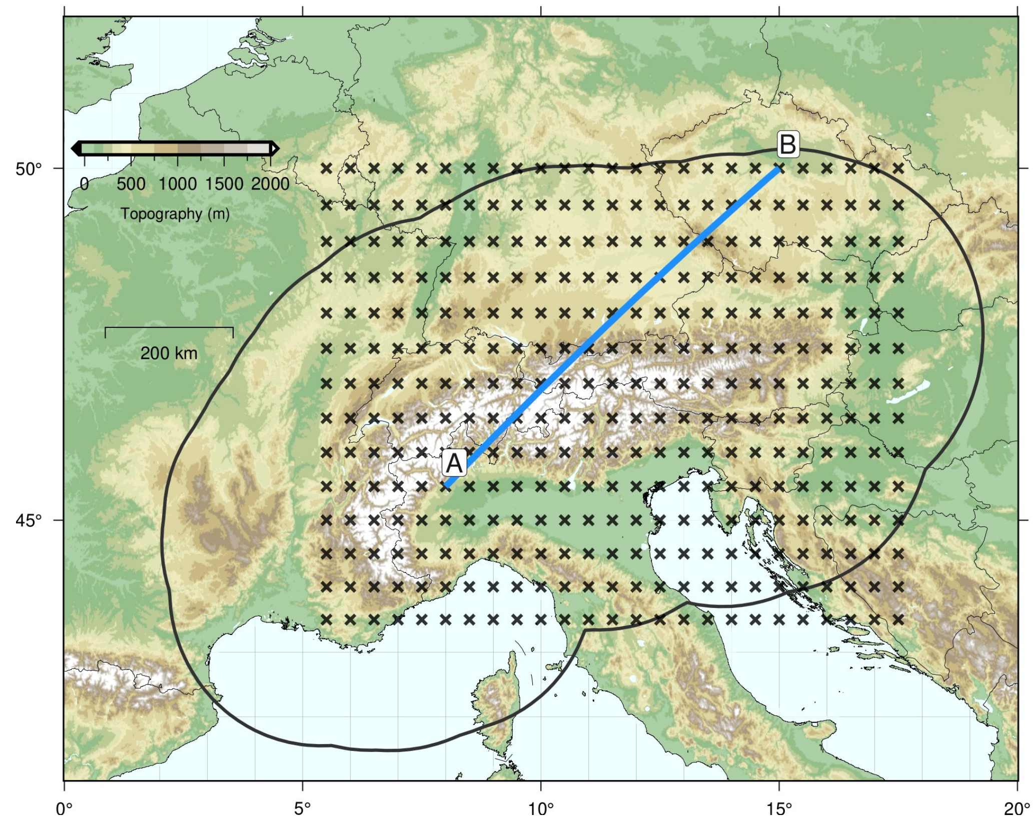
After the quality control steps, we obtain **78,630** receiver functions in total.

Clear P-wave onsets relative to noise and Moho Ps signals on the radial components.

Figure 3. *Map shows the number of receiver functions on each seismic sites. Plots show a selected subset of calculated receiver functions versus their back azimuth values from different environments (e.g., European foreland, high alpine region, and Pannonian basin).*

Thick sedimentary layer shifts arrivals.

Preliminary results

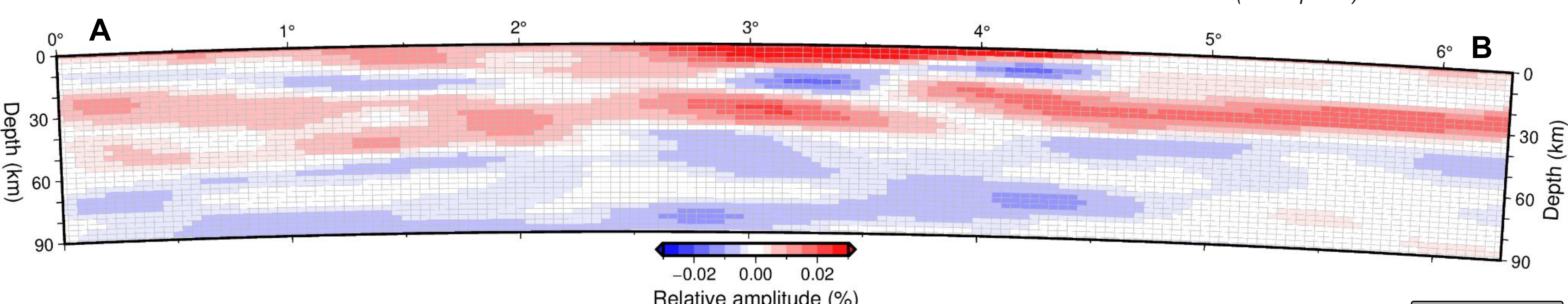


We define a preliminary coarse 3D grid using the iasp91 velocity model (2 km in depth and 0.5 degrees in latitude and longitude).

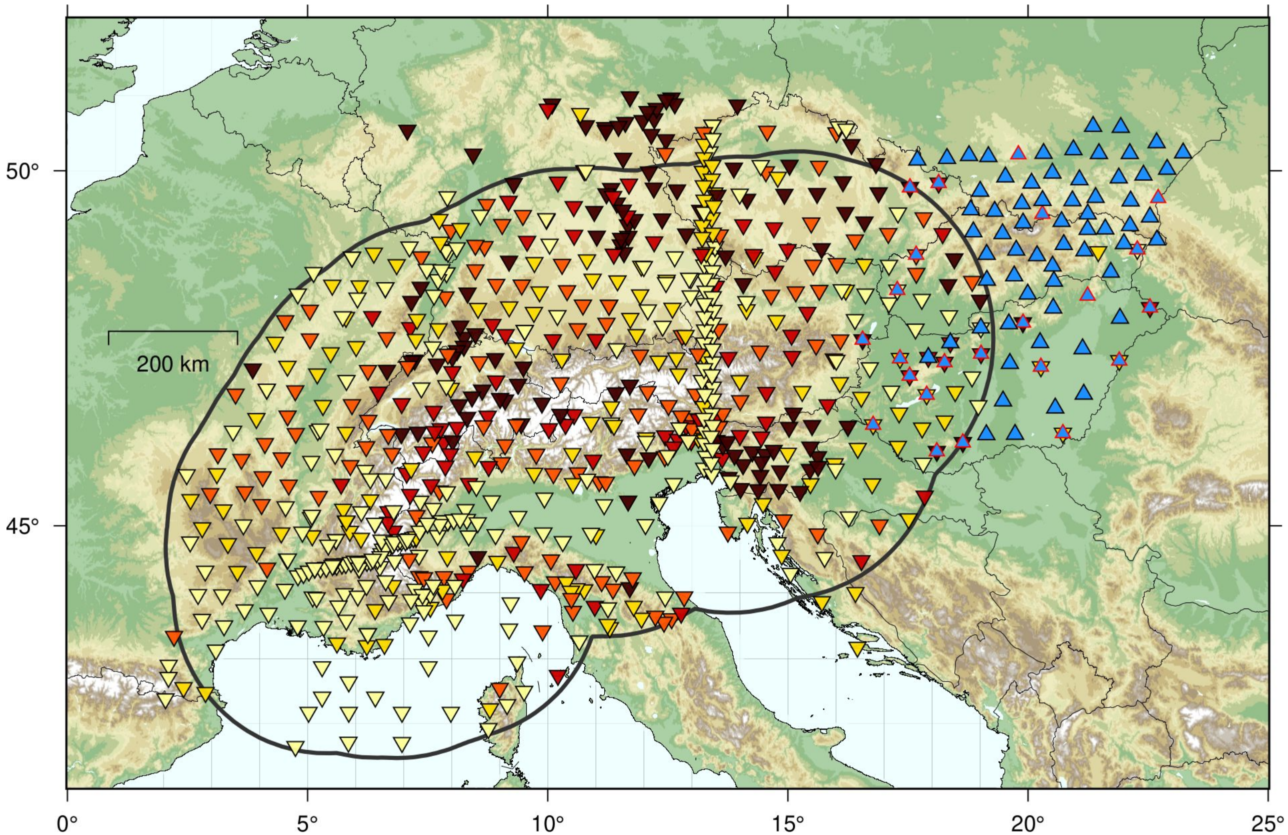
We calculate the theoretical ray trace paths, back-project and stack the amplitudes.

Plot a cross-section along most of the study area.

Figure 4. *Map showing the preliminary grid (black crosses) and the location of the cross-section shown below. Migrated receiver-function profile in spherical coordinates using the coarse 3D grid points within 50 km on either side of the cross-section (lower panel).*



Future work



Eastwards extension of the seismic network coverage by including the Pannonian-Carpathian Alpine Seismic Experiment (PACASE).

Figure 5. *Distribution of three component broadband seismometers used in this study (see caption of Figure 1 for more details). Blue triangles show the additional seismic sites we plan to incorporate to our analysis.*

Contributions and future work

- Preliminary receiver functions show clear P-wave and Ps amplitudes.
- We have implemented 3D spherical RF migration.
- The codes for reproducing our results are freely available on *Github*.
- Seismic data used here are archived at *EIDA* nodes and their status is open/unrestricted.

We intend to:

- Produce an open access Alpine Moho map, and migrated RF profiles.
- Include the PACASE data to extend the examined region.
- Define a denser 3D grid for the migrated RF profiles and consider using different regional velocity models (currently using iasp91).