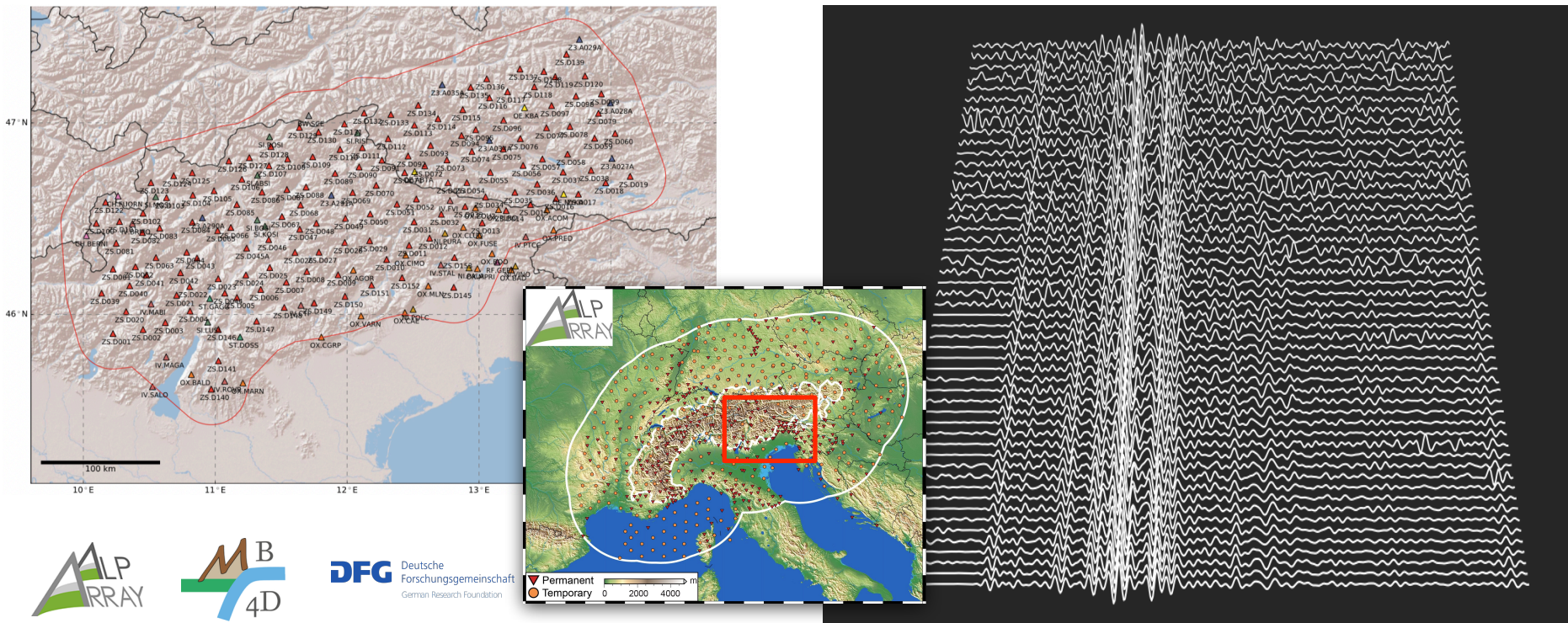


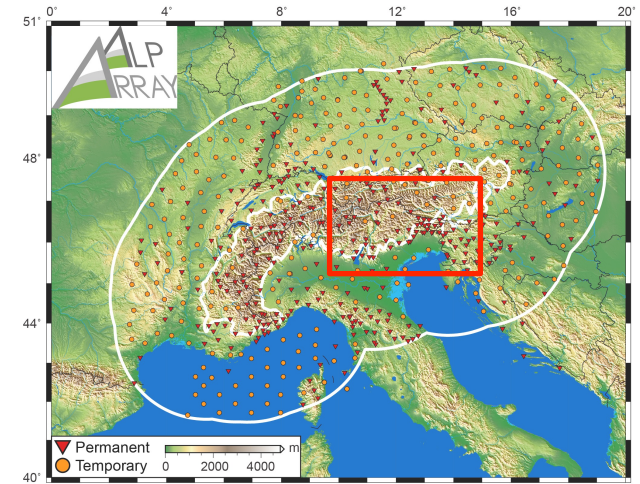
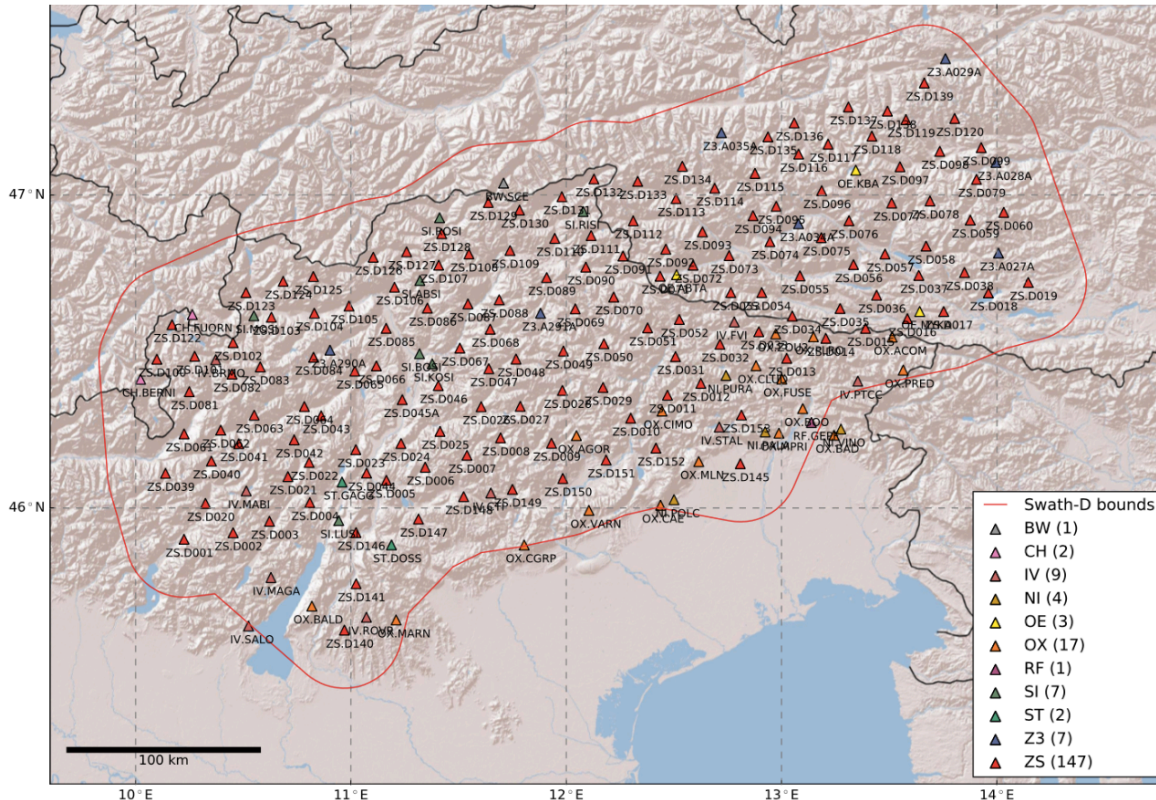
# Distribution of Active Seismic Deformation in the Eastern Alps from the Recent Swath-D Experiment

Rens Hofman, Joern Kummerow, Simone Cesca, Joachim Wassermann, Thomas Plenefisch, and the AlpArray Working Group





# Data and Study Area (Swath-D Network)



147 Swath-D stations (ZS)  
 7 AlpArray Backbone stations (Z3)  
 46 additional public stations  
 (ODC, LMU, ETH, INGV, GFZ)

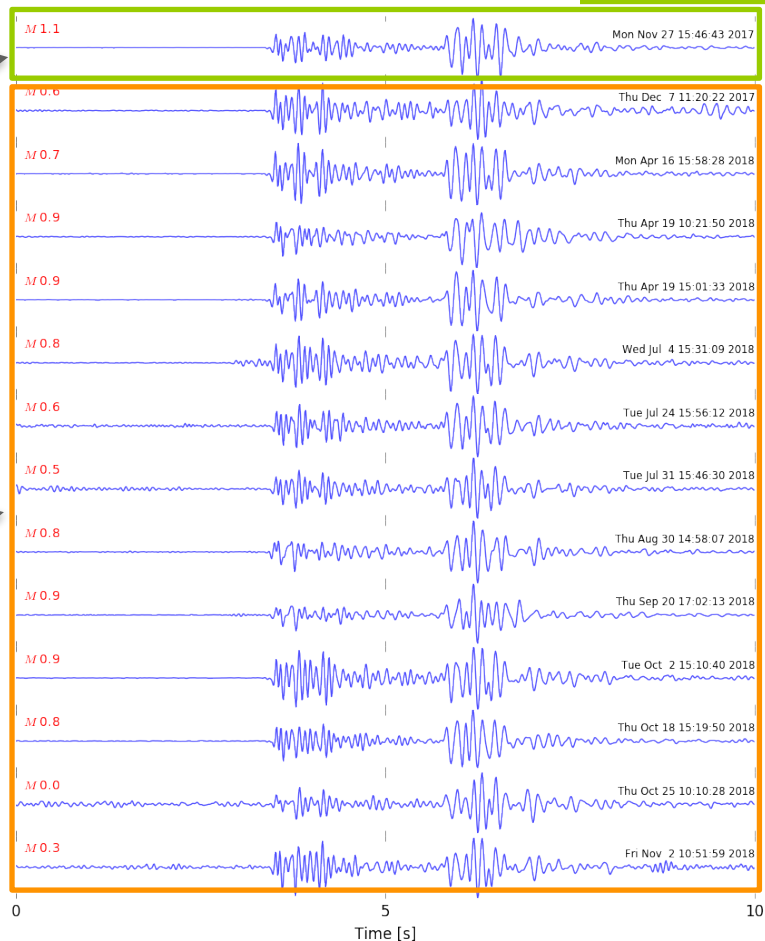
2 years of continuous data  
 (2017-2019)

# Template Matching

- GPU-accelerated implementation
- [CuPy](#) allows for an easy integration of CUDA in Python

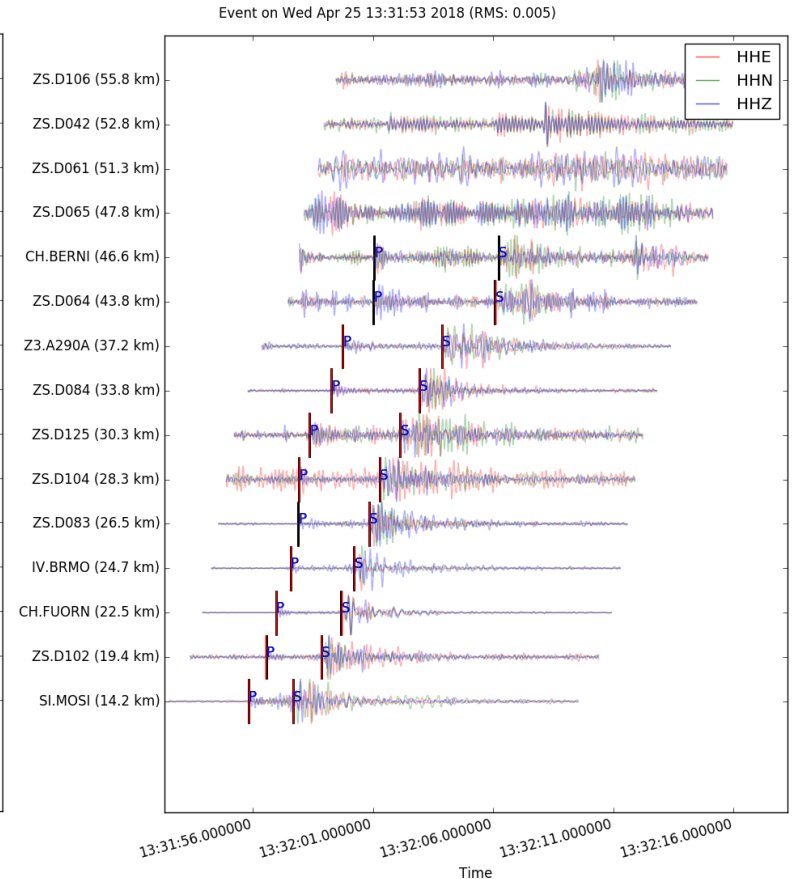
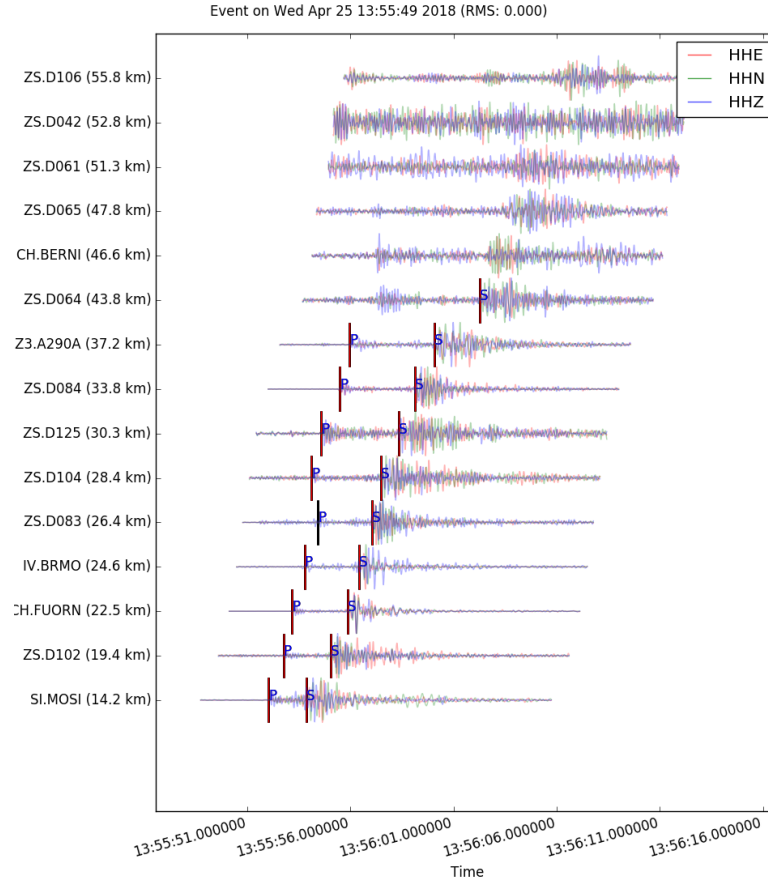
Template waveform

Detections



# Picking

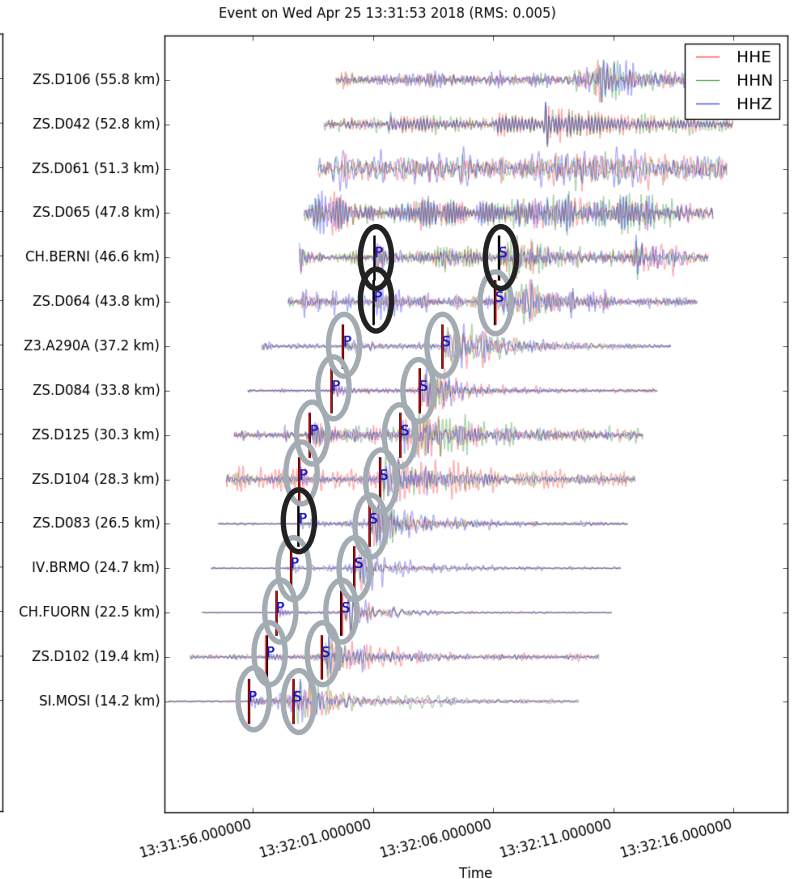
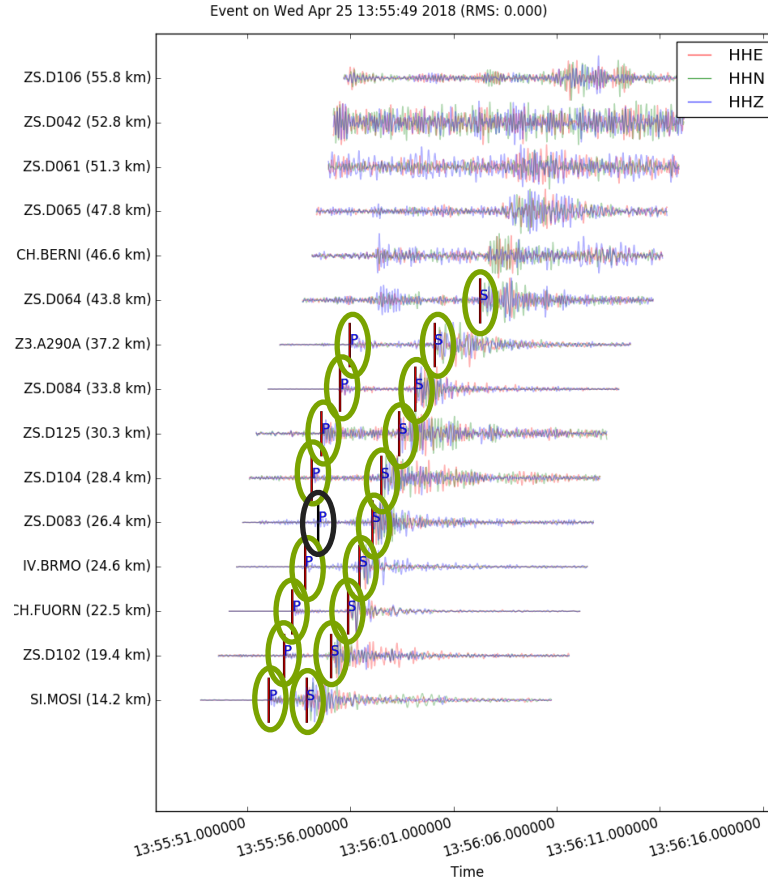
-  Hand picked phases
-  Correlated phases
-  Automatic picks



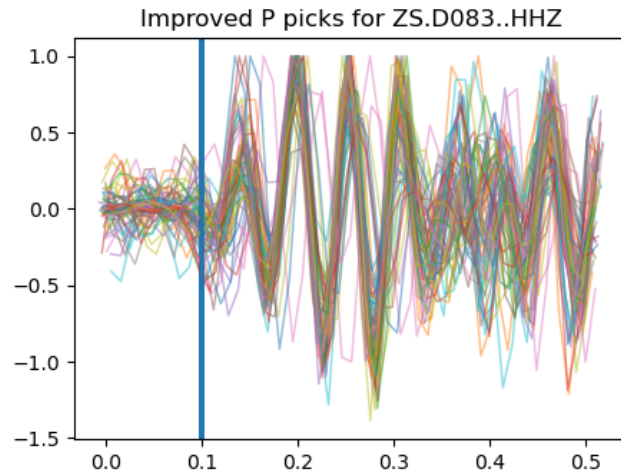


# Picking

-  Hand picked phases
-  Correlated phases
-  Automatic picks



# Picks



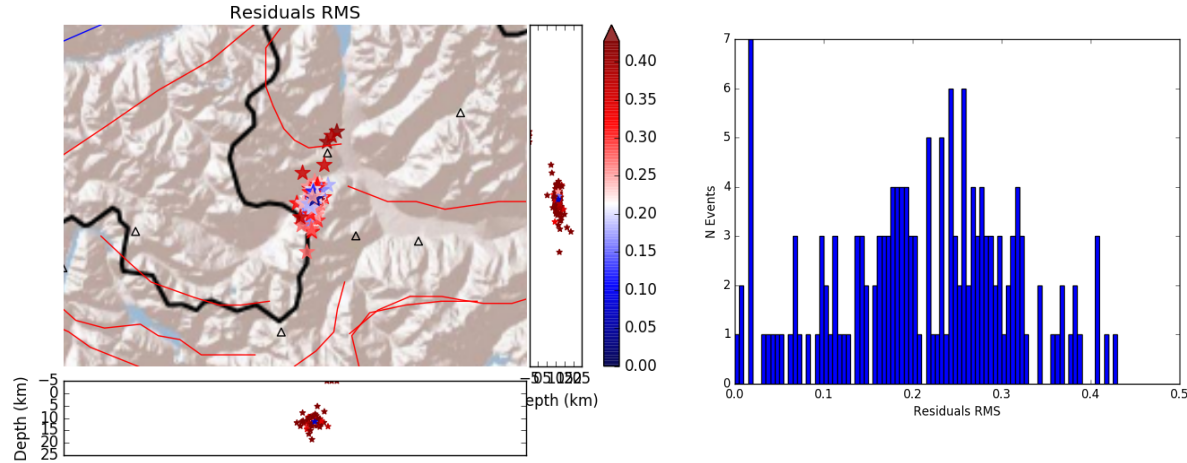
An optimized set of picks can be obtained by inverting a sparse matrix of absolute pick times and relative pick times based on cross-correlation lag time

$$\mathbf{d} = \mathbf{G}\mathbf{m}$$

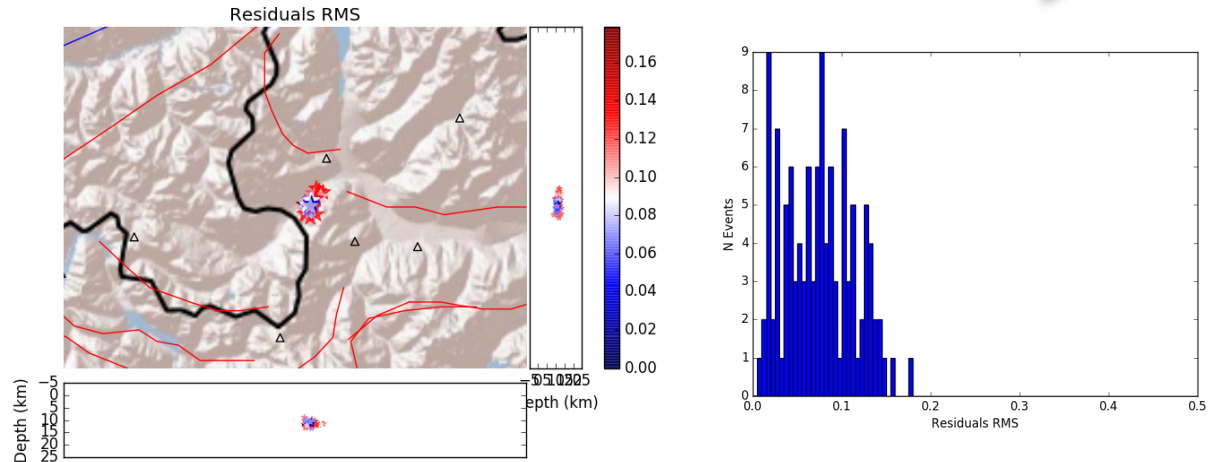
$$\begin{pmatrix} t_1 \\ t_3 \\ t_5 \\ t_6 \\ dt_{12} \\ dt_{23} \\ dt_{24} \\ dt_{45} \\ dt_{46} \\ dt_{56} \end{pmatrix} = \begin{pmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \\ 1 & -1 & 0 & 0 & 0 & 0 \\ 0 & 1 & -1 & 0 & 0 & 0 \\ 0 & 1 & 0 & -1 & 0 & 0 \\ 0 & 0 & 0 & 1 & -1 & 0 \\ 0 & 0 & 0 & 1 & 0 & -1 \\ 0 & 0 & 0 & 0 & 1 & -1 \end{pmatrix} \begin{pmatrix} T_1 \\ T_2 \\ T_3 \\ T_4 \\ T_5 \\ T_6 \end{pmatrix}$$

Shearer et al. (1997)

# Locations

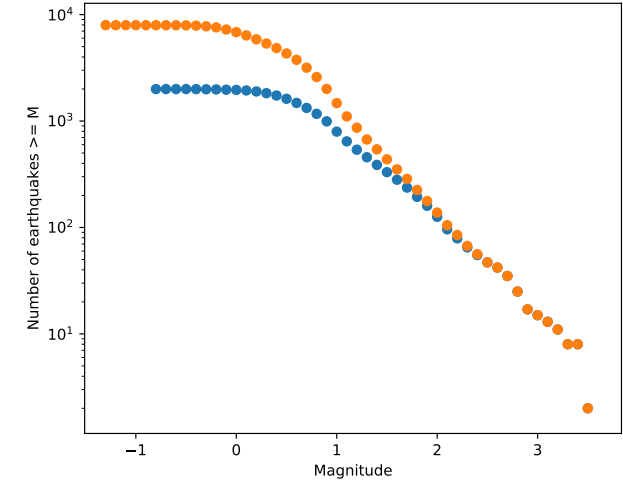
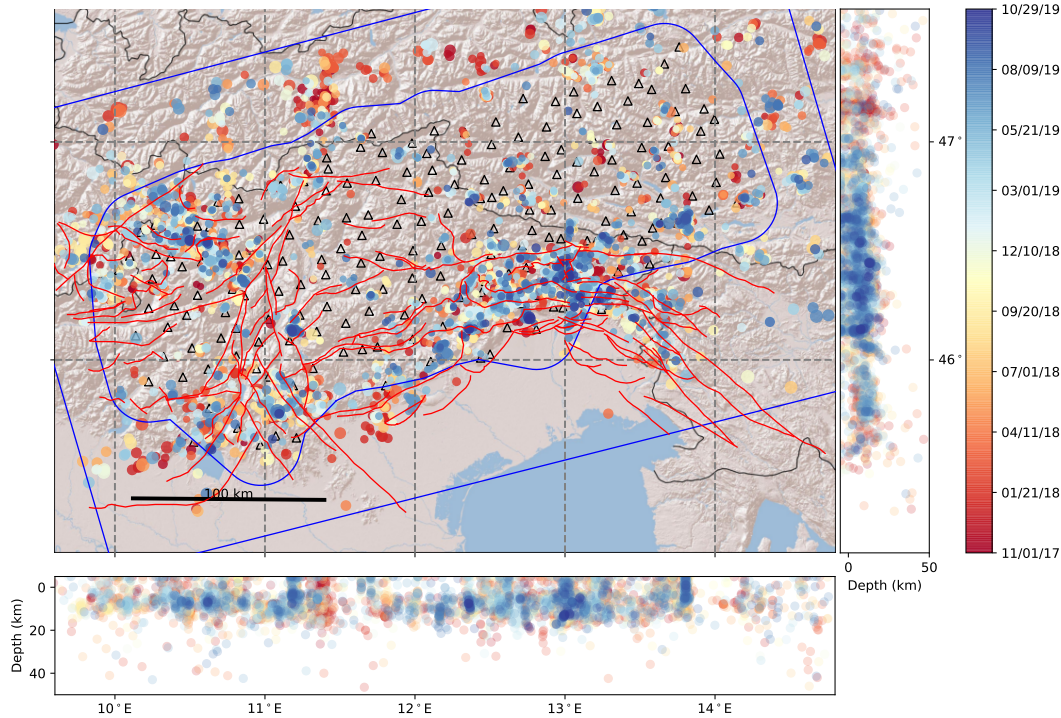


Example of an event cluster on the Swiss-Italian border before and after optimizing picks, including several relocalization iterations.





# Results



~ 7900 Events from late '17 to late '19  
 ~ 96500 Picks  
 Precise locations  
 Relative magnitudes

## Summary / Outlook

- GPU accelerated template matching algorithm was developed and applied
- A semi-automatic workflow was developed to pick and relocate detected seismicity based on waveform similarity
- A catalogue will be published with an interpretation of the regional scale seismic features
- Future work will be focused on smaller scale features

