


# High-Resolution Velocity Model of the Bohemian Massif Crust from Ambient Noise Tomography

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and AlpArray WG



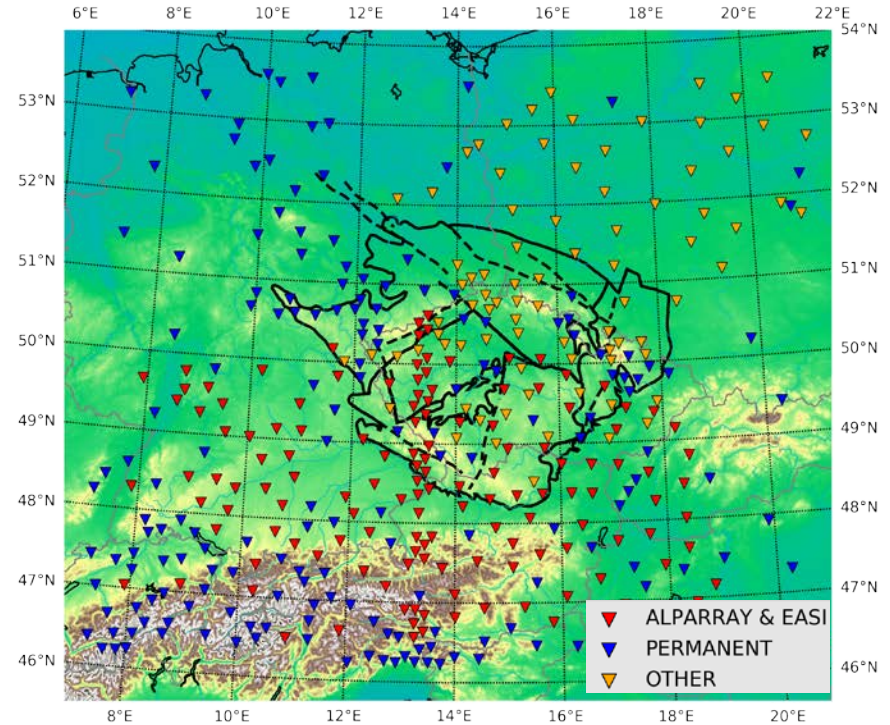
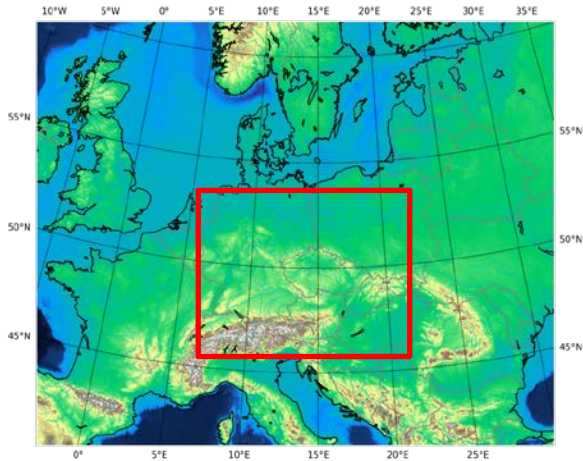
 EUROPEAN UNION  
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MINISTRY OF EDUCATION,  
YOUTH AND SPORTS

Workshop CzechGeo/EPOS  
Prague 5th Dec 2018

# Seismic stations used in the study

- The target of this study is Bohemian Massif
- We use continuous vertical-component broadband recordings



**Total Number of stations: 404**  
(About 160.000 hypothetical Source-Receiver pairs)

Permanent stations

Czech Regional Seismic Network (CRSN including MONET & WEBNET)  
Stations from neighbouring networks (SXNET, GRSN and PLSN)

Temporary stations from passive experiments

MOBNET IG (BOHEMA I-IV, PASSEQ, EGER-RIFT)  
ALPARRAY EASI & AASN

# Data Processing

## Ambient Noise Tomography

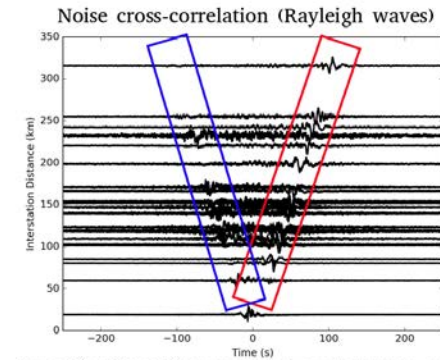
- Data Selection
- Instrumental Response Removal
- Station-Pair Processing
  - Cross-correlation (MSNOISE package, Lecocq et al., 2014)
  - Stacking of traces (MSNOISE package)
    - Threshold of 60 days (minimum)
  - Frequency Time Analyses FTAN (PYTHON packages)
    - period (frequency) sampling: third octave bands
  - Dispersion Curve picking
    - Automated picking
    - Progressive max-amplitude picker with fundamental mode priority
    - Dispersion curve length (maximum period) set according to inter-station distance
  - Visual checking of dispersion curve to eliminate outliers
    - Total number of accepted dispersion curves: 21 066
- Common Period Processing
  - 2-D Fast Marching Surface Wave Tomography (FMST package, Rawlinson 2005)
    - Surface sampling 22 x 22 km (processing grid)
    - 6 iterations (velocity search per period)
    - Reconstruction of dispersion curves at regular grid
- Common Grid-point Processing
  - 1D Non-linear Monte Carlo (GEOPSY package, Wathelet 2008)
    - 360 iteration, 280 initial models => 100 000 resulting models
    - “Five” layered models, IASP91 constrain
    - Linear gradient velocity

# Time Window Selection

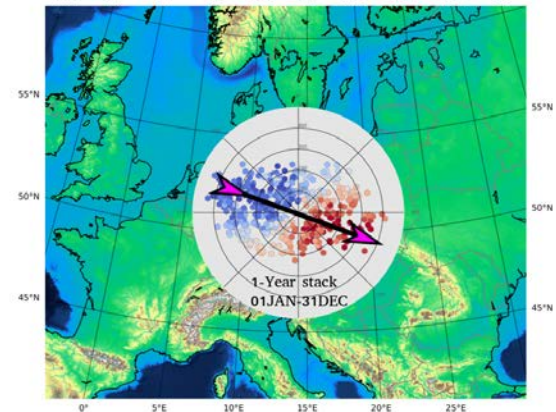
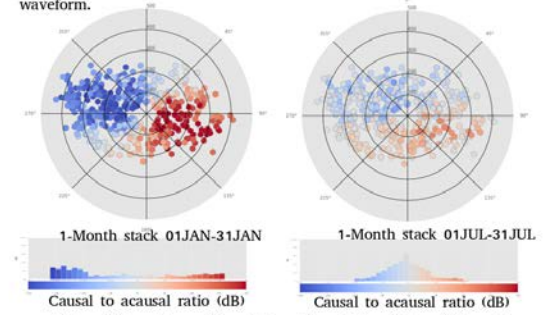
- Selection of quiet noise season
- Summer time June to August
- Isotropic ambient noise generators

Total Number of stations: 404  
Processing Time Period: June-August  
Station Pair Overlap: >60 Days  
Total Number Station Pairs: **21 066**

## (b) Source Directivity

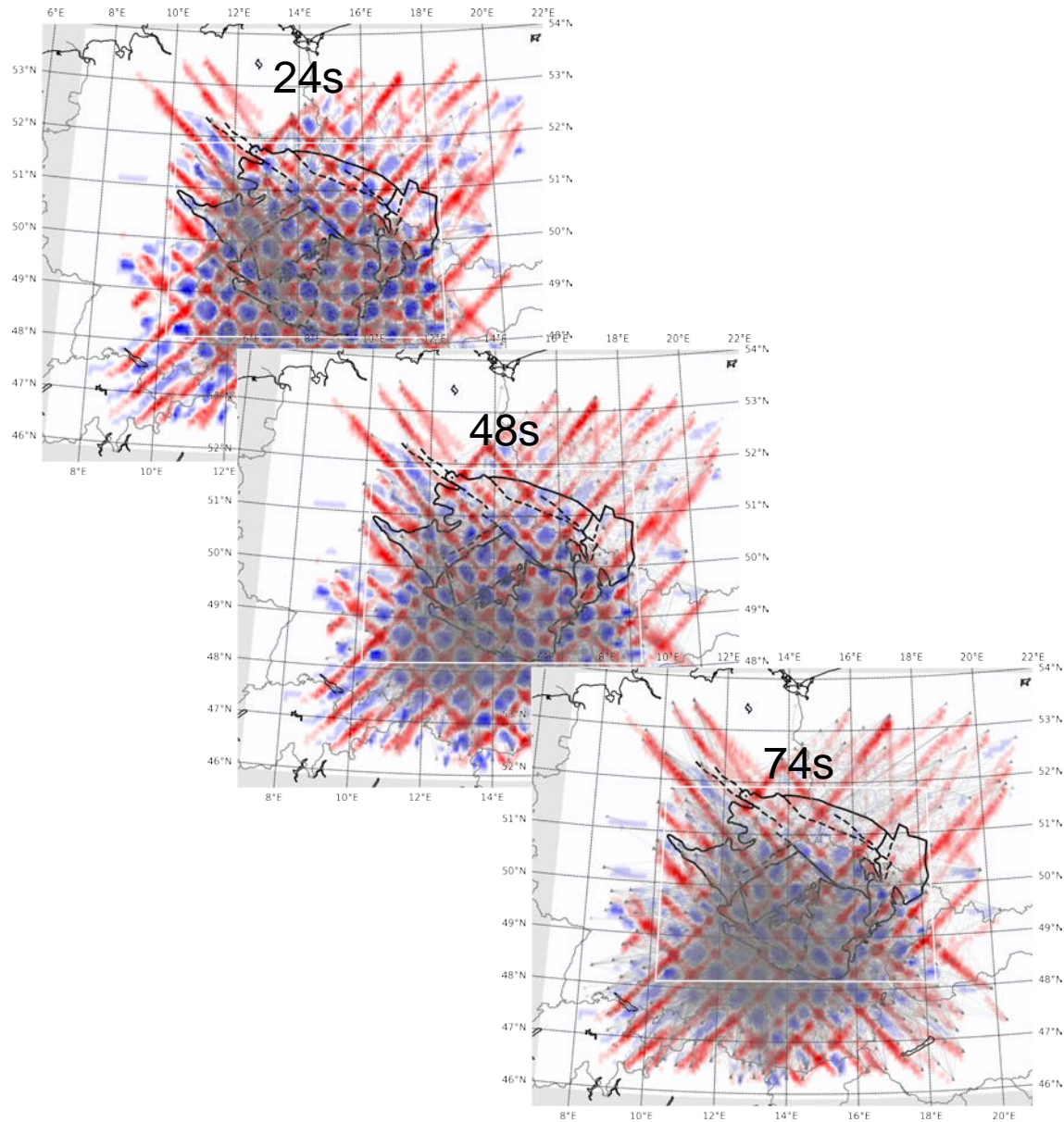
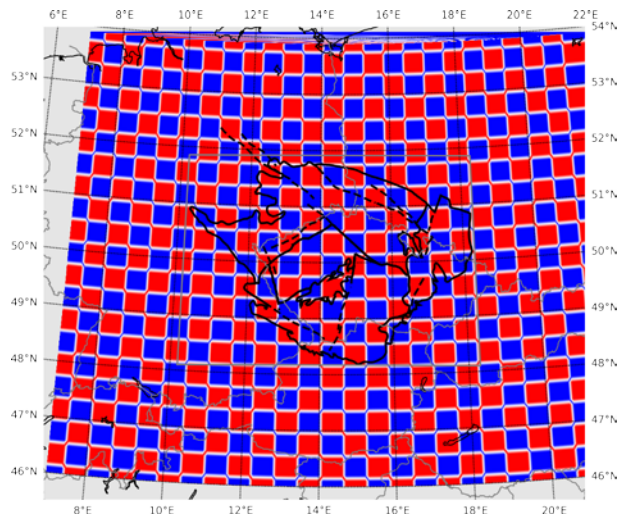


Source directivity attribute was defined as ratio between causal (red rectangle) and acausal (blue rectangle) parts of cross-correlation waveform.



# Spatial Resolution

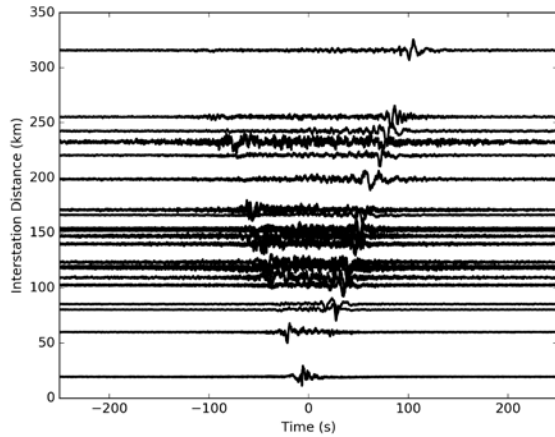
- Checkergboard Test
- Checker size 44x44km
- Input (21066 pairs)



# Rayleigh Wave Group Velocities

## Cross-correlation functions

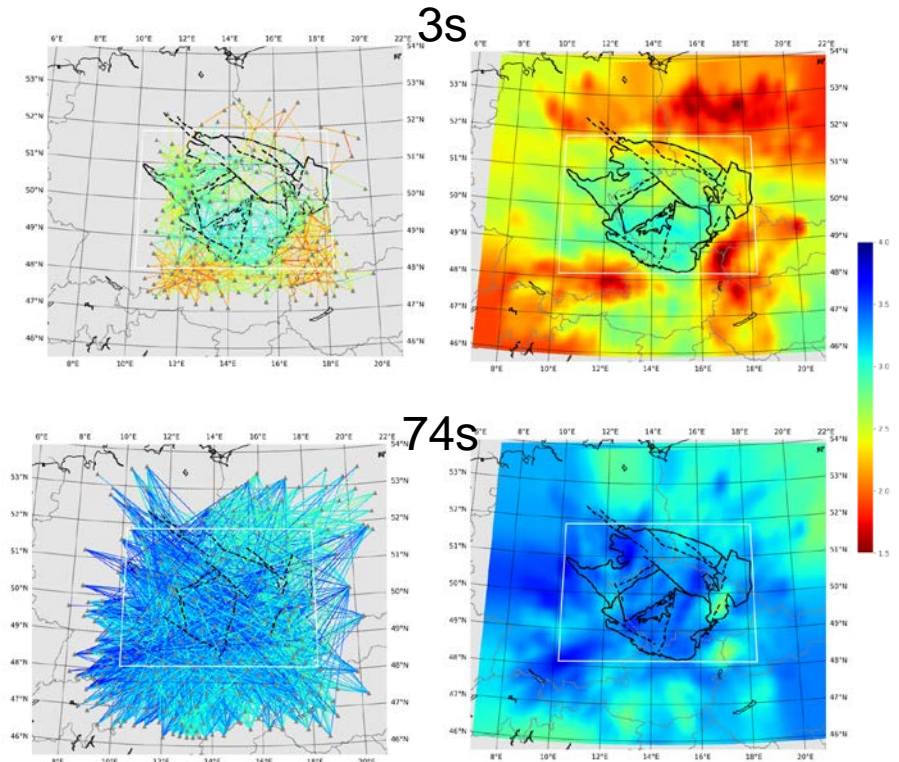
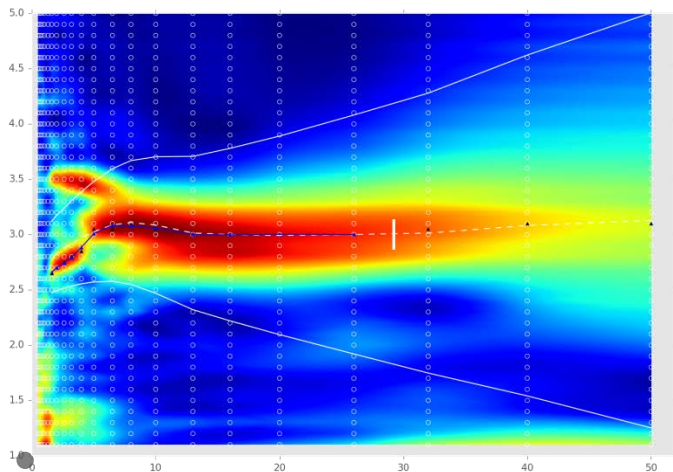
- MSNOISE package, Lecocq et al., 2014



- **2D Fast Marching Surface Wave Tomography**
- FMST Package (Rowlinson 2005)
- Surface sampling 22 x 22 km (processing grid)
- 6 iterations (velocity search per period)
- Reconstruction of dispersion curves at regular grid

## FTAN Analysis and dispersion curve picking

- Automated picker (Python Packages)



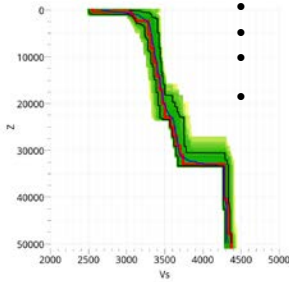
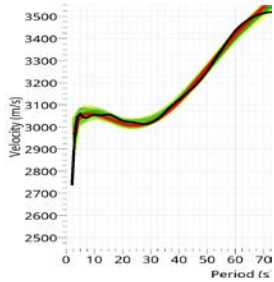
# Stochastic Inversion

## 1D Non-Linear Monte Carlo

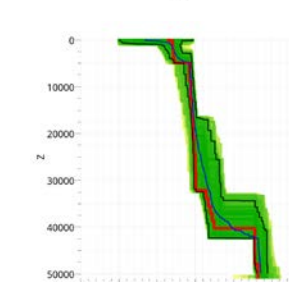
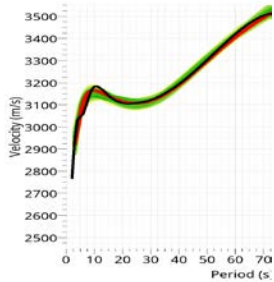
- GEOPSY Package (Wathelet 2008)
- 280 initial models, 360 iterations
- 100000 resulting models

- Five Layer Gradient Velocity Model**
- Surface Layer
  - Shallow Crust
  - Upper Crust
  - Lower Crust
  - Uppermost Mantle

Tepla-Barandien Saxothuringian  
49.5N 13.5E



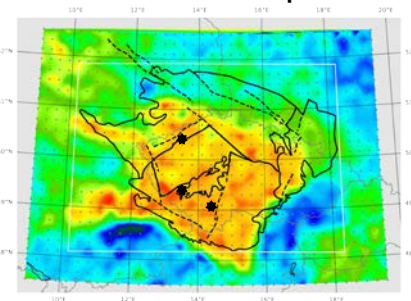
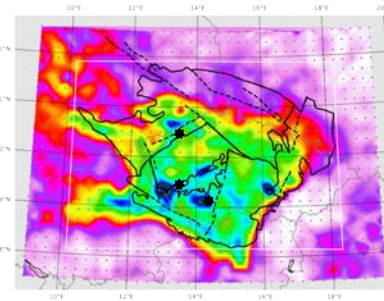
Moldanubian  
49.1N 14.4E



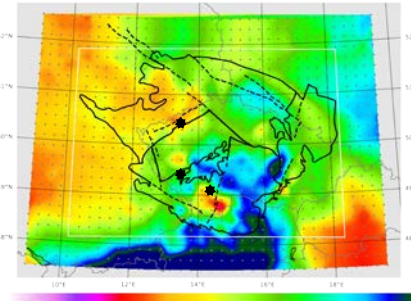
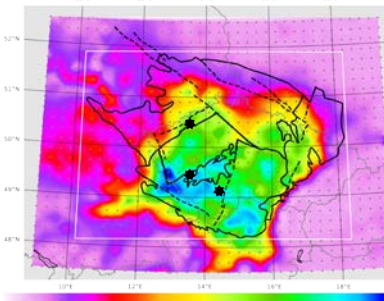
Vs – Mid SubLayer

Bottom Depth

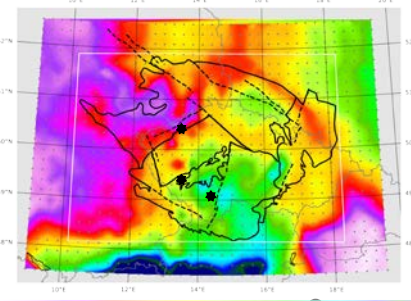
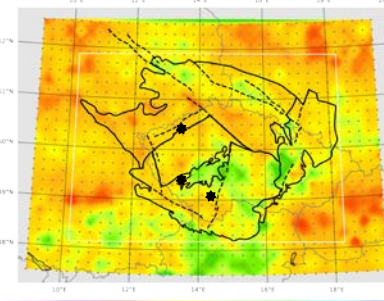
Surface Layer



Upper Crust



Lower Crust



# Conclusions

- \* Available permanent stations combined with temporary stations deployed in AlpArray and various MOBNET passive experiments provide sufficient spatial resolution to expected scale of major geological units in the Bohemian Massif.
- \* The source directivity analysis and seasonal variation tests showed that the Bohemian Massif area is predominantly affected by Atlantic Coast as main ambient noise source generator.
- \* Our ambient noise tomography flow gives fairly robust image of Crust velocities