Institute for Meteorology and Climate Research

Karlsruhe Institute of Technology

DESERVE
DEAD SEA RESEARCH VENUE
Helmholtz Virtual Institute

Seismological and Meteorological Measurements at the Dead Sea to Investigate the Impact of Wind on Seismic Signals

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1. Overview

We designed a target-oriented experiment in the Dead Sea valley to investigate the influence of meteorological parameters on ground motion.
Distinct local wind systems are common in this area and these are investigated within the DESERVE project.
The project is funded by the Helmholtz Association and focuses on multiple geoscientific disciplines addressing natural risks such as weather and climate aspects, seismic hazard and changes in water cycle in the environment of the Dead Sea region.

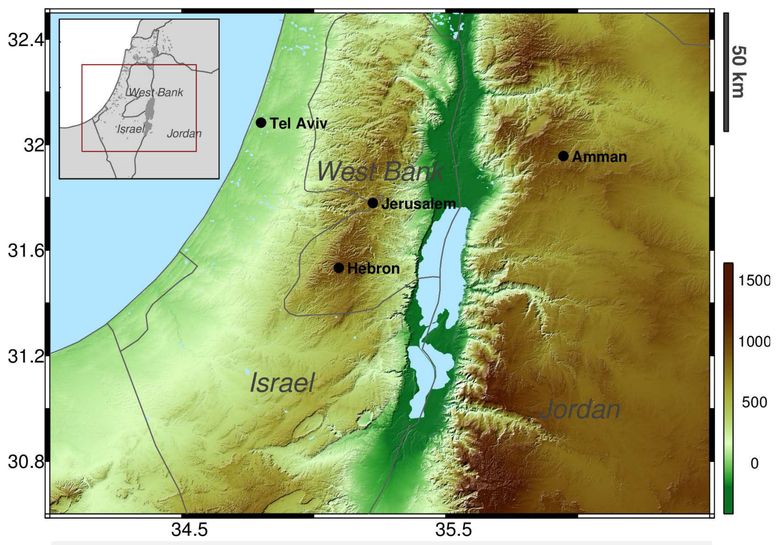


Fig. 1: Dead Sea area between Jordan, Israel and Palestine

The Dead Sea area forms a deep valley down to 429 m below sea level between mountains of up to 1000 m above sea level. Due to steep topography, high solar radiation, and the water body in the valley, temperature differences are high and cause diurnally occurring local wind systems.

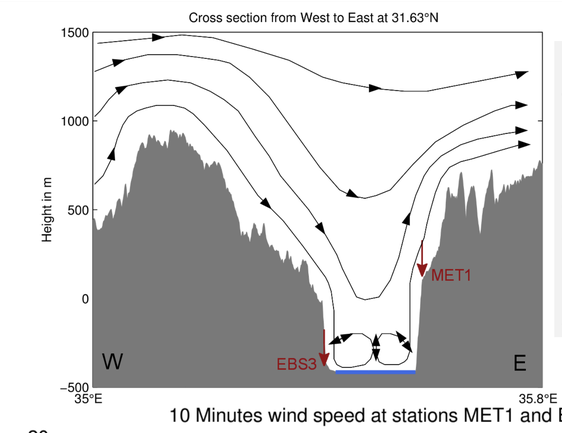


Fig. 2: Cross section of the valley from west to east. Black lines indicate common mesoscale west winds interacting with local winds in the valley

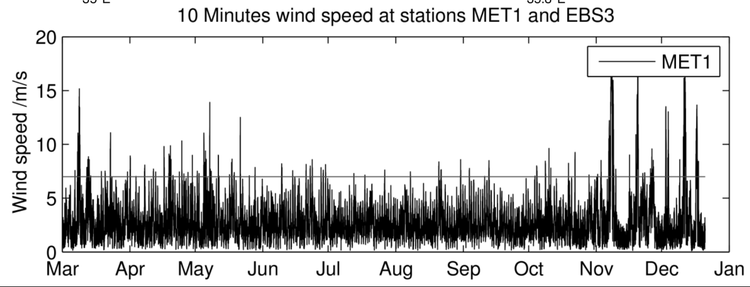
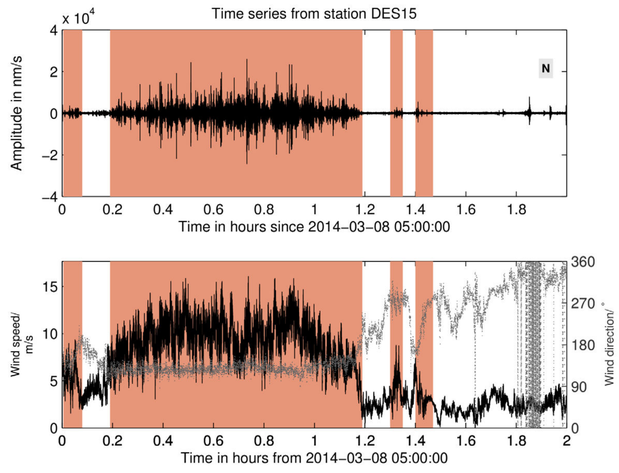


Fig. 3: Wind speed observed at station MET1

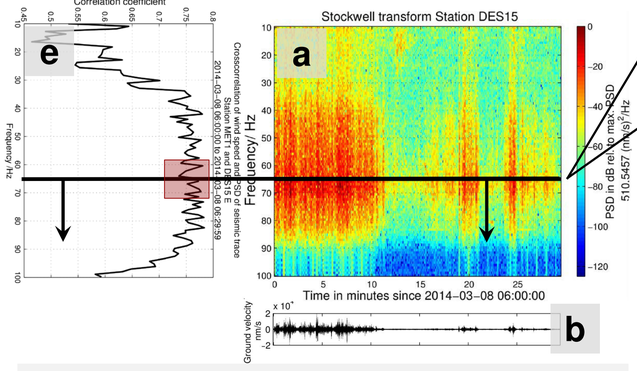
2. Background



Noise caused by weather phenomena is a common problem in seismology. However, hitherto investigations on the influence of wind on seismological data were mostly secondary results and therefore limited in the comparability of meteorological and seismic data sets.

Fig. 4: Temporal concurrence of high seismic amplitudes and high wind speeds at seismic station DES15 and meteorological station MET1

4. Correlation of Wind Speed and Ground Motion



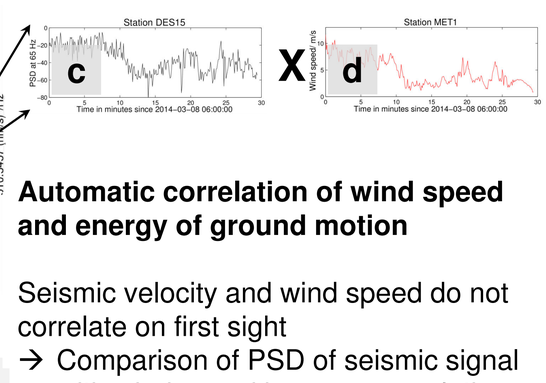


*Fig. 8: **a:** Energy in seismic trace (**b**). **c:** Energy of fixed frequency (here: at 65 Hz) and cross correlation with wind speed (**d**). **e:** Calculation for whole frequency range: Graph of cross correlation values*

Automatic correlation of wind speed and energy of ground motion

Seismic velocity and wind speed do not correlate on first sight
→ Comparison of PSD of seismic signal with wind speed by cross correlation

3. Measurements and Data

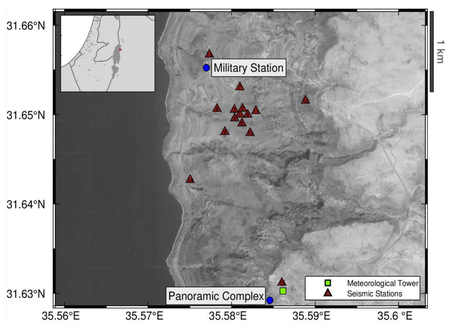


Fig. 5: Measurement site in north west part of the valley. Meteorological station is very close to seismic stations. Satellite image: Google maps

Measurements from March 2014 to February 2015:

3-component seismometers at 200 Hz sampling rate:
- 5 x 1 Hz Mark L-4C-3D
- 10 x 120 s Trillium Compact

Meteorological station:
- 10 m tower
- 20 Hz sampling
- Multiple meteorological parameters, amongst others: 3-component wind speed

Fig. 6: Meteorological station MET1

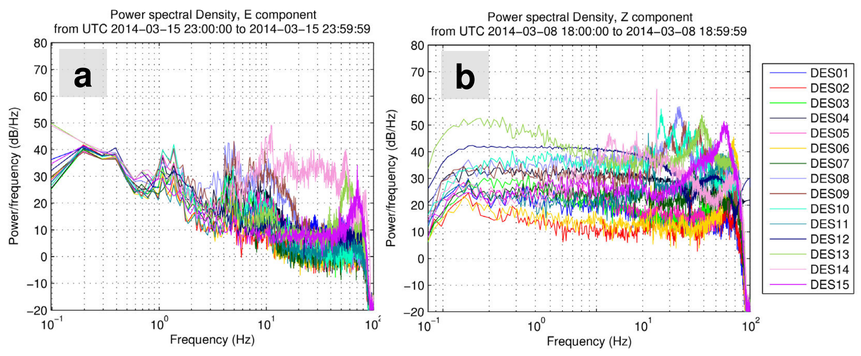


Fig. 7: Power spectral density at all seismic stations
***a** at night with low wind speeds*
***b** at night with wind speeds up to 15 m/s*

5. Storm Day in March 2014

From 8th to 9th March a storm with winds from south west occurred in the Dead Sea area. At the meteorological station MET1 we observed wind speeds up to 20 m/s.

There are correlations between wind speed and seismic data at multiple stations.

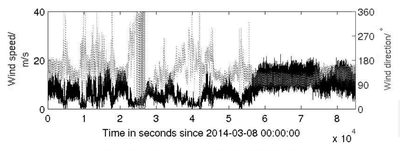


Fig. 9: 1 day wind speed at MET1

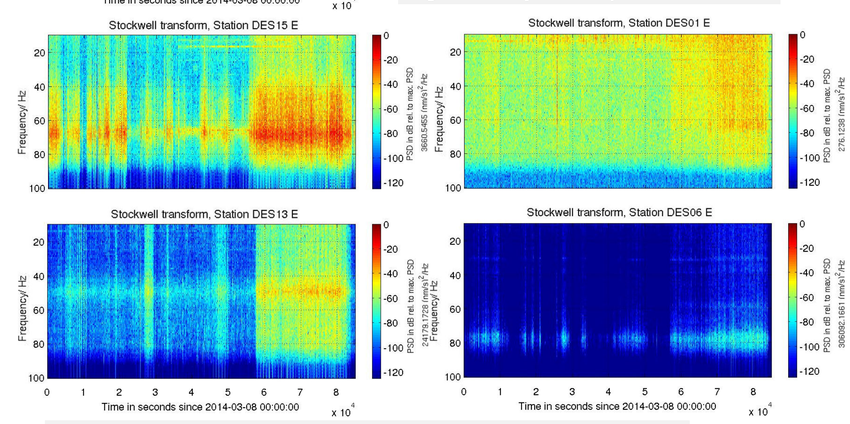


Fig. 10: Energy in seismic signals at 4 different stations the same day. Times with high energy correlate with high wind speeds (see fig. 9)

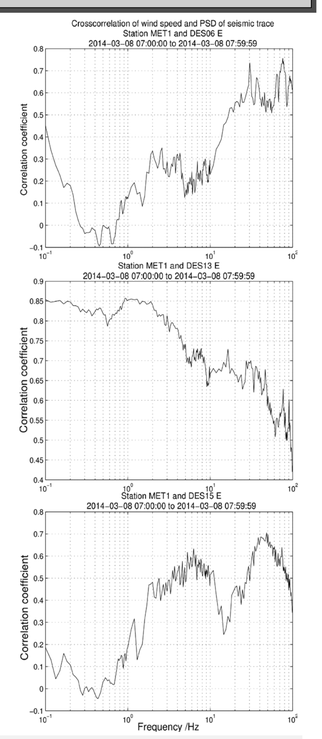


Fig. 11: Cross correlations between seismic PSD and wind speed from 7:00 to 8:00 UTC.

6. Outlook

First results show correlations between wind speed and seismic signals.
Open questions:
- What is the lower threshold in wind speed for the excitation of seismic noise?
- Is there an influence of the wind direction on the seismic noise field?
- What are the properties of correlation functions between wind speed and seismic amplitudes?
- How do site effects influence the seismic noise properties?

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