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Seismic Noise Characteristics at the Romanian Broadband Seismic Stations

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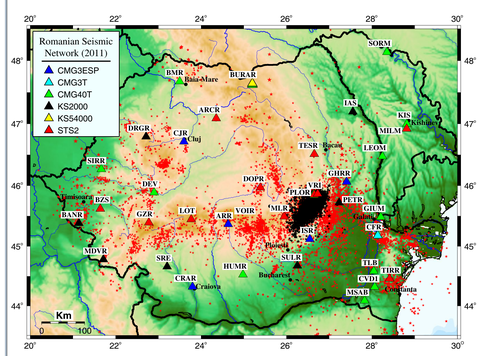
Introduction

In the present work we study the characteristics of the seismic noise recorded at the Romanian broadband seismic stations using power spectral density (PSD) estimates and their corresponding probability density functions (PDFs) (McNamara and Buland, 2004). This approach allowed us to investigate the variations of the seismic noise related to time of day, season, location or type of installation.

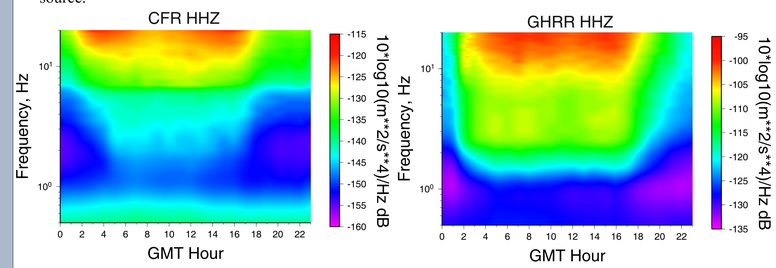
Data and Method

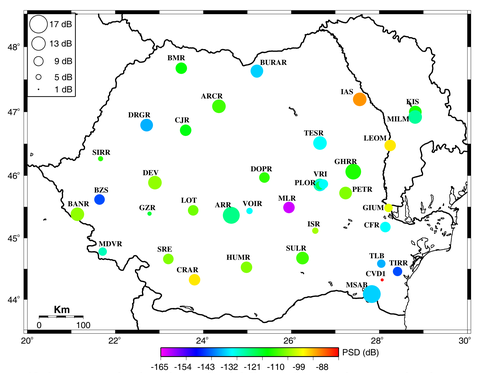


- Romanian Broadband Seismic Network (RBSN) - 48 stations;
- data from January 2006 to December 2010;
- PQLX software (McNamara and Boaz, 2005);
- no need to screen the data for earthquakes, spikes, calibration pulses, etc;
- Probability Density Functions: useful tool for monitoring the network performance and to evaluate the seismic noise level at a given station;
- several statistics can be calculated - min, max, mean, median, mode, etc.

Diurnal Variations

- at high frequencies (> 1Hz), seismic noise is mainly associated with the coupling of man and man-made machinery (power plants, factories, highways, etc.) energy into the Earth.
- the cultural noise level is different from site to site depending on the source and the distance to the source.



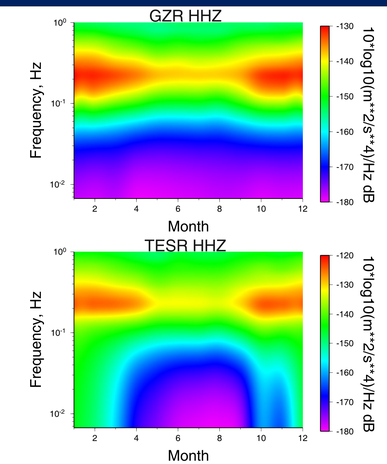


Nighttime noise levels and noise level difference between daytime and nighttime in the frequency range 1-20 Hz

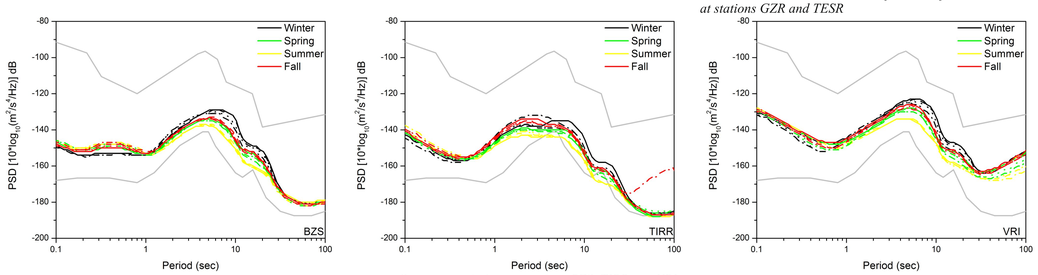
- computation of PDF median for each hour of the day over a 30 days period (figures up);
- computation of PDF median in the frequency range 1 - 20 Hz for daytime (10 - 14 h) and nighttime (0 - 4 h), respectively (only for vertical component);
- diurnal variations as the difference of the daytime and nighttime noise levels (figure on the left);
- the highest diurnal variation at MSAB station (17 dB) and the lowest at CVD1 station (3dB);

Seasonal Variations

- seismic noise seasonal variations are observed usually in the microseismic band (1-20 s);
- two prominent peaks in this frequency range: single frequency peak (T = 10 - 16 s) generated in shallow coastal waters and double-frequency peak (T = 4 - 8 s) generated by the superposition of ocean waves traveling in opposite directions;
- computation of PDF median for each month of the year 2010 (figures on the right) at two stations, GZR and TESR -> strong power increase (~20 dB) in the secondary microseism band (2.5 ~ 8 s) during the first and last three months;
- computation of the PDF median for periods of three months, from December 2006 to November 2010 (figures down): winter months (December 2006 - February 2007, December 2007 - February 2008, December 2008 - February 2009, December 2009 - February 2010), spring months (March 2007 - May 2007, March 2008 - May 2008, March 2009 - May 2009, March 2010 - May 2010), summer months (June 2007 - August 2007, June 2008 - August 2008, June 2009 - August 2009, June 2010 - August 2010), fall months (September 2007 - November 2007, September 2008 - November 2008, September 2009 - November 2009, September 2010 - November 2010);
- increase of the noise level during winter months;
- shift of the maximum of the double-frequency peak from shorter periods in the summer to larger periods in the winter for all the stations except the stations close to Black Sea.

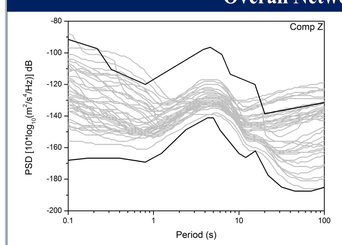


Variation in the PDF median as a function of month at stations GZR and TESR

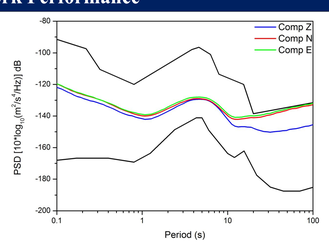


Seasonal variations at stations BZS, TIRR and VRI

Overall Network Performance



PSD median curves for all the Romanian broadband stations (vertical component)

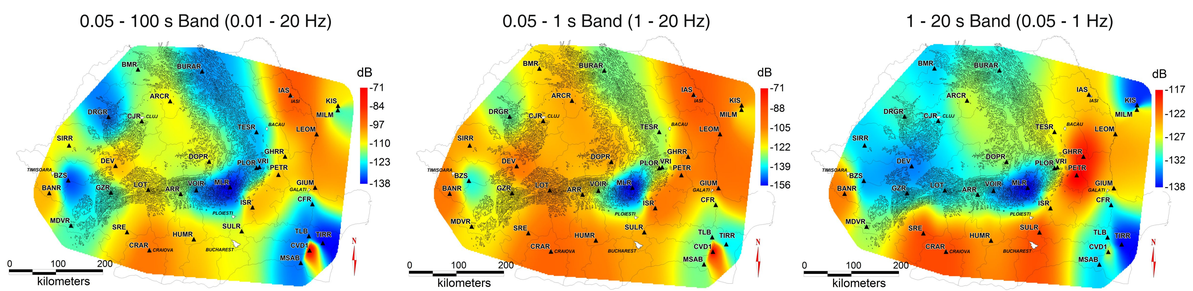


PSD median value across RBSN

- the lowest difference in noise levels, reaching 20-25 dB, is observed for periods between 2 and 10 sec (secondary microseism);
- for the primary microseism band (10-20 sec), an increase of the difference in the noise levels can be observed from 20 dB at T~10 sec to 30 dB at T~20 sec;
- for periods shorter than 2 sec (cultural noise), the power of the vertical components ranges between -160 dB up to -90 dB;
- the horizontal components are noisier than the vertical component (tilting effects) at periods larger than 10 s.

Geographic Variations

- investigation of the variation of the background seismic noise as a function of geographic location;
- maximum median noise levels are mapped across RBSN network in three period bands: 0.05 -100 s, 0.05 - 1 s and 1 - 20 s;
- natural neighbor interpolation method is used for mapping the median noise levels;
- stations with higher noise levels in the proximity of the cities and on sites with softer rock conditions;
- lower noise levels on sites with harder rock conditions;



PDF median noise levels mapped across the Romanian territory in three period bands

Conclusions

- Probability Density functions are used to evaluate the seismic background noise at RBSN stations;
- In the frequency range 1 - 20 Hz all stations exhibit diurnal variations related to cultural activities;
- Seasonal variations are observed in the microseismic band (1 - 20 s);
- High noise levels are observed for stations in the vicinity of the cities and on sediments;
- Low noise levels are observed for stations on hard rocks.

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