8th International Conference on Seismology & Earthquake Engineering
11-13 Nov. 2019, Tehran, Iran

# MONITORING OF VELOCITY CHANGES NOVEMBER 12, 2017 EARTHQUKAE, SARPOL-E ZAHAB (IRAN AND IRAQ BORDER) WITH MOVING WINDOW CROSS SPECRAL TECHNIQUE

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**Keywords:** Velocity changes, Moving Window Cross Spectral, Precursory, Earthquake, Sarpol-e Zahab

Ambient noise is instrumental in the investigation of seismic characteristics consistently. One of these seismic characteristics is seismic velocity, which can be monitored by ambient noise. In this paper, we took advantage of MSNoise Python package (Lecocq et al., 2014) for studying velocity changes before M-w 7.3 12 November 2017 Sarpol-e Zahab earthquake. At the first step, data collected from Iranian Seismological Center (IRSC) between January 2017 until December 2017, are resampled to 10 Hz. Two stations of Dehrash (DHR) and Layen (LIN) are selected because they were the nearest stations to the earthquake epicenter. Afterward, the vertical components of daily recordings are divided into 30 min segments. In the next step, segments are demeaned and detrended, then traces are normalized to three times the root-mean-square (RMS) and spectrally whitened between 0.01 and 8 Hz. In the following, the daily cross-correlations between a pair of stations are computed (Mordret et al., 2016). According to moving window cross spectral (MWCS) method, daily cross-correlation are stacked for whole period of this study called reference cross-correlation function (CCF), and in this case study, we compare stack of daily cross-correlations for every 5 days, 10 days, 30 days, which is called current window CCF, and linear stack method is selected for our work. In order to surface wave energy is dominated, CCF is filtered between 0.1 to 0.5 Hz. Owing to this fact that coda waves of CCF are less sensitive to changes in the noise source properties and distribution (Mordret et al., 2016). The velocity variations are measured on coda waves. With respect to (Figure 1), in our analysis causal and a causal side of CCF are used, and also time lags between 5 and 35 s in both sides (before and after zero time) are picked, then the similarity of the two time-series is assessed using the cross-coherence between energy densities in the frequency domain. The time delay between the two cross-correlations is found in the unwrapped phase of the cross spectrum and is linearly proportional to frequency. This delay for each window between two signals is the slope of a weighted linear regression (WLS) of the samples within the frequency band of interest (Clarke et al., 2011; Lecocq et al., 2014).

We got results that by 12 November of 2017 earthquake, the seismic velocity had decreased dramatically (Figure 2), which is more obvious in 30 days of CCF. These velocity changes before earthquakes can be used as an earthquake precursory.

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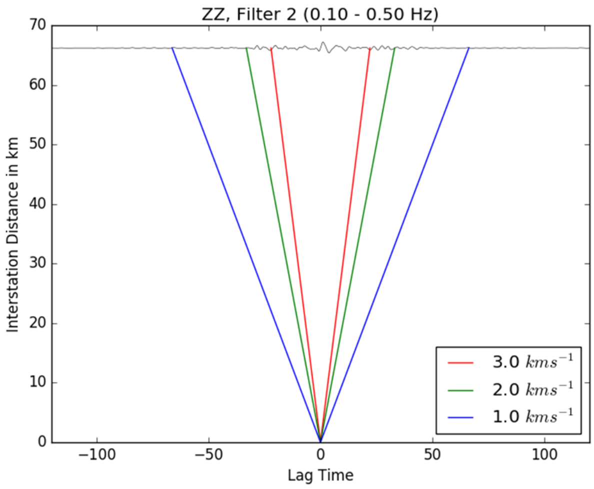


*Figure 1. Stacked daily cross-correlation function from January 2017 until December 2017 between DHR and LIN stations (the distance between two stations is about 66 km) The coda wave is assumed between 5 to 35 s lag times in both sides of zero.*

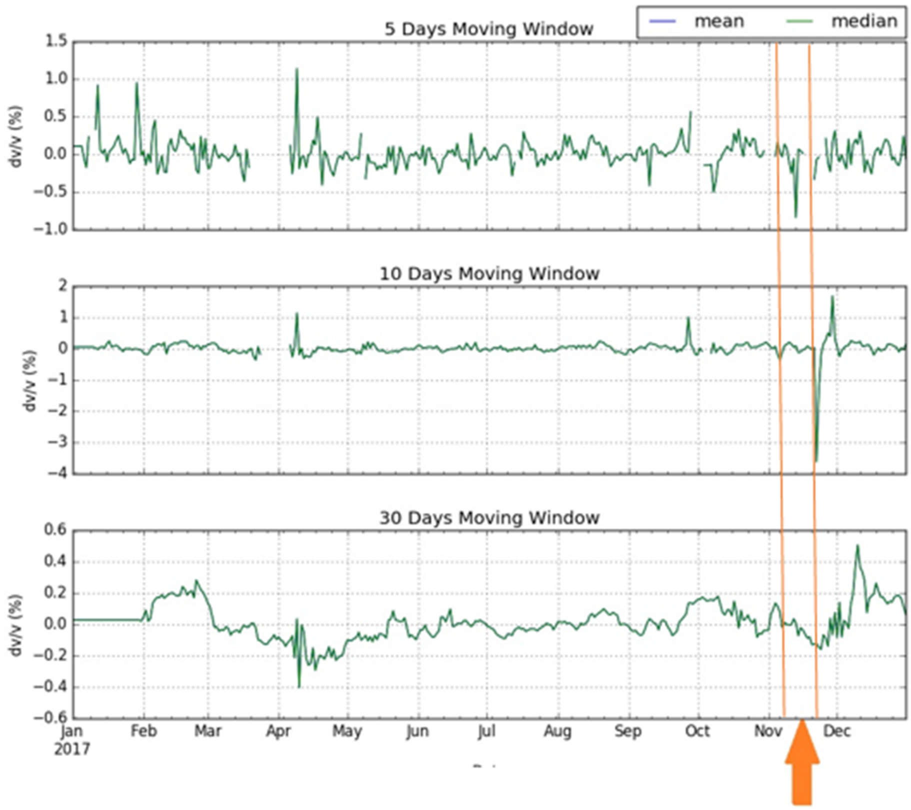


*Figure 2. Velocity variations between January 2017 and December 2017, the arrow indicates the date of Sarpol-e Zahab earthquake, and lines illustrate 5 days after and before the earthquake. In March and April of 2017, there was a gap of data, which is clear in 5 days and 10 days moving window. There is a trend in 30 days moving window during 7th to 17th November; however, in 5 days moving window velocity decreased sharply at the date of the earthquake.*