The free oscillation modes of Chile 2010 and 1960 events observed with the Grotta Gigante Horizontal Pendulums

U41A-4.
The 2010
Chile Earthquake

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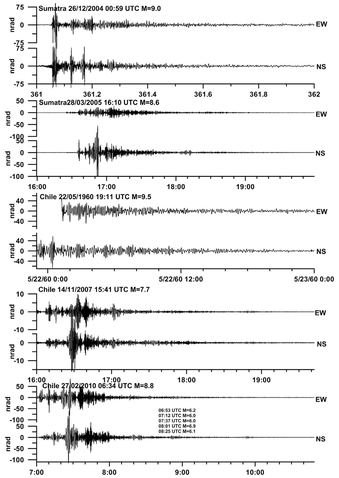
1 ULTRA BROAD BAND HORIZONTAL PENDULUMS

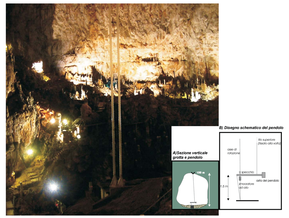
- First recordings in 1960. Continuous since 1964.
- Free oscillations generated by Chile 1960 earthquake were recorded for the first time
- instrument set up has been maintained in the same location: absolute control on amplification factor
- Earth tides allow absolute amplitude control
- Three major events in 100 years were recorded: Chile 1960 (M=9.5), Sumatra 2004 (M=9.0), Chile 2010 (M=8.8) (M after NEIC)

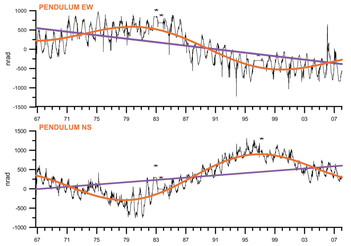
2 TIME SERIES OF CHILE 1960, 2007, 2010, SUMATRA 2004, 2005



3 INSTRUMENTS

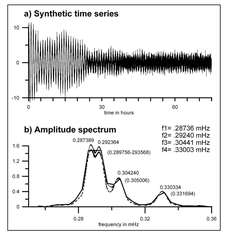
- Zöllner suspension horizontal pendulums. Period: 6 minutes.
- Length: 100 m. Geographical Position: Lat. 45.7083°, Long. 13.7633°
- Secular term deformation recorded. Identified signals: Earth tides, Carstic water flow,Ocean Loading, Free oscillations





4 SPECTRAL ANALYSIS

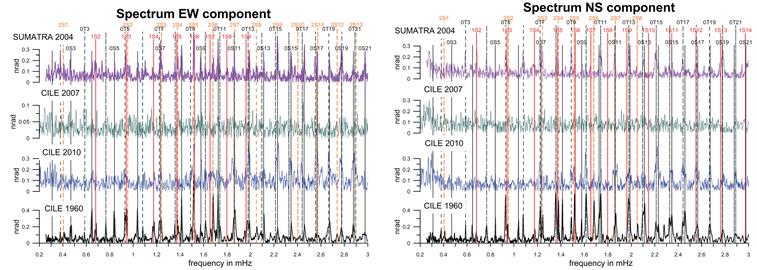
For the data series of N equidistant samples (sampling interval dt), K spectra were calculated for different lengths of data series, the time intervals ranging from the maximum window size of $T_{max}=(N-1)dt$, decreasing to $T_K=(N-1)dt-(K-1)dt_s$, dt_s a time interval suitably chosen. The K spectra thus have different resolved frequencies $f_{nK}=(n-1)/T_K$, with $n=1,2,\ldots,N/2$. The different K spectra are merged into a single composite spectrum. The advantage of this procedure with respect to a single spectrum, is that the presence of spectral peaks which possibly fall between two resolved frequencies of the single spectrum, are retrieved unambiguously.



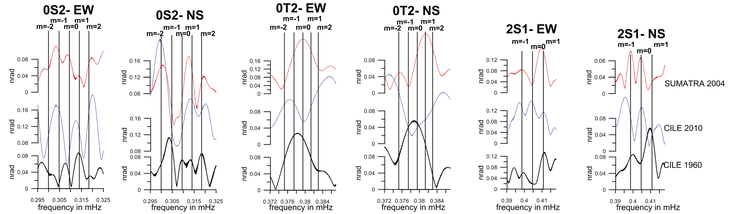
- Left: Amplitude spectrum of the synthetic data series (four damped oscillations). The Different curves have been obtained with a simple Fourier spectrum with windowing (heavy line), with the composite Fourier spectrum using a tapering window with taper-width M=N/2 (dashed) and M=N/3 (light continuous line). The time series is shown in the upper part of the figure.

5 FREE OSCILLATIONS SPECTRA

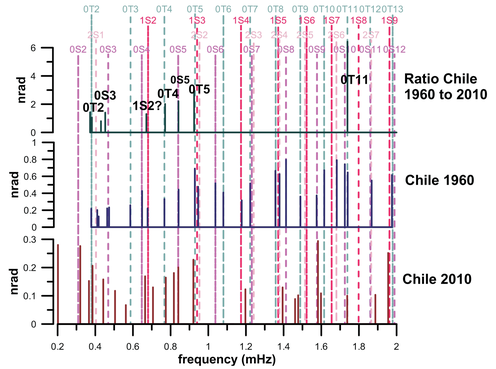
- Compare amplitudes of spectra. Interval of analysis: 75 hours.
- Number of data: Chile 1960: N=9000 (30 sec sampling)
- All other spectra: N=18000 (15 sec sampling).
- Distance from Trieste station:
- Chile 1960: 114°
- Sumatra 2004: 82°
- Chile 1960: higher amplitude for lower modes.



- Splitting of modes is shown for 0S2, 0T2, 2S1. Splitting frequencies are consistent among events. Deviations from theoretical frequencies are present.
- (frequencies: Zürn, Widmer, pers. Comunication; Dahlen and Sailor, 1979).



- Amplitude ratios of selected modes for Chile 1960 and Chile 2010. The Chile 1960 event activated modes that have an amplitude from two to eight times greater respect to the Chile 2010 event.



6 CONCLUSIONS

- Grotta Gigante tiltmeter produces absolute comparison of Chile 1960 and Chile 2010 events.
- Chile 2010 event deficient in the low free oscillation modes (with f < 1 mHz) compared to Chile 1960.
- Free oscillation modes are two to eight times smaller in amplitude.
- Splitting of modes observed on lowest modes: for example 0S2, 0T2 and 2S1. Splitting-frequencies are consistent.

REFERENCES

- Bolt B. and A. Marussi, Geophys. J.R.Astr. Soc., 1961.
- Braitenberg C. and M. Zadro, BSSA, 2007
- Dahlen F.A. and R.V. Sailor, Geophys. J.R.Astr. Soc., 1979.

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