Co-seismicity and Frequency-time analysis of surface wave for NW Himalayan

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Summary

Frequency time analysis of surface wave and co-seismicity are the key points to analyze the different characteristics of subsurface feature beneath the Himalaya Gharwal region. The different parameters group wave velocity, polarizing anomaly, gravity offset for NW of Himalaya Gharwal region are studied through earthquake data analysis from 2008 to 2012 with magnitude   4.5. The co-seismicity characteristic is analyzed by superconducting gravimeter data, which is most sensitive to the long period signals (gravity tides with period longer than 6h). The analysis result for co-seismicity is found approximately 40 nms^{-2}. The frequency time analyze of surface wave indicates the spectral content of signal changes with time. The study of group velocity anomalies correlate the major geological structure of the region, which is useful to prepare the of tomography map for the study of crustal structure.

Introduction

The superconducting (or cryogenic) gravimeter is based on the levitation of a superconducting sphere in a stable magnetic field created by current in superconducting coils (Prothero et al.,1968; Warburton et al., 1995; Goodkind, 1999). The first Indian superconducting gravimeter(SG) was installed in March 2007 at the Multi-Parametric Geophysical Observatory of the Wadia Institute of Himalayan (*First Observations of Free Oscillations of the Earth (FOE) from Indian Superconducting Gravimeter in Himalaya.)*. An earthquake is the result of sudden release of the energy in the earth crust due to discontinuous displacement along a fault plane within Earth. This will give rise to a change in Earth's mass distribution as well as the radiation of seismic wave, whose speed is depend up on density and elastic moduli of the rock through which they it passes. This in turn results in a change on the gravity potential field of the earth. Viewed from a point fixed with respect to the earth, it would be observed as a small change in local gravity acceleration through the effects: apparent addition and subtraction of the earth mass and a change in the distance to the center of the earth.
Surface-wave dispersion measurement determines the phase angle, amplitude, and group arrival time of surface waves as a function of period. These data are important for studies of the crust-upper mantle structure, the source mechanism of earthquakes, and the elastic properties of the earth. Time frequency distributions (TFDs) map a one-dimensional signal into a two-dimensional function of time and frequency, and describe how the spectral content of the signal changes with time. From a strict mathematical point of view, we want to have a joint distribution, which will give us the fraction of the total energy of the signal at time *t* and frequency   ; i.e., we look for the function $G(t,)$. The aim of time-frequency analysis is to come up with appropriate candidates for $G(t,)$.

Theory and/or Method

The seismic waves observed in earthquake records manifest clearly non-stationary characteristics, as well as wide frequency content. Those characteristics are twofold. The first characteristic involves variations with time of the intensity of the ground motion (acceleration, velocity or displacement). That is, with the arrival of the first seismic wave, it (the intensity) builds up rapidly to a maximum value for a certain time and then decreases slowly until it vanishes. The second characteristic involves variations with time of the frequency content, with a tendency to shift to lower frequencies as time increases. This behavior is well known as a frequency dependent dispersive effect. This phenomenon is very complex and involves the arrival of the different seismic phases (P, S and Surface waves), the intensity of the ground motion, the magnitude of the earthquake, source and path effects, and the local soil conditions/geometry of the soil layers at the recorded site (trapped waves may produce quasistationary waves).

The velocity of Rayleigh waves depend on frequency, and the lower frequency (higher wavelength) Rayleigh waves have higher velocity since they penetrate deeply into the Earth. The particle motion of dispersive Love waves creates a horizontal line perpendicular to the direction of wave propagation.

During the last decade with the availability of high-quality digital broad-band seismic data, we have seen a rapid progress in imaging the structure of crust and upper mantle with increasing resolutions. Studies at local and regional scales are now common for regions with a good coverage of stations and earthquakes. Phase and group-velocity distributions obtained from dispersive surface waves correlate well with the main tectonic belts and geological

Units, which provide better constrains on their geometry and relation to the regional tectonics (Levshin *et al.* 1992, 1994; Ritzwoller *et al.* 2002; Pasyanos, 2005).

For the analyze of surface wave, we use nine ~~station~~ earthquake stations of the Gharwal region ~~has studied~~. By analyze of high amplitude of surface wave, the group velocity of wave is useful for study of structure of NW Himalaya.

For the detection of the co-seismic gravity changes an offset in the data close to the event time of the earthquake has taken. for that purpose 1 hr before the earthquake and 1 hr after the earthquake data set has taken. the data has been divided into two blocks. Block one starts 1 hr before the earthquake and ends a few second before recording to the earthquake. Block two starts few min after the event time and up to 1 hr. The first few min of the recorded earthquake were not used for fitting because of the large vibration caused by seismic waves. Large acceleration due to high frequency seismic wave tends to saturate the gravimeter, rendering the gravity data at the time of the earthquake and shortly thereafter unusable. To observe the co-seismic gravity offset/change the data of the two blocks were separately fitted by a quadratic polynomial to consider the different non linear trends before and after earthquake.

$$Y(t)=a+b.t+c.t^2$$

The difference of the calculated gravity of the fitted function at the event time for each block will give co-seismic gravity changes:

$$g_{co\text{-}seismic}=y2(t0)\text{-}y1(t0)$$

This offset is found to be both positive and negative, and may vary for different earthquakes depending upon whether gravity values is increased or decreased after the earthquake occurrence, at the SG station.
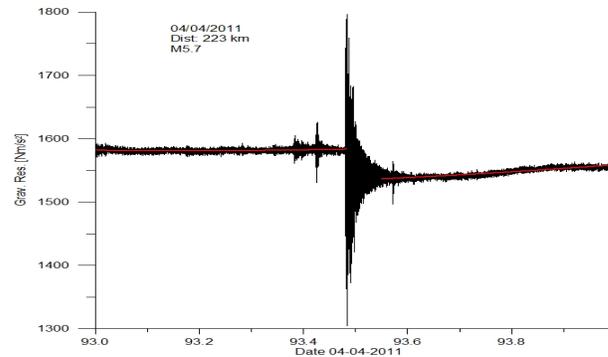
Example
a.
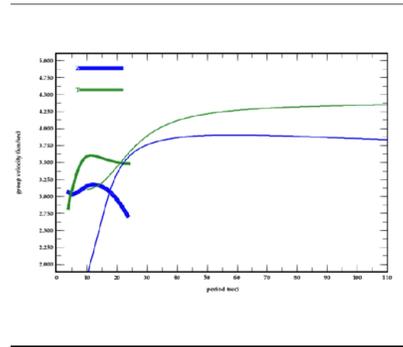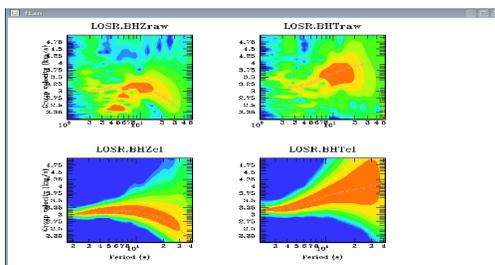
b.

 Fig a.FTAN raw and clean diagram

b . FTAN calculation of group velocities

c.

c. Enlarge view of offset of the Ghuttu station

Conclusions

It was observed that a clear offset was found in the near Western Nepal on date 04/04/2011 with magnitude 5.7. Its epicenter distance was around 223 km. The magnitude of the offset near Western Nepal was recorded approximately 40 nms^{-2} using the superconducting gravimeter data.
Dispersive behavior of surface wave helps in analysis of group velocity of surface wave. Due to which topographical map of the area is tomography of the area.

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References

Marian frequency, Jaqus Hinderar, Jeanot Trampert.Comparative study of superconducting gravimeter and broadband seismometer STS-1/Z in seismic and subseismic frequency band-1997

Dehant , V.1987 , Tidal parameter for an inelastic Earth.phys. Earth planets .inter ,49;97-116

Florsch ,N.,Hindere J.and Legro,H., 1995.Identification of quarter –dirunal tidal waves in superconducting gravimeter data .Bull,Inf.Maree.Terresters 122;9189-9198

Eric N. Ndikum1,2*, Charles T. Tabod1 , Alain-Pierre K. Tokam, Frequency Time Analysis (FTAN) and Moment Tensor Inversion Solutions from Short Period Surface Waves in Cameroon (Central Africa)

Anatoli L.Levshin, Michael H.Ritz Woller and Ludmila J. Ratnikova –Geophysics.J.Int(1994)117,577-590.The nature and cause of polarization anomalies of surface waves crossing northern and central Eurasia.

M.Didem cambaz and Hayrullah Karabulut –Gophysical .J.int(2010),Low wave Group velocity maps turkey and surrounding region.