Source model of the 1906 Ecuador-Colombia earthquake (Mw8.4) based on tsunami waveforms and seismic intensity data

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The 1906/01/31 Ecuador-Colombia earthquake (Mw8.4), is one of the largest megathrust earthquakes that have occurred at the interface of the Nazca and South-American plates. Recently the source process of the earthquake has been re-examined using historical tsunami waveforms, yielding a slip distribution mainly near to the trench (Yoshimoto et al. 2017, Y17), and a smaller moment magnitude than previous estimations (Kanamori and McNally, Mw8.8). Many studies have shown that tsunami data is able to constrain the long wavelength characteristics of slip during an earthquake. However to fully understand the strong ground motion generation process during earthquakes the study of shorter wavelength slip is also necessary. In this study we use the tsunami-slip model the 1906 earthquake (Y17), as well as comprehensive macroseismic intensity estimations of the earthquake (Sarabia and Cifuentes, 2007, SC07 to elaborate a multi-wavelength source model appropriate for the generation of broadband frequency ground motions as well as tsunami modeling. First, we investigated the spectral characteristics of the Y17 slip model (PSD), and applied a low pass filter to obtain a smooth slip distribution (LWN slip) (Figure 1a). We then used a Von-Karman PSD function to generate shorter wavelength slip models (HWN slip) (Figure 1b), and obtain broadband wavelength slip models of the earthquake (Figure 1c). The HWN slip models are constrained to have a given magnitude, correlation length and spectral decay, and a random phase. Our fault models span an area of 460 by 180 km^2 and a subfault size of 10km. We set the fault strike, dip and rake angles to 30, 13 and 118 degrees respectively and fault rupture velocity is fixed to 2.2 km/s. We simulated strong ground motions from the LWN and HWN slip models at the available intensity points. Strong motions are first calculated at a seismic bedrock condition (Pulido et al. 2015), and then we add site amplifications to simulated PGV values based on empirical relationships and an AVS30 map of Colombia (Eraso, 2015). Finally, we obtain simulated intensities based on our computed PGV values. Our results show that a multi-wavelength slip model of the earthquake is able to satisfactorily reproduce observed intensity values. Our estimated multi-wavelength slip model of the 1906 requires a slight increase in moment magnitude (~8.5), which represents the contribution of short-wavelength slips for strong motion generation.

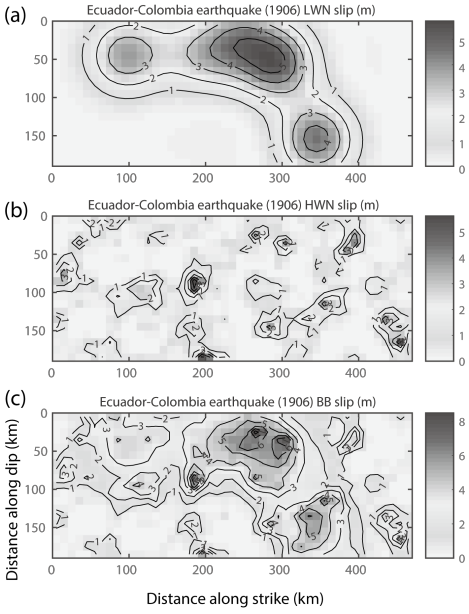

Figure 1. Typical multi-wavelength slip model of the 1906 Ecuador-Colombia earthquake; a) Long wavelength slip, b) Short wavelength slip and, c) Broadband wavelength slip.