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High-frequency seismic emission during Maule earthquake (Mw 8.8, 27/02/2010) inferred from high-resolution back-projection analysis of P waves

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Since its first application on Sumatra-Andaman earthquake, back-projection analysis has been widely exploited to infer the time-evolution of the rupture fronts of mega-earthquakes. In this technique, selected seismic phases recorded at teleseismic distances by a network of sensors are shifted according to a possible source position and a velocity model, and a multichannel version of the cross-correlation function is estimated. In this way, the time-dependent map of the seismic energy emission in the source area can be inferred.
We have back-projected the mainshock of Maule earthquake (Mw 8.8), which nucleated on 27/02/2010 in central Chile and is one of the largest earthquakes recorded in modern times. We have analyzed P phases filtered in the frequency range (0.4-3) Hz recorded by three seismic arrays located in US, Africa and Antarctica. Relative time shifts between sensors (inferred by maximizing the cross-correlation function) have been estimated with respect to a 1D global velocity model (ak135) and have been refined introducing two corrections, a static correction and a dynamic correction. The former is the time shift induced by local effects in the sensor area, whereas the latter is the correction associated with the source-sensor path and is mostly affected by medium properties in the source area. We have inferred these two corrections by analyzing the waveforms of 23 aftershocks and foreshocks with high magnitude (>5.3). In detail, static correction was chosen as the mean time shift averaged over all the events recorded by one station, while dynamic correction was the remaining part of the travel time after removing the 1D model travel time and the static correction. Moreover, dynamic corrections (and hence the complete travel times) have been interpolated over all the source area by Kriging, a spatial interpolation method.
Results show that high-frequency seismic energy emission mostly occurs along the coastline with a general northward migration during the event. Specifically, in the first minute of the rupture process, the energy emission occurs southerly from or close to the epicenter. Afterwards, seismic emission moves northwards, with a gap with respect to the first emission zone, and a further northward migration occurs till the end of emission. Both the spatial gap of seismic emission and the northward migration are in line with the results of other studies in the same area, whereas we find a shallower emission area and different emission features in the zone close to the epicenter. Results for different frequency bands and the analysis of secondary maxima of energy emission are being investigated. In particular, we are shifting towards higher frequencies looking at the frequency bands (1-4) Hz and (2-8) Hz. The former band displays an emission pattern similar to that of (0.4-3) Hz, but with a sharper gap of about 50 Km; the latter band shows coherent arrivals only during the first 80 s, with a clear energy emission south of the epicenter at the onset of the event and preserving the northward migration afterwards.