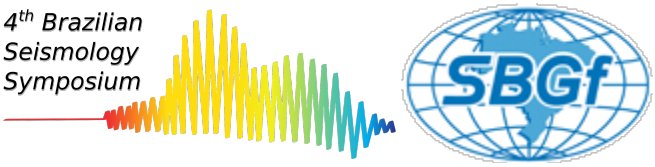

Development of computational routines for seismogram retrieval-processing and travel time anomaly measurement for multi-frequency tomography in Brazil

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We present a set of computational routines for retrieving, processing and managing seismological datasets based on the obspyDMT package (Hosseini & Siglock, 2017) as well as a routine for travel time anomalies measurements based on the cross-correlation method. Our developed routine allows the user to automatically retrieve three-component observed seismograms along with synthetic waveforms by setting a few key parameters as data center, network, epicentral distance, event magnitude, event catalog and date-time window. Synthetic seismograms matching the recorded ones are retrieved from the Syngine web service (Krischer et al., 2017), which uses the Instaseis package (van Driel et al., 2015) to calculate waveforms from Green's function databases generated with AxiSEM (Nissen-Meyer et al., 2014) and an event moment tensor for a desired reference Earth model. After the retrieving is finished, our routine organizes all folders, deleting the empty ones, and plots a map of event density per seismic station, a map with the focal mechanism beach balls of each event that has generated a record for our dataset and a histogram of event magnitude. For the processing step, to each downloaded waveform, our routine runs through all folders, removing trend and mean, resampling, deconvolving the instrument response to displacement, rotating vertical component and horizontal components to the transversal and radial ones, and adding ray-theoretical times of main phases. Our routines also check the seismogram headers and add missing information as epicentral distance, azimuth and back azimuth. After finishing the data processing, we developed a module for estimating travel time anomalies for P-phases and S-phases by cross-correlating synthetic and recorded seismograms, which are band-pass filtered for different periods. We apply the criteria of Ritsema & Van Heijst (2002) and Zaroli et al. (2010) to identify unreliable travel time anomaly measurements. For a multi-frequency tomography experiment in Brazil, we request seismograms from the IRIS and USP data centers, for the BL, BR, NB, ON, and XC networks, event magnitude above 5.5 mb from the GCMT catalog, epicentral distance larger than 30˚, in the period between 1992 and 2020. Synthetic seismograms are calculated using the 1D velocity structure from the AK135 model and moment tensors from the GCMT catalog. After data processing, we estimate travel times residuals for P-waves (e.g, P, PKIKP, PcP) and S-waves (e.g., S, SKS, ScS) by cross-correlating synthetic and recorded seismograms. Measurements are performed on bandpass-filtered seismograms for six different periods: 50 s, 32 s, 20 s, 16 s, 10 s and 6 s for multi-frequency imaging. We correct our measurements for the effects of Earth's ellipticity and variations of the crustal velocity structure using the model CRUST1.0. Thus, we build a travel time anomalies table with more than 200 000 measurements to derive new P-wave and S-wave seismic tomography models based on finite-frequency theory for Brazil. From here on, with this set of computational routines, we can easily update our travel time anomalies table for newly recorded seismograms and future seismic stations deployments in order to constantly obtain P and S velocity structure models beneath Brazil.