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BISTROP: Bayesian Inversion of Spectral-Level Ratios and P-Wave Polarities for Focal Mechanism Determination

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A thorough understanding of earthquake focal mechanisms gives information about the stress field, fault geometry, and deformation processes acting in a given region. Generally, the techniques aimed at determining focal mechanism are designed to analyse moderate-to-large earthquakes and operate both in the time and frequency domain, using different data (e.g., P polarities, S-wave polarization, S/P-amplitude ratios, etc.).
Using these approaches to small earthquakes is hampered by the low signal to noise ratio and the generally not sufficient description of the medium response at the wavelengths at which microearthquakes radiate.
We present a new method, Bayesian inversion of spectral-level ratios and P-wave polarities (BISTROP), that can be applied to both small and moderate-to-large magnitude events. BISTROP is based on a Bayesian approach that jointly inverts the long-period spectral-level P/S ratios and the P polarities to infer the fault-plane solutions. Compared with other observables (e.g., S-wave polarization or P- and S-waves amplitudes) the spectral levels are easier to measure and, as a consequence, they are generally available fora broad range of magnitude. Moreover, working with the ratio between the low-frequency part of the P- and S-wave spectra allows us to reduce the effects of the geological soil condition (site effect) and of both geometric and anelastic attenuation in the first approximation if they are not known.
We apply BISTROP to analyze synthetic and real data. We show that the obtained solutions for moderate earthquakes are comparable with those obtained using moment tensor inversion, and they are more constrained with respect to the solutions obtained using only P-polarity data for small earthquakes.