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Constraints on earthquake nodal planes obtained from regional and teleseismic data

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The Bulletin of the International Seismological Centre (ISC) contains information of earthquake mechanisms collected from many different sources including local, regional and global data centres, resulting in a satisfactory coverage over a wide magnitude range ($M \sim$ 2–9). Nevertheless, we find areas where the information on the source mechanism is missing for a large number of earthquakes in the M 4–5 range, and therefore, we investigate whether this gap can be filled by attempting to systematically compute focal mechanisms obtained from P-wave first motion polarities within the 2°–90° epicentral distance range. We download waveforms from international waveform data centres (IRIS, EIDA) and we pick P-wave first motion polarities using an automatic seismic phase picker. In addition, we make use of any available polarity data that are routinely reported to the ISC. The focal mechanisms are obtained using our modified version of the freely available HASH algorithm, taking into account a priori ISC hypocentre and/or 1D global velocity model uncertainties for the theoretical takeoff angle calculations. We first carry out benchmark tests using a global set of earthquakes with a wide range of magnitudes and we take into account the ISC locations and their associated errors. We find that stations in regional and teleseismic distances offer enough resolution in order to successfully determine at least one nodal plane in most cases (75%) where deviations in strike and dip from our benchmark mechanisms do not exceed 30°, whilst 50% of the obtained mechanisms show deviations up to 30° in strike, dip and rake. Similar results are also obtained when including the velocity model uncertainties. Moreover, we test the effect of using different criteria for the quantification of the mechanism robustness, notably, the azimuthal gap, the takeoff angle gap, the station distribution ratio and the fault plane uncertainties, and we find little evidence of one being more preferable to the others. We finally aim to apply our methodology to cases of interest in order to create a set of nodal plane constraints that could be useful for seismic source and hazard studies.