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Broadband seismometer orientations: A comparison of techniques and new results from the Cascadia Initiative

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We present a new Python-based, automated, and high-accuracy algorithm to determine the geographic orientation of the horizontal components of broadband seismometers during postprocessing of the data. As with some previous methods, our new method is based on measuring intermediate-period surface-wave arrival angles from teleseismic earthquakes. A crucial new aspect of our technique is the consultation of modern global dispersion maps when setting up the analysis window. We repeat measurements at several frequencies to lower biases from wave propagation in laterally heterogeneous structure. We include measurements from the first minor and major great-circle arcs to further lower biases caused by uneven geographical data coverage. We demonstrate the high accuracy of our technique through benchmark tests against a well-established "hands-on" but slow technique using data from instruments of the Global Seismographic Network for which orientations are well documented. We also compare the accuracy and consistency of our method against other current techniques. We find that our method requires fewer events to achieve the same or better accuracy. We present orientations for over 200 ocean bottom seismometers (OBS) from the Cascadia Initiative. We use these results to provide evidence that shielding OBSs improves long-period data quality, even in the deep ocean.