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Advancements in Teleseismic Waveform Inversion: High-Resolution Imaging of Crust and Upper Mantle Using Dense Seismological Networks

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Over the last decade, advancements in dense seismological networks, improved data quality, and increased computing capacity have facilitated the use of waveforms for seismological imaging. In this study, we focus on teleseismic waveform inversion to image the crust and upper mantle, leveraging dense broadband seismological networks. Our methodology involves selecting data based on earthquake magnitude and epicentral distance, calculating the apparent source time function, and employing amplitude and phase comparisons with synthetic traces for seismogram selection. The utilization of high computational power, specifically GPUs, enables us to employ iterative methods based on the gradient of the cost function, such as the l-BFGS method, making teleseismic waveform inversion applicable to real data. We demonstrate the effectiveness of this method on two datasets—one from Western Europe, a compilation of temporary deployments and permanent stations, and the other from Japan, utilizing the Hi-net and F-net networks. The density of stations in both cases ensures unprecedented accuracy in imaging the crust and mantle on a teleseismic scale. This research responds to the need to improve seismological imaging, and opens the way to advances in our understanding of crustal and mantle dynamics.

Keywords: Seismological Imaging Teleseismic Waveform Inversion Dense Seismological Networks