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"No data left behind": Efficient processing of large datasets for waveform tomography and Bayesian source inversion

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Seismic tomography has made giant progresses in the last decade. This has been due to improvements in the method, which allowed to combine the high information content of waveform modeling with the mathematically sound methods of tomographic inversion. The second factor is the vast growth of digitally available broadband seismograms.
Both factors together require efficient processing schemes for seismic waveforms, which reduce the necessary manual interaction to a minimum.
Since the data growth has mainly taken place on traditionally well instrumented regions, many areas are still sparsely instrumented, so the processing scheme should treat all data with highest care.

Our processing scheme "No data left behind", which is implemented in Python and incorporated into the seismology package ObsPy automates the steps for global or regional body wave tomography:

1. Data retrieval: Downloading of event-based seismic waveforms from ORFEUS and IRIS. This way around 1600 stations globally are available. Data from other sources can be added manually.

2. Preprocessing: Deconvolution of instrument responses, recognition of bad recordings and automated correction, if possible. No rejection is done in this stage.

3. Cutting of time windows around body wave phases, decomposition of the signals into 6 frequency bands (20s to 1 Hz), individual determination of SNR and similarity to synthetic waveforms.

4. Rejection of bad windows. Since the rejection is done based on SNR or CC with synthetics independently for each of the 6 frequency bands, even very noisy stations like ocean islands are not discarded completely.

5. Bayesian Source inversion: The source parameters including depth, CMT and Source Time Function are determined in a probabilistic way using a wavelet base and P- and SH-waveforms.

The whole algorithm is modular and additional modules (e.g. for OBS preprocessing) can be selected individually.