2. LOW-FREQUENCY DATA

Low-frequency data extrapolation is crucial for Full-waveform inversion (FWI) benefits in many ways from having low-frequency data. However, those are rarely available due to acquisition limitations. Here, we explore the feasibility of frequency bandwidth extrapolation using an Artificial Neural Network (ANN). The ANN is trained to be a non-linear operator that maps high-frequency data for single source and multiple receivers to low-frequency data. Assuming that the source is a delta function both in space and time, we train the network on synthetic data generated from random velocity models. We apply the ANN to multiple collocated sources-receivers acquisitions to predict 0.5 Hz data for synthetic data generated from random velocity models. We apply the ANN to predict a single complex amplitude at each receiver for a specific low frequency given several high-frequency values.

4. INPUTS AND OUTPUTS

The input data for the network are the frequency spectra recorded at each receiver and discretized by a few values. The frequency values are separated by a multiplicative increment such that selection is common for frequency domain inversions (Singe and Pruitt, 2004). The output data is a vector containing single complex amplitude for a selected low frequency at each receiver.

6. RESULTS

We perform a synthetic study for 2D acoustic isotropic media. Velocity model is the crop form central part of BP 2004 velocity model. Acquisition involved 240 collocated sources and receivers placed 80 m apart on the surface. We predicted 0.5 Hz data given for 2.5, 3.14, 3.50 and 4.97 Hz. General trends at predicted data matrices follow corresponding reference data, whereas small scale details as well as exact amplitudes were not well reconstructed by the ANN.

7. CONCLUSIONS

We explored the feasibility of reconstructing low-frequency data using an Artificial Neural Network given high-frequency spectra. Here, we assume the low-frequency wavefield content to be related with the one at higher frequencies through a non-linear operator encoded by the physics of wave propagation in the subsurface. We trained an ANN on data generated from random velocity models and then tested it on reference data.

Prediction results in general follow the reference data but the prediction accuracy is barely sufficient yet to make the reconstructed data directly usable in FWI. However, results are encouraging and in future work we will further investigate the dependency of the network training on model diversity and network topology.

REFERENCES


