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Case studies on 2D- and 3D-Time Reverse Modeling of low-frequency microtremors: Application to hydrocarbon reservoir localization

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Time Reverse Modeling (TRM) of seismic events with passively acquired signals is a promising complementary method for active seismic. It helps to localize weak seismic events which are continuous in time and limited in space, for example microtremors, which are usually difficult to detect with current procedures. The passively measured seismograms from several synchronous sensors of a seismic network at the Earth's surface are reversed in time and are then used as boundary values for TRM. Synthetic seismic wave propagation studies using a direct or parallelized explicit finite difference method based on a velocity-stress formulation demonstrate that TRM is able to localize the source of microtremor-like signals. Real examples of such signals might be so-called "hydrocarbon microtremors". Several field surveys have shown that hydrocarbon reservoirs may act as a secondary source of low frequency (i.e. 1Hz – 6Hz) seismic waves and these signals are sometimes termed "hydrocarbon microtremors". Applications of TRM on data passively acquired above hydrocarbon reservoirs give support to the hypothesis that there are microtremor-like signals originating from hydrocarbon reservoirs. We compare results from 2D- and 3D-TRM and discuss the advantage and the disadvantage of both approaches. We perform some case studies on several problems like uncertainty in the velocity model, resolution in space, length of modeling or other parameters. The results show the potential of TRM to be developed toward an effective tool for seismic source localization.