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# Fine-scale thermohaline ocean structure retrieved with 2D Pre-stack full-waveform inversion of multichannel seismic data: Application to the Gulf of Cadiz

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In this work we present a 2D time-domain, adjoint-state acoustic full-waveform inversion to retrieve high-resolution models of ocean physical parameters such as sound speed, temperature and salinity. The proposed method is first described and then applied to pre-stack multi-channel seismic (MCS) data acquired in the Gulf of Cadiz (SW Iberia) in 2007 in the framework of the Geophysical Oceanography project. The inversion strategy flow includes specifically-designed data pre-conditioning for acoustic noise reduction, followed by the inversion of sound speed in the shotgather domain. We show that the final sound speed model has a horizontal resolution of $\sim 70m$, which is two orders of magnitude better than that of the initial model constructed with coincident eXpendable Bathy Thermograph (XBT) data, and close to the theoretical resolution of $O(\lambda)$. Temperature (T) and salinity (S) are retrieved with the same lateral resolution as sound speed by combining the inverted sound speed model with the thermodynamic equation of seawater and a local, depth-dependent T-S relation derived from regional conductivity-temperature-depth (CTD) measurements of the National Oceanic and Atmospheric Administration database. The comparison of the inverted T and S models with XBT and CTD casts deployed simultaneously to the MCS acquisition shows that the thermohaline contrasts are resolved with an accuracy of $0.18^oC$ for temperature and $0.08PSU$ for salinity. The combination of oceanographic and MCS data into a common, pseudo-automatic inversion scheme allows to quantitatively resolve submeso-scale features that ought to be incorporated into larger-scale ocean models of ocean's structure and circulation.