Geophysical Research Abstracts
Vol. 18, EGU2016-13168-1, 2016
EGU General Assembly 2016

Pre-stack full-waveform inversion of multichannel seismic data to retrieve thermohaline ocean structure. Application to the Gulf of Cadiz (SW Iberia).

Daniel Dagnino (1), Clara-Estela Jiménez Tejero (1), Adrià Meléndez (1), Clàudia Gras (1), Valentí Sallarès (1), and César R. Ranero (2)

(1) Barcelona Center for Subsurface Imaging, CSIC, Barcelona, Spain, (2) Barcelona Center for Subsurface Imaging, Institute of Marine Sciences, ICREA at CSIC, Barcelona , Spain

This work demonstrates the feasibility to retrieve high-resolution models of oceanic physical parameters by means of 2D adjoint-state full-waveform inversion (FWI). The proposed method is applied to pre-stack multi-channel seismic (MCS) data acquired in the Gulf of Cadiz (SW Iberia) in the framework of the EU GO (Geophysical Oceanography) project in 2006.

We first design and apply a specific data processing flow that allows reducing data noise without modifying trace amplitudes. This step is shown to be essential to obtain accurate results due to the low signal-to-noise ratio (SNR) of water layer reflections, which are typically three-to-four orders of magnitude weaker than those in solid earth.

Second, we propose new techniques to improve the inversion results by reducing the artefacts appearing in the gradient and misfit as a consequence of the low SNR. We use a weight and filter operator to focus in the regions where the gradient is reliable. The source wavelet is then inverted together with the sound speed. We demonstrate the efficiency of the proposed method and inversion strategy retrieving a 2D sound speed model along a 50 km-long MCS profile collected in the Gulf of Cadiz during the GO experiment. In this region, the Mediterranean outflow entrains the Atlantic waters, creating a salinity complex thermohaline structure that can be measured by a difference in acoustic impedance. The inverted sound speed model have a resolution of 75m for the horizontal direction, which is two orders of magnitude better than the models obtained using conventional, probe-based oceanographic techniques.

In a second step, temperature and salinity are derived from the sound speed by minimizing the difference between the inverted and the theoretical sound speed estimated using the thermodynamic equation of seawater (TEOS-10 software). To apply the TEOS-10 we first calculate a linear-fitting between temperature and salinity using regional data from the National Oceanic and Atmospheric Administration (NOAA) compilation. Pressure is calculated from latitude and depth. In the final step, salinity is calculated using the Temperature-Salinity relation and the previously estimated temperature. The comparison of the inverted temperature, salinity model with measures from XBT and CTD probes deployed simultaneously to the MCS data acquisition shows that the accuracy of the inverted models is $\sim$0.15ºC for temperature and $\sim$0.1psu for salinity.