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High-resolution mapping of temperature and salinity from full waveform inversion of synthetic seismic data

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We present the Full Waveform Inversion of synthetic seismic oceanographic traces generated with oceanographic data acquired during the GO ("Geophysical Oceanography: A new tool to understand the thermal structure and dynamics of oceans)" survey performed in 2007 in the Gulf of Cádiz (Hobbs et al., 2007). To perform the inversion we first generated 1-D synthetic seismic traces along a high lateral resolution sound speed model inverted by Papenberg et al. (2010), along the GO-LR-10 line, which crosses the core of the Mediterranean Outflow Water. Each synthetic trace was subsequently inverted for sound speed. A time-domain finite difference scheme was used to compute the direct wavefield (assuming density as a constant) together with the adjoint source. Later the gradient of the objective function (i.e. the L-2 norm) is computed using the adjoint method (Fichtner et al., 2006) and then introduced in an iterative conjugate-gradient method. We applied a multi-scale strategy by successively inverting from low to high frequencies. Finally, we determined the temperature and salinity profiles from the final inverted sound speed model. For each depth, we used two empirical expressions between these physical parameters: the sound speed UNESCO formula by Chen and Millero (Chen and Millero, 1976), and a neural network relation between T, S and depth (Ballabrera et al., 2009) that were embedded within a grid search-type loop for T. The neural network was trained with the oceanographic dataset collected in the area during the GO survey.
We show that in these optimal conditions (e.g. controlled source, data free of noise), the method allows to retrieve very precise maps of sound speed (rms <0.6 m/s), salinity (rms <0.03) and temperature (rms <0.1 ºC) with a vertical resolution up to (10 m) and, most important, with the high lateral resolution characteristic of Multichannel Seismic data ($\sim$10 m).

References

Ballabrera-Poy, J., B. Mourre,E. García-Ladona, A. Turiel, A. and J. Font, 2009. Linear and non-linear T-S models for the eastern North Atlantic from Argo data: Role of surface salinity observations. Deep-Sea Research I, 56, 1605-1614.
Chen, C. T., and F. J. Millero, 1976. Speed of sound in seawater at high pressures, J. Acoust. Soc. Am., 60, 1270–1273, doi:10.1121/1.381240.
Fichtner, A., H.-P. Bunge and H. Igel, 2006. The adjoint method in seismology I. Theory, Phys. Earth Planet. Int., 157, 86-104.
Hobbs, R. (2007). GO–Geophysical Oceanography: A new tool to understand the thermal structure and dynamics of oceans, D318 Cruise Report. Available online at: http://www.dur.ac.uk/eu.go/cruise/report.html
Papenberg, C., D. Klaeshen, G. Krahmann and R.W. Hobbs, 2010. Ocean temperature and salinity inverted from combined hydrographic and seismic data, Geophys. Res. Lett., 37, L04601, doi:10.1029/2009GL042115.