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Application of transdimensional Markov chain Monte Carlo inversion to seismic oceanography study

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The information of the sea water structure and physical properties is essential to analyze the oceanographic feature of the sea water. However, observing the detail feature of the complex water structure by using conventional physical oceanographic instruments is difficult because of the low horizontal resolution. The Seismic Oceanography (SO) is a method to obtain the location of the water layer boundaries and/or the physical properties of water by using seismic exploration. The SO can generate the information with high horizontal resolution because the horizontal resolution of the seismic data is usually below 10 m. However, it is difficult to calculate the properties of sea water by using the conventional seismic inversion methods because of the band limited characteristic of the seismic data and low reflection coefficients between the water layers. Moreover, the wavelength of the source wavelet used in the seismic exploration disturbs the accurate imaging of the water layer boundaries. In this study, we apply transdimensional Markov chain Monte Carlo (McMC) inversion method to invert the location of water layer boundaries and sound speed of sea water simultaneously. The transdimensional McMC inversion assumes both the location of water layer boundary and the properties of sea water as inversion parameters and performs stochastic inversion, thus it can overcome the local minima problem. Moreover, it is less influenced by the problems from the insufficient low frequency information and the limitation of the offset range because it uses the post-stack data instead of the pre-stack data. We apply transdimensional McMC inversion to the field seismic data and invert the layer boundaries and sound speed of sea water. The inverted sound speeds are converted to the temperatures and compared with the true temperatures from Expendable Bathythermograph (XBT). The inversion results indicate that the transdimensional McMC inversion can find the location of water layer boundaries accurately and invert the temperature of the sea water similar to the true temperature.