WS08_06

Finite Difference Modelling Including Dynamic Speed of Sound in Water

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Summary

Identifying and implementing fit for purpose Earth complexity in synthetic modelling is an important part of testing the ability to recover broadband signal. Effects of dynamic speed of sound in water Vw(x,y,z,t) have widely been recognized in 3D marine processing, although 4D often highlights the complexity and requirement for adequate measurement and correction. Corrections are applicable to conventional 3D and VSP marine applications, even if the effect is not immediately obvious. In 2013 Chevron in conjunction with WesternGeco investigated, quantified and ranked the effects of Vw(x,y,z,t) in streamer 4D using finite difference modelling. However, modelling with Ocean Bottom Node data presents additional challenges. In 2015, Chevron built a complex 4D dynamic water column model closely based on Vw(x,y,z,t) observation. The model was specifically designed for evaluation of 4D OBN data. Processing in conjunction with CGG demonstrated the significance of no-correction, after typical correction and with alternative methods, including Up-Down deconvolution, the latter demonstrating a remarkably good efficient solution. Furthermore, Up-Down deconvolution enables efficient source signature deconvolution for enhanced bandwidth. Including the complexity of Vw(x,y,z,t) in modelling has enabled estimation of 4D signal to noise and design of mitigation measures in both acquisition and processing.

Identifying and implementing fit for purpose Earth complexity in synthetic modelling is an important part of testing the ability to recover broadband signal. Effects of dynamic speed of sound in water Vw(x,y,z,t) have widely been recognized in 3D marine processing e.g. Wombell (1997), although 4D often highlights the complexity and requirement for adequate measurement and correction. Corrections are applicable to conventional 3D and VSP marine applications, even if the effect is not immediately obvious. In 2013 Chevron in conjunction with WesternGeco investigated, quantified and ranked the effects of Vw(x,y,z,t) in streamer 4D using finite difference modelling (Seymour et al. 2014). However, modelling with Ocean Bottom Node data presents additional challenges. In 2015, Chevron built a complex 4D dynamic water column model closely based on Vw(x,y,z,t) observation. The model was specifically designed for evaluation of 4D OBN data. Processing in conjunction with CGG (Zietal and Haacke 2016) demonstrated the significance of no-correction, after typical correction and with alternative methods, including Up-Down deconvolution (Amundsen 2001), the latter demonstrating a remarkably good efficient solution. Furthermore, Up-Down deconvolution enables efficient source signature deconvolution for enhanced bandwidth. Including the complexity of Vw(x,y,z,t) in modelling has enabled estimation of 4D signal to noise and design of mitigation measures in both acquisition and processing.

Acknowledgements

The authors recognize and thank the hard work and contribution from the team at CGG Crawley UK in the processing of these data and specifically Ross Haacke, Robert Zietel and Mohammed Shanice.

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