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Performance Assessments of Absorbing Conditions for the Reverse Time-Harmonic Migration

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ABSTRACT

Waves are widely used for providing images of the subsurface. By making use of their reflection capabilities, it is possible to create a map identifying each change of medium. This map deserves a particular attention because it contains relevant information on the material characteristics of the propagation domain without requiring any extraction process. The Reverse Time Migration (RTM) is an imaging technique based on the solution of time-dependent wave equations set inside bounded regions given as the domain to be explored. RTM provides an efficient way for putting time information recorded by some receivers back to the piece of subsurface of interest. However, it is computationally intensive and can be difficult to implement for imaging realistic regions. Indeed, the required computational times can go too far industrial standards and moreover, the memory can be overloaded before the construction of the image is achieved. There is thus a need in improving the RTM performances by reducing its computational burden and obviously without impairing the quality of the image. A good image is obtained from accurate numerical waves which are computed in a given bounded domain limited by boundaries which are artificial with the exception of existing physical boundaries like the surface of the Earth. The numerical image is then obtained by solving wave equations coupled with specific boundary conditions on the artificial boundaries. These boundary conditions are generally referred as Absorbing Boundary Conditions (ABC) [1,2] and they absorb the propagating waves only, both the evanescent and grazing waves being left behind. In a recent work [3], we have investigated the interest of including grazing waves inside the modeling. The condition involves fractional derivatives and turns out being more efficient, in particular when the artificial boundary is close to the seismic source. Unfortunately, the computational costs are not reduced significantly due to the discretization of the fractional derivatives. However, this drawback is solved in the frequency domain where the fractional derivative is replaced by a fractional power of the wave number. On this basis, we propose herein to extend the RTM algorithm to the harmonic domain. It appears that since the solution methodology can be based on the solution of a single Helmholtz equation with multiple right-hand sides, it is possible to provide images of the subsurface faster than with RTM. Moreover, high-order ABCs can be used easily thus preserving the accuracy of the numerical solutions.

REFERENCES

[1] M. Taylor, *Pseudo-differential operators*, Princeton University Press (1981).

[2] B. Engquist and A. Majda, "Absorbing Boundary Conditions for the Numerical Simulation of Waves", *Math. Of Comp.* **31**, n°139, 629-651 (1977).

[3] H. Barucq, C. Bekkey, J. Diaz. "*Performance assessment of a fractional radiation boundary condition for the Helmholtz equation*", in "WAVES 13 : 11th International Conference on Mathematical and Numerical Aspects of Waves", 2013, pp. 291-292, http://hal.inria.fr/hal-00923995