2D Local propagation and FWI using Recursive Patched Green Functions

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Abstract

In some applications of seismic data, such as the time-lapse Full Waveform Inversion, it is required to calculate physical properties just at some target area instead of the complete domain. To do so, we designed a local solver which allows calculating the wave field in the frequency domain in the target area and in the receiver positions after the velocity is updated at the target area. This local solver uses the Recursive Patched Green Function (RPGF) method that is used in condensed matter physics to calculate Green functions in materials with anomalies. In the RPGF method, the target area and outside target area are split into different subsets of points which can have different forms, e.g. rectangles or layers. The subsets are connected by using the Dyson equation, which relates the Green functions before and after connecting a subset to the system. To build a local propagation we perform two steps. First, we calculate Green's Functions related to the target boundary using a recursive formula obtained with the RPGF method. Second, using as starting point the Green's functions calculated in the first step, we connect recursively each subset of the target area to the outside target area until build the entire computational domain. If we perform a local FWI the first step is performed once and the second is performed for each FWI iteration since the velocity is changing just at the target area.

In this work, we perform two experiments to test the RPGF method. First, we compare the performance of the RPGF method and the conventional method fixing the size of the entire computational domain, and then, varying the area of the target area. In this comparison, we asses the computational time and the memory consumption of both methods. We also assess the effect of the geometry of the subsets (rectangles or layers) on the performance of the RPGF method. Finally, in the second experiment, we perform a target-oriented FWI in a time-lapse scenario, using the RPGF local solver. Both experiments are performed on a typical 2D velocity model from the Brazilian pre-salt region. We find that there is a threshold target size below which the RPGF method is faster than the conventional method. This threshold size is around 40%-45% of the computational domain which is much bigger than a typical target in a time-lapse inversion.