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Traveltime computations on unstructured grid based on Huygens' principle

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Accurately calculating the travel times of seismic waves from a given source to a location in complex environments is critical for a wide range of applications from earthquake location to rupture propagation on a fault plane. It is also heavily used in exploration seismology in terms of tomography and migration.

Currently, the standard method for performing this calculation is to propagate the wavefront in a regular Cartesian grid using Huygen's principle with a finite difference approximation. This technique was developed by Podvin and Lecomte (1991) and is widely used due to its accuracy and speed in the presence of severe and complex velocity contrasts, hereafter referred to as the P&L method. We propose a new technique which also applies Huygen's principle but which uses a trilateration scheme on an unstructured grid. This method is called the double trilateration method. A fundamental difference between the two techniques is that P&L method assumes that the wavefront is planar while the double trilateration method assumes the wave front is circular in 2D and spherical in 3D. Another difference between the two techniques is that the double trilateration method handles variable mesh elements potentially allowing for environments with rough/curved interfaces to be handled in a more computationally efficient manner.

A comparison between the two techniques for a variety of different velocity models will be performed both in terms of time and accuracy.