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The perfectly matched layer in a novel triangular finite element method for seismic waves

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Our triangular finite element method (TFEM) is based on the first order wave equations expressed in terms of velocity and stress. Through its unstructured triangular grid it allows the study of complex models that can have a variety of source inputs. Another strength lies in being formulated so as to ensure the continuity of all the field components that are continuous across an elemental interface, including continuity of traction and tangential strain. As part of this, corner points, where faces meet, are excluded from the spatial discretization of the triangles. This circumvents possible inconsistencies in having both continuity of traction and continuity of tangential strain there.

To absorb the waves at the boundaries of the modelling domain a perfectly matched layer (PML) is added to the edges of the model. Its effectiveness in reducing reflections at the modelling domain boundaries has lead to the wide application of the PML in many areas of physics. In the TFEM complex stretched coordinates are used within the PML to introduce the damping. An additional boundary condition can be applied at the outermost edges of the PML to diminish reflections there.

We illustrate that the TFEM can be used to simulate models with explosive and plane wave sources. For plane waves the use of the PML is possible by placing the input at the interface between the interior modelling domain and the PML. Comparisons are made of time domain TFEM results with results obtained in the frequency domain using a generalised impedance operator method. In addition results for models with cracks are included. Finally, an analysis of the effectiveness of the PML in absorbing wave energy is provided.