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The efficiency of hybrid finite difference-finite element method for 2-D magnetotelluric modeling

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Finite difference (FD) and finite element (FE) methods have been used successfully and extensively to solve two-dimensional magnetotelluric modeling. The finite difference method is fast and stable, while the finite element method is more accurate when the complex subregions such as topography, bathymetry, and irregular anomalies are included inside the model. In this research, we develop a hybrid FD-FE method for solving two-dimensional magnetotelluric modeling. The common 5-points finite difference method is used to approximate the electromagnetic fields in the simple subregions such as most of air layer, host layers, and entire nearby boundary of domain, whereas the finite element method with quadrilateral elements are used to approximate those in the complex region such as terrain and bathymetry zones. The obtained system of equations is a linear combination of FD and FE system of equations. The efficiency and validity of the developed hybrid method are presented and compared with both common FD and FE methods. The results indicate that the hybrid FD-FE method provides the same accuracy as in FE method and the same speed and memory requirements as in FD method when the complex subregions appear in the computing domain. In the case where topography and bathymetry exist, the hybrid FD-FE method can handle them suitably similar to FE method, but can provide higher accuracy than FD method.