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Automatic differentiation and its use for unstructured-mesh ocean modeling

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Adjoint models are commonly used to calculate sensitivities of ocean models and optimize their parameters so that better agreement is achieved between model simulations and observations. One major obstacle in developing an adjoint model is the need to update the reverse code on each modifications of the forward code, which is not always straightforward. Automatic differentiation is a promising tool to generate the adjoint model code without user input. This technique has already been used for structured mesh ocean models, like the MITgcm, and the question is whether it remains practical for models formulated on unstructured meshes. We present an unstructured-mesh, adjoint, tidal model and discuss the sensitivities of the misfit between simulated and observed elevations to open boundary values, bottom friction coefficient and bottom topography. Then we analyze the dependence of the sensitivities on the wave and mesh resolution. As it turns out that it is possible to identify some under-resolved islands in the sensitivity patterns, we propose to refine the mesh prior to the parameter optimization. We also illustrate what happens when the parameters are optimized for an inappropriate mesh.