Decoupling strategy for large-scale multiphysics joint inversion

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We present a generalized 3-D multiphysics joint inversion scheme with a focus on large-scale regional problems. One of the key features of this scheme is the formulation of the structure coupling as a sparsity-promoting joint regularization. This approach makes it possible to simplify the structure of the objective function and to keep the number of hyperparameters relatively low, so that the inversion framework complexity scales well with respect to the number of geophysical methods and possible reference models used. To further simplify adding geophysical solvers to the framework and to optimize the discretization, we propose an alternating minimization scheme that decouples the inversion and the joint regularization steps. Decoupling is achieved by introducing an auxiliary multi-parameter model. This allows the individual subproblems to make use of problem-tailored grids and specialized optimization algorithms. As we will see, this is in particular important for the regularization subproblem. In contrast to straightforward ‘cooperative inversion’ formulation, decoupled inversion steps appear to be regularized by a standard quadratic model-norm penalty, and as a result existing separate inversion codes can be used with minimal, if any, modifications. The developed scheme is applied to magnetotelluric, seismic and gravity data and tested on synthetic model examples.