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Joint hydrogeophysical inversion using similarity measures

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It has been shown that parameter and state estimates obtained within a coupled hydrogeophysical framework are usually better than those from a single data inversion. Different approaches have been suggested in literature to combine the essentially two different modalities to obtain a single estimate for the property of interest. Most of these approaches rely on implementing some petrophysical relationship to couple the groundwater and geophysical variable. Such relationships are usually uncertain and hard to parametrize for a large region and can potentially produce mass errors in the final estimates or enforce similarity when there is none. Replacing the fixed petrophysical relationship by a more loose similarity constraint is therefore an appealing alternative to solve a coupled inverse problem.

In this work we further explore the potential of structure similarity measures for coupled inversion in 3D, specifically a version of cross-gradient field product and joint total variation. Besides, we propose an efficient computational approach applicable to large scale inverse problems to minimize the coupled objective function with multiple data misfits. To test the applicability of the structure similarity measures we analyzed three different synthetic scenarios for solute tracer tests, estimating initial conditions or hydraulic conductivity.