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Using the adjoint state variable for parameter estimation by inverse methods with parsimony.

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Since the pioneer work of Emsellem and de Marsily (WRR, 1971), many parameter estimation methods by inverse methods in hydrogeology are based on the minimization of an objective function using descent methods, which requires the computation of the gradient of an objective function. In many cases, the number of parameters to be estimated is large despite parameterization, and the standard computation of the gradient components by sensitivity coefficients may require a lot of computer time. An alternative is the computation of the adjoint variables which require a calculation similar to the forward problem, irrespective of the number of sought parameters.

The computation of the adjoint variable is usually embedded in the code used to compute the state variable. We discuss here an alternative that consists in (i) write the partial differential equation for the adjoint variable, (ii) writing an independent code for the adjoint variable, (iii) solved the adjoint problem on an independent mesh, different of the mesh used to compute the state variable with coarser time and space discretization to speed up the computation of the adjoint variable. We will present the methodology and discuss the use of coarser discretizations since coarser discretization can impact the accuracy of the computed gradients and lead to additional iterations to reach the objective function's minimum.