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Quality of the model and error analysis in variational data assimilation

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One can define "data assimilation" as the process mixing models and data as sources of information. The basic principle is to consider the initial condition as a control variable and optimize the initial condition in order to minimize the discrepancy between the observations and the solution of the model. A major advantage of this technique is the definition of an optimality system which contains all the available information. In practice the system includes errors of different nature: - physical errors in the model due to approximations to be used; - numerical errors due to the discretization of the equations and to numerical algorithms for solving the problem; - errors in the observations. Prediction should take into account all these sources of errors and it is clear that the "best" model will not lead necessarily to the "best" prediction with the same set of observations.

The purpose of this presentation is to analyze the impact of errors on the prediction in order to provide some information on the improvement of prediction. We give the statement of the data assimilation problem for a nonlinear evolution model to identify the initial condition. The equation of the error of the optimal solution is derived through the errors of the input data using the Hessian of the misfit functional and the second order adjoint technique. The Hessian properties are studied and the fundamental control functions are introduced to be used for error analysis. The sensitivity of the optimal solution to the input data is studied using the singular vectors of the specific response operators in the error equation. The sensitivity of the optimal solution to the variations of the observational operator is analysed. The relation between quality of the model and quality of the prediction via data assimilation is discussed.