Fundamental control functions and error sensitivity analysis in variational data assimilation

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The problem of variational data assimilation for a nonlinear evolution model is formulated as an optimal control problem to identify the initial-value function, using the observational data. The equation for the error of the optimal solution through the errors of the input data is derived, based on the Hessian of the misfit functional and adjoint equation techniques. The solvability of the error equation is proved for a class of data assimilation problems. The fundamental control functions are introduced as solutions of non-classical eigenvalue problems to be used for error analysis. The algorithms to study the sensitivity of the optimal solution to the errors of the input data (observation errors among them) are developed and justified, based on the fundamental control functions. The work was supported by the Russian Foundation for Basic Research (04-01-00615).