Comparative Numerical Results in 4D-Var Data Assimilation Problems Using POD Techniques

G. Dimitriu, R. Ştefănescu

The four-dimensional variational data assimilation (4D-Var) method has been a very successful technique used in operational numerical weather prediction at many weather forecast centers. A major difficulty in the operational use of 4D-Var data assimilation for oceanographic and atmospheric global circulation models is the large dimension of the control space, which is the size of the discrete model initial conditions, typically in the range $10^6 - 10^8$. A way to significantly decrease the dimension of the control space without compromising the quality of the final solution for the 4D-Var data assimilation, motivates us to construct the control variable on a basis of characteristic vectors capturing most of the energy and the main features of variability of the model. Proper orthogonal decomposition (POD) technique has been used to obtain low dimensional dynamical models of many applications in engineering and science. Basically, the idea starts with an ensemple of data, called *snapshots*, collected from an experiment or a numerical procedure of a physical system. The POD technique is then used to produce a set of basis functions which spans the snapshots collection.
The first part of our work carries out a comparison approach of the accuracy of numerical solutions to data asimilation problems in the case of three advection-diffusion equations, where the proper orthogonal decomposition is defined using H^1-norm and L^2-norm, respectively. The second part of the study analyses the performance of an adaptive POD procedure with respect to the data assimilation solution obtained with the classical POD technique. The study ends with some conclusions.