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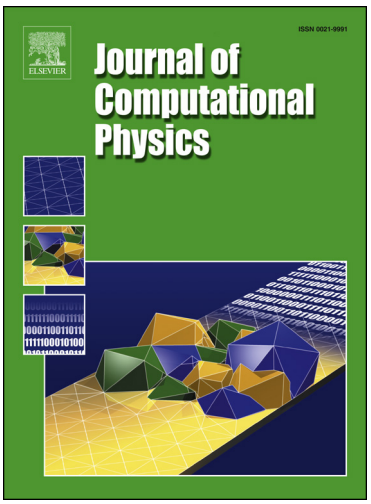

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Reconstruction of unsteady viscous flows using data assimilations schemes

V. Mons[a,*], J.-C. Chassaing[a], T. Gomez[b,c], P. Sagaut[d]

[a] *Sorbonne Universités, UPMC Univ Paris 06, CNRS, UMR 7190, Institut Jean Le Rond d'Alembert, F-75005 Paris, France*
[b] *Université Lille Nord de France, F-59000 Lille, France*
[c] *USTL, LML, F-59650 Villeneuve d'Ascq, France*
[d] *Aix Marseille Université, CNRS, Centrale Marseille, M2P2 UMR 7340, 13451 Marseille, France*

Abstract

This paper investigates the use of various data assimilation (DA) approaches for the reconstruction of the unsteady flow past a cylinder in the presence of incident coherent gusts. Variational, ensemble Kalman filter-based and ensemble-based variational DA techniques are deployed along with a 2D compressible Navier-Stokes flow solver, which is also used to generate synthetic observations of a reference flow. The performance of these DA schemes are thoroughly analyzed for various types of observations ranging from the global aerodynamic coefficients of the cylinder to the full 2D flow field. Moreover, different reconstruction scenarii are investigated in order to assess the robustness of these methods for large scale DA problems with up to 10^5 control variables. In particular, we show how an iterative procedure can be used within the framework of ensemble-based methods to deal with both non-uniform unsteady boundary conditions and initial field reconstruction. The different methodologies developed and assessed in this work give a review of what can be done with DA schemes in computational fluid dynamics (CFD) paradigm. In the same time, this work also provides useful informations which can also turn out to be rational arguments in the DA scheme choice dedicated to a specific CFD application.

Keywords: Data assimilation, Variational assimilation, Kalman filter, Ensemble methods, Unsteady flows

*Corresponding author.
Email address: vincent.mons@dalembert.upmc.fr (V. Mons)