Geophysical Research Abstracts, Vol. 9, 09938, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-09938

Variational estimation of 2D time consistent dense motion from image sequence

N. Papadakis, E. Mémin and T. Corpetti
IRISA/INRIA Campus de Beaulieu 35042 RENNES CEDEX (npapadak,memin@irisa.fr)

Satellite observations are currently of major importance in geosciences. The main limitation of actual data assimilation systems is the extraction of relevant information from such 'indirect' observations. Namely, it is possible to extract wind vectors from satellite images using correlation based or dense motion approaches. However, these vectors remain indirect observations computed from images.

In this paper, we face the problem of directly estimating time consistent fluid flow velocities from image sequences. We consider here a simplified problem, where the state space corresponds to the image domain. Thus, our goal is to extract dense motion fields from image sequences, according to a physical dynamical law. The state variable is composed by the vorticity and the divergence of the tracked velocity field. The associated evolution law is given by the 2D vorticity-velocity form of the Navier-Stokes equations or the vorticity-divergence form of shallow-water model, according to the application. We then introduce a variational framework derived from data assimilation principles in order to perform velocity estimation. We consider the images as observations, through optical flow constraints. The novelty of this approach relies on the fact that vector field correction is directly linked to the images. Following optimal control recipes, the associated minimization is conducted through an iterative process involving a forward integration of our dynamical model followed by a backward integration of the adjoint evolution law. Both evolution laws are implemented with upwind second order non-oscillatory scheme.

The approach is first applied on a synthetic sequence of turbulent 2D flow provided by Direct Numerical Simulation (DNS). As the actual vorticity of the flow is known, this test allows to validate the proposed method. We then apply the method to a real world meteorological satellite image sequence depicting the evolution of a cyclone.