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Assimilation of images in numerical models

F.-X. Le Dimet (1,2), I. Souopgui (1,3), O. Titaud (1,4), A. Vidard (1,5)

(1) Laboratoire Jean Kuntzmann, project-team INRIA MOISE, Grenoble, France, (2) [ledimet@imag.fr], (3) Université de Yaoundé I, Cameroon [Innocent.Souopgui@imag.fr], (4) [Olivier.Titaud@imag.fr], (5) [Arthur.Vidard@imag.fr]

Predicting the evolution of geophysical fluids (ocean, atmosphere, continental water) is a major scientific and societal challenge. To achieve this goal we need to take into account all the available information. This information can take several forms:

- mathematical information under the form of a set of non linear PDE's
- physical information : in-situ or remote measurements
- statistical information
- qualitative information

The prediction will be produced by an integration of the model from an initial state, therefore the problem is to retrieve , in a coherent manner, the initial fields from these heterogeneous sources of information. In the early '80 we proposed to use optimal control techniques to do this task and know this method has been adopted by the main meteorological operational centers. Since several decades many satellites have been launched for the observation of the Earth for a better knowledge of the atmosphere and of the ocean. It is clear that the dynamics of the images observed has a strong predictive potential , unfortunately, at the present time, this information is not optimally used in conjonction with numerical models. The purpose of this presentation is an extension of optimal control to the assimilation of images. Two basic techniques can be considered:

- from the images , based on some law of conservation of luminance, some velocity can be estimated then used as pseudo-observations in a classical scheme of variational assimilation
- the state variables of the fluids are augmented by objects such fronts, an extended model will include the dynamics of these objects. In the cost function of the variational formulation a quadratic term measuring the discrepancy between computed and observed images is included.

The choice of the space of images will be discussed and some examples displayed.

Keywords: Images, Optimal Control, Geophysical Fluids, Data Assimilation