Control and numerical simulation in large time horizons

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One of the main distinguishing aspects of climate science is that evolving phenomena have to be understood in a long time horizon. Mathematics and, in particular, modeling by means of Partial Differential Equations, Systems Theory and Control and Numerical Analysis are only partially capable of dealing with this challenging issue of large time dynamics, control and simulation.

In this lecture we shall analyze these issues on some simple models. First of all, following a recent joint work with A. Porretta, we will address the problem of large time versus steady state control. The problem we consider is as follows. Assume that the large time asymptotic behavior of a system is given by a steady state one. Can one say that the control in large time horizons converge, as the time horizon tends to infinity, to steady state controls in some sense?

We also address the problem of large time numerics for hyperbolic conservation laws. As we shall see (joint work with L. Ignat and A. Pozo), some numerical schemes that are well known to converge in finite time intervals, fail to capture the correct large time dynamics. This is a warning when considering climate issues.

Climate models are also submitted to uncertainty. We shall conclude this talk by introducing a new notion of averaged controllability that leads to a huge class of interesting and challenging mathematical problems.