A Nonlinear Tour of the Geosciences

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This is the announcement for a nonlinear tour of the geosciences, somewhat organized but still pleasurable, I hope. The vehicle we shall use is dynamical systems theory. This term refers to the study of systems of evolution equations whose solutions exist for all times. The theory is thus particularly well adapted to the study of the long-term behavior of Earth and the planets, their interiors and fluid envelopes.

Early applications of dynamical systems theory to the atmosphere and oceans involved models with a small number of degrees of freedom. This apparent limitation was due to the need for computation in dealing with nonlinearity, and the limitations of computers in the 1960s and ‘70s.

The theory applies, however, to systems of partial and stochastic differential equations (PDEs and SDEs), as well as to systems of ordinary differential equations (ODEs). As computing power has increased, and as our understanding of dynamical systems has deepened, the applications have expanded to more and more detailed and realistic models of the atmosphere, ocean, and solid earth. Examples of applications to each of these three areas will be given by pursuing a hierarchy of models, from the simplest to the most elaborate. This will allow us to assess the successes of the theory, as well as some of the many remaining open questions.