Editorial

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When the 25th General Assembly of the European Geophysical Society coincided with the beginning (at least according to *some* authorities) of the new Millennium in the year 2000, it was too good an opportunity to miss to organize a short (half-day), plenary review session during the General Assembly to reflect upon some highlights of the past in the development of nonlinear ideas in geophysics, and to look forward to their possible future development.

Although the origins of research into the mathematical nature and possibilities of nonlinear systems can be traced back to Poincaré, Birkhoff and other intellectual giants of the late 19th/early 20th centuries (or arguably even earlier, to Laplace and his contemporaries?), the late 1970's and (especially) the 1980's saw a major renaissance of this subject throughout the fields of pure and applied mathematics, physics, engineering and other disciplines (including the medical and life sciences, and especially in the atmospheric sciences). This was due in no small measure to advances in the technology of computers, and their increasingly widespread availability to a large section of the scientific community. The possibilities opened up by such technologies were realised early on by several workers in the geophysical sciences, and indeed some of the seminal early work on the modern theory of chaos was carried out in the early 1960's by atmospheric scientists such as Ed Lorenz and Barry Saltzmann using newly-available programmable digital computers. The impact of this early work on other areas of meteorology and the rest of the geophysical sciences was initially rather small, however, until its implications were realised and further developed elsewhere in mathematics and physics.

It was with the desire to ensure that the geophysical sciences should avoid losing similar opportunities to appreciate new and unexpected insights in the future, and to stay close to the 'cutting edge' of this area of science, therefore, that the present *Interdisciplinary Working Group on Nonlinear Processes in Geophysics* was established. EGS can take a certain pride in being one of the first major scientific societies to recognize and promote this topic as a distinctive growth area for the geophysical sciences; an initiative which has only recently been emulated in the AGU and elsewhere on the international scene.

NPG was established in its present form in late 1990 and early 1991, in response to an increasing recognition of the importance of nonlinear processes, scaling laws, and nonlinear models and techniques in the development of an understanding and a capability of predicting the behaviour of a wide variety of complex systems throughout the geophysical sciences. A key aim of the IWG has been not only to increase an awareness of nonlinear phenomena within the mainstream disciplines of geophysics, but also to facilitate links and collaborations between geophysical disciplines and with important developments in techniques for tackling nonlinear problems in the wider scientific community.

The early seeds of the present *IWG on Nonlinear Processes in Geophysics* can be found in the sporadic organization of solitary interdisciplinary Joint Sessions at EGS Assemblies in the late 1980's, starting with *Chaos & Turbulence in Geophysics* at the Bologna General Assembly in 1988 (a 1-day symposium with just 20 papers). The present IWG came into being in its present form in a formal sense in 1990, and appeared as such in the EGS programme for the first time at the Wiesbaden General Assembly in 1991. During that meeting, five short symposia were organized (with a total of around 120 papers), together with an effective participation in a single Joint Session (10 papers) on *Mechanisms for Low Frequency Atmospheric Fluctuations*. Since that time, the symposia organized by the IWG have grown steadily, both in size and scope, up to the present status in which 24 symposia or sub-symposia were organized or co-sponsored at the Nice General Assembly in 2000, with a total of nearly 600 papers and posters being presented in three parallel sessions throughout most of the week of the Assembly.

The papers presented in this issue arose from NPG's first plenary review symposium at the 2000 General Assembly, which shared the title of this editorial. During this session, six distinguished exponents of the application of nonlinear

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ideas to geophysical problems gave review lectures on some major developments which have taken place in recent years, covering a wide diversity of topics including the (now well-known) problems of scale-invariance and fractals (given by the 2000 L. F. Richardson Medallist, Benoit Mandelbrot), turbulent cascades and dynamics (with contributions by Uriel Frisch and Semen Moiseev), chaos in the Earth's climate (Valentin Dymnikov and Michael Ghil), and self-organized criticality as applied to understanding the dynamics of the Earth's lithosphere (by Don Turcotte), as well as a bold look (by Michael Ghil) into some of the possible future problems which our successors may be tackling into the 21st century. Four of these speakers generously agreed to produce written versions of their talks for the journal *Nonlinear Processes in Geophysics*, aimed at a wider readership than just the attendees of the 25th General Assembly of the EGS, and these are presented below. The result is a representative cross ection of our understanding of some key questions in nonlinear geophysics at the end of the 20th century, together with some thought-provoking speculations as to the future directions for this kind of research; a record which, I hope, will form a modest yet important point of reference for future students of this vigorous interdisciplinary subject area.