Satellite altimetry and oceanography: heading for the future

In the early 1980s, satellite altimetry was a controversial subject within the oceanographic community. The controversy was twofold.

In the first place, many scientists did not believe that satellite altimeters could measure the ocean surface topography with the required accuracy. Geosat and other altimeter missions have been very effective in demonstrating that altimetry is quantitatively useful for oceanographic studies. The first significant results obtained concerned the oceanic mesoscale circulation. Results for large-scale ocean circulation are now becoming more and more accurate as altimeter data processing techniques improve. Furthermore, the forthcoming Topex/Poseidon mission is specifically designed to increase our understanding of the general ocean circulation and is expected to result in significant new breakthroughs.

The second controversial issue was the use of altimeter data for ocean modelling. Early in the 1980s, oceanographers knew little about how to assimilate data into models. The ability of altimeter data to usefully constrain ocean models was questioned. Today, data assimilation constitutes a major research field in oceanography. Optimal assimilation schemes exist in theory. Unfortunately, they require too much computer time for most practical purposes. A great deal of effort is thus being devoted to research into computationally efficient sub-optimal techniques. Much progress has already been made. In particular we have gained understanding of the manner in which data, assimilated in different ways, can effectively constrain ocean simulations. A very active scientific community is working in this field but, clearly, more work is required.

The eighties were thus boom years for altimetry. Now, early in the nineties, we are faced with new challenges. By the end of 1992, two altimeters will, for the first time, be operating simultaneously: ERS-1 and Topex/Poseidon. The oceanographic community is waiting for their data. Accurate operational processing software and improved ocean models, mostly developed under the Woce programme, are ready. A wealth of new oceanographic results is expected in the next few months.

Looking further ahead, it is now a much needed and well accepted international goal to build a permanent Global Ocean Observing System (GOOS) to succeed WOCE. The system must provide long-term systematic, near-real-time observations for global ocean and climate predictions. A GOOS Development Panel has recently been established by the Committee on Climate Changes and the Ocean (CCCO) and the Joint Scientific Committee of the International Council of Scientific Unions – World Meteorological Organization (ICSU-WMO). Altimeter data will play a major role in GOOS, but only if the present effort continues. The current or soon-to-be-launched ERS-1, Topex/Poseidon and ERS-2 missions are planned to operate only through 1997. Although later missions are in the early planning and definition phases, none have been approved, and such future missions will not necessarily provide the same accuracy as Topex/Poseidon. This major concern was recently examined by an international working group on "Future Altimetry" that published a strategy document titled "The future of spaceborne altimetry: ocean and climate change" (Koblinsky, Gaspar and Lagerloef, editors, 1992).

The report's primary recommendation is for a succession of high-accuracy altimeter missions beyond 1997 to establish an uninterrupted multi-decadal time series of observations. The report stresses, once again, that a single altimeter cannot observe the whole spectrum of oceanic variability. It thus strongly urges multiple simultaneous altimeter missions. However, we have not yet defined the best sampling strategies for such missions, and this requires a new research effort. Sampling patterns corresponding to different orbital scenarios should be

extensively tested by assimilating simulated altimeter data into appropriate ocean models. A number of other important issues must also be resolved over the next few years both to increase the scientific return of future missions and to reduce costs, and a joint effort by the scientific and engineering communities is thus called for. We need precise assessments of orbital tracking systems, solid-state radar altimeter instrumentation, range corrections, tidal modelling and waveform processing.

The Future Altimetry Working Group report finally advocates a strategy of meeting future altimetry needs through the development lightweight, low-power systems leading to low-cost satellites and launch systems. It is our hope that such new altimeter missions will be decided on soon and that they will make a major contribution to the future Global Ocean Observing System.

Michel LEFEBVRE

Topex-Poseidon Project Scientist
Centre National d'Études Spatiales
18, avenue Édouard Belin
31055 Toulouse Cedex, France.

Philippe GASPAR

Co-Chairman, Future Altimetry Working Group
CLS Argos/Space Oceanography Group
18, avenue Édouard Belin
31055 Toulouse Cedex, France.