THE CONTRIBUTION OF 18 YEARS OF ALTIMETRY TO THE UNDERSTANDING OF OCEANIC PLANETARY WAVES

Paolo Cipollini

National Oceanography Centre, Southampton, UK

In the past 18 years, our knowledge of that particular class of oceanic planetary waves also known as Rossby waves has improved significantly. Before the advent of altimetry they were already an important dynamical concept with a good theoretical understanding, but supported by very few, sparse observations; now they are a well-documented phenomenon, recorded in many different parameters in all ocean basins. Though some of this advance comes from reanalysis of old data and model output, the greatest impetus has been the wide availability of high accuracy satellite datasets, especially altimetric ones including those from ESA's ERS-1, ERS-2 and Envisat missions. This paper illustrates what we have learnt on oceanic planetary waves during these 18 years, and summarises the questions still challenging observers and theoreticians today.

When, in the mid-1990s, researchers started to look for evidence of planetary waves in sea surface height (SSH) data from altimetry, the early observational results immediately highlighted a tendency of the waves to propagate (westward) faster than predicted by the linear theory, which was until then widely accepted, and therefore often referred to as 'classic' theory. Chelton and Schlax, in 1996, showed that the waves were ubiquitous and confirmed the apparent speed-up. These results prompted a theoretical burst, with several scientists updating and extending the theory in the attempt to reduce the observed speed discrepancy; the most complete extension to the theory is the one developed in the late 1990 and early 21th century by Killworth and co-authors. Altimetry has been instrumental in this considerable theoretical advance.

While contributing to the above success story, altimetry and other satellite-based observations of planetary waves have opened a number of intriguing questions on which researchers are focusing their efforts at present. First of all, there is the doubt on how much of the westward-propagating variability is in the form of waves and how much is in the form of mildly non-linear eddies. In a recent study using merged multi-satellite altimetric data, Chelton and co-authors suggest that poleward of 25 degrees of latitude eddies prevail; however, as we will illustrate in the presentation, vast regions of the world oceans show the signature of both phenomena, waves and eddies, which are intrinsically difficult to separate. Other dynamically important research is being carried out on the relative importance and significance of the various baroclinic modes of wave propagation, and on the occurrence of 'waveguides' of higher propagating energy in the various oceanic basins. A significant role has also been suggested for planetary waves in the El Niño cycle, and modelling studies indicate that they can speed up (and therefore accelerate the dynamics of the El Niño system) as an effect of anthropogenic climate change. Moreover, the suggestion that Rossby waves be able to generate short-term fluctuations of several Sverdrups in the Meridional Overturning Circulation (MOC) in the North Atlantic calls for an accurate monitoring of the waves to aid interpretation of direct MOC measurements from mooring data. Finally, there is the open question of the importance of the waves for phytoplankton growth and the carbon cycle, given that their signature is apparent in ocean colour data; this is being investigated with a combination of modelling and SSH, Sea Surface Temperature and surface chlorophyll observations from satellites.