FROM OCEAN MESOSCALE MODELLING TO OPERATIONAL OCEANOGRAPHY: A TRIBUTE TO A.R. ROBINSON

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Abstract

A.R. Robinson was the pioneer of ocean mesoscale modelling and data assimilation. His extraordinary knowledge about ocean mesoscale processes, advanced technologies for monitoring and numerical modelling made it possible for operational oceanography to emerge as a new science in support of the sustainable development of all marine activities.

Keywords: Circulation Models, Mesoscale Phenomena, Eastern Mediterranean

A.R. Robinson (1932-2009) was the founder of ocean forecasting, starting from mesoscale modelling up to the development of the general methods for ocean forecasting. He defined the three methodological phases for forecasting mesoscale eddies in the ocean and carried out the experiments at sea and with numerical models to demonstrate the effectiveness of the methodology [1].

Starting with the MODE and POLYMODE experiments in the 70's, he showed that the ocean was dominated by mesoscale eddies 4-5 times the Rossby deformation radius and that the energy and vorticity processes of this flow field are characterised by frontal dynamics and baroclinic instabilities [2]. In 1983 he designed and carried out the first 'Real Time Forecasting Experiment' in the California Current [3]. In the figure the principle of ocean forecasting is summarized: collect synoptic data and produce an initial condition as accurate as possible to control the error growth by intense nonlinearities in the ocean [4].

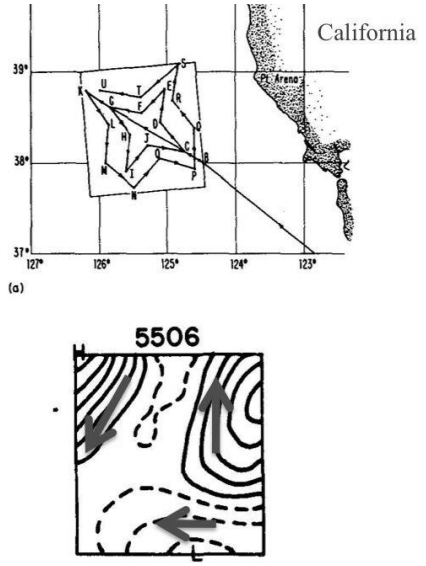

Fig. 1. The essential components of the first real time forecasting experiment carried out by Robinson and collaborators in the California current in 1983 [3, 4]. The top of the picture shows the sampling pattern in a 150 x 150 kmsq region which was repeated three times giving rise to data that allowed to calculate the geostrophic streamfunction shown in the panel below. The direction of currents is shown by red arrows overlaid on the pictures.

Robinson devised the in situ data collection sampling methods and the modelling tools at the same time, capable to forecast nonlinear ocean mesoscale eddies up to few weeks in the future. His contribution to ocean forecasting was even more important for the seminal work carried out at the beginning of the eighties in understading and demonstrating the usage of Geosat altimeter data for ocean forecast initailization, a crucial step for operational oceanography [5].

At the same time he was thinking to demonstrate that forecasting was possible in the Gulf Stream area, a region extremely non-linear and ageostrophic so that, if forecast would be successful, it would demonstrate that ocean forecasting is possible everywhere in the world ocean. Again he invented a method to overcome the scarcity of data in this region: the feature model initializion method that combines the oceanographic knowledge of the processes and structures of the region with observations that are gappy and unfrequent. The first successful forecast of Gulf Stream evolution and ring detachment was then carried out in 1984 [6].

Meantime all these developments were undergoing in the Atlantic and Pacific ocean he turned his attention to the Mediterranean Sea, preparing the ground for the modern and scientifically based evidence of the large scale general circulation of the Eastern Mediterranean Sea. He was the father of the 'Physical Oceanography of the Eastern Mediterranean-POEM' program that lasted ten years and collected the first intercalibrated basin scale data sets at 0.5 degree resolution for the entire eastern basin. His description of the general flow field of the Eastern Mediterranean is a benchmark of our understanding of the Mediterranean Sea circulation. It shows new structures and phenomena, the sub-basin scale gyres instabilities, new eddy-gyres structures never revealed before, recurrent eddies phenomena not yet fully understood. His work pointed out the intense eddy dynamics of the South-Eastern Levantine area [7], the presence of anticyclonic gyres that merge and enlarge, depicting the intense quasigeostrophic turbulent cascade processes of this area [8]. After this phase, as part of a general methodology for starting ocean forecasting activities in the world ocean, he dedicated a major effort to implement ocean forecasting in the Sicily Strait and Ionian Sea, describing the dynamics of these areas at unprecedented resolution and demonstrating the quality of forecasting [9] .

References

1 - Robinson A.R and Leslie W.G., 1985. Estimation and Prediction of Oceanic Fields. *Prog. Oceanogr.*, 14: 485-510

2 - Robinson A.R. (ed.), 1983. Eddies in marine Sciences, Springer-Verlag, New York/Heidelberg, 609 pp

3 - Robinson A.R., Carton J.A., Mooers C.N.K., Walstad L.J., Carter E.F., Rienecker M.M., Smith J.A. and Leslie W.G., 1984. A Real-Time Dynamical Forecast of Ocean Synoptic/Mesoscale Eddies. *Nature*, 309(5971): 781-783.

4 - Robinson A.R., Carton J.A., Pinardi N. and Mooers C.N.K., 1986. Dynamical Forecasting and Dynamical Interpolation: An Experiment in the California Current. *J. Phys. Oceanogr.*, 16: 1561-1579.

5 - DeMey, P. and Robinson A.R., 1987.Assimilation of altimeter eddy fields in a Limited Area Quasigeostrphic Model, *J. Phys. Oceanogr.*, 17(12): 2280-2293

6 - Robinson A.R., Spall M.A. and Pinardi N., 1988. Gulf stream simulation and the dynamics of ring and meander processes. *J. Phys. Oceanogr.*, 18(12): 1811-1853.

7 - Robinson, A.R., Hecht A., Pinardi N., Bishop J., Leslie W.G., Rosentraub Y., Mariano A.J. and Brenner S., 1987. Small Synoptic/Mesoscale Eddies: the energetic variability of the Eastern Levantine Basin, *Nature*, 327(6118): 131-134

8 - Robinson A.R., Malanotte-Rizzoli P., Hecht A., Michelato A., Roether W., Theocharis A., Unluata U., Pinardi N. and the POEM Group, 1992. General Circulation of the Eastern Mediterranean, *Earth-Sci. Rev.*, 32: 285-309.

9 - Robinson A.R. and Sellshopp J., 2002. Rapid assessment of the coastal ocean environment. *In*: N.Pinardi and J.D.Woods (ed.), Ocean Forecasting: Conceptual basis and Applications, Springer-Verlag, 203-232.