Proposal for a SCOR Working Group on the Physical and Biological Structure of Meso-scale Rings in World's Oceans.

Abstract

We propose to create a SCOR working group on the physical and biological structure of meso-scale rings in the world's oceans. The ultimate goal of this internationally constituted working group will be to prepare a comprehensive summary of the salient facts concerning ring formation, structure, and their biological, physical, and biogeochemical dynamics with the ultimate aim of providing an assessment of the role of rings in the world's oceans.

Scientific Background

Rings, the most energetic class of meso-scale eddies, were first recognized in the 1950's and 60's through work in the Northwestern Atlantic Ocean (Parker 1971; Saunders, 1971; Fuglister, 1972). They are distinct from other meso-scale eddies in that they transport biological properties across major ocean boundaries that are distinctly different from those of the surrounding waters in which they move. During the 1970's and 80's major programs to study cold-core and warm-core rings in major western boundary current regions were carried out in the Northwestern Atlantic (Gulf Stream) and Pacific (Kuroshio/Oyashio) and Southwestern Pacific (East Australian Current). Rings that occur in the Agulhas Current, Brazil Current, and Antarctic Circumpolar Current have also been extensively studied. Recent efforts have surveyed near equatorial features such as those created in the North Brazil Current. Work has continued unabated in the Northwestern Pacific on warm-core rings of the Kuroshio/Oyashio region where rings define crucial fisheries habitats (Itoh and Sugimoto, 2001, 2002).

Early international cooperation on ring research resulted in three special volumes of papers (Trantor, 1983; Wiebe and McDougall, 1986; Joyce and Wiebe, 1992). In spite of this, a key point made in the third volume was that the current state of knowledge on many topics is rudimentary and much basic research on rings remained to be done (Wiebe and Joyce, 1992). A review of ring properties and some of the biochemical issues on a global basis is presented in Olson (1991). In the intervening period, more work on rings has been completed and the time is right for there to be an integrated synthesis of the various data sets (Crawford, 2001). The proposed SCOR working group would undertake this synthesis and the final product would be a book that would summarize what is known about the physics, chemistry, and biology of rings worldwide. A major goal of the proposed working group would be to attempt to revise and consolidate the early efforts of Olson (1991) and others to address the larger scale role of rings.

The global nature and the multi-disciplinary aspects of the proposed working group activities appears ideally matched to the SCOR international purview.

Statement of Work/Terms of Reference

The proposed working group would complete the following:

1) A compilation of all of the literature that has been published since the first compilation of the literature was done by Olson and Wiebe (1983).

2) Based on the literature and unpublished data, a book would be prepared along the lines of the draft outline provided in Appendix 1. This outline will be updated to include biogeochemical and further issues in biogeography and fisheries.

3) An assessment of the need for additional research on rings and other meso-scale eddies in the context of basin-scale studies of the distribution and dynamics of biological populations and biogeochemical fluxes.

Meetings:

It is proposed that the first formal meeting of this Working Group take place in Woods Hole in early August, 2004 or in Sendai, Japan, in early December 2004 with four subsequent working group meetings (two of which would involve smaller disciplinary groups). The final meeting could take the form of a symposium.

Working Group Membership:

Working Group membership is proposed to consist of international experts who have had long experience working on rings. We anticipate having ten official members including the two co-chairs when the membership is complete. In addition, we anticipate that there will be several Associate Members in order to include some of the younger scientist currently working on rings.

Potential working group members include:
T. Sugimoto (co-chair) Japan
P. Wiebe (co-chair) USA
Y. Endo (Japan)
T. Joyce (USA)
S. Pionkovsky (Ukraine/USA)
I. Yasuda (Japan)
D. Olson (USA)
G. Flierl (USA)

Others Potential Participants:

Professor Johann Lutjeharms, Oceanography Department, University of Cape Town, South Africa

Laurent M. Chérubin, Instituto de Oceanografia, Universidade de Lisboa, Lisbon, Portugal

Open (biogeochemist)*

Open fisheries biologist (possibly from South Africa)

* One of the candidates for open biogeochemist is Prof. Toshiro Saino in Nagoya University, Japan.

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Appendix 1: Working book title: Oceanic Rings; A multidisciplinary perspective.

I. Introduction

A) Defining the term “ring”
- 1) Fuglister's definition
- 2) Brief historical review
- 3) Other allied features in the ocean and atmosphere

B) Rings and their role in the ocean
- 1) Rings as part of the ocean circulation
- 2) Rings and the structure of the pelagic ecosystem

C) Rings as model environments
- 1) Definitive tests for ocean models
- 2) Distinct traceable features in which to study the marine ecosystem

Perhaps these next two sections could be appendices?

II. Some preliminary concepts: Pt. I Physical Aspects

A) Some tools from geophysical fluid dynamics
- 1) Equations of motion
- 2) Mixing and turbulence
- 3) Effects of rotation

B) Descriptive tools

1) Water masses and their analysis
2) An introduction to coordinate systems
3) Notes on the instrumentation used to study rings

III. Preliminary concepts: Pt. II Biological Aspects

A) Some preliminaries on marine ecology
1) Pelagic communities
2) Food webs; Energy flow

B) Tools in Biological Oceanography
1) Sampling of the marine ecosystem
2) Analysis techniques

IV. Formation and occurence of rings

A) Parent currents and their properties
1) Oceanic jets: WBC's and their extensions, ACC
2) Water mass contrasts
3) Biological contrasts

B) Vortex formation
1) Meandering in zonal jets (Gulf Stream ex.)
2) Intrusive phenomenon (Brazil, Agulhas)
3) Source of ring core waters

C) Global distribution of rings
1) Map of ring locations
2) Brief description of different regimes

V. Ring structure

A) Density and velocity fields
1) Cyclonic/cold core rings
2) Anticyclonic/warm core rings
3) Gradient balance and structure of deep flow

B) Distribution of properties in rings
1) T/S anomalies in rings, water masses
2) Biogeochemical description; Nuts, Chl, O2
3) Species distributions

VI. Ring translation

A) Basic mechanisms
1) Beta--plane drift; shelf induced motion
2) Advection by larger scale circulation

B) Examination of fluid trapping in core
1) A Lagrangian view of the problem
2) Analysis of exchange mechanisms

VII. Evolution of rings in time

A) Observed trends in ring properties
1) Water mass anomalies and volume
2) Energetics and potential vorticity
3) Phytoplankton communities
4) Biomass and speciation in zooplankton

5) Fish and other higher trophic levels

B) Underlying mechanisms

1) Viscous versus radiative decay
2) Air--sea interaction effects
3) Enhancement of primary productivity
4) Differentiation of zooplankton community

VIII. Sub-ring scale processes

A) Submesoscale features

1) The ring front
2) Streamers and associated advective features
3) Convective cells in warm core rings

B) Fine and micro-scale processes

1) Intrusions and double diffusive mixing
2) Internal waves
3) Distribution of turbulence and microstructure

C) Biological interactions at small scales

1) Interactions at the ring front
2) Streamer events and off shelf advection
3) Biological mixing

IX. Global role of rings

A) Rings and the climatological fluxes

1) Meridional flux of heat and salt
2) Regional water mass modification and ventilation
3) Rings and the energetics of the ocean circulation

B) Rings and the ocean ecosystem

1) Biogenic fluxes and rings
2) Influence of biogeography
3) Interactions with recruitment processes

X. Rings and Fisheries Oceanography

A) Effect on fish migration routes

B) Effect on fish recruitment

XI. Ring Interaction with Continental Shelves

XII. Future Prospects