

## Prospectus

### Coupled Biological/Physical Models of Marine Systems: Skill Assessment

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**Goal:** To organize and present the state-of-the-art in quantitative evaluation of coupled physical-biological models.

#### Rationale

Simulation models coupling physics to biological processes in the ocean are the object of a large number of current research programs. Ocean physics have approached a high level of simulation sophistication, as the state space and the physical relationships within it are canonical; and modern computational technology for fluid mechanics has been advanced in scholarly communities for two generations or more. However the complexity of the biological state space presents an enormous explosion of state variables and their interaction. As a result, there is a recognizable mode of operation wherein ‘complete’ physics is coupled to reduced-complexity biology; and successful simulations are typically chosen to fit field problems and available data. The upshot of this situation is enormous diversity in what is possible in ‘replicating observations’, and even more importantly, in assimilating them into simulations and creating forecast systems.

It is a feature of the oceanic research landscape that many important programs are currently facing the consequences of this. The biological problems therein are of immediate human concern, and there is a sense that skillful simulations can be constructed. Yet what is meant by ‘simulation’ in this context is typically very different depending on the target problem. Examples include JGOFS, ECOHAB, and GLOBEC, the latter two having numerous regional manifestations in terms of target species, interactions, and data.

This project will concentrate on developing the theoretical basis for the underlying problem of *skill assessment* in all of its relevant senses, across species and ecosystems, geographical places, and data types and availability. Generic theoretical problems will be addressed in specific program contexts; the scholarly and practical aspects will be developed, discussed, and shared across this diverse landscape. The results will be peer-reviewed and published in one or more volumes of standard outlets. It is essential to address the broad diversity present here, in order to find common ground and the conceptual strength and generality that that leads to.

A scholarly basis of agreement is prerequisite to regulatory progress and public advisement. However it is a mistake to focus exclusively on the former, to the neglect of progress in the public sphere where real problems are originating and demanding attention. Exactly because of

the broad diversity of phenomena covered in the “phys-bio” and “ecosystem” rubrics, scientific progress must not be allowed to become irrelevant to these practical problems. Accordingly, coupled to scholarly advancements herein will be a parallel effort to embed findings in regulatory practice.

### **Skill Assessment Volume**

We propose to construct a special collection of scholarly papers to be published in a refereed journal. Papers would be by invitation. The *guest editors* will be: D.R. Lynch, F.E. Werner, D. J. McGillicuddy, Jr. They will invite contributors, compile the NOAA report, and arrange two special author’s meetings which are described below. These individuals have been heavily involved with related efforts in the ECOHAB, GLOBEC, JGOFS programs, and with the ongoing Gordon Research Conference on Coastal Ocean Simulation. This activity will occur between these scheduled conferences, such that the upcoming conference program (2007) will be a direct beneficiary of progress here. (Previous conferences have had direct attention to coupled physical-biological problems.)

One suitable venue for the Special Volume is the journal *Continental Shelf Research*. Prof. Lynch has served as guest co-editor for two recent volumes addressing shelf circulation models. Another possibility is an AGU volume in the CES series; Lynch edited a volume in the past decade with that publisher. Other outlets discussed to date include *Dynamics of Atmospheres and Oceans* (recent expansion of purview); *Fisheries Oceanography* (GLOBEC and SABRE volumes are examples); and *Deep-Sea Research II* (GLOBEC and ECOHAB volumes to date). The choice of outlet will be made by the guest editors, once the project is launched.

A special report to NOAA concerning the content, major findings, and recommendations by program will be prepared, and will be available prior to the publication of the journal issue. It will represent advance information about peer-reviewed contributions, and important concerns of intrinsic interest to NOAA and other agencies. A web site will contain the in-press manuscripts for background.

The work will be inspired by, and kept relevant to, NOAA’s Ecosystem Based Management activities and other contemporary programs of similar character.

### **Summary Outcomes**

- Assess the state of the art in coupled physical-biological and ecosystem skill assessment: theory, practice, data assimilation;
- Assemble active research teams and apex papers representing major ongoing research programs;
- Conduct two author's workshops to coordinate papers;
- Publish the collection in peer-reviewed literature;
- Construct a special report to NOAA containing major findings;
- Build an electronic archive of peer-approved preprint manuscripts;
- Develop an Implementation Plan for a Model Intercomparison and Evaluation Project.

## Coverage and Topics

Invitees will be assembled during December '05. They will be drawn from several sources. The '03 GRC speakers and moderators are a starting point. To this we will add representatives of USGLOBEC, GLOBEC International, ECOHAB, MERHAB, BOHAB, JGOFS, the ICES 'Fisheries Oceanography' community generally, and LAPCOD. We will supplement these communities with the 'water quality modeling' community which has advanced engineering practice in this arena – for example the communities modeling Mass Bays and the Chesapeake Bay; and the ERSEM experience. Management contributors from each of these general topic areas will also be invited.

Topics will be drawn from the following. An effort will be made to condense this list around major ongoing programs.

- Skill Metrics
- Data and Data Assimilation
- Field Experiences
- Predictability
- Test Cases and Data Sets for Verification – a primary activity of the MIEP working group
- Role of intra-species Biological Diversity
- Implications of Patchiness
- Spatially-Explicit Population Simulation

Simulation methods and their niches considered will include the major contemporary ideas. Special emphasis will be given to the problem being attacked, and the relative strengths of methods:

- Lagrangian versus Eulerian
- Individual-Based, Cohort, and Ecosystem models
- Monte Carlo approaches
- Objective Analysis, Filtering
- Subgridscale parameterization (both phys. and bio.)

Within the workshop framework, a model intercomparison and evaluation project (MIEP) working group will be formed and charged with defining and developing an implementation plan for one or more site-specific exercises in this general category.

## Timeline

The following timeline begins immediately; it puts the activity midway between the Coastal Ocean Modeling GRC's in '03 and '07.

- Invitations out: February '06
- Authors' Workshop 1: July '06
- Manuscript submissions for review: December '06
- Reviews complete : March '07
- Authors' Workshop 2: Spring '07

- Final manuscripts to Editors: August '07
- Publication to printer: September '07
- In print: December '07

### **Skill Assessment Vocabulary**

By comparison with the 1995 volume on Circulation modeling<sup>1</sup>: That volume avoided agreement on a skill vocabulary. The vocabulary concerning physical processes and states is canonical and widely shared in theoretical, computational, observational, and management/evaluative communities. Hence the task was easier: within the restricted domain left, let the authors explain the meaning of terms relevant to skill. In the present work, however, we are presented with no simple canonical description of things beyond physics, a great diversity of application involving aggregation and simulation of unobservable states, and a natural compounding of ambiguities concerning skill. It is one of the goals of the present volume to give more rigor to this arena. Accordingly, a concerted, volume-wide effort at defining an adequate skill assessment vocabulary, and using same, will be launched at the very start.

### **Financial Support**

The principal costs involved are those of convening the two workshops. The venue for these will be Woods Hole, MA and/or Chapel Hill NC. We anticipate covering travel and accommodation for participants. Two such workshops are planned, plus publication costs (color will be essential). Modest administrative assistance will be supplied at WHOI to support the workshops.

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<sup>1</sup> Lynch and Davies, eds.; *Quantitative Skill Assessment for Coastal Ocean Models*, AGU-CES.