

OC4335 Naval Ocean Analysis and Prediction (NOAP)

Distinguished Professor Peter C. Chu

Pre-requisite

OC4323 Numerical Air-Ocean Modeling (or concurrent)

Course Description

This course is designed for educating Navy officers with the most sophisticated methods, models, theories, and techniques currently used in the Naval Oceanographic Institutions. The course covers the Navy's needs for ocean prediction, the Navy's modeling and prediction program, and almost all the Navy's ocean analysis and prediction systems.

This course will show students a big picture of the U.S. Navy's operational ocean prediction system, as well as the research and development counterpart. Through the course work, students will understand the physics, formulation, strengths, and weaknesses of each model. Through the lab work (all the labs are simplified versions of the Navy's models), students will have a chance to implement and evaluate each of the provided models.

A good understanding of the Navy's ocean analysis and prediction systems (including their strengths and weaknesses) will assist students in pursuing their Navy relevant thesis research (short term) and supply them with a good foundation for providing tactical modeling support to the fleet throughout their oceanographic careers (long term).

Syllabus

Chapter 1 INTRODUCTION

Chapter 2 NAVAL OCEAN ANALYSIS AND PREDICTION (NOAP)
PROGRAM

- 2.1 The Principal Issue and Its Ocean Prediction Implications
- 2.2 Operational Naval Ocean Prediction
- 2.3 Shipboard Dynamic Forecasting
- 2.4 Shipboard Acoustic Forecasting
- 2.5 Navy Requirements for Littoral Sensing and Modeling
- 2.6 System Requirements for Littoral Ocean/Acoustic Predictions

Chapter 3 NAVAL OCEAN OBSERVING AND DATA SYSTEMS

- 3.1 Navy Requirements for Ocean Observing Systems
- 3.2 Special requirements for the Equipment
 - 3.2.1 Ocean Bathymetry Measurement System
 - 3.2.2 NAVOCEANO Satellite System
 - 3.2.3 In-Situ Ocean Systems
 - 3.2.4 Oceanographic Data Archiving and Distribution
- 3.3 Naval Oceanography Equipment Development
 - 3.3.1 Ocean Telemetry
 - 3.3.2 Acoustic Tomography
 - 3.3.3 Sampling Strategies
 - 3.3.4 Surface Drifters
- 3.4 Optimum Design of Observing Systems
- 3.5 Master Oceanographic Observation Data Set (MOODS)
- 3.6 Navy Oceanographic Data Distribution System (NOODS)
- 3.7 NAVOCEANO NIDAS System

Chapter 4 DATA ANALYSIS

- 4.1 Objective Analysis Techniques
- 4.2 Grid-Point Data Set Establishment
- 4.3 Empirical Orthogonal Functions (EOF)
- 4.4 Singular Value Decomposition (SVD) Method
- 4.5 Selected Topics for Thesis Research

Chapter 5 ATMOSPHERIC FORCING

- 5.1 Wind Forcing
 - 5.1.1 Surface Wind Climatology
 - 5.1.2 Synoptic Surface Wind Data (NCODA-Atmosphere and COAMPS)
- 5.2 Thermodynamic Forcing
 - 5.2.1 Bulk Parameterization Schemes for Air-Sea Flux Computation
 - 5.2.2 Synoptic Surface Flux Data
- 5.3 Satellite Capability for Estimating Atmospheric Forcing

Chapter 6 NAVAL OCEAN THERMAL ANALYSIS/PREDICTION SYSTEMS

6.1 Introduction to NAVOCEANO, FNOC Global Ocean Thermal Products

6.2 Thermodynamic Ocean Prediction System (TOPS)

6.2.1 Basic Physics

6.2.2 Mathematical Formulation

6.2.3 Atmospheric Forcing

6.2.4 TOPS Model Products

6.2.5 TOPS Model Performance

6.3 NCODA-OCEAN

6.3.1 Optimum Interpolation (OI) Technique

6.3.2 Sea Surface Temperature (SST) Analysis

6.3.3 Ocean Mixed Layer Analysis

6.3.4 Sub-Mixed-Layer Analysis

6.3.5 Model Products

6.3.6 Model Performance

6.4 NAVOCEANO Generalized Digital Environmental Model (GDEM)

6.5 Selected Topics for Thesis Research

Chapter 7 NAVY GLOBAL OCEAN CIRCULATION PREDICTION SYSTEM

7.1 The Global Hybrid Coordinate Ocean Model (HYCOM)

7.2 Basic Physics and Model Formulation

7.3 Major Features of the HYCOM

7.4 External Forcing Input

7.5 Model Code Explanation

7.6 Modeling Example A - Gulf Stream

7.7 Modeling Example B – Kuroshio

7.8 Selected Topics for Thesis Research

Chapter 8 NAVY REGIONAL OCEAN CIRCULATION PREDICTION SYSTEM

8.1 The Navy Coastal Ocean Model (NCOM)

8.2 Basic Physics and Model Formulation

8.3 Major Features of the NCOM

8.4 External Forcing Input

- 8.5 Model Code Explanation
- 8.6 Modeling Example A – South China Sea Circulations
- 8.7 Modeling Example B – Persian Gulf Circulation
- 8.9 Selected Topics for Thesis Research

Chapter 9 FNOC POLAR ICE PREDICTION SYSTEM (PIPS)

- 9.1 Basic Physics and Model Formulation
- 9.2 Major Features of PIPS Model
- 9.3 Modeling Example
- 9.4 Selected Topics of Thesis Research

Chapter 10 THE THIRD GENERATION WAVE MODEL (WAM)

- 10.1 Basic Physics and Model Formulation
- 10.2 Major Features of WAM
- 10.3 Modeling Example
- 10.4 Visual Sea Height Analysis (H-VISUAL)

Chapter 11 A PROTOTYPE LITTORAL ZONE PREDICTION SYSTEM

- 11.1 Difference between "Blue" and "Brown" Waters
- 11.2 Major Features of the Coastal Systems
- 11.3 Major Difficulties for Littoral Zone Ocean Prediction
- 11.4 Coupled Littoral Zone NORAPS/TOPS System
- 11.5 Selected Topics of Thesis Research

APPENDIX ACRONYMS AND NOMENCLATURE

- [Lab 1 Basic Matlab](#)
- [Lab 2 Establishment of Gridded Data from Observed Profiles](#)
- [Lab 3 Atmospheric Forcing Computed from the NOGAPS/NORAPS Data](#)
- [Lab 4 The MODAS Temperature and Salinity Fields](#)
- [Lab 5 Predicting Ocean Mixed Layer Features by TOPS](#)
- [Lab 6 The South China Sea Prediction by SWAFS](#)

- [Lab 7 Shipboard Ocean Analysis and Prediction](#)
- [Lab 8 Wave Prediction by the Navy's WAM](#)
- [Lab 9 Arctic Ice Prediction by PIPS](#)