南方科技大学 SOUTHERN UNIVERSITY OF SCIENCE AND TECHNOLOGY

课程详述

COURSE SPECIFICATION

以下课程信息可能根据实际授课需要或在课程检讨之后产生变动。如对课程有任何疑问，请联系授课教师。

The course information as follows may be subject to change, either during the session because of unforeseen circumstances, or following review of the course at the end of the session. Queries about the course should be directed to the course instructor.

1.	课程名称 Course Title	**海洋环流数值模拟 Numerical Simulation of Ocean Circulation**
2.	授课院系 Originating Department	海洋科学与工程系 Department of Science and Engineering
3.	课程编号 Course Code	OCE317
4.	课程学分 Credit Value	3
5.	课程类别 Course Type	**专业选修课 Major Elective Courses**
6.	授课学期 Semester	**秋季学期/Fall Semester**
7.	授课语言 Teaching Language	**中英双语 English & Chinese**
8.	授课教师、所属学系、联系方式（如属团队授课，请列明其他授课教师） Instructor(s), Affiliation& Contact （For team teaching, please list all instructors）	刘志强，海洋科学与工程系，17620783566 Zhiqiang LIU/Department of Ocean Science and Engineering
9.	实验员/助教、所属学系、联系方式 Tutor/TA(s), Contact	NA
10.	选课人数限额(可不填) Maximum Enrolment （Optional）	

11. 授课方式 Delivery Method	讲授 Lectures	习题/辅导/讨论 Tutorials	实验/实习 Lab/Practical	其它(请具体注明) Other（Please specify）	总学时 Total
学时数 Credit Hours	48				48

12.	先修课程、其它学习要求 **Pre-requisites or Other Academic Requirements**	OCE201 海洋科学导论 Introduction to Oceanography OCE305 物理海洋学 Physical Oceanography
13.	后续课程、其它学习规划 **Courses for which this course is a pre-requisite**	
14.	其它要求修读本课程的学系 **Cross-listing Dept.**	

教学大纲及教学日历 SYLLABUS

15. 教学目标 Course Objectives

本课程较全面、系统地介绍海洋环流数值模拟的基本理论、研究方法和应用实例，重点讲解编程语言(Fortran)程序设计基础，海洋环流控制方程各项的数值解，真实、理想地形下三维海洋过程的空间划分，时空插值方法等，海洋环流数值模式的分析方法和可视化，海洋环流过程和物质输运特征的动力学讨论。通过本课程学习，要求学生较全面掌握海洋环流数值模拟的基本理论，可以依托数值模式和关注的科学问题自主开发、调试高性能并行计算“虚拟海洋系统”，展开敏感性分析和动力过程诊断，解析海洋环流动力机制，将课堂理论学习和数值模式实践紧密结合，解决海洋科学研究中遇到的海洋环流相关问题。

This course introduces the fundamentals of numerical simulation of ocean circulation, including basics of programming language (Fortran), the differential format of terms in governing equations of Physical Oceanography, horizontal curvilinear grid and vertical s-coordinate, initial and boundary conditions, explicit and implicit methods, high-performance parallel computation, visualization of simulation and analysis methods. Students are required to develop, tune and validate the Virtual Ocean System by themselves, analyze and visualize the model results from this system, investigate the simulated multiscale oceanic processes, conduct sensitivity experiments and project the understandings to study the real ocean circulations.

16. 预达学习成果 Learning Outcomes

本课程在高年级以双语授课，要求学生掌握 Fortran 编程语言基础，海洋环流控制方程的数值解及其数学表述和数值方法实现，区域海洋环流模拟系统框架下“虚拟海洋系统”的搭建、调优、验证方法，数值模拟结果的可视化和过程分析，以及与现实海洋过程结合实现关键动力过程的清晰表达。课程中涉及物理海洋学基本数据的获取和数值分析等实践内容，与理论学习相互补充，拓展学生的研究能力。

This course will be delivered in both Chinese and English for upper-division undergraduates (mostly seniors after year 2) and graduate students, and by the end of the semester, students are expected to fully understand not only the basics of programming language (Fortran) and numerical solutions for the governing equations of ocean circulation, but also develop the capability to independently develop, tune and validate a “Virtual Ocean System”, analyze and visualize the model results from this system and investigate the simulated multiscale oceanic processes that reveal the dynamics governing the ocean circulation of real oceans. This course will also evolve the technologies of ocean observations and numerical analyses, as essential complementary practices to help the students deepen their understandings on the key oceanic processes.

17. 课程内容及教学日历 （如授课语言以英文为主，则课程内容介绍可以用英文；如团队教学或模块教学，教学日历须注明主讲人）
Course Contents (in Parts/Chapters/Sections/Weeks. Please notify name of instructor for course section(s), if this is a team teaching or module course.)

1. 绪论 （3 学时）

Introduction (3 credit hours)

海洋环流数值模拟历史和应用，虚拟海洋系统概论。

History of ocean circulation simulation, basic theories and recent advances, as well as introduction to Virtual Ocean

System.

2. Fortran 编程语言基础（6 学时）

Basics of Fortran Programming Language (6 credit hours)

Linux 平台下的 Fortran 语言，Fortran 数学表达式，流程控制与逻辑运算，循环，数组和函数

Fortran programming language on Linux platform, mathematical expression in Fortran, Computational Flow Control and Logic, Loop, Array and Subroutine.

3. 区域海洋环流数值模拟系统（3 学时）

Application of Regional Ocean Modelling System (3 credit hours)

海洋环流数值模拟系统的基本架构和各模块设计、运行逻辑

Structure of Regional Ocean Modelling System, kernel, logic and operation.

4. 控制方程在海洋环流数值模式中的表达（9 学时）

Numerical treatment of governing equations for ocean motion (9 credit hours)

连续性方程的数值解，数值模式的时间步进，内插和外插，对流项的高阶数值解，地球自转的数值实现，密度和压强梯度力，环流过程的湍封闭方程。

Numerical solutions for continuity equation, time-stepping of momentum equation, implicit and explicit methods, and mode-split. High-order numerical solution for advection processes, numerical treatment of earth rotation, density and pressure gradient force, fundamental of turbulence closure method.

5. 对流扩散方程的数值解（3 学时）

Numerical treatment of transport-diffusion equation (3 credit hours)

一维到三维温度、盐度扩散过程，分子和湍流扩散。

Numerical solutions for one to three dimensional transport-diffusion equation of ocean circulation, molecular and turbulence diffusion.

6. 海洋环流数值模拟中的边界条件问题（3 学时）

Boundary conditions for regional ocean modelling system (3 credit hours)

周期边界、固定边界、梯度边界、单波辐射边界、多波辐射边界的应用和误差分析。

Errors of Periodic Boundary Condition, Clamp Boundary Condition, Gradient Boundary Condition and Radiation Boundary Condition.

7. 陆架、陆坡海洋环流过程重构（2 学时）

Numerical reconstruction of coastal processes (2 credit hours)

陆架流、陆坡流对风场的响应，上升流和下降流的数值模拟和敏感性分析

The wind-driven shelf and slope processes, upwelling and downwelling circulation, their numerical reproducing and

sensitivity experiments.

8. 潮汐和河口环流（3 学时）

Tides and Estuary circulation (3 credit hours)

理想河口环流的重构和交换流计算，潮汐在调整河口环流中的作用

Estuarine circulation of an idealized estuary, (un)importance of Coriolis process. Tidal elevation and currents, as well as their impacts on the exchanging flow in an idealized estuary.

9. 虚拟海洋系统搭建（6 学时）

Development of Virtual Ocean System (6 credit hours)

数值模拟水体网格划分和正交性分析，垂向水体分层，模块设置和参数化。

Horizontal and vertical discretization of ocean waters, solutions for terms in the governing equations and parameterization.

10. 虚拟海洋系统可视化和过程分析（4 学时）

Visualization of Virtual Ocean System (4 credit hours)

基于 Matlab 语言的模型可视化基础，netcdf 自解释数据处理，动力过程分析

Basics of Matlab Visualization for Oceanic Processes, netcdf data processing and ocean dynamics analyses.

11. 虚拟海洋系统验证和调优（6 学时）

Validation and optimization of Virtual Ocean System (6 credit hours)

海洋调查数据获取和 Matlab 数据处理，模式-观测数据比对和模式调优，敏感性分析

Acquiring and reanalyses of ocean observations, Matlab-based data processing, cross validation of observation and simulation, optimization of Virtual Ocean System and sensitivity experiment.

18. 教材及其它参考资料 Textbook and Supplementary Readings

1.王东晓、宏波、蔡树群, 海洋环流数值模拟. 气象出版社. 2005

2.Dale Haidvogel and Aike Beckmann, Numerical Ocean Circulation Modeling, Imperial College Press,1999.

课程评估 ASSESSMENT

19.

评估形式 Type of Assessment	评估时间 Time	占考试总成绩百分比 % of final score	违纪处罚 Penalty	备注 Notes
出勤 Attendance		10		
课堂表现 Class Performance		0		
小测验 Quiz		0		
课程项目 Projects		0		
平时作业 Assignments		30		

期中考试 **Mid-Term Test**		0		
期末考试 **Final Exam**		0		
期末报告 **Final Presentation**		60		
其它（可根据需要改写以上评估方式） **Others (The above may be modified as necessary)**				

20. 记分方式 **GRADING SYSTEM**

√ A. 十三级等级制 **Letter Grading**
☐ B. 二级记分制（通过/不通过） **Pass/Fail Grading**

课程审批 REVIEW AND APPROVAL

21. **本课程设置已经过以下责任人/委员会审议通过**
This Course has been approved by the following person or committee of authority

海洋科学与工程系本科教学委员会
Department of Ocean Science and Engineering Undergraduate Committee