Syllabus for OC-4413, Air-Sea Interaction (4-0)

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Course Description

Fundamental concepts in turbulence; oceanic planetary boundary layer including the dynamics of the well mixed surface layer; atmospheric planetary boundary layer, including surface layer, and the bulk formulas for estimating air-sea fluxes.

Course Structure

Chapter 1 Introduction

1.1. Importance of Air-Sea Interaction
1.2. Atmospheric Effects on the Ocean
1.3. Oceanic Effects on the Atmosphere
1.4. Importance to the Naval Operations

Chapter 2 Basic Concepts of Instability

2.1. Buoyancy Driven Instability
2.2. Kelvin-Helmholtz Instability

Chapter 3 Planetary Boundary Layers of Atmosphere and Oceans

3.1. Atmospheric Planetary Boundary Layer
3.2. Oceanic Planetary Boundary Layer

Chapter 4 Basic Concepts of Turbulence

4.1. Boussinesq Approximation
4.2. Viscous Stress and Force
4.3. Nature of Turbulence
4.4. Analysis Methods for Turbulent Flows
4.5. Spectral Gap

4.6. Averaging Operator
4.7. Reynolds Equations
4.8. Turbulent Kinetic Energy
4.9. TKE Equation
4.10. KE and PE Equations for the Mean Flow
4.11. Boundary Layer Assumptions
4.12. Scales of Turbulent Flows
4.13. Flux Richardson Number

Chapter 5 Atmospheric Surface Layer

5.1. Mixing Length Theory (First-Order Closure)
5.2. Dynamics of the Neutral Surface Layer
5.3. Determination of l
5.4. Simplification of the Basic Equation
5.5. General Solution for Neutral Surface Layer – Log Profile
5.6. Non-Neutral (Stratification) Surface Layer
5.7. Fluxes in the Atmospheric Surface Layer
5.8. Obukhov Length Scale for the Stratified Surface Layer
5.9. Similarity Theory
5.10. Determination of Similarity Functions
5.11. Log-Linear Profiles in near Neutral Surface Layer

Chapter 6 Calculation of Air-Sea Fluxes

6.1. Drag Coefficient
6.2. Heat and Moisture Exchange Coefficients
6.3. Bulk Formulae for the Air-Sea Fluxes

Chapter 7 Ocean Mixed Layer Dynamics

7.1. Well Mixed Surface Layer
7.2. Ocean Mixed Layer Dynamics
7.3. TKE Closure
7.4. Obokhov Length Scale of the Ocean Mixed Layer
7.5. Analytical Solutions with $w_{-h} = 0$
7.6. Thermodynamic Features of the Detrainment Regime