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Description:
This course surveys dynamical processes that determine estuarine and continental shelf circulation. The primary focus is on geophysical scale flow where the earth’s rotation and buoyancy effects are important. Analytical and numerical methods are used to isolate and study these processes.

Prerequisites:
Knowledge of partial differential equations (MATH 612, or equivalent), understanding of the basic concepts of geophysical fluid dynamics (OCNG 609, or equivalent), and basic programing experience (e.g., MATLAB, FORTRAN, Python, or other scientific scripting language) are all strongly encouraged.

Learning outcomes:
The student will learn the fundamental physical processes acting in coastal and estuarine flow, and the analytical and numerical methods used to investigate these phenomena. By the end of the class, students will be able to read and understand most newly published scientific papers on the subject of estuarine and continental shelf circulation.

Course Outline:

Barotropic flow:
Review of barotropic flow – shallow water theory.

Shelf waves – using Strum-Liuville theory to determine cross-shelf structure of cross-shore modes.

Slowly evolving frictional flow – the arrested topographic wave.

Baroclinic flow:
Review of the effects of stratification – the reduced gravity model.

The Rossby adjustment problem in the presence of a coast.

Coastal upwelling – Ekman dynamics.

Stratified continental shelf waves – the slope Burger number.
Shelf break processes – Frontal trapping depth.

River plumes – Reduced gravity plumes.

Estuaries – Knudsen’s relation, the effects of fresh water discharge and tidal mixing.

Hydraulic control – two-layer flow through a constriction.

Turbulent mixing:
Mixed layer models – shear mixing and the critical Richardson number.

Second moment closure.

Grading:
Homework will be assigned approximately every other week, and will account for 40% of your grade. Students will be expected to contribute to, and occasionally lead the discussion of the topic paper. Contribution to the discussion will be based on questions submitted at the start of class and participation in the discussion based on these questions. Class participation will account for 30% of your grade. A research project, either a small original project or an in-depth review of established work, with a typed report and oral presentation will account for the remaining 40% of your grade.

Text:
There is no single adequate textbook for this topic, so we will read and discuss one or two seminal scientific papers on each of the various subjects, supplemented with textbook chapters and other reading. A list of relevant textbooks is:

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