Geophysical Physical Dynamics 3
Winter Quarter 2025

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Class meets T/Th from 11-12:20

The goal of GFD 3 --- a third course on geophysical fluid dynamics --- is to provide physical oceanography students with the background required to work at the frontier of research on unbalanced processes with an emphasis on upper-ocean and mixed layer dynamics. Some of these were once balanced but have ceased to be so (e.g. frontal instabilities), some were never balanced (e.g. internal waves), and some are nonlinear interactions between the two. These topics are of increasing community interest and are central to many ongoing SIO research projects but are not accommodated in parts I and II of the geophysical fluid dynamics sequence SIO 212. Most of these topics are not covered in any pedagogical textbooks, and students (and PIs!) are left to pick up what they can from individual research papers. Here we hope to put together a systematic treatment, an broad intellectual framework in which to understand many of these hot topic issues. This material is intended primarily for second year and above students who have at least taken the first year Fluids and GFD courses. Other interested scientists at any level are quite welcome to sit in and join the discussion.

Each class will involve a combination of lectures and discussion of relevant papers that connect lecture material to areas of active research. The paper associated with each lecture is listed below. Additional reference material of possible interest is listed further down.

SCHEDULE

- 1/7: [Jen] Overview of the class, parameter space, non-dimensional numbers, phenomena
- 1/9: [Jen] Internal wave dynamics
- 1/14: [Jen] More internal waves, propagation, WKB, ray tracing.
- 1/16: [Jen] Yet more internal waves. Tidal generation and propagation
- 1/21: [Bill] What is the near-inertial band and why does it deserve three lectures?
- 1/23: [Bill] (continued)
- 1/28: [Bill] (continued}
- 1/30: [Bill] Stirring and mixing

- 2/4: [Bill] Shear Dispersion
- 2/6: [Bill] Frontogenesis and Frontolysis
- 2/11: [Bill] Frontogenesis and Frontolysis
- 2/13: [Bill] Frontogenesis and Frontolysis
- 2/18: [Bill] Instabilities of the Surface Boundary Layer
- 2/20: [Jen] Lee waves and ray tracing = wave / mean flow interaction "lite"
- 2/25: [Jen] Bringing back advective terms to internal waves, part I: wave-wave interactions and the G-M continuum
- 2/27: [Jen] Bringing back advective terms to internal waves, part II: ray tracing in a mean flow.
- 3/4: [Jen] Bringing back advective terms to internal waves, part III: internal wave / mesoscale interactions
- 3/6: [Jen] Bringing back advective terms to internal waves, part IV: internal wave / front interactions
- 3/11: tbd / presentations
- 3/13: tbd / presentations

Office hours: contact either professor individually to figure out a good time to stop by.

HOMEWORK

The classes will involve a combination of formal lectures on the underlying theoretical framework coupled with class discussion and presentation of research papers --- both classic and cutting edge. There will be a few formal homeworks, as we think there are some things you will (later) appreciate having had to derive yourself, and thus understand thoroughly. However befitting a senior graduate student class the majority of the work expected will be a combination of reading assigned cutting edge papers (and coming to class prepared to discuss them), and a modest size term project of flexible nature. There are no written exams.

GRADING

Grades will be based on a combination of written assignments and class participation.