APMA 935 • Analysis & Computation of Models • Spring 2008

Waves & Stability in Models for Fluids & Geofluids

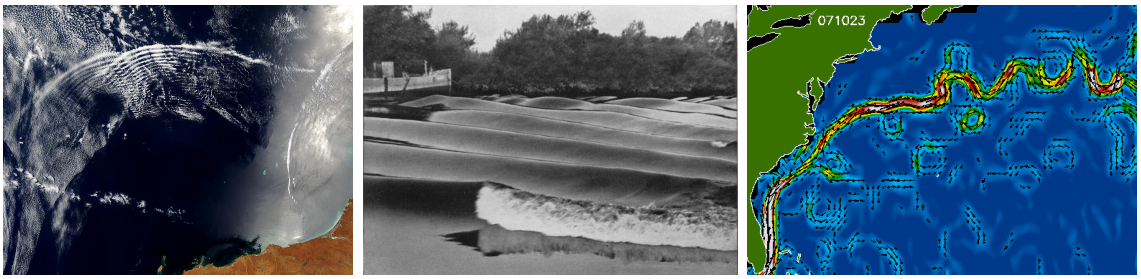
The propagation of waves represents one of the fundamental mechanisms for the transport of energy in a moving fluid. Two of the most familiar examples are sound waves and surface water waves. Waves can also appear due to flow instabilities, as an onset to the complexity of fluid turbulence. The theme of this course will be the development of analytical methods for the understanding of waves and instabilities — in specific contexts taken from fluid models.

The theory of acoustics begins from the demonstration that weak variations in flow, density and pressure result in the linear wave equation. Beyond simple translation, linear wave propagation can display richer behaviours due to the effects of spatial dimensionality, dispersion and refraction. When the background flow has stronger spatial variation, as for jet and shear flows, the possibility arises for nonlinear instability. Finally, variations in background density can be addressed under the Boussinesq assumption, which is the foundation for the modelling of thermal convection and geophysical flows. Many of the new types of waves and instabilities introduced through these buoyancy effects are particularly relevant to the dynamics of the atmosphere and ocean.

In addition to focussing on model development and analysis, assigned work will also emphasize proficiency in the use of research tools for searching the scientific journal literature. Computer visualization and numerical computing will involve the use and modification of Matlab scripts.

Readings: P.G. Drazin, Introduction to Hydrodynamics Stability (2002)
J. Pedlosky, Waves in the Ocean and Atmosphere (2003)
G.B. Whitham, Linear and Nonlinear Waves (1974)
J.C. McWilliams, Fundamentals of Geophysical Fluid Dynamics (2006)

Further information & updates: www.math.sfu.ca/∼muraki



Illustrations of a variety of waves in geophysical fluid flows. The left image captures an atmospheric wave off the Australian coast, as evidenced by cloud and sea surface waves. The centre image shows tidally-enhanced waves on the Trent River. The right image is a sea surface temperature/velocity map showing the unstable meanderings of the Atlantic Gulfstream.