Earth and Space Sciences 533 – Atmospheric Sciences 512
Dynamics of Snow and Ice Masses
Spring 2009

Mon-Wed 9:30-10:50
Johnson Hall 027

Learning Objectives

- You will develop an appreciation of ice as the most dynamic solid surface on planet Earth.
- You will understand processes controlling motion of glaciers, snow, and sea ice.
- You will be able to calculate or predict ice motions using a variety of simple approximations.
- You will develop an appreciation of the advances in ice dynamics since c1950.

Subject outline:

- Introduction and perspective
- Mechanical behavior of glacier ice, snow, and sea ice
- Flow of sloped ice and snow slabs
- Valley glaciers and ice streams - side drag
- Flow lines in glaciers and ice sheets - longitudinal gradients
- Three-dimensional flow and topography of ice-sheet surfaces
- Snow slope stability and avalanches
- Ice sheet systems - inland ice, ice streams, ice shelves
- Sliding of snow and ice
- Glacier surges
- Response of glaciers and ice sheets to climate change
- Instabilities in ice sheet response
- Kinematics of sea ice
- Large scale rheology of sea ice
- Modeling sea ice motions and characteristics

We will have to be selective, because we will probably not have enough time to address all of these topics.

Sources of information

Books:

- Paterson. 1994. *The Physics of Glaciers.3rd Ed.* Pergamon.
- Hooke. 2005. *Principles of Glacier Mechanics.2nd ed.* Prentice Hall.
- Colbeck (Ed.). 1980. *Dynamics of Snow and Ice Masses.* Academic Press.
- Hutter. 1983. *Theoretical Glaciology.* Reidel.
- van der Veen. 2001. *Fundamentals of Glacier Dynamics.*
- Untersteiner. 1987. *The Geophysics of Sea Ice.* Plenum.
- Salm and Gubler (Eds.). 1987. *Avalanche Formation, Movement and Effects.* IAHS Publication No. 162.

Principal Journals

- *Journal Glaciology*
- *Annals of Glaciology*

- *Journal of Geophysical Research*
- *Geophysical Research Letters*
- *Cold Regions Science and Technology*

Class Organization

- Lectures.
- Review and discussion of previous class by students.
- Scheduled presentations or literature review by participants.
- By end of third week, each student tentatively chooses a "focus area".
- By end of fifth week, each student chooses a focus area and tentative topic.
- By end of seventh week: each student chooses a definite topic.

Assigned Work

- Readings from selected book chapters and journal articles
- Presentations and discussion in class
- Occasional homework problems
- Mid-term exam
- Presentation of term topic (oral presentation, written summary, and bibliography)

Example focus areas

Glaciers:

- Glacial erosion, transport and deposition
- Stability of the West Antarctic Ice Sheet
- Current changes in the ice sheets and causes
- Ice sheet dynamics in climate models
- Ice motion and problems of ice core interpretation
- Glacier surges
- Ice streams
- Response of glaciers to climate change
- Rheology of glacier ice

Seasonal snow:

- Snow creep and forces
- Prediction of avalanche hazard
- Avalanche run out and impact forces

Sea ice:

- Large scale motions
- Processes of ridging and lead formation
- Structural patterns of ridges and leads

Assessment

- Homework 25%
- Mid-term 25%
- Project 25%
- Participation 25%