▶last updated September 27, 2021

Description/Objectives: Glaciers and ice sheets are one of the most important elements of Earth's global climate system. This course introduces undergraduate and graduate students to the history of ice on Earth, contemporary glaciology, and the interactions between climate, glaciers, landforms, and sea level. Drawing from basic physical concepts (mass, momentum and energy conservation), lab experiments, numerical modeling, and a variety of geological and geophysical observations, we tackle important glaciological questions, and equip students with some of the data analysis and modeling skills used in glacier and climate science. Students will gain an appreciation for the variety of physical processes studied by glaciologists, the outsized importance of ice sheets for the global climate system, and the large gaps that remain in our understanding.

Main Text

R. LeB. Hooke 2020, Principles of Glacier Mechanics, 3rd Edition, Cambridge University Press, 220 p.

Secondary Texts

K.M. Cuffey & W.S.B. Paterson 2010, The Physics of Glaciers, 4th Edition, Academic Press, 500 p.

J. Oerlemans 2008, Minimal Glacier Models, Utrecht Publishing and Archiving Services, 103 p.

J. Imbrie & K.P. Imbrie, Ice Ages: Solving the Mystery, Harvard University Press, 224 p.

D.I. Benn & D.J.A. Evans 2010, Glaciers & Glaciation, 2nd Edition, Routledge, 816 p.

Requirements/Grading:

Problem Sets and Labs:	55%
Midterm Exam:	20%
Final Exam (376)	25%
Four-Page Research Paper (576)	25%

Prerequisites and Restrictions:

MAT 104 & PHY 103, or permission of instructors.

Other Information:

There is one optional weekend field trip to Upstate New York in April. If you do not attend the trip, you will turn in a short essay in lieu of the field notes.

Schedule/Classroom Assignment:

3:00 pm – 4:20 pm M W
Guyot Hall (GUYOT) 154

M Jan 24	The history of ice on Earth, and other planets and moons[a]
⊕	Glacier mass balance and response to climate forcing
W Jan 26	Surface mass balance; ablation and accumulation zones[y] Readings: Cuffey & Paterson Chapter 4.2
M Jan 31	The simplest glacier model[a] Readings: Oerlemans pp. 5–13 PS01: *Simple glacier model and the glacial history of tropical Africa*, **due Feb 08**
W Feb 02	Earth's radiative balance and climate science primer[a] Readings: Hooke TBD
M Feb 07	Sensitivity of glaciers to climate forcing part II (the geometric glacier model)[a] Readings: Oerlemans et al. (2011) PS02: *Geometric model and hysteresis in glaciers*, **due Feb 13**
⊕	Ice Sheets
W Feb 09	Ice as a non-linear fluid[y] Readings: Hooke pp. 68–73; Millstein et al. 2021
M Feb 14	Ice sheets part I[y] Readings: Hooke pp. 352–366
W Feb 16	Ice sheets lab experiment[y] PS03: *Ice sheet experiment and model*, **due Feb 25**
M Feb 21	Ice sheets part II[y] Readings: Hooke pp. 352–366
W Feb 23	Heat flow in ice sheets[y] Readings: Cuffey & Paterson pp. 245-281
M Feb 28	The binge-purge model and Heinrich events[a] Readings: MacAyeal (1993)
W Mar 02	Midterm Exam
Mar 05–13	Spring Recess

⊕	Ice Shelves
M Mar 14	Ice shelves part I[y] Readings: Hooke pp. 366–387
W Mar 16	Ice shelves lab experiment[y] PS04: *Ice Shelves experiment and model*, **due Mar 25**
M Mar 21	Ice shelves part II[y] Readings: Hooke pp. 366–387
⊕	Glacial Hydrology
W Mar 23	Superglacial and subglacial hydrology part I[y] Readings: Cuffey & Paterson Chapter 6.2
M Mar 28	Superglacial and subglacial hydrology part II[y] Readings: Cuffey & Paterson Chapter 6.2
⊕	Glacial Geomorphology
W Mar 30	Glacial Landforms[a] Readings: Benn TBD
M Apr 04	Glacial Sedimentology[a] Readings: Benn TBD
⊕	Paleoclimate and the Future of Ice on Earth
W Apr 06	Snowball Earth[a] Readings: Hoffman & Schrag 2002 PS05: *Snowball Earth*, **due April 19**
M Apr 11	Cenozoic ice ages and orbital climate forcing[a] Readings: Imbrie & Imbrie TBD
W Apr 13	Climate records from ice cores[a] Readings: Abram et al. (2013)
M Apr 18	Sea level change[a] Readings: Clark et al. 2002; Dyer et al. 2021
W Apr 20	Predictions of future ice volume and sea level[a] Readings: Geyman et al. 2021
M May 2	Due: 4-page Research paper or Three-hour take-home Final Exam