The Cryosphere
GEOL 410/510 WI 2011

http://web.pdx.edu/~chulbe/COURSES/CRYO

lecture: T 8:00 to 9:50 am CH S17
lab: TR 8:00 to 9:50 am CH 1
final: Thursday 3/17/2011 8:00 to 9:50 am

prerequisite: upper-division or graduate standing in a physical or natural science curriculum

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office hours: M 11:00 am to noon & T 4:00 to 5:00 pm (or by appointment)

1 overview

The cryosphere, the part of Earth's surface environment where water is in solid form, is an integral component of the global climate system. It is also, in some regions, experiencing rapid change. In this class we will explore the cryosphere from the Arctic to the Antarctic, in order to understand why ice matters to climate and to ecosystems, as well as how and why the cryosphere is changing. The course includes both lecture and lab time. Lab work uses modern observational data and state-of-the-art climate simulations in order to understand the patterns and processes of climate change, with an emphasis on the cryosphere.

If you are a student with a documented disability and registered with the Disability Resource Center, please contact me so that we can arrange whatever academic accommodations you need.

If you are a Veteran and have questions about University services or need assistance with your transition from military to campus life, please contact Chris Goodrich, Coordinator of Veterans Services at the Office of Veterans' Services, SMSU room 425.

2 key lecture topics

- components of the cryosphere & climate basics
- the Arctic: ocean basin, frozen ground, connections
- the Antarctic: ice sheet dynamics, scales of change

3 laboratory

3.1 lab exercises

This class will devote a significant amount of time to computer laboratory work, including both assigned lab exercises and a term project of your own design. We will use the Matlab programming environment and a user interface to a research-grade global climate model. Due dates for lab assignments will be announced in class.

3.2 term project

The cryosphere is vast and in this class we will have time to develop only a basic understanding of its key components and processes. Lab exercises are designed to support the lecture but here too we will only capture a glimpse of what is possible. The term project for this class is designed to allow you to deepen your understanding of some component of the cryosphere. Some of the lab time will be dedicated to working on your project.

You are asked to identify a component of the cryosphere, or a particular cryosphere interaction with some other component of the Earth system and study it detail, using observational data from a scientific archive, a computational model, or some combination of the two. Two examples:

- We will investigate temperature change over the last century at high latitude locations in the northern and southern hemispheres, placing those records in a global context. A project could expand on that work by placing time series of cryosphere indicators such as sea ice extent and permafrost temperature into that context. A permafrost project could include numerical models of subsurface temperature response to temperature change in the overlying atmosphere.
- We will use a global climate model to explore some aspects of change in the cryosphere. A project could involve running the model for a different scenario than one covered in the lab or extracting data from the model output to perform a more sophisticated investigation than those we perform in class.

You may work individually or in groups (making sure that everybody in the group is involved). The topic for your project and research group should be identified by 1 February.

Your goals are:

1. identify a study topic and group
2. develop a set of resources including published literature, data, and computational tools, as appropriate
3. write a short paper about the project
4. prepare and deliver a classroom presentation about the project

4 evaluation

lab exercises 30%
midterm 20%
final 20%
term project 30%

5 approximate schedule

week	*topics*	*reading*	*other events*
1	global connections climate basics: feedbacks, variability, trends	*Global Outlook* Ch 1 to 4	lab: global climatology
2	components of the cryosphere	Seager, 2006, *American Scientist*	lab: global climatology continued
3	components of the cryosphere	Scambos, 2011, *Bull. Atom. Sci.*	lab: temperature time series
4	the Arctic: environments, ocean basin & circulation	*Global Outlook* Ch 5 to 8	lab: temperature time series continued project: topic & group
5	the Arctic: sea ice	Serreze *et al.*, 2007, *Science*	lab: EdGCM
6	the Arctic: What's up with the Greenland Ice Sheet?	Straneo et al., 2010, *Nature Geoscience*	midterm
7	the Antarctic: geologic & climate history	Bindschadler, 2006, *Phil. Trans. R. Soc. A*	lab: EdGCM
8	the Antarctic: Antarctic Peninsula	McClintock et al., 2008, *American Scientist*	lab: projects
9	the Antarctic: ice sheet dynamics, scales of change		lab: projects
10	project presentations		

6 references

Links to these materials, along with others that you might find interesting, are provided at the class website.

Global Outlook for Ice and Snow Pål Prestrud (Chair), United Nations Environment Program
`http://www.unep.org/geo/geo_ice/`

Bindschadler, R., 2006, The environment and evolution of the West Antarctic ice sheet: setting the stage, *Philosophical Transactions of the Royal Society A*, 364(1844), 1583-1605.

McClintock, J, H. Ducklow, and W. Fraser, 2008, Ecological responses to climate change on the Antarctic Peninsula, *American Scientist*, 96(4), 302-310.

Scambos, T, 2011, Earths ice: Sea level, climate, and our future commitment, *Bulletin of the Atomic Scientists*.

Seager, R., 2006, The source of Europe's mild climate, *American Scientist*, 94(4), 334-34.

Serreze, M.C., Holland, M.M., Stroeve, J., 2007, Perspectives on the Arctic's Shrinking Sea-Ice Cover, *Science*, 315(5818), 1533-1536.

Straneo, F., G. S. Hamilton, D. A. Sutherland, L. A. Stearns, F. Davidson, M. O. Hammill, G. B. Stenson, and A. Rosing-Asvid, 2010, Rapid circulation of warm subtropical waters in a major glacial fjord in East Greenland, *Nature Geoscience*, 3, 182-186.

7 a story

Once upon a time, a student in an upper-division elective course decided it was appropriate to sit at his computer and work on a project while one of his peers was presenting her work to the class. Much to rude student's surprise, the grade the he received for his own presentation accounted for this disrespectful behavior. Much to your gentle instructor's surprise, it had not occurred to the rude student that it was his obligation, as a member of the class, to treat his peers with respect. The morals of the story are two: as members of this class, it is our obligation to respect each other [1]; and what surprises your gentle instructor may surprise you as well.

[1] As a member of the Portland State University faculty, I "strive to ensure that the highest ethical standards of professional behavior are realized within the University," as established in the *Faculty Code of Conduct*. As a member of the PSU student body, you are bound by a *Student Code of Conduct*. It is your responsibility to be familiar with the code of conduct, which can be read at the Dean of Students website `http://www.pdx.edu/dos/codeofconduct`.