GEOG 419 – THE CRYOSPHERE

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Office hours: Tuesday (10:00-13:00)

Course Description

The cryosphere collectively describes elements of the earth system containing water in its frozen state and includes ice sheets, ice caps and glaciers, sea ice, snow cover, solid precipitation, freshwater (lake and river) ice, as well as seasonally frozen ground and permafrost. The cryosphere is an integral part of the global climate system with important linkages and feedbacks operating through its influence on energy, moisture and gas fluxes.

This course will provide a physical introduction to the cryosphere and cryosphere-climate interactions. Topics covered will include the material and thermodynamic properties of snow and ice, the role of the cryosphere in the climate system, and the response of the cryosphere to climate change (past, present and future). Students will be introduced to, and get the opportunity to experiment with, snow and ice process models.

Prerequisite

GEOG 303 or GEOG 309 (or permission of the instructor)

Class Meetings

Lecture: Tuesday: 14:30-16:20 (Room: RCH 209)

Lab: Tuesday: 16:30-17:20 (Room: EV2 1002A – Geddes lab)
Evaluation

Lab assignments (3):
- Analysis and interpretation of winter surface-based measurements: 10%
- Snow modeling with SNOWPACK: 10%
- Lake ice modeling with FLake: 10%

Midterm exam: 25%

Term paper:
- Proposal: 10%
- Paper: 25%
- Oral presentation: 10%

Lab Assignments:

- Assignments are to be turned in as hard copies during the lab section on the specified dates. *No late assignments will be accepted.* Consultation and discussion of lecture/lab material with classmates is acceptable but all three assignments are to be completed individually.
- Access to the computer lab is restricted by code to those enrolled in particular courses including this one. Food and/or drink are NOT permitted in the lab.
- Students are responsible for maintaining their own backups of their work. There are a number of options available for backing up your work, including the N: drive for FE students. It is suggested that you keep two copies of your work in separate locations. Remember that you are only as far ahead as your latest backup!

Term Paper:

Students are to produce a term paper (20 pages double spaced, exclusive of title page, abstract, figures, and tables) on a topic of their choice relevant to the course (25% of grade) and make a presentation to the class (10% of grade). Students must first have their topic approved by the instructor. In this respect, students must submit a one-page summary of their proposed project (10% of grade). Deadlines for each deliverable can be found in the “Lecture and Lab Schedule” below.

The term project involves completion of an extensive survey of the scientific literature on a relevant topic (e.g. remote sensing, numerical modeling or in-situ studies of any element of the cryosphere; cryosphere-climate interactions on a variety of space and time scales; representation of elements of the cryosphere in climate or weather prediction models; impact of changes in any element or a group of elements of the cryosphere on Society). The review paper is single-authored.
# Lecture and Lab Schedule

<table>
<thead>
<tr>
<th>Week</th>
<th>Date</th>
<th>Lecture</th>
<th>Lab</th>
<th>Readings</th>
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<tbody>
<tr>
<td>1</td>
<td>Jan 6</td>
<td>Introduction to the Cryosphere</td>
<td>Assignment #1: Surface-based</td>
<td>Chap. 1</td>
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<td>measurements I</td>
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<td>2</td>
<td>Jan 13</td>
<td>Material Properties of Snow and Ice</td>
<td>Assignment #1: Surface-based</td>
<td>Chap. 2</td>
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<td>measurements II</td>
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<td>3*</td>
<td>Jan 20</td>
<td>Snow and Ice Thermodynamics</td>
<td>Assignment #2: SNOWPACK I</td>
<td>Chap. 3</td>
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<td>Proposal due</td>
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<td>4</td>
<td>Jan 27</td>
<td>Seasonal Snow – Part 1</td>
<td>Assignment #2: SNOWPACK II</td>
<td>Chap. 4</td>
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<tr>
<td>5</td>
<td>Feb 3</td>
<td>Seasonal Snow – Part 2</td>
<td>Assignment #2: SNOWPACK III</td>
<td>Chap. 4</td>
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<td>6</td>
<td>Feb 10</td>
<td>Freshwater Ice – Part 1</td>
<td>Assignment #3: FLake I</td>
<td>Chap. 4</td>
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<td>Assignment #3: FLake II</td>
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<td>Assignment #3: FLake III</td>
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<td>8*</td>
<td>Feb 24</td>
<td>Midterm exam</td>
<td>Assignment #3: FLake I</td>
<td>Chap. 4</td>
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<td>Freshwater Ice – Part 2</td>
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<td>9</td>
<td>Mar 3</td>
<td>Sea Ice</td>
<td>Assignment #3: FLake II</td>
<td>Chap. 5</td>
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<td>10</td>
<td>Mar 10</td>
<td>Glaciers and Ice Sheets</td>
<td>Assignment #3: FLake III</td>
<td>Chap. 6</td>
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<td>11*</td>
<td>Mar 17</td>
<td>Permafrost and Seasonally Frozen</td>
<td>Assignment #3: FLake III</td>
<td>Chap. 7</td>
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<td>Ground</td>
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<td>12</td>
<td>Mar 24</td>
<td>The Cryosphere and Climate Change</td>
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<td>Chap. 8</td>
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<td>13</td>
<td>Mar 31</td>
<td>Oral presentation today</td>
<td>Term paper due</td>
<td>Chap. 9</td>
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Claude will be away from the office on weeks 3, 8 and 11. Alternate arrangements will be made for these classes (e.g. invited speakers).

Textbooks and Other Resources

1. **Required Textbook**


The paperback version of the book is $25.75. Copies are available at the UW Bookstore.

2. **Other Textbooks**


Copies have been placed on reserve at the Dana Porter library.

3. **Journal**

*The Cryosphere* – An interactive open access journal of the European Geosciences Union (EGU) accessible at http://www.the-cryosphere.net/home.html

“The Cryosphere (TC) is an international scientific journal dedicated to the publication and discussion of research articles, short communications and review papers on all aspects of frozen water and ground on Earth and on other planetary bodies.”

4. **Lecture Materials**

PDF Acrobat versions of the PowerPoint presentations and other relevant documents (numerical models documentation, reports, articles) will be distributed through LEARN.
University of Waterloo LEARN Course Environment

This course uses the LEARN course environment for course material dissemination and information exchange. LEARN is a web-based course management system that enables instructors to manage course materials (posting of lecture notes etc.), interact with their students, and provide feedback. YOU NEED TO ENSURE THAT YOU CAN ACCESS LEARN. Note that lecture slides are posted on LEARN the day prior to each lecture. Assignment materials are also distributed through LEARN.

Logging Into LEARN

Since LEARN is a web-based system, you will need a browser. Once you have started up your browser, you can access LEARN via: http://learn.uwaterloo.ca

Checking Your Userid and Password

Your password can be checked and reset (if needed) by going to: https://watiam.uwaterloo.ca/idm/user/login.jsp
If you still cannot get on LEARN after checking and resetting your password, please confirm with your instructor that you are on the class roster.

Getting Help

Documentation for LEARN is available at: http://av.uwaterloo.ca/uwace/training_documentation/index.html
Academic Integrity

To create and promote a culture of academic integrity, the behaviour of all members of the University of Waterloo is based on honesty, trust, fairness, respect and responsibility.

Grievance

A student who believes that a decision affecting some aspect of his/her university life has been unfair or unreasonable may have grounds for initiating a grievance. Read Policy 70 - Student Petitions and Grievances, Section 4, http://www.adm.uwaterloo.ca/infosec/policies/policy70.html

Discipline

A student is expected to know what constitutes academic integrity, to avoid committing academic offenses, and to take responsibility for his/her actions. A student who is unsure whether an action constitutes an offense, or who needs help in learning how to avoid offenses (e.g., plagiarism, cheating) or about "rules" for group work/collaboration should seek guidance from the course professor, academic advisor, or the Undergraduate Associate Dean. When misconduct has been found to have occurred, disciplinary penalties will be imposed under Policy 71 – Student Discipline. For information on categories of offenses and types of penalties, students should refer to Policy 71 - Student Discipline, http://www.adm.uwaterloo.ca/infosec/Policies/policy71.html

Appeals

A student may appeal the finding and/or penalty in a decision made under Policy 70 - Student Petitions and Grievances (other than regarding a petition) or Policy 71 - Student Discipline if a ground for an appeal can be established. Read Policy 72 - Student Appeals, http://www.adm.uwaterloo.ca/infosec/Policies/policy72.html

Accommodation for Students with Disabilities

Students who anticipate needing accommodations should contact as early as possible The Office for Persons with Disabilities (OPD) at ext. 5082.

Religious Observances

Students need to inform the instructor at the beginning of term if special accommodation needs to be made for religious observances that are not otherwise accounted for in the scheduling of classes and assignments.