Course Description

High latitude environments are the focus of increasing scientific attention because of their role in forcing and responding to global change. The impact of changes in the extent and thickness of sea ice, the extent and water equivalent of snow cover, and the potential release of high latitude stores of soil carbon on global climate are difficult to quantify, but have far-reaching implications. This course will provide a comprehensive assessment of the high latitude climate system. Topics that will be covered include: the Arctic energy budget, Arctic atmospheric circulation, the hydrologic cycle in the Arctic, Arctic ocean-sea ice-climate interactions, modeling the Arctic climate system, the application of remote sensing to Arctic climate studies, an evaluation of recent climate variability and trends, and the future state of the Arctic.
Course Goal and Student Learning Outcomes

**Goal:** The goal of this course is to provide students with a comprehensive understanding of (1) high latitude climate system processes, (2) the past variability and current state of the Arctic cryosphere and how this relates to the Arctic climate system, and (3) the tools necessary to understand and predict future changes to the Arctic (i.e. climate models).

**Student Learning Outcomes:** By the end of the course, students should be able to:
- Understand the key components and processes of the Arctic climate system;
- Understand the elements of the cryosphere, and how they relate to global climate;
- Critically assess and synthesize key literature on the Arctic climate system in the preparation of an in-depth term paper, and present the results to the class.

**Prerequisites**

GEOG 209; GEOG 309

**Class Meetings**

Wednesday 8:30 – 11:00
Arts Lecture 210

**Evaluation**

3 assignments @ 10% 30%

Term Project
   Paper 30%
   Presentation 10%

Final Exam 30%

Note: Assignments are to be handed in electronically (by email to Chris.Derksen@ec.gc.ca) on the specified dates. No late assignments will be accepted. Consultation and discussion of course material with classmates is acceptable but all course work is to be completed individually.

**Textbook**

Term Project

Students are required to write a term paper (10-20 pages) on a topic of their choice relevant to the course (30% of grade) and make a presentation to the class (10% of grade). Students must first have their topic approved by the instructor.

Some potential topics of interest include:
- The northern carbon balance
- Role of climate on the distribution of permafrost
- Role of permafrost in northern hydrology
- Northern snow re-distribution and change
- Role of snow in the northern water budget
- Role of snow in the terrestrial energy budget
- Role of lakes ice in the climate system
- Role of sea ice in the climate system
- Snow metamorphosis in northern environments
- The Arctic oscillation
- Arctic versus Antarctic warming
- Cryosphere evidence for climate change in northern environments
- Factors driving variability in sea ice extent
- The influence of ice sheets and glaciers on sea level change
- The freshwater budget of the Arctic
- The future of Arctic sea ice from model predictions

Lecture Schedule

<table>
<thead>
<tr>
<th>Week</th>
<th>Topic</th>
<th>Readings</th>
<th>Assignments</th>
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</thead>
<tbody>
<tr>
<td>11 Sept. 2013</td>
<td><strong>CLASS WILL NOT MEET</strong></td>
<td>Serreze &amp; Barry 2005 Ch1 &amp; Ch2</td>
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<tr>
<td>18 Sept. 2013</td>
<td>Course overview; Introduction</td>
<td>Serreze &amp; Barry 2005 Ch3</td>
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<tr>
<td>25 Sept. 2013</td>
<td>Arctic energy budget</td>
<td>Serreze &amp; Barry 2005 Ch4</td>
<td>#1 assigned</td>
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<tr>
<td>2 Oct. 2013</td>
<td>Atmospheric circulation</td>
<td>Serreze &amp; Barry 2005 Ch5</td>
<td>#1 due; #2 assigned</td>
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<tr>
<td>9 Oct. 2013</td>
<td>Surface energy budget</td>
<td>Serreze &amp; Barry 2005 Ch6</td>
<td></td>
</tr>
<tr>
<td>16 Oct. 2013</td>
<td>The hydrologic cycle</td>
<td>Serreze &amp; Barry 2005 Ch8</td>
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<tr>
<td>23 Oct. 2013</td>
<td>Climate regimes of the Arctic</td>
<td>Serreze &amp; Barry 2005 Ch 7</td>
<td>#2 due; #3 assigned</td>
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<tr>
<td>30 Oct. 2013</td>
<td>Arctic ocean-sea ice-climate interactions</td>
<td>Serreze &amp; Barry 2005 Ch 9</td>
<td></td>
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<tr>
<td>6 Nov. 2013</td>
<td>Modeling the Arctic system</td>
<td></td>
<td>#3 due</td>
</tr>
<tr>
<td>13 Nov. 2013</td>
<td>Remote sensing of the Arctic cryosphere</td>
<td>Serreze &amp; Barry 2005 Ch 11</td>
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<tr>
<td>20 Nov. 2013</td>
<td>Recent variability, trends, and the future</td>
<td></td>
<td></td>
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<tr>
<td>27 Nov. 2013</td>
<td>Student presentations; Review</td>
<td></td>
<td>Term paper due</td>
</tr>
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</table>
Unclaimed Assignments

Unclaimed assignments will be retained for until one month after term grades become official in quest. After that time, they will be destroyed in compliance with UW’s confidential shredding procedures.

Academic Integrity

In order to maintain a culture of academic integrity, members of the University of Waterloo community are expected to promote honesty, trust, fairness, respect and responsibility.  www.uwaterloo.ca/academicintegrity/

Students who are unsure what constitutes an academic offence are requested to visit the on-line tutorial at http://www.lib.uwaterloo.ca/ait/

Research Ethics

Please also note that the University of Waterloo requires all research conducted by its students, staff, and faculty which involves humans as participants to undergo prior ethics review and clearance through the Director, Office of Human Research and Animal Care (Office). The ethics review and clearance processes are intended to ensure that projects comply with the Office's Guidelines for Research with Human Participants (Guidelines) as well as those of provincial and federal agencies, and that the safety, rights and welfare of participants are adequately protected. The Guidelines inform researchers about ethical issues and procedures which are of concern when conducting research with humans (e.g. confidentiality, risks and benefits, informed consent process, etc.). If the development of your research proposal consists of research that involves humans as participants, please contact the course instructor for guidance and see http://iris.uwaterloo.ca/ethics/

Note for Students with Disabilities

The Office for Persons with Disabilities (OPD), located in Needles Hall, Room 1132, collaborates with all academic departments to arrange appropriate accommodations for students with disabilities without compromising the academic integrity of the curriculum. If you require academic accommodations to lessen the impact of your disability, please register with the OPD at the beginning of each academic term.

Religious Observances

Student needs 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.
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, www.adm.uwaterloo.ca/infosec/Policies/policy70.htm. When in doubt please contact your Undergraduate Advisor for details.

Discipline

A student is expected to know what constitutes academic integrity, to avoid committing academic offence, 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. For information on categories of offences and types of penalties, students should refer to Policy 71, Student Discipline, www.adm.uwaterloo.ca/infosec/Policies/policy71.htm. For typical penalties, check Guidelines for Assessment of Penalties, www.adm.uwaterloo.ca/infosec/guidelines/penaltyguidelines.htm

Appeals

A decision made or penalty imposed under Policy 70 - Student Petitions and Grievances (other than a petition) or Policy 71 – (Student Discipline) may be appealed if there is a ground. A student who believes he/she has a ground for an appeal should refer to Policy 72 (Student Appeals) www.adm.uwaterloo.ca/infosec/Policies/policy72.htm
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 by going to: http://ego.uwaterloo.ca/~uwdir
If your password check fails, you can unlock your password and receive a new one by going to: http://ego.uwaterloo.ca/~uwdir/UnLock.html
If you still cannot get on 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