DEPT OF GEOGRAPHY & ENVIRONMENTAL STUDIES
CARLETON UNIVERSITY

Course Outline

GEOG 4013: COLD REGIONS HYDROLOGY
January – April 2026

Instructor: Dr. Jennifer Totten
Office Hours: Wednesdays 9:30 – 11:00 am (Loeb A209); Mondays & Thursdays 7 – 9 pm (on Discord)
E-mail: **jennifer.totten@carleton.ca**
Lectures: Wednesdays 11:35 am – 2:25 pm,
Link to BrightSpace Page: https://brightspace.carleton.ca/d2l/home/365755

Pre-Requisite: GEOG 3103 (or permission of the instructor)

Course Objectives:

Hydrology is the branch of science concerned with the properties of the earth's water, and especially its movement in relation to the land. The seasonal cycling into winter imposes many restrictions on the movement and storage of water as it shifts through the hydrological cycle. Snow and ice play a pivotal role in the year-round water cycle in cold regions, including the Arctic and Antarctic. Students will examine their various contributions in order to understand how the cold regions hydrological cycles differ from more temperate areas. Students will develop a working knowledge of the processes particular to the cold phase of the hydrological cycle in cold regions. Since Canada is, in essence, a cold region, we will place considerable emphasis on Canada's physical environments and issues arising from the cold part of our yearly hydrological cycle.

Students will carry out analyses of hydrological regimes as impacted by snow and ice. As hydrology is a quantitative science, the students will acquire practical experience with hydrological data analysis assignments involving calculations and the use of spreadsheets. Students will participate in outdoors field assignments to gain experience with snowpack analysis & river ice cover development. As this is a 4th year course, there will be a mix of formats for the term, including lectures & discussion sessions. Students will learn to critically review journal articles relating to various topics throughout the term and discuss these articles during discussion group sessions.

Learning outcomes:

1. Describe, characterize, and classify snow formation, accumulation and transformation processes, using appropriate tools and techniques.
2. Interpret and synthesize snow values from field data to create a basin snowmelt balance projection.
3. Identify, classify, describe, document and map winter ice formations (rivers, lakes & oceans) through the progression of the cold season.
4. Describe, characterize, and classify anthropogenic influences and results on ice formation in river and lake environments.
5. Interpret and synthesize climatological and hydrological data from different sources
6. Distinguish between observations and interpretations. Evaluate the limitations of both field and

published data with respect to incomplete or contradictory data; evaluate interpretations.
7. Evaluate and critically review new research directions from recent published journal articles; participate in discussions with peers and instructor.
8. Communicate hydrological data, interpretations and results effectively in written form.

General areas of study:

1. Introduction
2. Snow processes: accumulation, distribution, snowmelt processes, energy balance, residual snow banks, modelling, hydrology
3. Lakes: heat balance, thermal regimes, stratification & turnover patterns
4. Rivers: stream types, thermal regimes
5. Ice formation: crystallographic processes, primary and secondary ice formation
6. Freezing processes and patterns: lakes & reservoirs, rivers, calm vs. turbulent conditions, initial ice to freeze-over, effects of rapids
7. Ice effects: hydraulics, behavior & bearing capacity, hanging dams and ice jams, erosive effects on shorelines, thermal expansion formations, anthropogenic influences and effects.
8. Ice decay: crystallographic processes, patterns for melt & break-up, variations with ice types & water body types
9. Glacier hydrology: water storage; water movement; output patterns & hydrological impacts
10. Permafrost hydrology: surface & groundwater movement, icings & frost blisters, pingos
11. Polar Oceans: basins, processes, thermal regimes, salinity, water movement, polynyas, ice formation; sea ice, ice shelves, ice bergs

Reading material:

There is no textbook for this course, but there will be considerable reading required for this course. Students will be supplied with related readings from textbooks, web reports or scientific journals which *must be read for discussion at the start of each week's lecture*. It is the responsibility of each student to familiarize themselves with this material. The readings will be made available on the BrightSpace course web site for ease of access. Participation in the discussion of the readings goes towards the class participation grade, thus attendance will always be tracked. General reference material will also be made be available through ARES, the University's Library access portal.

Course communication:

Communication for this course will be through a number of means. The lectures will be held in-person, on campus. Course material will be available on *BrightSpace*. Additionally, there will be an online forum (hosted on *Discord*), there is access via email or you may consult me on campus or online. There are several forums set up on the GEOG 4013 Server on Discord: a general discussion forum for students to communicate with one another, and one set up for asking the Instructor questions (so you don't have to email, unless it's personal). There are both texting channels & voice channels, so there are many options

for us to stay in touch. The instructions for accessing the Discord server are posted separately on the *Brightspace* course page, but the link is here below.

https://discord.gg/KnA9XEmMxR

I will be available for my **office hours** on Wednesdays from 9:30-11:00 am on campus (Loeb A209), or online on Discord Monday & Thursday evenings from 7-9 pm. I may also answer questions at other times on the Discord server if I drop by. I will be checking the "Ask-the-Prof" forum frequently.

Course assessment:

The assessment for the course will be based on several components:

1. There will be 4 assignments on various aspects of the course material. These will comprise 60% of the total grade.
2. Class participation in weekly reading-based discussions is mandatory, and is worth 20% of the final grade. ***Attendance will be tracked***.
3. A final in-person on paper closed-book 3-hour examination worth 20% of the total grade will be given, which will be made up of both long and short answer questions. This exam will cover the full term's material. **You MUST pass the exam to pass the course**.

All elements of the course will be marked both for content (e.g. ideas, structure of arguments, research, citations etc.) and presentation (e.g. quality of writing, grammar, spelling, and graphical presentation). All assignments are to be submitted through *Brightspace*.

Exercise topics:

Cold regions hydrological issues: data analysis assignment (10%); given Jan 14th, due Jan 27th
Field assignment: snowpack analysis (10%), done Jan 28th, due Feb 10th **
Field assignment: river ice analysis (10%), done Feb 11th, due Mar 3rd **

Research project – analysis of scientific papers (25%), given Jan 14th, outline due Feb 24th, due Apr 5th
In-class presentation of research project (5%), given Jan 14th, due April 1st

** Dates for field work are subject to change – they depend on conditions outdoors being suitable for carrying out the data collection & observation. This would shift the due dates – but there will be a minimum of 2 weeks to complete the reports.

Attendance and submission policy for course

All 4 Exercise reports and all weekly discussion sessions contribute to your grade. *Completion of all labs, weekly discussions and the final exam are required for successful completion of the course*. Submission dates are important. Lab reports are due via *Brightspace* by 11:59 pm on the date specified (see attached schedule). Assignments will only be accepted **for 2 days beyond the due date** with a penalty of 5% (of the lab itself) per day, *unless prior arrangements have been made*. The only exception is for reasons of illness or extenuating circumstances (see below).

Carleton University has a new procedure for Academic Consideration for Medical or other Extenuating Circumstances that temporarily hinder a student's capacity to fulfil in-class academic requirements. The details of the policy & procedures are listed in the .pdf available on the course page on BrightSpace or from the Registrar's office. Students need to complete the online *Academic Consideration for Coursework Form* to request academic accommodation for missed course work including exams and assignments. Here is the link to the form: https://carleton.ca/registrar/academic-consideration-coursework-form/ As per the Policy, students are to speak with their instructor before submitting a request for Academic Consideration. Requests are not automatically approved. Approving and determining the accommodation remains at the discretion of the instructor. As such, you should connect with me directly to discuss requested accommodations arising from medical or other situations. Please send me an email or discuss this with me during my Office Hours.

Unless otherwise specified, group work is not acceptable. This includes all term work and the final exam. Sharing of answers on the final exam is ***strictly forbidden***. Submitting work that has been previously used in this or other courses is not permitted **in this course. Any use of generative AI tools to produce assessed content is not permitted in this course, and is considered a violation of academic integrity standards.** Assignments will be returned via *Brightspace*, and general feedback will be provided at that time. If you have any questions about the grading, please discuss this with me via email or during Office Hours.

Standing in this course is determined by the course instructor subject to the approval of the Faculty Dean. This means that grades submitted by the instructor may be subject to revision. No grades are final until they have been approved by the Dean.

Academic Integrity Policies

Instructional offences include among other activities cheating, contravening examination regulations, plagiarism, submitting similar work in 2 or more courses *without prior permission*, and disrupting classes. Conduct offenses apply in areas of discrimination and sexual harassment. Further information about University regulations which define and regulate these offences is found at: https://carleton.ca/secretariat/policies/.

The University Academic Integrity Policy defines plagiarism as "*presenting, whether intentionally or not, the ideas, expression of ideas or work of others as one's own."* This includes reproducing or paraphrasing portions of someone else's published or unpublished material, regardless of the source, and presenting these as one's own without proper citation or reference to the original source. Examples of sources from which the ideas, expressions of ideas or works of others may be drawn from include but are not limited to: books, articles, papers, literary compositions and phrases, performance compositions, chemical compounds, artworks, laboratory reports, research results, calculations and the results of calculations, diagrams, constructions, computer reports, computer code/software, material on the internet and/or conversations.

Examples of plagiarism include, but are not limited to:

- any submission prepared in whole or in part, by someone else, including the unauthorized use of generative AI tools (e.g., ChatGPT);
- using ideas or direct, verbatim quotations, paraphrased material, algorithms, formulae, scientific or mathematical concepts, or ideas without appropriate acknowledgment in any academic assignment;
- using another's data or research findings without appropriate acknowledgement;
- submitting a computer program developed in whole or in part by someone else, with or without modifications, as one's own; and
- failing to acknowledge sources through the use of proper citations when using another's work and/or failing to use quotations marks.

Plagiarism is a serious offence that cannot be resolved directly by the course's instructor. The Associate Dean of the Faculty conducts a rigorous investigation, including an interview with the student, when an instructor suspects a piece of work has been plagiarized. Penalties are not trivial. They can include a final grade of "F" for the course.

Statement on Student Mental Health

As a University student you may experience a range of mental health challenges that significantly impact your academic success and overall well-being. If you need help, please speak to someone. There are numerous resources available both on- and off-campus to support you. Here is a list that may be helpful:

Emergency Resources (on and off campus): https://carleton.ca/health/emergencies-and-crisis/emergency-numbers/

- Suicide Crisis Helpline: call or text 9-8-8, 24 hours a day, 7 days a week.
- For immediate danger or urgent medical support: call 9-1-1

Carleton Resources:
• Mental Health and Wellbeing: https://carleton.ca/wellness/
• Health & Counselling Services: https://carleton.ca/health/
• Paul Menton Centre: https://carleton.ca/pmc/
• Academic Advising Centre (AAC): https://carleton.ca/academicadvising/
• Centre for Student Academic Support (CSAS): https://carleton.ca/csas/
• Equity & Inclusivity Communities: https://carleton.ca/equity/

Off Campus Resources:
• Distress Centre of Ottawa and Region: (613) 238-3311 or TEXT: 343-306-5550, https://www.dcottawa.on.ca/
• Mental Health Crisis Service: (613) 722-6914, 1-866-996-0991, http://www.crisisline.ca/
• Empower Me: 1-844-741-6389, https://students.carleton.ca/services/empower-me-counselling-services/
• Good2Talk: 1-866-925-5454, https://good2talk.ca/
• The Walk-In Counselling Clinic: https://walkincounselling.com

Academic Accommodation

Carleton is committed to providing academic accessibility for all individuals. You may need special arrangements to meet your academic obligations during the term. The accommodation request processes, including information about the *Academic Consideration Policy for Students in Medical and Other Extenuating Circumstances*, are outlined on the Academic Accommodations website (https://students.carleton.ca/course-outline) Please review the information about accommodations promptly.

Academic Consideration for medical or other extenuating circumstances: Write to me as soon as possible after the need for accommodation is known to exist, normally no later than 24 hours after the submission deadline. If you are going to miss course obligations (labs or submission deadlines), you must complete the Academic Consideration for Coursework Form (https://carleton.ca/registrar/academic-consideration-coursework-form/) to request academic accommodation for missed course work. Request are not automatically approved. Approving & determining the accommodation remains at the discretion of the instructor.

Academic Accommodations for Students with Disabilities: The Paul Menton Centre for Students with Disabilities (PMC) provides services to students with Learning Disabilities (LD), Psychiatric/mental health disabilities, Attention Deficit Hyperactivity Disorder (ADHD), Autism Spectrum Disorders (ASD), chronic medical conditions, and impairment in mobility, hearing and vision. If you have a disability requiring academic accommodations in this course, please contact PMC at 613-520-6608 or pmc@carleton.ca for a formal evaluation. If you are already registered with PMC, contact your PMC coordinator to send me your Letter of Accommodation at the beginning of the term. Please consult the PMC website for the deadline to request accommodations for the formally scheduled exam.

Other Important Student Support Locations on Campus:

Paul Menton Centre (500 Unicentre) for students needing accommodation
Centre for Student Academic Success (4th Floor, Library, 613-520-2600, ext.3822)

Important dates for this term:

Note: the dates on which individual lectures are presented may not be exactly as shown. Weekly readings will be provided on the *BrightSpace* website.

For January 7th, please read & make notes – be prepared to discuss:

1. S.G. Herrero (2024) Climate Change in Cold Regions. *Science of the Total Environment.* https://doi.org/10.1016/j.scitotenv.2024.173127
   This reading is available on the course website on BrightSpace

1	January 7	Introduction & Snow Hydrology
2	January 14	Snow Hydrology – cont'd (for 1.5 hrs) **Assignment 1 – Data analysis – discussed in class**
3	January 21	Rivers & Lakes – winter functioning **Term project handed out**
4	January 28	Growth of Ice (for 1.5 hrs) **Assignment 1 due** **Assignment 2 – Field work: snow stratigraphy (**come prepared to go outside, bring notebook & pencil, camera)
5	February 4	River & Lake Ice processes
6	February 11	River & Lake Ice processes (continued) **Assignment 2 due,** **Assignment 3 - Field work: river ice analysis (**come prepared to go outside, bring notebook & pencil, camera)
7	February 18	READING WEEK - NO CLASSES
8	February 25	River and lake ice break-up **Project topic & outline due today**
9	March 4	Rideau River case study & Ice Roads

		Assignment 3 due
10	March 11	Glacier Hydrology
11	March 18	Polar Oceans
12	March 25	Sea ice formation differences Arctic to Antarctic
13	April 1	Course review and Exam format **Presentations;**

Assignment Schedule for Winter 2026 Term. ***Assignment due dates are fixed.***
Jan 14: Assignment 1 given & explained, due Jan 27th.
Jan 21: Term project given & explained, due April 1st.
Jan 27th: Assignment 1 DUE @ 11:59 pm. **Jan 28: Assignment 2 given & explained, due Feb 10. ** Field Assignment ****
Feb 10: Assignment 2 DUE @ 11:59 pm. **Feb 11: Assignment 3 given & explained, due Mar 3. ** Field Assignment ****
Feb 16 - 20: Reading Week, no classes or lab sessions.
Feb 25: Term Project outline due.
Mar 3: Assignment 3 DUE @ 11:59 pm.
Apr 1: Presentations due in class.
Apr 5: Papers due @ 11:59 pm.