

ENVR 3000 T05: Introduction to Numerical Modelling and Applications in Environmental Sciences

Course syllabus
Winter 2023

Instructor:	Dr. Juliana M. Marson (Juliana.MariniMarson@umanitoba.ca)
Preferred form of address:	Dr. Marson, Professor Marson
Class schedule:	MWF 1:30-2:20 pm at 123 St. Paul's College
Office hours:	MWF 2:20-3:10 pm (or by appointment)
Pre-requisites:	MATH 1500 and ENVR 1000 or GEOG 1290

Course objectives

To introduce students to the essential elements of numerical modelling, focusing on how they can be used to understand the environment and predict changes (naturally or anthropogenically driven). For example, how do the IPCC models work to predict environmental responses to climate change? How can we use a model to assess if building a dam in a specific river will alter the physical conditions of the ocean where it discharges? Students will get familiarized with the origin of models, concepts of discretization, initial and boundary conditions, parameterizations, and will learn how numerical modelling is used in several aspects of environmental assessment through case studies. By the end of this course, they will know the strengths and weaknesses of numerical models.

Suggested reading

1. **Introduction to Environmental Modeling**, William G. Gray and Genetha A. Gray (2017). Cambridge University Press
2. **Environmental Modelling: Finding Simplicity in Complexity**, Second Edition. Edited by John Wainwright and Mark Mulligan. © 2013 John Wiley & Sons, Ltd.
3. **Environmental modelling and prediction**, Gongbing Peng, Lance M. Leslie, and Yaping Shao (Eds.)

Topics

1. Intro to course
 2. What is a model?
 - 2.1. Definition
 - 2.2. What do we use models for?
 - 2.3. Types of models
 - 2.4. The benefits and challenges of deterministic models
 3. What is environmental modelling?
 - 3.1. Environment components
 - 3.2. Coupling
 - 3.3. Challenges
 - 3.4. Scales
 - 3.5. Forcing
 4. Model equations
 - 4.1. Physical laws
 - 4.2. Approximations (scaling)
 5. Numerical method
 - 5.1. Discretization
 - 5.2. Finite element/volume
 - 5.3. Finite difference
 - 5.3.1. Time step and grid cell size definitions
 - 5.3.2. Taylor Series Approach
 - 5.3.3. Examples of discretized equations
 6. The model grid
 - 6.1. Lumped vs. distributed models
 - 6.2. Types of horizontal grids
 - 6.3. Types of vertical grids
 - 6.4. Horizontal resolution
 - 6.5. Domain and period of integration
 - 6.6. Computational cost
 - 6.7. Nesting
 - 6.8. Downscaling (and upscaling)
 7. Boundary conditions
 - 7.1. Time boundary: initial conditions
 - 7.2. Open lateral boundaries
 - 7.3. Natural boundaries
 8. Subgrid scale processes and parameterizations
 9. Numerical stability
 10. Quality control
 - 10.1. Lax equivalence theory
 - 10.2. Verification
 - 10.3. Checking parameterizations
 - 10.4. Calibration
 - 10.5. Validation
 11. Understanding processes through models
 - 11.1. Sensitivity analysis
 - 11.2. Hindcasts
 - 11.3. Reanalysis and data assimilation
 12. Projecting future changes
 - 12.1. Climate scenarios
 - 12.2. Ensembles
 13. Predictability and Uncertainty
 14. Model complexity
 15. Steps of the modelling process
 16. How to give a presentation
 17. History of models and weather prediction
 18. Atmosphere models
 19. Ocean models
 20. Lagrangian tracking models
 21. Iceberg models
 22. Other models of the cryosphere
 23. Biogeochemical models
 24. Vegetation models
 25. Climate models
- *Topics may vary*

Assessment

Exit slips	10%
Article: Written report	35%
Article: Presentation	15%
Model glossary	10%
Final	30%

Assessment information

Exit slips

At the end of every class, deliver a slip of paper with 3 key points of the lecture. One or more of those points can be replaced by a question about something you found confusing. Each delivered slip is worth 1 point if all 3 key points are present and mostly correct, 0.5 point if not all 3 key points are present or if they are partially correct, 0 if not delivered.

Article assignment

By the end of the first week of class, students will have chosen a scientific article based on numerical models (from a list I will provide or some other paper of your interest that should be approved by me) to work on.

Written report: Throughout the course, the student will produce a written report where they will identify key characteristics of the model used in the study and will evaluate the effectiveness of those configurations to the scientific objective of the paper. This written report will be submitted to me every 2 weeks (indicated in the [Key dates](#) section as “checkpoints”) so I can give the student feedback on their progress so far. The characteristics of the model to be highlighted every two weeks are related to the two-week period content presented in class. At the end of each class, I will indicate the fields in the written report that are related to that class and should be filled.

RUBRIC: Each checkpoint is worth 5% maximum, where you will receive

- 0% if you miss the checkpoint (or did not complete any key characteristics)
- 2.5% if you hand in the report and most key characteristics are partially described
- 5% if you hand in the report and most key characteristics are reasonably described

The final form of the written report is worth 10% maximum, where you will receive

- 0% if you do not hand it in (or hand it in blank)
- 2.5% if you hand in the report and most sections are partially developed
- 5% if you hand in the report and most of the sections are reasonably developed
- 7.5% if you hand in the report and most of the sections are well developed
- 10% if you hand in the report and **all** of the sections are well developed

Standards for “partially”, “reasonably”, and “well” developed will be presented in class with an example.

Presentation: Towards the end of the course, students will give a 15 min presentation of their article and the model used in it. Instructions on how to give a presentation (including rubric) will be discussed in class.

Model glossary

Each student will receive a set of 5+ keywords that they will define using [Quizlet](#). Each keyword definition is worth 2% maximum, where you will receive

- 0% for missing keyword or incorrect definition
- 1% for decent definition
- 2% for great definition

The complete set of cards is due on the last day of class, **April 12**.

Final

The final exam (date to be determined) will consist of short-answer questions, based on all of the material covered in the course – with the exception of case studies. **Tip:** the Quizlet set produced by the class will be a valuable tool for studying. The more definitions you have in there, the larger the chances that it will cover all the aspects evaluated in your exam!

Grading scale

<i>LETTER GRADE</i>	<i>PERCENTAGE RANGE</i>	<i>DESCRIPTION</i>
A+	90-100	Exceptional
A	80-89.9	Excellent
B+	75-79.9	Very Good
B	70-74.9	Good
C+	65-69.9	Satisfactory
C	60-64.9	Adequate
D	50-59.9	Marginal
F	0-49.9	Failure

NOTE: All final grades are subject to departmental review.

Key dates

- Class from 1:30 pm - 2:20 pm
- Assignment due
- Article presentations

JANUARY

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13 <i>Choose article</i>	14
15	16	17	18	19	20 <i>Checkpoint</i>	21
22	23	24	25	26	27	28
29	30	31				

FEBRUARY

S	M	T	W	T	F	S
			1	2	3 <i>Checkpoint</i>	4
5	6	7	8	9	10	11
12	13	14	15	16	17 <i>Checkpoint</i>	18
19	20	21	22	23	24	25
WINTER TERM BREAK						
26	27	28				

MARCH

S	M	T	W	T	F	S
			1	2	3 <i>Checkpoint</i>	4
5	6	7	8	9	10	11
12	13	14	15	16	17 <i>Checkpoint</i>	18
19	20	21	22	23	24	25
26	27	28	29	30	31 <i>Final form of written report</i>	

APRIL

S	M	T	W	T	F	S
						1
2	3 Presentations	4	5 Presentations	6	7 NO CLASS	8
9	10 REVIEW	11	12 REVIEW <i>Quizzlet cards</i>	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29

Assignment extensions

Reasons for granting an extension (assignments): a death in your immediate family, an illness in either yourself or in a dependent (requires email notification BEFORE the due date), and requirement to travel for work. The instructor will not accept an email dated AFTER the due date.

Reasons for not granting an extension: having another assignment or midterm on the same day, being away from the university for a personal reason (i.e. holiday or personal vacation), being too busy with other course work (i.e. having a midterm that same day or week), not attending the lectures due to personal or compassionate reasons (or other reasons), car broke down and could not submit assignment on time, computer is not working properly and you lost the assignment, or any other reason deemed inappropriate by the instructor. This is not an exhaustive list. Please don't ask for an extension if any of these or similar reasons apply. If you know that you will be away, you **MUST** submit the assignment before the due date.

If you miss the **final exam** due to illness or compassionate reasons, you must make arrangements with your own Faculty office.

Communication

Effective September 1, 2013, the University requires all students to activate an official University email account. The U of M will only use your university email account for official communications, including messages from your instructors, department or faculty, academic advisors, and other administrative offices (http://umanitoba.ca/registrar/email_policy/).

Please use your UManitoba email address for all email communications with me (Juliana.MariniMarson@umanitoba.ca). You are welcome to send course-related questions about the course structure (**provided you check the syllabus first**) or content to my email address, or to request a meeting outside of office hours. I expect all emails to be professional and courteous, and will respond within 48 hours during the work week.

Office hours

I will hold regular office hours on the dates/times indicated on page 1. If you can't make it to office hours, please feel free to send me an email so that we can set up another meeting.

Voluntary withdrawal date

The voluntary withdrawal date is the last date for withdrawing from this course without academic penalty. The voluntary withdrawal date for this course is **March 22, 2023**. Evaluative feedback will be provided prior to this date.

Expectations

I expect you to:

- Read and regularly consult the course syllabus. Ask for clarification on any part of the course syllabus that is unclear
- Take notes during lectures
- Arrive on time and listen actively during lectures

- Regularly check your UM email to read course announcements
- Complete all quizzes and exams without consulting any other person
- Follow university policies on plagiarism, cheating, and exam impersonation
- Let me know as soon as possible if you encounter obstacles that will prevent you from completing any aspect of the course on-time
- Be courteous and respectful to students and the instructor, and follow university policies on Respectful Work and Learning Environment and Inappropriate and Disruptive Student Behavior
- Ask questions
- Communicate with me as much as possible about any extra difficulties you encounter during the semester

You can expect me to:

- Do my best to create a welcoming, inclusive, and positive learning environment
- Treat you fairly and respectfully
- Listen to and consider all feedback you give about the course, and implement changes where possible
- Respond to questions and concerns you have sent to my University of Manitoba email account within 48 hours during the work week
- Hold regular office hours
- Make appointments outside of office hours as needed

Missing course work for medical reasons

Students who are unable to meet a course requirement due to medical circumstances are currently not required to submit medical notes. However, students are required to contact their instructor or academic advisor by email to inform of the missed work and to make arrangements for extensions, deferrals, or make-up assignments. Please follow these guidelines if you are unable to meet an academic requirement for your courses.

- Contact your instructor for term work such as a class, quiz, midterm/test, assignment, lab;
- Contact an advisor in your faculty/college/school of registration for a missed final exam (scheduled in the final examination period);
- Inform your instructor/advisor as soon as possible do not delay. Note for final exams, students must contact within 48 hours of the date of the final exam; and
- Email your instructor/advisor from a U of M email address, and include your full name, student number, course number, and academic work that was missed.

Student accessibility

The University of Manitoba is committed to providing an accessible academic community. Students Accessibility Services (SAS) offers academic accommodation supports and services such as note-taking,

interpreting, assistive technology and exam accommodations. Students who have, or think they may have, a disability (e.g., mental illness, learning, medical, hearing, injury-related, visual) are invited to contact SAS to arrange a confidential consultation.

Student Accessibility Services
 520 University Centre
 Phone: (204) 474-7423
 Email: Student_accessibility@umanitoba.ca

Copyright

All course material is copyrighted by Juliana Marson, 2021. No audio or video recording of this material, lectures, or presentations is allowed in any format, openly or surreptitiously, in whole or in part without written permission from Juliana Marson. Course materials (both paper and digital) are for the participant's private study and research, and must not be shared. Violation of these and other Academic Integrity principles, will lead to serious disciplinary action.

Policy on Respectful Work and Learning Environment (RWLE)

- Each individual has the right to participate, learn, and work in an environment that promotes equal opportunities and prohibits discriminatory practices.
- RWLE [2016], Section 2.2 The University wishes to promote and support a community which embraces diversity and inclusion, provides for equality of opportunity, and recognizes the dignity of all people.
- RWLE [2016], Section 2.3 Members of the University Community, including every student and employee, are entitled to a respectful work and learning environment that is:
 - (a) Free from Discrimination and provides for Reasonable Accommodation;
 - (b) Free from Harassment; and
 - (c) Collegial and conducive to early resolution of conflict between members of the University Community.
- Respectful Work and Learning Environment Policy: <http://bit.ly/2b63HQO>
- Student Discipline Bylaw: <http://bit.ly/2b3RL3p>

Inappropriate and disruptive student behaviour

- Inappropriate and disruptive behavior that interferes with the learning of other students, or the instructors' ability to teach will not be tolerated. Such behaviours would include but would not be limited to the following:
 - (a) threats to the physical safety of the individuals or others;
 - (b) verbal threats to or abuse of students or University personnel;
 - (c) recurring and willful damage of University property;
 - (d) inappropriate or disruptive behaviour as a result of misuse of drugs or alcohol on University property; and

(e) actions which habitually interfere with the learning environment or requires the inordinate time and attention of faculty and staff.

- Inappropriate or Disruptive Student Behaviour Policy: <http://bit.ly/2a15au5>
- Student Discipline Bylaw: <http://bit.ly/2b3RL3p>

Academic integrity

Students are responsible for ensuring they understand the University of Manitoba's policy on Academic Integrity (plagiarism, cheating, and examination impersonation). These policies are available in the University Catalog 2016-2017, General Academic Regulations <http://bit.ly/2asrlZN>

The penalties for plagiarism and cheating are severe and range from receiving a grade of zero on an assignment, to academic suspension. For more information on Cheating, Plagiarism, and Fraud: <http://bit.ly/2b63fBP> & <http://bit.ly/2b63ywR>

All work is to be completed independently unless otherwise specified.

Schedule "A"

Schedule "A" is the new requirement passed by the University of Manitoba Senate in 2016 that requires that a mandated list of supports for services plus contact information is provided to students. While this information is important and useful, should you require advice and support, the instructor is happy to meet with you and discuss issues and concerns

Student Resources

Writing and Study Skills Support

The Academic Learning Centre (ALC) offers services that may be helpful to you as you fulfill the requirements for this course. Through the ALC, you may meet with a study skills specialist to discuss concerns such as time management, reading and note-taking strategies, and test-taking strategies. You may also meet one-on-one with a writing tutor who can give you feedback at any stage of the writing process, whether you are just beginning to work on a written assignment or already have a draft. Writing tutors can also give you feedback if you submit a draft of your paper online. (Please note that the online tutors require 48 hours, from Mondays to Fridays, to return your paper with comments.)

All Academic Learning Centre services are free for U of M students. For more information, please visit the Academic Learning Centre website at: umanitoba.ca/student/academiclearning/

You can also talk to a member of the Academic Learning staff by calling 480-1481 or by dropping in at 201 Tier Building.

University of Manitoba Libraries (UML)

As the primary contact for all research needs, your liaison librarian can play a vital role when completing academic papers and assignments. Liaisons can answer questions about managing citations, or locating appropriate resources, and will address any other concerns you may have, regarding the research

process. Liaisons can be contacted by email or phone, and are also available to meet with you in-person. A complete list of liaison librarians can be found by subject: <http://bit.ly/WcEbA1> or name: <http://bit.ly/1tJ0bB4>. In addition, general library assistance is provided in person at 19 University Libraries, located on both the Fort Garry and Bannatyne campuses, as well as in many Winnipeg hospitals. For a listing of all libraries, please consult the following: <http://bit.ly/1sXe6RA>. When working remotely, students can also receive help online, via the Ask-a-Librarian chat found on the Libraries' homepage: www.umanitoba.ca/libraries.

The English Language Centre

The English Language Centre has workshop and programs in advanced academic and health-sciences English (located at 520, University Centre).

Homepage: <http://umanitoba.ca/student/staffdir/elc.html>

Student Accessibility Services

Student Accessibility Services (SAS) provides support and advocacy for students with disabilities of all kinds: hearing, learning, injury-related, mental health, medical, physical or visual. Students with temporary disabilities such as sprains and breaks are also eligible to use our services. SAS acts as a liaison between students and the faculty and staff of the University of Manitoba as well as support agencies within the province of Manitoba. Please phone: 474-6213 (voice) or 474-9690 (TTY) for service. For more information, please visit the Student Accessibility website at: <http://umanitoba.ca/student/saa/accessibility/>

Mental Health

For 24/7 mental health support, contact the Mobile Crisis Service at 204-940-1781.

Student Counselling Centre (SCC)

Contact SCC if you are concerned about any aspect of your mental health, including anxiety, stress, or depression, or for help with relationships or other life concerns. SCC offers crisis services as well as individual, couple, and group counselling. Student Counselling Centre:
<http://umanitoba.ca/student/counselling/index.html>

474 University Centre or S207 Medical Services (204) 474-8592

Student Support Case Management (SSCM)

Contact the Student Support Case Management team if you are concerned about yourself or another student and don't know where to turn. SSCM helps connect students with on and off campus resources, provides safety planning, and offers other supports, including consultation, educational workshops, and referral to the STATIS threat assessment team. Student Support Intake Assistant
<http://umanitoba.ca/student/case-manager/index.html>

520 University Centre (204) 474-7423

University Health Service

Contact UHS for any medical concerns, including mental health problems. UHS offers a full range of medical services to students, including psychiatric consultation. University Health Service
<http://umanitoba.ca/student/health/>

104 University Centre, Fort Garry Campus (204) 474-8411 (Business hours or after hours/urgent calls)

Health and Wellness

Contact our Health and Wellness Educator if you are interested in information on a broad range of health topics, including physical and mental health concerns, alcohol and substance use harms, and sexual assault.

Health and Wellness Educator <http://umanitoba.ca/student/health-wellness/welcome.html>
Katie.Kutryk@umanitoba.ca

469 University Centre (204) 295-9032

Live Well @ UofM

For comprehensive information about the full range of health and wellness resources available on campus, visit the Live Well @ UofM site: <http://umanitoba.ca/student/livewell/index.html>

Copyright

All students are required to respect copyright as per Canada's Copyright Act. Staff and students play a key role in the University's copyright compliance as we balance user rights for educational purposes with the rights of content creators from around the world. The Copyright Office provides copyright resources and support for all members of the University of Manitoba

Visit <http://umanitoba.ca/copyright> for more information.

University and Unit Policies, Procedures, and Supplemental Information

Your rights and responsibilities

As a student of the University of Manitoba you have rights and responsibilities. It is important for you to know what you can expect from the University as a student and to understand what the University expects from you. Become familiar with the policies and procedures of the University and the regulations that are specific to your faculty, college or school.

The Academic Calendar

<http://umanitoba.ca/student/records/academiccalendar.html> is one important source of information. View the sections University Policies and Procedures and General Academic Regulations. While all of the information contained in these two sections is important, the following information is highlighted.

If you have questions about your grades, talk to your instructor. There is a process for term work and final grade appeals. Note that you have the right to access your final examination scripts. See the Registrar's Office website for more information including appeal deadline dates and the appeal form <http://umanitoba.ca/registrar/>

You are expected to view the General Academic Regulation section within the Academic Calendar and specifically read the Academic Integrity regulation. Consult the course syllabus or ask your instructor for additional information about demonstrating academic integrity in your academic work. Visit the Academic Integrity Site for tools and support <http://umanitoba.ca/academicintegrity/> View the Student Academic Misconduct procedure for more information.

Sexual Assault

- If you experience Sexual Assault or know a member of the University community who has, it is important to know there is a policy that provides information about the supports available to those who disclose and outlines a process for reporting.
- The Sexual Assault policy may be found at:
http://umanitoba.ca/admin/governance/governing_documents/community/230.html
- More information and resources can be found by reviewing the Sexual Assault site
<http://umanitoba.ca/student/sexual-assault/>
- For information about rights and responsibilities regarding Intellectual Property view the policy
http://umanitoba.ca/admin/governance/media/Intellectual_Property_Policy_-_2013_10_01.pdf

Academic Programs and Regulations

- For information on regulations that are specific to your academic program, read the section in the Academic Calendar and on the respective faculty/college/school web site
<http://umanitoba.ca/faculties/>
- Contact an Academic Advisor within our faculty/college or school for questions about your academic program and regulations <http://umanitoba.ca/academic-advisors/>

Student Advocacy

Contact Student Advocacy if you want to know more about your rights and responsibilities as a student, have questions about policies and procedures, and/or want support in dealing with academic or discipline concerns.

<http://umanitoba.ca/student/advocacy/>

520 University Centre 204 474 7423 student_advocacy@umanitoba.ca