

SWS6932 A field guide to modeling soil processes

Catalogue Description: A gentle introduction into the realm of modeling for students whose graduate work deals with soil processes.

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| Term | Summer B |
| Meeting Time | Chat session: determined in the first week of the course (1-2 times per week) |
| Instructor | Stefan Gerber 3179 McCarty Hall Phone: 352-294-3174, or cell 352 642 2201 sgerber@ufl.edu |
| Enrollment cap | 10 |
| Office hours | Tuesdays and Thursdays 12:30pm to 2:30 pm or by appointment |

Course pre-requisite: Students are expected to bring a background in soil biological and physical processes, and are ready to familiarize themselves with calculus and linear algebra. Students are required to bring a laptop to class pre-installed with R studio or R, and a working web-browser. R-studio is downloadable from <https://www.rstudio.com/>.

Course Description

Process-based models are increasingly used to put field and laboratory data into a larger context. The course aims to equip students whose primary research is in the field or laboratory with basic modeling skills. In other words, the course provides a gentle introduction into the realm of modeling. We will address how to convert a conceptual model into a series of differential equation. We will then work to implement these equations into a numerical model. We will use a simple web-based tool to analyze the behavior of several interacting components. Next to this system analysis tool, we will utilize the statistics software R to code up, analyze and visualize dynamic soil processes. Students will learn to assess stability, uncertainty, and limitation of models they are designing and/or working with. Example and exercises will be based on biogeochemical and physical processes in the soil, and focus on carbon and nutrient dynamics and reactive transport of tracers (e.g. gases, contaminants, nutrients) in soils. A major component of this course will be students evaluating their own data in the context of either an existing model they are adapting or a simple new model that they design and code up.

Course Objectives

By the end of this course, students will be able to

- Use their understanding of chemical and physical processes to convert a conceptual model into simple numerical code
- Effectively assess model results and troubleshoot model bugs and crashes
- Critically evaluate models through exploration, sensitivity analysis and model-data comparison

Course Format

3 credit course with focus on learning the concepts of box modeling and hands-on exercises initially. With the progression of the semester, the weight of the course work will shift towards discussion and the development of individual projects.

Course text

Reading assignments will be available on the course website <https://lss.at.ufl.edu/> in form of scientific papers.

Course Parts

Week 1: From conceptual model to a numerical framework

Use Insightmaker to define a conceptual model of vegetation-soil element cycle

Representation of dynamic equations on a discrete grid

Behavior of first order differential equations (Analysis of litter decomposition experiment)

Homework: Code simple nitrogen cycle model in Insightmaker and evaluate model response

Week 2: Data and algorithms

Difference between R and basic programming language

Using variables, vectors, matrixes effectively

Flow control (Looping, if else)

Structure of a program (subroutines, functions)

Project work: choose your model system for which you create a conceptual model

Homework: 1) Transfer the conceptual litter decomposition model to R, 2) Code up a simple forest nitrogen cycle model)

Week 3: Understand model behavior

Analysis of model steady states

Chaos – The Lorenz model

Sensitivity analysis

Model scales (timescales and spatial scales)

Stability

Homework: Program up the CENTURY model code and analyze litter decomposition dynamics

Week 4: Reactive transport models

Introduction into advection and dispersion

Concepts of reactive transport models

Project work: code up your conceptual model in R code and turn in model documentation draft

Homework: Compare a discrete model of advection diffusion with analytical solution

Week 5: Model-data fusion

Model data fits using least square and maximum likelihood

Error assessment from model-data comparison

Constraining and interpreting parameter uncertainty

Choose the best model among several alternatives

Project work: Turn in sensitivity analysis

Homework: Estimate optimal parameter values for a simple watershed nitrate export model

Week 6: Final Presentation and outlook

Structure of generic differential equation solver (deSolve)

Apply deSolve to a reactive transport model

Final presentations

Milestones for Semester Project

Week 2: Conceptualize a particular system (ideally one that you are working with in your thesis and for which you may have some data already available) (written report)

Week 4: Code up a new model or adapt an existing model based on the conceptual model (Model documentation)

Week 5: Evaluate model behavior (sensitivity analysis, oral or written report)

Week 6: Interpret your data in the context of your model (Final Oral presentation)

Grading System

The class does not hold any ‘traditional’ exams, instead grades will be informed from turned in homework assignment and from in-class presentations, and from a series of assignments towards the semester project (see “Milestones” above).

Homework (60% towards final grade): Students will be graded based on a) their homework and b) their project. Homework will range from short assignment for the next class to larger projects spanning an entire week. These assignments will be appropriately weighted. Assignments include written reports, written short answers, as well as oral presentations.

Semester Project Model Analysis (40 % towards final grade) Students will devise (or adapt) a specific model to analyze data of their choice. The project encompasses a series of deliverables, including

- Report on the conceptual model and goals for analysis 5%
- Preliminary model analysis (Informal presentation) 5%
- Uncertainty analysis Interpretation of model behavior (Written report or presentation) 10%
- Model technical report (Model documentation) 10%
- Final presentation: Concise summary of findings (Oral presentation) 10%

Homework turned in late results in a loss of half of the maximum points, unless late turn-in is caused by excused absences. In case of an excused absence, homework late submission should not exceed the number of days of excused absences. Best practice for make-up is to arrange a new deadline with the instructor. Make-up class presentations should be scheduled with the instructor. The content of make-up homework may or may not be different. In general, acceptable reasons for late turn-in include illness, serious family emergencies, special curricular requirements (e.g., judging trips, field trips, professional conferences), military obligation, severe weather conditions, religious holidays and participation in official university activities such as music performances, athletic competition or debate. Absences from class for court-imposed legal obligations (e.g., jury duty or subpoena) must be excused. Other reasons also may be approved.

Grades

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| Course Points | ≥95.0 | ≥90.0 | ≥85.0 | ≥80.0 | ≥75.0 | ≥70.0 | ≥65.0 | ≥60.0 | ≥55.0 | ≥50.0 | ≥45.0 | <45 |
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| Letter Grade | A | A- | B+ | B | B- | C+ | C | C- | D+ | D | D- | E |
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For information on current UF policies for assigning grade points, see <https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx>

Online Course Evaluation Process

Student assessment of instruction is an important part of efforts to improve teaching and learning. At the end of the semester, students are expected to provide feedback on the quality of instruction in this course using a standard set of university and college criteria. These evaluations are conducted online at <https://evaluations.ufl.edu>. Evaluations are typically open for students to complete during the last two or three weeks of the semester; students will be notified of the specific times when they are open. Summary results of these assessments are available to students at <https://evaluations.ufl.edu/results>.

Chat Attendance

Class attendance is highly recommended. I understand, we are all busy and 100% may not always be possible. Omitting substantial portions (> 10%) of the class will hamper the student's ability to complete the required homework and project in a satisfactory manner and will thus affect the grade. It is the student's responsibility to maintain satisfactory academic performance and attendance. Neither the Instructor nor the TA are required to cover missed materials with a student if the absence is unexcused.

Class Demeanor and Etiquette

Students are expected to be considerate and respectful towards fellow students, teaching assistants, instructors, and guest lecturers. This includes a behavior that is not disruptive to class such as punctual attendance, the silencing of cell phones and similar electronic devices, and avoiding private conversations.

Academic Honesty

As a student at the University of Florida, you have committed yourself to uphold the Honor Code, which includes the following pledge: *"We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honesty and integrity."* You are expected to exhibit behavior consistent with this commitment to the UF academic community, and on all work submitted for credit at the University of Florida, the following pledge is either required or implied: *"On my honor, I have neither given nor received unauthorized aid in doing this assignment."*

It is assumed that you will complete all work independently in each course unless the instructor provides explicit permission for you to collaborate on course tasks (e.g. assignments, papers, quizzes, exams). Furthermore, as part of your obligation to uphold the Honor Code, you should report any condition that facilitates academic misconduct to appropriate personnel. It is your individual responsibility to know and comply with all university policies and procedures regarding academic integrity and the Student Honor Code. Violations of the Honor Code at the University of Florida will not be tolerated. Violations will be reported to the Dean of Students Office for consideration of disciplinary action. For more information regarding the Student Honor Code, please see: <http://www.dso.ufl.edu/sccr/process/student-conduct-honor-code>.

Software Use

All faculty, staff and students of the university are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal

penalties for the individual violator. Because such violations are also against university policies and rules, disciplinary action will be taken as appropriate.

Campus Helping Resources

Students experiencing crises or personal problems that interfere with their general well-being are encouraged to utilize the university's counseling resources. The Counseling & Wellness Center provides confidential counseling services at no cost for currently enrolled students. Resources are available on campus for students having personal problems or lacking clear career or academic goals, which interfere with their academic performance.

University Counseling & Wellness Center, 3190 Radio Road, 352-392-1575,
www.counseling.ufl.edu/cwc/

Counseling Services

Groups and Workshops

Outreach and Consultation

Self-Help Library

Wellness Coaching

U Matter We Care, <http://www.umatter.ufl.edu>

Career Resource Center, First Floor JWRU, 392-1601, www.crc.ufl.edu/

Students with Disabilities

The Disability Resource Center coordinates the needed accommodations of students with disabilities. This includes registering disabilities, recommending academic accommodations within the classroom, accessing special adaptive computer equipment, providing interpretation services and mediating faculty-student disability related issues. Students requesting classroom accommodation must first register with the Dean of Students Office. The Dean of Students Office will provide documentation to the student who must then provide this documentation to the Instructor when requesting accommodation

0001 Reid Hall, 352-392-8565, www.dso.ufl.edu/drc/

University of Florida Complaints Policy

The University of Florida believes strongly in the ability of students to express concerns regarding their experiences at the University. The University encourages its students who wish to file a written complaint to submit that complaint directly to the department that manages that policy.

A student who is unsure as to the official responsible for handling his or her particular complaint may contact the Ombuds office or the Dean of Students Office. For complaints that are not satisfactorily resolved at the department level or which seem to be broader than one department, students are encouraged to submit those complaints to one of the following locations:

Ombuds: <http://www.ombuds.ufl.edu/>
31 Tigert Hall, 352-392-1308

The purpose of the Ombuds office is to assist students in resolving problems and conflicts that arise in the course of interacting with the University of Florida. By considering problems in an unbiased way, the Ombuds works to achieve a fair resolution and works to protect the rights of all parties involved.

Dean of Students Office: <http://www.dso.ufl.edu/>
202 Peabody Hall, 352-392-1261

The Dean of Students Office works with students, faculty, and families to address a broad range of complaints either through directly assisting the student involved to resolve the issue, working with the student to contact the appropriate personnel, or referring the student to resources or offices that can directly address the issue. Follow up is provided to the student until the situation is resolved. Additionally, the University of Florida regulations provide a procedure for filing a formal grievance in Regulation 4.012: <http://regulations.ufl.edu/regulations/uf-4-student-affairs/>