**Numerical Weather and Climate Prediction - MTEOR 408X / 508X**

**Spring 2022 Syllabus**

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**Instructor: Prof. Christina Patricola**

[cmp28@iastate.edu](mailto:cmp28@iastate.edu); 515-294-9874

3017 Agronomy Hall

**Course time and location**: Tuesday and Thursday, 12:40-1:55 PM – location TBD

**Credit hours**: 3 credits

**Student hours**: TBD

**Prerequisites**: MTEOR 227 or equivalent and MTEOR 443

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**Course objectives**

Upon completion of the course students will be able to:

* Understand basic principles of numerical weather/climate models including numerical solution methods for the atmospheric governing equations and parameterizations for physical processes that cannot be represented explicitly
* Understand the capabilities and limitations of numerical weather/climate models
* Construct well-designed numerical weather/climate model simulations, run them on high-performance computing systems, critically and quantitatively evaluate model performance, and interpret and communicate the results

**Website:** TBD

**Textbooks**

Required: Numerical Weather and Climate Prediction, Thomas Tomkins Warner

Recommended (optional): Introduction To Three-dimensional Climate Modeling, Warren M. Washington

**Course delivery mode and attendance**

Course activities must be attended in-person. Multiple absences may result in a reduced final grade.

**Communication**

I will use Canvas and email to communicate with students. I strive to reply within two days.

**Course outline**

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| --- | --- | --- | --- |
| **Week** | **Date** | **Planned Topics** | **Reading** |
| 1 | Jan 18 | Course overview  Primitive equations and approximations | Syllabus  Warner Ch. 1-2  <https://www.meted.ucar.edu/ucar/unix> |
| Jan 20 | Supercomputing: hardware, file systems, modules, job scripts  Compiling model code | <https://portal.tacc.utexas.edu/user-guides/stampede2>  <https://www2.mmm.ucar.edu/wrf/OnLineTutorial/> (Intro-compilation) |
| 2 | Jan 25 | Spatial finite-difference methods  Map projections | Warner 3.1 |
| Jan 27 | Configuring the model domain | <https://www2.mmm.ucar.edu/wrf/OnLineTutorial/> (geogrid)  <https://www2.mmm.ucar.edu/wrf/users/namelist_best_prac_wps.html> |
| 3 | Feb 1 | Spectral methods | Warner 3.2 |
| Feb 3 | Data products for model initial and boundary conditions | NCAR Research Data Archive: <https://rda.ucar.edu/>  <https://www2.mmm.ucar.edu/wrf/OnLineTutorial/> (ungrib) |
| 4 | Feb 8 | Initial conditions  Surface and lateral boundary conditions | Warner Ch 3.1, 3.5-3.6 |
| Feb 10 | Generating initial and boundary conditions | <https://www2.mmm.ucar.edu/wrf/OnLineTutorial/> (metgrid and real) |
| 5 | Feb 15 | Time differencing methods  Numerical stability | Warner Ch. 3.3-3.4 |
| Feb 17 | Configuring model time step and physics | <https://www2.mmm.ucar.edu/wrf/users/namelist_best_prac_wrf.html> |
| 6 | Feb 22 | Physical parameterizations | Warner Ch. 4.1-4.4 |
| Feb 24 | Running WRF | <https://www2.mmm.ucar.edu/wrf/OnLineTutorial/> (WRF single domain) |
| 7 | Mar 1 | Experimental design | Warner Ch. 10 |
| Mar 3 | Benchmarking; I/O |  |
| 8 | Mar 8 | Mid-term exam |  |
| Mar 10 | In-class project session |  |
|  | Mar  13-19 | Spring break, classes recessed | |
| 9 | Mar 22 | Presentations (grad students only) |  |
| Mar 24 | Presentations (grad students only) |  |
| 10 | Mar 29 | Experimental design | Warner Ch. 10 |
| Mar 31 | Surface processes | Warner Ch. 5  <http://iowa-nwa.com/conference/> |
| 11 | Apr 5 | Ensemble methods | Warner Ch. 7 |
| Apr 7 | Signal-to-noise | Scaife and Smith (2018) |
| 12 | Apr 12 | Verification methods | Warner Ch. 9 |
| Apr 14 | Analyzing model output | Warner Ch. 11 |
| 13 | Apr 19 | In-class project session |  |
| Apr 21 | Climate modeling | Warner Ch. 16 |
| 14 | Apr 26 | Downscaling | Warner Ch. 16 |
| Apr 28 | History and future of modeling |  |
| 15 | May 3 | Project presentations (all students) |  |
| May 5 | Project presentations (all students) |  |
| 16 | May 10 12PM | Final exam |  |

**Grading**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Contribution** | **Undergraduates** | **Graduate students** |
| **Homework** | 10% | Same | |
| **Exams** | 40% | Same | |
| **Written project** | 30% | * Design and perform control simulation; verify with observations | * Design and perform control simulation; verify with observations * Design and perform experimental simulations to test research hypothesis; interpret results |
| **Presentations** | 20% | One presentation | Two presentations |

Late policy: Late work submitted within 24 hours of the deadline is eligible for 75% credit.

Final letter grades will be assigned according to the following scale:

|  |  |
| --- | --- |
| **Final score** | **Final letter grade** |
| 93-100 | A |
| 90-93 | A- |
| 87-90 | B+ |
| 83-87 | B |
| 80-83 | B- |
| 77-80 | C+ |

|  |  |
| --- | --- |
| **Final score** | **Final letter grade** |
| 73-77 | C |
| 70-73 | C- |
| 67-70 | D+ |
| 63-67 | D |
| 60-63 | D- |
| < 60 | F |

**Feedback**

* To support learning, students will be asked to use Plus/Delta to provide anonymous constructive feedback on what is going well and what would be helpful to change in the course.
* Additional feedback is welcome throughout the semester via formats including: verbal (e.g., during office hours, before/after class), written (e.g, via email), or anonymous (e.g., in my campus mailbox).

**COVID-19 health and safety**

Students and instructor are responsible for abiding by the university’s COVID-19 health and safety expectations, which may evolve over time: <https://web.iastate.edu/safety/updates/covid19>.

**Plagiarism and Academic Dishonesty**

Plagiarism is the act of representing directly or indirectly another person’s work as your own. It can involve presenting someone’s speech, wholly or partially, as yours; quoting without acknowledging the true source of the quoted material; copying and handing in another person’s work with your name on it; and similar infractions. Even indirect quotations, paraphrasing, etc., can be considered plagiarism unless sources are properly cited. Plagiarism will not be tolerated, and students could receive an F grade on the assignment or an F grade for the course. The Iowa State University policy for academic misconduct can be found in the [Student Disciplinary Regulations](http://www.policy.iastate.edu/policy/SDR)*.*

**Accessibility**

Iowa State University is committed to assuring that all educational activities are free from discrimination and harassment based on disability status. Students requesting accommodations for a documented disability are required to work directly with staff in Student Accessibility Services (SAS) to establish eligibility and learn about related processes before accommodations will be identified. After eligibility is established, SAS staff will create and issue a Notification Letter for each course listing approved reasonable accommodations. This document will be made available to the student and instructor either electronically or in hard-copy every semester. Students and instructors are encouraged to review contents of the Notification Letters as early in the semester as possible to identify a specific, timely plan to deliver/receive the indicated accommodations. Reasonable accommodations are not retroactive in nature and are not intended to be an unfair advantage. Additional information or assistance is available online at [www.sas.dso.iastate.edu](http://www.sas.dso.iastate.edu), by contacting SAS staff by email at [accessibility@iastate.edu](mailto:accessibility@iastate.edu), or by calling 515-294- 7220. Student Accessibility Services is a unit in the Dean of Students Office located at 1076 Student Services Building.

**Discrimination and Harassment**

Iowa State University does not discriminate on the basis of race, color, age, ethnicity, religion, national origin, pregnancy, sexual orientation, gender identity, genetic information, sex, marital status, disability, or status as a U.S. Veteran. Inquiries regarding non-discrimination policies may be directed to Office of Equal Opportunity, 3410 Beardshear Hall, 515 Morrill Road, Ames, Iowa 50011, Tel. 515-294-7612, Hotline 515-294-1222, email [eooffice@iastate.edu](mailto:eooffice@iastate.edu).

**Religious Accommodations**

Iowa State University welcomes diversity of religious beliefs and practices, recognizing the contributions differing experiences and viewpoints can bring to the community. There may be times when an academic requirement conflicts with religious observances and practices. If that happens, students may request reasonable accommodation for religious practices. In all cases, you must put your request in writing. The instructor will review the situation in an effort to provide a reasonable accommodation when possible to do so without fundamentally altering a course. For students, you should first discuss the conflict and your requested accommodation with your professor at the earliest possible time. You or your instructor may also seek assistance from the [Dean of Students Office](http://dso.iastate.edu) at 515-294-1020 or [the Office of Equal Opportunity](https://www.eoc.iastate.edu) at 515-294-7612.

**Prep Week**

This class follows the Iowa State University [Prep Week](https://www.provost.iastate.edu/academic-programs/policies/prep-week-and-finals-week) policy, as noted in the [ISU Policy Library](https://www.policy.iastate.edu/) and section 10.6.4 of the Faculty Handbook.

**Principles of Community**

Students are responsible for living the tenets established in ISU’s [Principles of Community](https://www.diversity.iastate.edu/connect/principles): Respect, Purpose, Cooperation, Richness of Diversity, Freedom from discrimination, and the Honest and respectful expression of ideas. I strive to uphold these principles as well.

**Student Health and Wellness Resources**

Iowa State University is committed to proactively facilitating all students’ well-being. We welcome and encourage students to contact the following on-campus services for their physical, intellectual, occupational, spiritual, environmental, financial, social, and/or emotional needs:

* Student Wellness call 515-294-1099 or via website ([http://studentwellness.iastate.edu](http://studentwellness.iastate.edu/));
* Thielen Student Health Center call 515-294-5801 (24/7 Medical Advice) or via website ([http://www.cyclonehealth.org](http://www.cyclonehealth.org/));
* Student Counseling Services call 515-294-5056 or via website ([https://counseling.iastate.edu](https://counseling.iastate.edu/));
* Recreation Services call 515-294-4980 or via website ([http://recservices.iastate.edu](http://recservices.iastate.edu/)).
* Students dealing with heightened feelings of sadness or hopelessness, thoughts of harm or suicide, or increased anxiety may contact the ISU Crisis Text Line (Text ISU to 741-741) or contact ISU Police Department 515-294-4428.
* Basic needs. To learn effectively, you must have basic security: a roof over your head along with a reliable place to sleep and enough food to eat (view the [Food Security at ISU Student Wellness page](https://www.studentwellness.iastate.edu/food-insecurity/)). If you’re having trouble with any of those things, please talk with me or the [Dean of Students Office](http://www.dso.iastate.edu/) ([studentassistance@iastate.edu](mailto:studentassistance@iastate.edu); 515-294-1020). Together we can work to meet those needs.

**Expectations for mutual respect and professionalism**

All participants in the course, including students and instructors, are expected to treat each other with courtesy and respect. Comments to others should be factual, constructive, and free from harassing statements. It is the instructor’s goal to promote an atmosphere of mutual respect in the classroom. Please contact the instructor if you have suggestions for improving the classroom environment.

**Free expression (required syllabus statement)**

Iowa State University supports and upholds the First Amendment protection of [freedom of speech](https://www.studentconduct.dso.iastate.edu/know-the-code-resources/resources-for-students/harassment-and-free-speech/free-speech) and the principle of [academic freedom](https://www.iowaregents.edu/plans-and-policies/board-policy-manual/39-academic-freedom) in order to foster a learning environment where open inquiry and the vigorous debate of a diversity of ideas are encouraged. Students will not be penalized for the content or viewpoints of their speech as long as student expression in a class context is germane to the subject matter of the class and conveyed in an appropriate manner.