CLIM 751: PREDICTABILITY AND PREDICTION OF WEATHER AND CLIMATE – CONCEPTS AND PHENOMENOLOGY

Fall 2024 - Syllabus

Instructors: J. Shukla (office: 105 Research Hall, email: jshukla@gmu.edu)
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Class Schedule: Monday 10:30 am – 1:10 pm (face-to-face: 121 Research Hall)

Course Homepage:
http://cola.gmu.edu/kinter/CLIM751/
http://mymasonportal.gmu.edu (Blackboard)
All reading materials will be posted on Blackboard.

Textbooks, Recommended and Supplementary Reading Materials:
Required Reading: See list.

Course Description:
This course covers predictability and seamless prediction of weather and climate for timescales ranging from days to decades. Studies limitations to predictability due to chaos, and possible sources of predictability due to slowly varying surface boundary conditions produced by interactions among atmospheres, ocean and land system. Discusses predictability of droughts and floods, monsoons, ENSO, decadal variations and climate change. Classes will be held online using Blackboard and sessions will be recorded for future reference.

Course Requirements:
1. Presentation of Selected Papers from the Literature: 70%
2. Data analysis project: 30%
Each week, selected students will be assigned to present papers from the scholarly literature. All students are expected to read all the required papers each week. One student will be asked to present the paper, and one student may be asked to summarize the impact of the paper, e.g., with a summary of the papers that have cited it since publication. All students are expected to conduct a data analysis exercise, using data sets provided for the course including long time series of re-forecasts and verifying observations. A separate assignment sheet describes the data analysis project.

Detailed Course Schedule (subject to minor adjustment)

<table>
<thead>
<tr>
<th>Date</th>
<th>Week</th>
<th>Lecturer</th>
<th>Topic</th>
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</thead>
<tbody>
<tr>
<td>26 Aug</td>
<td>1</td>
<td>Kinter/Shukla</td>
<td>Logistics; Introduction; Prediction of Weather &amp; Climate</td>
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<tr>
<td>2 Sep</td>
<td>NA</td>
<td>NA</td>
<td>HOLIDAY</td>
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<tr>
<td>9 Sep</td>
<td>2</td>
<td>Shukla</td>
<td>Weather Predictability</td>
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<tr>
<td>16 Sep</td>
<td>3</td>
<td>Shukla</td>
<td>Dynamical Seasonal Prediction</td>
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<tr>
<td>23 Sep</td>
<td>4</td>
<td>Kinter</td>
<td>Data Analysis Project</td>
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<tr>
<td>30 Sep</td>
<td>5</td>
<td>DelSole</td>
<td>Predictability of Decadal Var. &amp; Climate Change</td>
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<tr>
<td>7 Oct</td>
<td>6</td>
<td>Kinter</td>
<td>Ensembles and Predictability</td>
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<tr>
<td>14 Oct</td>
<td>NA</td>
<td>NA</td>
<td>HOLIDAY</td>
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<tr>
<td>21 Oct</td>
<td>7</td>
<td>Dirmeyer</td>
<td>Land Surface Predictability</td>
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<tr>
<td>28 Oct</td>
<td>8</td>
<td>Krishnamurthy</td>
<td>Predictability of the South Asian Monsoon</td>
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<tr>
<td>4 Nov</td>
<td>9</td>
<td>Straus</td>
<td>Intraseasonal Predictability</td>
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<td>11 Nov</td>
<td>10</td>
<td>Huang</td>
<td>Seasonal Prediction: ENSO</td>
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<td>18 Nov</td>
<td>11</td>
<td>Buckley</td>
<td>Predictability of North Atlantic SST</td>
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<tr>
<td>25 Nov</td>
<td>12</td>
<td>Burks</td>
<td>The Ocean’s Role in Tropical Climate Prediction</td>
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<tr>
<td>2 Dec</td>
<td>13</td>
<td>Kinter</td>
<td>Predictability of Extreme Events</td>
</tr>
<tr>
<td>9 Dec</td>
<td>14</td>
<td>Students</td>
<td>Data Project Presentations</td>
</tr>
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</table>
PAPERS The papers listed below (subject to revision) are readings for each week of the course. The references below are either REQUIRED (should be read by all students), RECOMMENDED (optional reading), or PRESENTED (to be presented by students; highlighted in yellow). In some weeks, there will be two papers presented by students. In other weeks, there will only be a single paper presented, whose impact will be assessed by a different student. A separate schedule of student presentations will be provided.

1 – INTRODUCTION (no student presentations this week)

2 – WEATHER
- **TO BE PRESENTED**: Lorenz, E. N. (1982) Atmospheric predictability experiments with a large numerical model, Tellus, 34:6, 505-513, DOI: 10.3402/tellusa.v34i6.10836

3 – DYNAMICAL SEASONAL PREDICTION
4 – DATA ANALYSIS PROJECT


5 – DECADAL & CLIMATE CHANGE

- **TO BE PRESENTED**: Scaife and Smith, 2018: A signal-to-noise paradox in climate science. npj [https://www.nature.com/articles/s41612-018-0038-4](https://www.nature.com/articles/s41612-018-0038-4)

6 – ENSEMBLES


7 – LAND SURFACE


8 – SOUTH ASIAN MONSOON


**TO BE PRESENTED:** Krishnamurthy, V., 2017: Seasonal prediction of South Asian monsoon in CFSv2, *Climate Dyn.* doi:10.1007/s00382-017-3963-8


9 – INTRASEASONAL


10 – SEASONAL PREDICTION: ENSO


11 – OCEAN DYNAMICS AND NORTH ATLANTIC SST

• **TO BE PRESENTED:** Smith et al (2020). North Atlantic climate far more predictable than models imply, *Nature*, doi: https://doi.org/10.1038/s41586-020-2525-0.

• **TO BE PRESENTED:** Yeager et al (2018). Predicting near term changes in the earth system, BAMS, doi: 10.1175/BAMS-D-17-0098.1

• **REQUIRED:** Buckley, M.W. and J. Marshall (2016). Observations, inferences and mechanisms of the Atlantic Meridional Overturning Circulation: a review. *Reviews of Geophysics*, 54, 5—63. doi: 10.1002/2015RG000493. ONLY required to read sections 2.4 and 6. The rest of the paper, particularly the introduction and section 2 may be useful background for students, particularly those not familiar with the oceanography of the Atlantic Ocean.


12 – OCEAN’S ROLE


13 – EXTREME EVENTS


• **REQUIRED**: Vitart, F., Robertson, A.W., 2018: The sub-seasonal to seasonal prediction project and the prediction of extreme events. *npj Clim Atmos Sci* 1, 3. https://doi.org/10.1038/s41612-018-0013-0


Goals and Learning Outcomes:
The course will:

1. *Provide a background in the scientific problem of weather and climate predictability.* Students will gain an in-depth understanding of how and why weather and climate may be predictable. Students will have the opportunity to critically review the scholarly literature on the predictability of variations of the Earth system at time scales of days to decades. The emphasis on both the nature of scientific findings and the impact that individual papers have had on subsequent scholarship ensure that students will gain an appreciation for the practice of professional scientific inquiry.

2. *Provide knowledge and skills necessary to conduct original quantitative research in predictability.* By have access to a current research-quality data set for analysis and manipulation, the students will develop the ability to work with high-volume geophysical data from a variety of sources.

3. *Reinforce oral and written communication skills.* Students will present papers from the literature, evaluate the impact these papers have had on the scientific body of knowledge, and critically examine the results reported in the literature. Students will write reports on the findings of their calculations with research-quality data sets, with the potential to submit truly new findings for peer-reviewed publication.

GMU Email Accounts:
Students must use their own Mason email and Blackboard accounts to receive important University information, including messages related to this class. See http://masonlive.gmu.edu for more information.

Online Tools:
Any student use of Generative Artificial Intelligence (AI) tools should follow the fundamental principles of the Honor Code. Some kinds of participation in online study sites violate the Mason Honor code: these include accessing exam or quiz questions for this class; accessing exam, quiz, or assignment answers for this class; uploading of any of the instructor’s materials or exams; and uploading any of your own answers or finished work.

Academic Integrity:
Mason is an Honor Code university; please see the Office for Academic Integrity (https://oai.gmu.edu/) for a full description of the code and the honor committee process. The principle of academic integrity is taken very seriously and violations are treated gravely. What does academic integrity mean in this course? Essentially this: when you are responsible for a task, you will perform that task. When you rely on someone else’s work in an aspect of the performance of that task, you will give full credit in the proper, accepted form. Another aspect of academic integrity is the free play of ideas. Vigorous discussion and debate are encouraged in this course, with the firm expectation that all aspects of the class will be conducted with civility and respect for differing ideas, perspectives, cultures, and traditions. When in doubt (of any kind) please ask for guidance and clarification.

Diversity and Inclusion:
This course will be conducted in a manner that is consistent with the George Mason University policies on non-discrimination (https://universitypolicy.gmu.edu/policies/non-discrimination-policy/), and diversity (https://stearnscenter.gmu.edu/knowledge-center/general-teaching-resources/mason-diversity-statement/) and the policy prohibiting sexual and gender-based harassment and inter-personal violence (https://universitypolicy.gmu.edu/policies/sexual-harassment-policy/). The instructors in this course are committed to recognizing and celebrating diversity, one of Mason’s core values. The
University promotes a living and learning environment for outstanding growth and productivity among its students, faculty and staff. Through its curriculum, programs, policies, procedures, services and resources, Mason strives to maintain a quality environment for work, study and personal growth.

An emphasis upon diversity and inclusion throughout the campus community is essential to achieve these goals. Diversity is broadly defined to include such characteristics as, but not limited to, race, ethnicity, gender, gender identity, religion, age, disability, and sexual orientation. Diversity also entails different viewpoints, philosophies, and perspectives. Attention to these aspects of diversity helps promote a culture of inclusion and belonging, and an environment where diverse opinions, backgrounds and practices have the opportunity to be voiced, heard and respected.

The reflection of Mason’s commitment to diversity and inclusion goes beyond policies and procedures to focus on behavior at the individual, group and organizational level. The implementation of this commitment to diversity and inclusion is found in all settings, including classroom settings; it is also found with the delivery of services and activities, including, but not limited to, curriculum and teaching.

Acknowledging that the attainment of diversity and inclusion are dynamic and continuous processes, and that the larger societal setting has an evolving socio-cultural understanding of diversity and inclusion, Mason seeks to continuously improve its environment. To this end, the University promotes continuous monitoring and self-assessment regarding diversity. The aim is to incorporate diversity and inclusion within the philosophies and actions of the individual, group and organization, and to make improvements as needed.

As faculty members and designated “Responsible Employees,” the instructors for this course are required to report all disclosures of sexual assault, interpersonal violence, and stalking to Mason’s Title IX Coordinator per university policy 1412. If you wish to speak with someone confidentially, please contact the Student Support and Advocacy Center (703-993-3686) or Counseling and Psychological Services (703-993-2380). You may also seek assistance from Mason’s Title IX Coordinator (703-993-8730; titleix@gmu.edu).

Gender identity and pronoun use: If you wish, please share your name and gender pronouns with me (ikinter@gmu.edu) and indicate how best to address you in class and via email. I use he/him/his for myself, and you may address me as Dr. Kinter or Prof. Kinter in email and verbally.

Disability Accommodations:
Disability Services at George Mason University is committed to providing equitable access to learning opportunities for all students by upholding the laws that ensure equal treatment of people with disabilities. If you are seeking accommodations for this class, please first visit http://ds.gmu.edu/ for detailed information about the Disability Services registration process. Then please discuss your approved accommodations with me. Disability Services is located in Student Union Building I (SUB I), Suite 2500. Email:ods@gmu.edu | Phone: (703) 993-2474

Other Useful Campus Resources:
Mason has several support services for students. Please go to https://stearnscenter.gmu.edu/knowledge-center/knowing-mason-students/student-support-resources-on-campus/ for a directory of services.

University Policies:
The University Catalog, http://catalog.gmu.edu, is the central resource for university policies affecting student, faculty, and staff conduct in university academic affairs. Other policies are available at http://universitypolicy.gmu.edu/. All members of the university community are responsible for knowing and following established policies.