

Senior Research Project
CLIM 408
Syllabus

Course Coordinators: Cristiana Stan (Atmospheric Sciences) and Stacey Verardo (Earth Sciences) Instructor: R. Paul Acosta
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Course Objectives: This course is designed to offer students the opportunity to explore and research a topic of their choice relevant to their major. A student taking the class will *i*) use critical thinking to formulate a research question, *ii*) make effective use of library, Internet, and other research resources, *iii*) engage in the key elements of conducting original research, *iv*) employ effective writing skills in summarizing past research on the topic, provide a concise, easy to follow description of the specific methods used in the research, and clearly synthesize and visualize the results.

This course will focus on reviewing the seminal literature dealing with our understanding of Miocene Climatic Optimum (MCO) hydroclimate with a focus on North America. It will consist of weekly reading, writing, coding and presentation assignments, as well as a final project that will apply analysis techniques from the literature towards diagnosing MCO simulations, and performing model-data analysis. Each week's assignment will entail facilitating discussion of weekly reading, and discussion of progress in research and writing.

Writing Intensive Learning Outcomes

- **Writing-to-Learn:** students will use informal or formal writing in ways that deepen their awareness of the field of study and its subject matter.
- **Writing-to-Communicate:** students will compose one or more written genres specific to the field of study in order to communicate key ideas tailored to specific audiences and purposes; genres may be academic, public, or professional.
- **Writing-as-a-process:** students will draft and revise written works based on feedback they receive from instructors and peers, using strategies appropriate to the genre, audience, and purpose.

Requirements: In order to successfully complete the course each student is expected to:

1. Attend regularly scheduled meetings with the research faculty advisor
2. Listen to the [recorded lecture on how to write scientific research reports and papers](#)
3. Complete each of the assignments that build the research proposal
4. Conduct original research* on the selected topic
5. Submit a written research proposal that is a minimum of 10 fully developed paragraphs and reviews a minimum of 5 sources (preferable academic journals)
6. Submit the written report on the project during the week of Final Exam
7. Present the research project at the final student presentation at the end of the semester

*The type of research for:

Meteorology Option

1. Students are not required to conduct data analysis
2. Read 4 journal papers
3. Read one non-peer reviewed article (media, book chapter, blogs)

Computational Atmospheric Sciences Option

1. Students are required to conduct data analysis

Schedule:

WEEKS	TOPIC	DUE
1	Research process, tools and approaches	
2	Topic finalization	
3-4	Literature review techniques, bibliography	
5-6	Developing a research proposal	Literature review (≥ 500)
7	Planning and executing research	
8	Communicating your work	Full proposal ($\geq 1000^*$)
9-11	Continuing research	
12	Completing research, planning and writing the written report	Draft 1 of report
13-14	Revising written report	Draft 2 of report
15-16	Finishing report	Final report ($\geq 2500^*$)

Writing assignments are listed under the column “DUE” – numbers in parentheses are expected minimum word counts for each assignment. A single-spaced page using 12-point Times New Roman font in MS Word has about 500 words. *Note that the Full Proposal and Final Report include the Literature Review in their word counts. The Final Report may also include figures and/or tables (although they say, “a picture is worth a thousand words”, alas, we cannot count figures toward your final word count).

Policies and Grading:

All students at George Mason are required to take a writing intensive (WI) course in their major. CLIM 408 has been approved by the Faculty Senate Writing Across the Curriculum Committee to fulfill all the Writing Intensive requirement in the Atmospheric Sciences major. It does so through the 1000-word paper on literature review due at the end of week 8th and the 3500-word research report. The research report will be completed through a draft /feedback/revision process. The first draft will be due at the end of week 12th; I will provide commentary on the draft and the revised report will be discussed during weeks 13-14th. The final report is due on the week of finals.

The final grade is based 100% on the report.

The [standard undergraduate grading scale](#) is used.

It is acceptable to use AI for this course as a tool to enhance – not replace – independent thought.

EXTRA CREDIT:

Extra credit will not be given in this course.

STUDENTS WITH DISABILITIES:

If you are a student with a disability and you need academic accommodations, please see me and contact the Office of Disability Services (ODS) at 993-2474, <http://ods.gmu.edu>. All academic accommodations must be arranged through the ODS.

GMU EMAIL:

All George Mason students are issued an e-mail account. *Students must use their MasonLive email account to receive important University information, including messages related to this class. See <http://masonlive.gmu.edu> for more information.*

UNIVERSITY POLICIES:

Common Policies Addendum Policies about Academic Standards, Accommodations for Students with Disabilities, FERPA, and Title IX affecting all GMU Students:
<https://stearnscenter.gmu.edu/home/gmu-common-course-policies/>

WHERE TO GET HELP:

If you encounter any difficulties in this course, first contact your research advisor **immediately!** Do not wait until the end of the semester to ask for help in understanding the material in order to improve your grade - by then, it may be too late. Do not be afraid to ask for help - that is our job!

The Counseling Center is committed to improving academic and personal skills, and offers many workshops and counseling groups throughout the semester.

Make use of the many rich academic and personal opportunities available at Mason!

Course Schedule: Due dates and weekly reading

Time: Friday 10-12 am EST via teams

Week 1 – Jan 20-23

- Watch lecture on scientific research, reports and papers ([video](#))
- Discussion

Week 2 – Jan 30

- Xingying Huang, Daniel L. Swain, Climate change is increasing the risk of a California megaflood. *Sci. Adv.* **8**, eabq0995(2022). DOI:10.1126/sciadv.abq0995
- The Hydroclimate and Environmental Response to Middle Miocene Warming in the Southwestern USA: Stable Isotope Evidence, Spaur et al., 2025 <https://doi.org/10.1029/2024PA005056>

Week 3 – Feb 6

- Topic Finalization (1-2 sentences)
- Burls, N. J., and A. V. Fedorov (2017), Wetter subtropics in a warmer world: Contrasting past and future hydrological cycles, *Proc. Natl. Acad. Sci. U. S. A.*, *114*(49), 12888–12893, doi:10.1073/pnas.1703421114.
- Acosta, R. P., N. J. Burls, M. J. Pound, C. D. Bradshaw, S. J. Feakins, J. McCoy, M. Gibson, J. M. K. O’Keefe, 2024: Climate conundrum: a wet or dry European and Northern African climate during the middle Miocene, *Geophysical Research Letter*.

Week 4 – Feb 13

- Bahadori, A., Holt, W.E., Feng, R. *et al.* Coupled influence of tectonics, climate, and surface processes on landscape evolution in southwestern North America. *Nat Commun* **13**, 4437 (2022). <https://doi.org/10.1038/s41467-022-31903-2>

Focus on Figure 10 and why the authors believe this is the best Middle Miocene reconstruction of North America.

- Boos, W.R., Pascale, S. Mechanical forcing of the North American monsoon by orography. *Nature* **599**, 611–615 (2021). <https://doi.org/10.1038/s41586-021-03978-2>

Week 5 – Feb 20

- Developing research proposal (Literature Review Progress (≥ 500 words))
- Pascale, S., Boos, W., Bordoni, S. *et al.* Weakening of the North American monsoon with global warming. *Nature Clim Change* **7**, 806–812 (2017). <https://doi.org/10.1038/nclimate3412>
- Bhattacharya et al., 2022 Expansion and Intensification of the North American Monsoon During the Pliocene. <https://doi.org/10.1029/2022AV000757>

Weeks 6 – Feb 27

- Fu et al., 2022 Warmer Pliocene Upwelling Site SST Leads to Wetter Subtropical Coastal Areas: A Positive Feedback on SST. <https://doi.org/10.1029/2021PA004357>

Week 7 – Mar 6

- Full proposal (≥ 1000 words)

- Payne, A. E., Demory, M. E., Leung, L. R., Ramos, A. M., Shields, C. A., Rutz, J. J., ... & Ralph, F. M. (2020). Responses and impacts of atmospheric rivers to climate change. *Nature Reviews Earth & Environment*, 1(3), 143-157.
- Wang, S., Ma, X., Zhou, S., Wu, L., Wang, H., Tang, Z., ... & Gan, B. (2023). Extreme atmospheric rivers in a warming climate. *Nature Communications*, 14(1), 3219.

Week 8 – Mar 13

- Shields, C. A., Kiehl, J. T., Rush, W., Rothstein, M., & Snyder, M. A. (2021). Atmospheric rivers in high-resolution simulations of the Paleocene Eocene Thermal Maximum (PETM). *Palaeogeography, Palaeoclimatology, Palaeoecology*, 567, 110293.

Week 9 – Mar 20

- **Figures Draft 1**
- Steinthorsdottir, M., Coxall, H. K., De Boer, A. M., Huber, M., Barbolini, N., Bradshaw, C. D., ... & Strömberg, C. A. E. (2021). The Miocene: The future of the past. *Paleoceanography and Paleoclimatology*, 36(4), e2020PA004037.
 - Section 1 - Introduction
 - Section 3 - Tectonics, Paleogeography, Erosion, and Ocean Gateways
 - Section 10 - Climate Modeling of the Miocene
 - Section 11 – Conclusions

Week 10 – Mar 20

- Burls, N. J., Bradshaw, C. D., De Boer, A. M., Herold, N., Huber, M., Pound, M., Donnadieu, Y., Farnsworth, A., Frigola, A., Gasson, E., von der Heydt, A. S., Hutchinson, D. K., Knorr, G., Lawrence, K. T., Lear, C. H., Li, X., Lohmann, G., Lunt, D. J., Marzocchi, A., Prange, M., Catherine A. Riihimaki, C. A., Siler, N. & Zhang, Z., 2021: Simulating Miocene warmth: insights from an opportunistic Multi-Model ensemble (MioMIP1). *Paleoceanography and Paleoclimatology*, e2020PA004054.
- Acosta, R. P., Burls, N. J., Pound, M. J., Bradshaw, C. D., De Boer, A. M., Herold, N., Huber, M., Liu, X., Donnadieu, Y., Farnsworth, A., Frigola, A., Lunt, D. J., von der Heydt, A. S., Hutchinson, D. K., Knorr, G., Lohmann, G., Marzocchi, A., Prange, M., Sarr, A. C., ... Zhang, Z. 2024: A Model-Data Comparison of the Hydrological Response to Miocene Warmth: Leveraging the MioMIP1 Opportunistic Multi-Model Ensemble. *Paleoceanography and Paleoclimatology*, 39(1), e2023PA004726. <https://doi.org/10.1029/2023PA004726>

Week 11 – Mar 27

- **Writing Draft 1**

Week 12 – Apr 3

- **Figure Draft 2**

Week 13-14 – Apr 6-17

- **Writing Draft 2**

Week 15 – Apr 20 –24

- **Final Report (≥2500, ideally ~3500 words)**
- **Final Presentation with the lab**
- Undergraduate Research Symposium (Optional)

Week 16 May 1st

Final department presentation (April 29th)

Final day to submit to the university