ATM OCN 323: The Science of Climate Change

Fall 2015

Instructor	Galen A. McKinley, 1511 AOS&S, gamckinley@wisc.edu; *Office hrs: M2:30-3:30*
Class Time	TTh 11-12:15
Location	811 AO&SS
Credits	3
Course website	Learn@UW, https://learnuw.wisc.edu/
Prerequisites	PHYS 103, 201 or 207; and MATH 221

Course Description:

This is a calculus-based treatment of climate system physics and the mechanisms of modern-day anthropogenic climate change. By the end of this course, students will understand:

a. How solar radiation and rotating fluid dynamics determine the basic climate state;
b. Mechanisms of natural variability and change in climate;
c. Why anthropogenic climate change is occurring; and
d. Which scientific uncertainties are most important to estimates of 21st century change.

This course is designed for undergraduate and graduate students seeking a quantitative introduction to climate and climate change science. Credit cannot be received if ATM OCN 425 has already been completed.

Text:

Required:

Cook, K.H. 2013. Climate Dynamics, Princeton, 200pp.

Recommended:

Williams, R.G. and M.J. Follows. 2011. Ocean Dynamics and the Carbon Cycle, Cambridge, 404pp.
(Electronically at UW-Madison: https://search.library.wisc.edu/catalog/9910137653802121)

Archer, D. 2012. Global Warming: Understanding the Forecast, 2nd Edition, Wiley, 201pp.

Supplementary readings will also be assigned and posted on Learn@UW.

Week-by-week overview (details on last page):

Part I. The Climate System

Week 1: Observed climate and its variability
Week 2: Radiative energy and the Layer Model
Week 3: Global energy balance
Week 4: Circulation: Key forces
Week 5: Circulation: Atmosphere
Week 6: Exam 1
Week 7: Circulation: Ocean
Week 8: Climate variability – El Niño and other coupled modes
Week 9: Carbon: Natural and anthropogenic
Week 10: Sensitivity, Feedback and Models

Part II: Climate Change

Week 11: Exam 2
Week 12: Anthropogenic climate change and its impacts
Week 13: Uncertainty: Separating variability from change and process uncertainty
Week 14: Climate in the news: the Polar Vortex, the Hiatus, El Niño 2015
Week 15: Term Project Presentations and Review

Grading:	Final Scale:
Mid-terms (2x15%), final (20%) (total 50%)	100-93%=A
Weekly problem sets (30%)	92-88%=AB
Term project on data or model analysis (15%)	83-97% = B
Attendance and Participation (5%)	78-82% = BC
	70-77% = C
	60-69% = D

Undergraduate and graduate students will be graded based on the same assignments and criteria, meaning that graduate students will not be able to count this course toward their 50% "Graduate only" credits.

Exams:

Exams will cover lecture material and all lecture readings. These will include 10-15 multiple choice and 6 written-response questions. There will be two non-cumulative exams, in-class on 10/6 and 11/10. There will be a cumulative final exam in the exam period.

Term Project:

A term project will be completed. Students will develop a hypothesis with respect to the changing physical climate and evaluate this hypothesis using data and/or computer models. In Week 10, a term project proposal will be due. Students will briefly present their findings in Week 15. On the last day of class, project reports will be due. Detailed guidelines for all components of this project, including instructions for writing of the proposal and final report, will be handed out by week 5 of the semester.

Abbreviations

Cook = required text
IPCC = Intergovernmental Panel on Climate Change, http://www.ipcc.ch
IPCC AR5 = Fourth Assessment Report of the Intergovernmental Panel on Climate Change, 2013.
- TS = Technical Summary
- SPM = Summary for Policy Makers
- WG1 = Working Group 1: Physical Science
- WG 2 = Working Group 2: Vulnerability of Socio-Economic and Natural Systems
- WG 3 = Working Group 3: Mitigation Options

Attendance:

Class attendance is critical, and attendance is your responsibility. In accordance with UW-Madison policy, I will avoid scheduling mandatory course requirements on dates of key religious holidays. In addition, I will attempt to accommodate university-endorsed extracurricular activities (not including practices) if they conflict with class attendance. You must provide adequate and reasonable advance notice (>72 hrs notice). If illness will prevent your attendance, you must let me know in advance of the class meeting. Both excused and unexcused absences may negatively impact your final grade.

Academic integrity:

Academic integrity is expected from all students. Please make you are familiar with the expectations as outlined at http://students.wisc.edu/doso/acadintegrity.html and http://students.wisc.edu/doso/students.html. Failure of the course, at a minimum, will result if these standards are not respected.

Week	Date		Topic	Reading, ***Assignment Due***
1	3-Sep	1	Observed Climate and Variability	Cook Ch 1-3
2	8-Sep	2	Radiative Energy and the Layer Model	Cook Ch 4 ***Problem Set 1***
	10-Sep	3	Layer Model Practice Session	
3	15-Sep	4	Radiative Energy and the Layer Model	
	17-Sep	5	Global Energy Balance	Cook Ch 5 ***Problem Set 2***
4	22-Sep	6	Global Energy Balance	
	24-Sep	7	Key Forces	Cook Ch 6 ***Problem Set 3***
5	29-Sep	8	Key Forces	
	1-Oct	9	Circulation: Atmosphere	Cook Ch 7 ***Problem Set 4***
6	6-Oct	10	**Exam 1** (Lectures 1-9, Problem Sets 1-4)	
	8-Oct	11	Circulation: Atmosphere	Cook Ch 9
7	13-Oct	12	Circulation: Ocean	Cook Ch 8 Williams and Follows Ch 8 (e-book)
	15-Oct	13	Circulation: Ocean	***Problem Set 5***
8	20-Oct	14	Mechanisms of Variability: ENSO and other coupled modes	Cook Ch 3, plus reading TBD
	22-Oct	15	Mechanisms of Variability: ENSO and other coupled modes	***Problem Set 6***
9	27-Oct	16	Radiative Forcing of Climate Change	Cook Ch 10
	29-Oct	17	Carbon cycle	Reading TBD ***Problem Set 7***
10	3-Nov	18	Sensitivity and Feedback	Cook Ch 11
	5-Nov	19	Climate models	Cook Ch 12 ***Problem Set 8***
11	10-Nov	20	**Exam 2** (Lectures 10-19, Problem Sets 5-8)	
	12-Nov	21	Anthropogenic climate change	IPCC AR5 SPM
12	17-Nov	22	Impacts: Sea Level	Nicolls (2011)
	19-Nov	23	Impacts: Weather Extremes	Nat'l Climate Assessment, Chap 2 ***Problem Set 9***
13	24-Nov	24	Lecture cancelled	
	26-Nov	25	HAPPY THANKSGIVING	
14	1-Dec	26	Distinguishing variability from change	Cunningham et al. (2007); Deser et al (2012)
	3-Dec	27	Process uncertainy: Clouds, Aerosols, Precipiation, Glaciers	Schiermeier (2010); Koonin (2014) ***Problem Set 10***
15	8-Dec	28	Climate in the News: Vortex, Hiatus, El Nino 2015	Huber and Knutti (2014); Francis and Vavrus (2012); 4.1 in Walsh et al. (2014)
	10-Dec	29	Term Project Presentations	
16	15-Dec	30	Review and Final Discussion	***Term Project Reports***
	17-Dec		**Final Exam (Cumulative). Thurs 12/17, 10AM - 12PM Location: AOSS 811**	