SYLLABUS
Paleoclimatology and Paleoceanography
Spring 2009

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Audience: This course is intended for advanced undergraduate and graduate students who are interested in learning about the history of the earth's climate, and how paleoclimate studies can help us learn more about the workings of the climate system and associated biogeochemical cycles. There are no specific prerequisites, but some coursework in earth sciences, oceanography, and/or geochemistry is helpful.

Format: Tuesday's class period is devoted to an overview/background lecture on each weekly topic, and during Thursday's class students will work with instructors on in-class problems related to Tuesday's lecture material.

Problem sets:
Three problem sets will be assigned during the semester. Problem set must be submitted in *Geophysical Research Letters* journal article format (instructions provided).

Grading:

25% Recitation section participation & assignments
25% Problem sets
20% Midterm Exam
30% Final Exam

Text: Ruddiman, W. F., 2008. Earth's Climate: past and future. W.H. Freeman & Son, 2nd edition.

Schedule:

Week 1 (JLS):
Jan 6 Introduction and overview
Jan 8 Global Energy Balance and Faint Young Sun
Reading : Ruddiman 1st Ed: Ch 2 (pp. 19-31) and 3 for reference
Ruddiman 2nd Ed: Ch 2

Week 2 (KMC):
Jan 13 CO2-Weathering Climate regulation
Jan 15 Recitation: Energy Balance and Long term CO2
Reading: Ruddiman 1st Ed: Ch 4 and 5 for reference
Ruddiman 2nd Ed: Ch 3 and 4 for reference

Hoffman, Paul F. and Schrag, Daniel P., Snowball Earth, *Scientific American*, January 2000, pp 68-75.
Discussion: Donnadieu et al., A 'snowball Earth' climate triggered by continental break-up through changes in runoff, *Nature*, 428, pp. 303-306, 2004

Week 3 (KMC):
Jan 20 Greehouse Earth: Cretaceous Climate/ Late Paleocene Thermal Maximum
Ruddiman 2nd Ed: Ch 5 for reference
Jan 22 Recitation: Problem Set 1 Work Session
Discussion: Pagani et al., Arctic hydrology during global warming at the Paleocene/Eocene thermal maximum, Nature, 442, 2006.

Week 4 (JLS):
Jan 27 Cenozoic Cooling and Glaciation
Jan 29 Milankovitch and Monsoons
Week 4 Reading: Ruddiman 1st Ed: Ch 7, 8
Ruddiman 2nd Ed: Ch 6, 7

Week 5 (JLS): **Problem Set #1 due**
Feb 3 Milankovitch and Glaciation
Feb 5 Recitation: Milankovitch
Week 5 Reading: Ruddiman 1st Ed Ch 9, 10
Ruddiman 2nd Ed: Ch 8, 9
Raymo, M. E. and P. Huybers, 2008, Unlocking the mysteries of the Ice Ages, *Nature*, v. 451, p. 284-285.

Week 6 (JLS):
Feb 10 Ice Core Records of Atmospheric Composition
Feb 12 **Midterm exam**

Week 7 (JLS):
Feb 17 Last Glacial Maximum: Ice Sheets, Sea Level, Dust, Dating
Feb 19 Recitation: Oxygen Isotopes in paleoclimate studies
Week 7 Reading: Ruddiman 1st Ed: Ch 13
Ruddiman 2nd Ed: Ch 12

Week 8 (JLS):
Feb 24 Last Glacial Maximum: Ocean Circulation
Feb 26 Recitation: Carbon Isotopes (13C, 14C) in paleoclimate studies
Week 8 Reading:

Lynch-Stieglitz, J., J.F. Adkins, W.B. Curry, T. Dokken, I.R. Hall, J.C. Herguera, J.J.-M. Hirschi, E. Ivanova, C. Kissell, O. Marchal, T.M. Marchitto, I.N. McCave, J.F. McManus, S. Mulitza, U.S. Ninnemann, E.-F. Yu, R. Zahn, Atlantic overturning circulation during the last glacial maximum, *Science,* 316, 66-69, 2007.

Week 9 (KC):
Mar 3 Last Glacial Maximum: Temperature reconstructions
Mar 5 Recitation: Problem Set 2 Work Session
Week 9 Reading: Ruddiman 1st edition Chapter 13
Ruddiman 2nd Ed: Chapter 12
Discussion: Dahl KA, Oppo DW, Sea surface temperature pattern reconstructions in the Arabian Sea, Paleoceanography 21 (1): Art. No. PA1014 MAR 28 2006.

Week 10 (KC):
Mar 10 Last Glacial Maximum: CO_2
Mar 12 Recitation: Marine biogeochemical cycles
Week 10 Reading: Ruddiman 1st Ed: Chapter 11
Ruddiman 2nd Ed: Chapter 10

Week 11 (JLS): **Problem Set #2 due**
Mar 24 Rapid Climate Change – Records from Ice Cores and Land
Mar 26 Recitation: Oxygen isotopes and paleo-hydrology
Week 11 Reading: Ruddiman 1st Ed: Chapter 15
Ruddiman 2nd Ed: Ch 14
Clement, A. C., and L. C. Peterson (2008), Mechanisms of abrupt climate change of the last glacial period, Rev. Geophys., 46, RG4002, doi:10.1029/2006RG000204.

Week 12 (JLS):
Mar 31 Rapid Climate Change – Oceanic Records and Mechanisms
Apr 2 Recitation: Dating paleoclimatic archives
Week 12 Reading: Rahmstorf, S. Ocean circulation and climate during the past 120,000 years, *Nature, 419*, 209-214, 2002.

Week 13 (KC):
Apr 7 Holocene Climate
Apr 9 Recitation: Problem Set 3 Work Session
Week 13 Reading: Ruddiman 2nd edition: pp 240-46

Week 14 (KC):
Apr 14 Climate change during the last millennium
Apr 16 Recitation: Multi-proxy reconstruction
Week 14 Reading: Ruddiman 1st Ed: Chapter 15
Ruddiman 2nd Ed: Chapter 16
Discussion: Cook ER, Woodhouse CA, Eakin CM, et al., Long-term aridity changes in the western United States, *Science* **306** (5698): 1015-1018, 2004

Week 15 (KC): **Problem Set #3 due**

Apr 21 A paleoclimate perspective on global warming
Reading: Intergovernmental Panel on Climate Change AR4, 2007, Executive Summary.

Apr 23 Final Exam Review- Bring questions

May 1, 11:30-2:30pm: **FINAL EXAM**