**ILLINOIS STATE UNIVERSITY**

**DEPARTMENT OF GEOGRAPHY-GEOLOGY**

**GEO 341 – Climate and Global Environmental Change**

**SPRING 2006**

**Catalog Description:**

CLIMATE AND GLOBAL ENVIRONMENTAL CHANGE 3 S

*GEO 204; GEO 200 or GEO 211; GEO 201 req. or cons inst req.*

An overview of concepts, methods, theory and debates surrounding climate and global environmental change.

**Course Overview:**

This is a course on the concepts, methods, science and controversy behind climate and global environmental change. Students will gain an appreciation for the complexity of the discussions that surround climate and environmental change, and why these may be some of the most pressing issues facing our society in the coming decades.

Instructor: Dr. Dagmar Budikova

Class Time: MWF 12:00-12:50 am in FHS 216

Office Hours: MW 2:00-3:00 pm or by appointment

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**Student Objectives/Outcomes:**

Through successful completion of GEO 341, students have the opportunity to:

1. Acquire basic theoretical concepts, definitions and methodologies necessary to comprehend some of the most critical discussions that surround the science of climate and global environmental change.
2. Understand why climate and environmental change is one of the most pressing and complex issues facing society in the 21st century.
3. Appreciate the complexities of some of the key debates that surround the issues of climate and global environmental change
4. Be able to answer questions such as “Is our climate changing?”; “How climate change measured?”; “Why does environmental change matter?”, “What impact will climate and environmental change have on me as an individual, on society, and the life on Earth?”, “Is human activity a cause of such changes?”
5. Learn to critique some of the latest scientific literature on various topics that surround the debate of climate and environmental change

**Class Structure:**

Students will meet with the instructor for 3 hours each week. Two of those hours will be dedicated to presenting new material through lectures, and 1 hour will be dedicated to discussion of scientific literature on related topics.

**Required Student Tasks/Assignments:**

This is a reading-intensive course. During the semester students will be required to write one research essay (15-20 pages) on a suggested topic relevant to global climate change. Students will be given one midterm examination that will cover the material introduced during lecture and discussion sessions. The final examination will be similar to the midterm test and will be comprehensive. Students will be required to read scientific articles assigned to them each week and prepare critical reviews and summaries of these works. These readings will then be central to the discussion sessions, held once each week (see schedule below for details).

**Readings:**

**Required text:**

Robinson P. J., and A. Henderson-Sellers. 1999. Contemporary Climatology. Second Edition. Prentice Hall. Essex. England. 317 pp.

**Literature for class discussion (see syllabus for details):**

Alley, R. B., J. Marotzke, W. D. Nordhaus, J. T. Overpeck, D. M. Peteet, R. A. Pielke Fr., R. T. Pierrehumbert, p. B. Rhines, T. F. Stocker, L. D. Talley, J. M. Wallace. (2003). Abrupt climate change. Science. 299: 2005-2010.

Bryson, R. A. (1997). The Paradigm of Climatology: An Essay. Bulletin of the American Meteorological Society. 78: 449-455.

Free, M., A. Robock. (1999). Global warming in the context of the Little Ice Age. Journal of Geophysical Research. 104: D16: 19057-19070.

Hansen, B., S. Osterhus, D. Quadfasel, W. Turrell. (2004). Already the day after tomorrow? Science. 305: 953-954.

Kerr, R. A. (2005). Confronting the bogeyman of climate system. Science: 310: 432-433.

King, D. A. (2004). Climate change science: Adapt, mitigate, or ignore? Science. 303: 176-177.

Kunkel, K. E., R. A. Peilke Jr., S. A. Changnon. (1999). Temporal fluctuations in weather and climate extremes that cause economic and human health impacts: A review. Bulletin of the American Meteorological Society. 80: 1077-1098.

Landsea, C. W., J. A. Knaff. (2000). How much skill was there in forecasting the very strong 1997-98 El Nino? Bulletin of the American Meteorological Society. 81: 2107-2120.

Leathers, D.J., Yarnal, B. and Palecki, M.A. 1991 The Pacific/North American teleconnection pattern and United States climate. I. Regional temperatures and precipitation associations. Journal of Climate 4, 517-522.

O’Brien, K. L., and Leichenko, R. M. (2003). Winners and Losers in the context of global change. Annals of the Association of American Geographers. 93: 89-103.

Ramanathan, V, P. J. Crutzen, J. T. Kiehl, D. Rosenfeld. (2001). Aerosols, climate, and the hydrological cycle. Science: 294: 2119-2123.

Rosenzweig, Cynthia, Ana Iglesias, X.B. Yang, Paul R. Epstein, and Eric Chivian. 2001. Climate change and extreme weather events; Implications for food production, plant diseases, and pests. Global Change & Human Health, Vol. 2, No. 2, pp. 90-104.

Wunsch, C. (2002). What is the thermohaline circulation? Science. 298: 1179-1181.

**Grading Scheme:**

Mid-term exam 15%

Final Exam - Comprehensive 15%

10 literature summaries 20%

Class research paper 30%

* Written report (70%)
* Class presentation (30%)

Discussion participation 20%

**Final grade assignments:**

Less than 60 = F;

60 and above = D;

70 and above = C;

80 and above = B;

90 and above = A

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| **COURSE SYLLABUS\*** | | | | |
| **Week** | **Week of** | **Task** | **Text Reading** | **Discussion Readings**  **for Fridays** |
| **1** | Jan 16th | Introduction to climate science: scope and controls | Ch. 1 | Bryson (1997) |
| **2** | Jan 23rd | Earth’s energy budget – terrestrial radiation; global radiation budgets; **Library visit & rankings of topics for research paper** | Ch. 2 & 3 |  |
| **3** | Jan 30th | Precipitation measures, global precipitation distribution, surface water budget | Ch. 5 | Ramanathan et al. (2001) |
| **4** | Feb 6th | General circulation, permanent and semi-permanent features, large-scale effects of surface boundary | Ch. 6 & 7 | Wunsch (2002)  Kerr (2005)  Hansen et al. (2004) |
| **5** | Feb 13th | Tropical climates – ENSO, the ITCZ, the monsoons, hurricanes | Ch. 8 | Landsea and Knaff (2000) |
| **6** | Feb 20th | Extratropical climates – Rossby waves, polar fronts and jets, cyclones and anticyclones, airmasses | Ch. 9 | Leathers et al. (1991) |
| **7** | Feb 27th | Extratropical climates continued | Ch. 9 |  |
| **8** | Mar 6th | **Mid-term Exam – no lecture this week**  Human interaction with climate continued – human response to climate, physiological responses, bio-meteorological indices, climate and health, urban climates | Ch. 11 | Kunkel et al. (1999) |
| **9** | Mar 13th | **SPRING BREAK** | | |
| **10** | Mar 20th | Human interaction with climate continued – impact of humans on climates – deforestation, air pollution and acid rain, ozone depletion, desertification | Ch. 11 | Rosenzweig et al. (2001) |
| **11** | Mar 27th | Climate history and drivers | Ch. 12 | Little Ice Age Movie  Free and Robock (1999) |
| **12** | Apr 3rd | Climate history and drivers continued  **Term paper due** | Ch. 12 | Alley et al. (2002) |
| **13** | Apr 10th | Climate modeling | Ch. 13 |  |
| **14** | Apr 17th | Future climates | Ch. 14 | O’Brien and Leichenko (2003) |
| **15** | Apr 24th | Future climates; **Paper presentations (Wednesday and Friday)** | Ch. 14 |  |
| **16** | May 1st | **Paper presentations (all week)** |  |  |

\*Any component of this schedule is subject to change with notice.

**Topics for class research paper:**

***General Instructions:***

Paper objective: The objective of your term paper will be to provide a literature review/ synthesis of one of the general topics below. The general topics suggested below should be only used as a guide in helping you focus the final research questions you wish to concentrate on.

Paper format: formal research paper (see any scientific paper for general format)

Paper length: 15 pages double spaced for undergraduates; 20 pages double-spaced for graduate students

Number of references: 15 scientific articles or published books for undergraduate students; 20 scientific articles for graduate students (maximum of 5 from the internet unless otherwise suggested)

Presentation format: web site or power point or poster

Presentation delivery: In class during last two weeks of class; for bonus points during undergraduate research symposium

1. *Climate history of central US.* The climate of the Midwest has not remained constant over time. What do instrumental and paleoclimatic records suggest about the historical changes in spring and summer hydroclimatic (e.g. precipitation, drought and flood frequency) records across the region since the turn of this century and in the distant past? What were some of the contributing factors attributed to these fluctuations?
2. *Interannual climate variability in US.* The weather varies from one year to the next about a long-term expected mean value. It is now known that the key factor that influences year-to-year variation in the climate of the United States is the El Nino Southern Oscillation (ENSO), a concept that includes El Nino and La Nina events that originate in the equatorial Pacific Ocean. What geographic areas and times of the year are most significantly impacted by ENSO in terms of temperature and precipitation? What areas and seasons show the least amount of climatological impact?
3. *Decadal climate variability in US.* The Pacific Decadal Oscillation (PDO) has been referred to as a long-lasting ENSO event of the northern Pacific basin. What are the common signatures of the PDO in the Pacific basin, in terms of sea surface temperatures, and sea level pressures? How do these conditions impact the atmospheric circulation and climatic variables such as surface air temperature and precipitation over in the United States? Specifically, what geographic areas are most significantly impacted by the PDO in terms of temperature and precipitation? What areas show the least amount of climatological impact?
4. *Future climate of central US.* What type of a picture do the most current climate models paint for Midwestern climate during the next century and beyond? On what issues are these models in general agreement on, and on what issues do they diverge? In other words, what is the uncertainty that surrounds these predictions? What are some of the most significant social and economic issues that precipitate from the predicted changes?
5. *Illinois drought 2005.* The Drought Monitor along with the Palmer Drought Severity Index (PDSI) track the hydroclimatological conditions of an area of interest. What does each index measure and how? How is the information contained in these indices different from that of measuring precipitation alone to monitor floods or droughts? Illinois has been in a drought for since March 2005. What climatological conditions have contributed to the drought? How has the spatial extent and severity of the drought varied over the past year? What are reported causes of this drought? How does the intensity of this drought compare to other droughts recorded in Illinois in the past? What are the documented social and economic impacts of this drought to date? When do scientists believe this drought will end? You may need to consult newspapers and the internet for answer some of these questions. Be careful to choose reliable sources.
6. *Hurricanes and climate change.* The past summer witnessed an unprecedented hurricane activity in the Atlantic Ocean. Is this observation part of a long-term climatic trend? How are various scientists explaining this anomaly? How well has it been tied to the global warming debate?
7. *Human-climate interactions.* Humans have a demonstrated impact on the climate system. Using one specific case study, document and explain how land-use change has impacted the climate in a region of the United States.
8. *Methods in paleoclimatology.* Paleoclimatology studies past climates using various proxy data sources. Choose two of such sources and describe how they contributed to our understanding of climate histories in the central or eastern United States.
9. *The climate change debate.* The Kyoto protocol is a document surrounded by countless controversy. Why is that? Explain the origin of and motivation behind the document. List and explain some of the reasons why the United States did not sign it and why other countries did. How do you feel about this decision? Provide valid arguments supported by statistics and existing literature to support your reasoning.
10. *Climate forecasting.* Being able to provide climate forecasts on time scales in excess of one month and up to one year in advance has been at the heart of the climate mission of the United States for several years now. What organization issues these forecasts in the United States, and who stands to benefit most from them? What are the problems surrounding the tie between the science and society in this issue? Are climatologists producing products that few are able to use?

**Relevant literature for research papers:**

Changnon, S. A. et al. 2005. Climate Atlas of Illinois. Illinois State Water Survey. Champaign, Illinois. 309 pp.

Croley II, Thomas E., Frank H. Quinn, Kenneth E. Kunkel, and Stanley A. Changnon. 1998. Great Lakes Hydrology Under Transposed Climates. Climatic Change, Vol. 38, No. 4, April, pp. 405-433.

Crowley, T.J. (2000). Causes of climate change over the past 1,000 years. Science. 289: 270-277.

Dennis P. Lettenmaier, Andrew W. Wood, Richard N. Palmer, Eric F. Wood, and Eugene Z. Stakhiv. 1999. "Water Resources Implications of Global Warming: A U.S. Regional Perspective," Climatic Change, Vol. 43, No. 3, November, pp. 537-579.

Drake, F. 2000. Global Warming. The Science of Climate Change. London: England. Arnold. 273 pp.

Elliott, W. P. and Angel, J.K. (1997). Variations of cloudiness, precipitable water, and relative humidity over the United States: 1973-1993. Geophysical Research Letters. 24: 41-44.

Fleming, J.R. (1998). Historical perspectives on climate change. Oxford: Oxford University Press.

Harvey, L.D.D. (1999). Global Warming: The Hard Science. Pearson Education. Harlow.

Houghton, J.T., Ding, Y., Griggs, D.J., Noguer, M., van der Linden, P.J., Dai, X., Maskell, K., and Johnson, C. A. (eds). (2001). Climate Change 2001: The Scientific Basis. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel of Climate Change. Cambridge University Press. Cambridge: United Kingdom. 881 pp.

Jones, P.D., New, M., Parker, D. E., Martin, S., and Rigor, J.G. (1999). Surface air temperature and its change over the past 150 years. Reviews of Geophysics. **37:** 173-199.

Kalkstein, L.S., Yarnal, B.M., and Scheraga, J.D. (eds). (1998). Regional assessments of climate change and policy implications. Climate Research. 11 (1).

Karl, T.R., and Trenberth, K.E. (1999). The human impact on climate. Scientific American. 281: 100-105.

Karl, T.R., Nicholls, N., and Gregory, J. (1997). The coming climate. Scientific American. **279:** 78-83.

Karoly, D. J. (2003). Ozone and climate change. Science. 302: 236-237.

Karoly, D. J., K. Braganza, P. A. Stott, J. M. Arblaster, G. A. Meehl, A. J. Broccoli, K. W. Dixon. (2003). Detection of a human influence on North American Climate. Science. 302: 1200-1203.

Kerr, R. A. (2004). A few good climate shifters. Science. 305: 599-600.

Kiehl, J.T., and Trenberth, K.E. (1997). Earth’s annual global mean energy budget. Bulletin of the American Meteorological Society. **78:** 197-208.

Loáiciga, H.A. 2003. "Climate Change and Ground Water," Annals of the Association of American Geographers, Vol. 93, No. 1, March, pp. 30-41.

Mann, M.E., Bradley, R.S., and Hughes, M.K. (1998). Global-scale temperature patterns and climate forcing over the past six centuries. Nature. **392:** 779-787.

Milly, P. C. D., R. T. Wetherald, K. A. Dunne, and T. L. Delworth. 2002. "Increasing risk of great floods in a changing climate," Nature, Vol. 415, 31 January, pp. 514 - 517.

National Assessment Synthesis Team. (2000). Climate Change Impacts on the United States: The Potential Consequences of Climatic Variability and Change. US Global Change Research Program. 400 Virginia Avenue, SW. Suite 750. Washington DC. 20024.

Oreskes, N. (2004). The scientific consensus on climate change. Science. 306: 1686-1687.

Ott, H.E. (1998). The Kyoto Protocol: Unfinished business. Environment. **40:** 18-20; 41-45.

Patz, Jonathan A. and R. Sari Kovats. 2002. "Hotspots in climate change and human health," British Medical Journal, Vol. 325, 9 November, pp. 1094-1098.

Pearce, F. (1997). Greenhouse wars. New Scientist. July: 38-43.

Pearson, P.N., and Palmer, M.R. (2000). Atmospheric carbon dioxide concentrations over the past 60 million years. Nature. **406:** 695-699.

Pielke, R. A. Sr. (2005). Land use and climate change. Science: 310: 1625-1626.

Priem, H.N.A. (1997). CO2 and climate: A geologist’s view. Space Science Review. 81: 173-198.

Schneider, D. (1997). The rising seas. Scientific American. **279:** 112-117.

Schnur, Reiner. 2002. "Climate science: The investment forecast," Nature, 31 January, Vol. 415, pp. 483 - 484.

Skelnikoff, E. (1999). The role of science in policy: The climate change debate in the United States. Environment. 41: 16-25.

Vörösmarty, Charles J., Pamela Green, Joseph Salisbury, and Richard B. Lammers. 2000. "Global Water Resources: Vulnerability from Climate Change and Population Growth," Science, Vol. 289, 14 July, pp. 284-288.

Whyte, I. D. 1995. Climatic Change and Human Society. London: England. Arnold. 217 pp.