

# GEO 377P/387H

# PHYSICAL CLIMATOLOGY

(MWF 11:00-12:00)

Fall 2012

**Goals:** To provide, from a global perspective, an introduction to the physical interactions in the climate system that includes the atmosphere, the ocean, and the land surface. To discuss how the system responds to various forcing factors.

**Topics:** Basics of weather and climate and their mathematical equations. Radiation, Convection, Clouds, Precipitation, and General Circulation. Physical processes having an impact on precipitation and evapotranspiration at the earth's surface. Key global change issues explored using simple, web-based climate models.

**Instructor:** Dr. Zong-Liang Yang, Tel: 512-471-3824, Email: [liang@jsg.utexas.edu](mailto:liang@jsg.utexas.edu)

**Lectures:**

MWF, 11:00 - 12:00

JGB Room 3.222

**Office Hours:**

Friday, 3-5pm or by appointment, JGB Room 5.220DA

**Required Textbook:**

[Global Physical Climatology](#) (Dennis L. Hartmann, Academic Press, pp. 411)

**Prerequisite:**

Basic calculus and physics (M308M and PHY 303K or equivalent courses) and an interest in interdisciplinary processes.

**Grading Policy:**

Generally, homework will be due one week from the date when it is given; if it is given on Friday, it will be due next Friday in the beginning of the class. Late homework will not be accepted without a pretty good reason. You are encouraged to work together on your homework if you wish, but make sure you understand what you write down.

Pop-quizzes will be given at random times without prior notice, about every 2 weeks. In these you will be given a question related to the subject matter and/or assigned reading materials to write about or a problem to solve, and about 5 minutes to do it. Please bring loose-leaf paper, a pencil, and a scientific calculator to every class.

There will be no mid-term test and final examination. Participation in class discussions, and raising good questions during lecture are strongly encouraged. Grades will be determined from the following formula:

Homework/Participation	30%
Bi-weekly 10-minute quiz	30%
Literature Review	20%
Presentation	20%

For undergraduate students, the emphasis is on the basic understanding of the materials and hands-on experience of the web-based climate models.

Graduate students, however, need to read and comment on cutting-edge research articles in the literature. In addition, graduate students are expected to demonstrate more skills in quantitative analysis and numerical modeling.

**Final Letter Grades:** The percent-letter grade relationship will usually be: **>90 A, 80-89 B, 70-79 C, 60-69 D, and < 60 Ouch.** Your attendance and extra credits will affect your final grades.

#### Major References:

*A Climate Modelling Primer*, Third Edition, K. McGuffie and A. Henderson-Sellers, John Wiley & Sons, Ltd., 2005.

*Atmospheric Science: An Introductory Survey*, Second Edition, J. M. Wallace and P. V. Hobbs, Academic Press, 2006.

*Climatology*, R. V. Rohli and A. J. Vega, Jones and Bartlett Publishers, 2008.

*Meteorology Today: An Introduction to Weather, Climate, and The Environment*, Ninth Edition, C. D. Ahrens, Brooks/Cole, 2009.

*El Niño, La Niña, and the Southern Oscillation*, S. G. Philander, Academic Press, 1990.

*Climate System Modeling*, K. E. Trenberth, QC 981 C65 1992.

*Physics of Climate*, J. Peixoto, QC 981 P.434 1992.

*Climate Change 2007: The Physical Science Basis*, Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, S. Solomon, D. Qin, M. Manning, M. Marquis, K. Averyt, M. M. B. Tignor, H. L. Miller, Jr., and Z. Chen, Cambridge University Press, 2007. <https://www.ipcc-wg1.unibe.ch/publications/wg1-ar4/wg1-ar4.html>

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

*General Circulation Model Development: Past, Present and Future*, Edited by D. A. Randall, Academic Press, 2000.

*Climate Change: Developing Southern Hemisphere Perspectives*, Edited by T. W. Giambelluca and A. Henderson-Sellers, John Wiley & Sons, 1996. QC 981.8 C5 C5147 1996.

*An Introduction to Dynamic Meteorology*, Third Edition, J. R. Holton, Academic Press, 1992.

*Storm and Storm Dynamics*, W. R. Cotton and R. A. Anthes, Academic Press, 1989.

*Cloud Dynamics*, R. A. Houze, Jr., Academic Press, 1993.

*Mesoscale Meteorological Modeling*, Second Edition, R. A. Pielke, Sr., Academic Press, 2002.

*The Atmospheric Boundary Layer*, J. R. Garratt, QC 880.4 B65 G37 1992.

*Handbook of Hydrology*, D. R. Maidment, GB 662.5 M35 1993.

*Land Surface Evaporation: Measurement and Parameterization*, T. J. Schmugge and J.-C. Andre, QC 915.6 L36 1991.

*Ecological Climatology: Concepts and Applications*, Second Edition, Gordon B. Bonan, Cambridge University Press, pp. 678, 2008.

## GEO 377P/387H (Unique 27705/27825)

## PHYSICAL CLIMATOLOGY

(MWF 11:00 - 12:00 JGB 3.222)

Fall 2012

Tentative Schedules (to be refined during the course of the semester)

Last updated on 09/24/12 05:04 PM

	Monday	Wednesday	Friday	Topics	Assignments
Week 1	8/27	8/29 Syllabus/course layout	8/31 <a href="#">Chapter 1: Introduction to the Climate System</a>	1	<a href="#">Diagnostic Test</a> (take-home test; due on 9/5 before class starts); <a href="#">CO<sub>2</sub> now</a> ; <a href="#">Celsius-Fahrenheit conversion</a> ; Read <a href="#">Geology of mankind</a> ; <a href="#">GCC</a> and <a href="#">ESS</a> ; Read <a href="#">Obama/McCain</a> ; <a href="#">Washington Update</a> ;
Week 2	9/3 Labor Day Holiday	9/5 Discussion of Diagnostic Test	9/7 Quiz #1; <a href="#">Components of the Climate System</a>	2	Read <a href="#">IPCC 2007 Chapter 4</a> , relate the recent Greenland ice melt with the recent changes in the entire cryosphere (e.g., snow cover, sea ice, Antarctic ice sheet, and permafrost). <a href="#">HW#1 (Due right before 9/24)</a>
Week 3	9/10 <a href="#">Chapter 2</a> , Global Energy Balance	9/12	9/14	2,3	Read <a href="#">Theory</a> ; <a href="#">Inversion in satellite sounding</a> ; <a href="#">DMS</a> ; IPCC <a href="#">radiative forcing</a> (1); <a href="#">NRC2005</a> and <a href="#">forcing</a> (2); <a href="#">Bad Greenhouse</a> .
Week 4	9/17	9/19 Two assumptions of the simplest GH model; see <a href="#">A simple greenhouse model, a leaky greenhouse, and a more opaque greenhouse</a> (section 2.3.1-2.3.3)	9/21 Quiz #2; <a href="#">Chapter 3</a> , Radiative Transfer, Clouds and Climate	2,3	Read <a href="#">Simple greenhouse models</a> ; Read IPCC 2007 <a href="#">Chapter 2</a> ; <a href="#">HW #2 (Due 9/28)</a>
Week 5	9/24 <a href="#">Chapter 4</a> Surface Energy Balance	9/26 <a href="#">ABL</a> , <a href="#">Thermodynamics</a> , <a href="#">Reynolds decomposition</a> , <a href="#">Eddy covariance</a> , <a href="#">Bulk aerodynamic</a>	9/28 Atmospheric Stability and Clouds (see <a href="#">notes</a> )	3,4	Earth's Global Energy Budget ( <a href="#">Trenberth et al. 2009</a> ; <a href="#">Kiehl and Trenberth, 1997</a> ); <a href="#">Land Use (1)</a> & <a href="#">Land Use (2)</a> ; <a href="#">RSS</a> ; <a href="#">Land DAAC</a> ; <a href="#">1km AVHRR</a> ; <a href="#">greenness</a> ; <a href="#">ecosystem modeling</a> ; Hoffmann <a href="#">1</a> & <a href="#">2</a> ; <a href="#">Forests and Climate Change</a> ; <a href="#">white roof</a> ; <a href="#">global decreasing ET trend</a> ; <a href="#">land CO2 and climate</a>

		<a href="#">formulas</a>			
Week 6	10/1 Guest Lecture " <b>The Past as Prologue: Learning from the Climate Changes in Past Centuries</b> " by <a href="#">Prof. Michael Mann</a>	10/3 <a href="#">Chapter 5</a> , Hydrologic Cycle (additional <a href="#">lecture notes</a> ); <a href="#">Supplementary Materials for Ch 4 and 5</a>	10/5 Quiz #3; Atmospheric humidity variables ( <a href="#">Overview for Ch4 and Ch 5</a> ; Land surface modeling <a href="#">1, 2</a> ))	4,5	Read <a href="#">precipitation</a> ; <a href="#">land P trend</a> ; <a href="#">IPCC report on P</a> ; <a href="#">pan evaporation ET</a> and <a href="#">remote sensing</a> ; <a href="#">Potential Temperature</a>
Week 7	10/8 <a href="#">Chapter 6 Atmospheric General Circulation and Climate (advanced materials)</a> , ( <a href="#">Introductory materials</a> )	10/10	10/12	6	Read <a href="#">Alley</a> , <a href="#">ChenHu</a> , <a href="#">LiangXie</a> , <a href="#">Pierrehumbert</a> , <a href="#">York</a> , <a href="#">Yang</a> ; Read IPCC 2007 <a href="#">Chapter 7</a> (7.2) and <a href="#">Chapter 8</a> (8.2.3). <a href="#">HW #3 (Due 10/24)</a>
Week 8	10/15	10/17	10/19 Quiz #4 <a href="#">Chapter 7. Ocean General Circulation and Climate (advanced materials)</a> ( <a href="#">Introductory materials</a> );	6,7	read <a href="#">200mbWind</a> ; <a href="#">ArcticT</a> ; <a href="#">VerticalT</a> ; read <a href="#">zonal lapse rate</a> and <a href="#">global sediment load</a> ; Read ocean warming <a href="#">(1)</a> , <a href="#">(2)</a> and <a href="#">(3)</a> ; <a href="#">SST</a> , <a href="#">SSTA</a> ; <a href="#">ocean monitoring</a> ; <a href="#">ocean heat content</a> ; <a href="#">figure</a> ; <a href="#">salinity trend</a> ; <a href="#">Hurricanes</a> ; <a href="#">THC</a> ; <a href="#">El Nino FAQ</a> ; Read IPCC 2007 <a href="#">Chapter 5</a>
Week 9	10/22 <a href="#">Water Forum: Texas Drought and Beyond</a>	10/24	10/26	6,7	<a href="#">Impacts research</a> ; <a href="#">Dangerous anthropogenic interference</a> ; <a href="#">Hockey stick debate</a>
Week 10	10/29 <a href="#">Chapter 8</a> , Paleoclimate	10/31	11/2 Quiz #5	8	<a href="#">Marine biology &amp; glacial cycles &amp; more</a> ; <a href="#">Thresholds</a> ; <a href="#">benchmark glaciers</a> ; <a href="#">SOCC</a> ; <a href="#">NSIDC glaciers</a> ; Read IPCC 2007 <a href="#">Chapter 6</a>
Week 11	11/5 <a href="#">Chapter 9 Climate Sensitivity and Feedback Mechanisms</a>	11/7	11/9	9	Read IPCC 2007 <a href="#">Chapter 11</a> ; <a href="#">Motivational homework</a> Web-Based EBM Modeling Project; read <a href="#">Antarctic sea ice</a>
Week 12	11/12 <a href="#">Chapter 10. Climate Modeling (0-100Y; Regional Climate Modeling Precipitation Trend)</a>	11/14	11/16 Quiz #6	10	read <a href="#">GCM history</a> ; <a href="#">energy budget</a> ; <a href="#">AMIP</a> ; Randall on modeling <a href="#">1</a> , <a href="#">2</a> ; Read IPCC 2007 <a href="#">Chapter 8</a> , <a href="#">Chapter 10</a> and <a href="#">Technical Summary</a>
Week 13	11/19 <a href="#">Chapter 11 &amp; 12</a> , Natural and Anthropogenic Climate Change	11/21	11/23 Thanksgiving	11, 12	Read IPCC 2007 <a href="#">Chapter 11</a> ; <a href="#">GW &amp; sea level rise</a> ; <a href="#">CCC</a> ; <a href="#">GW &amp; glacier melt</a>
Week 14	11/26	11/28	11/30 Presentation Part I	11, 12	read <a href="#">0-2000 AD</a> and <a href="#">news release</a> ; <a href="#">Data Error</a> ; tropospheric and surface temperature trends <a href="#">(1)</a> and <a href="#">(2)</a> ; dust <a href="#">(1)</a> and <a href="#">(2)</a> ; " <a href="#">Hockey stick</a> "; <a href="#">RealClimate</a> ; <a href="#">ClimateArk</a> ; <a href="#">GW and Health</a> ; <a href="#">Warm Feeling</a>
Week 15	12/3 Presentation Part II	12/5 Presentation Part III	12/7 Course Evaluation		

\* The report must be in the following format. Text must be double-spaced. Margins must be one inch on all four sides; type size must be at least **11 point**.

**Term paper due November 19, 2012.**

The report should provide a critical review of at least **five** closely related papers selected from the assignment column above. The review must be in the following format. There is a **15-page minimum** including tables, figures and references. Text must be double-spaced. Margins must be one inch on all four sides; type size must be at least **11 point**. The review should include a title and an abstract.

For an example of the review, the students may refer to [Pierrehumbert](#) or [Yang](#).

Sample Homework Sheets: [1](#), [2](#) ([a](#), [b](#), [c](#), [d](#)), [3](#) ([sun](#)), [4](#), [5](#)

Student / Presentation in Spring 2011	Term paper	References
Beckner-Irwin, Zoey (4/28) (presentation)	El Nino and La Nina (ENSO) and Their Impacts on Global Climate and Population	
Langston, Jasmine (4/28) (presentation)	Investigating the Feedbacks between Climate Change and the Global Carbon Cycle Generated between Various Climate Models	Cox et al. (2000), Fridlingstein et al. (2003), Sanders et al. (2005), Schlesinger et al. (2000), Sokolov et al. (2008)
Millican, Alessandra (5/3) (presentation)	The Impact of Global Warming on Hurricane Activity	<a href="#">Webster</a> , Emanuel <a href="#">1</a> and <a href="#">2</a>
Pescatore, John (5/5) (presentation)	The Use of High-Performance Computing in Climate Modeling	
Picton, Jeff (5/5) (presentation)	The Urban Climate: Energy Balance and Heat Island	
Pharr, Paige (5/3) (presentation)	Climate Change and the Potential Effects on Hydrology	
Vinas, Keri (4/28) (presentation)	Factors Influencing Plant Update of Carbon Dioxide in the Atmosphere	

Student / Presentation in Fall 2008	Term paper	References
Detmer, Ria (2 December) ( <a href="#">presentation</a> )	<a href="#">Anthropogenic Influences and Their Impact on Global Climate</a>	
Eastwood, Erin (2 December) (presentation)	<a href="#">Pangean Paleoclimate</a>	<a href="#">Loope et al. (2004)</a> , <a href="#">Parrish and Peterson (1988)</a> , <a href="#">Peterson (1988)</a> , <a href="#">Rowe et al. (2007)</a> , <a href="#">Soreghan et al. (2002)</a>
		<a href="#">Barnett et al.</a>

Huang, Lei (25 November) ( <a href="#">presentation</a> )	<a href="#">Review on Ocean Heat Content and Ocean Warming</a>	(2001), <a href="#">Boyer et al. (2005)</a> , <a href="#">Levitus et al. (2000)</a> , <a href="#">Levitus et al. (2001)</a> , <a href="#">Willis et al. (2004)</a>
Ingol, Eusebio (2 December) ( <a href="#">presentation</a> )	<a href="#">Climate Change Impacts on the Water Resources</a>	<a href="#">Murphy (1999)</a> , <a href="#">Wilby (1997)</a> , <a href="#">Yates (2003)</a> , <a href="#">IPCC Chapter 10 (2001)</a> , <a href="#">IPCC (2008) Climate Change and Water</a> , <a href="#">IPCC (2001) Working Group II: Impacts, Adaptation and Vulnerability</a>
Issac, Toby (4 December) ( <a href="#">presentation</a> )	<a href="#">Approaches and Challenges in Ice Sheet Modeling</a>	<a href="#">Greve (2000)</a> , <a href="#">Huybrechts and de Wolde (1999)</a> , <a href="#">Huybrechts et al. (2004)</a> , <a href="#">Pattyn et al. (2008)</a> , <a href="#">Ridley et al. (2005)</a>
Mirabito, Chrisopher (4 December) ( <a href="#">presentation</a> )	<a href="#">Oceanic Climate Change: Contributions of Heat Content, Temperature, and Salinity Trends to Global Warming</a>	<a href="#">Barnett et al. (2001)</a> , <a href="#">Boyer et al. (2005)</a> , <a href="#">Levitus et al. (2000)</a> , <a href="#">Levitus et al. (2001)</a> , <a href="#">Willis et al. (2004)</a>
Neupane, Naresh (4 December) ( <a href="#">presentation</a> )	<a href="#">To Study the Various Factors Affecting the Summer Monsoon Rainfall in Nepal</a>	<a href="#">Hansen et al. (2000)</a> , <a href="#">Lau et al. (2006)</a> , <a href="#">Ramanathan et al. (2001)</a> , <a href="#">Ramanathan et al. (2005)</a> , <a href="#">Saji et al. (1999)</a>
Riel, Bryan (4 December) ( <a href="#">presentation</a> )	<a href="#">Effect of Ocean Warming on West Antarctic Ice Streams and Ice Shelves</a>	<a href="#">Oppenheimer (1988)</a> , <a href="#">Payne (2004)</a> , <a href="#">Shepherd (2004)</a> , <a href="#">Wigley and Raper (2005)</a> , <a href="#">IPCC (2007) Chapter 4</a>
Schroeder, Dustin (25 November) ( <a href="#">presentation</a> )	<a href="#">The West Antarctic Ice Sheet and Sea Level Rise</a>	<a href="#">Alley (2005)</a> , <a href="#">Bindschadler (2006)</a> , <a href="#">Holt (2006)</a>

		<a href="#">Shepard (2004)</a> , <a href="#">Vaughn (2007)</a>
Shaw, John (25 November) ( <a href="#">presentation</a> )	<a href="#">Predicting the Affects of Climate Change on Global Rivers: A Review</a>	<a href="#">Zonal lapse rate</a> and <a href="#">Global sediment load</a>
Shi, Mingjie (25 November) ( <a href="#">presentation</a> )	<a href="#">Changes and Feedbacks of Land Use and Land Cover under Global Change</a>	<a href="#">Forests and Climate Change</a> ; <a href="#">Land Use (1)</a> & <a href="#">Land Use (2)</a>
Sun, Ying (2 December) ( <a href="#">presentation</a> )	<a href="#">Retrieval and Application of Land Surface Temperature</a>	<a href="#">Jin (2004)</a> , <a href="#">Pinheiro et al. (2006)</a> , <a href="#">Prigent et al. (2003)</a> , <a href="#">Wan and Dozier (1996)</a> , <a href="#">Wang et al. (2008)</a>

Student / Presentation in <b>Fall 2007</b>	Literature Review	References
Chan, Wa Seong / <a href="#">Climate warming and Himalaya snowmelt</a>	<a href="#">Report</a>	<a href="#">Barnett</a>   <a href="#">Nijssen</a>
Davidson, Sarah Cain / Groundwater recharge	<a href="#">Report</a>	<a href="#">Gurdak</a>   <a href="#">Higgins</a>   <a href="#">Pool</a>   <a href="#">Scott</a>   <a href="#">Seyfried</a>
Kim, Il Nam/ <a href="#">Global warming and ocean chemistry</a>	<a href="#">Report</a>	
Reardon, Betty Jane/ <a href="#">Climate change</a>	<a href="#">Report</a>	<a href="#">Guisan</a>   <a href="#">Parmesan</a>
Rosero Ramirez, Enrique X / <a href="#">Land-atmosphere interaction</a>	<a href="#">Report</a>	
Siler, Clark D. / <a href="#">Water availability</a>	<a href="#">Report</a>	
Smith, Virginia Burton / Global warming and drought	<a href="#">Report</a>	<a href="#">PDSI</a>   <a href="#">Drought</a>

Student / Presentation in <b>Fall 2006</b>	Literature Review	References
Amanda Barr / <a href="#">Land Use and Global Warming</a>	<a href="#">Report</a>	<a href="#">Global carbon</a> , <a href="#">desert ecosystems</a>
Cedric David / <a href="#">Hydrology in Land Surface Models</a>	<a href="#">Report</a>	<a href="#">Land</a>
Xiaoyan Jiang / <a href="#">Coupling of Aerosols and Hydrologic Cycle</a>	<a href="#">Report</a>	<a href="#">Aerosols</a> , <a href="#">ecosystems</a>
Jihee Song / <a href="#">Sensitivity of Biogenic Emissions to Climate</a>	<a href="#">Report</a>	
Chase Asher / <a href="#">Global Sea Level</a>	<a href="#">Report</a>	
Jeremy Krimmel / <a href="#">Hockey Stick</a>	<a href="#">Report</a>	



Leslie Llado / <a href="#">Groundwater</a>	<a href="#">Report</a>	
Bennett Pifer / <a href="#">Hockey Stick</a>	<a href="#">Report</a>	
Cynthia Valle / <a href="#">Groundwater 2</a>	<a href="#">Report</a>	

Student / Presentation in <b>Fall 2005</b>	Literature Review	Articles
Avnery, Shiri / <a href="#">Fire and Climate</a>	ENSO and Fire [ <a href="#">Report</a> ]	ENSO-fire <a href="#">1</a> , <a href="#">2</a> , <a href="#">3</a> , <a href="#">4</a> , <a href="#">5</a>
Diehl, Theresa / <a href="#">Oceanic Warming</a>	Ice sheets and Climate [ <a href="#">Report</a> ]	<a href="#">Barnett</a> , <a href="#">Payne</a> , <a href="#">Oppenheimer</a> , <a href="#">Shepherd</a> , <a href="#">Hansen</a> , <a href="#">McKittrick</a> , <a href="#">Wigley &amp; Raper</a>
Ewing, Ryan / <a href="#">Snowball</a>	Snowball Climate [ <a href="#">Report</a> ]	Baum_Crowley <a href="#">1</a> , <a href="#">2</a> , <a href="#">Hyde</a> , <a href="#">Pierrehumbert</a> , <a href="#">Thresholds</a>
Gulden, Lindsey / <a href="#">BVOG</a>	Groundwater and Climate [ <a href="#">Report</a> ]	<a href="#">Alley</a> , <a href="#">ChenHu</a> , <a href="#">LiangXie</a> , <a href="#">Pierrehumbert</a> , <a href="#">York</a>
Katerndahl, Tiffany / <a href="#">Hurricanes</a>	Hurricanes and Global Warming [ <a href="#">Report</a> ]	<a href="#">Webster</a> , Emanuel <a href="#">1</a> and <a href="#">2</a> ; Hurricane <a href="#">1</a>
Kinney, Jacki / <a href="#">Hurricanes</a>	Hurricanes and Global Warming [ <a href="#">Report</a> ]	<a href="#">Webster</a> , Emanuel <a href="#">1</a> and <a href="#">2</a> ; Hurricane <a href="#">1</a>
Kuntz, Matt / <a href="#">Hurricane and Global Warming</a>	Hurricanes and Global Warming [ <a href="#">Report</a> ]	<a href="#">Webster</a> , Emanuel <a href="#">1</a> and <a href="#">2</a> ; Hurricane <a href="#">1</a>
Su, Hua / <a href="#">Groundwater</a>	Groundwater and Climate [ <a href="#">Report</a> ]	<a href="#">ChenHu</a> , <a href="#">LiangXie</a> , <a href="#">York</a> ,
Thijs, Ann / <a href="#">Land Cover Change</a>	Land Use/Land Cover Change and Climate [ <a href="#">Report</a> ]	<a href="#">Land Use (1)</a> & <a href="#">Land Use (2)</a>
Wolaver, Brad	Groundwater Recharge in Mexico/Texas Border [ <a href="#">Report</a> ]	<a href="#">Aquifer classification</a>