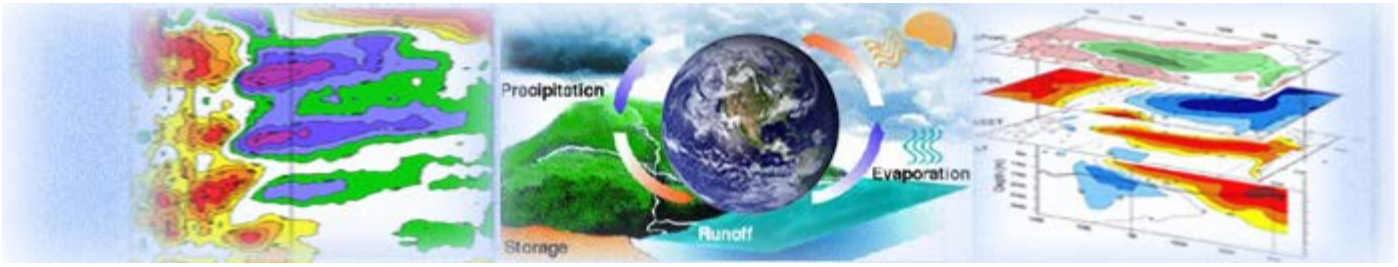

GEO 387H Physical Climatology

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Instructor: Dr. Zong-Liang Yang

Objectives: This course investigates the nature of Earth's climate and examines the processes that maintain our climate system based on physical principles. The class is concerned primarily with the global climate and its geographic variation on scales of hundreds to thousands of kilometers. Topics include the energy balance, the hydrologic cycle, general circulation of the atmosphere, general circulation of the oceans, how they all interact and vary at various spatial and temporal scales, and regional to global scale climate modeling. The hydrologic cycle topic covers processes and modeling of surface hydrology or land surface-atmosphere interactions. Human-induced modifications to the climate system, such as urbanization, anthropogenic global warming, desertification, and tropical deforestation, are discussed. Descriptive, analytical, programming, and modeling skills will be taught as well.

Prerequisites: A working knowledge of calculus (e.g., M408D) and physical sciences (e.g., PHY 303K) will be assumed, as well as computer skills in computation and graphics. It will be assumed that students will at least be acquainted with some of the basic physical principles of atmospheric science through courses such as GRG 301K (Weather and Climate), or consent of instructor.

This course is for any graduate students (GEO 387H) or upper-division undergraduate students (GEO 377P).

- Homework
- **Inquiry-Based Climate Models**
- Land Surface Model: Community Land Model Diagnostics
- Numerical Weather Forecasting Model: Weather Research and Forecasting (WRF)
- General Circulation Model: Community Climate System Model (CCSM)
- Observed Datasets: Global Change Master Directory
- The IPCC Data Distribution Center (AR4 GCM data)
- September 21, 2007 The Challenge of Global Warming & the Austin Climate Protection Plan City of Austin Mayor Will Wynn

Current Weather in Austin | Climate Outlooks
Any questions/comments please contact Zong-Liang Yang

Last updated on 03/03/11 04:38 PM by Zong-Liang Yang

GEO 377P/387H (Unique 27770/27860)

PHYSICAL CLIMATOLOGY

(TTh 9:30-11:00AM EPS Room 1.126)

Spring 2012

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

Last updated on 02/03/12 06:10 PM

	Tuesday	Thursday	Topics	Assignments
Week 1	1/17 Syllabus/course layout	1/19 Chapter 1: Introduction to the Climate System	1	Diagnostic Test (take-home test; due on 1/24 before class starts); CO_2 now; Celsius-Fahrenheit conversion
Week 2	1/24 Discussion of Diagnostic Test	1/26 Quiz #1; Components of the Climate System; Additional reading: Biogeochemistry of Atmospheric Trace gases and Aerosols	2	Read GCC and ESS; Read IPCC 2007 Chapter 4 , 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). HW#1 (Due right before 2/7)
Week 3	1/31 Chapter 2, Global Energy Balance	2/2 A simple greenhouse model, a leaky greenhouse, and a more opaque greenhouse (see section 2.3.1-2.3.3)	2,3	Read Theory; Read Simple greenhouse models; Inversion in satellite sounding; DMS; IPCC radiative forcing (1); NRC2005 and forcing (2); Bad Greenhouse.
Week 4	2/7 Chapter 3, Radiative Transfer, Clouds and Climate	2/9 Quiz #2; Two assumptions of the simplest GH model	2,3	Read IPCC 2007 Chapter 2; HW #2 (Due 2/21)
Week 5	2/14 Chapter 4 Surface Energy Balance	2/16 ABL, Thermodynamics, Reynolds decomposition, Eddy covariance, Bulk aerodynamic formulas	3,4	Earth's Global Energy Budget (Trenberth et al., 2009; Kiehl and Trenberth, 1997); Land Use (1) & Land Use (2); RSS; Land DAAC; 1km AVHRR; greenness; ecosystem modeling; Hoffmann 1 & 2 ; Forests and Climate Change; white roof; global decreasing ET trend; land CO2 and climate
Week 6	2/21 Potential Temperature, Atmospheric Stability and Clouds (see notes)	2/23 Quiz #3; More on atmospheric stability and clouds Atmospheric humidity variables	4,5	Read precipitation; precip measurements; land P trend; IPCC report on P; pan evaporation ET and remote sensing; Read Obama/McCain; Washington Update;
Week 7	2/28 Chapter 5, Hydrologic Cycle (additional lecture notes); Supplementary Materials for Ch 4 and 5	3/1 Overview for Ch4 and Ch 5 (Land surface modeling 1, 2)	4,5	Read Alley, ChenHu, LiangXie, Pierrehumbert, York, Yang; Read IPCC 2007 Chapter 7 (7.2) and Chapter 8 (8.2.3). HW #3 (Due 3/8)
Week 8	3/6 Chapter 6 Atmospheric General Circulation and Climate (advanced materials), (Introductory materials)	3/8 Quiz #4	6,7	read 200mbWind; ArcticT; VerticalT; read zonal lapse rate and global sediment load;Read ocean warming (1), (2) and (3); SST, SSTA; ocean monitoring; ocean heat content; figure; salinity trend; Hurricanes; THC; El Nino FAQ; Read IPCC 2007 Chapter 5
Week 9	3/20 Chapter 7, Ocean General Circulation and Climate (advanced materials) (Introductory materials);	3/22	6,7	Impacts research; Dangerous anthropogenic interference; Hockey stick debate
Week 10	3/27 Chapter 8, Paleoclimate	3/29 Quiz #5	8	Marine biology & glacial cycles & more; Thresholds; benchmark glaciers; SOCC; NSIDC glaciers; Read IPCC 2007 Chapter 6
Week 11	4/3 Chapter 9 Climate Sensitivity and Feedback Mechanisms	4/5	9	Read IPCC 2007 Chapter 11; Motivational homework Web-Based EBM Modeling Project; read Antarctic sea ice
Week 12	4/10 Chapter 10, Climate Modeling (0-100Y; Regional Climate Modeling Precipitation Trend)	4/12 Quiz #6	10	read GCM history; energy budget; AMIP; Randall on modeling 1, 2; Read IPCC 2007 Chapter 8, Chapter 10 and Technical Summary
Week 13	4/17	4/19 Chapter 11 & 12, Natural and Anthropogenic Climate Change	10, 11, 12	Read IPCC 2007 Chapter 11; GW & sea level rise; CCC; GW & glacier melt

Week 14	4/24	4/26 Presentation (1)		read 0-2000 AD and news release; Data Error; tropospheric and surface temperature trends (1) and (2); dust (1) and (2); "Hockey stick"; RealClimate; ClimateArk; GW and Health; Warm Feeling
Week 15	5/1 Presentation (2)	5/3 Presentation (3)		

* 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 April 19, 2011.

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.

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	Webster, Emanuel 1 and 2
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**) (presentation)	Anthropogenic Influences and Their Impact on Global Climate	
Eastwood, Erin (**2 December**) (presentation)	Pangean Paleoclimate	Loope et al. (2004), Parrish and Peterson (1988), Peterson (1988), Rowe et al. (2007), Soreghan et al. (2002)
Huang, Lei (25 November) (presentation)	Review on Ocean Heat Content and Ocean Warming	Barnett et al. (2001), Boyer et al. (2005), Levitus et al. (2000), Levitus et al. (2001), Willis et al., (2004)
		Murphy

Ingol, Eusebio (**2 December**) (presentation)	Climate Change Impacts on the Water Resources	(1999), Wilby (1997), Yates (2003), IPCC Chapter 10 (2001), IPCC (2008) Climate Change and Water, IPCC (2001) Working Group II: Impacts, Adaptation and Vulnerability
Issac, Toby (**4 December**) (presentation)	Approaches and Challenges in Ice Sheet Modeling	Greve (2000), Huybrechts and de Wolde (1999), Huybrechts et al. (2004), Pattyn et al. (2008), Ridley et al. (2005)
Mirabito, Chrisopher (4 December) (presentation)	Oceanic Climate Change: Contributions of Heat Content, Temperature, and Salinity Trends to Global Warming	Barnett et al. (2001), Boyer et al. (2005), Levitus et al. (2000), Levitus et al. (2001), Willis et al., (2004)
Neupane, Naresh (4 December) (presentation)	To Study the Various Factors Affecting the Summer Monsoon Rainfall in Nepal	Hansen et al. (2000), Lau et al. (2006), Ramanathan et al. (2001), Ramanathan et al. (2005), Saji et al. (1999)
Riel, Bryan (4 December) (presentation)	Effect of Ocean Warming on West Antarctic Ice Streams and Ice Shelves	Oppenheimer (1988), Payne (2004), Shepherd (2004), Wigley and Raper (2005), IPCC (2007) Chapter 4
Schroeder, Dustin (25 November) (presentation)	The West Antarctic Ice Sheet and Sea Level Rise	Alley (2005), Bindschadler (2006), Holt (2006), Shepard (2004), Vaugn (2007)
Shaw, John (25 November) (presentation)	Predicting the Affects of Climate Change on Global Rivers: A Review	Zonal lapse rate and Global sediment load
Shi, Mingjie (25 November) (presentation)	Changes and Feedbacks of Land Use and Land Cover under Global Change	Forests and Climate Change; Land Use (1) & Land Use (2)
Sun, Ying (**2 December**) (presentation)	Retrieval and Application of Land Surface Temperature	Jin (2004), Pinheiro et al. (2006), Prigent et al. (2003), Wan and Dozier (1996), Wang et al. (2008)

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

Student / Presentation in **Fall 2006**	Literature Review	References
Amanda Barr / Land Use and Global Warming	Report	Global carbon, desert ecosystems
Cedric David / Hydrology in Land Surface Models	Report	Land
Xiaoyan Jiang / Coupling of Aerosols and Hydrologic Cycle	Report	Aerosols, ecosystems
Jihee Song / Sensitivity of Biogenic Emissions to Climate	Report	
Chase Asher / Global Sea Level	Report	
Jeremy Krimmel / Hockey Stick	Report	
Leslie Llado / Groundwater	Report	
Bennett Pifer / Hockey Stick	Report	
Cynthia Valle / Groundwater 2	Report	

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

GEO 377P/387H

PHYSICAL CLIMATOLOGY

(TTh 9:30-11:00)

Spring 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@mail.utexas.edu

Lectures:
Tuesdays and Thursdays, 9:30 – 11:00 am
EPS Room 1.126

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 Thursday, it will be due next Thursday 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.