11:670:461 Climate Dynamics

Prerequisites: 11:670:324 DYNAMICS OF THE ATMOSPHERE and 11:670:431 PHYSICAL METEOROLOGY

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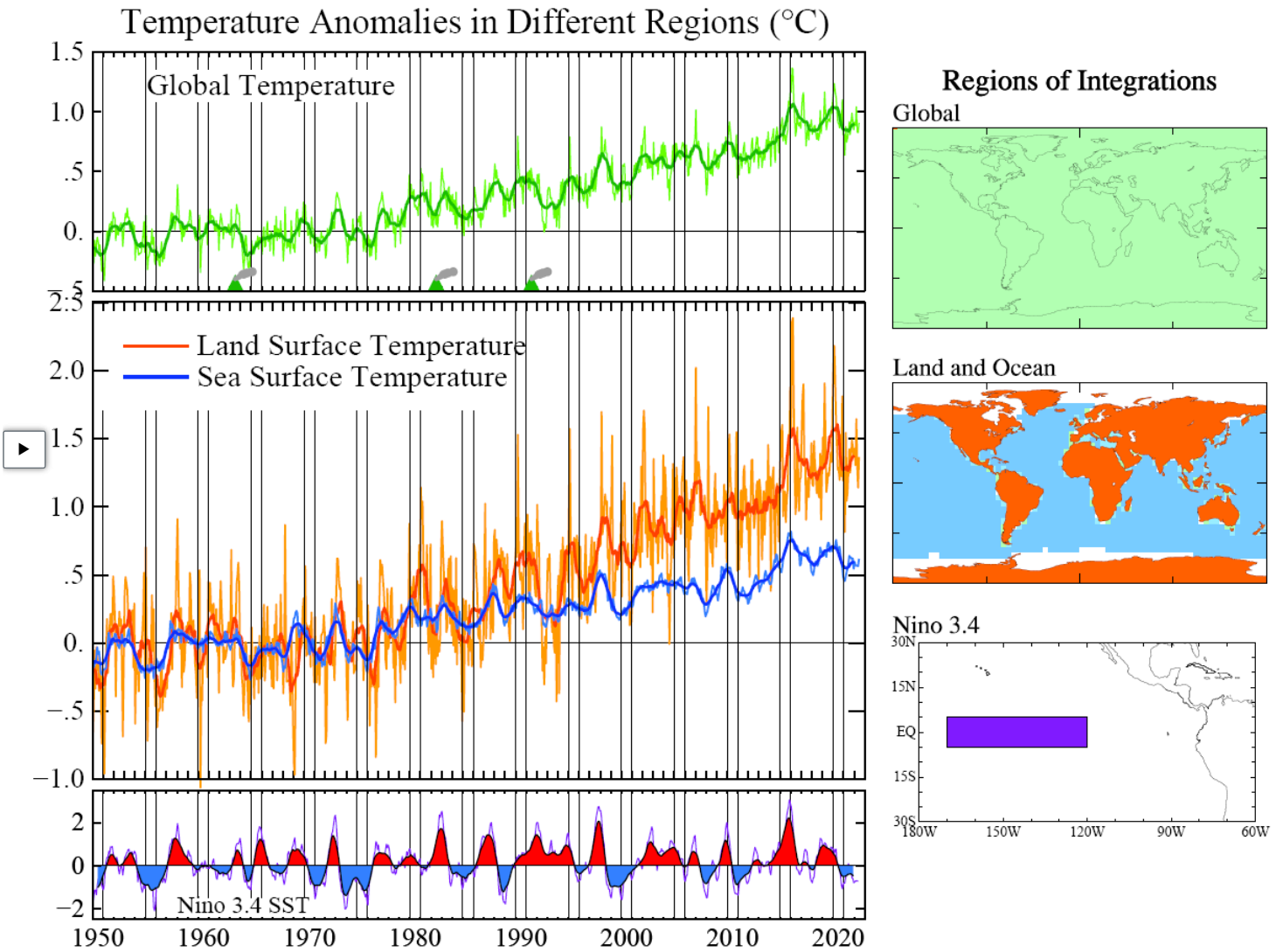
Classes in Room 223, Environmental and Natural Resources Building
Monday and Thursday, 12:10 p.m. to 1:30 p.m.



Recent climate change. Monthly (thin lines) and 12-month running mean (thick lines or filled colors in case of Niño 3.4 Index) global land-ocean temperature anomaly, global land and sea surface temperature, and El Niño index. All have a base period 1951-1980. Figure from http://www.columbia.edu/~mhs119/Temperature/T_moreFigs/ (http://www.columbia.edu/~mhs119/Temperature/T_moreFigs/) Green triangles denote the 1963 Agung, 1982 El Chichón, and 1991 Pinatubo volcanic eruptions. Niño 3.4 is the tropical Pacific region 5ºN-5ºS, 170-120ºW.

Required Text:

Goosse, H., P.Y. Barriat, W. Lefebvre, M.F. Loutre, and V. Zunz, 2010: *Introduction to climate dynamics and climate modelling.* Online textbook available at http://www.climate.be/textbook (http://www.climate.be/textbook/)

Download pdf of the text from above link or from First Class Module.

or buy the updated text:

Goosse, Hugues, 2015: *Climate System Dynamics and Modelling*, (Cambridge University Press, Cambridge, UK), 378 pp. (http://www.cambridge.org/us/academic/subjects/earth-and-environmental-science/climatology-and-climate-change/climate-system-dynamics-and-modelling)

Reference Texts:

IPCC (http://www.ipcc.ch/), particularly the new Working Group I report from the 6th Assessment, **https://www.ipcc.ch/report/ar6/wg1/ (https://www.ipcc.ch/report/ar6/wg1/)**

State of the Climate in 2021 **(https://www.ametsoc.org/ams/index.cfm/publications/bulletin-of-the-american-meteorological-society-bams/state-of-the-climate/)**, Special Supplement to the *Bulletin of the American Meteorological Society*, Vol. 103, No. 8, August 2021

Archer, David, and Raymond Pierrehumbert (Editors), 2011: *The Warming Papers, The Scientific Foundation for the Climate Change Forecast*, (Wiley-Blackwell, Oxford, UK), 419 pp. (http://www.amazon.com/The-Warming-Papers-Scientific-Foundation/dp/1405196165/)

For links to other important global warming source material, including the U.S. National Climate Assessment, visit the US Global Change Research Program web page, **http://www.globalchange.gov/ (http://www.globalchange.gov/)**

Learning Goals:

Upon completion of this class, students will be able to:

1. Demonstrate an understanding of anthropogenic impacts on atmospheric chemistry and climate and their potential environmental and societal consequences.
2. Exhibit critical thinking when confronting new information.
3. Communicate clearly orally and in writing, including by electronic means.
4. Apply the mathematical and physical foundations of meteorology and climatology to solve problems using analytical and computational methods.

Information on COVID protocols

It is great to see you in person this Fall semester and I am looking forward to a rewarding instructional experience for both for myself and you. In order to provide everyone with a safe learning environment, I ask that you abide by the following rules for attending my class.

First, I would like you to know that I am fully vaccinated and boosted.

Please follow all Rutgers Community Safety Practices: **https://coronavirus.rutgers.edu/ (https://coronavirus.rutgers.edu/)**.

If you feel unwell, DO NOT attend class. Let me know and I will work with you to make up work.

I will be wearing a mask while I am lecturing. Every student in this class will also be expected to wear an appropriate mask (exhaust valves not permitted), properly cared for, and worn, covering both the mouth and nose, as detailed in the Rutgers **Community Safety Practices. (https://coronavirus.rutgers.edu/health-and-safety/community-safety-practices/)** Please come to class prepared. If you forget, a disposable mask will be provided. I will not begin each class session until everyone is wearing a mask.

Please let me know if you cannot clearly hear what I am saying. Speaking through a mask is challenging. If you let me know I can modify my mask and speech to be more clear.

CLASS SCHEDULE

Date	Subject	Reading*
Sept. 8	Introduction	**IPCC WG I Summary for Policymakers (https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_SPM.pdf)**
Sept. 12	Climate System - Atmosphere	G1
Sept. 15	Climate System - Ocean	G1

Sept. 19	Climate System - Ice and Land	G1
Sept. 22	Climate Variability, El Niño, ENSO, QBO, AO	G5, Hansen et al. (2010) (http://climate.envsci.rutgers.edu/pdf/HansenRevGeophys2010RG000345.pdf), McPhaden et al. (2006) (http://climate.envsci.rutgers.edu/pdf/McPhadenENSO1740.pdf), McPhaden (2015) (http://climate.envsci.rutgers.edu/climdyn2019/McPhadenENSOnclimate2775.pdf)
Sept. 26	IPCC, Reconstructing Past Climates	G5, NAS report (http://climate.envsci.rutgers.edu/pdf/NASreport.pdf), IPCC (http://www.ipcc.ch/), Vinnikov et al. (2002) (http://climate.envsci.rutgers.edu/pdf/VinnikovEtAlHourly2001JD002007Published.pdf), Vinnikov et al. (2004) (http://climate.envsci.rutgers.edu/pdf/Vinnikov2003GL019196.pdf)
Sept. 29	IPCC, Reconstructing Past Climates	G5, NAS report (http://climate.envsci.rutgers.edu/pdf/NASreport.pdf), IPCC (http://www.ipcc.ch/), Vinnikov et al. (2002) (http://climate.envsci.rutgers.edu/pdf/VinnikovEtAlHourly2001JD002007Published.pdf), Vinnikov et al. (2004) (http://climate.envsci.rutgers.edu/pdf/Vinnikov2003GL019196.pdf)
Oct. 3	Energy Balance **Term Paper Topic Due**	G2
Oct. 6	Energy Balance	G2
Oct. 10	Reanalysis	Reanayses 'R' Us (http://www.realclimate.org/index.php/archives/2011/07/reanalyses-r-us/), Summary Table from UCAR (https://climatedataguide.ucar.edu/climate-data/atmospheric-reanalysis-overview-comparison-tables), ECMWF reanalysis (https://www.ecmwf.int/en/research/climate-reanalysis)
Oct. 13	Water and Carbon Cycles	G2, Oki and Kanae (2006) (http://climate.envsci.rutgers.edu/pdf/OkiKanaeGlobalHydrology1068.pdf), Robock et al. (2000) (http://climate.envsci.rutgers.edu/pdf/DataBank.pdf), Robock et al. (2003a) (http://climate.envsci.rutgers.edu/pdf/Robock2002JD003245.pdf)
Oct. 17	Water and Carbon Cycles	G2
Oct. 20	Climate Modeling	G3
Oct. 24	Radiative Forcing, Climate Feedbacks	G4, IPCC AR6 WGI, Chapter 7, "The Earth's energy budget, climate feedbacks, and climate sensitivity" (https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_Chapter07.pdf)
Oct. 27	Long-range Weather Forecasting	see handouts in Long-range Forecasting Module
Oct. 31	**Exam 1**	
Nov. 3	Future Climate Scenarios, Global Warming	G6, AR6 WG I Technical Summary (https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_TS.pdf)
Nov. 7	Global Warming **Term Paper Outline Due**	G6
Nov. 10	Global Warming	G6
Nov. 14	Climate Intervention (also called Climate	Stratospheric Aerosol Geoengineering

	Engineering or Geoengineering)	(http://climate.envsci.rutgers.edu/pdf/RobockStratAerosolGeo.pdf)
Nov. 17	Volcanic Eruptions and Climate	Robock (2000) (http://climate.envsci.rutgers.edu/pdf/ROG2000.pdf)
Nov. 21	Volcanic Eruptions and Climate	
Nov. 22 TUESDAY	Policy Debate	AR6 WGII (https://www.ipcc.ch/report/sixth-assessment-report-working-group-ii/), Poland Coal (http://climate.envsci.rutgers.edu/climdyn2020/Poland.pdf), Carbon Offsets (https://www.cis.upenn.edu/~bcpierce/papers/carbon-offsets.pdf), Exxon report (http://climate.envsci.rutgers.edu/pdf/UCSexxon_report.pdf), Exxon knew (https://www.nytimes.com/2017/08/23/climate/exxon-global-warming-science-study.html)
Nov. 24	THANKSGIVING	
Nov. 28	Nuclear Winter **Term Paper Due**	http://climate.envsci.rutgers.edu/nuclear/ (http://climate.envsci.rutgers.edu/nuclear/)
Dec. 1	Ozone Hole (https://ozonewatch.gsfc.nasa.gov/facts/hole_SH.html)	Montreal Protocol (https://www.unep.org/ozonaction/who-we-are/about-montreal-protocol), YouTube (https://www.youtube.com/watch?v=AU0eNa4GrgU) (https://www.youtube.com/watch?v=AU0eNa4GrgU)
Dec. 5	Oral Term Paper Presentations	
Dec. 8	Oral Term Paper Presentations	
Dec. 22 noon - 3 pm	**Final Exam, Room 223**	

*G = Chapter in Goosse

Course grade will be determined by:

Homework	35%
Term paper	25% (paper 15%, oral 10%)
Exam	15%
Final exam	25%
	100%

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