
Global Warming - Understanding the Forecast

Script (2005)	Video Lectures (Classroom)	Topical Courses (2013)
	Intro	Welcome (6:01) Using Units (3:44) Units of Energy (5:12) Units of Light (3:16)
Ch 1: Blackbody Radiation - Summary - Heat and Light - Energy through a Vacuum (1) - Blackbody Radiation (4) - Ultraviolett Catastrophy (7) - Box: Quantum Wierdness and Spooky Action at a Distance (10) - Take-Home Points (11) - Exercises (12)	Ch 2 Lecture 2: Heat and Light Lecture 3: Blackbody Radiation & Quantum Mechanics	Heat (4:15) Light (5:48) Blackbody Radiation (6:07)
Ch 2: The Layer Model - Summary (1) - The Bare-Rock Layer Model (1) - Box: Pi and transcendental numbers (4) - The Layer Model With Greenhouse Effect (6) - Take-Home Points (9)	Ch 3 Lecture 4: Our First Climate Model Lecture 5: The Greenhouse Effect	Naked Planet Climate Model (8:13) The Greenhouse Effect (9:41)
Ch 3: Greenhouse Gases - Summary (1) - About Gases (1) - Gases, Vibrations, and Light (2) - How a Greenhouse Gas Interacts with Earth-Light (3) - Band Saturation (5) - Greenhouse Gases and the Planetary Energy Budget (6) - Take-Home Points (7) - 1. Lab (7) - 2. CO2 (7) - 3. Earth Temperature (8)	Ch 4 Lecture 6: What Makes a Greenhouse Gas Lecture 7: Greenhouse Gases in the Atmosphere	Greenhouse Gas Physics (7:42) The Band Saturation Effect (12:41)
Ch 4: Convection - Summary (1) - Meet the Atmosphere (1) - Pressure as a Function of Altitude (1) - Box: The Story of e (2) - Adiabatic Expansion (3) - Water Vapor and Latent Heat (4) - Convection (5) - Moist Convection (6) - Convection in the Layer Model (7) - Lapse Rate and the Greenhouse Effect (7) - Take-Home Points (8) - Lab (8)	Ch 5 Lecture 8: What Holds the Atmosphere up Lecture 9: Why it's Colder Aloft	Atmospheric Temperature Structure (8:38) Pressure in a Standing Fluid (10:58) Water Vapor and Latent Heat (8:30) Moist Convection (2:01)
Ch 5: Heat, Winds and Currents - Summary (1) - Averaging and Aliasing (1) - Weather vs. Climate (2) - So We Have to Simulate the Weather (4) - Take-Home Points (8) - Lab (8)	Ch 6 Lecture 10: Wind, Currents and Heat	Heat Transport (3:29) Coriolis Acceleration (5:25) Geostrophic Motion (5:21) The Turbulent Cascade (3:27)

Ch 6: Feebacks - Summary (1) - Positive and negative Feedbacks (1) - Water vapor Feedback (2) - Ice Albedo Feedback (3) - Clouds (4) - Ocean Currrents (7) - Terrestrial Biosphere Feedbacks (8) - Carbon Cycle Feedbacks (8) - The Paleoclimate Record Urges Us to Macabre Creativity in Forecasting the Future (8) - Svante Arrhenius (9) - Lab (10) - Take-Home Points (11)	Ch 7 Lecture 11: Ice, Water Vapor Feedbacks Lecture 13: Clouds	Positive and Negative Feedbacks (4:36) Ice Albedo Feedback (2:17) Water Vapor Feedback (7:01) Clouds (9:15) Aerosols (5:48) Climate Sensitivity (4:38)
Ch 7: Carbon on Earth - Summary (1) - The Chemistry of Carbon (1) - The Gaia Hypothesis (4) - The Atmosphere and Other Carbon Reservoirs (4) - The Silicate Thermostat (6) - Take-Home Points (7) - Lab (8)	Ch 8 Lecture 14: The Weathering CO2 Thermostat Lecture 15: Lungs of the Carbon Cycle	The Weathering CO2 Thermostat (8:44) The Goldilocks Planets (3:41) The Oceans in the Carbon Cycle (5:15) The Land Surface in the Carbon Cycle (5:28)
Ch 8: Fossil Fuels - Summary (1) - Energy Sources (1) - Current Energy Consumption (5) - Future Energy Consumption (6) - Take-Home Points (6) - Lab (6) 1. Hubbert's Peak 2. The Kaya Identity 3. IPCC CO2 Emission Scenarios	Ch 9 Lecture 16: The Battery of the Biosphere Lecture 17: Coal and Oil Lecture 18: Oil and Methane	The Battery of the Biosphere (5:16) Oxidation and Reduction of Carbon (6:11) Coal (4:20) Oil (6:59) Natural Gas (2:30) Forecasting Future Emissions (3:38)
Ch 9: The Perturbed Carbon Cycle - Summary (1) - Ozone (1) - Methane (2) - CO2 (3) - Take-Home Points (9) - Lab (9) 1. Long-Term Fate of Fossil Fuel CO2 2. Effect of Cutting Carbon Emissions. 3. Climate Sensitivity of this model	Ch 10 Lecture 19: The Carbon Cycle Today Lecture 20: The Long Thaw	Human Impact on the Carbon Cycle (3:12) Ocean Buffer Chemistry (6:14) The Perturbed Carbon Cycle (2:42) Methane as a Greenhouse Gas (8:49) The Long CO2 Tail (5:37) Why the CO2 Tail Matters (6:35)
Ch 10: Is it Reliable? - Summary (1) - Is the Globe Warming? (1) - The Thermometer Record (1) - Box: Consensus in Science (2) - Temperatures Measured from Satellites (3) - Glaciers (3) - Temperature Reconstructions for the Deeper Past (4) - Past Forcings (6) - Model Data Comparison (7) - Vostok Record (8) - Take-home Points (8) - Lab - 1. Data Reduction (9) - Seasonal Cycle - Climatology - Trends - Anomalies (9) - 2. Statistics (9)	Ch 11 Lecture 21: The Smoking Gun Lecture 22: The Present in the Bosom of the Past	Land Surface Temperature Records (4:15) Sea Surface Temperature Records (3:20) Satellite Temperature Records (2:26) The Smoking Gun: Warming Since the 1970s (6:54) Paleoclimate and Proxy Measurements (3:46) Tree Rings (4:25) Borehole Temperatures (2:48) Oxygen Isotopes (4:45) Solar Intensity and the Hockey Stick (6:19) Glacial - Interglacial Cycles (6:24)

Ch 11: The Forecast - Summary (1) - Temperature Forecast (1) - Rainfall Forecast (4) - Storms and Extreme Weather Events (4) - Ice and Sea Level (5) - Greenland ice sheet (5) - Antarctic ice sheet (5) - West Antarctic ice sheet (6) - ice streams (6) - Archimedes' principle (6) - Larsen ice shelf (7) - Biological Impacts (8) - Human Impacts (9) - aquifers - water table (9) - Abrupt Climate Change (9) - Dansgaard-Oeschger events (10) - Bond cycles (10) - Lab (11)	Ch 12 Lecture 11: Six Degrees	Global Weirding (3:48) Monsoons (2:09) Vegetation (2:57) Impacts of Sea Level (2:01) Antarctic Ice Sheet (2:52) Greenland Ice Sheet (3:55) Paleo Sea Level Changes (2:11) Water Vapor and Storminess (1:02) Hurricanes (3:14) Extreme Weather (1:40) Ecosystem Impacts (2:31) Human Impacts (1:41)

Ch 12: Decisions, Decisions
- Summary (1)
- Global Warming is a Large-Scale Problem (1)
- Negotiations (3)
    - Framework Convention on Climate Change or FCCC (3)
    - Conference of Parties or COP (4)
    - IPCC (4)
- Economics (6)
    - Costs of Climate Change (7)
    - Costs of Kyoto (7)
- Dangerous Anthropogenic Interference (9)
- Alternatives (10)
    - nuclear energy (11)
    - Windmills (11)
    - photovoltaics, (12)
    - hydrogen (12)
    - sequestration. (13)
- Summary (14)
- Take-Home Points (14)
- Lab
    - Compound Interest (14)
    - DT2x (14)
    - Carbon-Free Energy (15)
    - Carbon Stabilization and Kyoto (15)
	Ch 13
	Lecture 23: Hot, Flat and Crowded
		Stabilization Scenarios (2:27)
		Temperature Targets (1:52)
		Slug Theory (5:42)
		Geoengineering: CO2 Capture and Sequestration (6:47)
		Geoengineering: Solar Radiation Management (3:57)
		Economics of Climate Change (8:50)
		Mitigation: Short-Term (4:18)

The web page above has pointers to movies of model output and a data browser.
1. Data Reduction.
Chapter 10, page 8

ch 11, page 10
In a more general sense, the abrupt climate change record of the past serves as a warning because climate swings such as this were not anticipated in the past record, and would be impossible to predict for the future. Models tend to underpredict the swiftness and the severity of these events, presumably because positive feedbacks in the real world are difficult to capture in the models. An abrupt climate shift would be a surprise, like the ozone hole. Once the climate rearranged into some different circulation mode, it could remain locked in that mode for centuries.

page 11
Point your web browser at http://geosci.uchicago.edu/~archer/PS134/lab.hadley.html . the data browser to answer the following questions. Use the movies and
(a) Estimate a global average temperature increase from the beginning to the end of the simulation. Document your estimate by recording

ch12, page 6: An economist at Yale, William Nordhaus, has constructed an economic model to gauge the costs of climate change versus the costs of decreasing CO_2 emissions. Nordhaus" book can be downloaded from http://www.econ.yale.edu/~nordhaus/homepage/homepage.htm .

David Archer - The Long Thaw

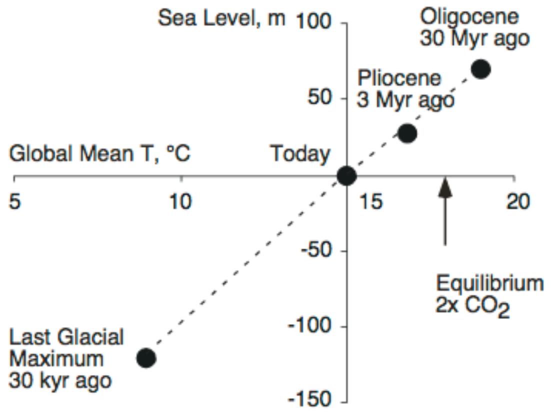

Figure 11-7

Source: Lecture (2005), global_warming-understanding_the_forecast_fig11-7, page 203

Most of the time the earth was some kind of a hothouse
Anmerkung: Wir Menschen sind in einer Erd-Anomalie entstanden. Die Frage ist, ob wir uns diese Anomalie erhalten wollen.

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Joachim Gruber