Earth Futures: A General Education Sustainability Course at The Pennsylvania State University

http://www.e-education.psu.edu/earth103/
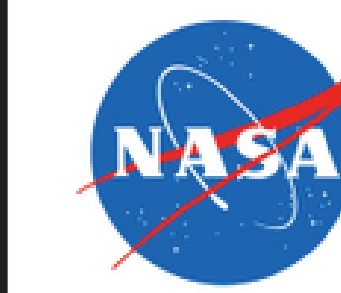
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InTeGrate
Interdisciplinary Teaching of
Geoscience for a Sustainable Future

PENNSTATE

Overview

Earth in the Future: Predicting Climate Change and Its Impacts Over the Next Century is a general education course designed to give a broad survey of the science underlying climate change as well as the impacts on natural and human systems. The course has three major goals: 1) to provide an understanding of climate science and of the possible scenarios of how climate may change in the future; (2) to analyze the linkages between climate and major human and natural systems, including agriculture, water, ocean circulation, and coastal ecosystems, necessary to assess the potential impacts of climate change; and (3) to understand the potential responses to climate change, including both adaptation to, and mitigation of change. The general education course is the entry point for a new BS-degree program, Earth System Science and Policy (ESSP). The course is taught in blended and online formats.

Laboratories

From its beginning, the course has included laboratory exercises designed to enhance the student's understanding of climate science. Laboratory exercises are now in every module, including STELLA-based model experiments. These exercises form an essential part of the on-line version of the course, however, the identical exercises are involved in the face-to-face version.
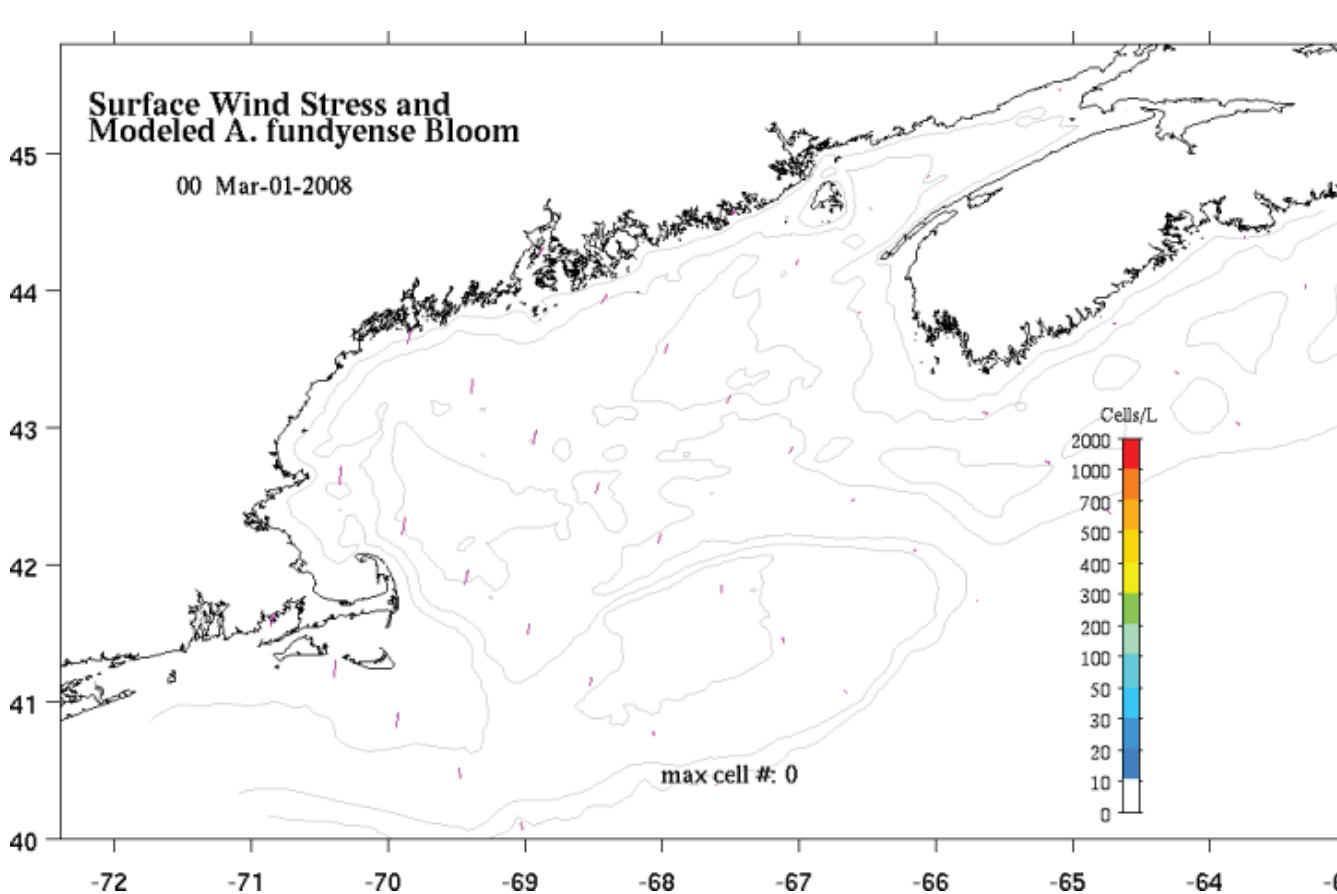
Examples of Lab Exercises

STELLA Diagram for the Planetary Climate Model
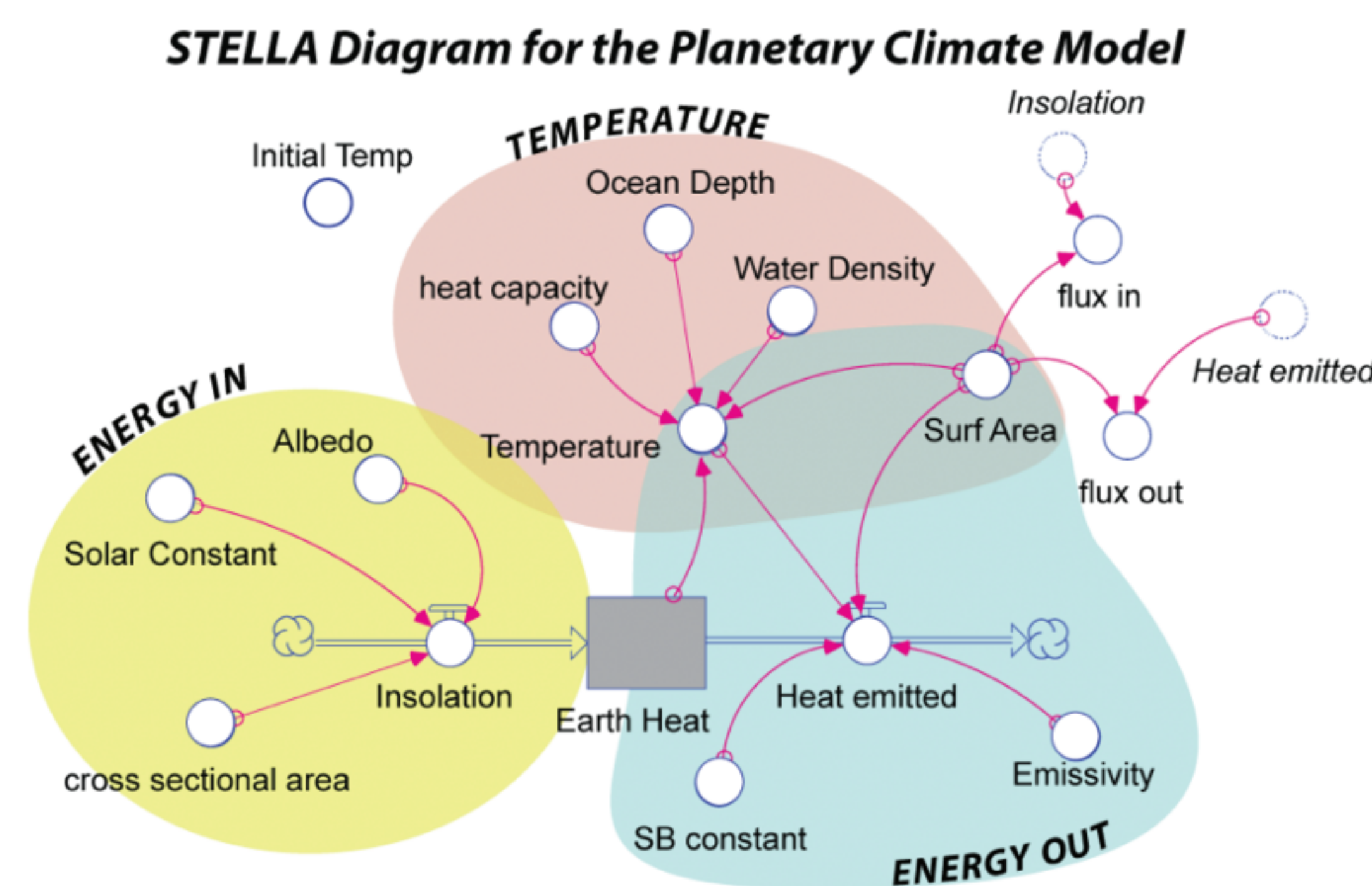
STELLA model constructed for lab exploring the climate system (Module 3)
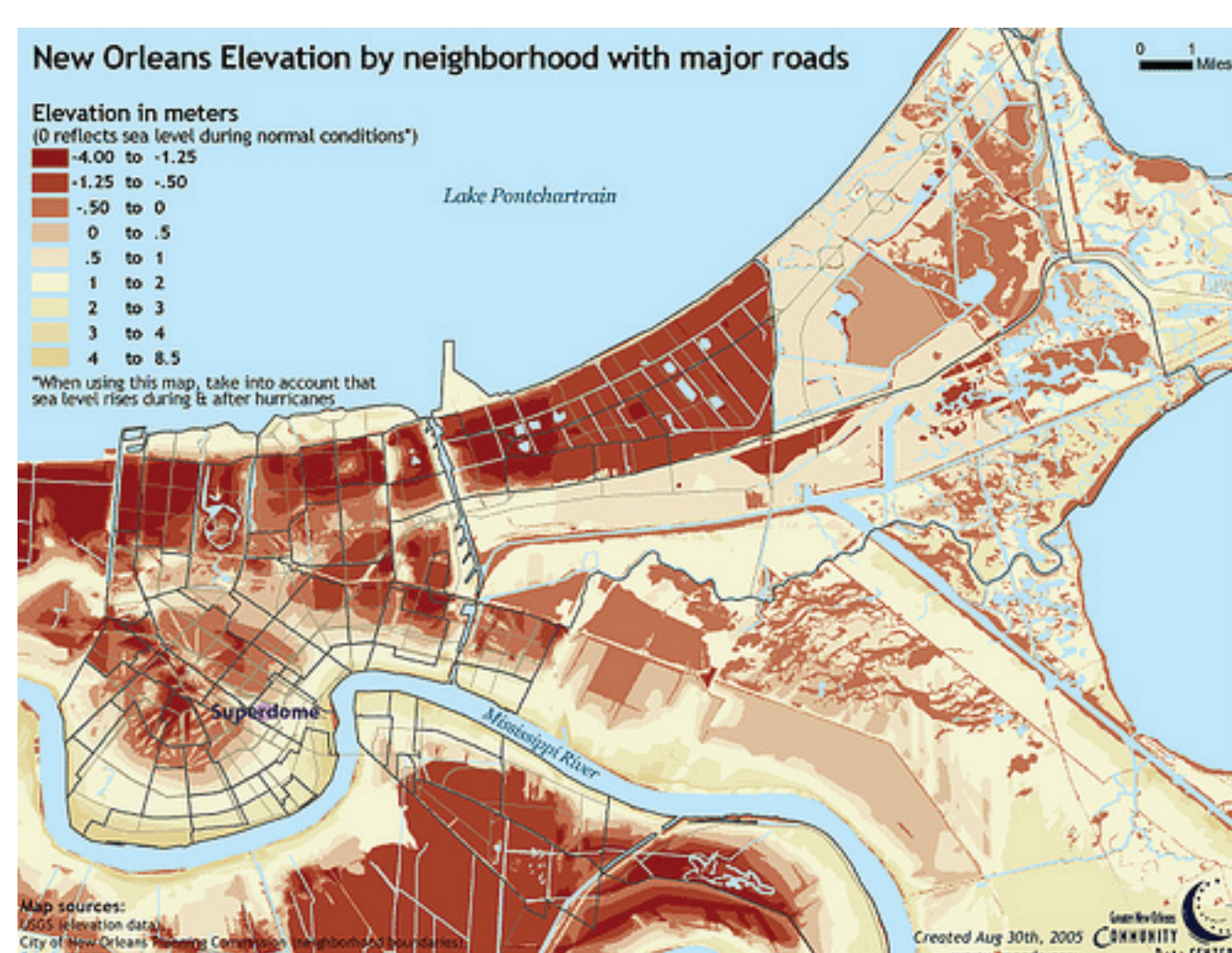
New Orleans elevation map for sea level rise lab (Module 10)

Prediction of harmful algal blooms in the Gulf of Maine. Lab in Module 7

Caitlin Seaview Survey coral reef health self guided reef exploration (Module 7)
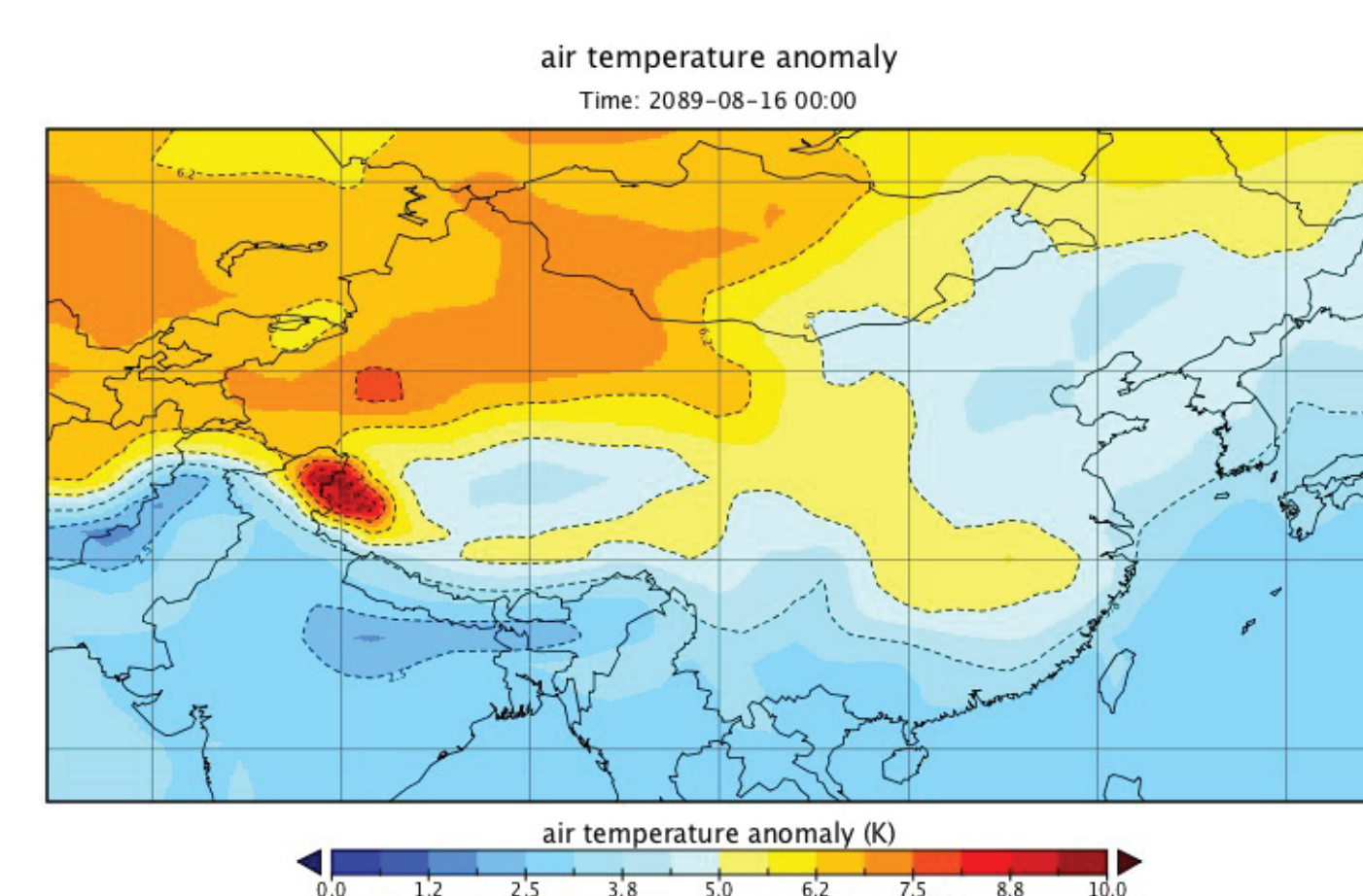
China temperature anomaly 2080-99 A2 emission (Climate model lab, Module 4)

Delivery and Structure

Initially the course was taught face to face on a yearly basis. Recently we have developed an on-line version of the course, and, now routinely teach the course online through the PSU World Campus and in blended format on campus. The course is broken up into twelve weekly modules as per all on-line courses at Penn State. Both versions of the course are continually assessed. The simultaneous instruction provides a unique opportunity to compare the strengths and weaknesses of the two different modes of education. The labs have proven to be challenging for the on-line students, so we have different assignments for online and face to face cohorts.

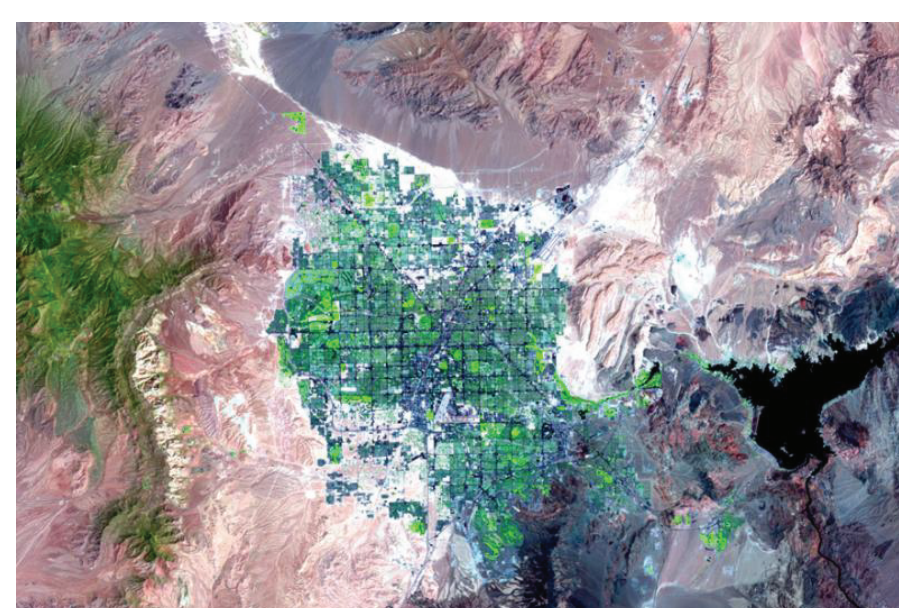| Module	Topic	Objective	Lab 1	Lab 2
1	Ancient Climate	Ancient climate change and proxies. Pleistocene, PETM, Younger Dryas and Snowball used as examples.	Pleistocene climate cycles	PETM paleotemperature estimates
2	Recent Climate	How recent trends are analyzed. Hockey Stick. Focus on temperature, precipitation and ENSO.	Trends in State College climate data	Analysis of warming trends in borehole data
3	Climate System	Basis of the climate system. Radiation, heat transport, albedo, moisture and greenhouse gases.	Stella model experiments of climate system	
4	Climate Models	How different types of models work. IPCC emission scenarios and predictions based on them.	Regional model predictions	
5	Carbon Cycle	Basis of the marine and terrestrial carbon cycle in and their role in climate change.	Carbon cycle model experiments	
6	Ocean Circulation	Drivers of surface and deep ocean circulation and how they affect climate.	Surface ocean Circulation	Deep Ocean Circulation
7	Acidification, Red Tides and Jellyfish	Biological impacts of climate and environmental change on marine ecosystems.	Reef exploration and health	Harmful algal bloom prediction
8	Water Resources	Behavior of ground water and impacts of human activities and climate change.	Stream flooding	Groundwater flow modeling
9	Food Supply	Threats of climate and population growth on food supply in developed and underdeveloped countries.	Land use changes in Europe and Africa	Population and food supply modeling
10	Sea Level Rise	Understanding the processes and threats of sea level rise. Coastal engineering.	Flood mapping	Causes of sea level rise
11	Terrestrial ecosystems	Impact of climate change on vulnerable organisms	IUCN Red List	
12	Adaptation to and Mitigation of Climate Change	Practises that will increase sustainability in the face of climate change including changes in economies. Sequestration and other engineering designed to lessen impacts of climate change.	Modeling the economic impact of climate change	Sequestration modeling

Knobs, Bells and Whistles

The on-line course makes extensive use of YouTube including both professionally produced and amateur videos. In addition, where we need to explain a difficult concept that would be hard using words, we use a program called Jing that allows us to record an explanation of a powerpoint slide. Reading is taken largely from Scientific American. Finally, we are taping short introductions for each module.
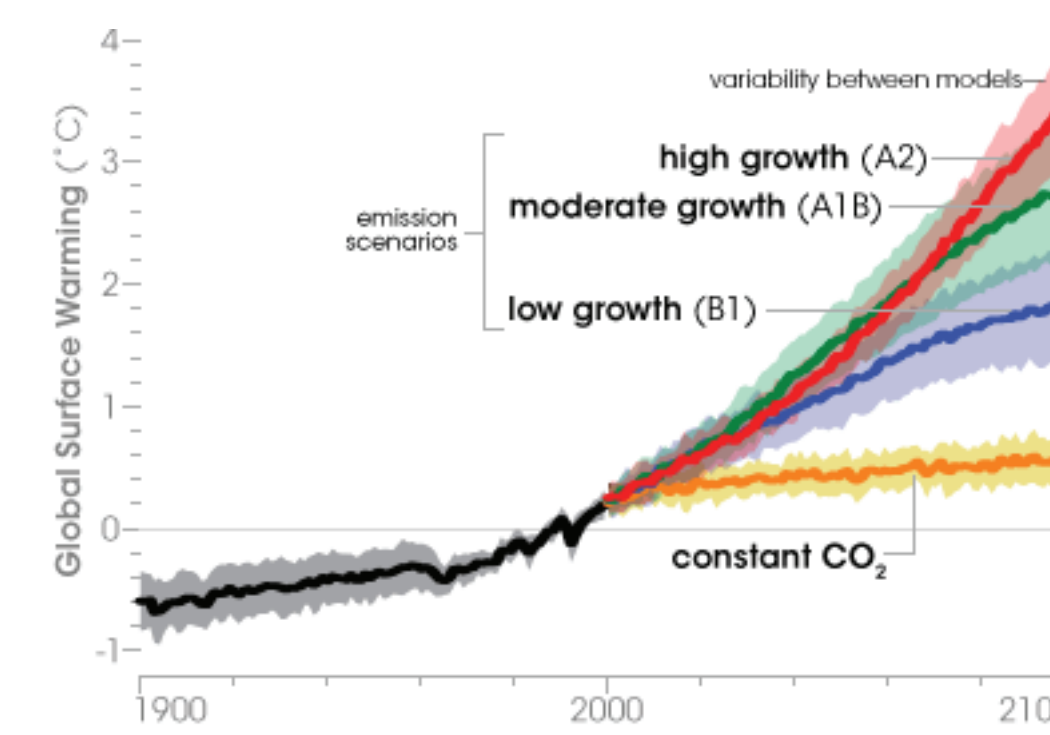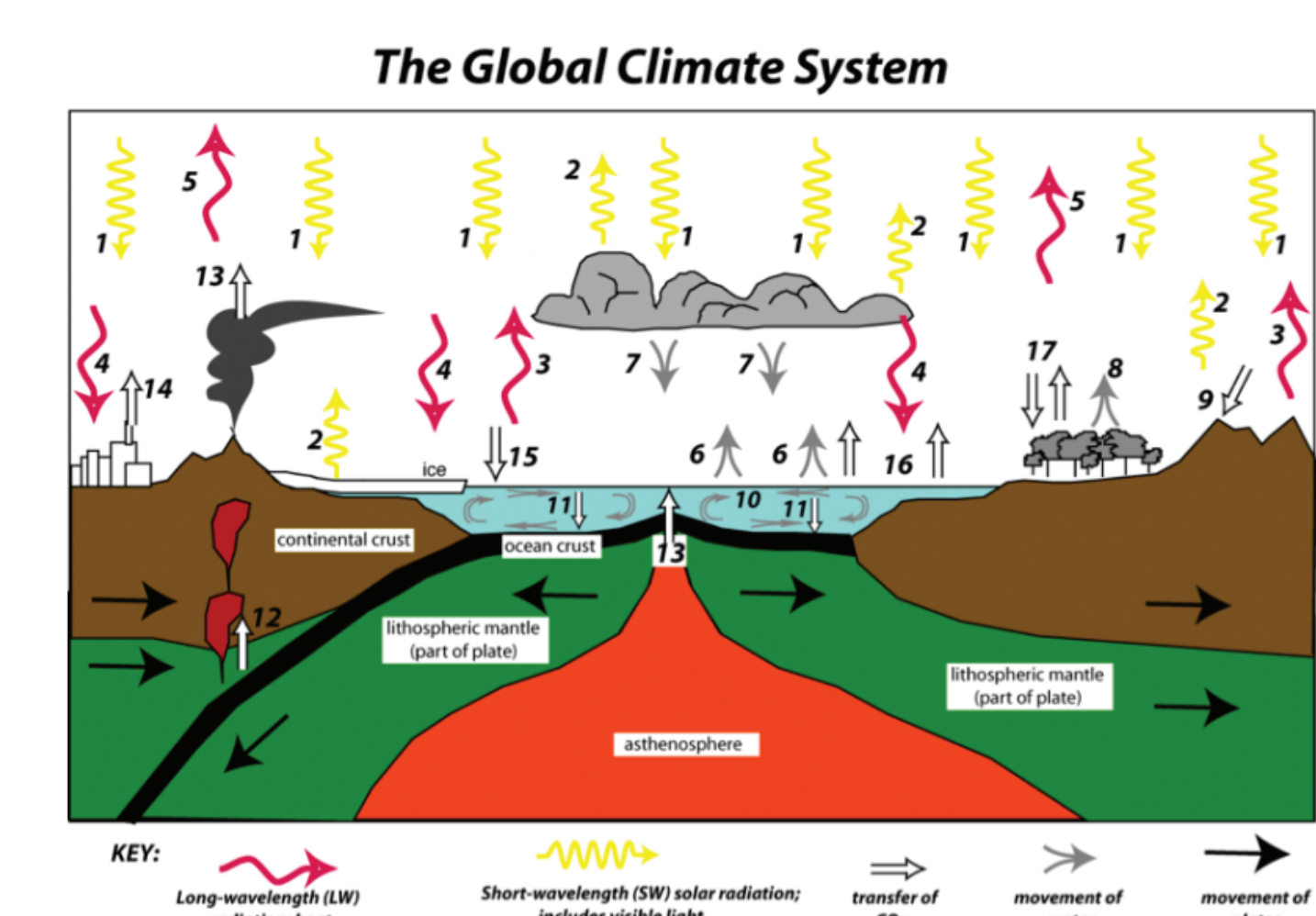

IPCC emission scenario projections

Damage from Hurricane Sandy

LANDSAT image of Las Vegas

Subsistence farming in India

The Global Climate System

Future Plans

Earth in the future will be the first course as part of proposed on-line minor and certificate programs in Earth Sustainability developed as part of the NSF InTeGrate GEO-STEP Center (based at Carleton College). We are currently in the process of developing other on-line courses including ones on Energy, Water and Coastlines. In the next year we will be initiating courses in Food Supply and a capstone course in Earth Modeling. The courses all have a social science perspective. The course is openly accessible as part of the Earth and Mineral Science open education resource program (http://www.e-education.psu.edu/earth103/).