

Climate System and Observations 1: Historical Trends Analysis

Session 2, Changing Planet Workshop, June 27 30, 2011, Dickinson College, Carlisle, PA

Jeff Niemitz, Professor of Earth Sciences, Dickinson College

Summary of the Session: *Is the climate changing, and if so why?* During this workshop session we will work through and discuss lab exercises in which students use NASA-GISS weather station data to examine historical temperature trends for selected locations, interpret trends, and test hypotheses. The lab exercises are provided as a separate document.

Background: This 90-minute session is part of a four-day workshop that brought together faculty from multiple colleges and diverse disciplines to work collaboratively on developing new and revised courses, explore engaged learning pedagogies, and add to their knowledge for interdisciplinary teaching about climate change within a liberal arts curriculum. The workshop was held twice on the campus of Dickinson College, first in summer 2010 and again in summer 2011. Participants came from more than 20 colleges and universities and with expertise in disciplines that span the sciences, social sciences and humanities. The workshops are part of a NASA supported project Cooling the Liberal Arts Curriculum, A Campaign for Climate Change Education (<http://communities.earthportal.org/changingclimate/>).

Climate System and Observations

Purpose of session:

- To give a brief overview of the Earth's climate system and the role of the interactions of other spheres of the Earth on climate and climate change over time.
- To present one NASA dataset (NASA-GISS) that is helpful for student understanding of recent (last 100+ years) temperature change across the world.

Outcomes of session:

- A broad context for a climate change course or module
- Two examples of activities for labs in climate change using:
 - Different types of data sets
 - Quantitative reasoning (graphing, basic statistics using Excel)
 - Critical thinking about the implications of data trends from different geographies
 - Hypothesis testing (heat island effect vs. climate change)

Topic Overview

Is the climate changing and, if so, why?

The answer to this question is, of course, a qualified yes. If we look at the evidence for climate change over deep (geologic) time and our interpretations are correct then we see significant climate variation. In fact the variation is so extreme that what we are experiencing now is a very moderate climate regardless of human interactions.

The "why" is the more important aspect of our discussion among us and with our students. This session will take a brief look at the climate system of Earth and why it is so relatively moderate compared to Venus or Mars. Each 'sphere' of the Earth System plays an important role in controlling Earth's climate. We will look at some of these (particularly

the hydrosphere, the lithosphere, and the cryosphere) and how change create positive and negative feedbacks to change the climate over various time scales.

Another part of the equation is the changes to the earth which occur regardless of what humans do. The celestial mechanics of the Earth-Sun connection are well known and predictable. Commonly known as Milankovitch cycles, they can be highly correlated to the most recent major changes in climate, glacial and interglacial fluctuations. Indeed, Milankovitch cycling has most likely been occurring since the Earth first started to rotate on its axis. Except in a few rare cases we do not have good geological evidence over deep time for the effects of this cycling.

Resources

Books:

- Archer, D., 2008, *The Long Thaw: How Humans Are Changing the Next 100,000 Years of Earth's Climate*: Princeton University Press.
- Bradley, R., 1999, *Paleoclimatology: Reconstructing climates of the Quaternary*: Academic Press
- Fagan, B., 2009, *The Great Warming: Climate Change and the Rise and Fall of Civilizations*: Bloomsbury Press
- Kolbert, E., 2006, *Field Notes from a Catastrophe: Man, Nature, and Climate Change*: Bloomsbury, USA
- Mann, M. and Kump, L., 2008, *Dire Predictions, Understanding Global Warming*: DK Adult Pub.
- Parrish, J., 1998, *Interpreting Pre-Quaternary Climates from the Geologic Record*: Columbia Univ. Press
- Ruddiman, W., 2007, *Earth's Climate: Past and Future*: 2nd edition. Freeman Pub.

Articles:

- Alley, R., 2004, *Abrupt Climate Change*: Sci. Amer., v. 265, n. 11, p. 62-69
- Broecker, W. and Denton, G., 1990, *What Drives Glacial Cycles?*: Sci. Amer. v. 251, n. 1, p. 49-56
- Falkowski, P. and others, 2000, *The Global Carbon Cycle: A Test of Our Knowledge of Earth as a System*: Science, v. 290, 13 October, p. 291-96.
- Kasting, J., Toon, O., and Pollock, J., 1988, *How Climate Evolved on Terrestrial Planets*: Sci. Amer., v. 258, n. 2, p. 90-97.
- Ruddiman, W. and Kutzbach, J., 1991, *Plateau Uplift and Climate Change*: Sci. Amer., v. 252, n. 3, p. 66-75
- Stommel, H. and Stommel, E., 1979, *The Year without Summer*: Scientific Amer. V. 240, n. 6, p. 176-186.

Exercise I: Is Global Climate Change Real? We will use NASA/GISS data to explore temperature trends in our hometowns or other chosen locations. See Appendix I.