IDSC 100-01
Sept. 15, 2005

Tipping Point Games, Climate Change, & Climate Data

Context

Climatologists (scientists who study climate) often talk about the two stable modes of operation (e.g., warm vs. cold, wet vs. dry) in a climate system. Abrupt climate change occurs at the transition between these two modes. We'll further explore this idea using models - more familiar and simple "tipping point" games. As you play, think carefully about the characteristics and behaviors that you encounter.

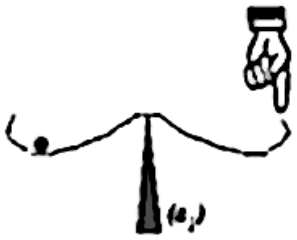
Play the "Tip It" Game

Trish has set up several stations where you can join with 3-4 others to play this game (you can get your own on eBay). You will get brief instructions from Trish. Play the game for a while and have fun. Carefully observe the system's behavior.

When you are done playing a round, talk with your team about your observations and be ready to report back to the full class on the question below.

- What did you observe about this system's behavior? Name as many observations as you can. Jot down answers below.

Thought Experiments: The "Tippy Balance"



In this game, there are two "wells" where the ball is most stable. Using this balance to reason by *analogy* to the climate system, answer the following questions about climate behavior.

1. First, identify and label the parts of the tippy balance system that represent a "regime," "perturbation," and "threshold point" in the climate system (label figure at above right).

2. Think about **various types of climate perturbations when starting in a stable climate regime** (in our analogy, the ball starts in a well and you poke the balance).

a. If the climate system experiences a *gentle perturbation* which lasts only a short time (in the analogy, a gentle quick push of a finger on the well opposite to the ball, shown above), how will the climate system likely respond?

b. What might happen to the climate system if the perturbation is *extremely sudden*, or *much stronger*? (Think about slamming the opposite arm of the balance down—where will the ball go?) How confident are you of your prediction?

c. Based on what you already know, speculate on several specific perturbations in our climate system (natural or human-made) that might cause a climate "regime shift".

3. Now think about **what happens when the climate resides at or near a tipping point** (the ball begins at the sharp tip, or the threshold point, and you poke the balance).

Figure 2

a. Starting in this precarious configuration, how extreme would a perturbation need to be in order to cause the system to change modes?

b. What do you think happens to the predictability of the climate system as it approaches the threshold, or the tipping point?

c. **Challenge question**: Do you think we have any way of knowing whether our climate is currently near a threshold or tipping point?

Questions to Consider

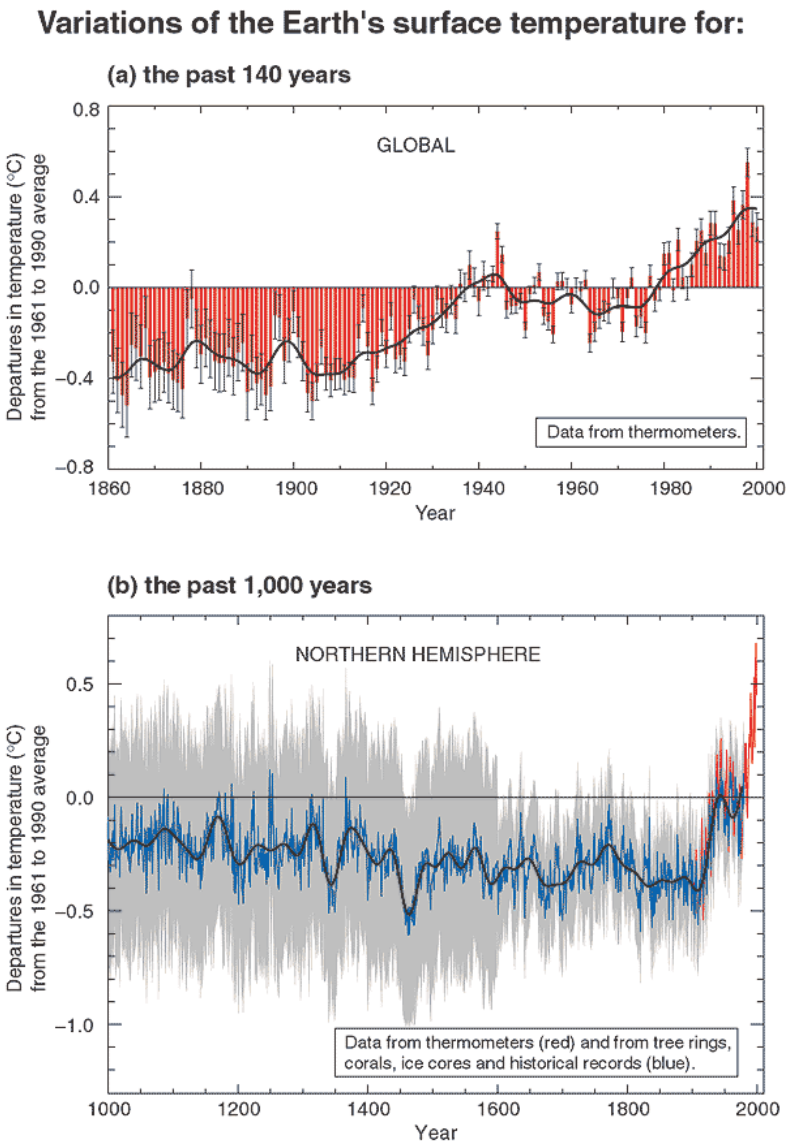
Look at the average global surface temperature data plots on p. 4 and read the figure captions carefully (color coding should help). Read the y axis label carefully; the temperature scale is relative.

1. Carefully describe the trends and findings in the plots.

2. By about how much has the average global temperature increased in the last ~150 years? In the last 1000 years?

3. If global average temperatures continue to increase (for whatever reason), what are the different ways in which the climate might respond? Use what you've just learned to draw in a curve for your prediction(s) that continues into the future, for the top plot.

4. What questions do these data raise in your mind?



From IPCC Climate Change 2001: The Scientific Basis. Summary for Policy Makers. http://www.grida.no/climate/ipcc_tar/wg1/figspm-1.htm . Figures captions modified from this source.

(a) For the 140 years before the year 2000, the Earth's **global surface temperature** is shown **year by year (red bars)** and approximately **decade by decade** (**bold black line**, a smoothed annual curve suppressing fluctuations that occur on timescales of less than a decade). *Uncertainties* due to a variety of sources are shown in the annual data by *thin black whisker bars* that represent the 95% confidence range.

(b) Same data as in (a) on far right of plot. Additionally, the **year by year (blue curve)** and **50 year average** (**bold black curve**) variations of the **average surface temperature of the Northern Hemisphere for the past 1000 years** have been reconstructed from "proxy" data calibrated against thermometer data (see list of the main proxy data in the diagram). The 95% confidence range of *uncertainty* in the annual data is represented by the *grey region*.