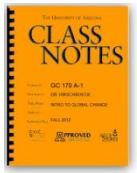
Topic #3 – Part II: QUANTIFYING GLOBAL CHANGE:

Time Series Plots (cont.) & Footprints



OBJECTIVES FOR TODAY'S CLASS:

Finish discussing issues related to QUANTIFYING NATURE in Global Change

Use the proper terminology to describe changes depicted in TIME SERIES graphs

Get on overview of the ECOLOGICAL FOOTPRINT concept

- **Get an overview of the Linking-to-Life Term Project, including PART A (assigned today & due Friday)**

GLOBAL CHANGE

"The one universal ever-operating law throughout has been the law of change . . ." ***~ Laurence M. Gould***

Earth has always been changing in:

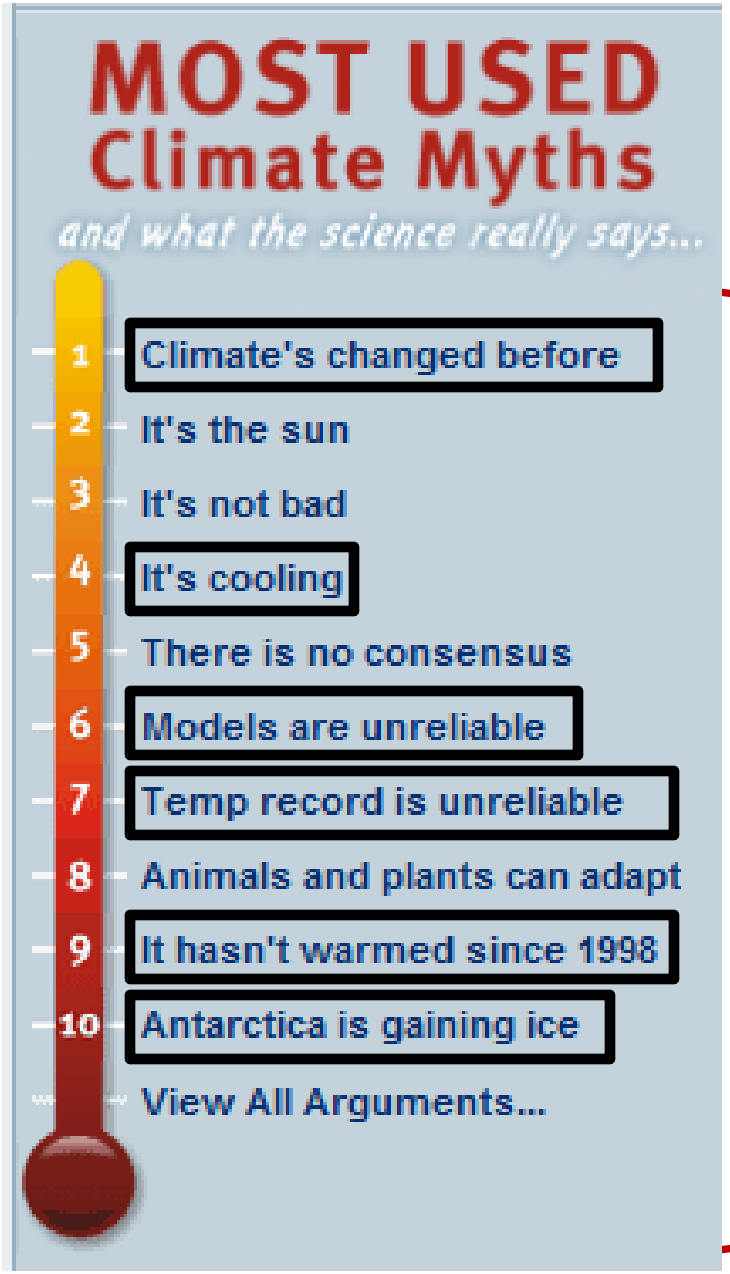
Atmosphere (gases – composition, abundance, vertical structure

Solid Earth (core, mantle, crust, plate tectonics, volcanism, surface processes)

Hydrosphere (liquid, gaseous, solid)

Biota (biosphere) (animal & plant life)

. . . .and in patterns and distribution of the above



How can claims like these be evaluated?

"Time Series" analysis!

IN-CLASS ACTIVITY

"Think-Pair-Share"
Exercise on:
PLOTTING CHANGE OVER TIME

RECOGNIZING & DESCRIBING DIFFERENT TYPES OF CHANGE AS DEPICTED IN TIME SERIES PLOTS

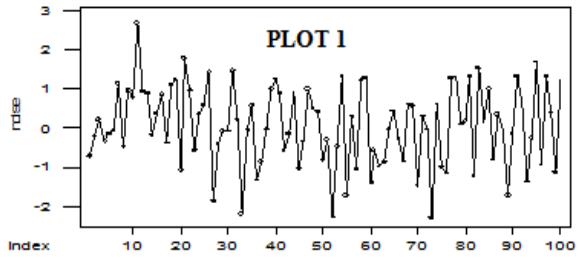
Here are some terms that will help you describe time changes more precisely in fewer words:

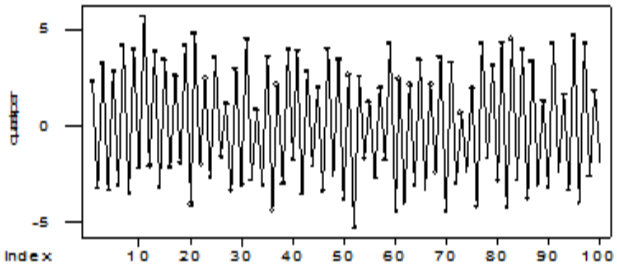
- **Mean** = average (a constant mean stays the same over time and looks like a horizontal line.)
- **Variance** = the range of fluctuations (wiggles) above and below the mean (statistically the variance is the square of the standard deviation about the mean)

Terms (cont.)

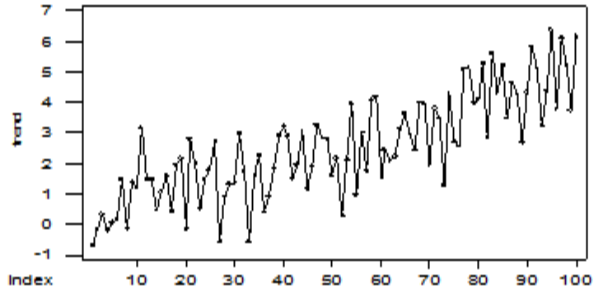
Periodic = perfect oscillations (fluctuations) (going up and down regularly or in a perfect wave-like motion)

- **Quasi-periodic** = almost regular oscillations (in nature things are quite often quasi-periodic rather than perfect oscillations)
- **Trend** = a line of general direction (increasing or decreasing)

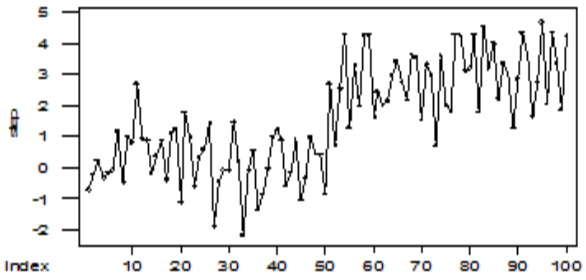




PLOT 2

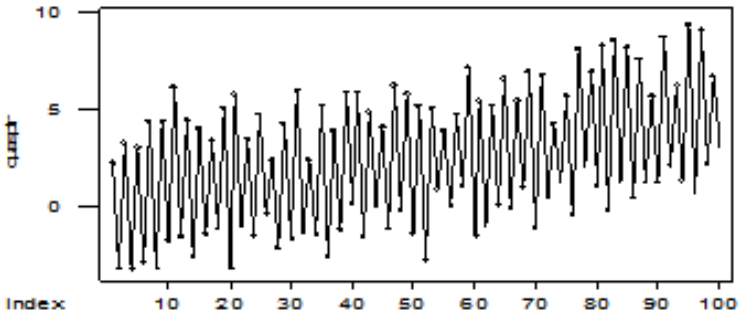


PLOT 3

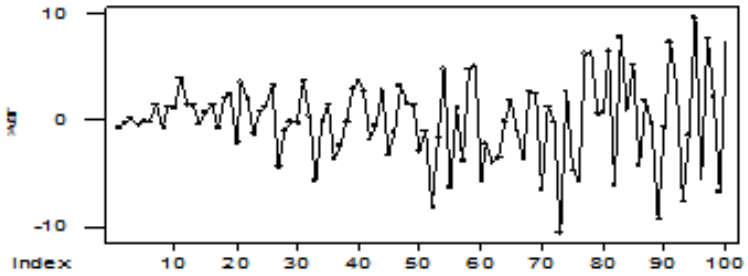


PLOT 4

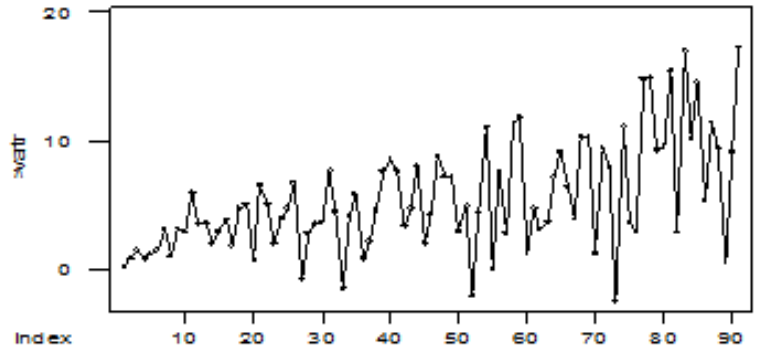
PLOT #1: "White noise" (random fluctuations) but with constant mean and variance [answer given for you]



PLOT 5



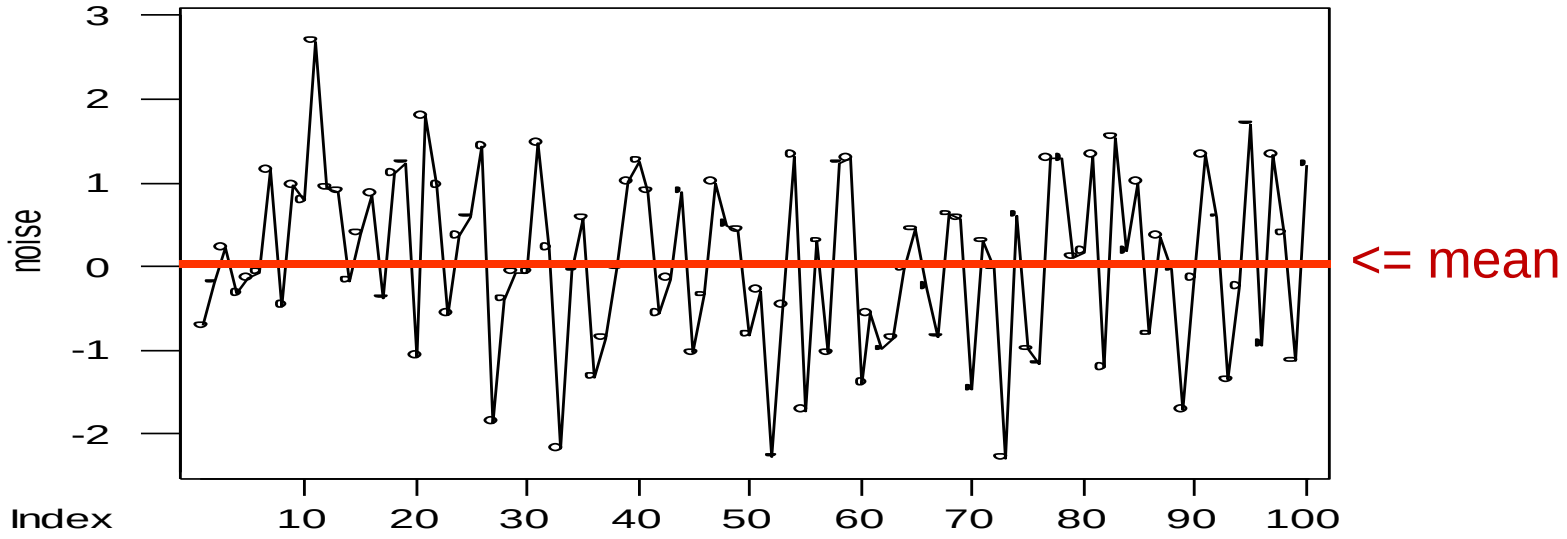
PLOT 6



PLOT 7

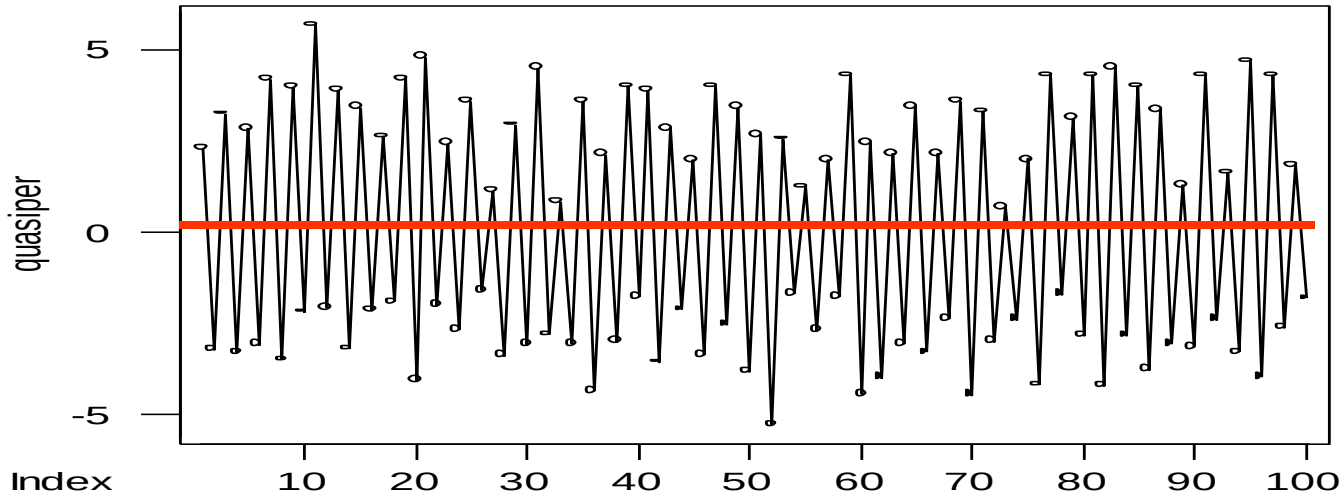
YOU FILL IN THE REST!

Time Series Plot 1



"White Noise" or "Random"plot -- This plot appears to go up and down without any regular pattern (e.g., randomly); there are about as many points above the time series mean (average) as below; and the range of wiggles (variance) above and below the mean seems to be about the same over time.

Time Series Plot 2

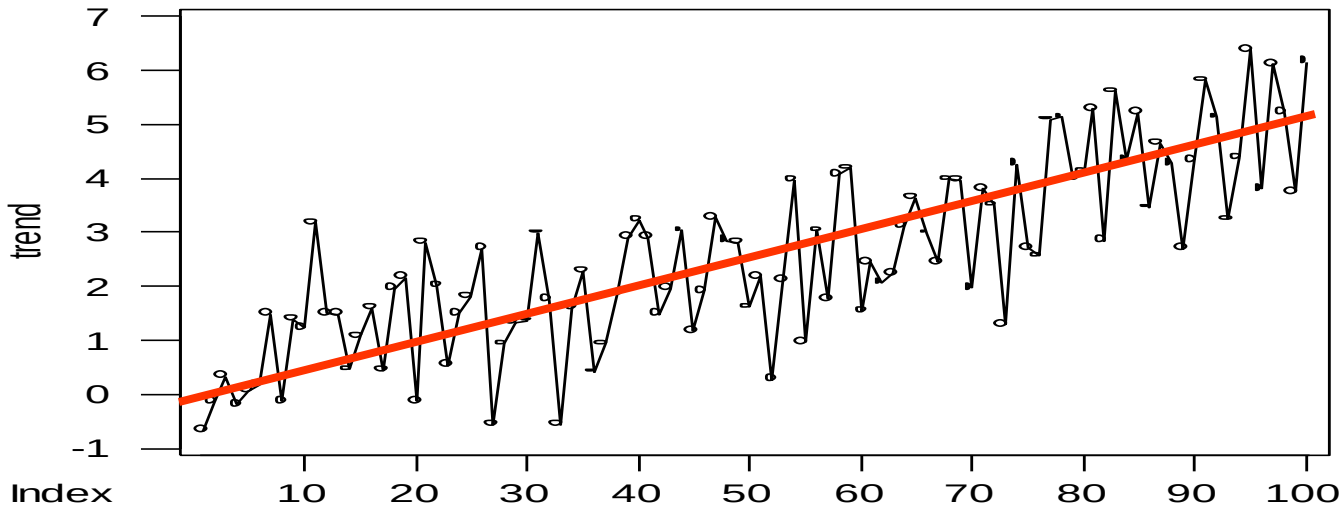


Regular ups and downs . . . but not perfect . .

Is the mean constant?

Is the variance constant?

Time Series Plot 3

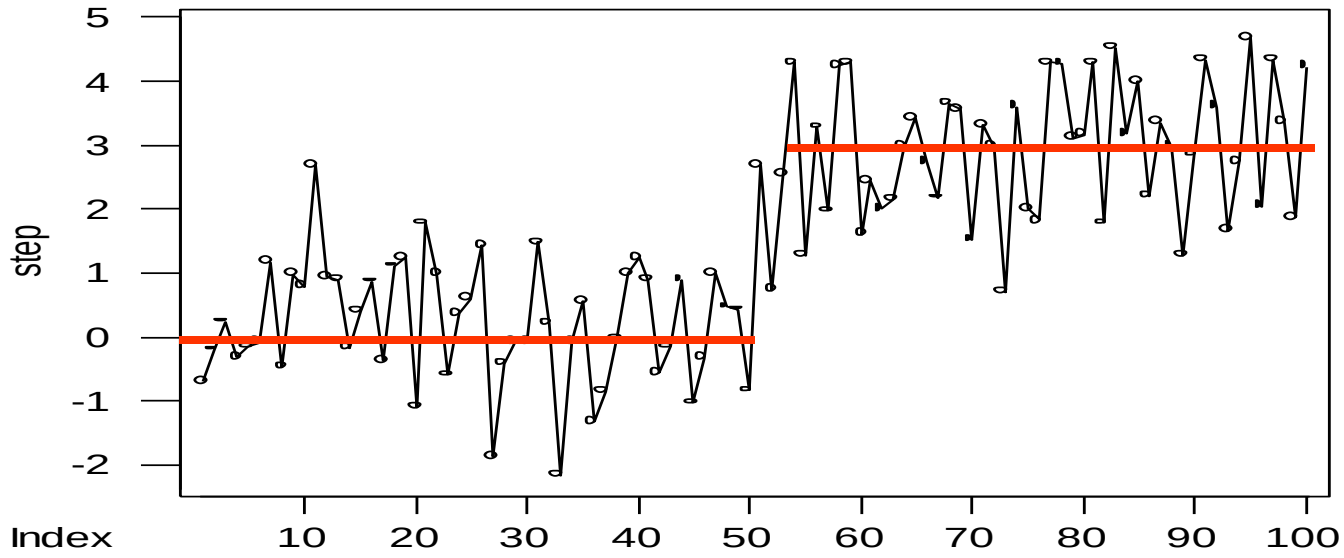


Hmmm, something is changing here . . .

What's happening to the mean?

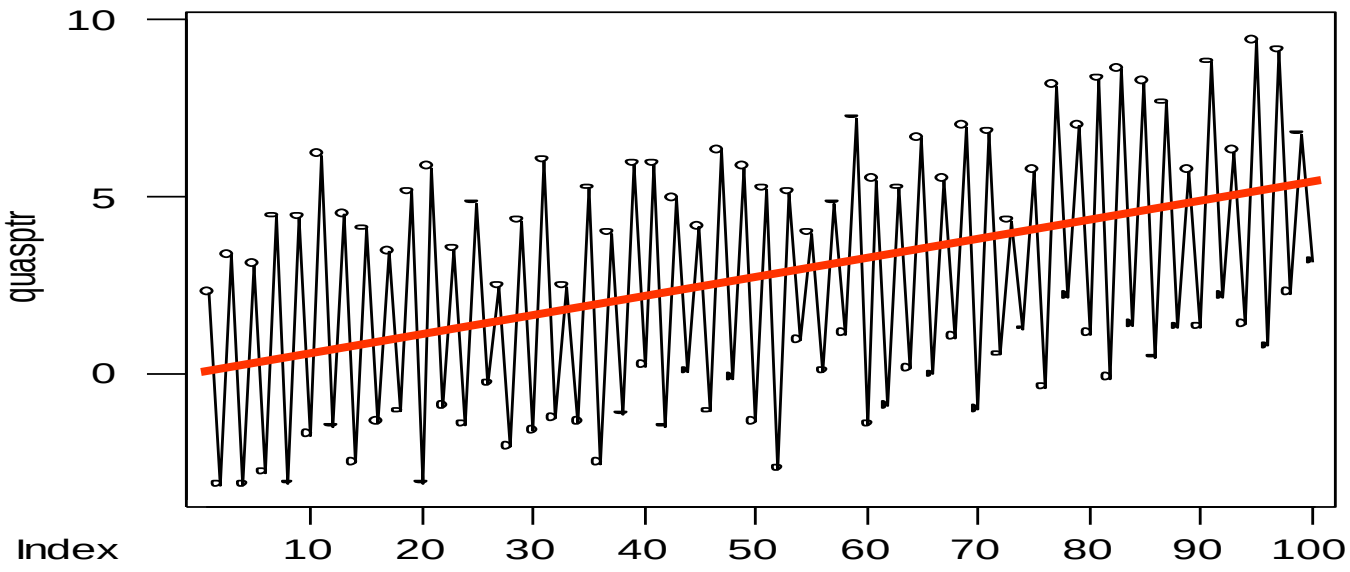
Is the variance constant?

Time Series Plot 4



Looks a little like a "set of stairs" with an abrupt jump between two series, each with a constant _____

Time Series Plot 5

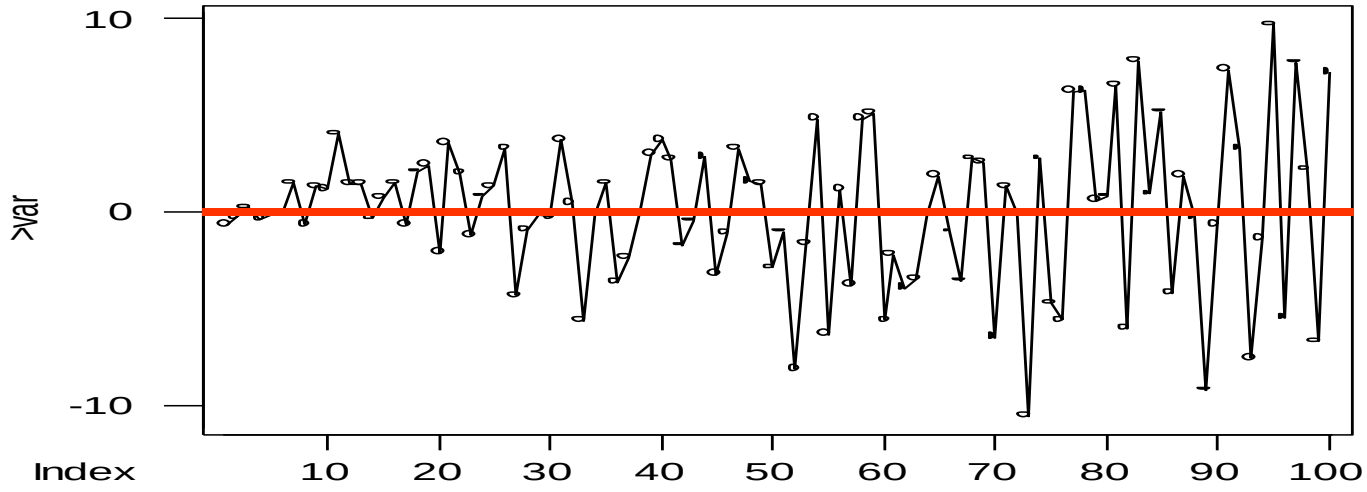


Looks like Plot #3, but it's different – in what way?

What's going on with the mean?

The variance?

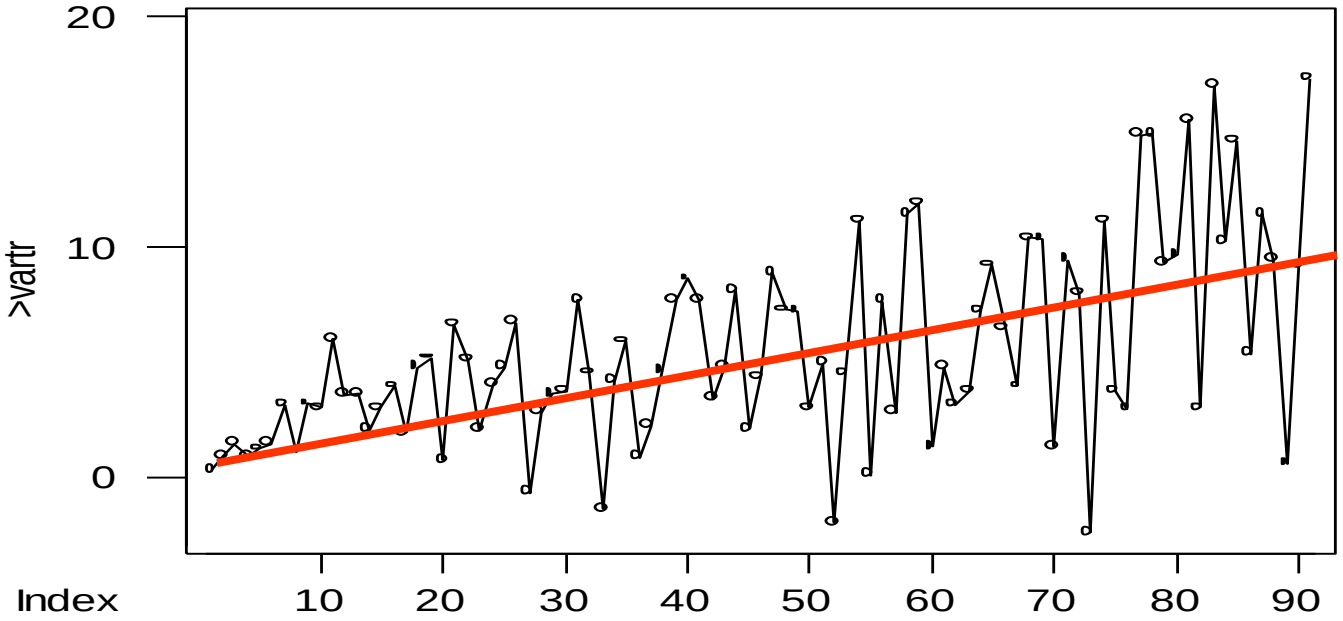
Time Series Plot 6



What's going on with the mean?

The variance?

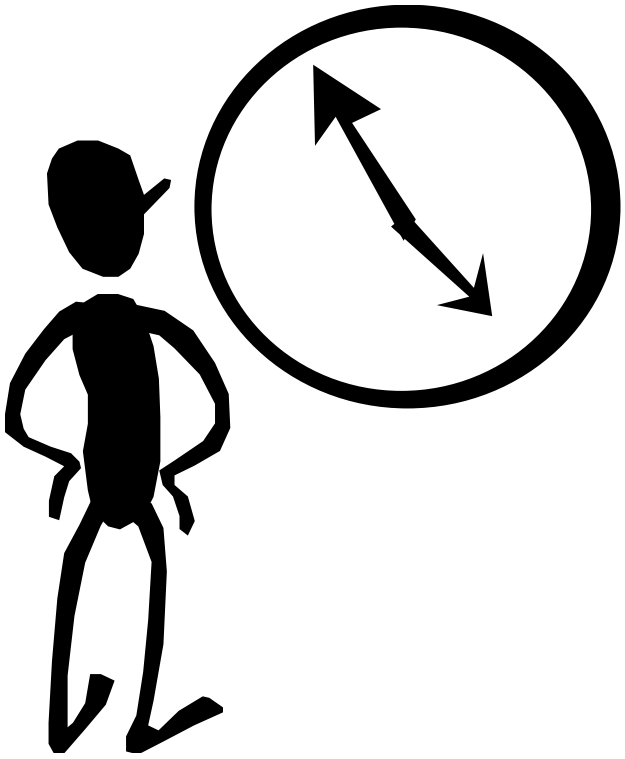
Time Series Plot 7



Is there a trend?

What's going on with the mean over time?

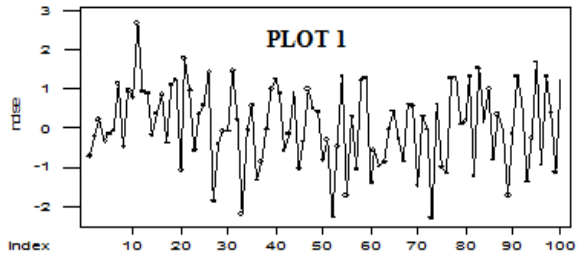
What's going on with the variance?



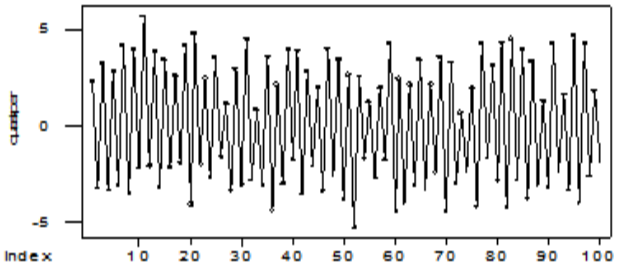
IT'S TIME TO END YOUR DISCUSSION . . .

PLEASE WRAP IT UP AND QUIET DOWN.

ANSWERS TO TIME SERIES GRAPHS

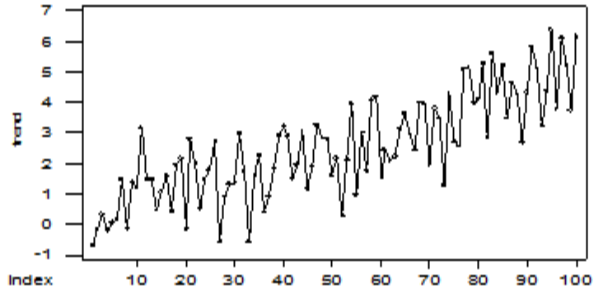


PLOT #1: "White noise" (random fluctuations) but with constant mean and variance [answer given for you]



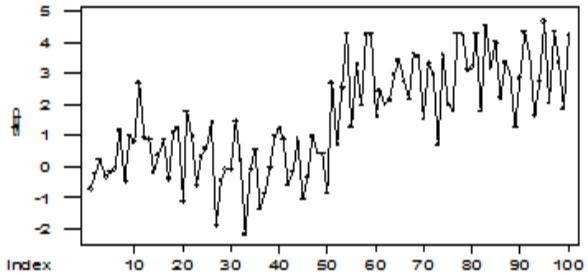
PLOT 2

PLOT #2: "Quasi-periodic plot" with constant mean and variance.
[Graph goes up and down very regularly (periodically); the mean stays the same, the range of fluctuations above and below the mean stays about the same over time.]



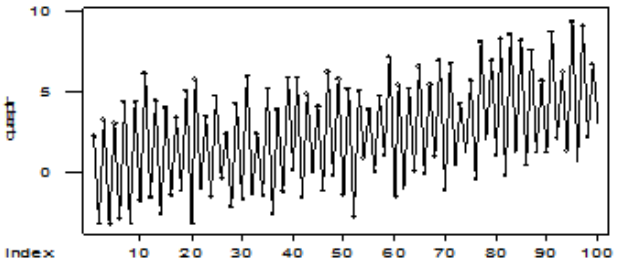
PLOT 3

PLOT #3: "Trend" plot with the mean increasing over time, but a constant variance. [Graph shows trend of increasing values and increasing mean; the range of fluctuations is about the same.]

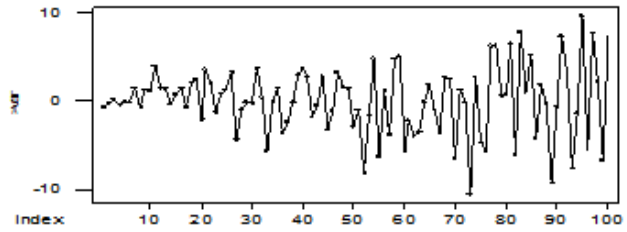


PLOT 4

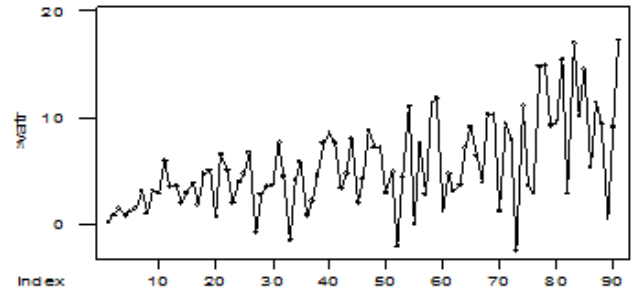
PLOT #4: "Step Change" plot with an abrupt jump between two series like Plot 1.
[Graph shows a "jump" or abrupt change between two different time series, each having a constant mean and variance]



PLOT 5



PLOT 6



PLOT 7

PLOT #5: "Quasi-periodic with upward trend" plot

[Graph shows an increasing trend and increasing mean, but has regular periodic ups and downs above and below the increasing mean.]

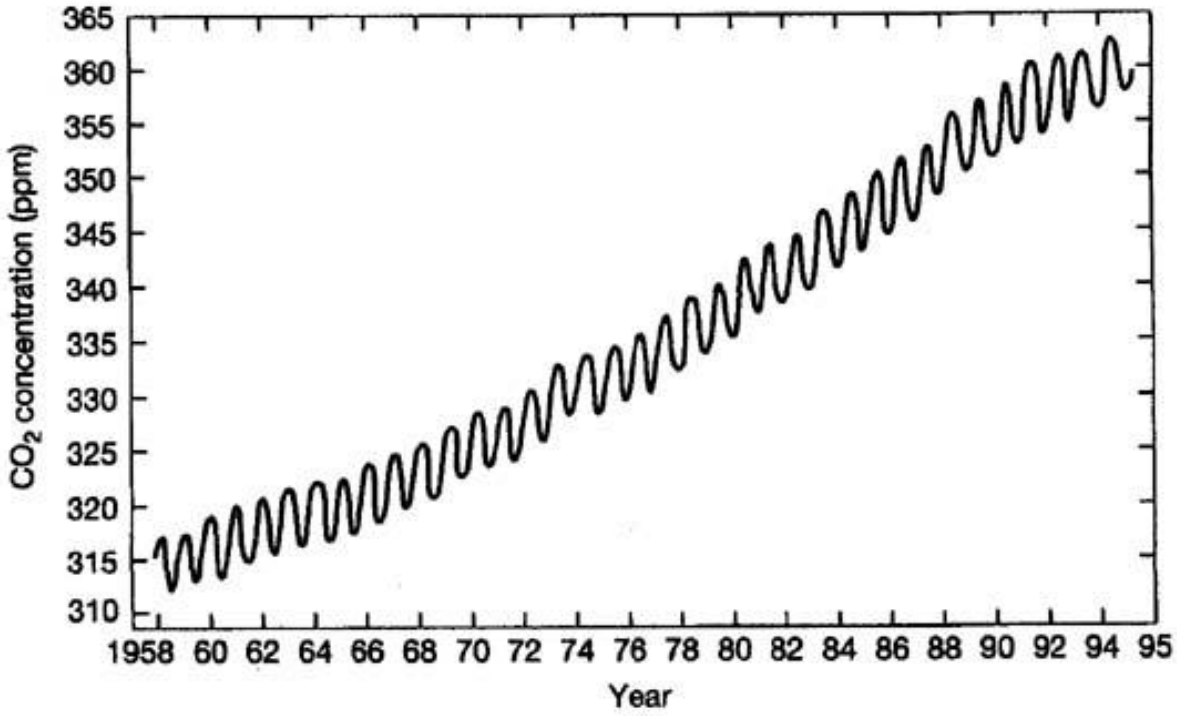
PLOT #6 "Increasing variance but constant mean" plot.

[Graph's mean is constant but the range of fluctuations above and below the mean increases over time.]

PLOT #7 "Trend with increasing mean and increasing variance" plot

[Graph had both an increasing mean and an increase in the range of fluctuations above and below the mean over time – the extremes are getting bigger!]

the “Keeling curve” is most like Plot # ____ ?



Answer = Plot #5 WHY?

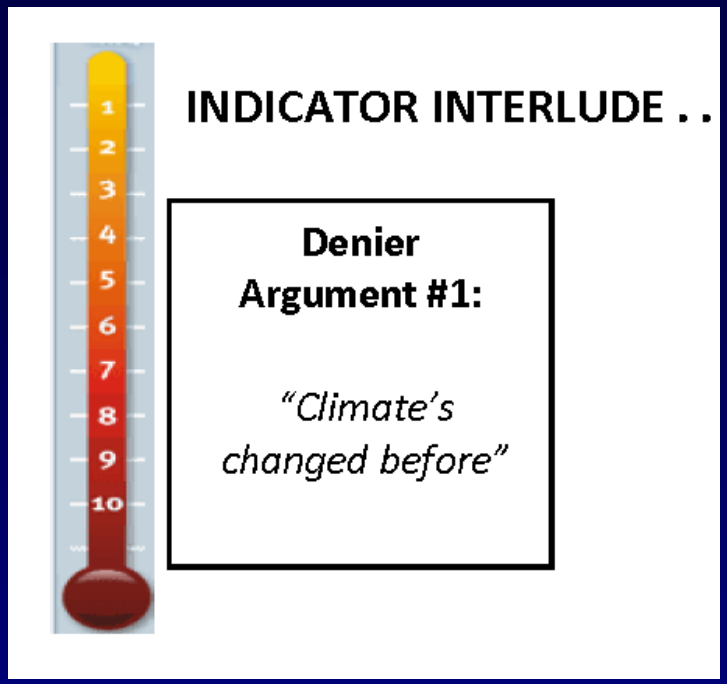
The Keeling curve shows an increasing trend with a regular-to-quasi-periodic oscillation.

(Plot #3 is the second best answer, but Keeling curve is much more periodic.)

But what's the difference between TRENDS & UP & DOWN VARIATIONS???

http://www.youtube.com/watch?v=e0vj-0imOLw&feature=player_embedded

http://www.skepticalscience.com/going-down-the-up-escalator-part-1.html



Response:

Yes, the climate has changed before – see the times series plots we just looked at!

Scientists have studied this thoroughly for years and no one disputes this.

Natural climate change in the past PROVES that climate is sensitive to an energy imbalance.

If the planet accumulates heat, global temperatures will go up.

Currently, increased amounts of CO2 are imposing **an energy imbalance** due to the enhanced greenhouse effect.

Past climate change actually provides evidence for our climate's sensitivity to CO2.

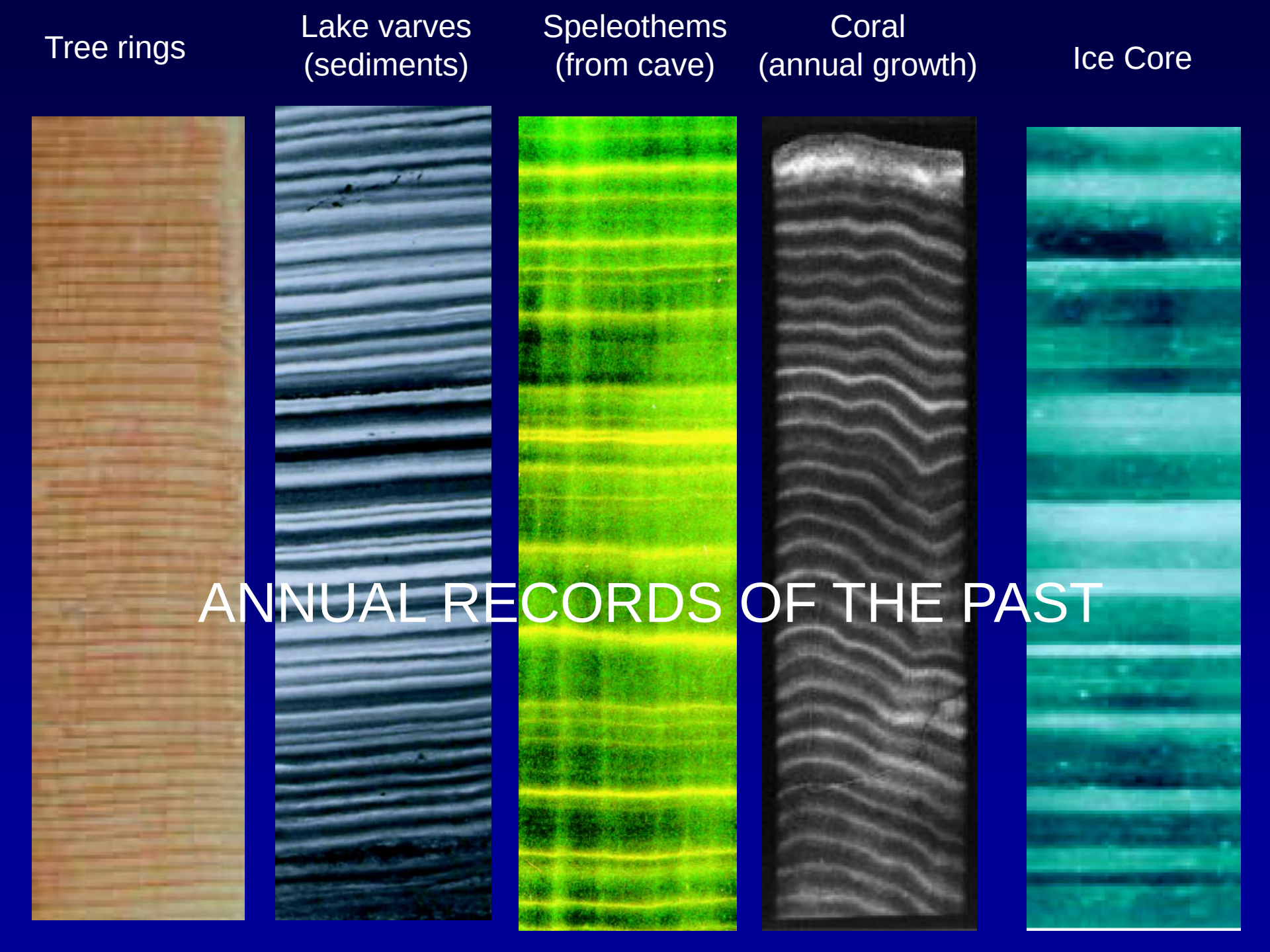
To make an incontrovertible case about the role that humans play in global warming, what do scientists need?

1) a long-term temperature record, i.e., centuries
2) over a large part of the globe
3) To be able to say . . . . .

"What's the average been for several hundred years, & is this a significant departure from that?"

"And that's very difficult to do."

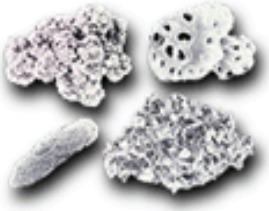
(James Trefil, physicist)

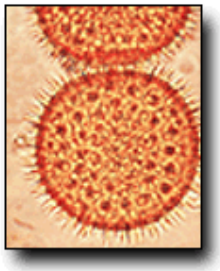

Tree rings
Lake varves (sediments)
Speleothems (from cave)
Coral (annual growth)
Ice Core
ANNUAL RECORDS OF THE PAST

“PROXY” DATA or NATURAL ARCHIVES of CLIMATE

Corals

Ice cores





Pollen

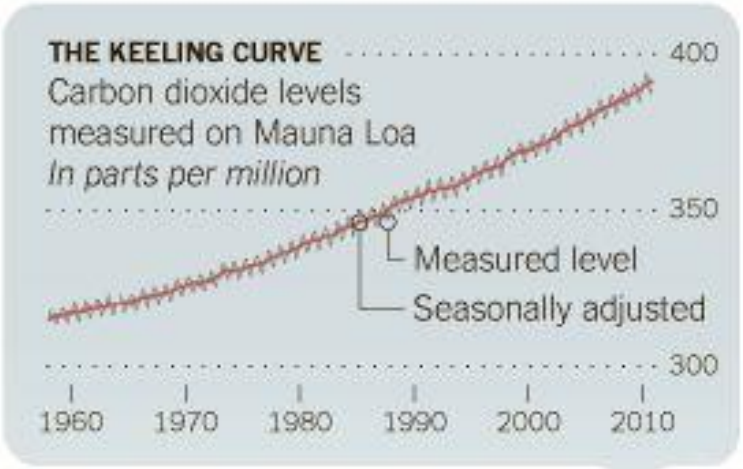
Lake, bog & ocean sediments

The New York Times December 22, 2010

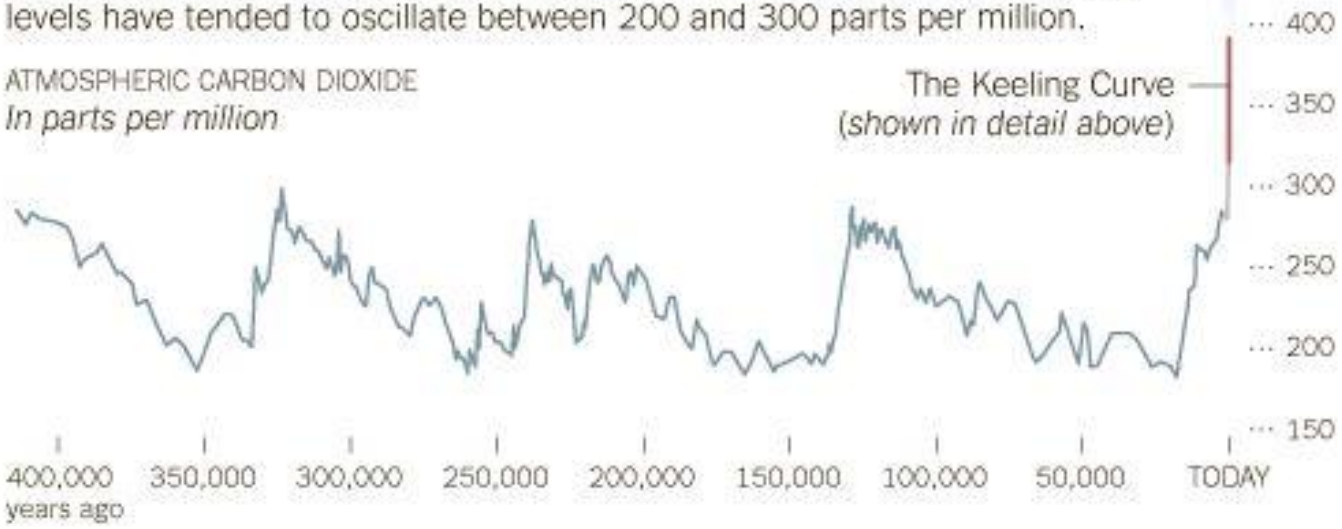
An Ominous Rise

Charles David Keeling began taking precise measurements of carbon dioxide in the atmosphere in the 1950s.

The graph of his findings, known as the Keeling Curve, shows that the amount of carbon dioxide is rising continuously over time.



PAST LEVELS OF CARBON DIOXIDE can be measured in air bubbles trapped in Antarctic ice. Samples dating back nearly half a million years suggest that levels have tended to oscillate between 200 and 300 parts per million.



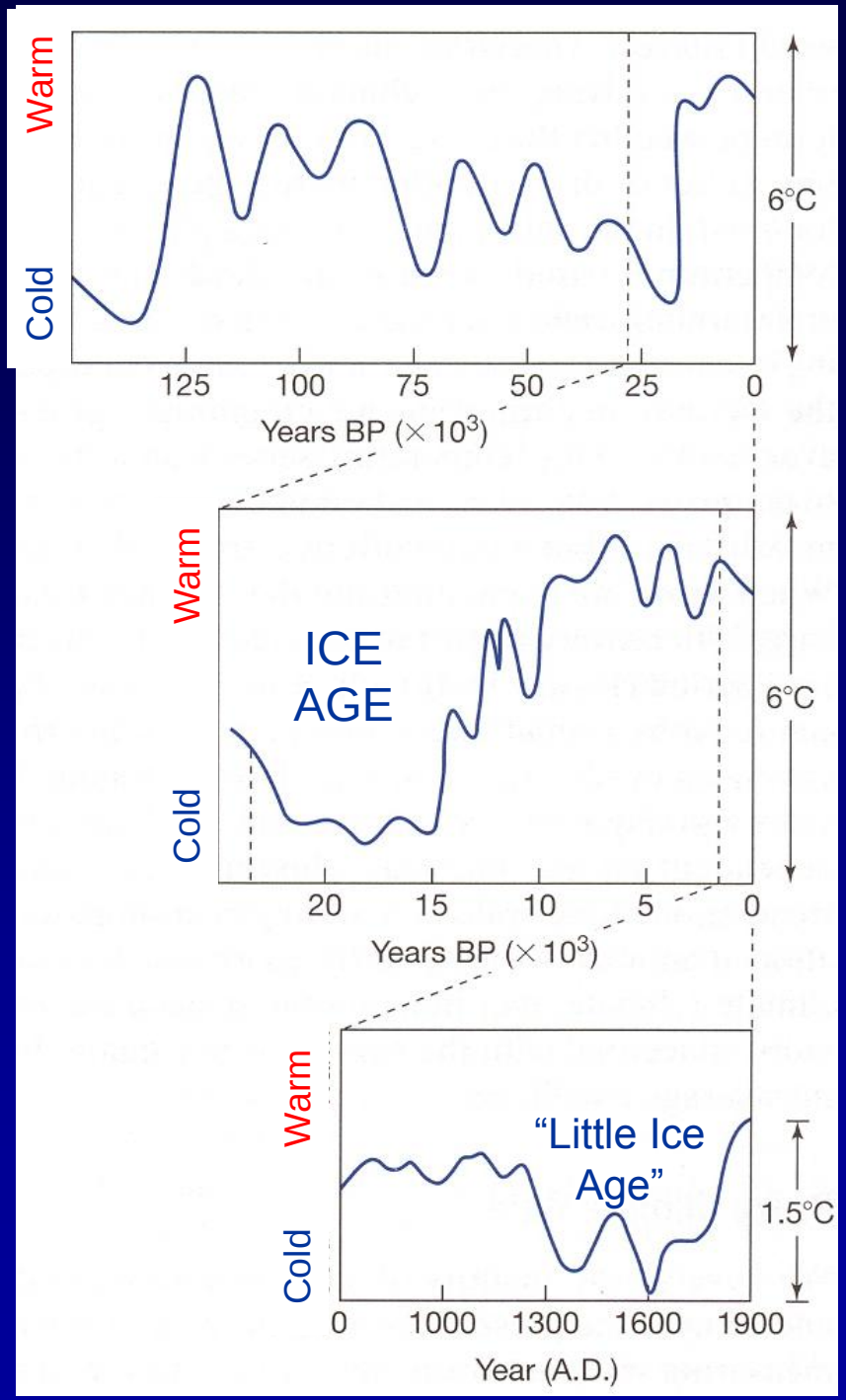
http://www.youtube.com/watch?v=SXHDwdd7Tf8&lr=1

WHAT NATURAL ARCHIVES REVEAL:

Over different "Telescoping" Time Scales Of Variability about:

Mean Global Temperature Change

Since The Last Glacial Maximum
(Years BP = "years before present")

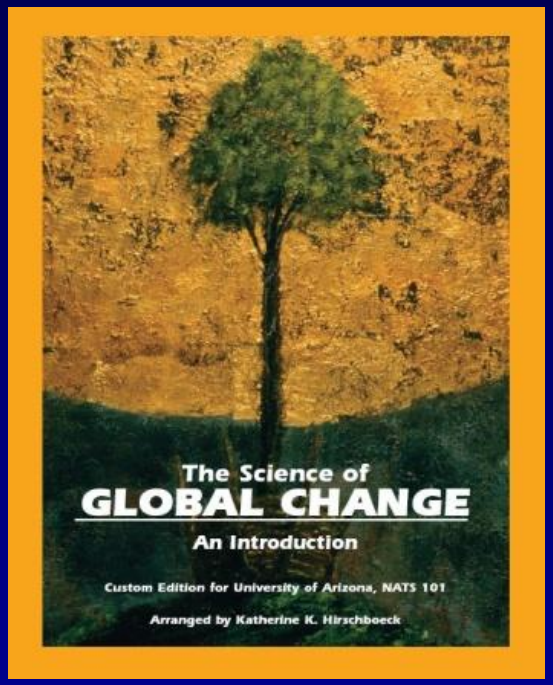


Generalized oxygen isotope curve from deep-sea sediments

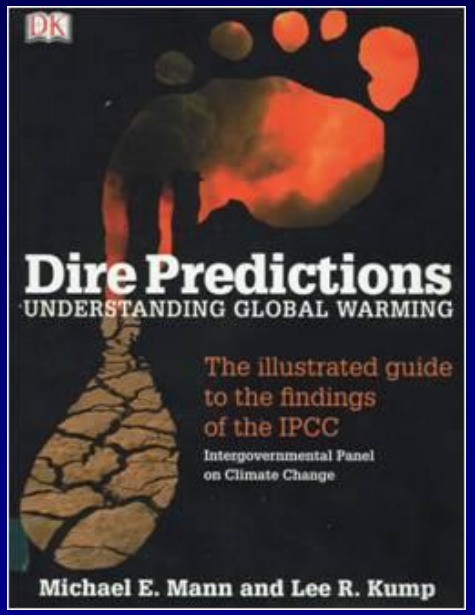
Generalized estimates from pollen data & alpine glaciers (mid-latitudes of eastern N. America & Europe)

General estimates from historical documents (emphasis on the North Atlantic region)

YOUR 2 TEXTBOOKS:



E-TEXT

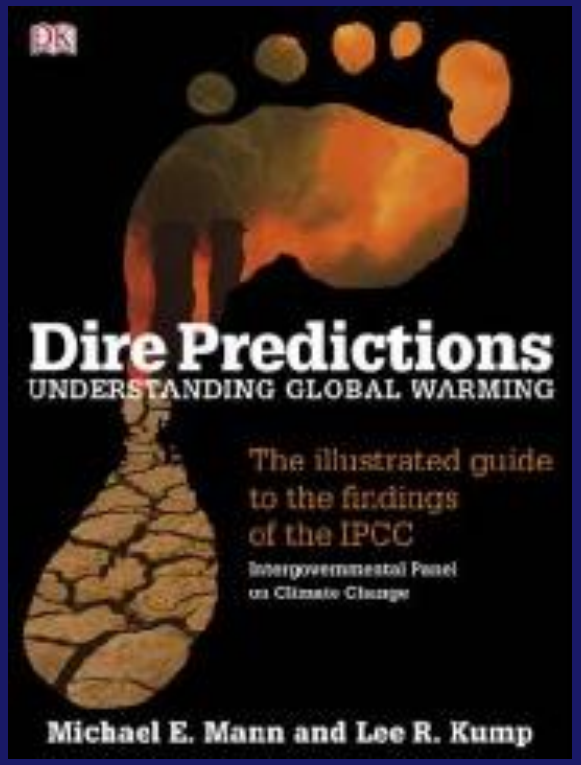


READING ASSIGNMENTS:

CLASS NOTES p 4 also online

http://fp.arizona.edu/kkh/nats101gc/Reading-and-RQ-schedule.htm

YOUR FOOTPRINT!



For FRIDAY Aug 31st:
Bring in the results of Linking-to-Life PART A: YOUR FOOTPRINT (worth 5 pts)

- http://www.footprintnetwork.org/en/index.php/GFN/page/calculators/

A Tool for Quantifying Global Change Impacts: **"The Footprint" Concept**

Examples: Ecological Footprint, Carbon Footprint, Water Footprint

Your Ecological Footprint = A measure of how much area of Earth's biologically productive land and water you require . . .

(a) to produce all the **RESOURCES** you consume , and

(b) to absorb the **WASTE** you generate

. . . . using prevailing technology and resource management practices.

The Ecological Footprint

MEASURES

How fast we consume resources and generate waste

Energy

Settlement

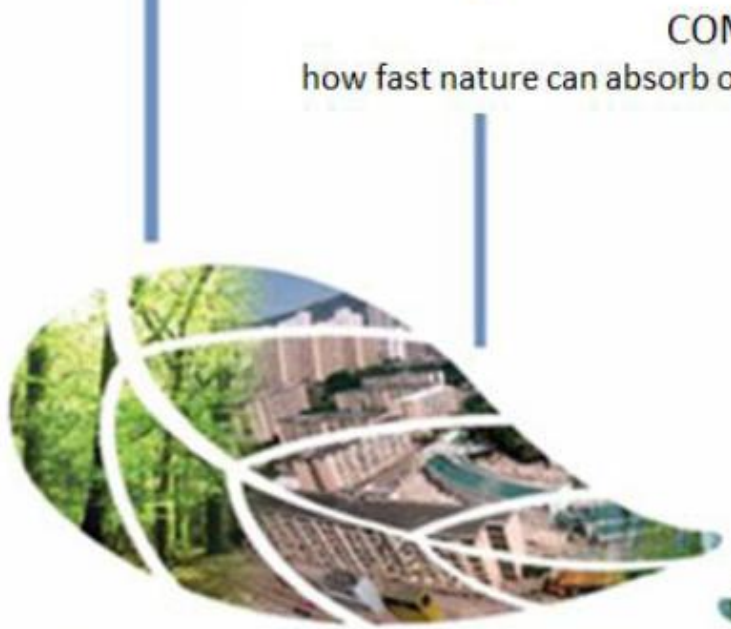
Timber & paper

Food & fiber

Seafood

COMPARED TO

how fast nature can absorb our waste and generate new resources



Carbon footprint

Built up Land

Forest

Cropland & pasture

Fisheries

The Ecological Footprint includes the **AREAS for producing the resources consumed, the SPACE for accommodating** buildings and roads needed, and the **ECOSYSTEMS for absorbing the waste emissions, such as carbon dioxide.**

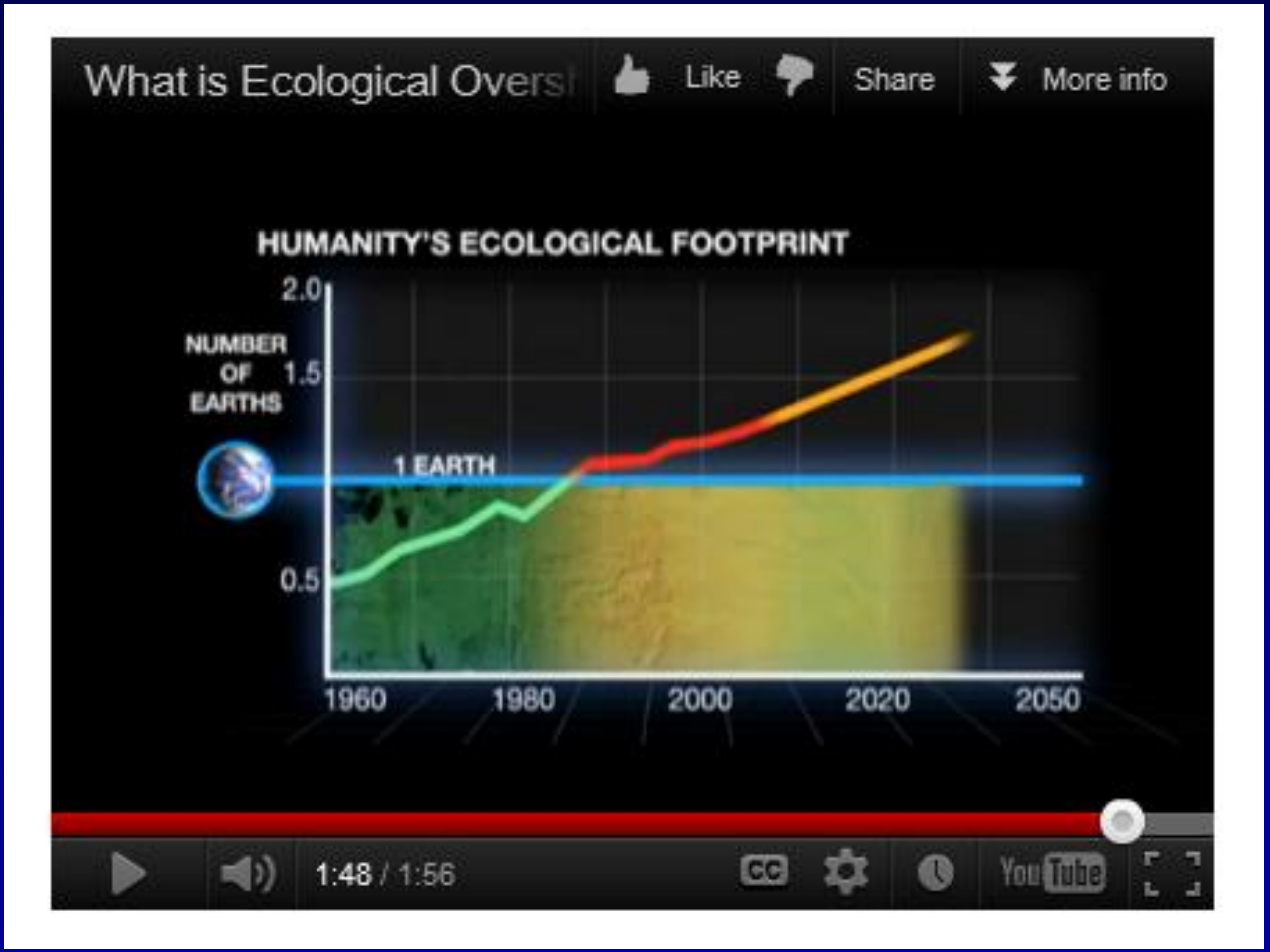
The Ecological Footprint is usually measured in GLOBAL HECTARES (or sometimes, number of "Earth's needed").

(This is because trade is global and therefore an individual or country's Ecological Footprint includes land or sea from all over the world.)

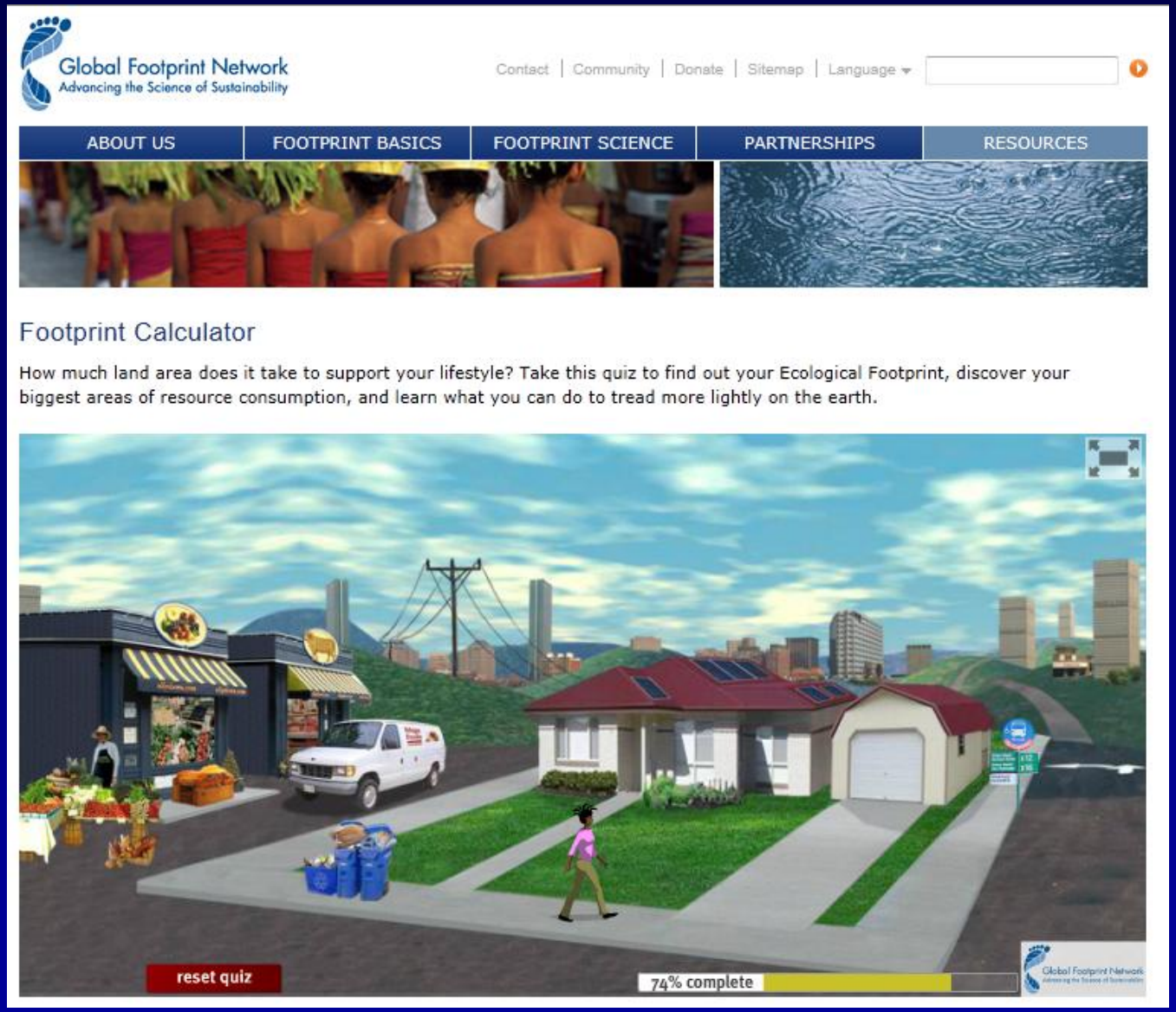
The Footprint can be computed for an individual, a particular activity, a group of people, or an entire nation

Was last Wednesday, Aug 22 . . . .!
20 year as ago, in 1992 it was Oct 21

http://www.footprintnetwork.org/en/index.php/GFN/page/video_overshoot_explained/

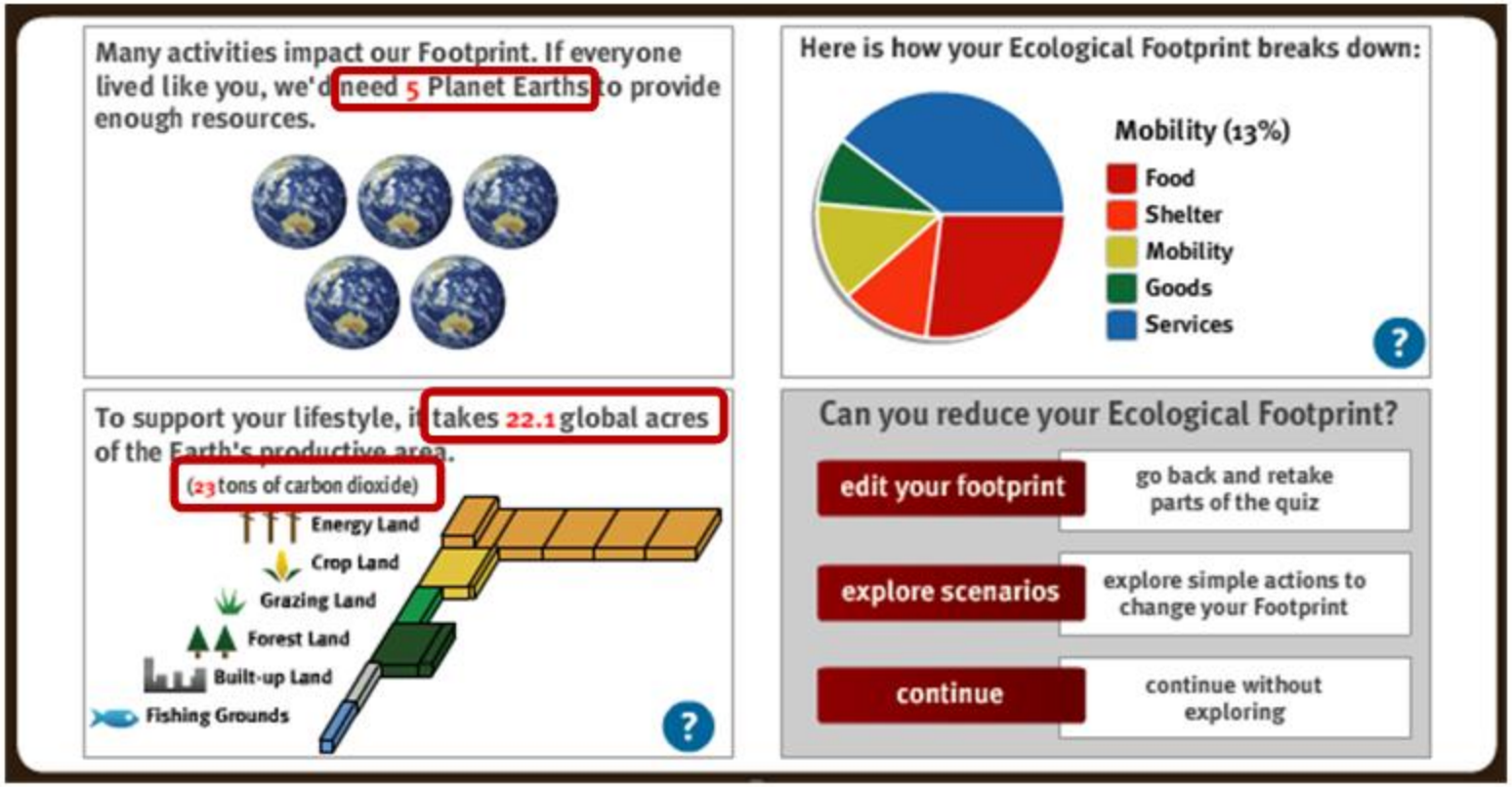


ECOLOGICAL FOOTPRINT CALCULATOR



http://www.footprintnetwork.org/en/index.php/GFN/page/calculators/

USA AVERAGE Ecological Footprint (based on 2008 data)

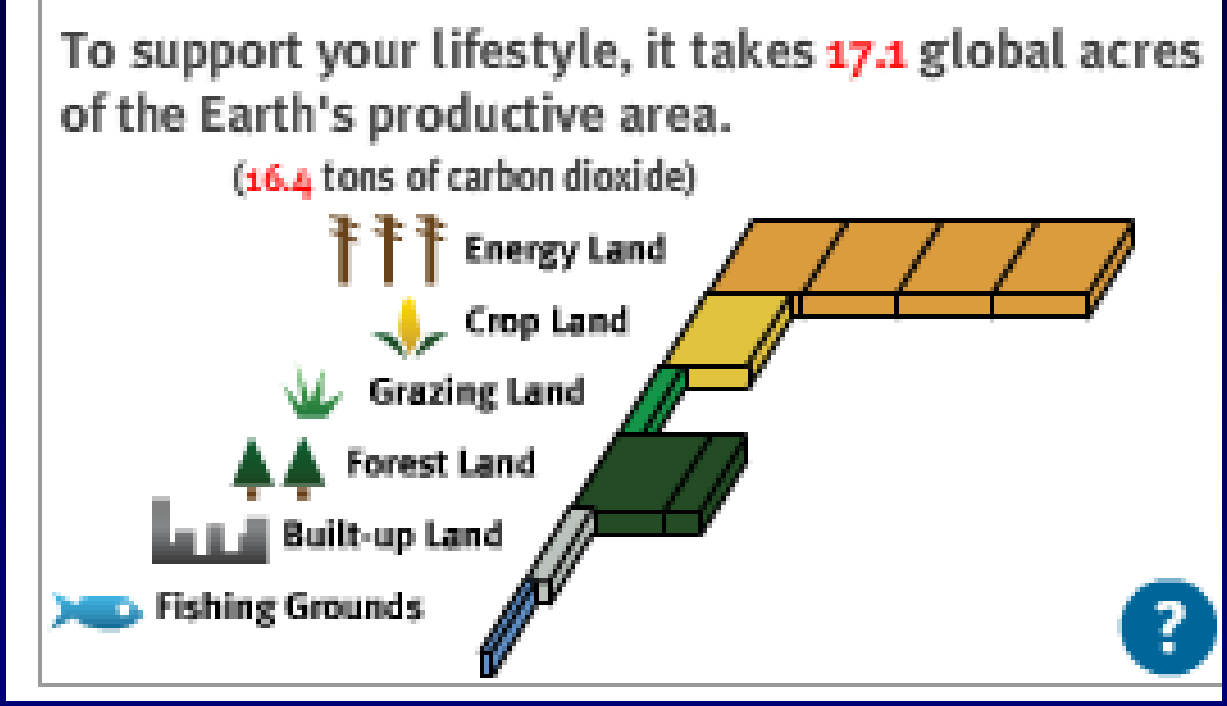


The Ecological Footprint calculator "represents the amount of land and sea area needed to provide the resources a person needs (food, shelter, etc.), and absorb the wastes they create (including carbon dioxide)"

SOURCE: http://www.footprintnetwork.org/en/index.php/GFN/page/footprint_calculator_frequently_asked_questions/

The Ecological Footprint results box:

What does it mean?



The large amount of **'ENERGY LAND'** needed to support the average lifestyle of someone in the United States represents **the global land area** (primarily forest, but also ocean) **needed to "uptake" the CO_2 "waste" emitted** in the USA due to energy use (coal fire plants, auto emissions, etc.)

The **'SERVICES'** category includes **activities "that are not considered personal, but societal.** These areas include (but are not limited to) health care, entertainment, restaurants, real estate, legal services, government and the military.

Everyone taking the quiz has a portion of their nation's "services" Footprint allocated to them.

PROJECT PART A
SIMPLIFIED DIRECTIONS:

1) Compute Footprint
http://www.footprintnetwork.org/en/index.php/GFN/page/calculators/

2) Save in a document and date it

3) Write a short summary of what you noticed about what's contributing to YOUR footprint (1 paragraph)

4) Deposit in the D2L Dropbox

LINKING-TO-LIFE TERM PROJECT OVERVIEW

(worth a total of 60 pts)

Part A Your Ecological Footprint (5 pts)

Part B Thinking More Deeply (10 pts)

Part C Film Review Discussion Posts (10 pts)

Part D Final Project Report (35 pts)

OBJECTIVE: The goal of your "personal project" is to investigate and/or creatively explore a question of importance to you that connects some aspect of Global Change science (as addressed in our GC 170A1 class this semester) to YOUR everyday life (e.g., personal interests, curiosity, academic major, present or future consumer choices, future profession, social /environmental concerns, etc.)

To accomplish this goal you will:

- **pose a question** (after thinking deeply about a few possibilities)
- **investigate it by collecting data and relevant information**
- **analyze and present the information visually** (tables, charts, images)
- **draw a conclusion** (about what you learned, discovered, decided)
- **prepare a report summarizing and illustrating the above**

OVERVIEW:

The assignment involves the following steps:

1. **PART A: YOUR ECOLOGICAL FOOTPRINT** - To get you started on how things you do in your everyday life link up to many of the issues we'll be covering in this class, the first assignment will be to calculate your Ecological Footprint.

2. **PART B: THINKING MORE DEEPLY** - In this assignment, you will explore and think about aspects of science, our class, and select one or more of the suggested project categories that interest you. The goal is to begin formulating a question that you will investigate for your project.

3. **PART C: FILM REVIEW & DISCUSSION** -- For this assignment you will view one of the full-length films which will be posted in D2L for different project categories. You will also watch two (or more) of the shorter videos. The films will give you background information (and probably raise some issues) about consumerism, sustainability, and the environment. Hopefully they will also spark some ideas on what you might want to learn about or investigate for your personal project. **Descriptions of the FILMS & VIDEOS available for viewing**

4. **PART D: FINAL REPORT** -- For this assignment you will collect the data/information you need, analyze or interpret it by organizing your supporting information, and draw your conclusion based on the supporting information. You will then design ways to present your findings visually and summarize your findings in a report.

TWO IMPORTANT GUIDELINES TO HELP YOU IN YOUR TERM PROJECT:

#1. The most *critical* element of your Final Project Report (PART D) is **how accurately and effectively you link your project topic and question to our GC 170A course material!** There are many questions you could pursue as you explore your topic this semester, but do not get sidetracked on an issue that doesn't link directly to one of our class topics.

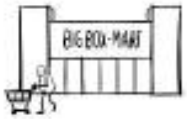
#2. To assist you in **focusing on topics related to the course** that are also **linked to your life,** we will start out with **PART A** calculating your **ECOLOGICAL FOOTPRINT** -- (a simple and fun way to earn the first 5 points of the term project! In fact, depending on what you end of doing for your project, you may end up calculating your footprint several times during the semester. The calculation for PART A will be a baseline with which you can compare -- and also

FOOTPRINT CALCULATOR FOR PART A:
http://www.footprintnetwork.org/en/index.php/GFN/page/calculators/

When you are done, your results will be displayed on the screen in a box that looks like the image below. MAKE A SCREEN SHOT of this image and be sure you **save it in a doc (indicating the date you calculated your footprint). You will use this in class and mayb need to refer back to later in the semester as your project**

PROJECT CATEGORIES

See category choices below or devise your own.

PROJECT CATEGORY	Earth's Global Environment	Energy Conservation	Transportation Options	Water Sustainability	Food & the Environment	Artistic Expression / Advocacy	GC-Savvy Consumerism, Sustainability & Business
							
POSSIBLE QUESTIONS *You are encouraged to come up with your OWN question to investigate!* *But if you like, you may use one of these suggestions.*	How do human's impact the environment in different parts of the world? Are there global examples of sustainable practices? What is my response to the "Home" film: "Listen . . .to this extraordinary story and decide what you want to do with it."	Where does my energy come from? How can I lower my carbon footprint -- why should I? Is solar energy viable for me? Will energy policies work? Does our local utility have a "green power" program?	Can I find a "dream car" that balances performance, fuel economy, cost, and "crashworthiness"? What's the most sustainable form of transportation for my needs? What's the most promising type of alternative fuel vehicle? What are + and - of travel by plane vs., train, vs. auto?	Where does my water come from? What are Tucson & Phoenix water managers doing to address sustainability? How is climate change exacerbating the future of water in the arid West -- and the world? What's the connection between energy & water supplies?	How does food production impact global change? How far does my food travel to get to me? Why does meat add so much CO2? How are food production and deforestation linked? Which Tucson supermarkets provide the most food choices?	Can science and art be linked? How can my art, writing, or poetry express my views on the environment? What does the SGC textbook cover "say" to me about Global Change? Is there an advocacy group that resonates with me?	How can I make "global change savvy" consumer choices? Can a business be run sustainably? Can Energy Star labels help me find "green" electronics and appliances? How can I detect and avoid "greenwashing"?