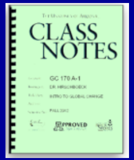
Topic #2 (cont.)
QUANTIFYING GLOBAL CHANGE (cont.)

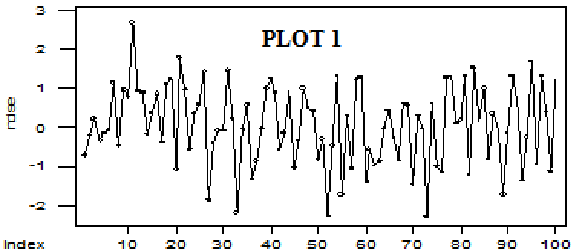
Time Series Graphs
WRAP-UP . . .

Class Notes page # ➔ 

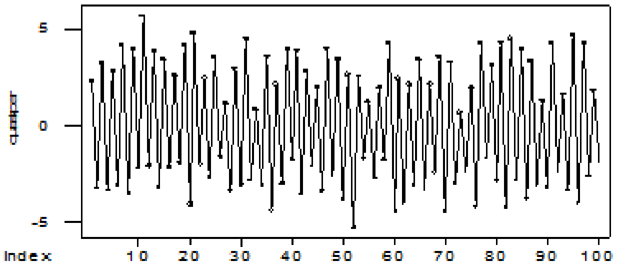
p 13

ANSWERS TO TIME SERIES GRAPHS

pp 13-14

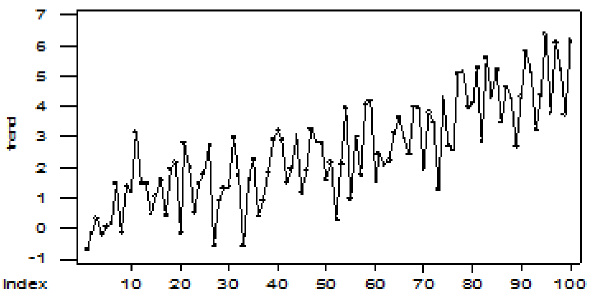


PLOT #1: "White noise" (random fluctuations) but with constant mean and variance *[answer given for you]*



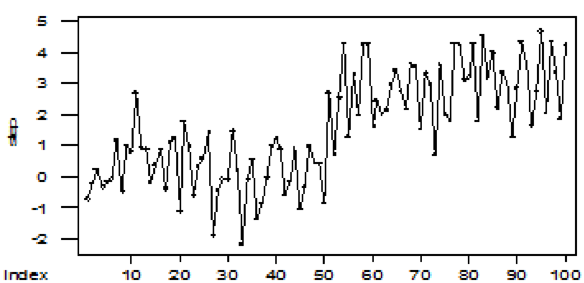
PLOT 2

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.]



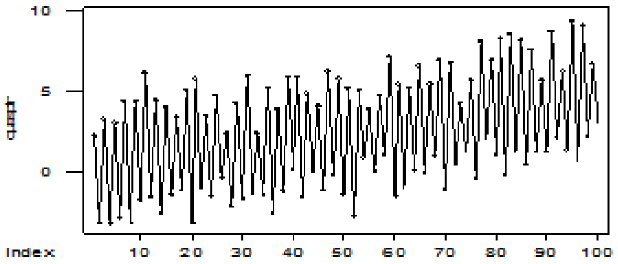
PLOT 3

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

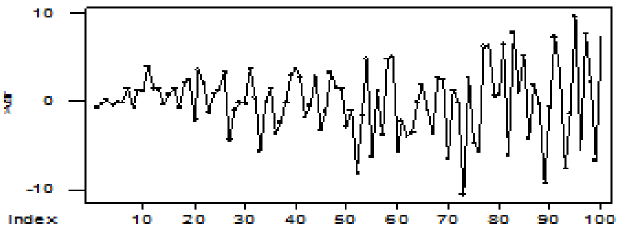
PLOT #4: "Step Change" plot with an abrupt jump between two series like Plot 1.
[Graph shows a "jump" or abrupt change between two different time series, each having a constant mean and variance]



PLOT 5

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

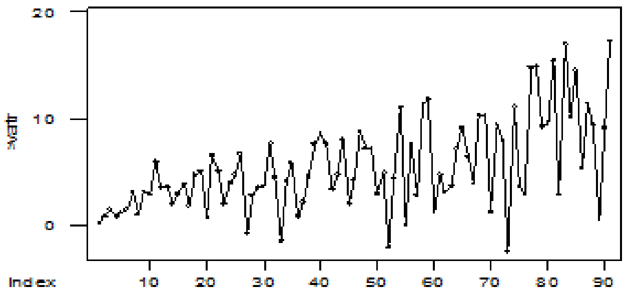
[Graph shows an increasing trend and increasing mean, but has regular periodic ups and downs above and below the increasing mean.]



PLOT 6

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.]

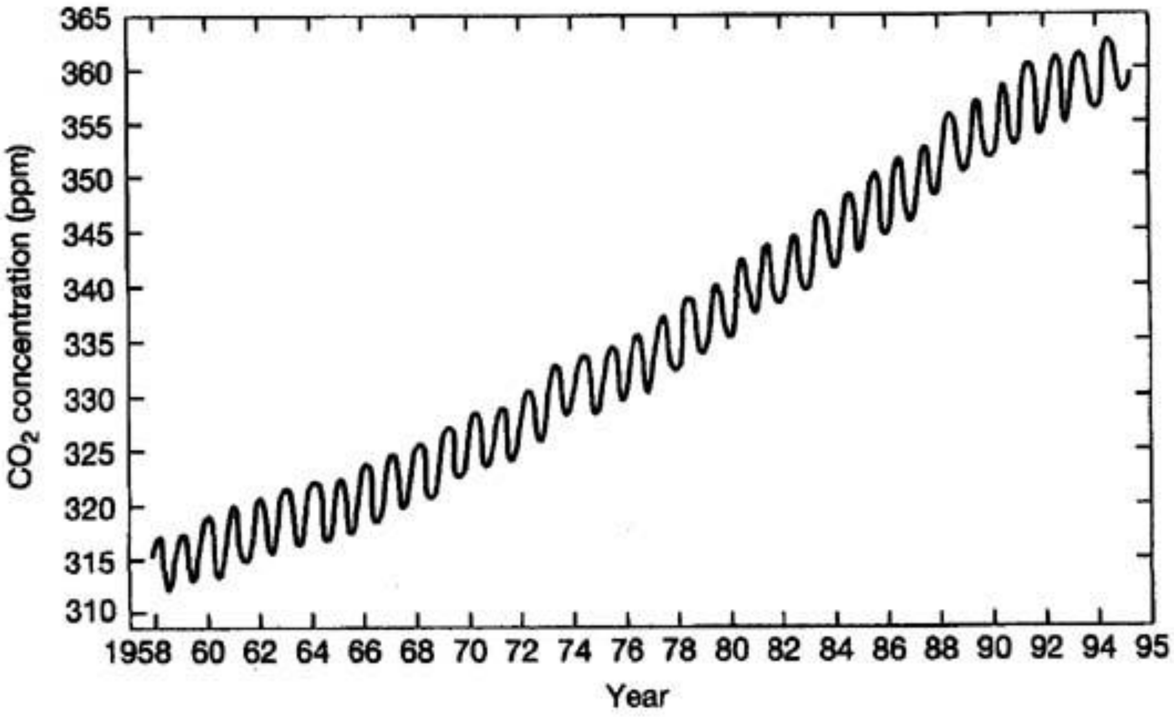


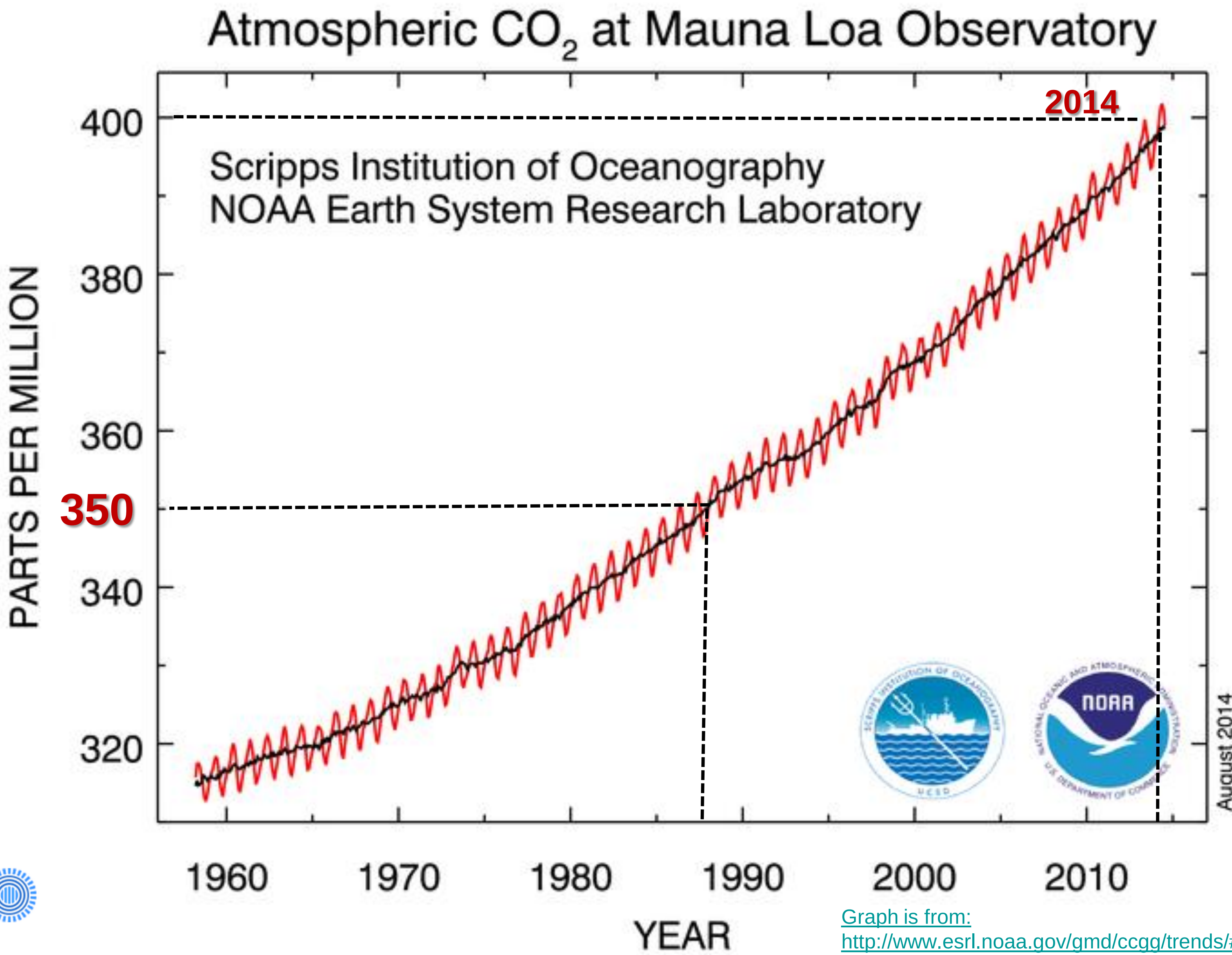
PLOT 7

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

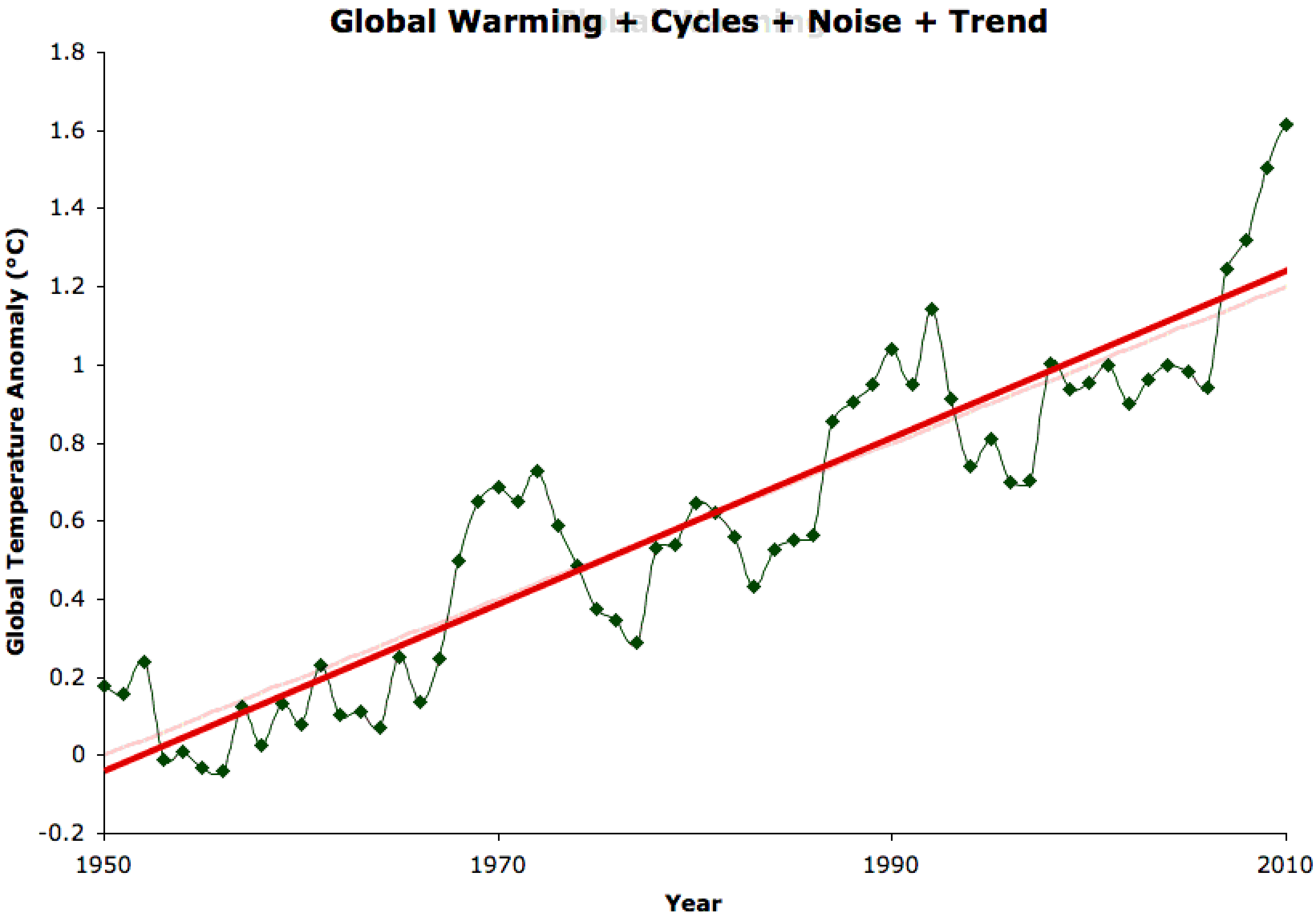
[Graph had both an increasing mean and an increase in the range of fluctuations above and below the mean over time – the extremes are getting bigger!]

the "Keeling curve" is most like Plot # 3 (or 5)





Graph is from:
http://www.esrl.noaa.gov/gmd/ccgg/trends/#mlo



http://www.skepticalscience.com/going-down-the-up-escalator-part-2.html

But what's the difference between

REAL TRENDS

and

UP & DOWN VARIATIONS???

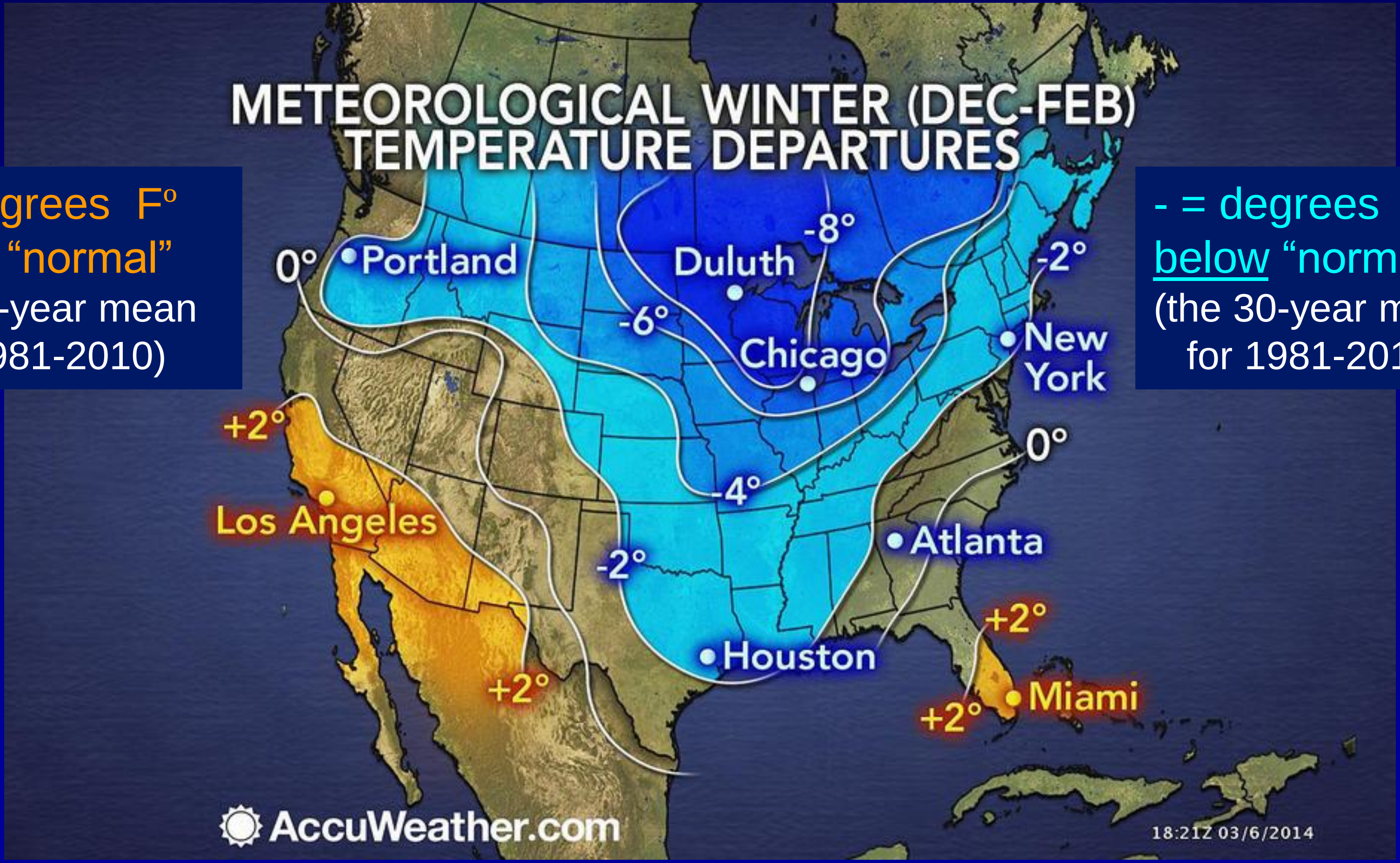
Typical comment heard last winter in Eastern U.S . . . . .

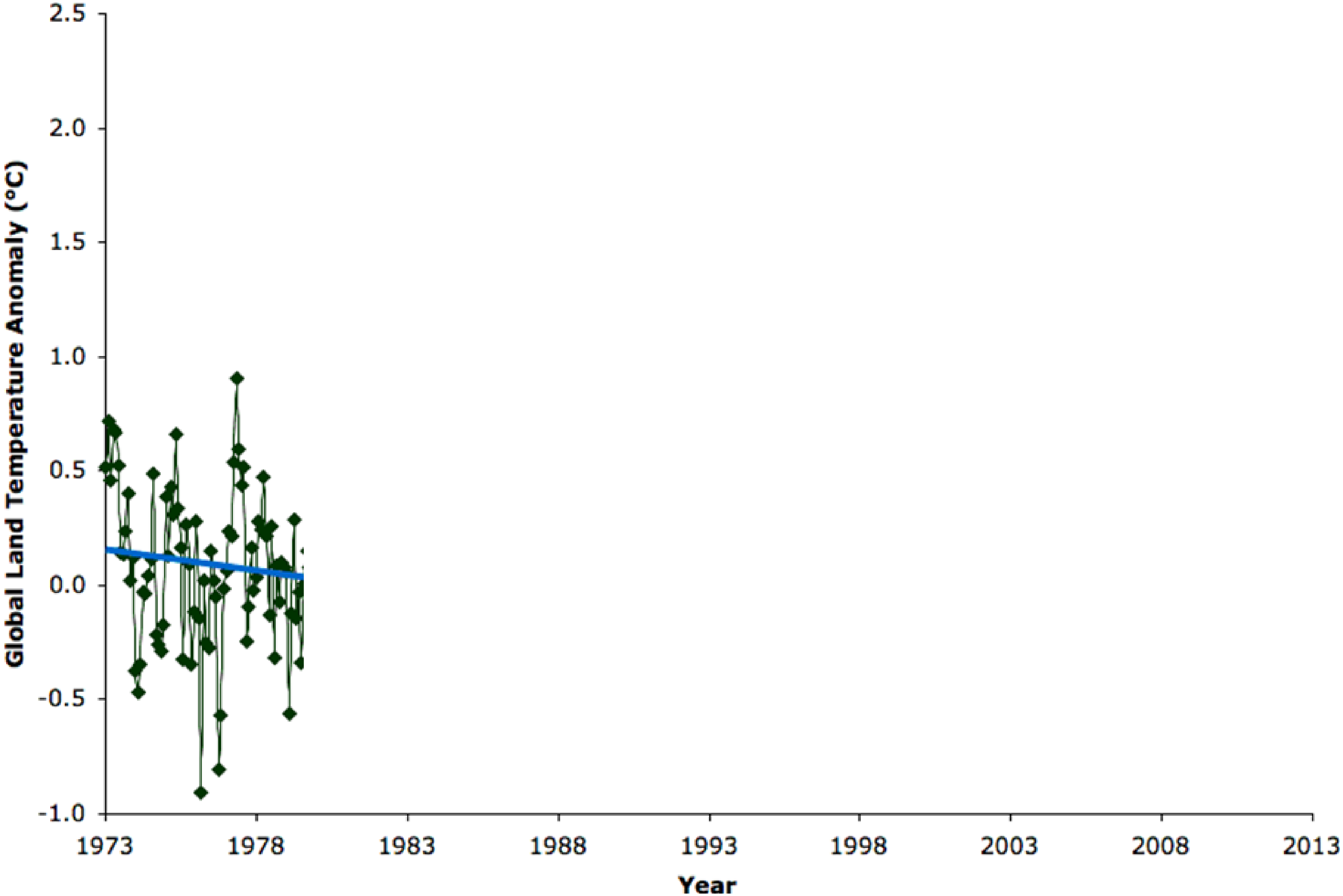
"How can we say GLOBAL WARMING is going on when we have extreme cold temperatures occurring!"

TEMPERATURE "DEPARTURE" MAP FROM LAST WINTER:

+ = degrees F° above "normal" (the 30-year mean for 1981-2010)

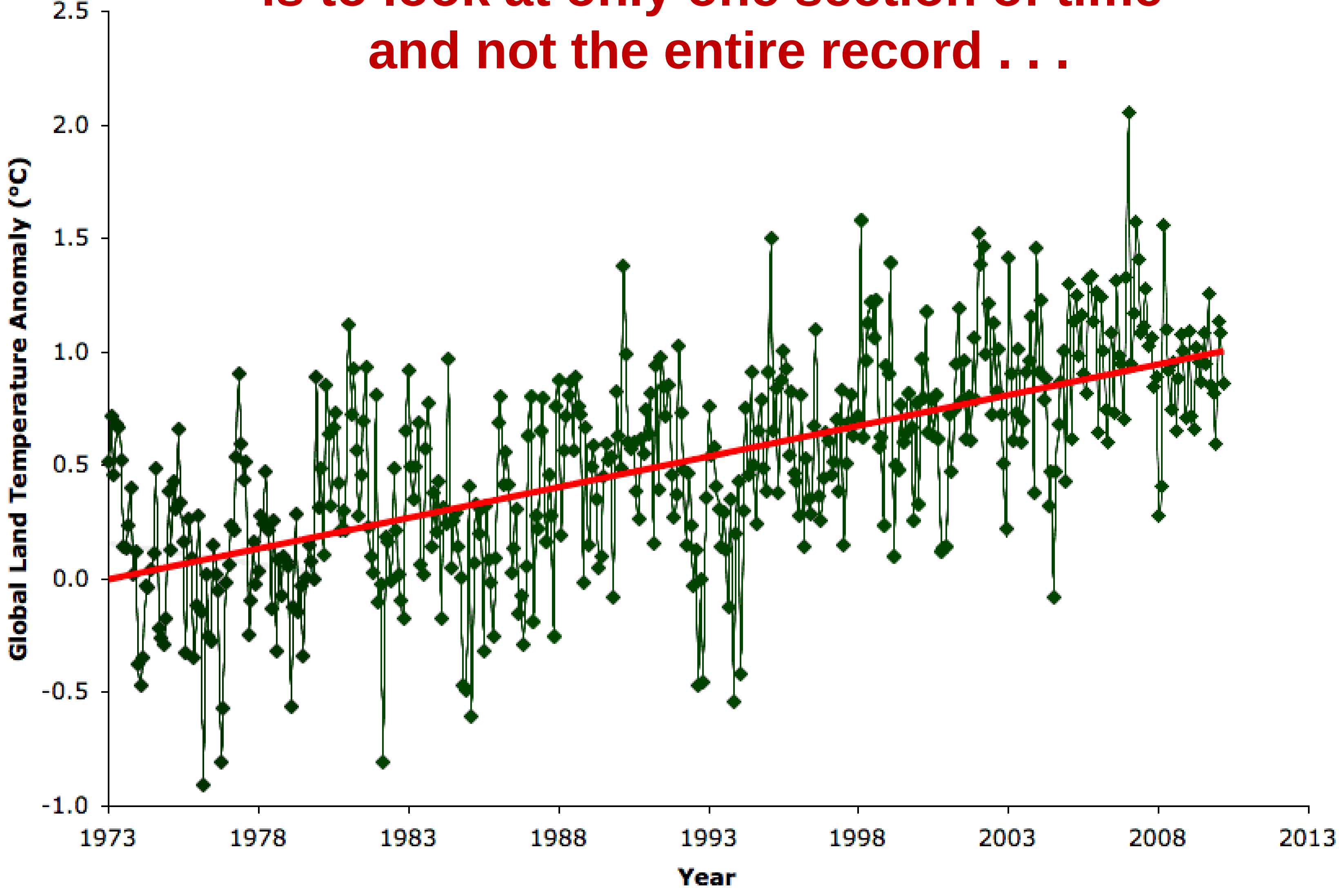
- = degrees F° below "normal" (the 30-year mean for 1981-2010)





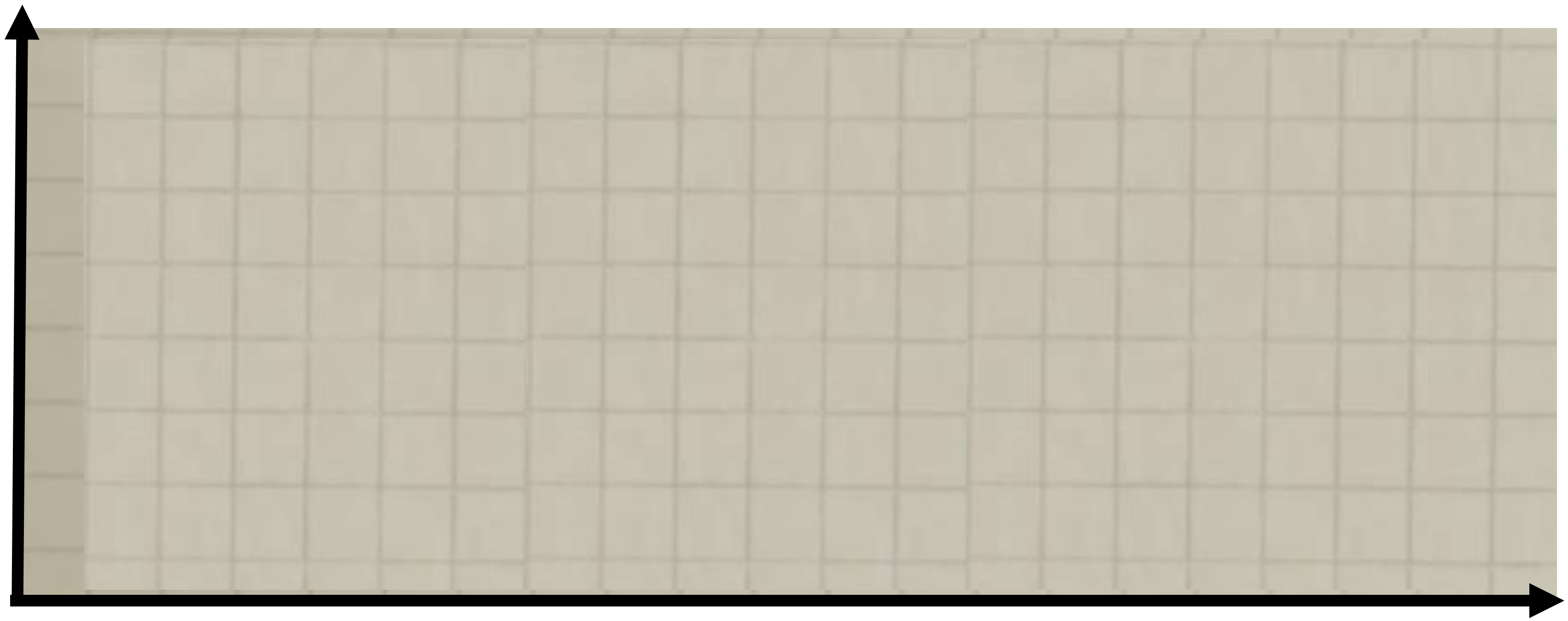
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
Global Land Temperature Anomaly (°C)
1973
1978
1983
1988
1993
1998
2003
2008
2013
Year

A common mistake when interpreting a time series is to look at only one section of time and not the entire record . . .

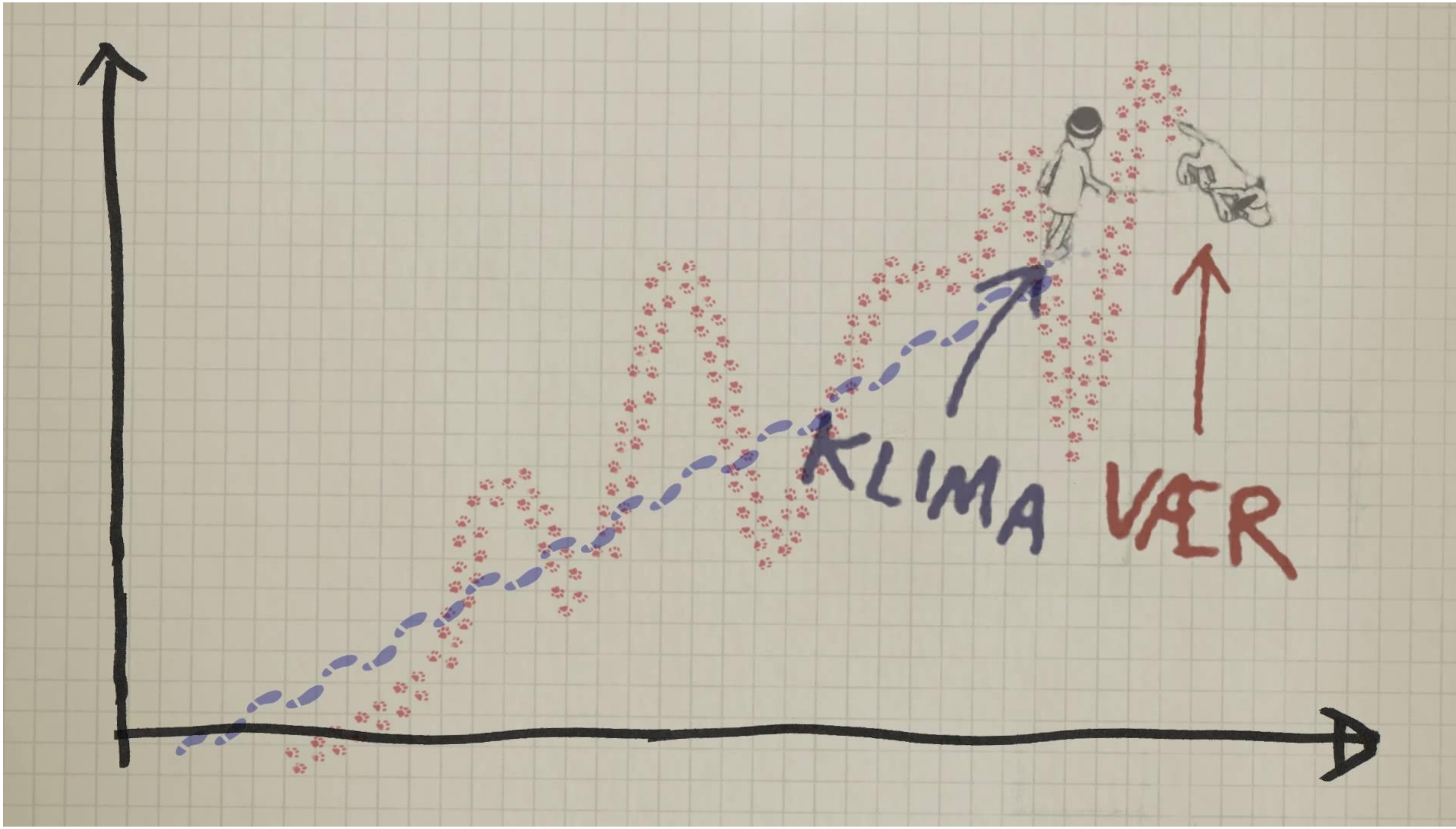


A common mistake when interpreting a time series is to look at only one section of time and not the entire record . . .

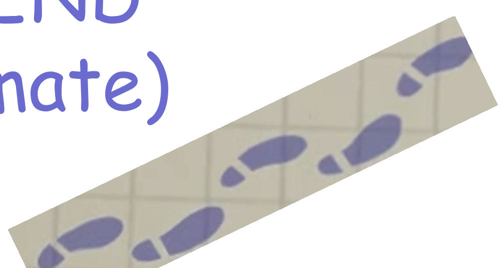
TREND Vs. VARIABILITY: An Animated Illustration



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

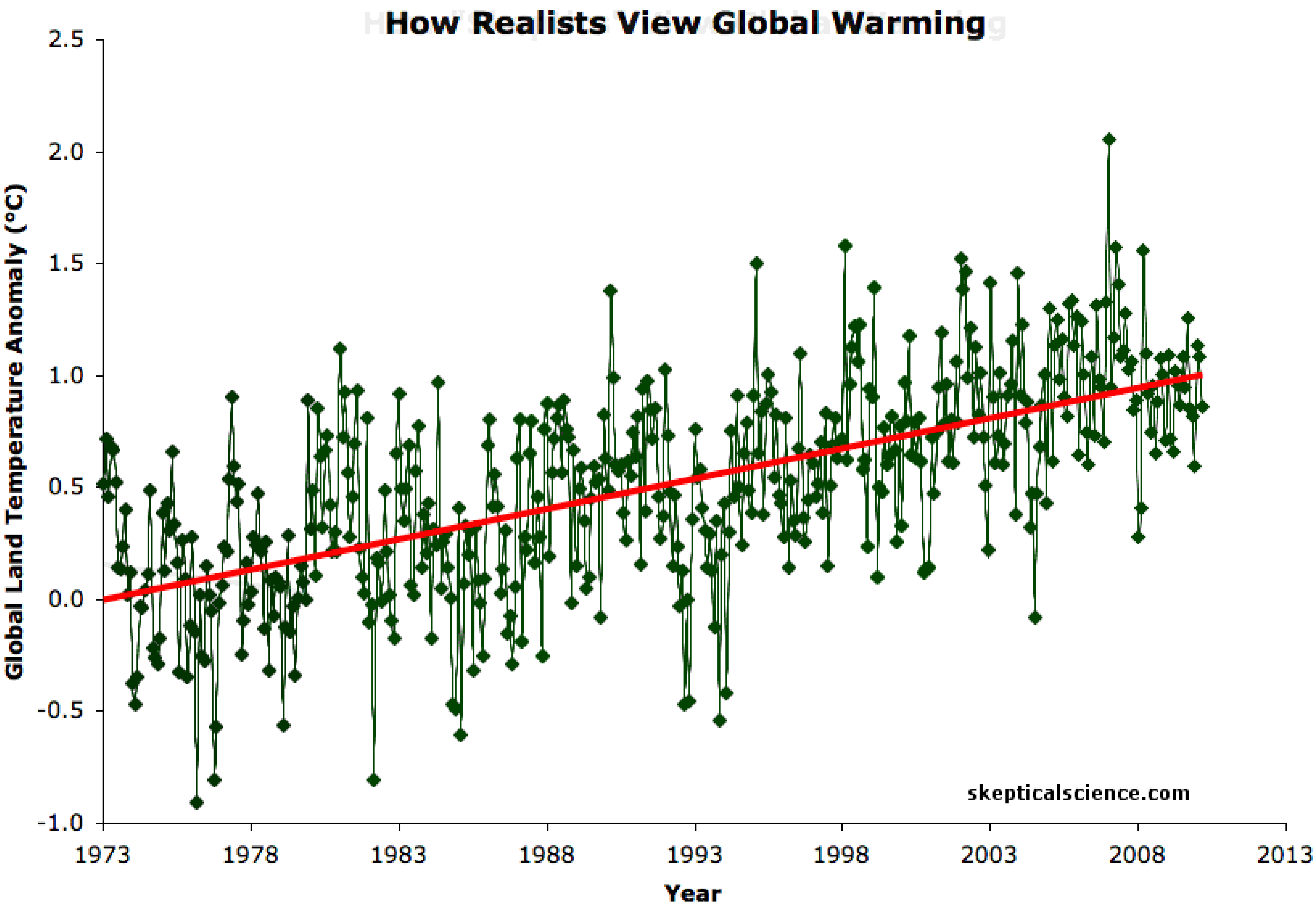


TREND
(Climate)



VARIABILITY
(Day-to-Day
Weather)

From SKEPTICALSCIENCE.COM website:



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

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)

Bottom of p 15

ANNUAL RECORDS OF THE PAST

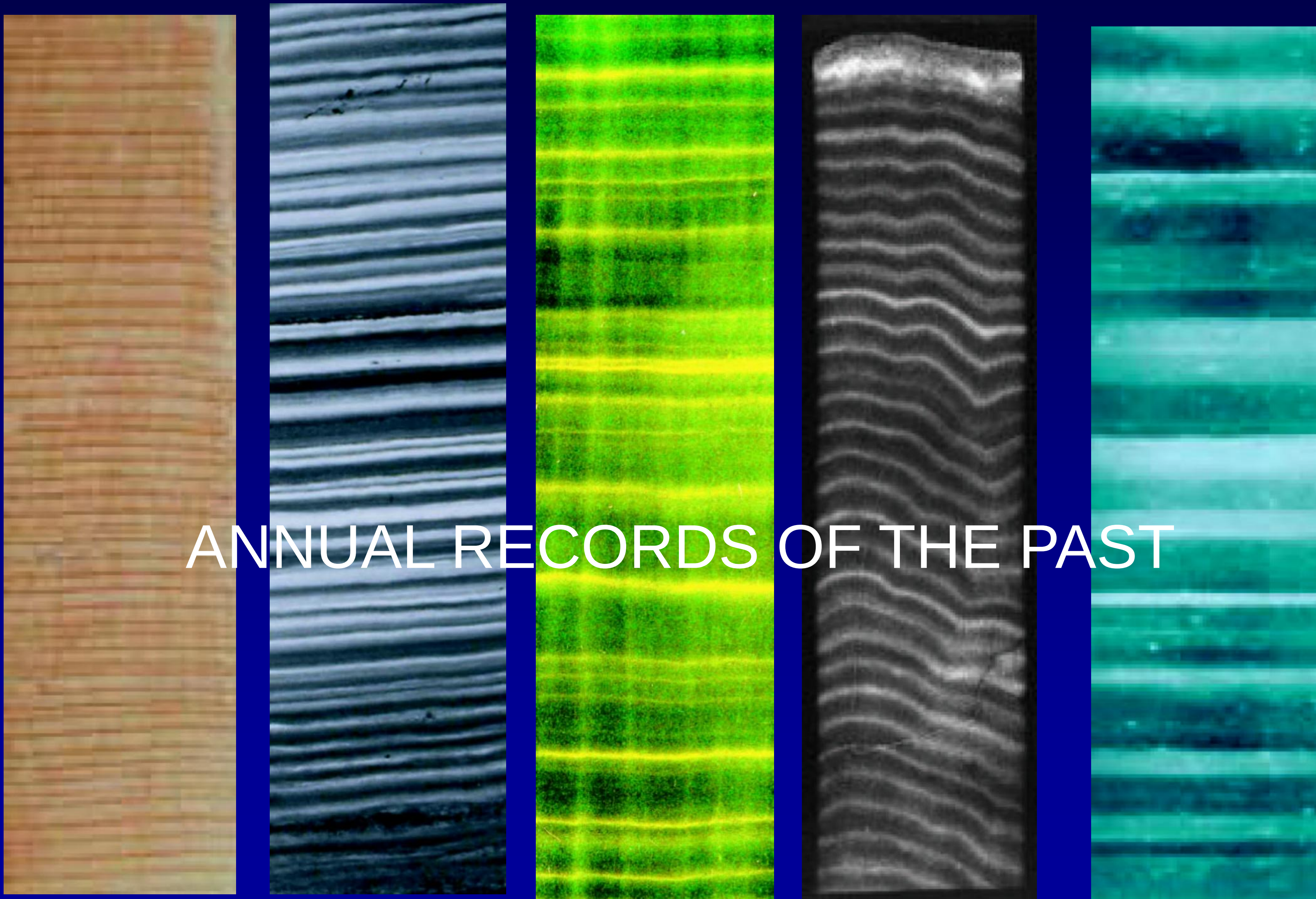
Tree rings

Lake varves (sediments)

Speleothems (from cave)

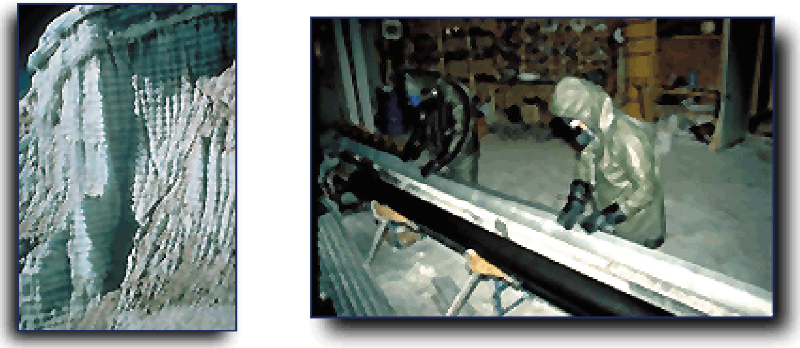
Coral (annual growth)

Ice Core



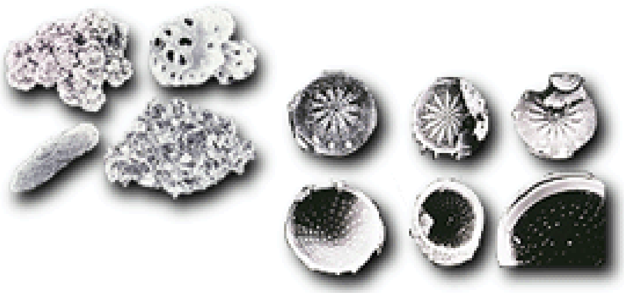
“PROXY” DATA or
NATURAL ARCHIVES of CLIMATE

Corals



https://www.youtube.com/watch?v=3dwZqj4lq3k

Ice cores



Pollen

Lake, bog & ocean sediments

Slides from Chapter 4 (pp 48-49) were inserted here from the recommended text

University of Arizona's Laboratory of Tree-Ring Research

LARGEST TREE-RING ARCHIVE IN THE WORLD!

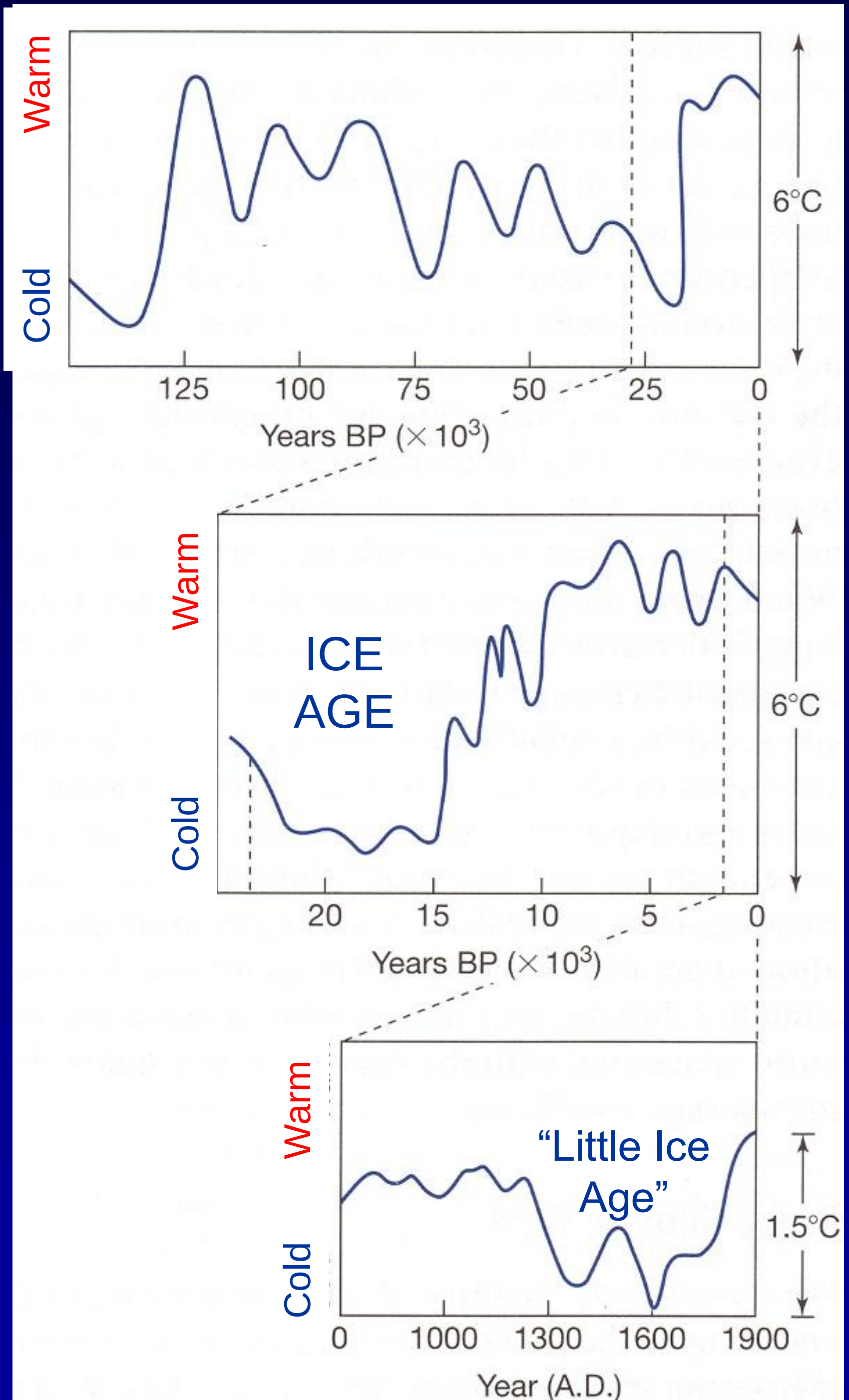
You'll see it for yourself in a future assignment!

WHAT NATURAL ARCHIVES REVEAL:

Over different "Telescoping" Time Scales Of Variability about:

Mean Global Temperature Change

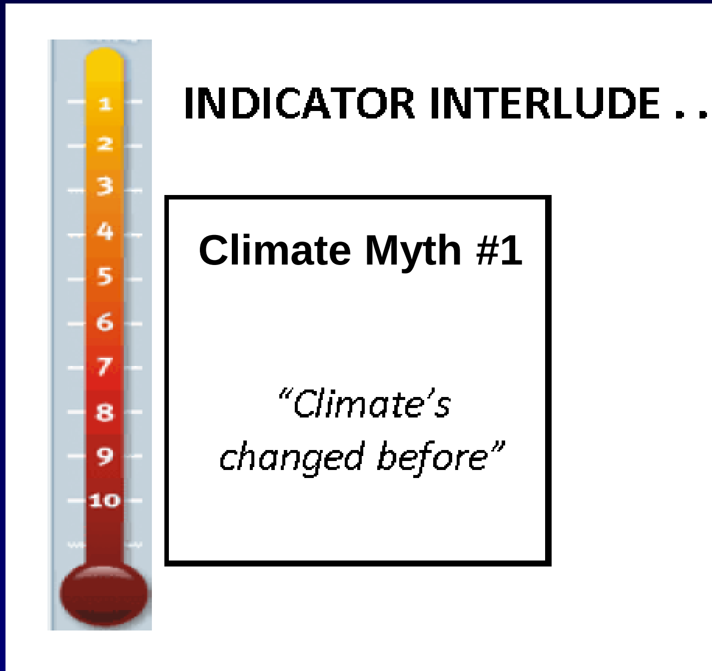
Since The Last Glacial Maximum
(Years BP = "years before present")



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)



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 CO_2 are imposing **an energy imbalance** due to the enhanced greenhouse effect.

Past climate change actually provides evidence for our climate's sensitivity to CO_2.

Topic #3 ENERGY & MATTER OVERVIEW

OBJECTIVES:

To review basic physical concepts of energy and matter and some key ways in which they interact.

"Science shows us that the visible world is neither matter nor spirit;

the visible world is the invisible organization of energy."

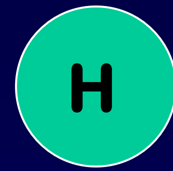
Heinz R. Pagels (b. 1939), U.S. Physicist

QUICK
MATTER REVIEW

Matter:

Whatever occupies space & is perceptible to the senses; made up of atoms; matter can be in form of solids, liquids, or gases

Atom:



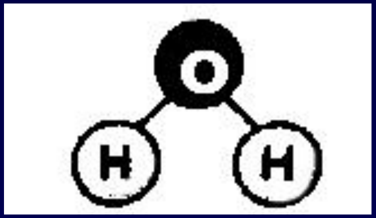
-- Fundamental building blocks for all matter
-- the smallest representative sample of an element.

Element:

A chemical substance (material) made from a single type of atom that cannot be broken down any further – and still maintain its identity as that element
. . . as in the *Periodic Table of the Elements*

p 17

Molecule:



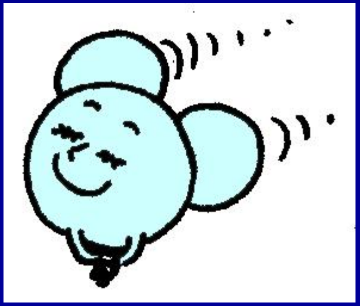
-- Any collection of two or more atoms bound together

-- a cluster of atoms bound together

MOLECULES are the basic constituent of different kinds of materials.

-- the smallest part of any substance that has all the chemical properties of the substance

e.g., a water molecule = H_2O



STATES OF MATTER

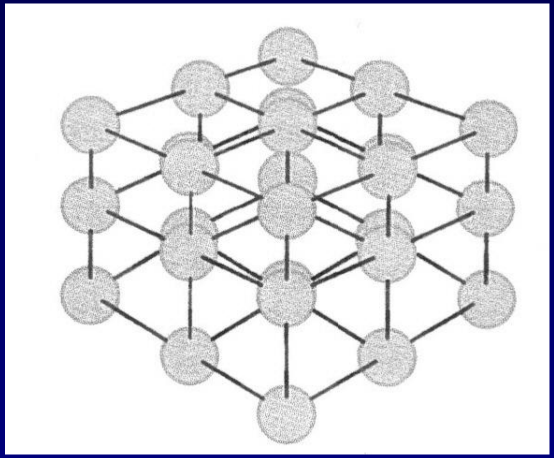
Solid:

-- a substance that resists changes of shape and volume

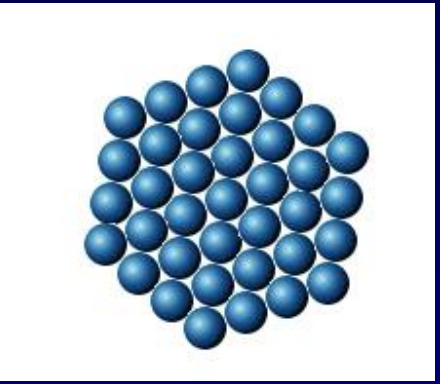
-- characterized by *structure* in the particular order and bonding of atoms that make up the material

Example = a crystal in which the molecules are locked into a strict geometrical order.

Various Representations of Molecules arranged in a SOLID

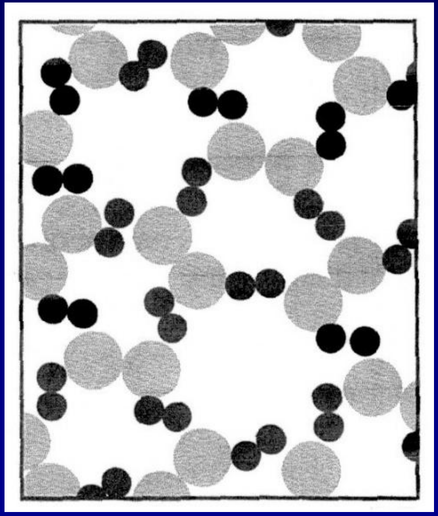


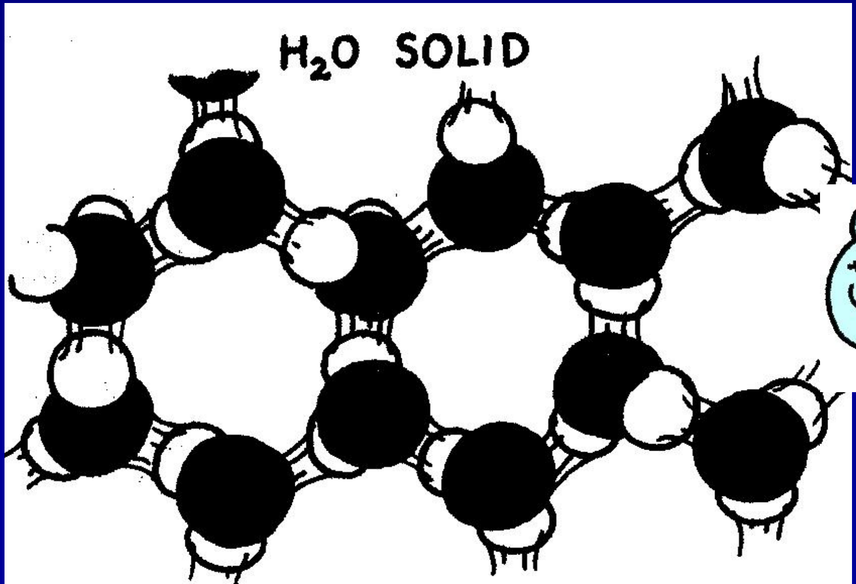
3-D view of a solid crystal structure

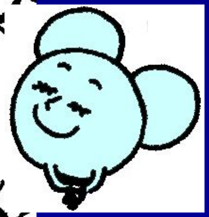


"top down" view of a Neon crystal

"top down" view of water (H_2O) arranged in solid (ice) form







Liquid:

-- a substance that flows freely in response to unbalanced forces

-- molecules more or less move freely past one another as individuals or small groups

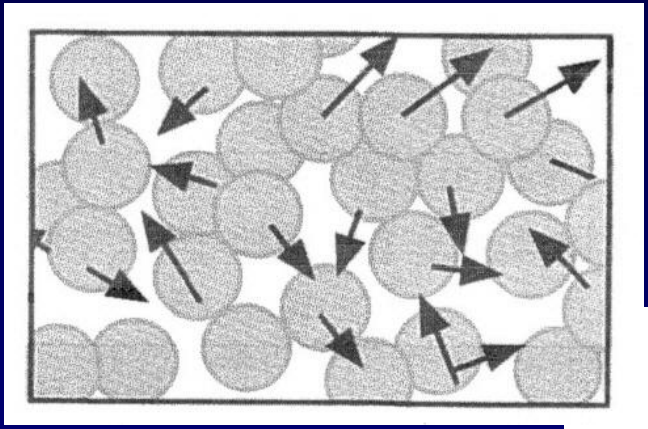
-- are not confined to fixed positions (as in solids)

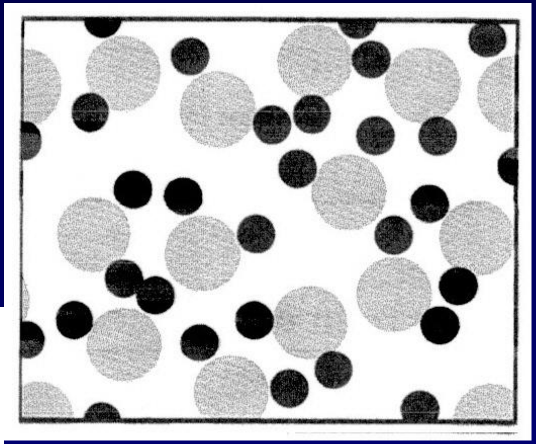
-- **LIQUIDS CAN EXHIBIT PRESSURE**

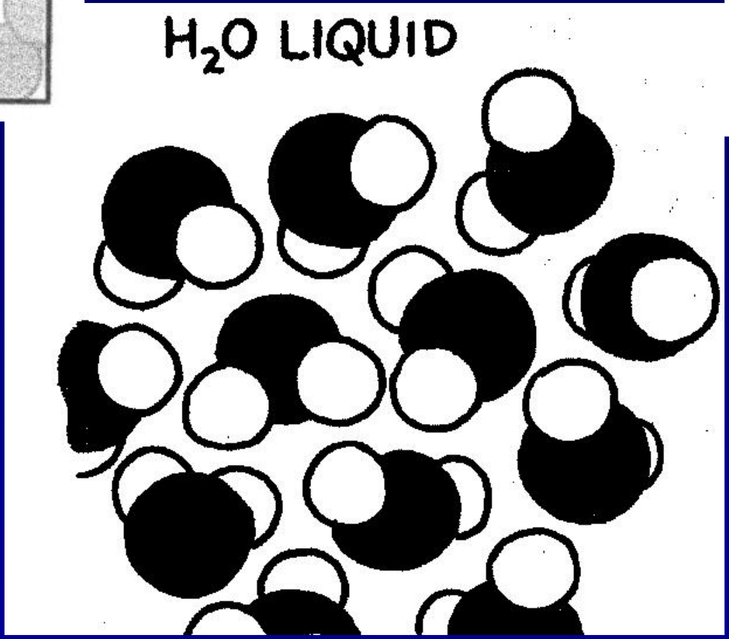
(pressure = a force per unit area)

. . . and will take the shape of the container they are in.

Various Representations of Molecules arranged in a LIQUID







Gas:

-- a substance that expands (and contracts) easily, rapidly, and indefinitely

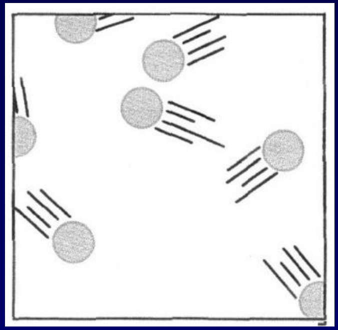
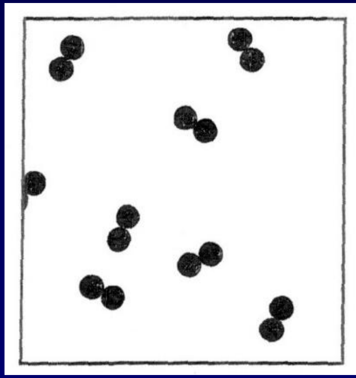
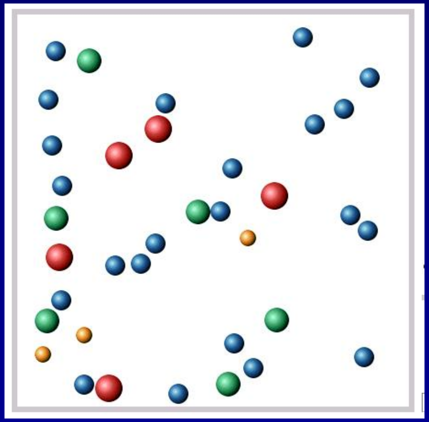
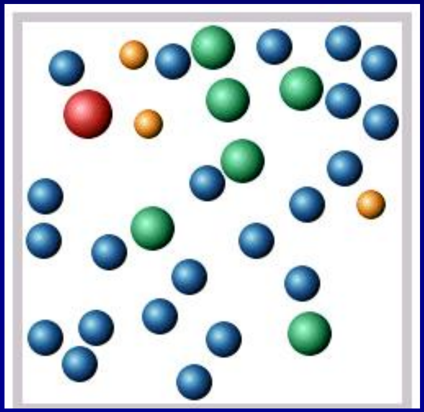
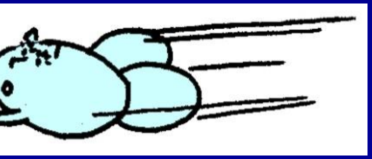
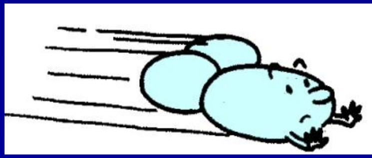
-- fills all space available to it

-- takes the shape of its container

- -- the distance between molecules is such that no cohesive forces exist
- -- atoms or molecules are in high speed motion
- -- many collisions and rebounds occur

-- **GASES ALSO EXHIBIT PRESSURE**

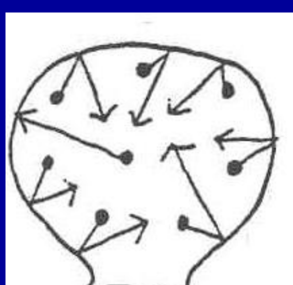
Various Representations of Molecules arranged in a GAS

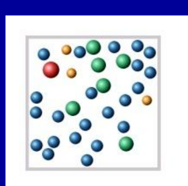
Heat added = increase in total energy + work done against outside pressure

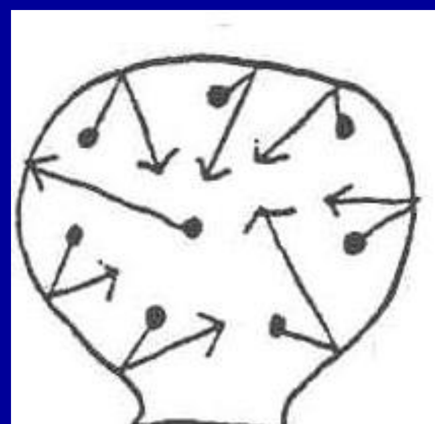
With increasing T (temperature)

→ Volume increases & Density decreases

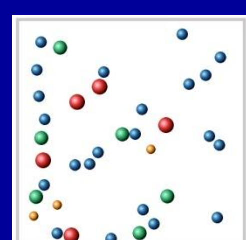


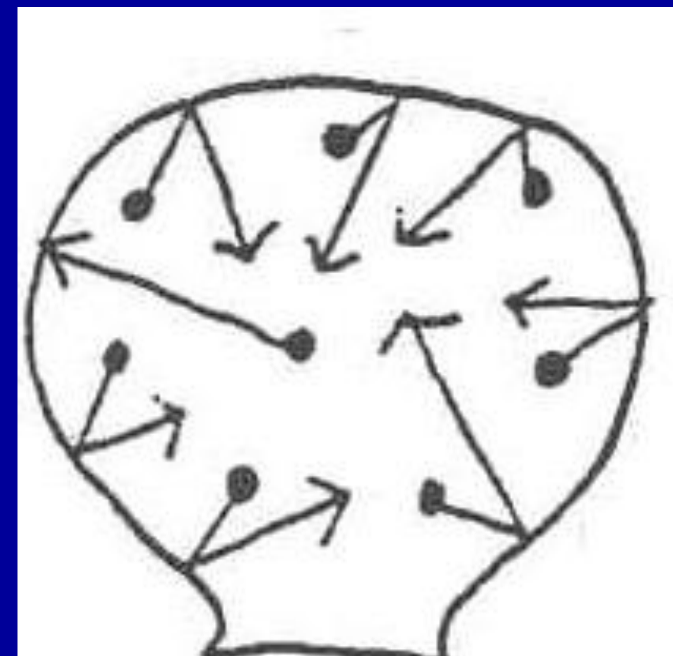
COLD



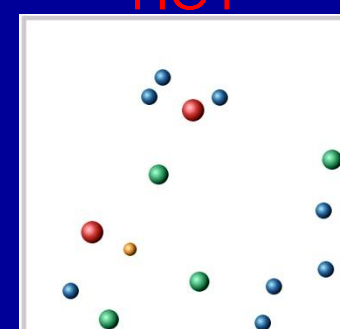


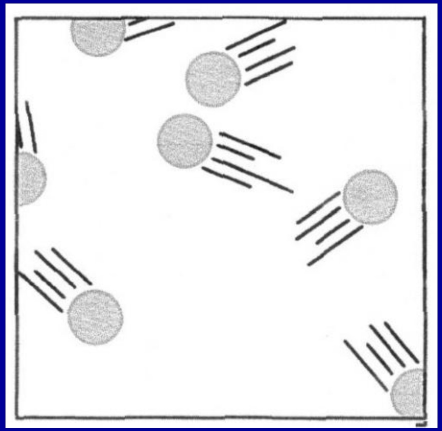
WARM





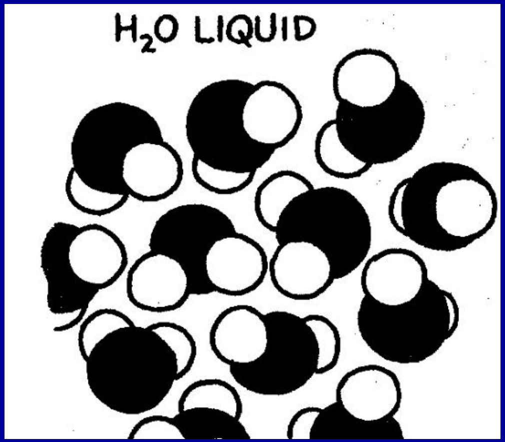
HOT



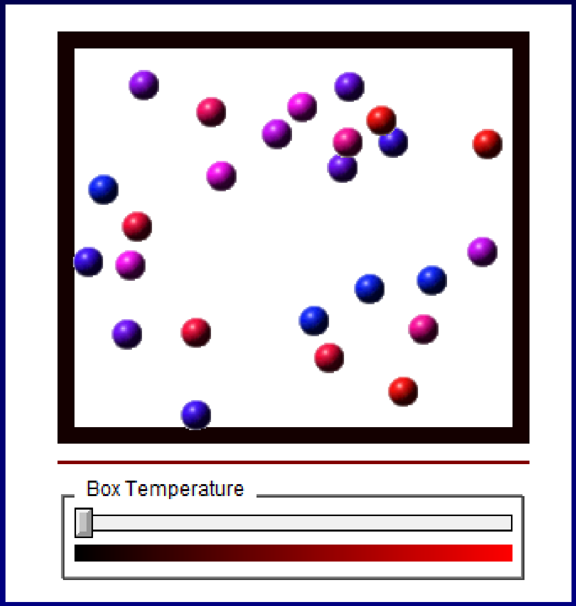


At higher air temperatures, H_2O molecules collide & rebound more frequently, leading to expansion of the air & the water vapor in the air.

At lower air temperatures as air gets more dense, H_2O molecules are more likely to bond so that a phase change to liquid water or even solid ice can occur.



A Simple Demo :



http://www.colorado.edu/physics/2000/bec/temperature.html

WHAT DOES THIS HAVE TO DO WITH GLOBAL CHANGE & MY DAILY LIFE ?????

Arizona Daily Star
www.dailystar.com® www.azstarnet.com®
Published: 08.31.2006

Ariz. heat cheats drivers at gas pump

standard not enforced, costing $115M yearly in state, study says

spending about $115 million more a year on gasoline and diesel fuel
uel temperatures were regulated to the federal standard, according to

LAT Home | My LATimes | Print Edition | All Sections

FEDERAL STANDARD:
Fuel at gas pump should be dispensed into a vehicle's tank at a temperature of 60 ºF

If temperature is not 60 º F, the cost of a gallon should be adjusted to reflect the volume of fuel at 60 º F.

"It's a significant number, and one that we shouldn't be paying," said Judy Dugan, research director at Santa Monica-based Consumer Watchdog, formerly called the Foundation for Taxpayer and Consumer Rights. "With every rise in the price of gas, hot fuel becomes a more important issue."

The U.S. government defined volume of a gallon of gas:

At 60 degrees, a gallon is 231 cubic inches.

But when fuel is warmer than 60 degrees, the liquid expands, yielding less energy per gallon.

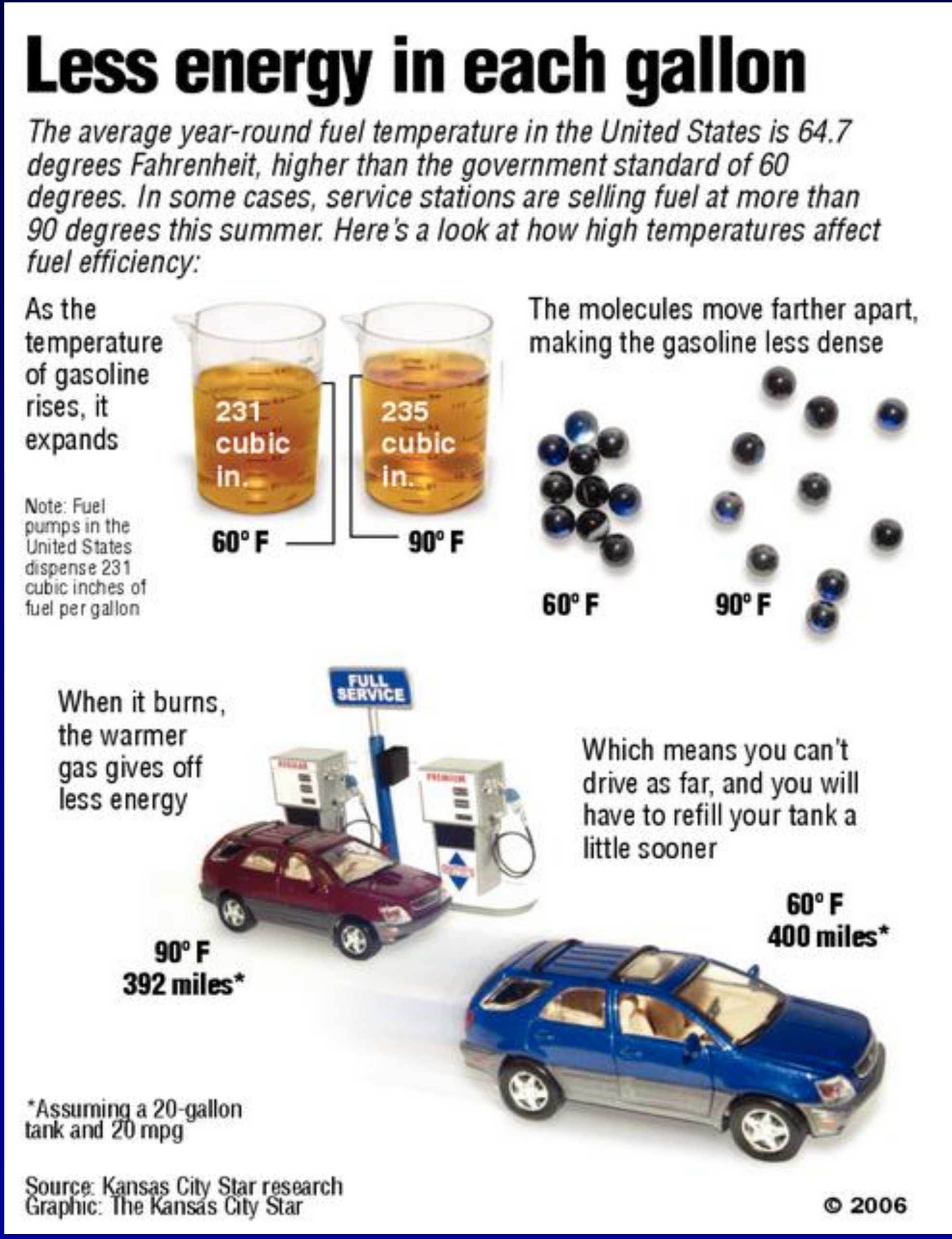
http://articles.latimes.com/2008/may/23/business/fi-hotfuel23

Laws of physics cost us money !!

Basic physics!

Depending on the temperature, the difference can amount to a few cents per gallon . . . .

. . . . But it adds up to big money — coming straight out of consumers' pockets.



Lecture Break!

http://www.symphonyofscience.com/videos.html

"We Are All Connected"

REMEMBER FOR THURSDAY:

(1) Your first GRADED RQ (RQ-1) based on the ATOMS Chapter (at the very end of the E-TEXT) is due THIS THURSDAY Sep 4th.

(2) CLICKER Debut: Please register your CLICKER or RESPONSE WARE Device ID and bring your device to class next week for use in class! Directions on how to REGISTER your CLICKER/ ResponseWare for use in THIS class are in D2L

(3) Registration directions for your E-text are posted under QUICK LINKS and also in the D2L Checklist.