

Open this site for exercise I

<http://data.giss.nasa.gov/gistemp/>

Climate Change Education: The Science

- Why teach about Climate Change?



Climate Change Education: The Science

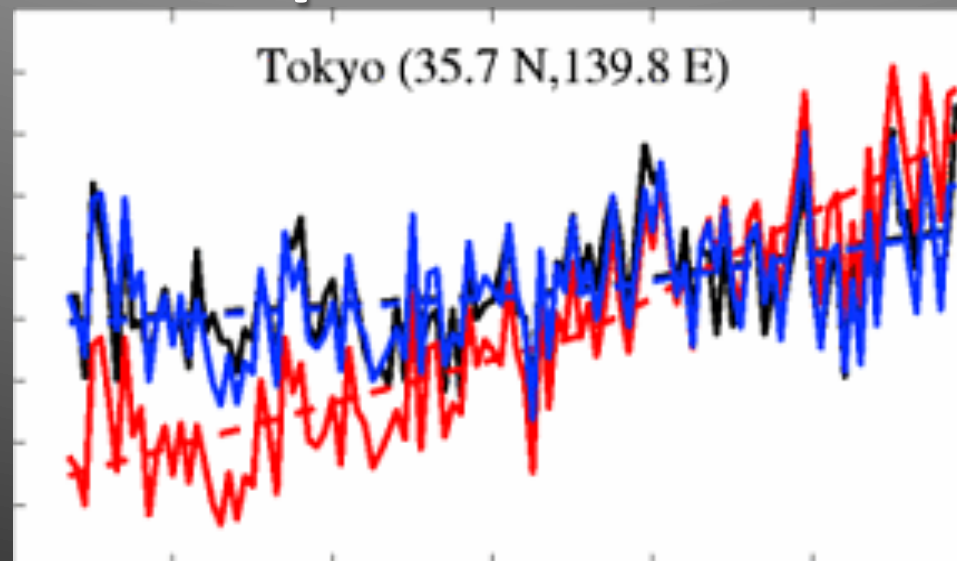
- How do your students learn best?



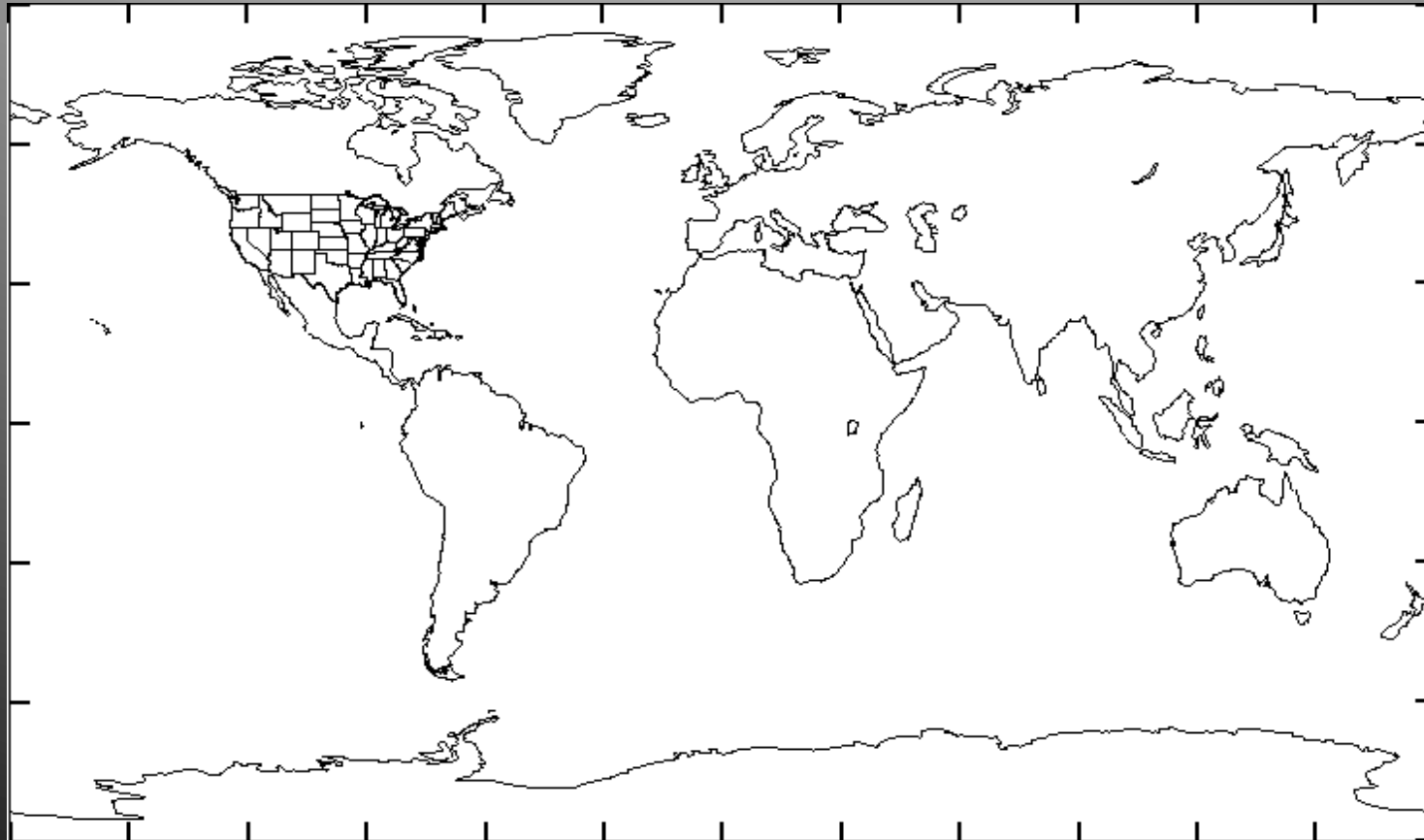
Let's look at some Temperature data

<http://data.giss.nasa.gov/gistemp/>

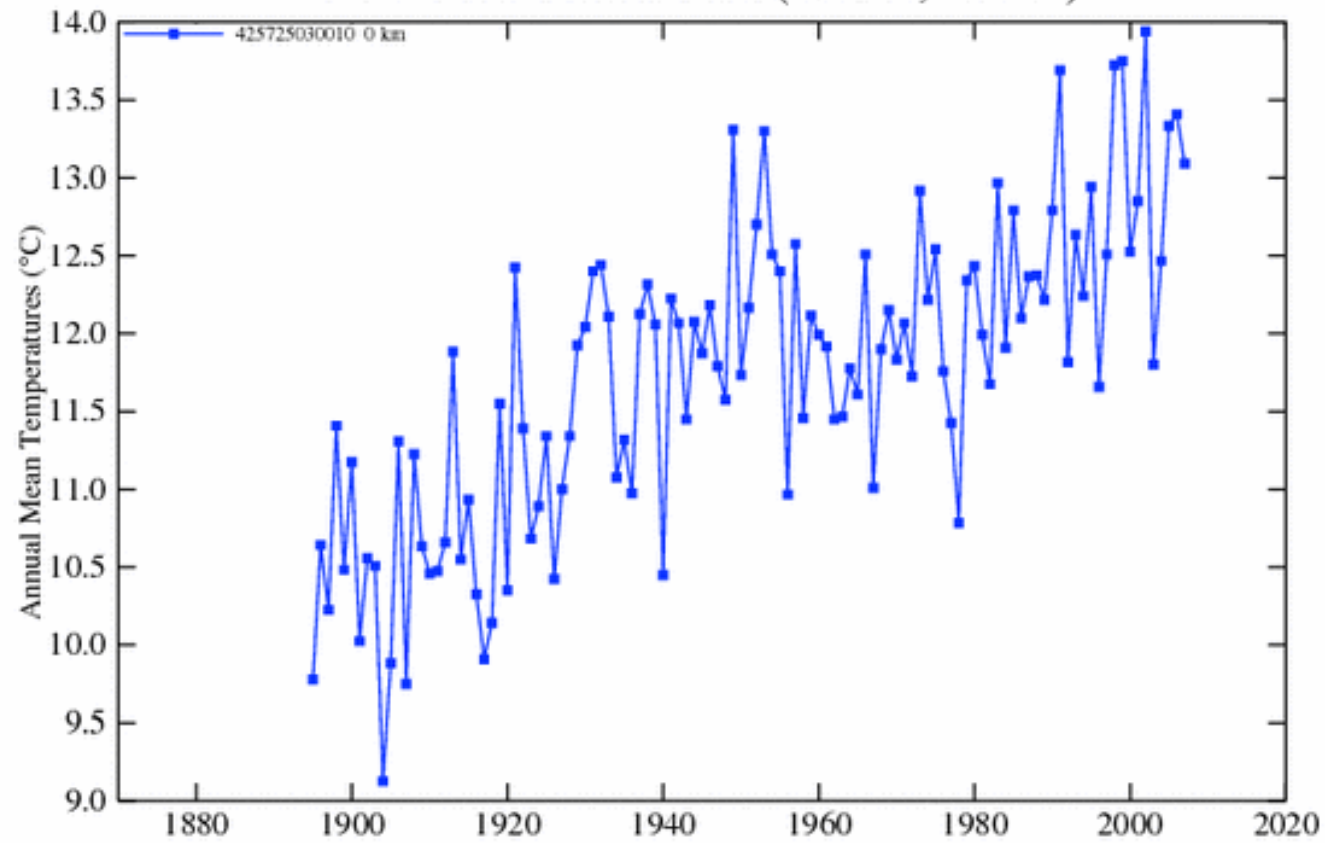
Open this View



Click at desired location on the map below
or enter here a station name to search for:

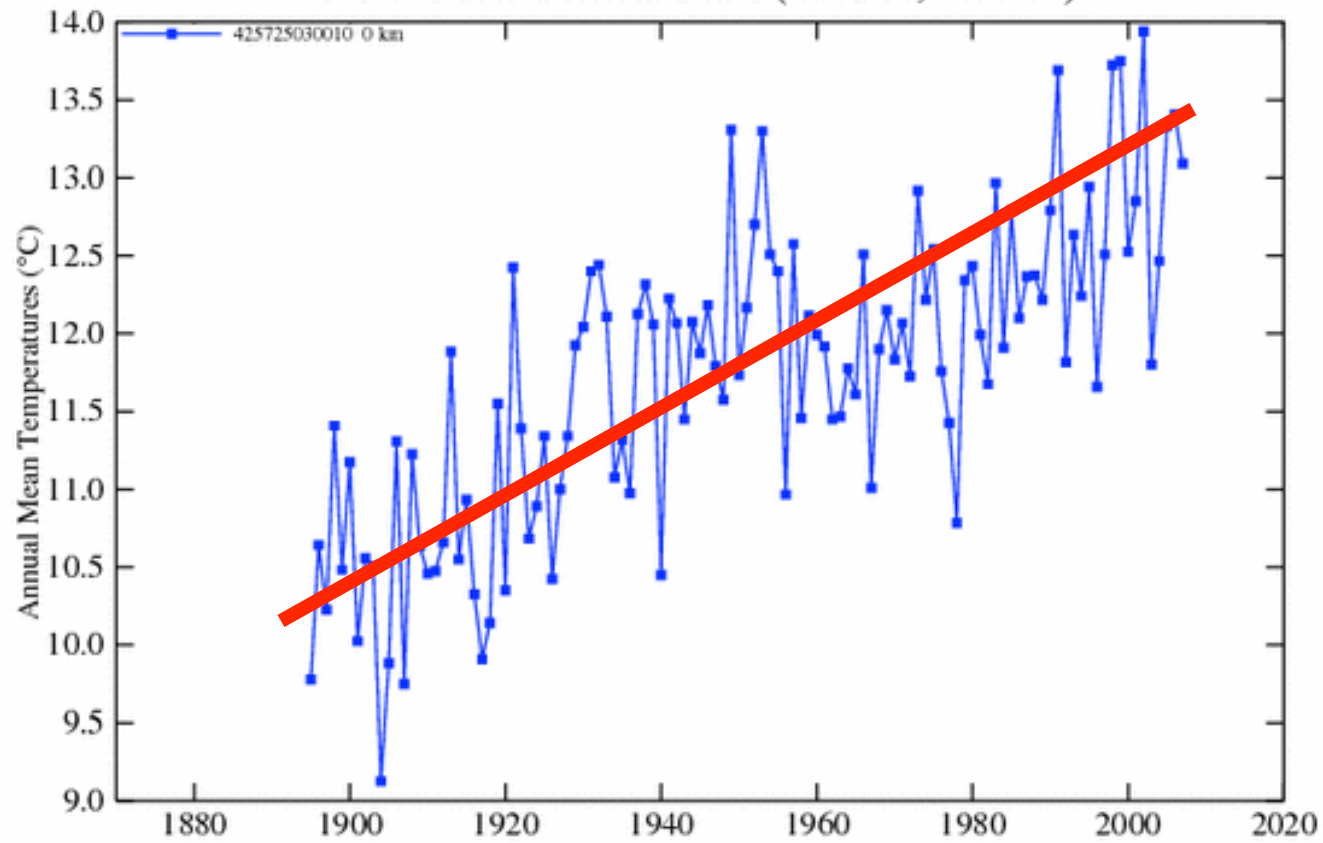


New York Central Park (40.8 N,74.0 W)



YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	D-J-F	M-A-M	J-J-A	S-O-N	metANN
1895	-3	-5.9	0.3	8.6	16.2	21.9	21.5	23.1	20.5	9.6	7	1.9	-3.8	8.4	22.2	12.4	9.78
1896	-2.8	-2	-1.2	10.2	18.1	19.9	23.7	23.3	18.1	10.4	8.1	-0.3	-1	9	22.3	12.2	10.64
1897	-2.4	-1	3.3	8.8	14.9	18.4	23.6	21.6	17.9	12.1	5.8	2.1	-1.2	9	21.2	11.9	10.22
1898	0.1	0.6	6.3	7.3	13.6	20.8	23.6	22.9	20.1	13.7	5.8	0.1	0.9	9.1	22.4	13.2	11.41
1899	-2.1	-3.9	1.8	8.4	15.7	22.4	23.7	22.9	17.4	13.3	6.1	1.7	-2	8.6	23	12.3	10.48
1900	-0.9	-2.2	-0.4	9.1	14.2	20.8	24.4	24	20.4	15.1	7.9	0.1	-0.5	7.6	23.1	14.5	11.17
1901	-1.1	-4.5	2.2	7.9	13.3	20.7	24.8	23.1	19	12.1	2.7	0.8	-1.8	7.8	22.9	11.3	10.02
1902	-2.2	-2.7	5.3	9.3	14.1	18.6	21.9	21.3	17.9	13.1	9.3	-0.9	-1.4	9.6	20.6	13.4	10.56
1903	-2.2	-0.6	7.7	10.3	16.5	16.9	22.9	19.7	18.3	13.2	4.3	-1.6	-1.2	11.5	19.8	11.9	10.51
1904	-5.1	-5.3	1.1	7.1	16.8	20.2	22.6	21.3	18	10.5	3.9	-2.7	-4	8.3	21.4	10.8	9.12

New York Central Park (40.8 N, 74.0 W)



West Point, NY

75 Km

New York City

Image USDA Farm Service Agency
Image © 2010 New York GIS

Image © 2010 DigitalGlobe

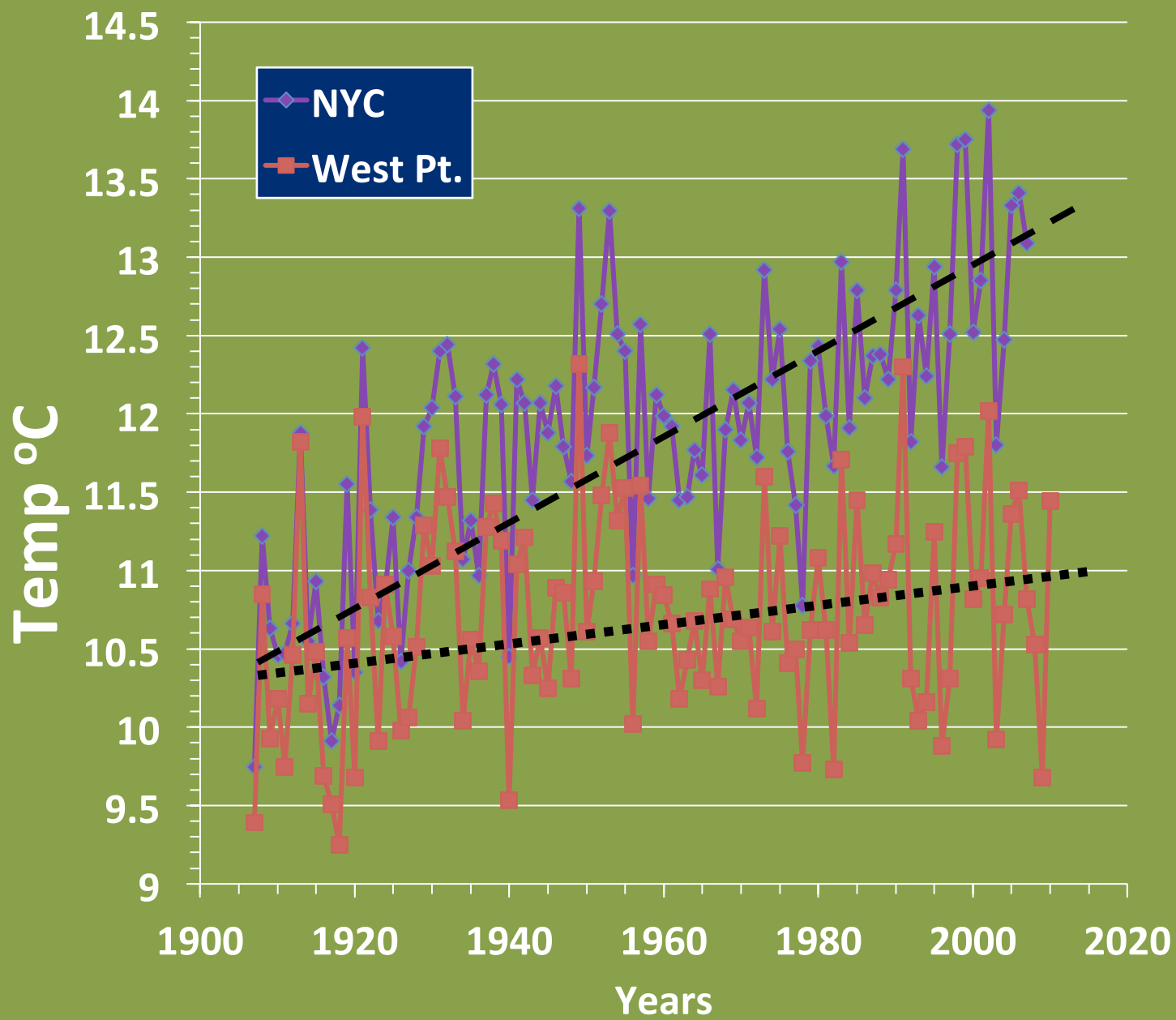
©2009 Google

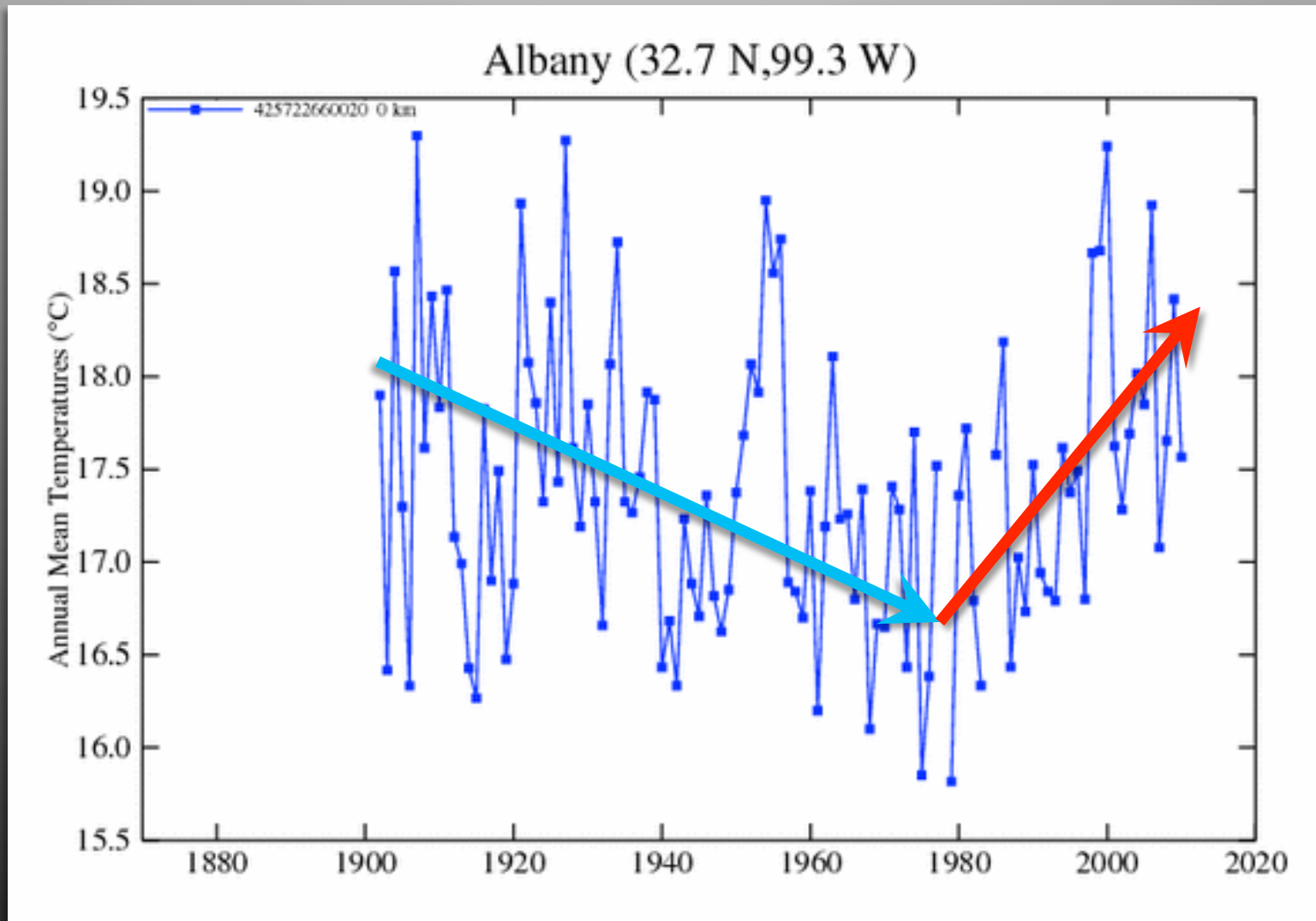
29 km

Imagery Dates: Jul 5, 2007 - Aug 31, 2010

41°04'46.81" N 73°55'57.21" W elev 0 m

Eye alt 99.23 km





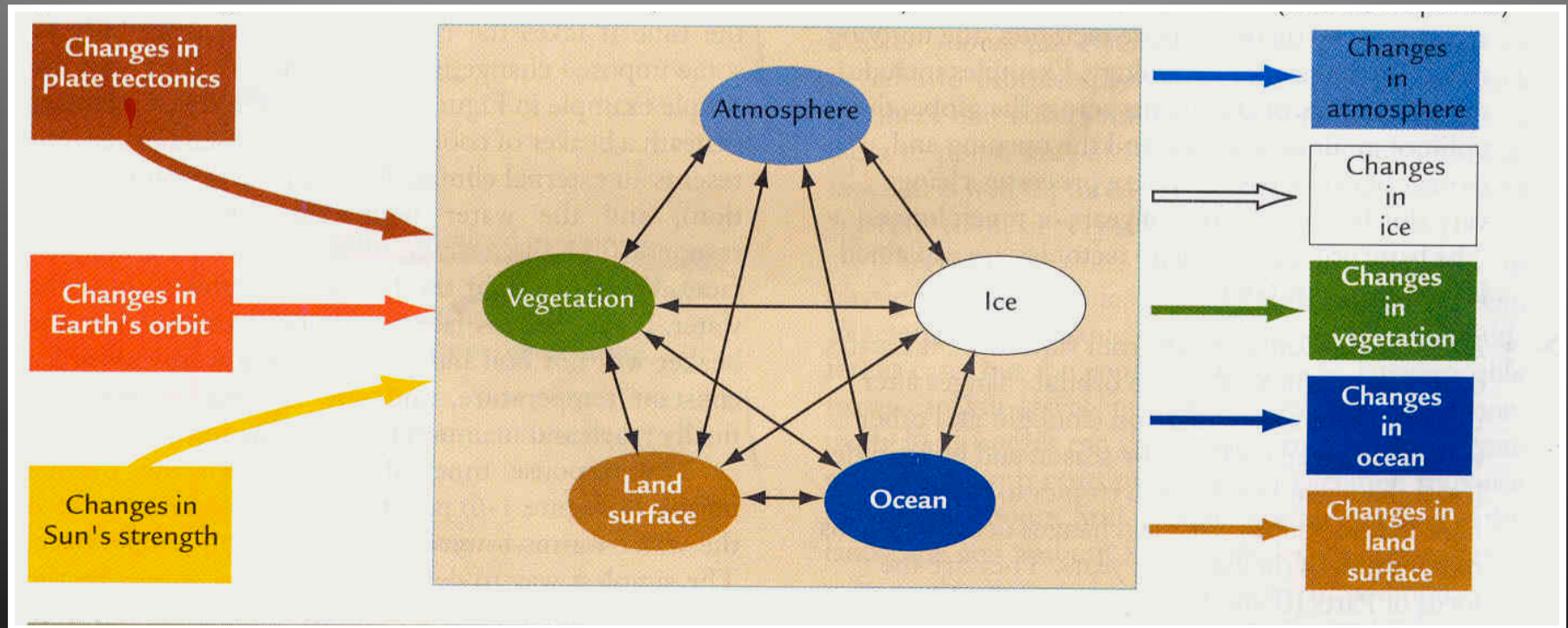
Climate Change Education: The Science

- What should your students know?

External Forcings

Climate Interactions

Climate Responses

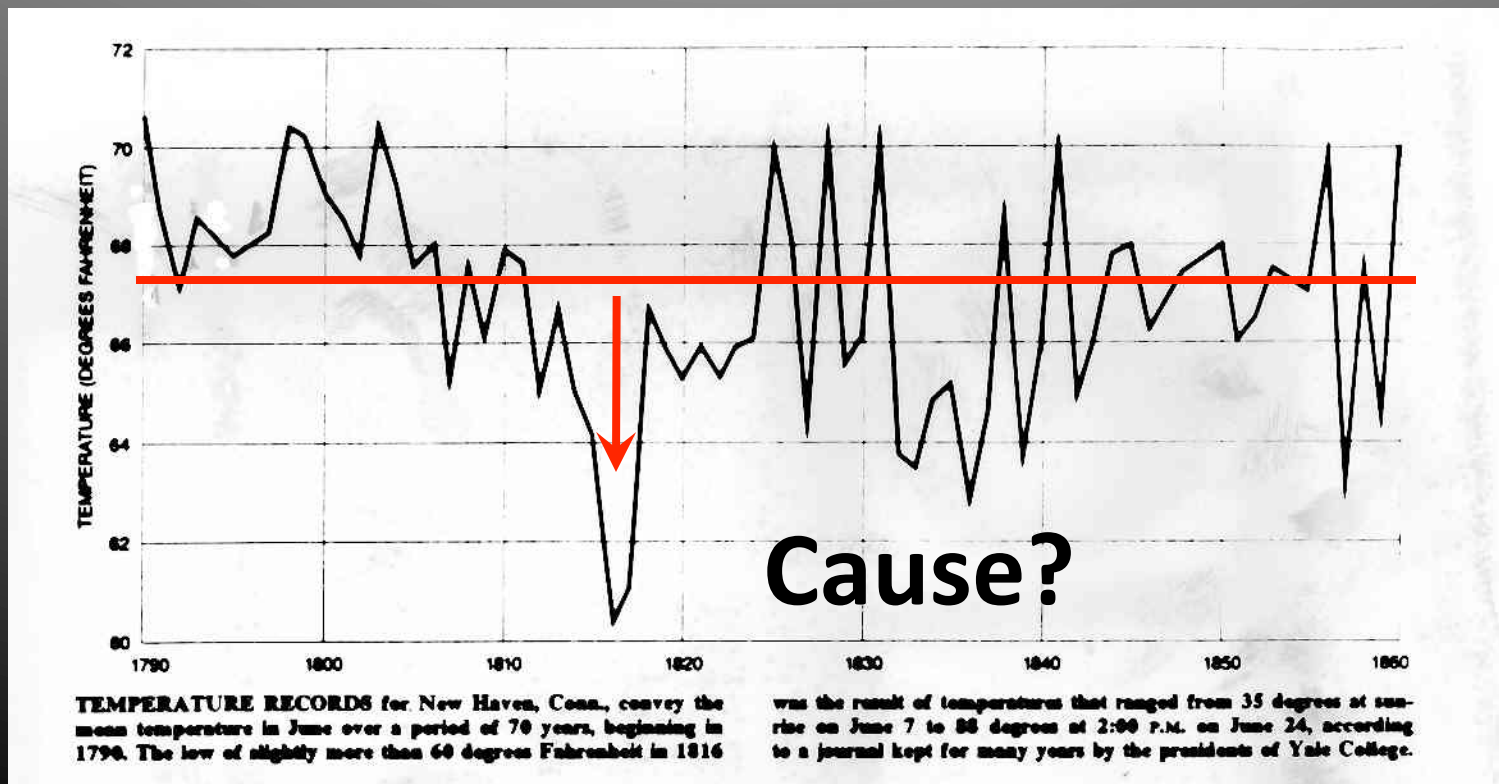
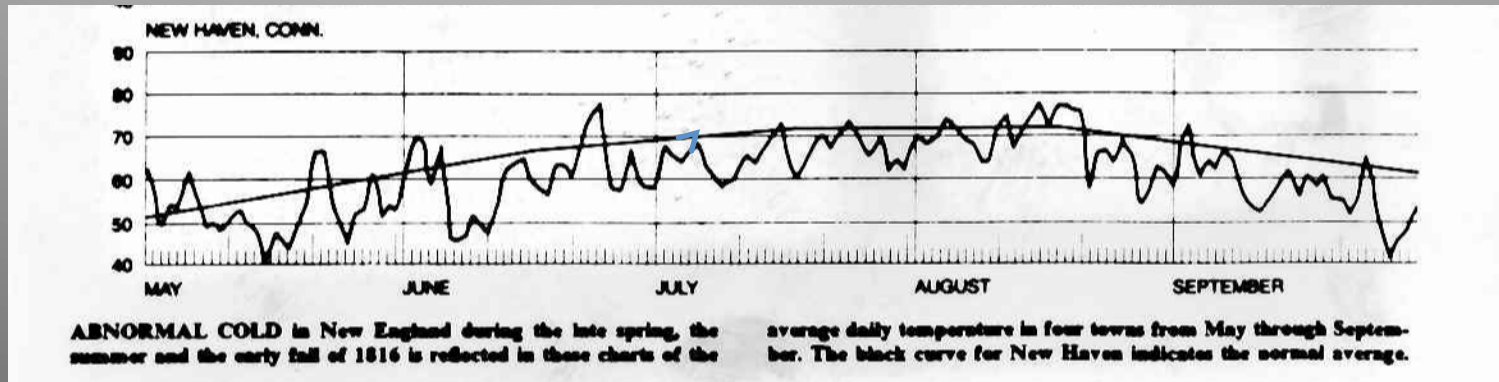


Climate vs. Weather (rate of process)



"The Year without Summer"

(Stommel and Stommel, 1979)



What should all our students know about Climate Change Science?

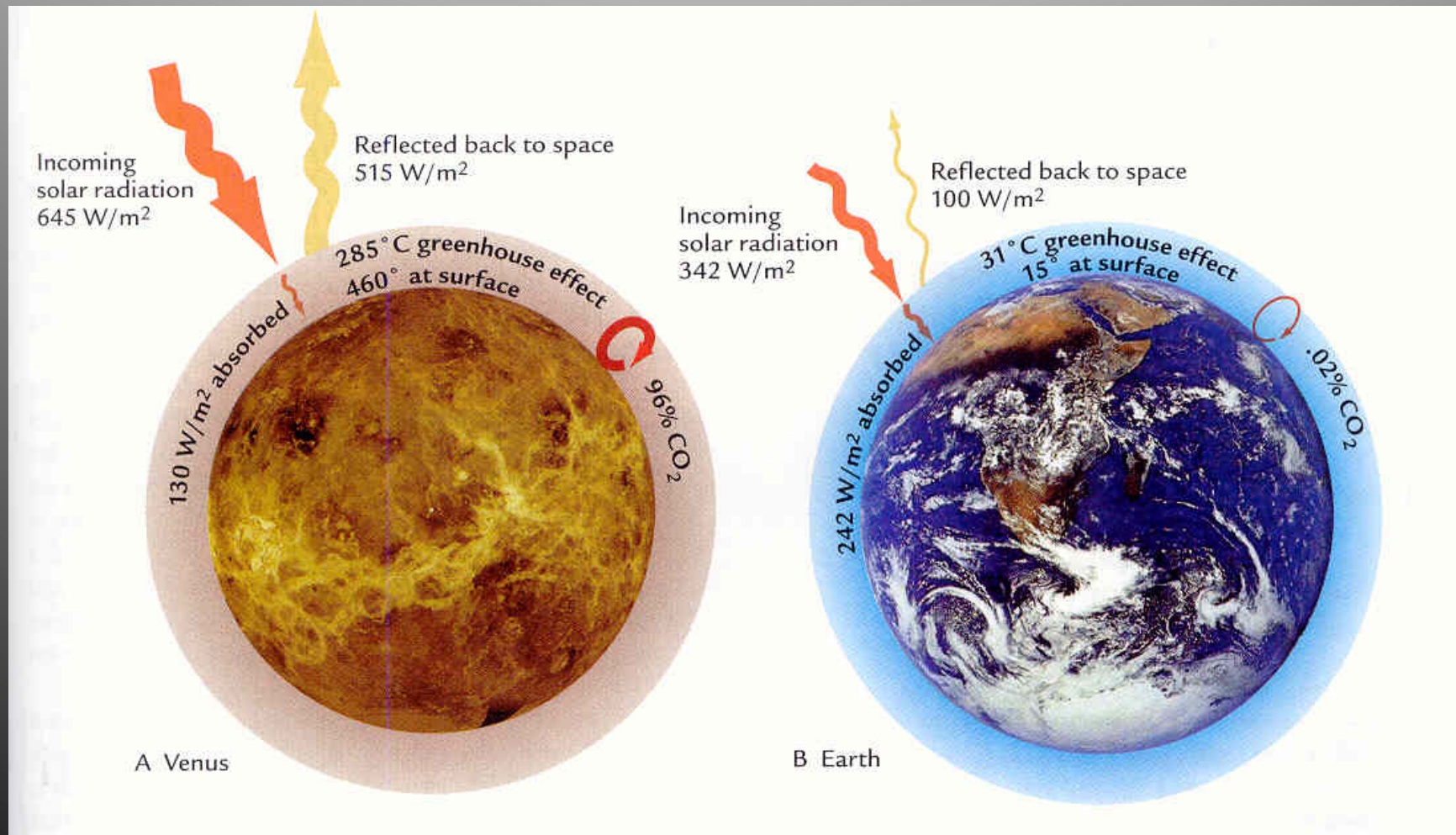
- **Climate vs. Weather**
- **Greenhouse Principle**
- **Earth – Sun Relationships**
- **Milankovitch mechanisms**
- **Earth – Atmosphere interactions**
- **Feedback mechanisms/Response times**

Suggested Resource:

**Ruddiman, 2001,/2007, Earth's Climate: Past and Future:
W.H. Freeman**

VENUS (Hi CO₂)

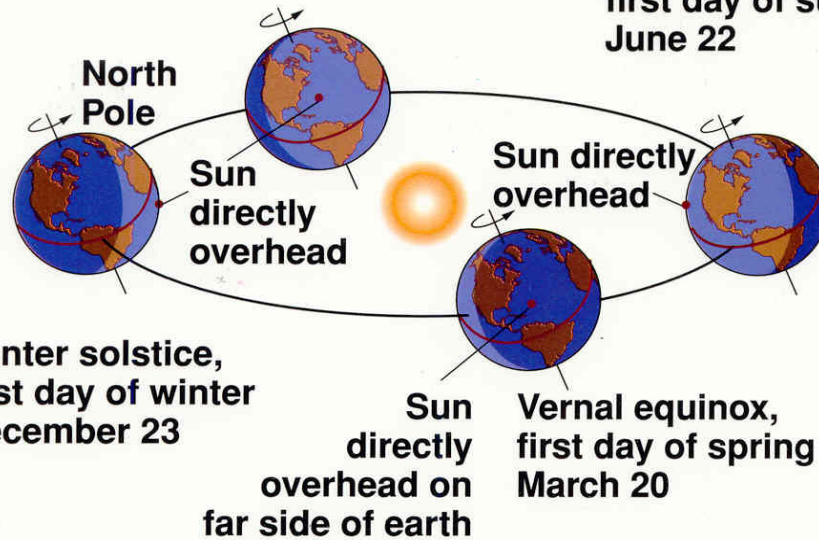
EARTH (Lo CO₂)



THE GREENHOUSE EFFECT

Autumnal equinox,
first day of autumn
September 23

Summer solstice,
first day of summer
June 22

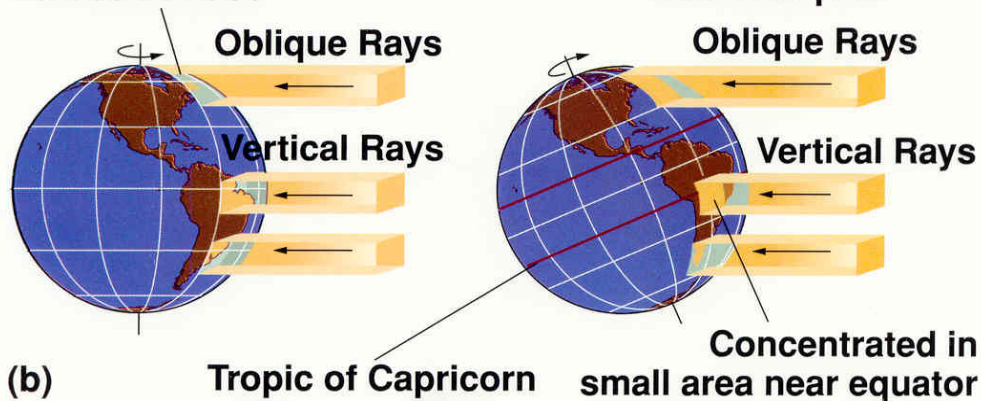


Winter solstice,
first day of winter
December 23

Vernal equinox,
first day of spring
March 20

Sun's rays glance
across surface

Spread over large
area near pole



Climate System

Factors:

- Solar distance
- Rotation
- Tilt

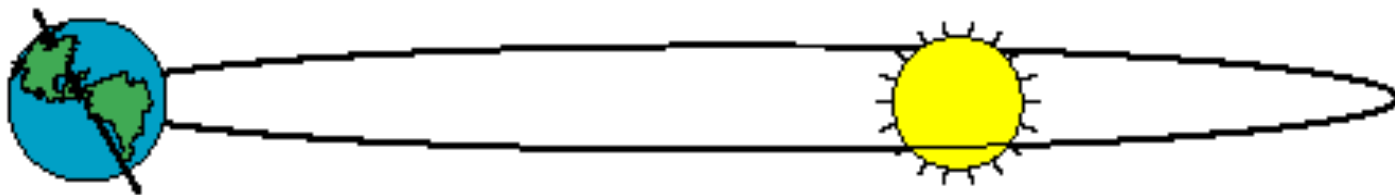
Result:

Daily and Seasonal
Temperature variation

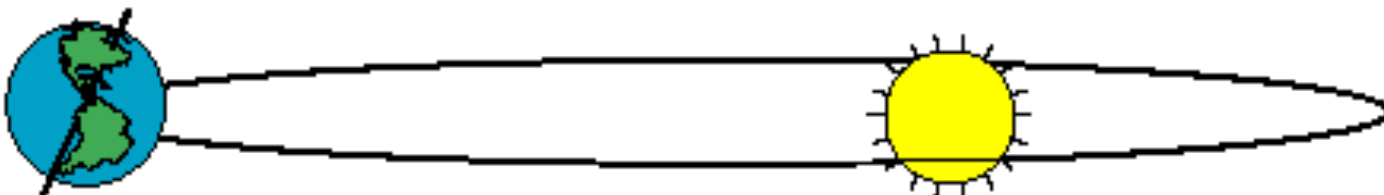
Long-Term Climate Cycle Mechanisms

(Milankovitch, 1941)

Precession of the Equinoxes (19 and 23 k.y.)



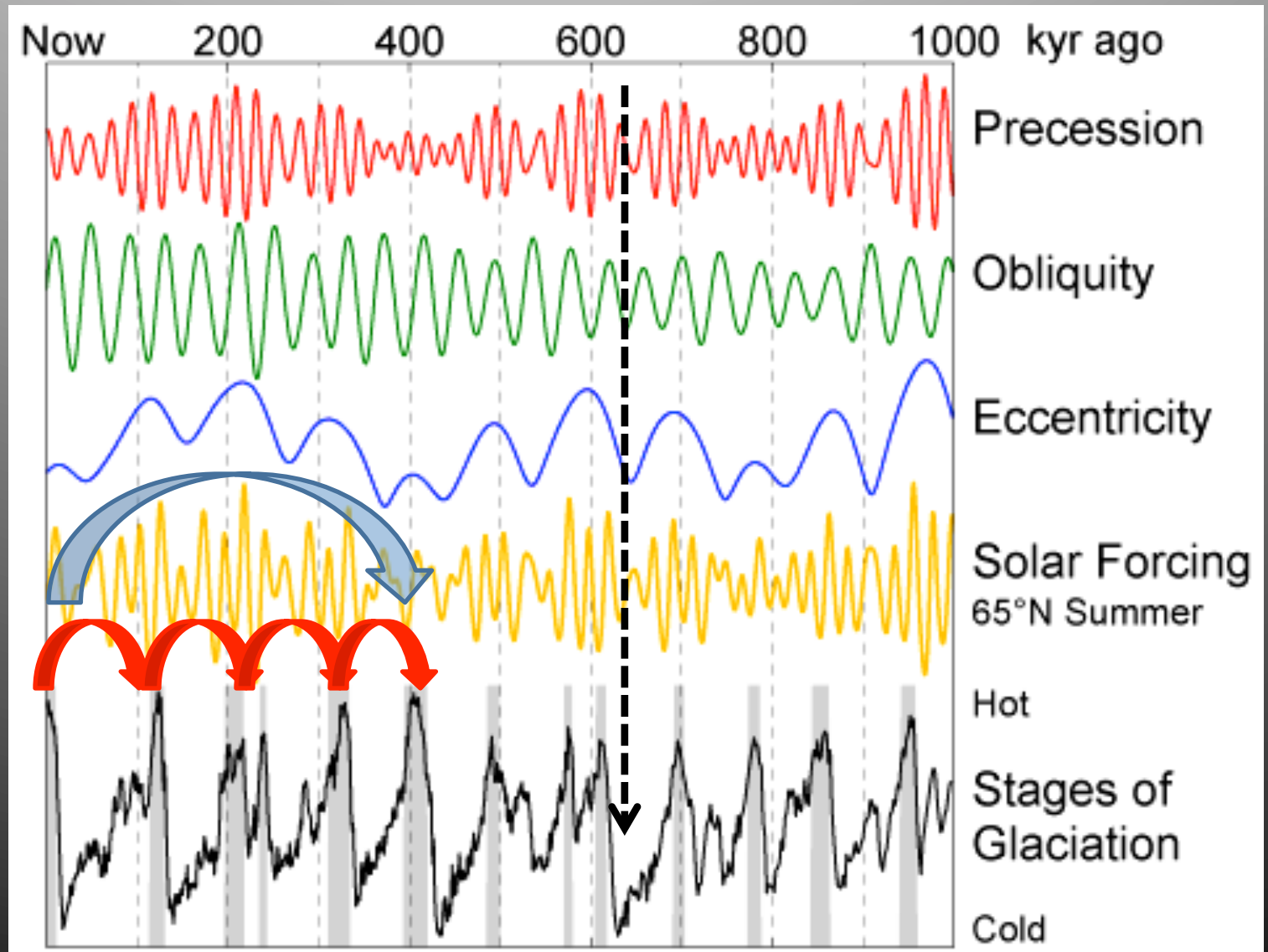
Northern Hemisphere tilted away from the sun at aphelion.



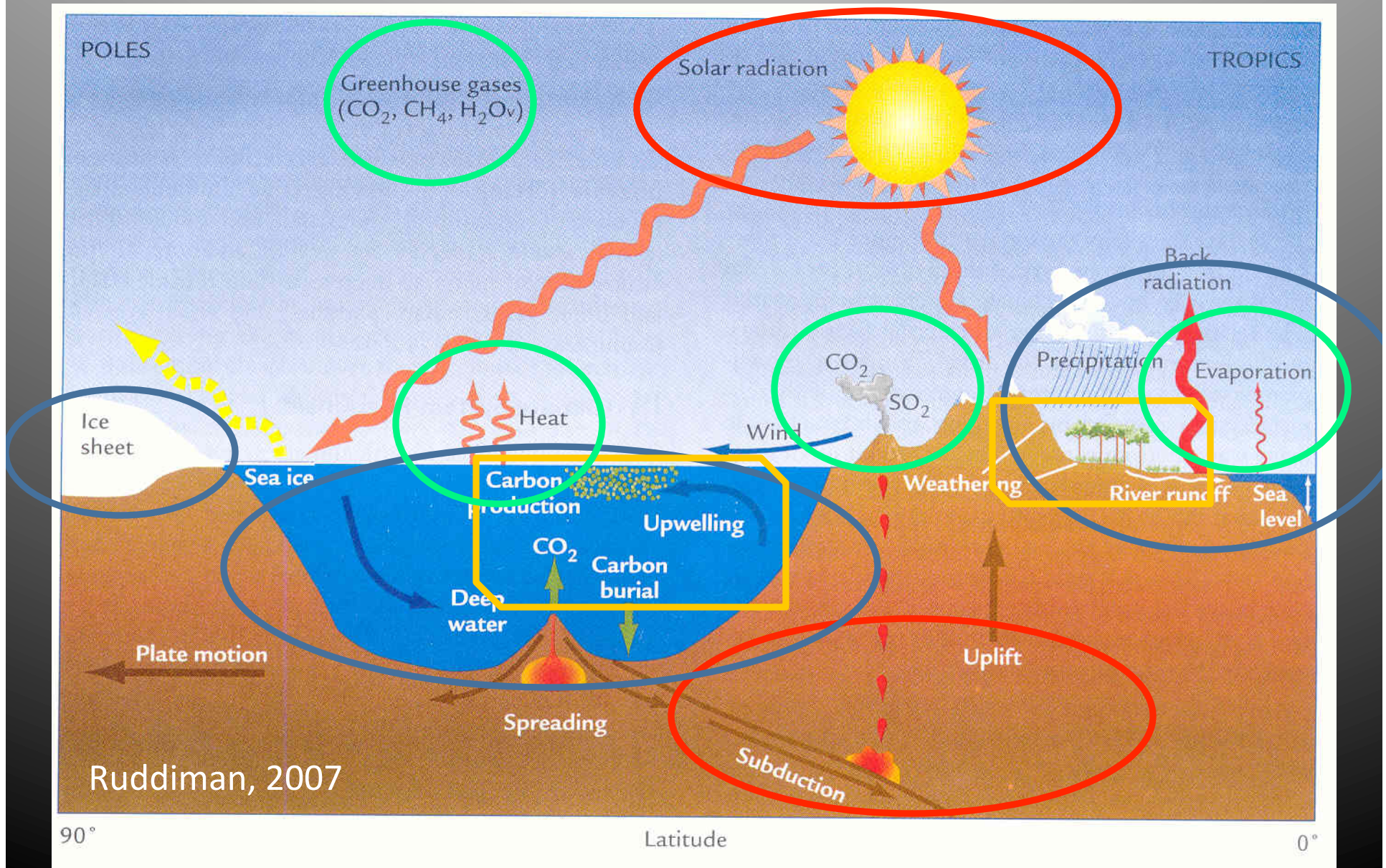
Northern hemisphere tilted toward the sun at aphelion.

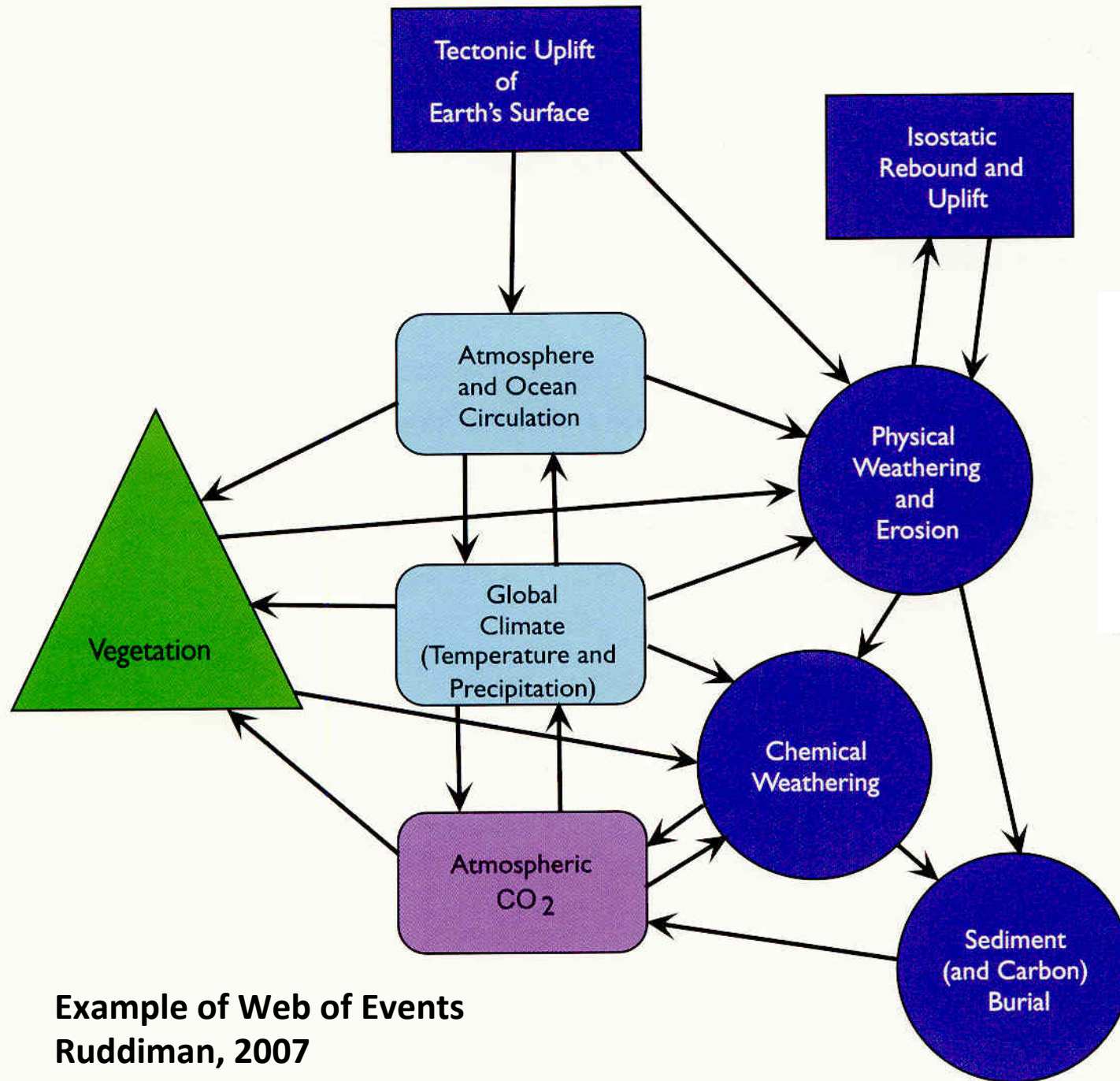
Modulation:

$$A + B + C =$$



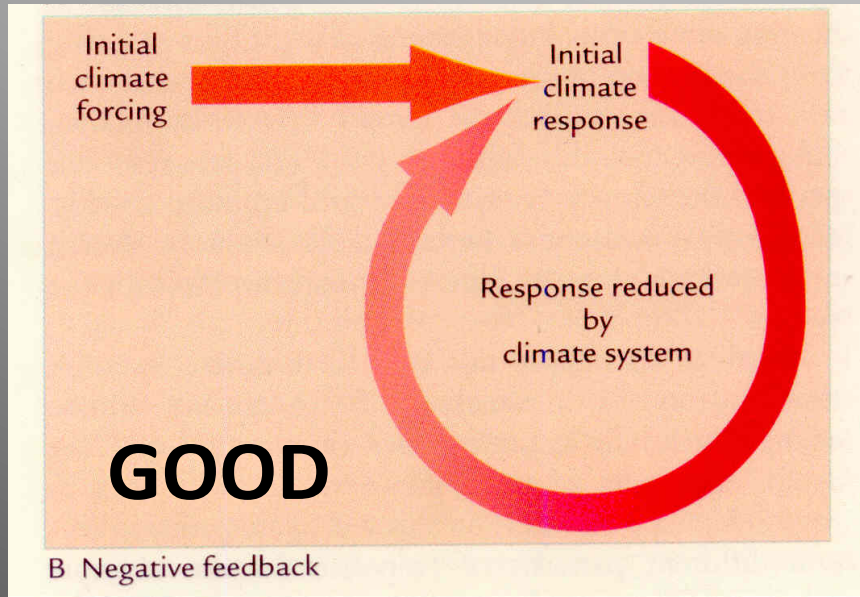
Climate Interactions





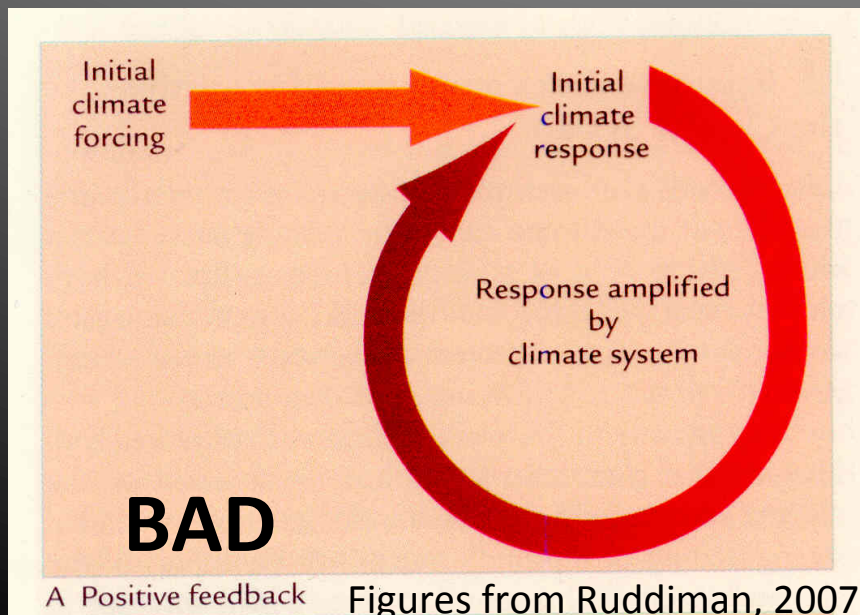
Example of Web of Events
Ruddiman, 2007

FEEDBACK MECHANISMS



NEGATIVE FEEDBACK

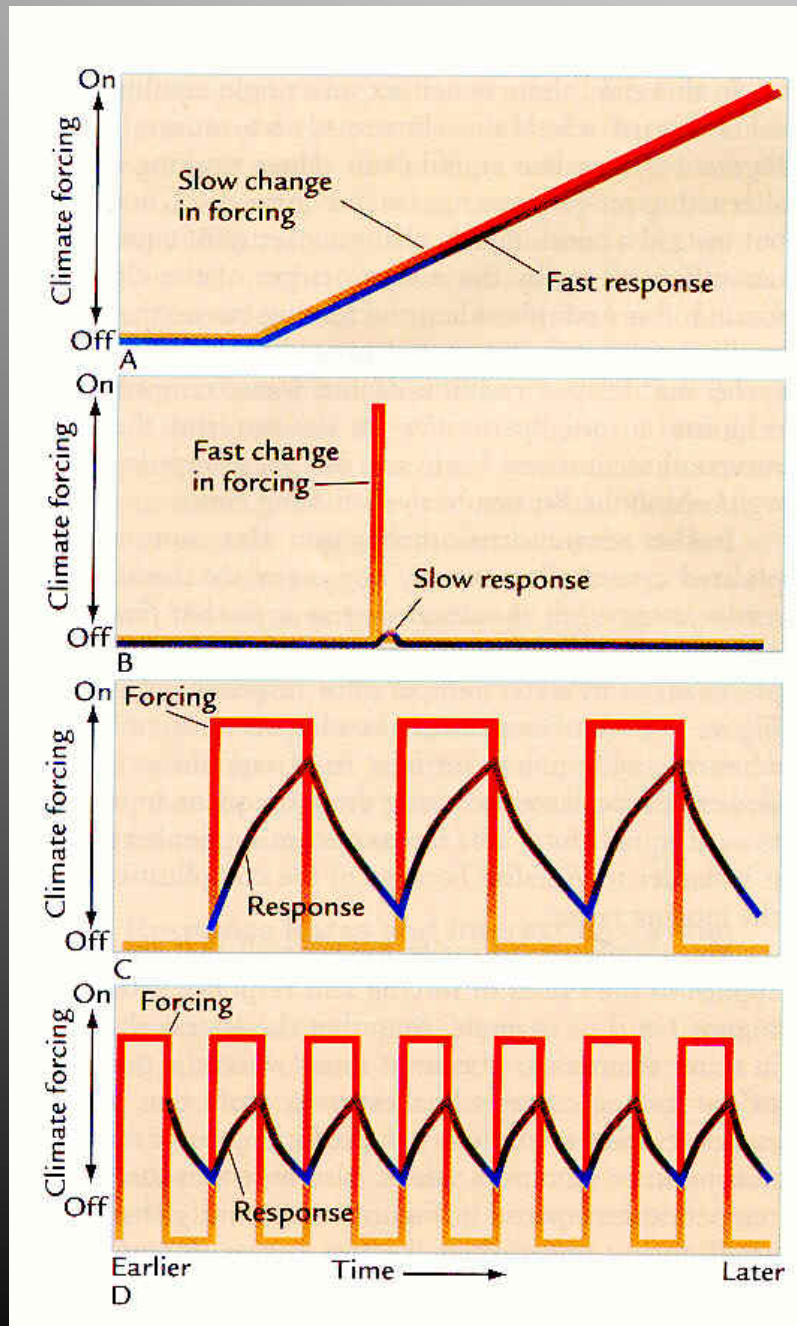
e.g., Excess CO_2 in atmosphere →
Atmosphere warms →
More evaporation → More rain →
More weathering of rocks →
Uses excess CO_2 →
Atmosphere cools



POSITIVE FEEDBACK

e.g., Reduce solar radiation →
poles gain more ice →
increase reflectivity of
earth's surface →
less solar energy absorbed →
more ice forms and so on....

Figures from Ruddiman, 2007



Forcing and Response Rates

Example: Movement of Continents to higher latitudes and climate change

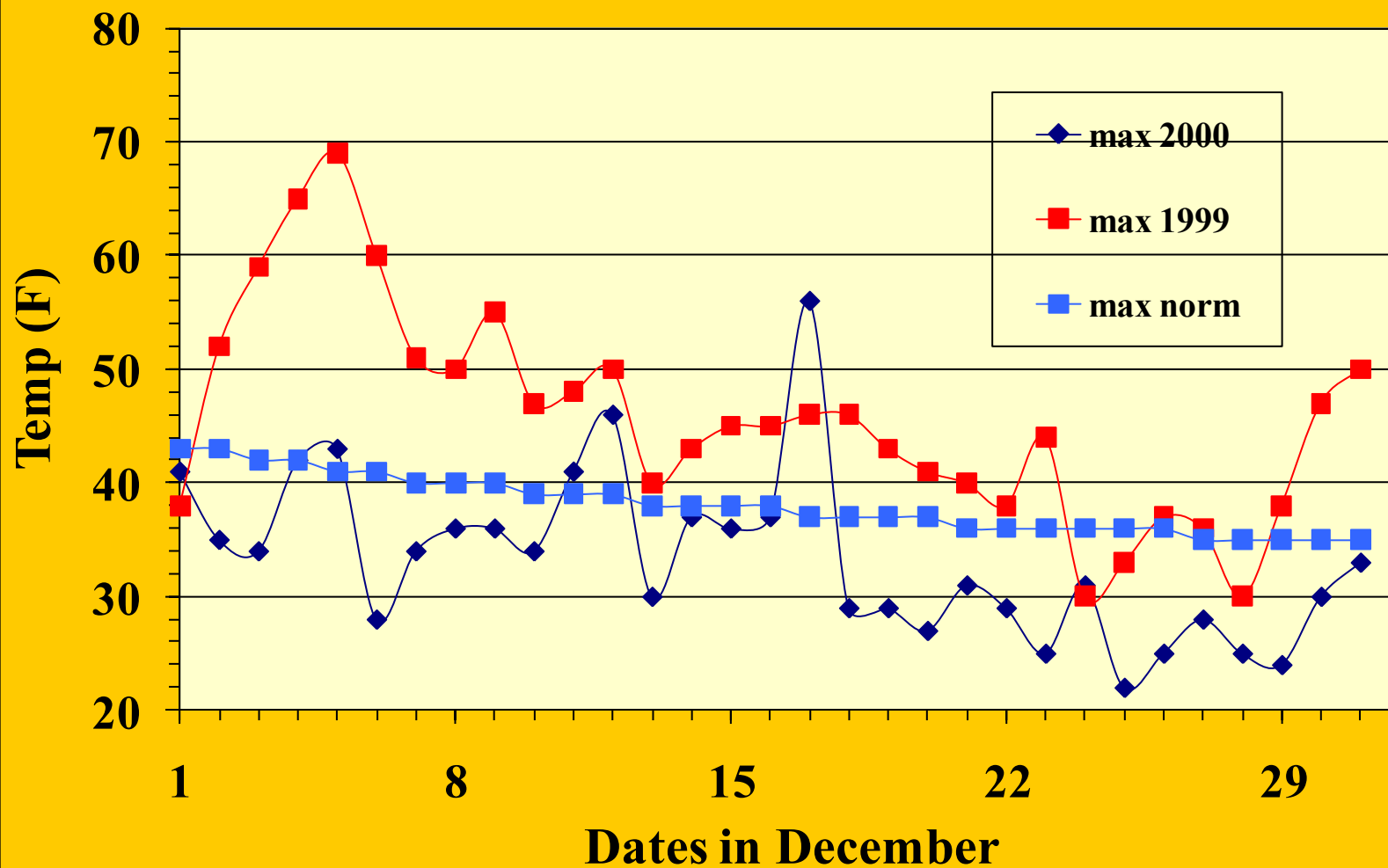
Example: Volcanic eruption and globally small change in climate (1815)

Lower frequency cycling of climate forcing → greater magnitude response

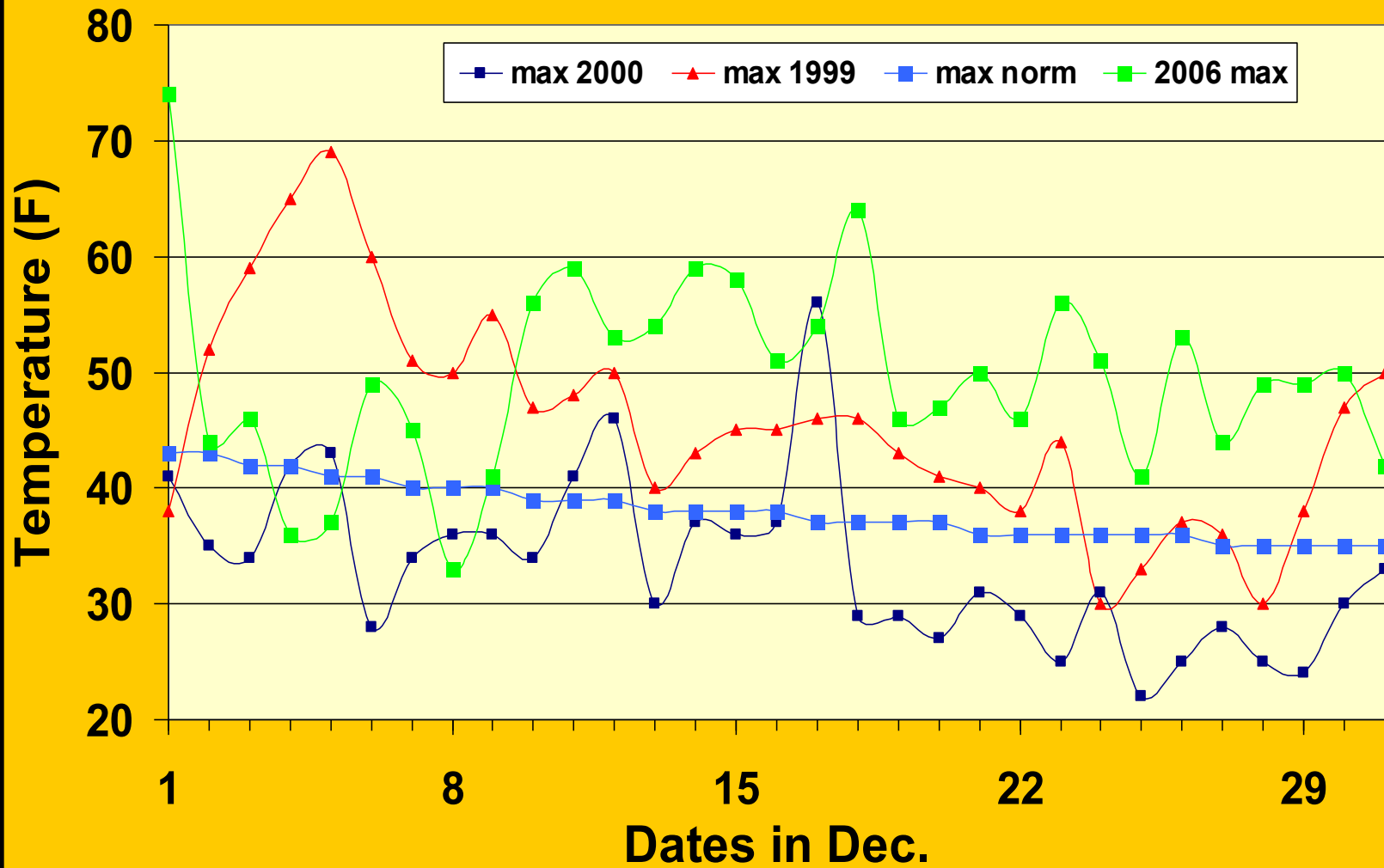
Higher frequency cycling of climate forcing → smaller magnitude response



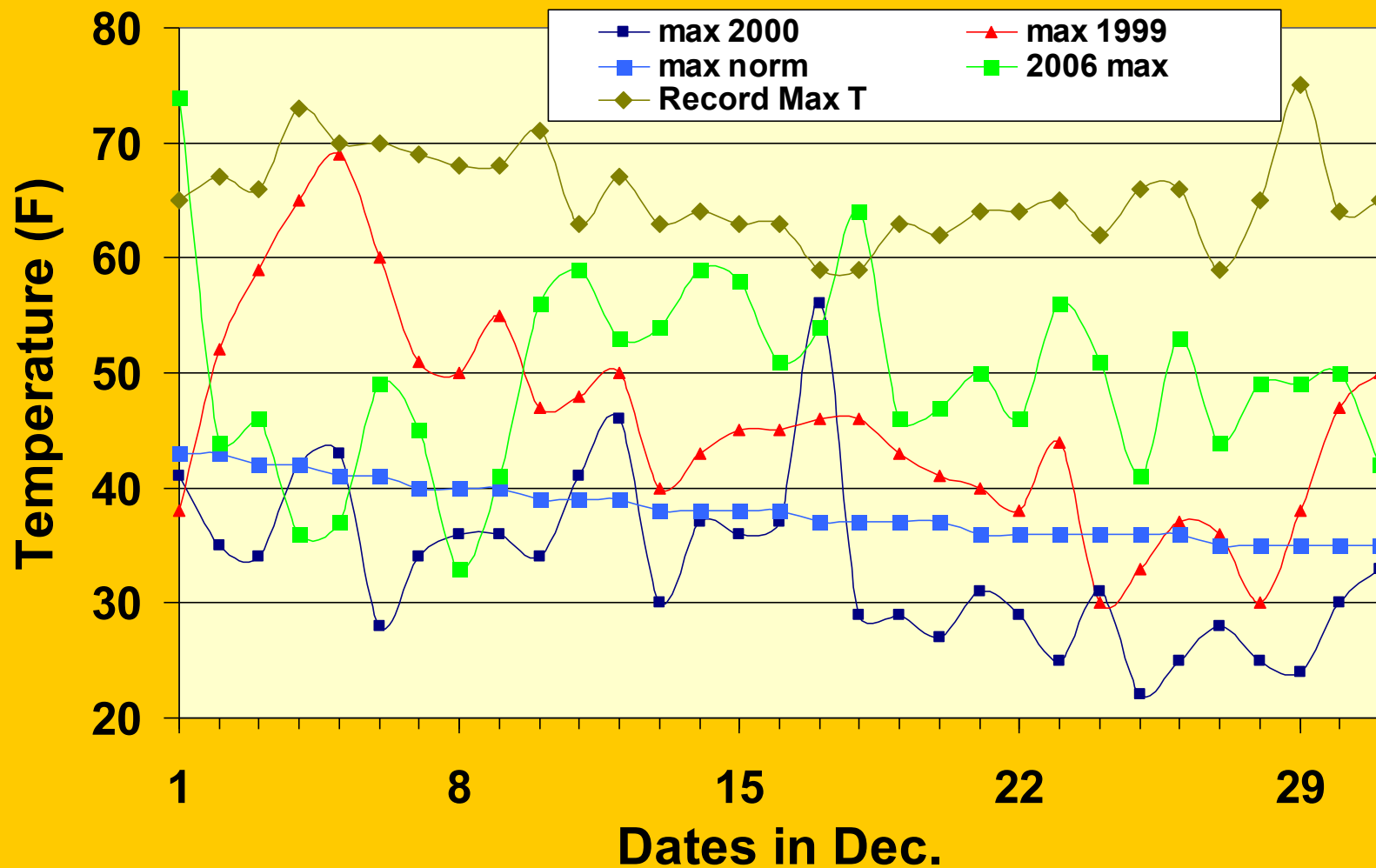
Harrisburg Max T -Dec. 1999, 2000

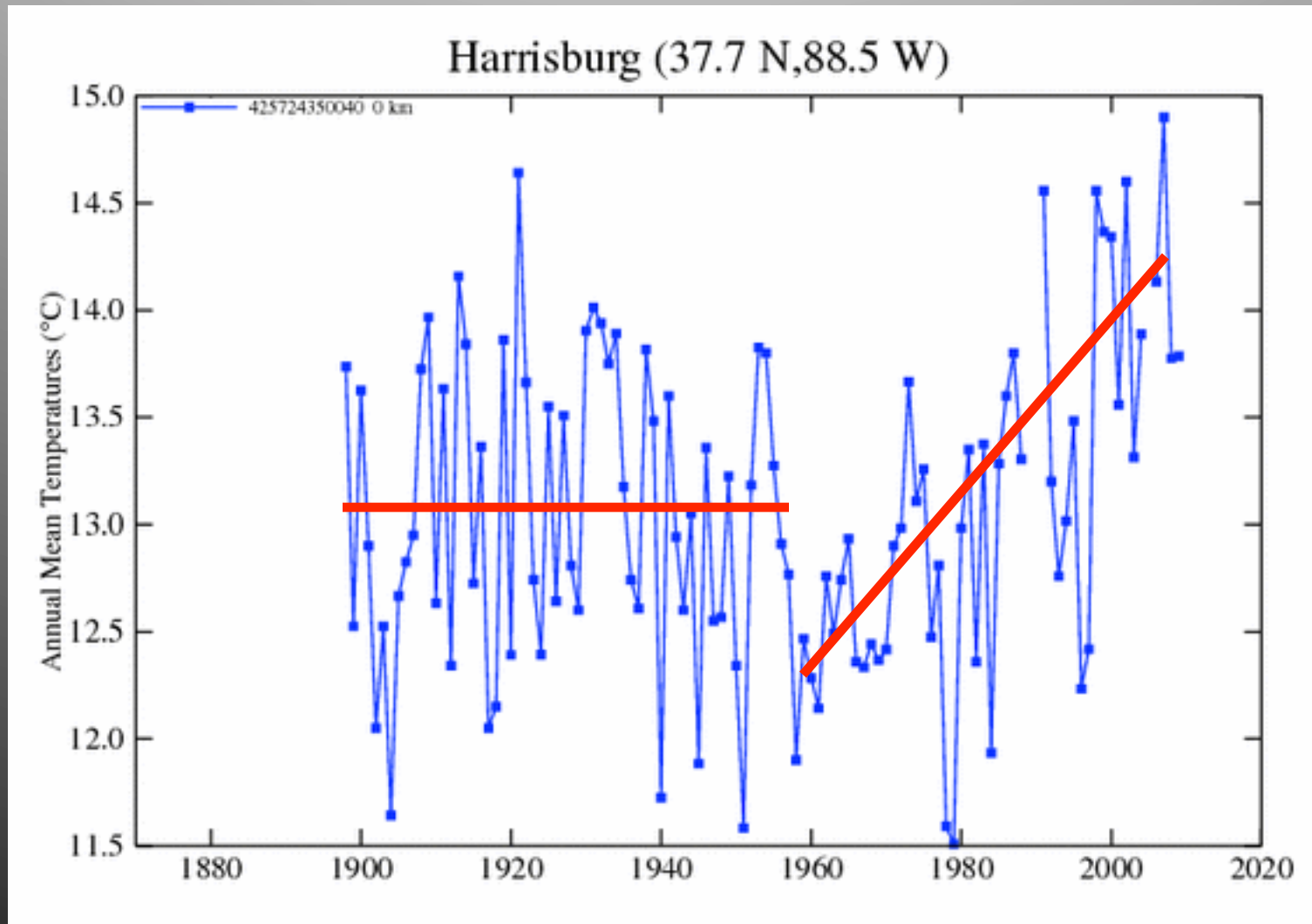


Harrisburg Max T- Dec 1999, 2000, 2006



Harrisburg Max T- Dec 1999, 2000, 2006





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