Environmental Education Association of Oregon Sept 2016 Workshop on Climate Science Basics

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Southern Oregon Climate Action Now

SOCAN

Confronting Climate Change

http://socan.info

The Basic Science

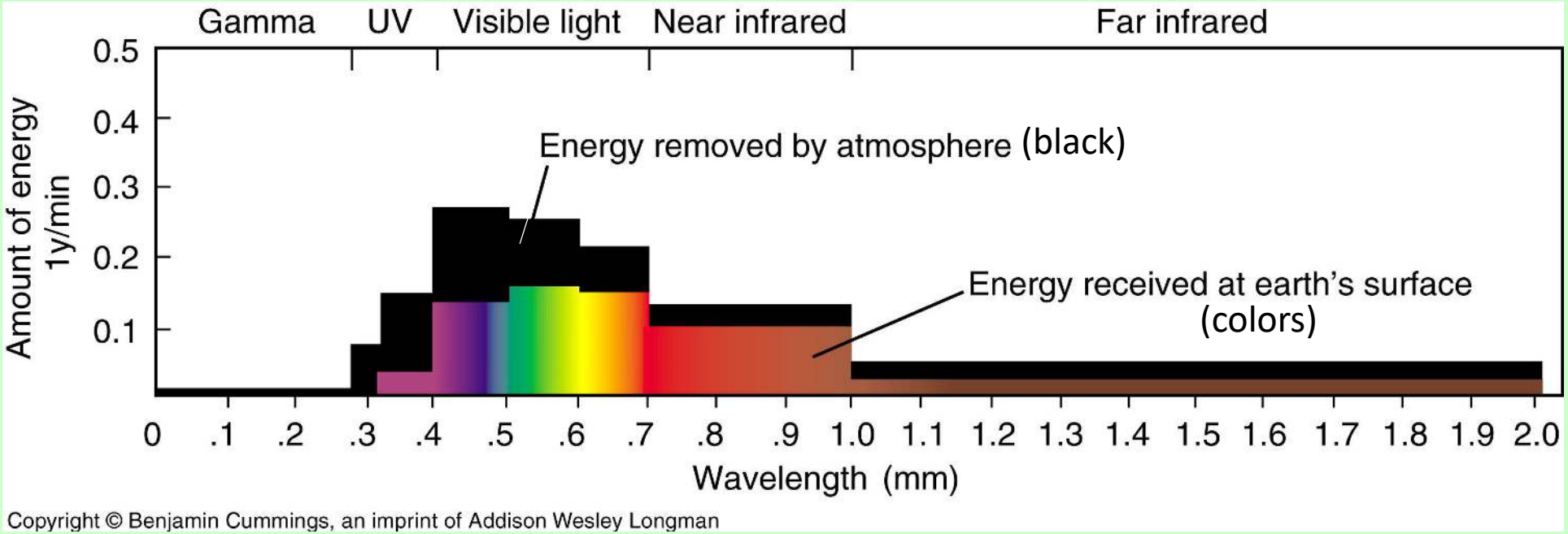
Directions – Basic Science

1. Examine the images; analyze and interpret them (8 minutes)
2. Arrange them into a sequence that tells the basic scientific story of global warming (8 minutes)
3. Use your images to tell your story to another team (9 minutes)
4. Summary (5 minutes)

The Spectrum of Incoming Radiation

Depicts the wavelengths of incoming solar radiation reaching Earth, their relative energy intensity, and the proportion reaching the Earth's surface.

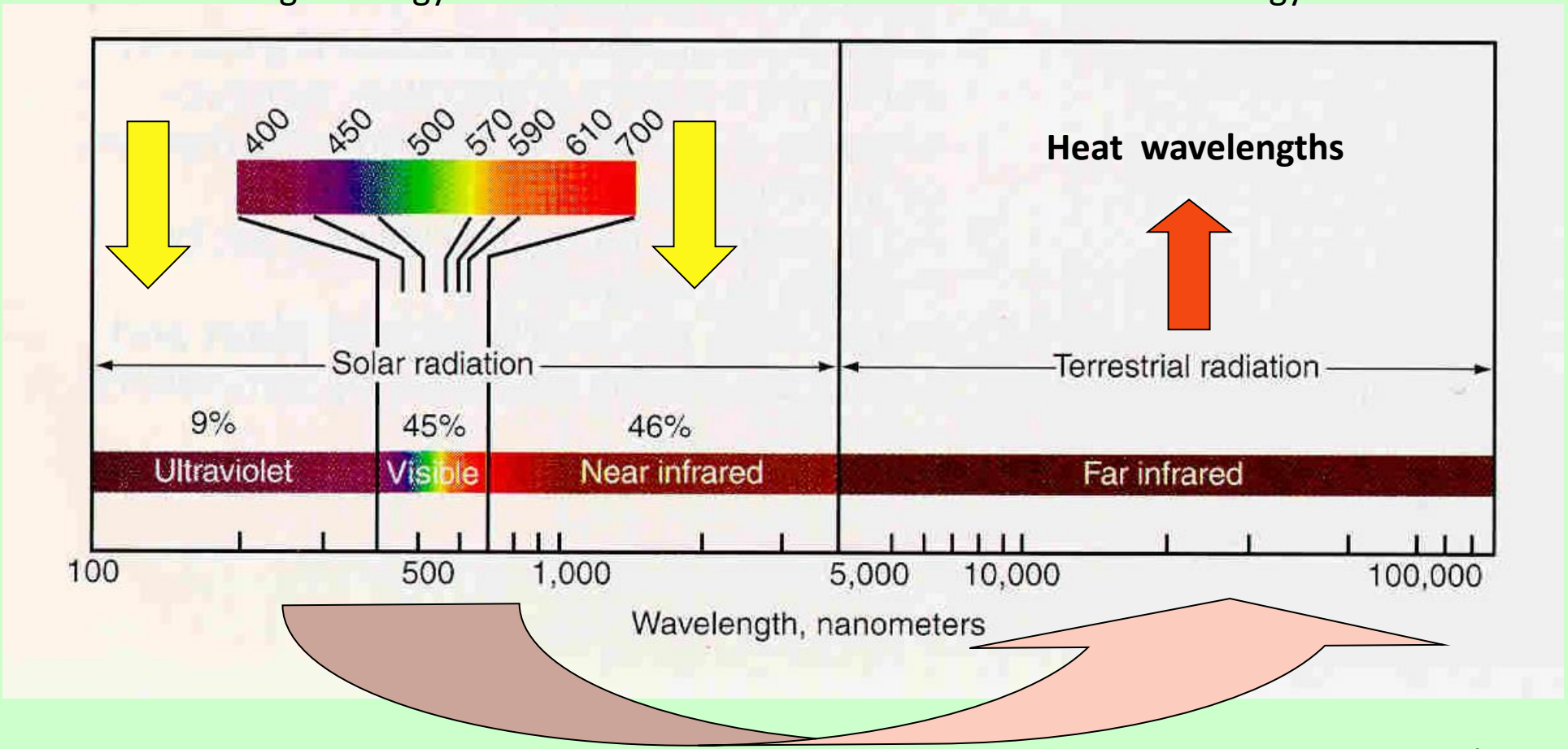
High energy short wavelengths — **Visible medium wavelengths** — **Heat long wavelengths** → **Microwaves TV/Radio FM-AM**



Transformation of Radiation at Earth's Surface

Hot bodies
emit radiation
in shorter wavelength form =
Visible and UV Light Energy

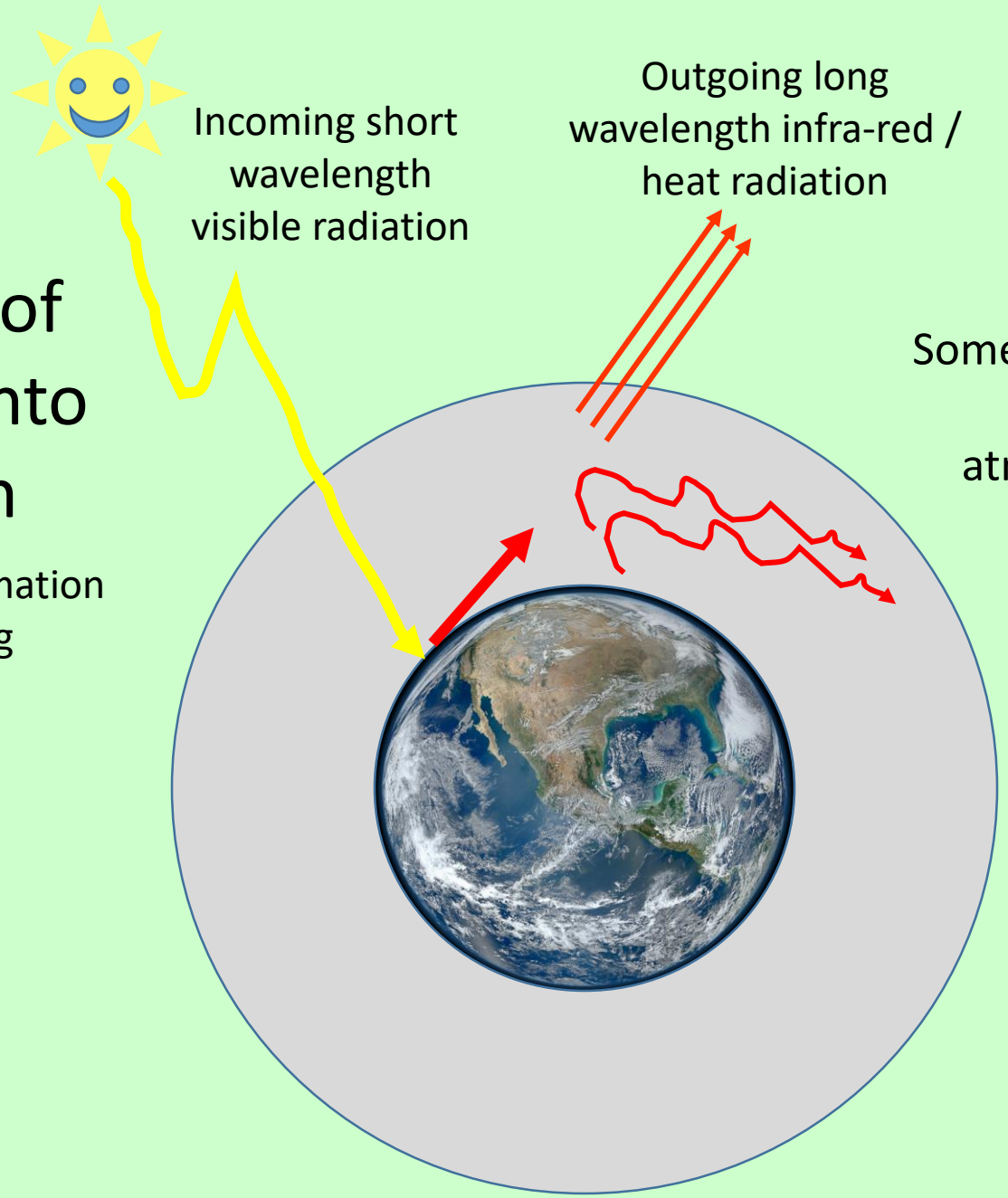
Cooler bodies
emit radiation
in longer wavelength form
= Heat Energy



Depicts the transformation of incoming solar radiation from shortwave to outgoing longwave infra-red / heat radiation

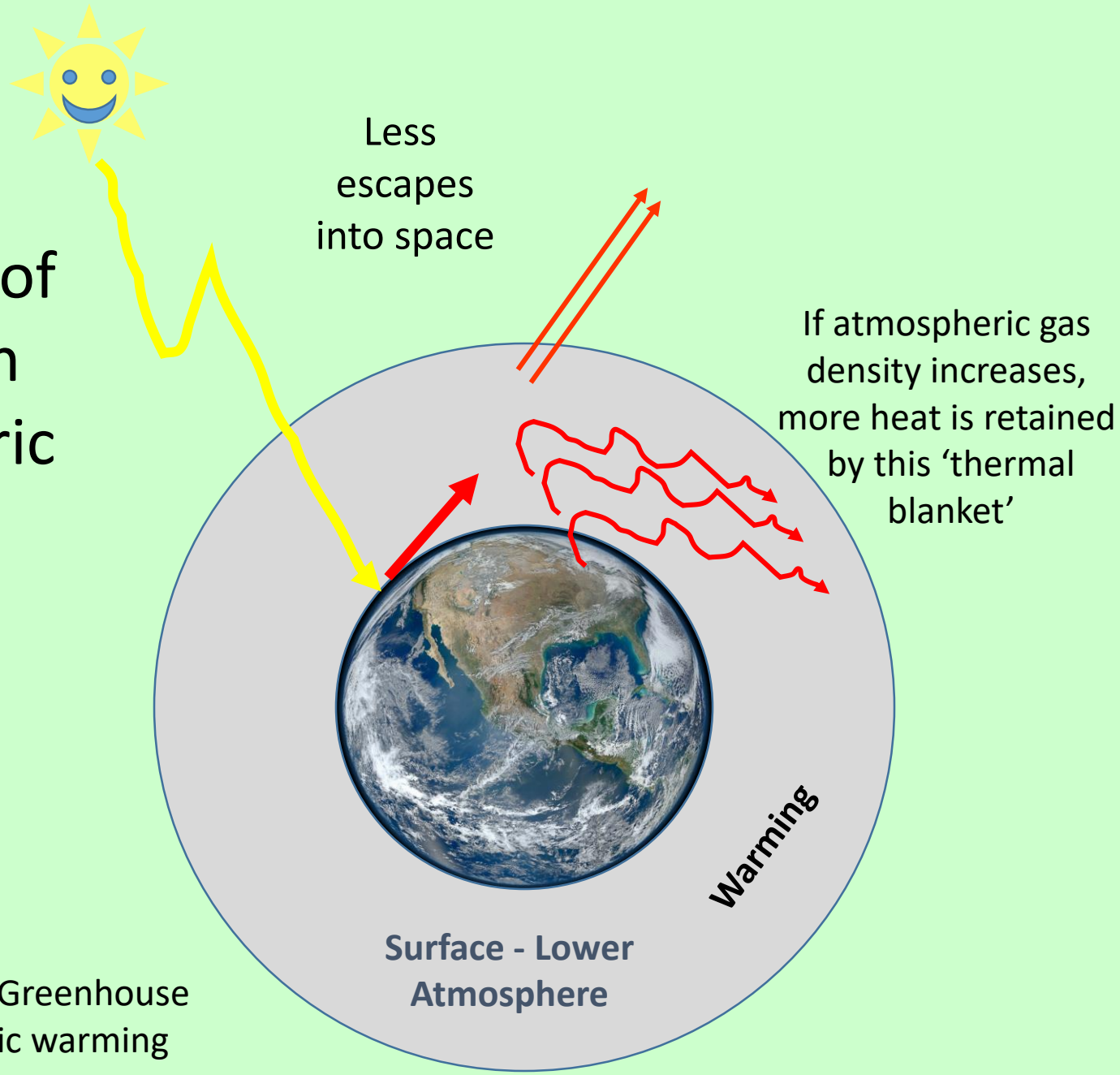
The Transformation of Incoming Radiation into Outgoing Radiation

Depicting the solar radiation transformation that causes atmospheric warming



NOTE: Absorbency is in lower atmosphere – which is where we live

The Transformation of Solar radiation with increased atmospheric greenhouse gas concentration

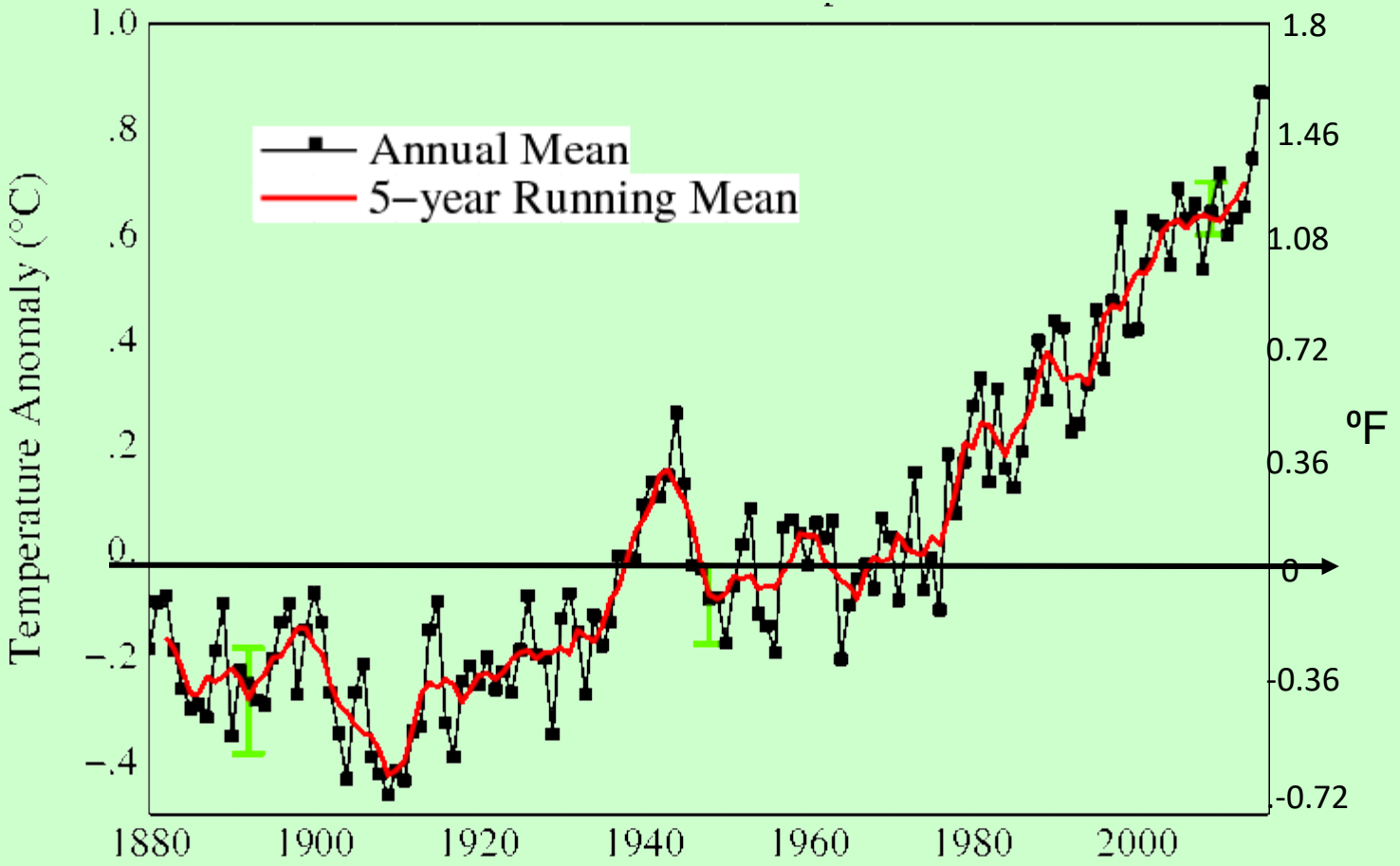


Depicting how increasing atmospheric Greenhouse Gas concentration causes atmospheric warming

Global Temperatures 1880 – 2015

cf 1951-1980

Depicting the pattern of global atmospheric temperature since records were first collected

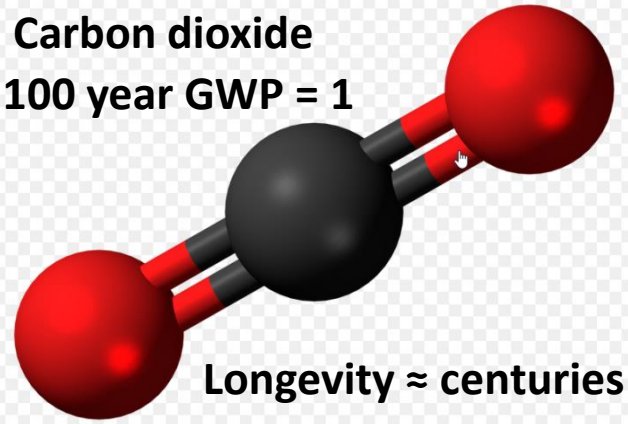


http://data.giss.nasa.gov/gistemp/graphs_v3/Fig.A2.gif

The Main Greenhouse Gases

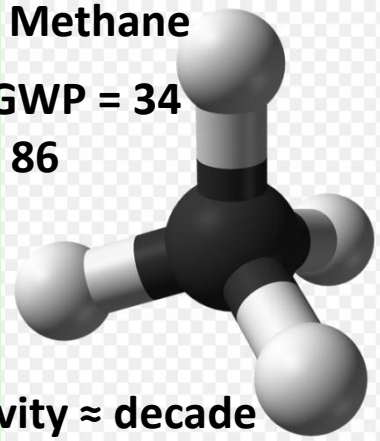
The main greenhouse gases and their Global Warming Potential (GWP)

Carbon dioxide
100 year GWP = 1



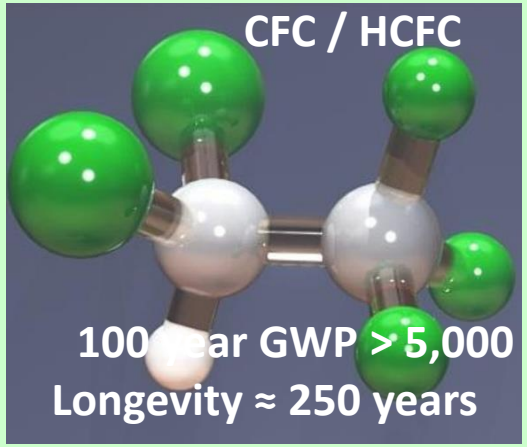
Longevity ≈ centuries

Methane
100 year GWP = 34
20 GWP = 86



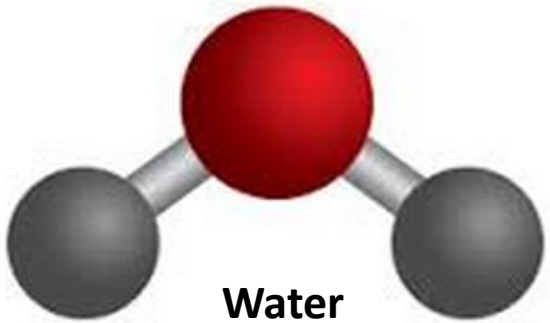
Longevity ≈ decade

CFC / HCFC



100 year GWP > 5,000
Longevity ≈ 250 years

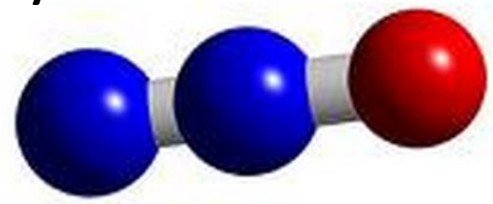
Longevity ≈ 10 Days



Water
Dihydrogen monoxide

Nitrous oxide

100 year GWP = 298

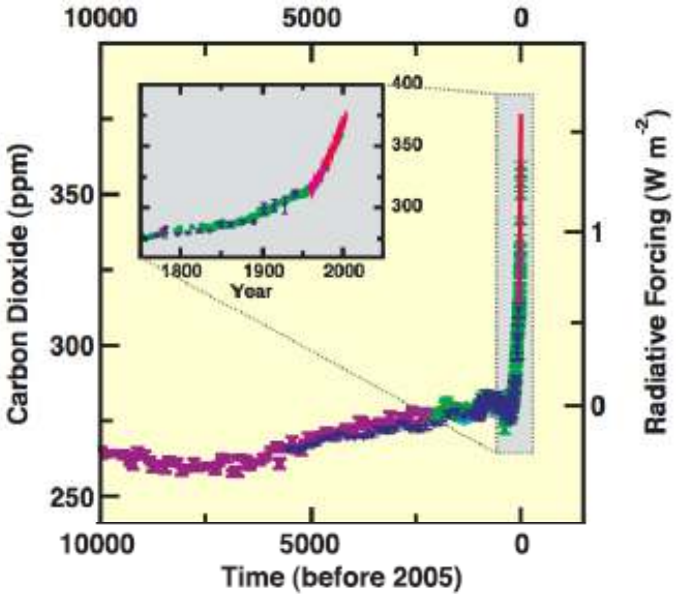


Longevity ≈ century

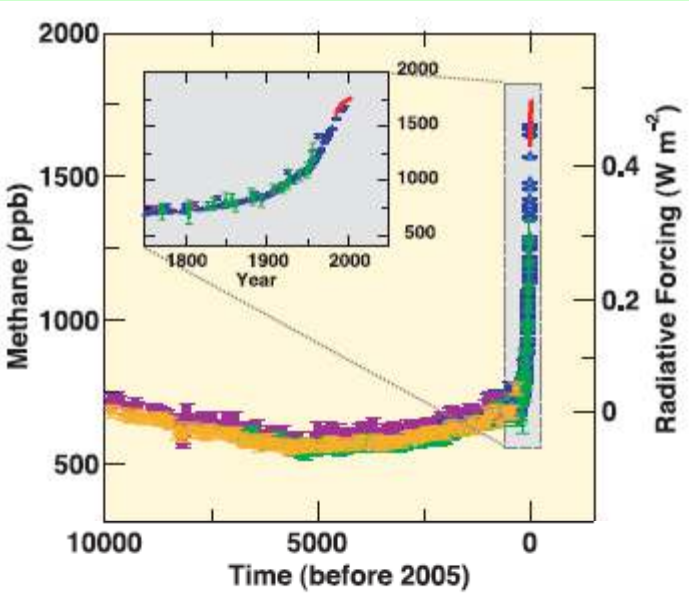
Atmospheric Greenhouse gas Concentrations from Ice Core and Modern Data

Depicting the pattern in atmospheric concentration of major greenhouse gases over this millennium

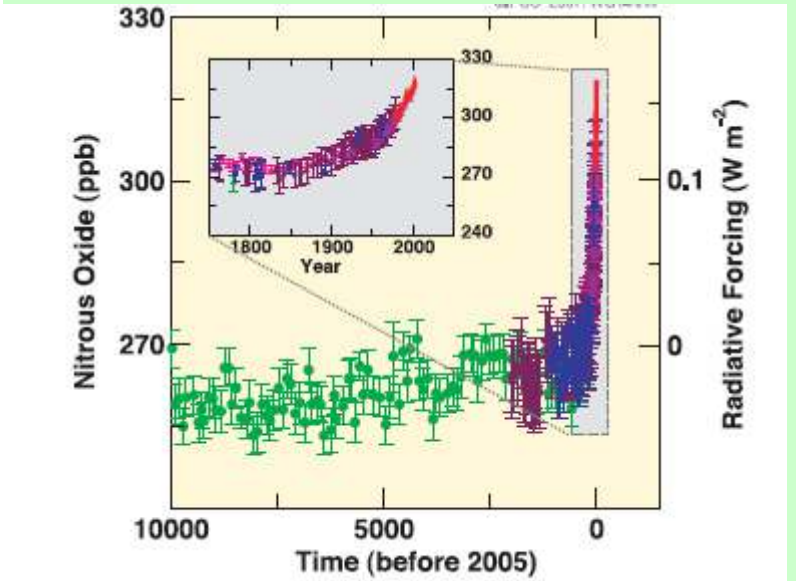
Carbon dioxide



Methane



Nitrous oxide



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Competing Hypotheses

Competing Hypotheses

- **Background - An Everyday Example**

- **What might you do?**
- **Engage in random acts of hope and desperation – like polishing the screen**
- **Pray for Divine intervention**
- **Assert the TV is really working and sit and watch the blank screen anyway**
- **Give up and read a book**
- **OR**
- **Try science … generate and test hypotheses…**

Competing Hypotheses

- **An everyday illustration of Competing Hypotheses**

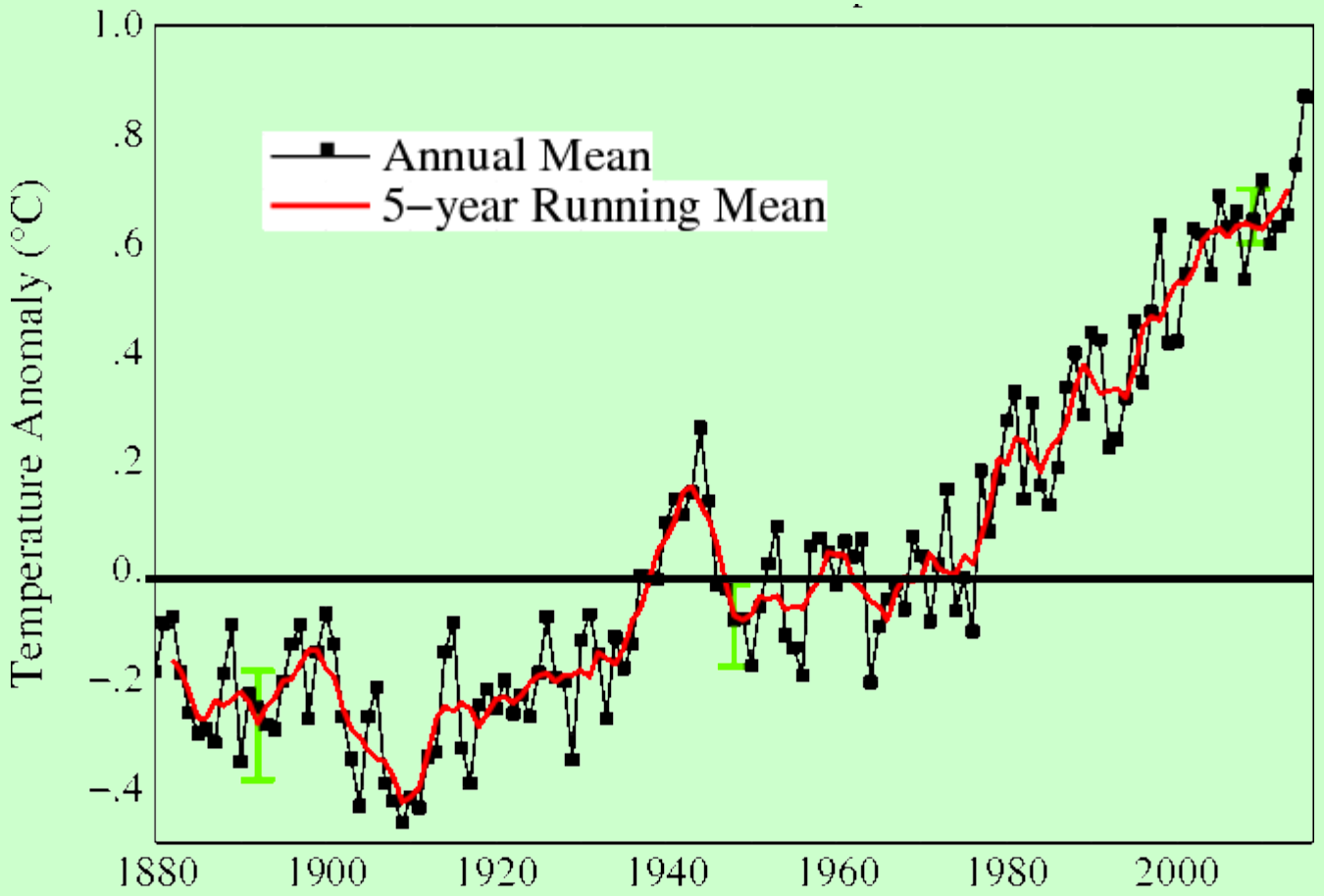
- **1 - The remote is not switched to ‘TV’**
- **2 – The TV is not plugged in**
- **3 – The power connection to the TV is broken**
- **4 – The power strip is turned off**
- **5 – The circuit breaker for the TV line is off**
- **ONLY if / when these have been falsified would we infer the TV is broken.**

The Competing Hypotheses to explain the global temperature increase

Task is to evaluate whether your data image(s) support(s) your assigned hypothesis

1. Solar Radiation
2. Volcanoes
3. El Niño Southern Oscillation ENSO
4. Milankovitch Cycle
5. Greenhouse Gases

NASA GISS Global Atmospheric Temperature Trend 1880 - 2015

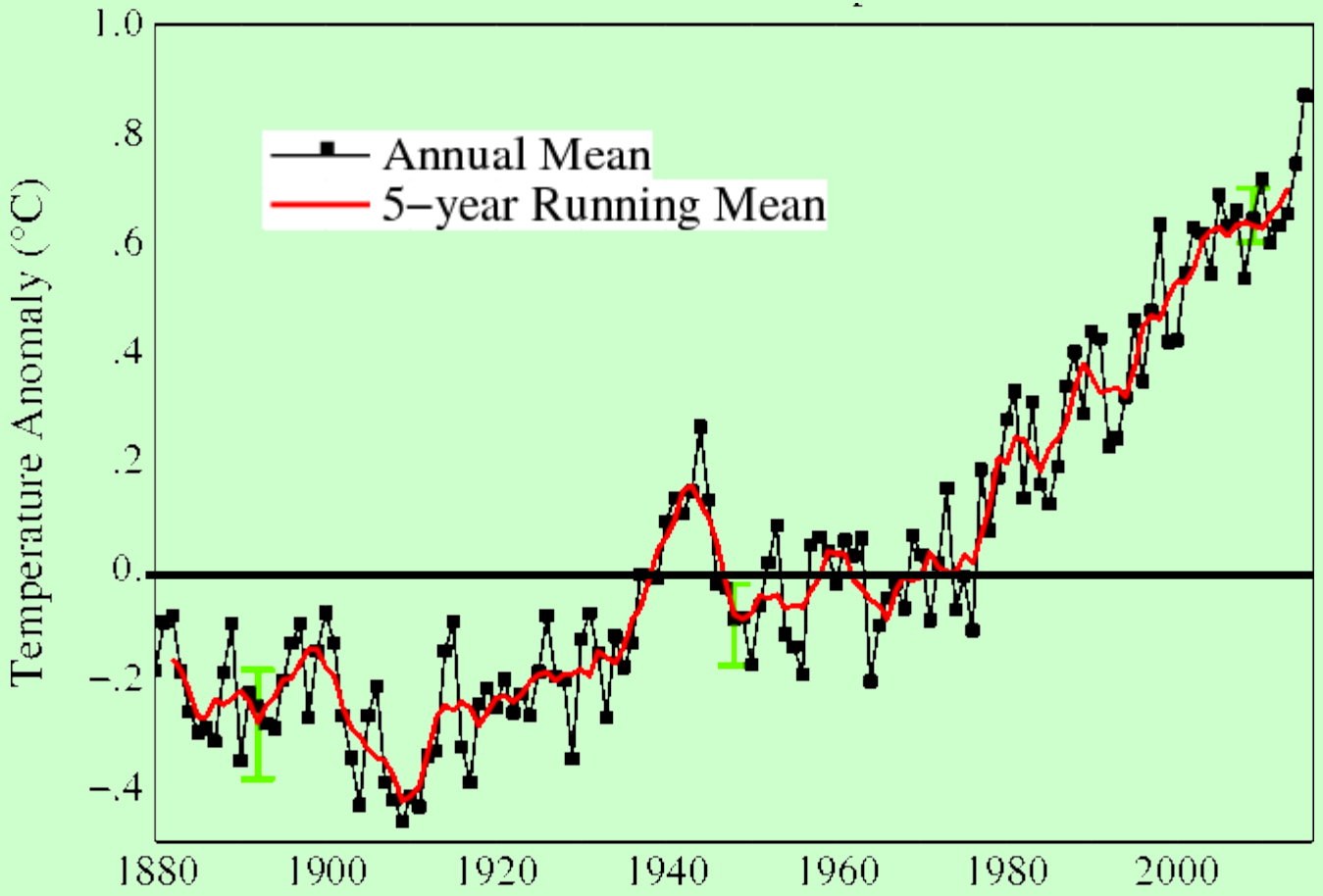


http://data.giss.nasa.gov/gistemp/graphs_v3/Fig.A2.gif

Directions – Competing Hypotheses

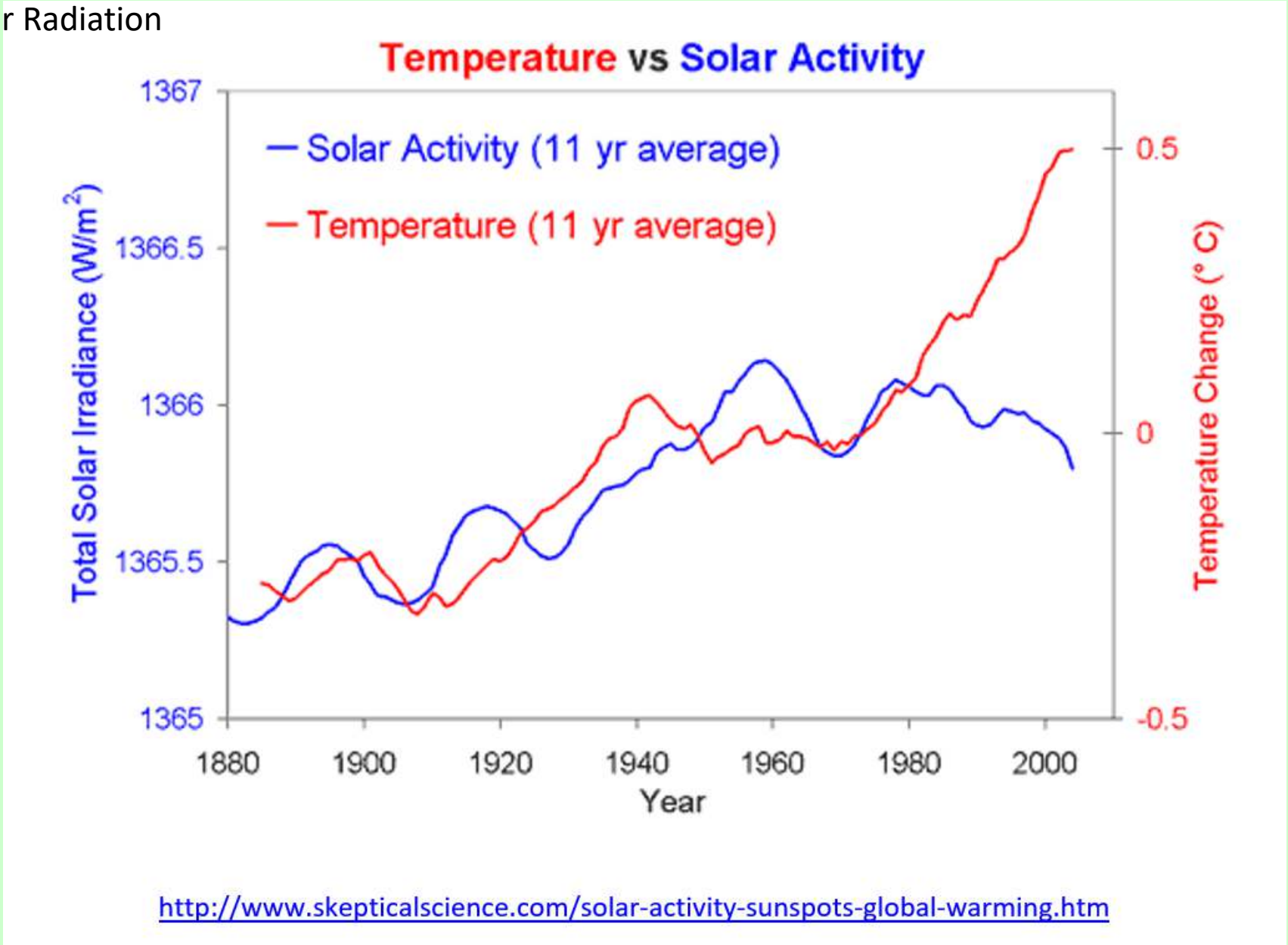
1. Examine your image(s); discuss how well the data in your image(s) support the hypothesis on your global temperature history graph. Identify a spokesperson to share your analysis with the workshop participants (10 minutes)
2. Team spokesperson shares your data (we will have the slides available) and conclusions with other workshop participants (10 minutes).
3. Summary – wrap-up

NASA GISS Global Atmospheric Temperature Trend 1880 - 2015



http://data.giss.nasa.gov/gistemp/graphs_v3/Fig.A2.gif

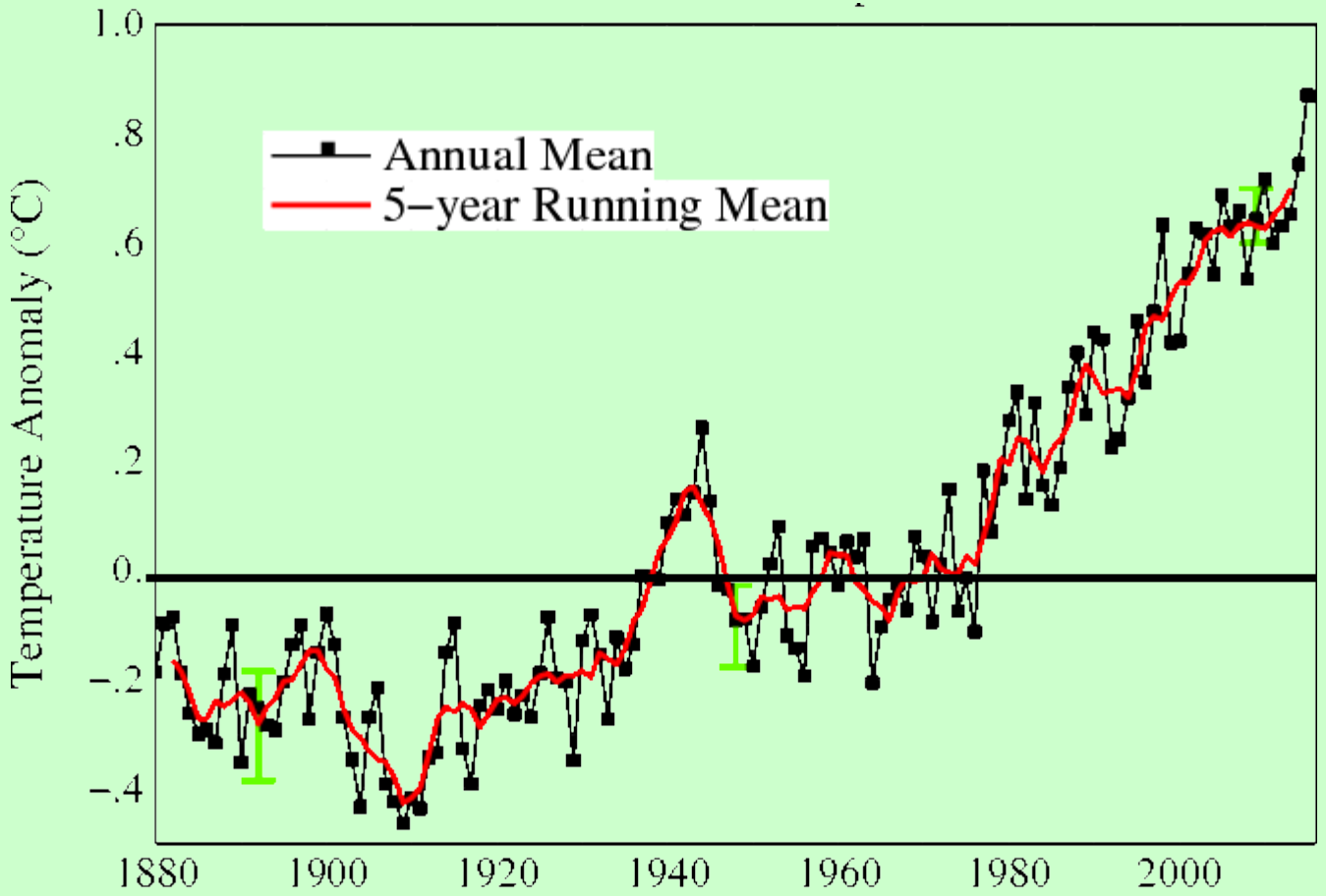
Hypothesis 1 – Solar Radiation



http://www.skepticalscience.com/solar-activity-sunspots-global-warming.htm

Depicting the pattern of solar radiation activity and global temperature from 1880

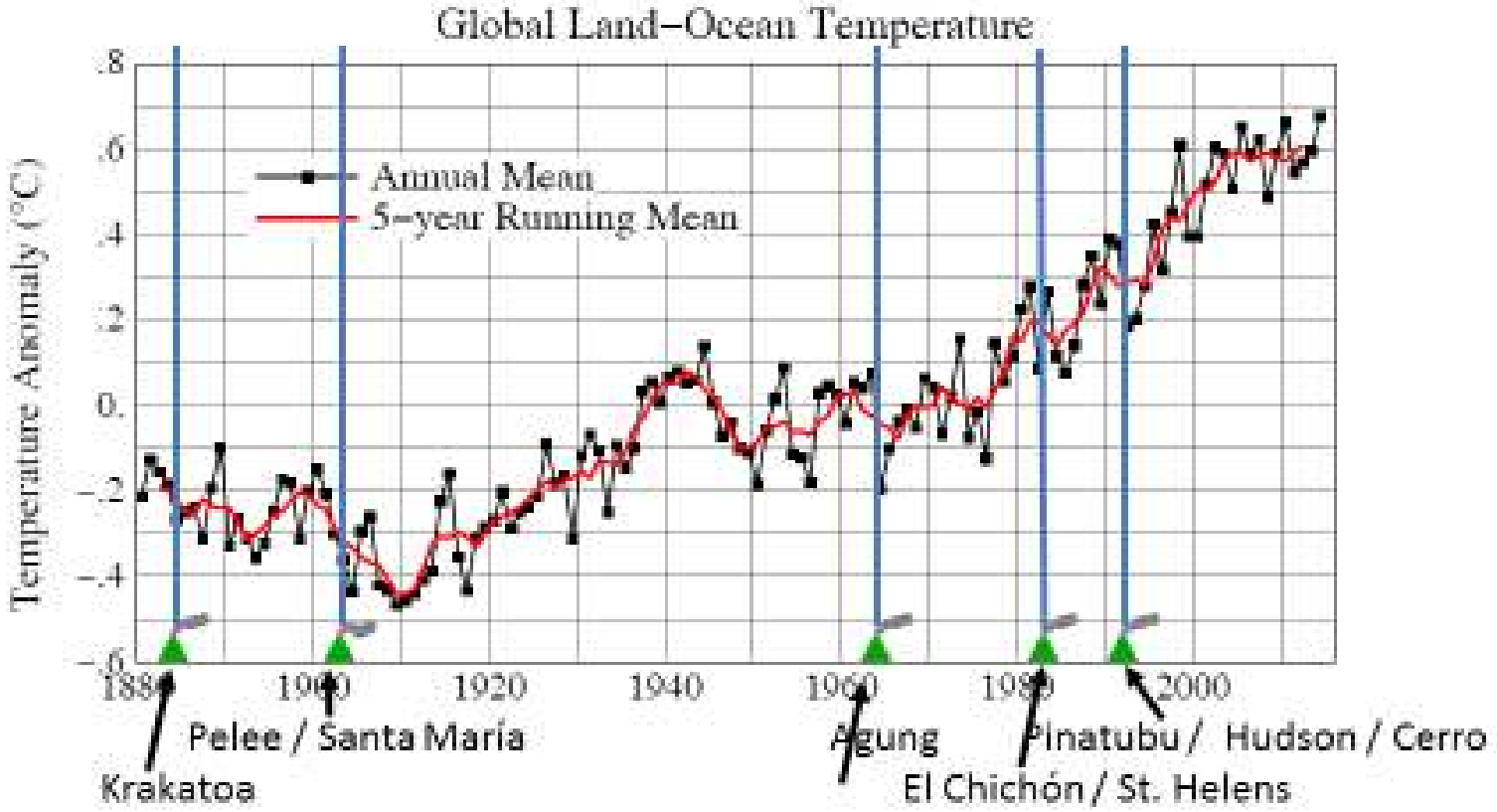
NASA GISS Global Atmospheric Temperature Trend 1980 - 2015



http://data.giss.nasa.gov/gistemp/graphs_v3/Fig.A2.gif

Hypothesis 2 – Volcanoes

Volcanoes and Global Temperature

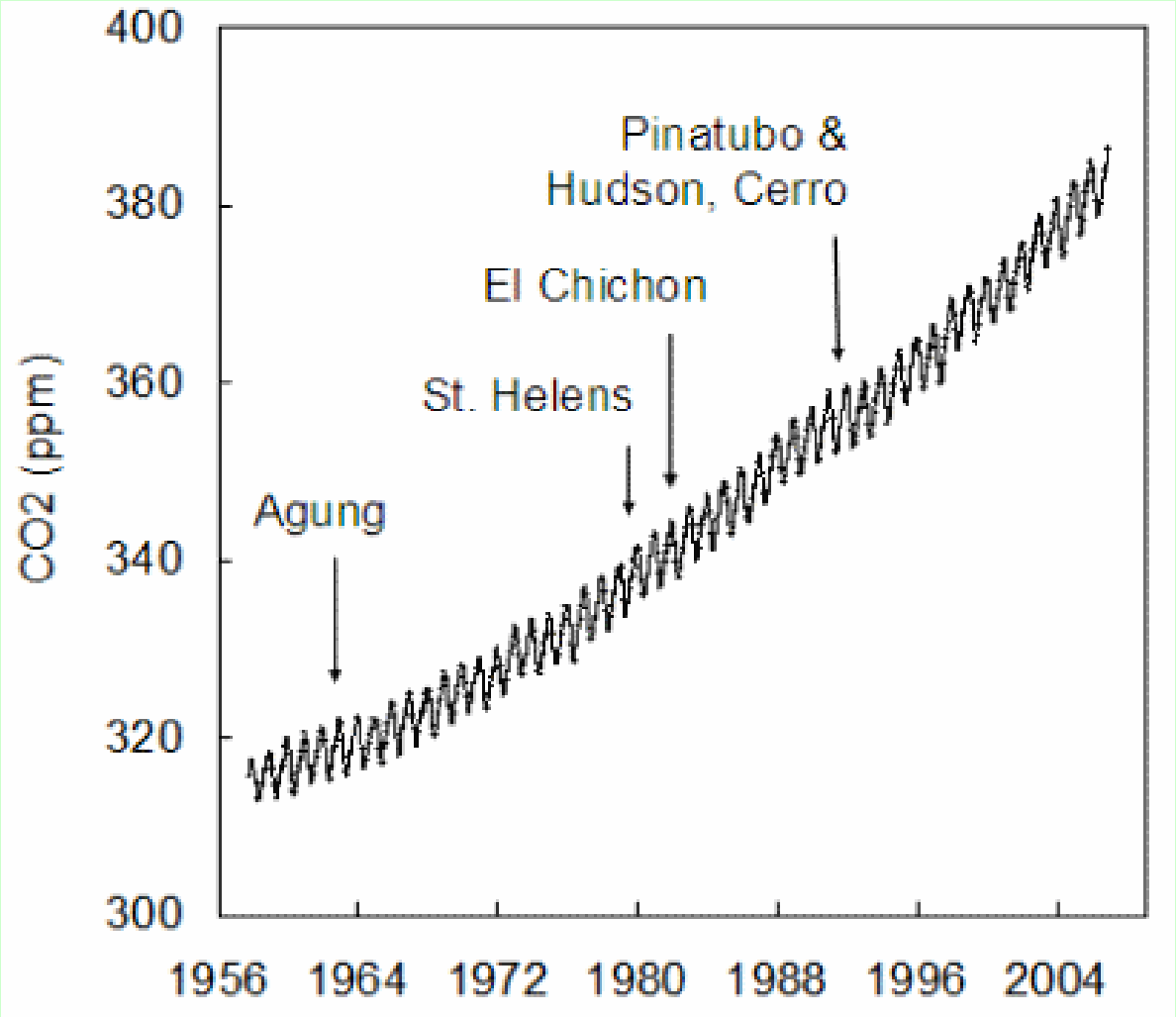


Depicting what happens to global temperature following major volcanic eruptions

http://csas.ei.columbia.edu/2015/01/16/global-temperature-in-2014-and-2015/

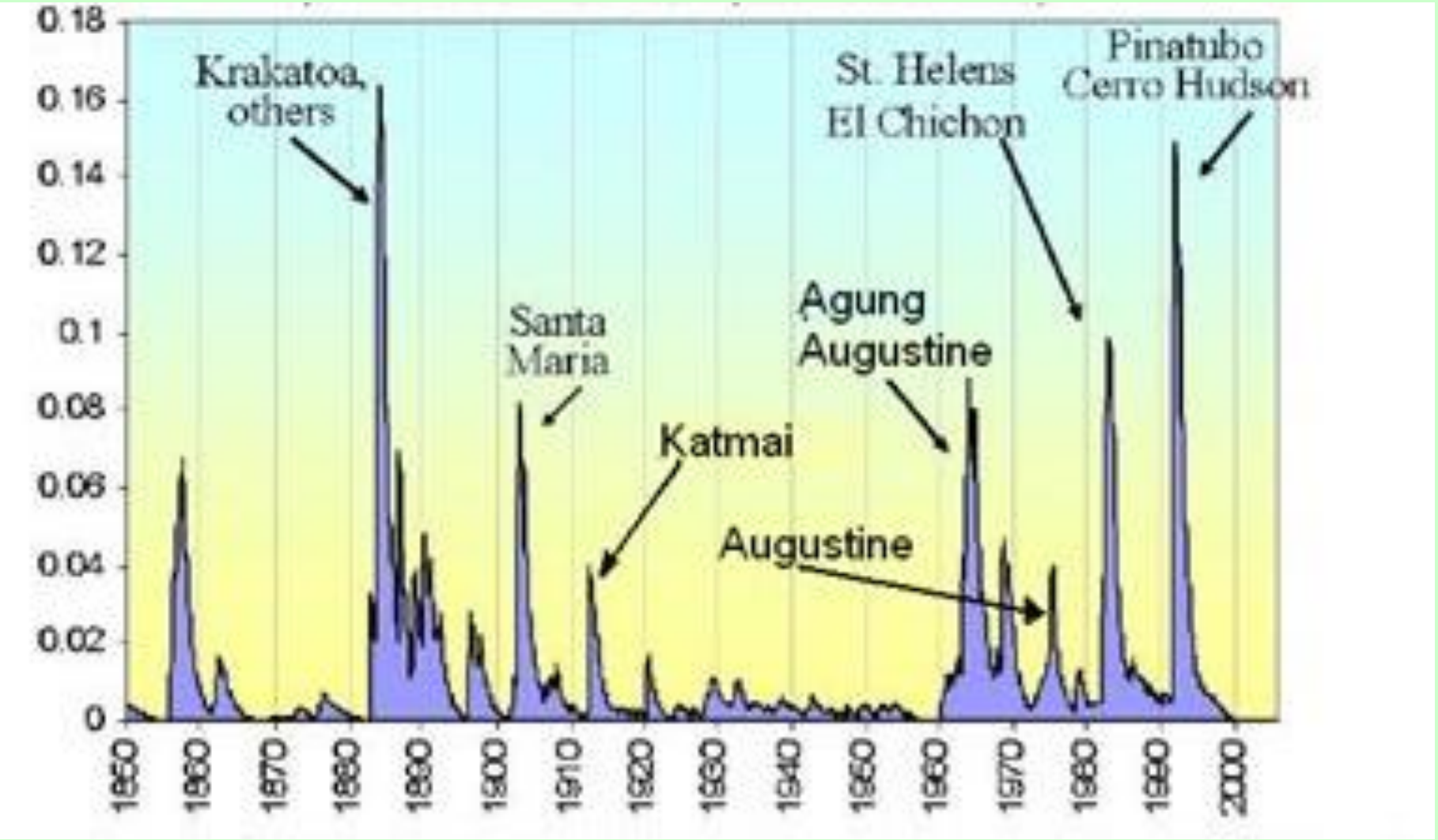
Volcanoes and Atmospheric Carbon dioxide trends

Depicting the impact of volcanic eruptions on the general atmospheric carbon dioxide trend



http://blogs.edf.org/climate411/2007/05/21/volcanoes/

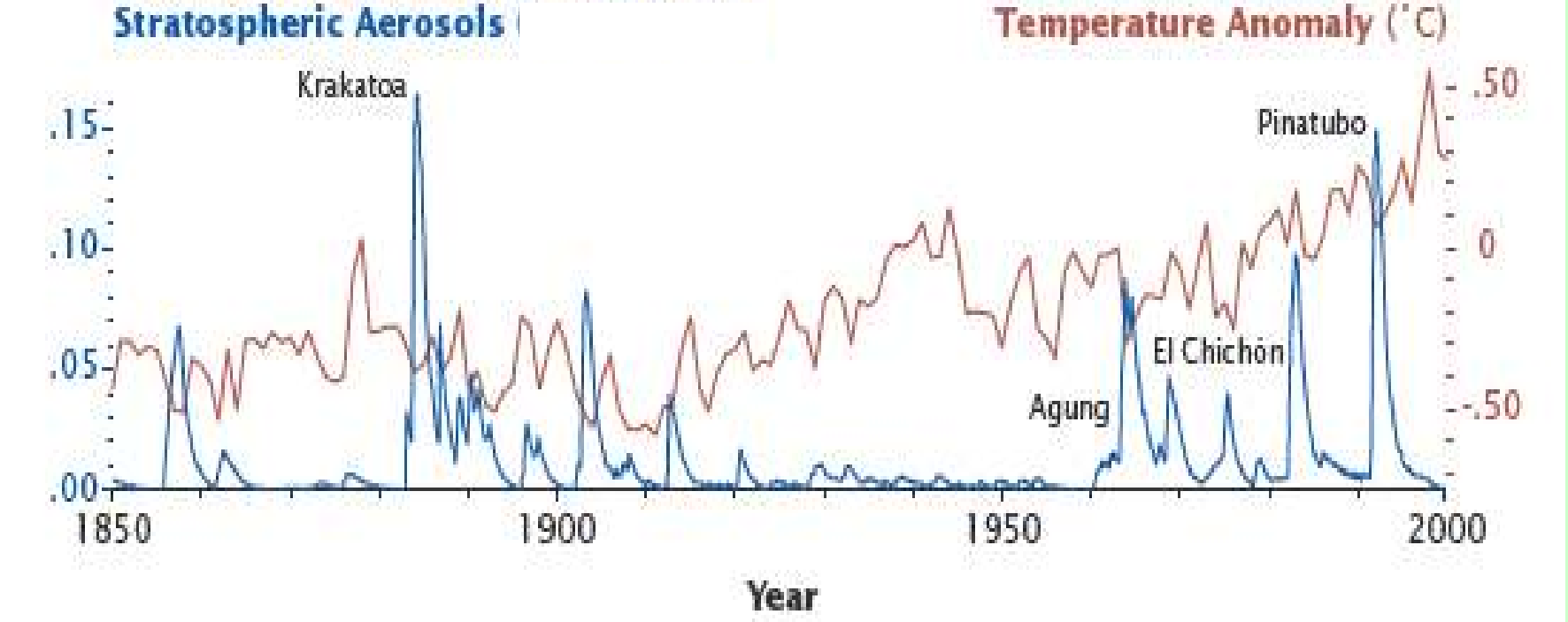
Volcanoes and Stratospheric aerosols



Depicting the impact of volcanic eruptions on the concentration of atmospheric aerosols reflecting incoming radiation

http://images.intellicast.com/App_Images/Article/175_16.jpg

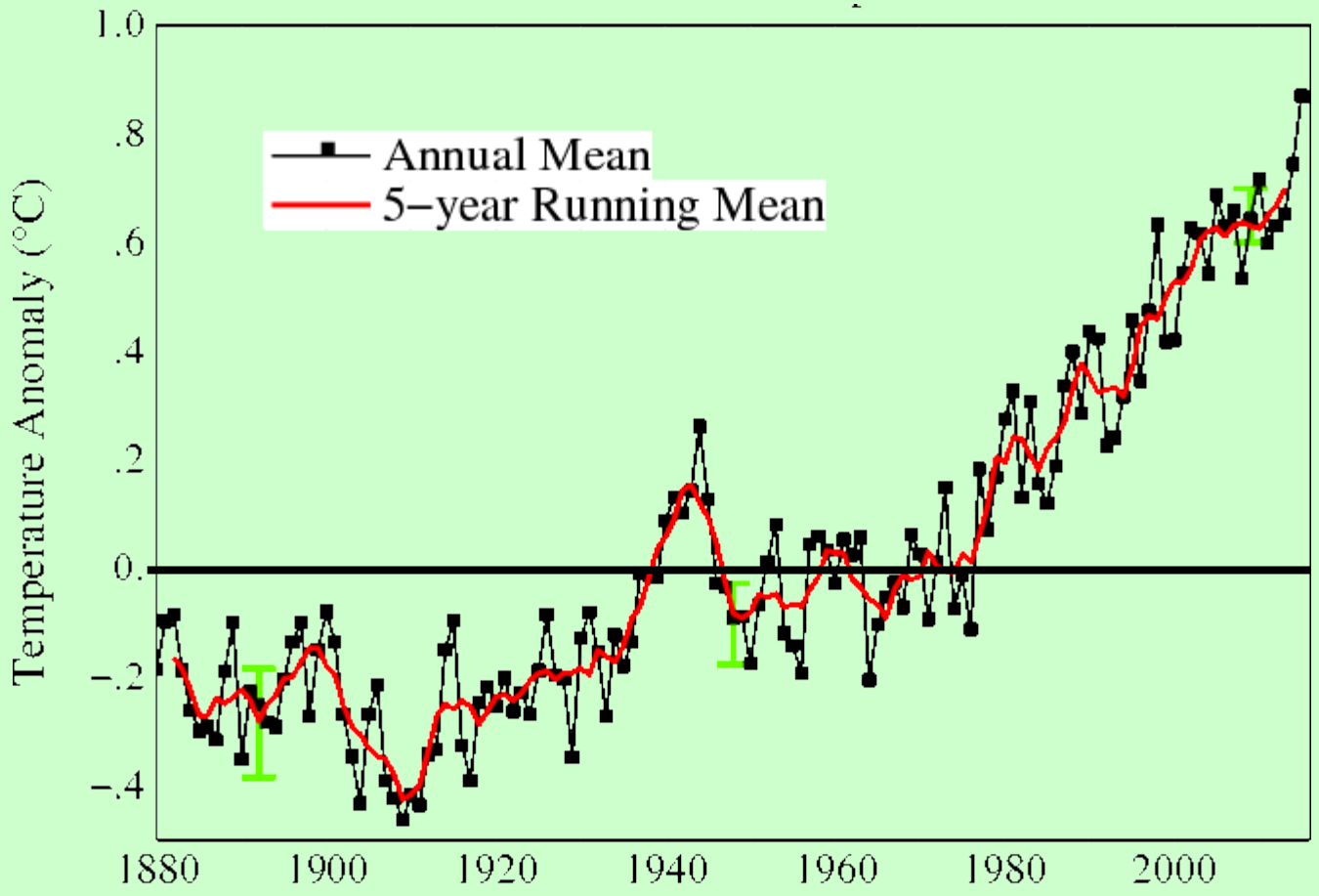
Volcanoes, stratospheric aerosols, and temperature trends



Depicting the impact of volcanic eruptions on the atmospheric aerosol content and temperature

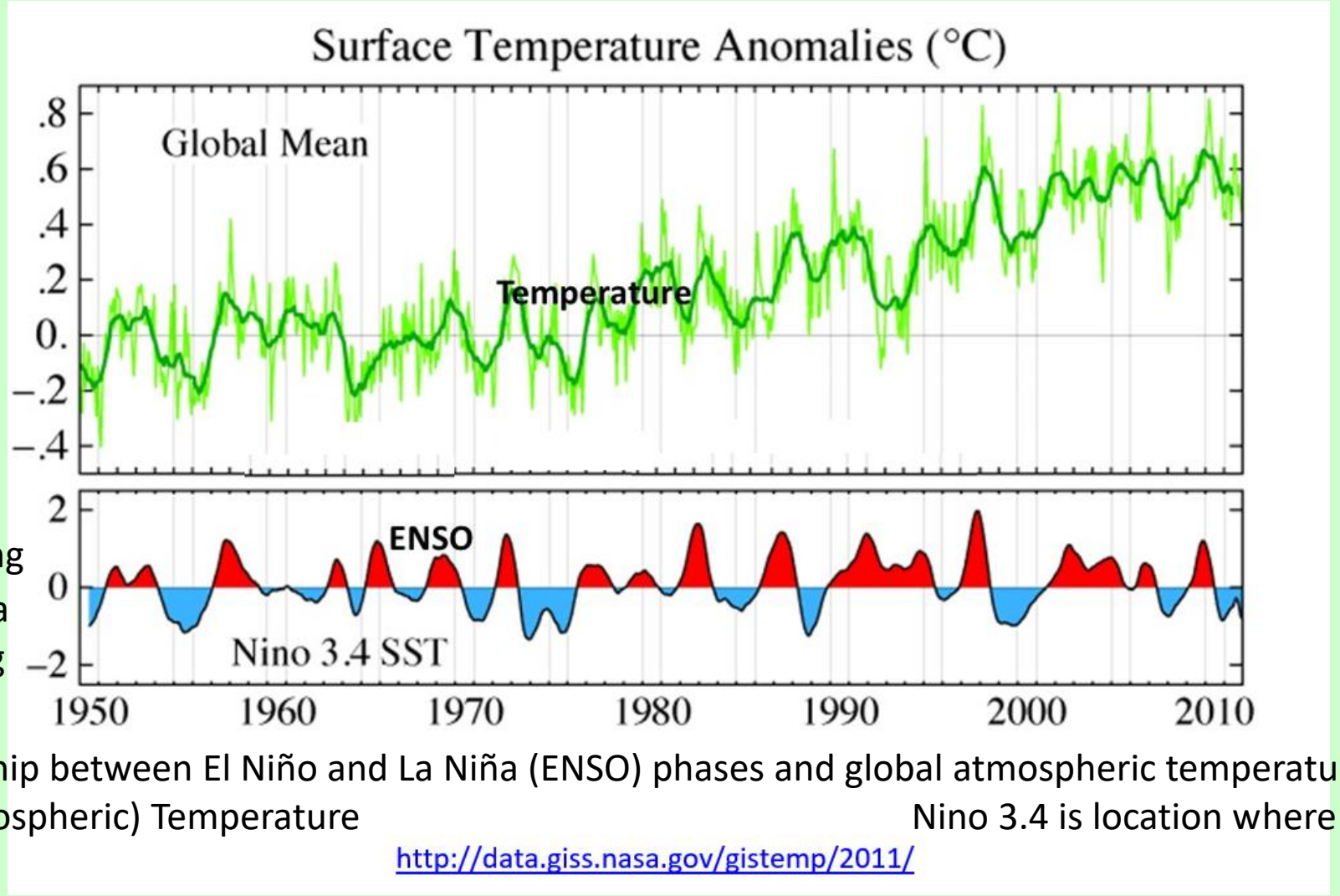
http://earthobservatory.nasa.gov/Features/Aerosols/page3.php

NASA GISS Global Atmospheric Temperature Trend 1980 - 2015



http://data.giss.nasa.gov/gistemp/graphs_v3/Fig.A2.gif

El Niño / La Niña and Temperature



El Niño warming

La Niña cooling

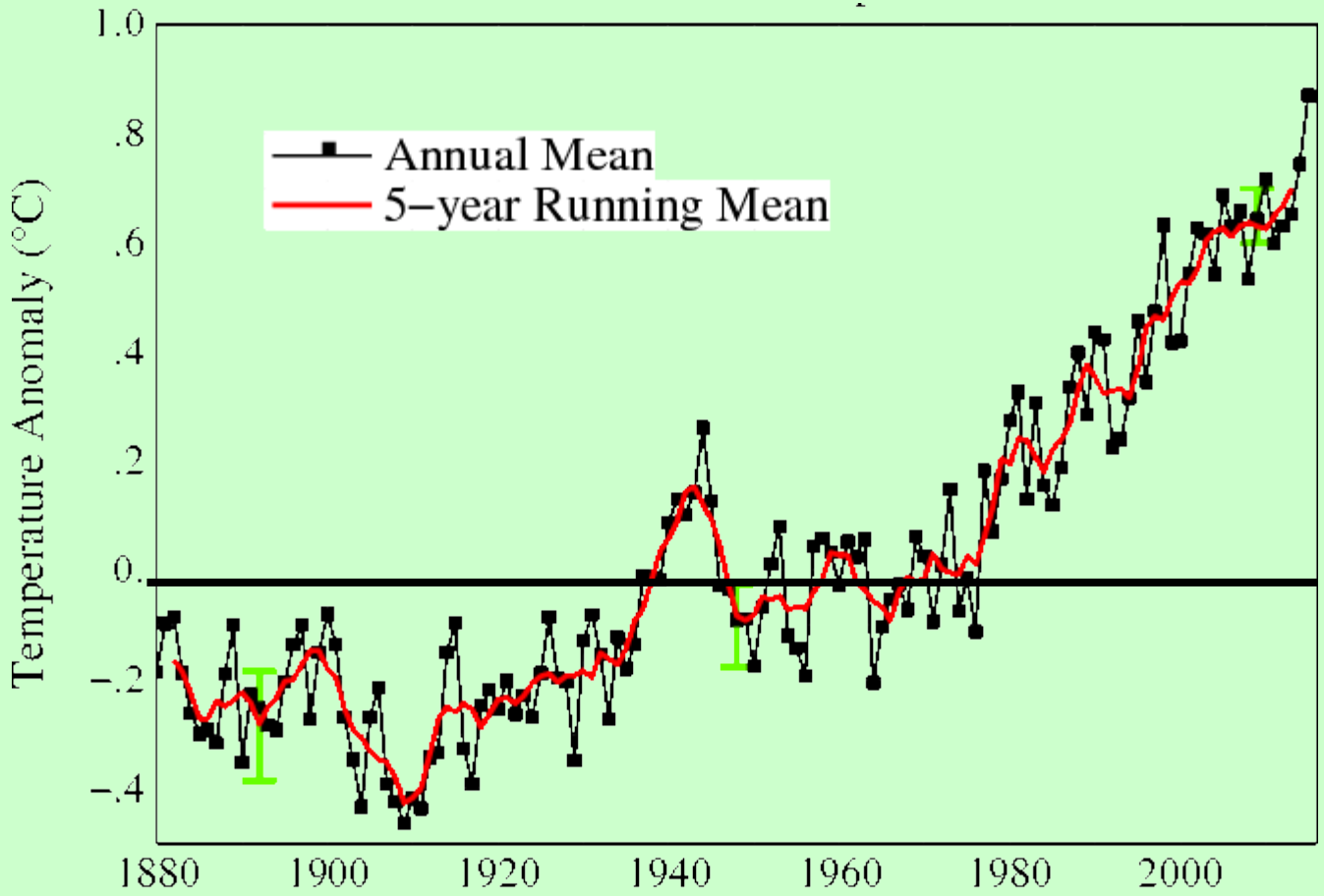
Depicting the relationship between El Niño and La Niña (ENSO) phases and global atmospheric temperature;

SST = Sea Surface (Atmospheric) Temperature

Nino 3.4 is location where data were collected

http://data.giss.nasa.gov/gistemp/2011/

NASA GISS Global Atmospheric Temperature Trend 1980 - 2015

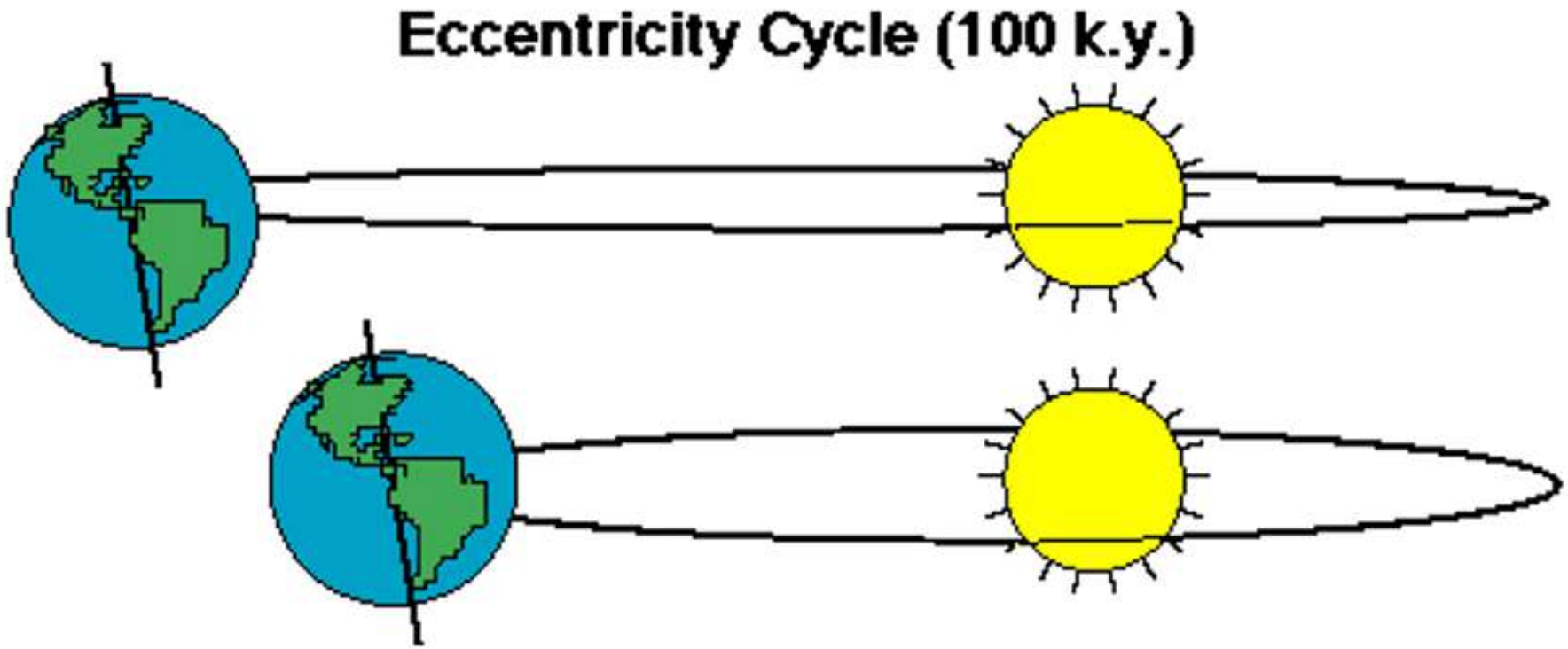


http://data.giss.nasa.gov/gistemp/graphs_v3/Fig.A2.gif

Milankovitch and Temperature

i – How does the shape (Eccentricity) of the Earth's Orbit around the sun vary?

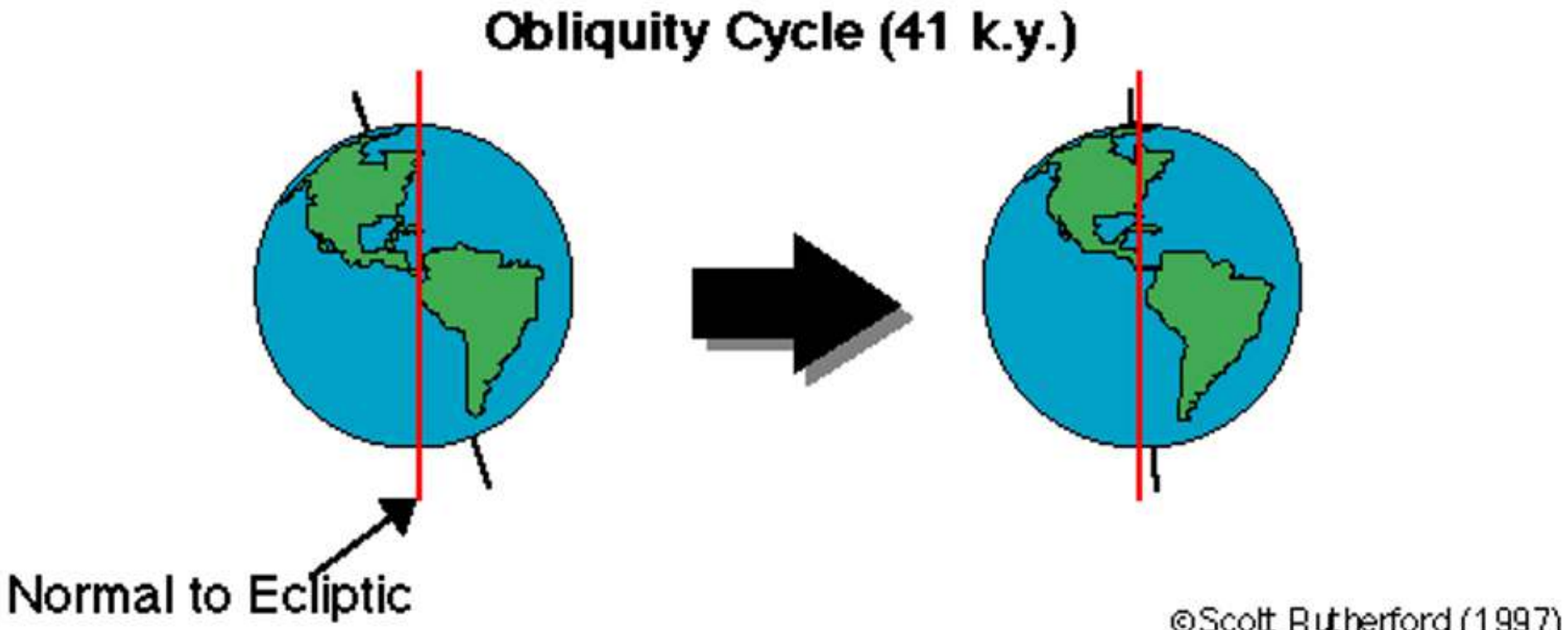
Depicting the cycle in the shape of Earth's orbit around the sun over a 100,000 year cycle



http://deschutes.gso.uri.edu/~rutherfo/milankovitch.gif

ii – How does the tilt of the Earth (Obliquity of the Ecliptic) vary?

Depicting the cyclic pattern in the axis of the Earth's tilt over a 41,000 year cycle

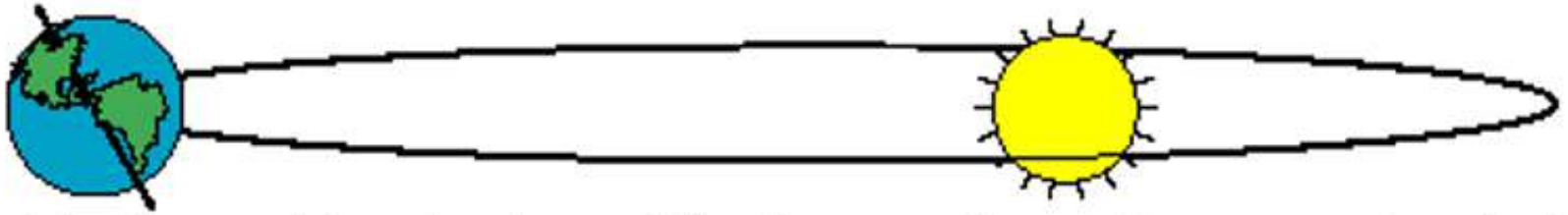


http://deschutes.gso.uri.edu/~rutherfo/milankovitch.gif

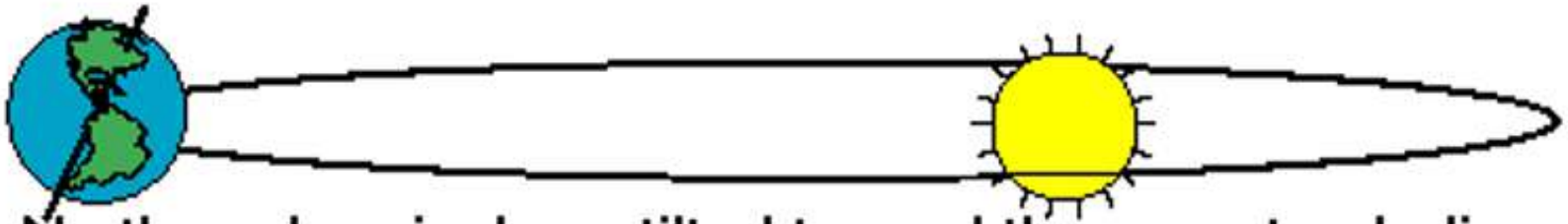
iii – How does the rotation of the tilt (Precession of the equinoxes) vary?

Depicting the cyclic rotation in the axis of the Earth's tilt over an approximately 20,000 year cycle

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



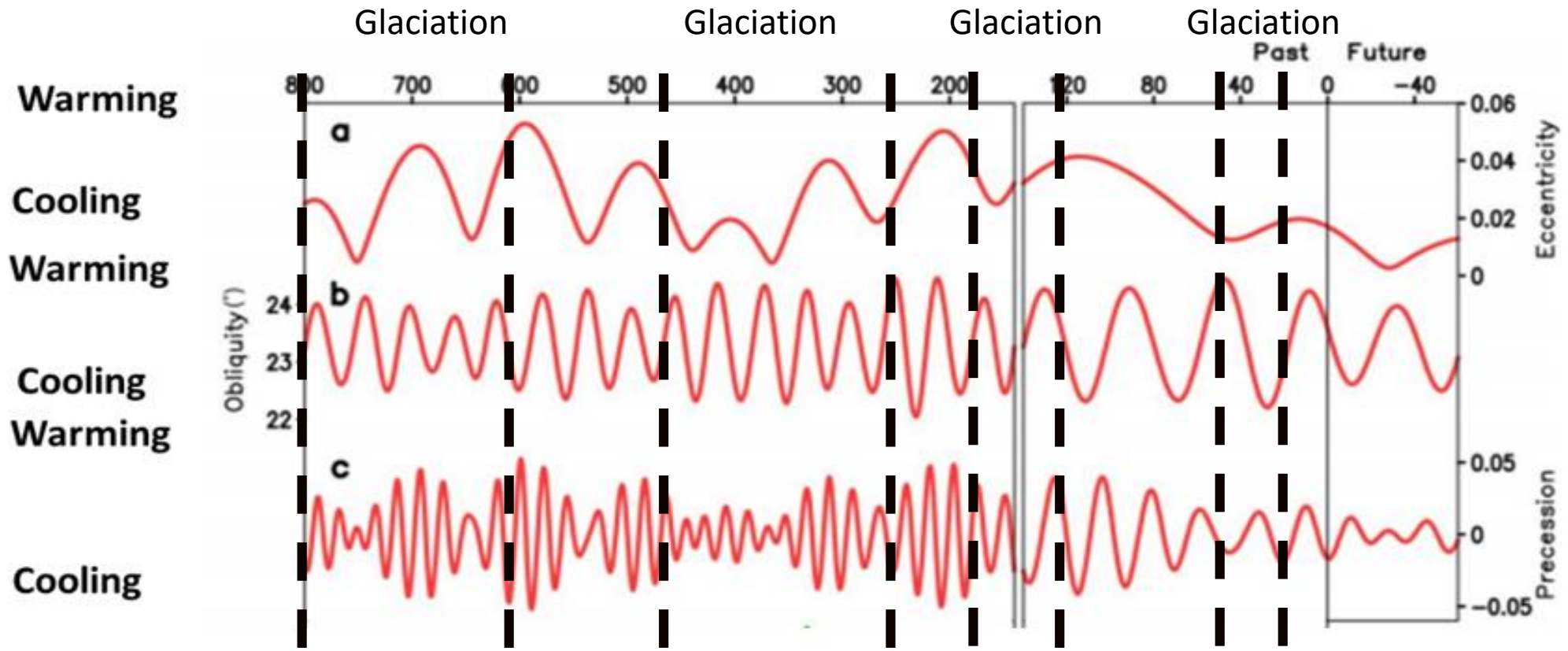
Northern Hemisphere tilted away from the sun at aphelion.



Northern hemisphere tilted toward the sun at aphelion.

http://deschutes.gso.uri.edu/~rutherfo/milankovitch.gif

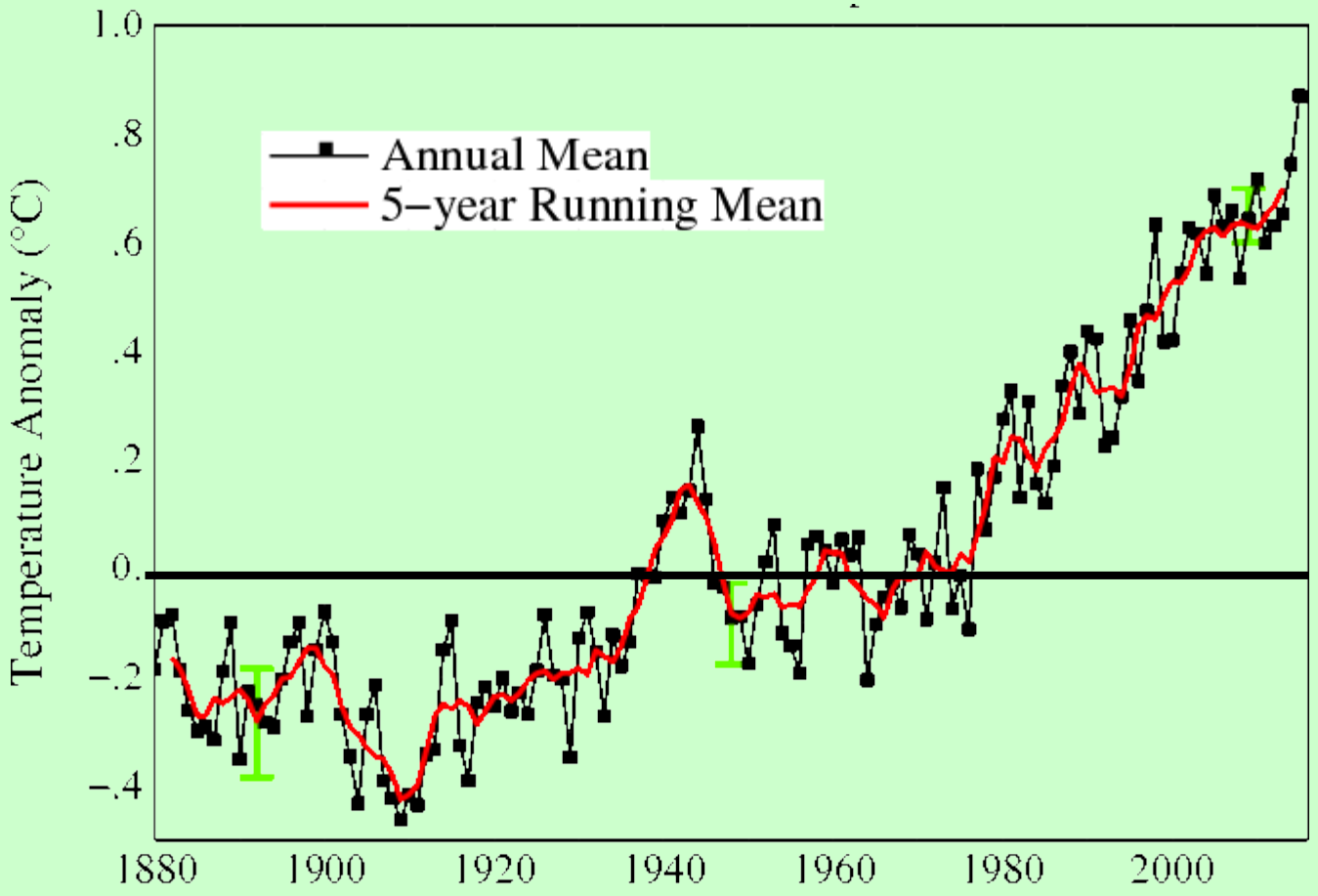
iv - What is the current influence of the three Milankovitch sub-cycles on global temperature?



http://www.stopgreensuicide.com/Ch5_Paleo_WG1AR5_SOD_Ch05_All_Final.pdf

Depicting the relationship between the Milankovitch Cycles and current temperature

NASA GISS Global Atmospheric Temperature Trend 1980 - 2015



http://data.giss.nasa.gov/gistemp/graphs_v3/Fig.A2.gif

Atmospheric Greenhouse Gas Concentrations for Two Millennia

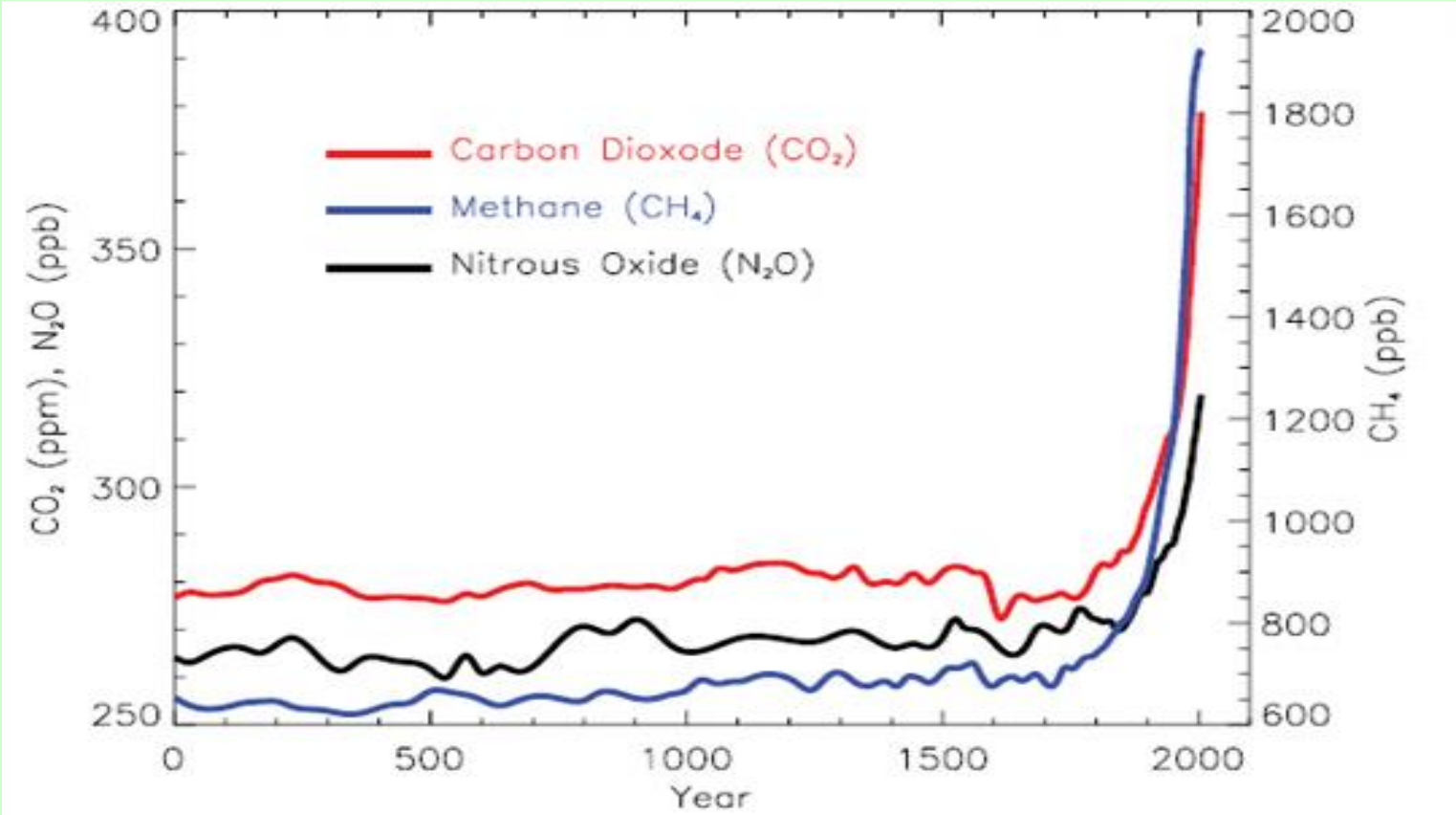


Figure 1. Atmospheric concentrations of important long-lived greenhouse gases over the last 2,000 years. Increases since about 1750 are attributed to human activities in the industrial era. Concentration units are parts per million (ppm) or parts per billion (ppb), indicating the number of molecules of the greenhouse gas per million or billion air molecules, respectively, in an atmospheric sample.

IPCC AR4 FAQ

http://www.global-greenhouse-warming.com/greenhouse-gas.html

Admonitions

- Include discussion on ‘what we can do’
- Be positive and optimistic about our collective prognosis
- Contact us for questions
- socanhotline@gmail.com
- http://socan.info