



# The Changing Global Environment Part I

Those who dwell among the beauties  
and mysteries of the earth are never  
alone or weary of life.

Rachel Carson



# Physical Geography

Geography is the study of the distribution of natural and cultural elements on the earth's surface and of the interrelationship of these elements.

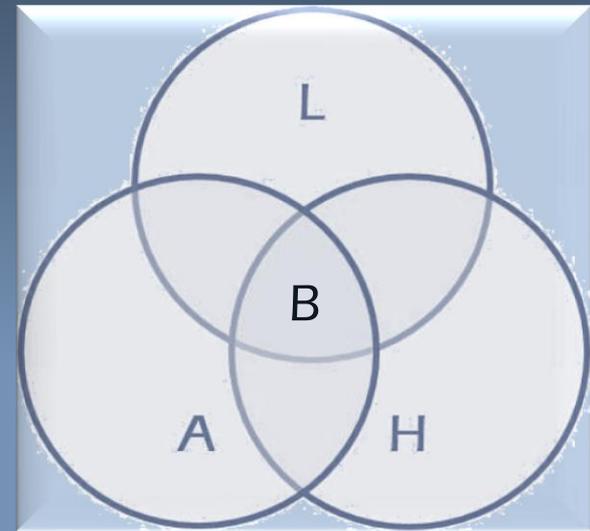
Physical geography is concerned with the natural environment, which can be subdivided into four basic spheres – the atmosphere, the hydrosphere, the biosphere and the lithosphere.

Many of earth's physical features affect, at least to some degree, a region's culture, demographics, politics and economics.



# The Environmental Spheres

- › Atmosphere
  - › *atmo*, Greek for air
- › Hydrosphere
  - › *hydro*, Greek for water
- › Biosphere
  - › *bio*, Greek for life
- › Lithosphere
  - › *litho*, Greek for stone



**interacting spheres**



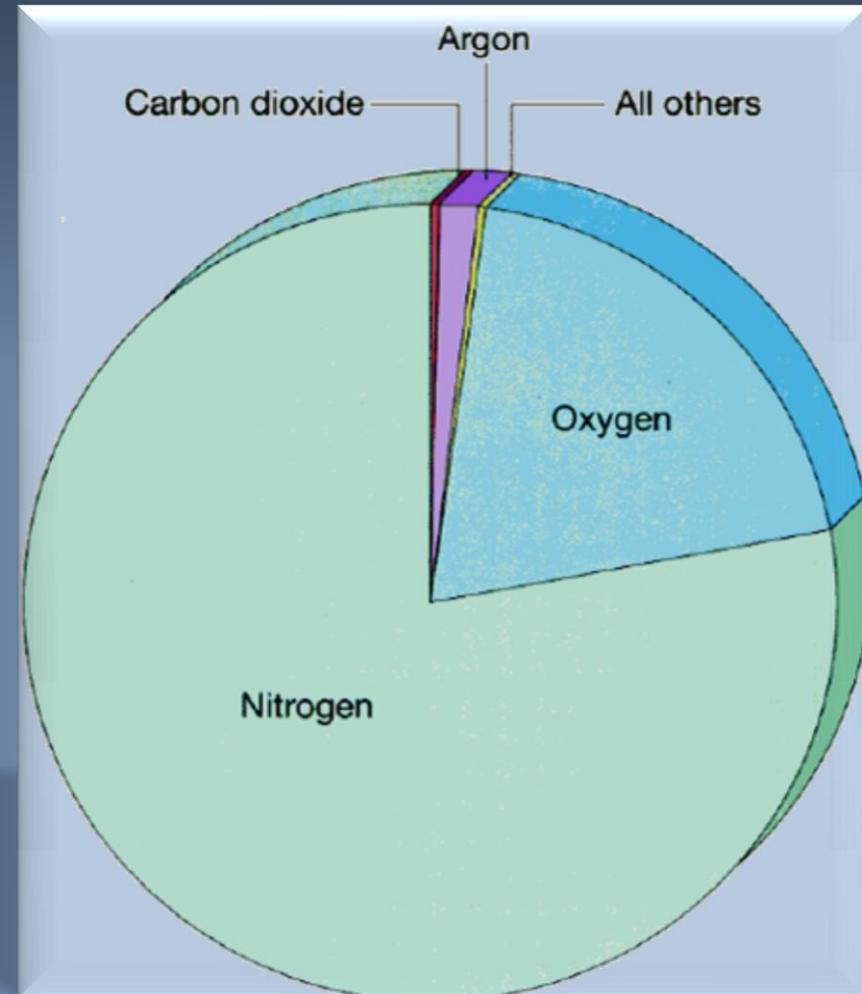
# I. THE ATMOSPHERE





# Composition of the Atmosphere

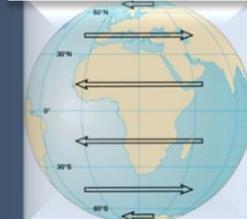
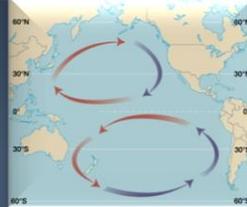
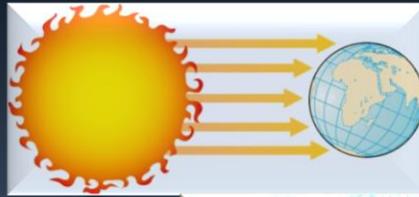
- › shallow, encircling envelope of gases that makes life possible
- › permanent gases
  - › nitrogen (78%) and oxygen (21%) dominate (total 99%)
- › variable gases
  - › water vapor
  - › argon (0.9%)
  - › carbon dioxide (0.038%)
  - › ozone
- › particulates (aerosols)
  - › tiny solid and liquid particles
  - › affect weather and climate





# Weather and Climate

- › Weather takes place in the **lowest layer** of the atmosphere.
- › Weather and climate have different meanings but they share the same elements. The four **principal elements** of weather and climate are temperature, moisture content, pressure and wind.
- › The main **controls** on these elements are latitude, global distribution of oceans and land masses, circulation of the air in the atmosphere and the water in the oceans, altitude, topography and storm systems.
- › The **Coriolis effect** plays an important role in the atmosphere as it affects the formation of storms and the direction of winds ... important elements of Earth's climate system.



# Weather and Climate Controls

Climate Control	Effect on Temperature (T) and Precipitation (P)
<b>L</b> atitude	<b>T</b> The further from the Equator (north or south) the cooler the temperatures
	<b>P</b> The closer to the Poles, the lower the precipitation, since cooler air holds less moisture
<b>O</b> cean <b>C</b> urrents	<b>T</b> Warm ocean currents, raise temperatures along the coast (esp. in winter); cold ocean currents lower temperatures
	<b>P</b> Warm ocean currents create wet coastal climates; cold ocean currents help create drier coastal climates
<b>W</b> ind and Air <b>M</b> asses	<b>T</b> Onshore winds moderate temperatures; offshore winds result in extreme temperatures. Polar air masses are cold whilst tropical air masses are warm
	<b>P</b> Onshore winds carry moisture inland; offshore winds bring drier conditions. Canada experiences prevailing westerlies. Continental air masses are dry whilst maritime air masses are moist
<b>E</b> levation	<b>T</b> The higher the elevation, the cooler the temperature
	<b>P</b> The higher the elevation, the higher the precipitation possible
<b>R</b> elief	<b>T</b> Mountains block winds; temperatures on the windward side can be moderate and on the leeward side, they can be extreme; south facing slopes in the NH are warmer
	<b>P</b> Windward regions are wet and leeward regions are dry (rain shadow effect); south facing slopes in the NH are drier
<b>N</b> ear <b>W</b> ater	<b>T</b> Temperatures are moderated (warmer winters; cooler summers) when winds move inland; continental areas far from oceans experience extreme temperatures
	<b>P</b> Coastal areas with mountains receive higher precipitation continental areas receive less precipitation especially when blocked by mountains



# Coriolis Effect

- › Definition: an apparent deflection of any freely moving object from its expected (straight) path
- › Four basic points to remember:
  1. Deflection is to the *right* in the northern hemisphere and to the *left* in the southern hemisphere.
  2. Deflection is *greatest at the poles* and progressively less toward the equator, where there is zero deflection.
  3. The effect is *proportional to the speed of the object*, so a fast-moving object is deflected more than a slower one.
  4. The effect influences the *direction* of movement, not the speed.





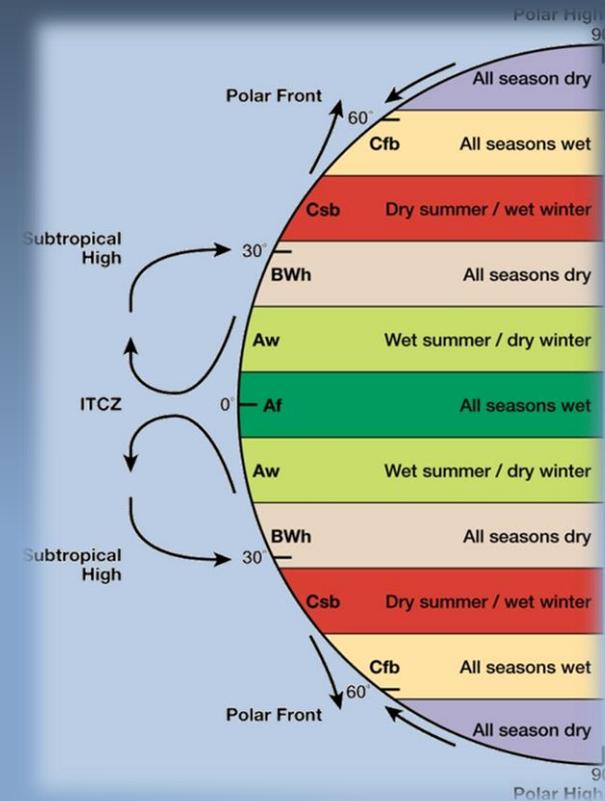
# Global Climates

- › Human settlement and food production are closely linked to local patterns of weather and climate.
- › People in different parts of the world adapt to weather and climate in different ways.
- › Climate links us together in the global economy.
  - › opportunities
  - › hardships
  - › challenges in growing food



# World Climate Regions

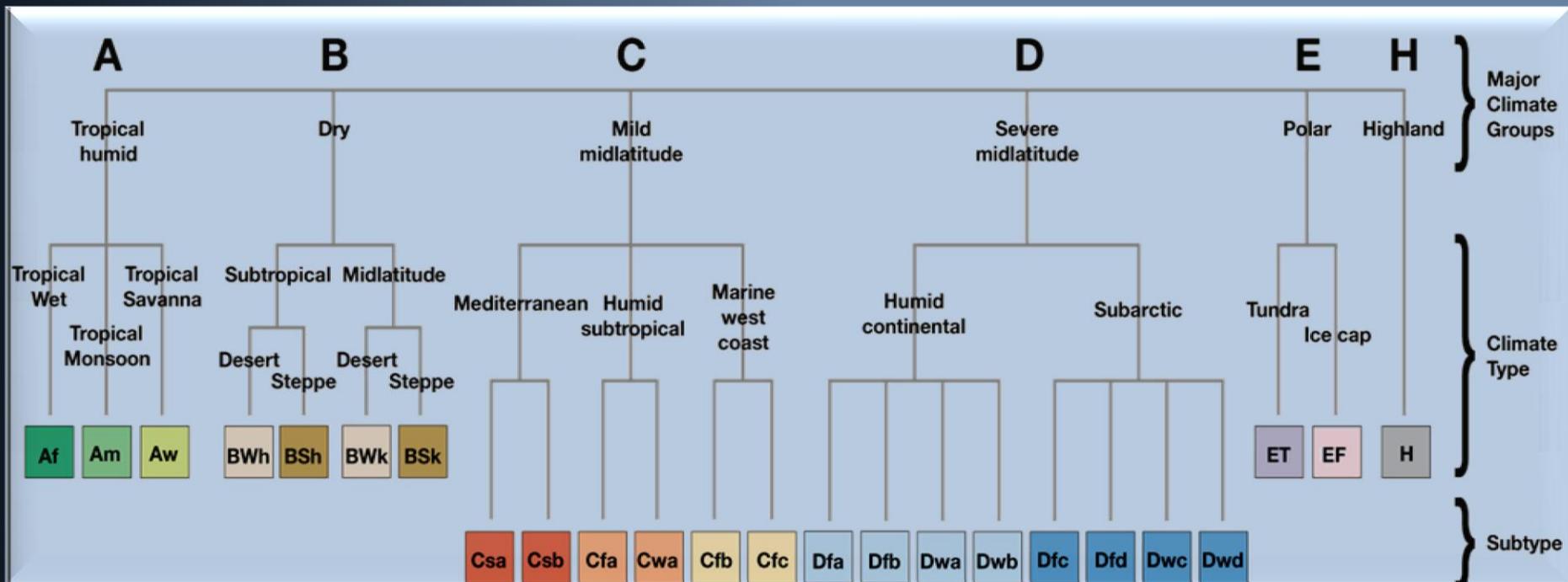
- › **Weather:** short-term, day-to-day atmospheric processes
- › **Climate:** long-term, average conditions, at least 30 years of daily weather data (temperatures and precipitation)
- › **Climate regions:** boundaries drawn around areas with similar average climate conditions





# Modified Köppen System

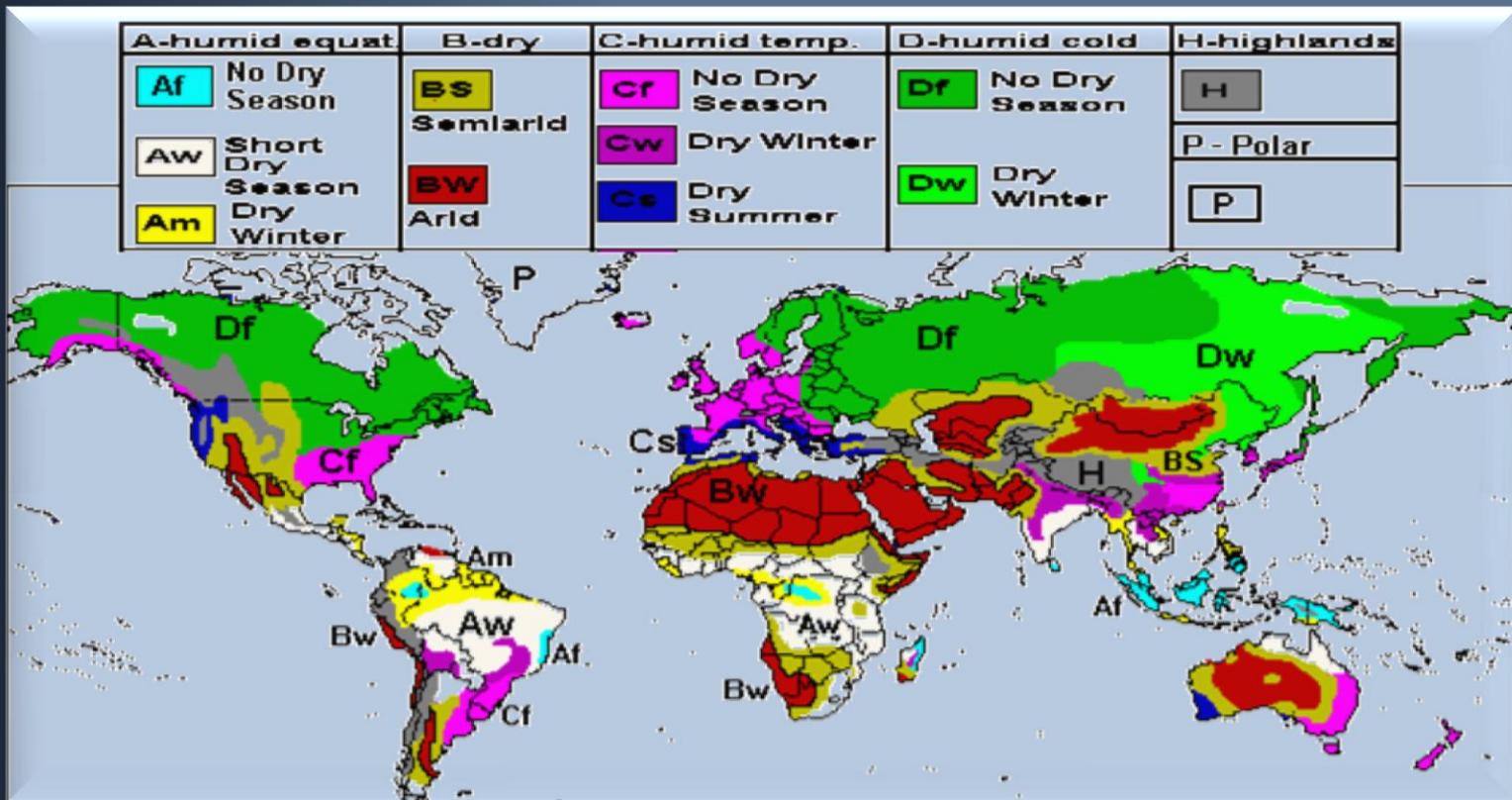
- › Five major climate groups
- › Groups A, B, C, D and E
  - › 14 individual climate types
- › Special category of highland (H) climate





# World Climate Regions

Knowledge of climate regions helps us make inferences about human activities and settlement. For example, a desert climate hampers agriculture; while adequate rainfall and warm temperatures permit farming.





# Climographs

- › **Climographs** were developed to make it easier to characterize the climate of specific places.
- › They provide the **average temperature** and **average precipitation** for every month in one year.
  - › Monthly average temperature is shown as a line connecting twelve points (one for each month).
  - › Monthly average precipitation is shown as a bar for each month.
  - › Pay close attention to the scales on each.



# Interpreting Climographs

For each of the 5 climographs that follow, answer the 8 questions below. [Tip: the inch scale and degree scale are *not* the same for all 5 climographs.]

1. What is the warmest month of the year?
2. What is the wettest month of the year?
3. What does this climograph tell you about the growing season?
4. Is the growing season as long as where you live? Does it start and end at the same time as where you live?
5. In which month(s) is the average temperature below freezing?

[continued on next slide]



# Interpreting Climographs

-continued-

6. Do you think this city gets many blizzards with more than ten inches of snow at one time?
7. Which do you think sells better in this city — long underwear or bathing suits?
8. Just for fun ... which of the following cities do you think this climograph describes? Why?

Anchorage

Atlanta

Boston

Chicago

Denver

Des Moines

Duluth

Houston

Los Angeles

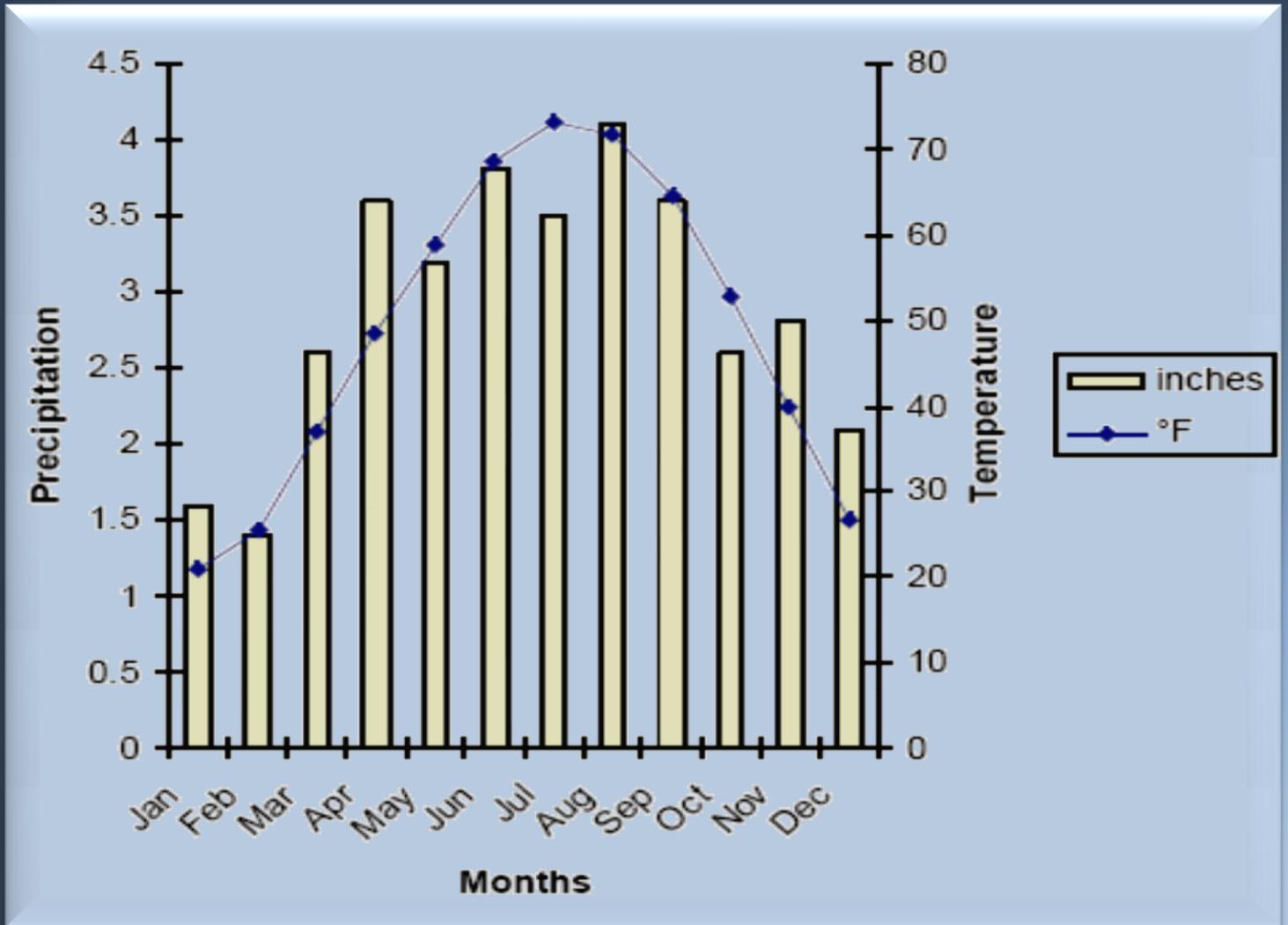
Miami

Phoenix

Seattle

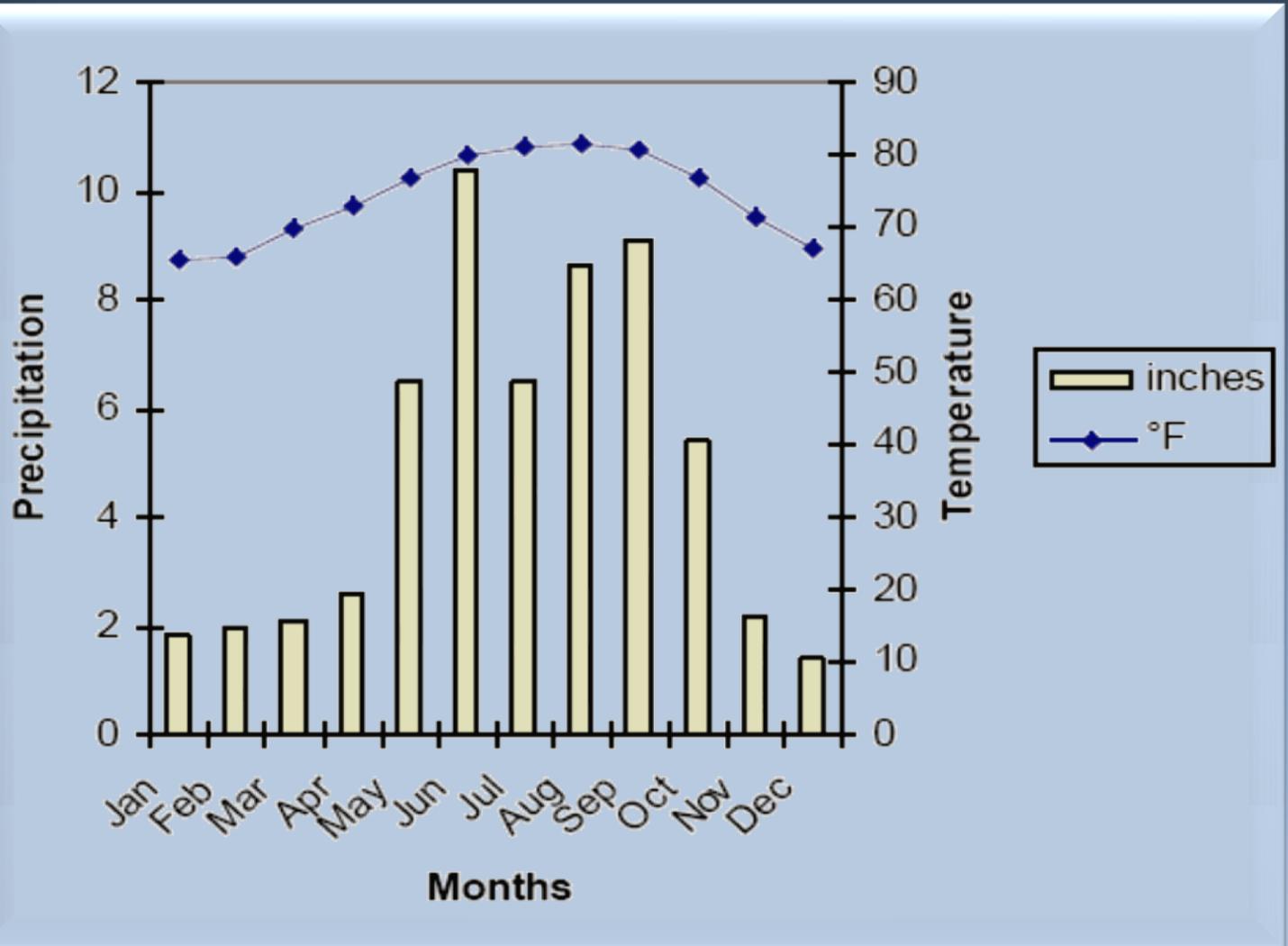


# Climograph # 1



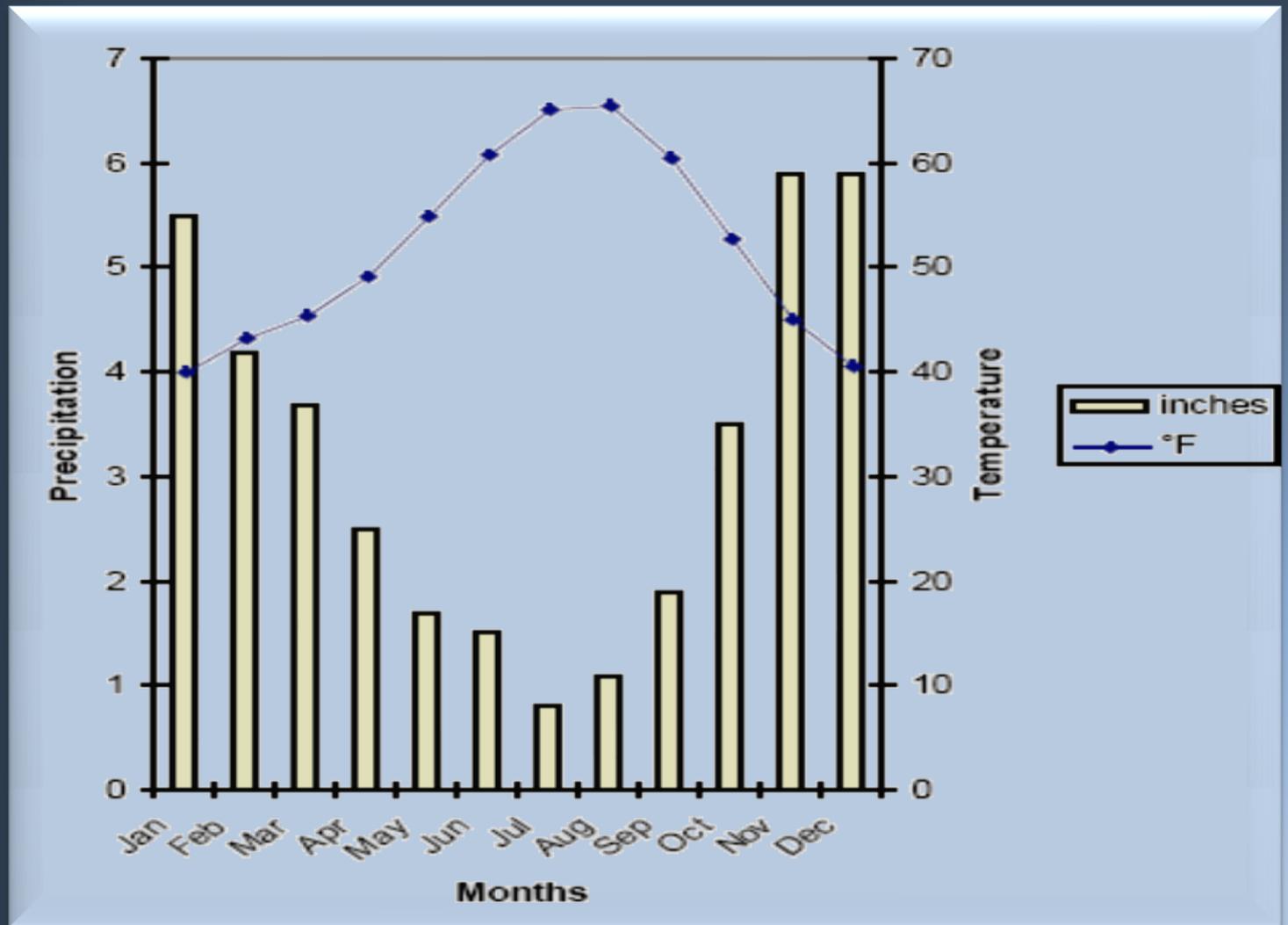


# Climograph #2



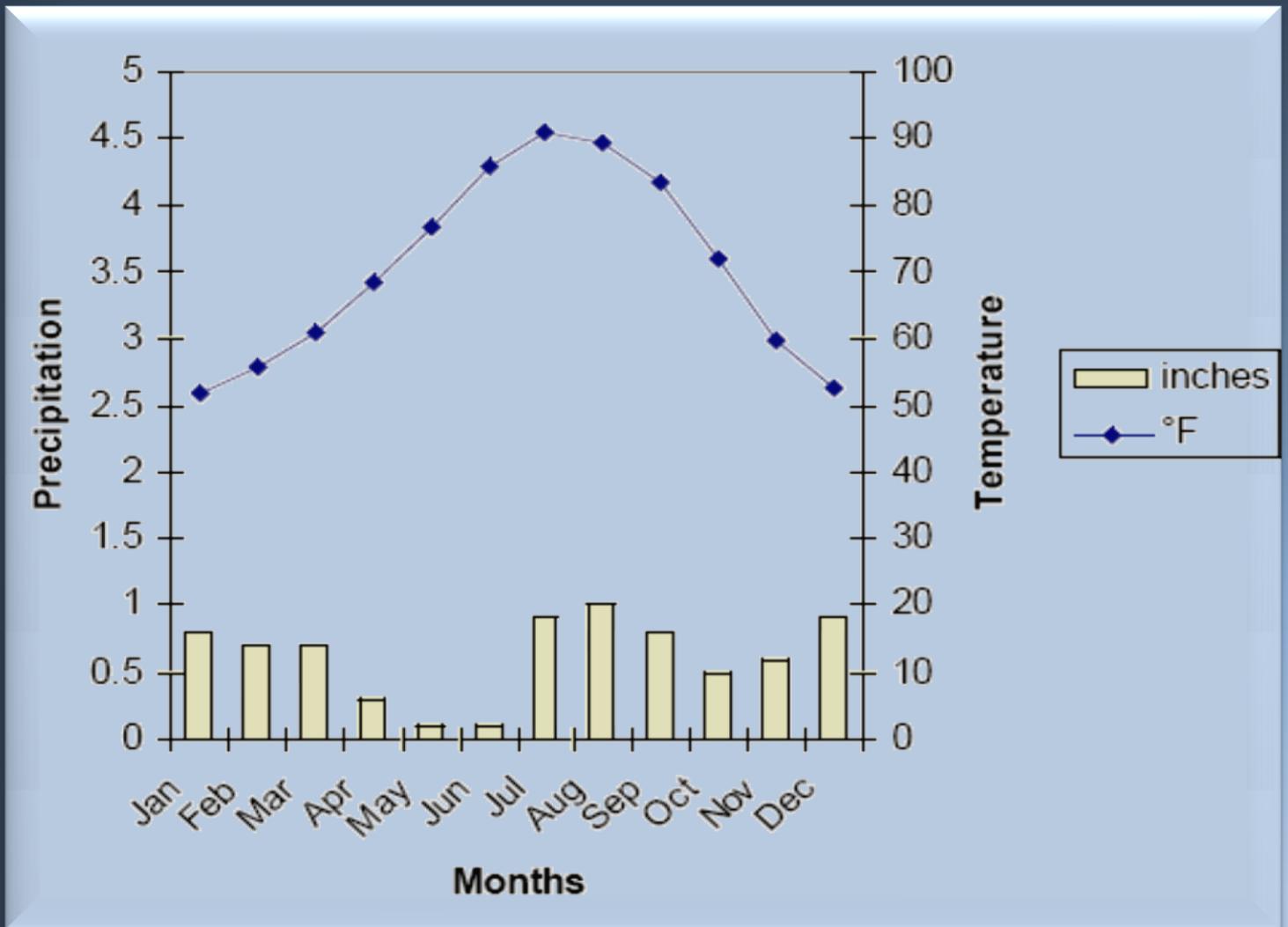


# Climograph #3



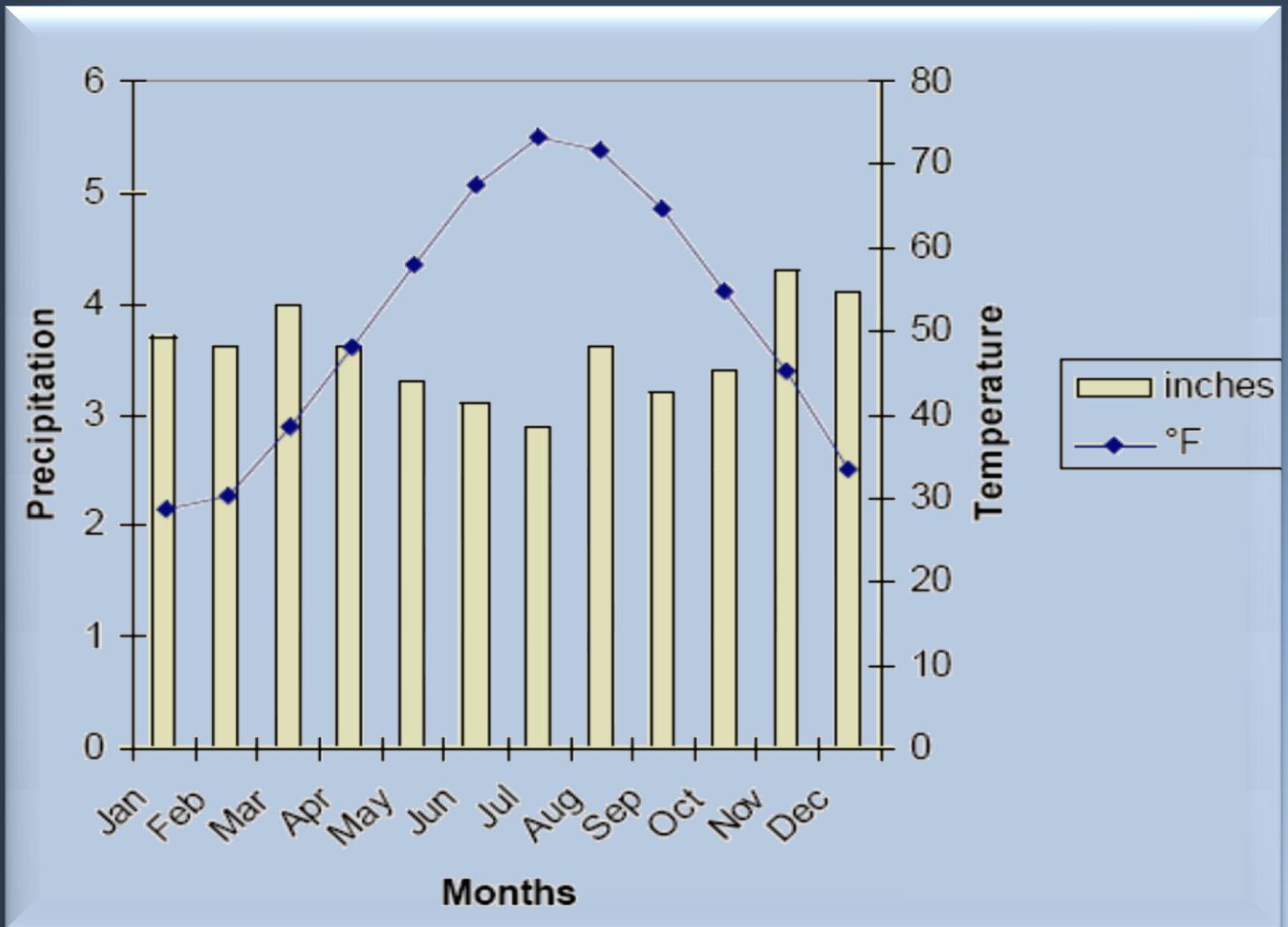


# Climograph #4





# Climograph #5





# How did you do?

climograph	Q1	Q2	Q3	Q4	Q5	Q6	Q7	city
#1	July	August	Mar-Nov	[varies]	Dec-Feb	no	UW	Chicago
#2	August	June	12 months	[varies]	None	no	BS	Miami
#3	August	Nov.	12 months	[varies]	None	no	BS	Seattle
#4	July	August	12 months	[varies]	none	no	BS	Phoenix
#5	July	Nov.	Mar-Nov	[varies]	Jan-Feb	no	UW	Boston

Q3: #1: avg temps drop below freezing in Dec-Feb. #5: avg temps drop below freezing in Jan-Feb and could frost in Dec.

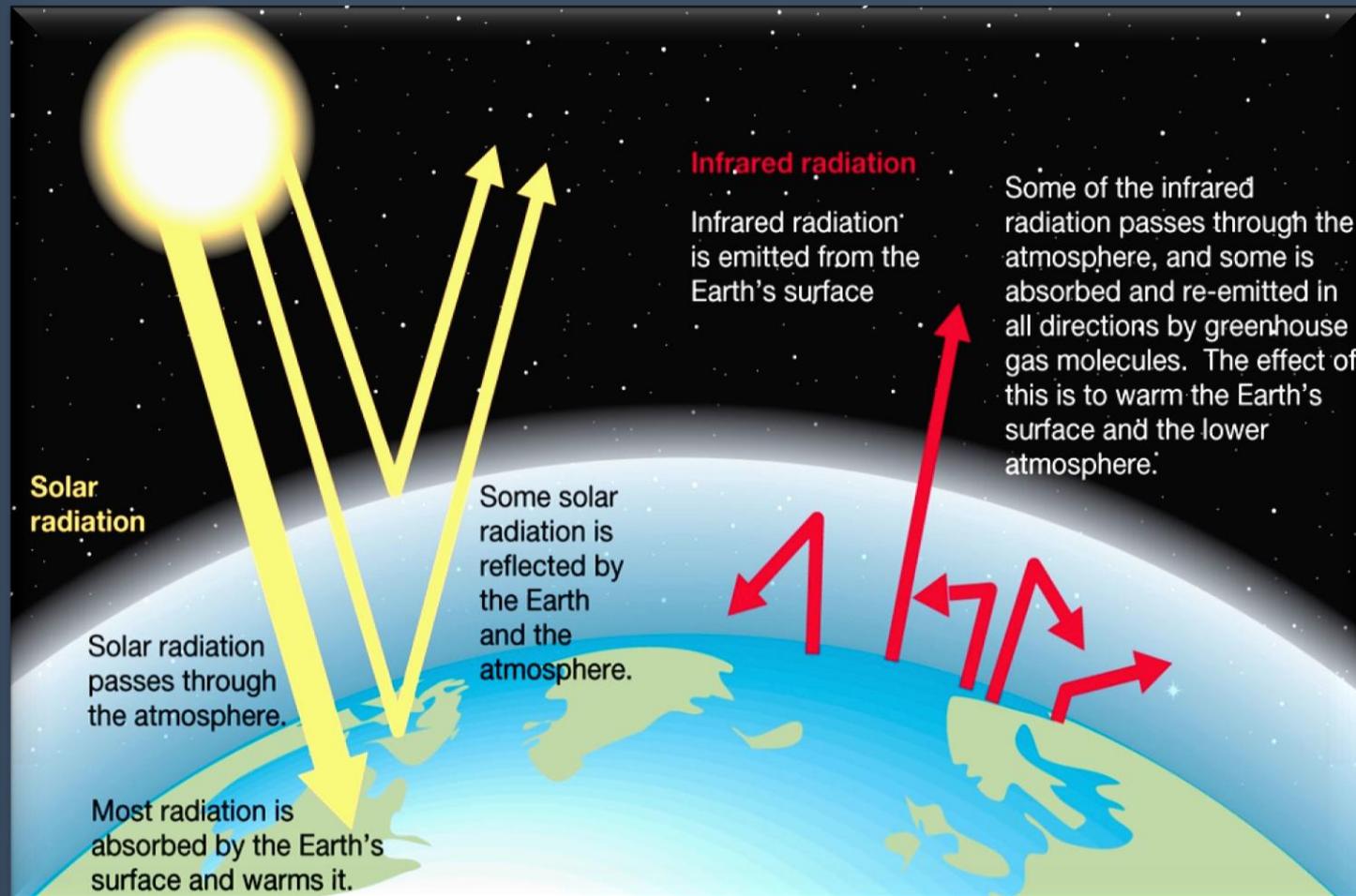
Q6: #1: not much precipitation during cold months. #5: enough precipitation but not a strong cold season.

Q7: #1 and #5: stays cool (if not cold) much longer than it is warm and temps never rise high.



# The Greenhouse Effect

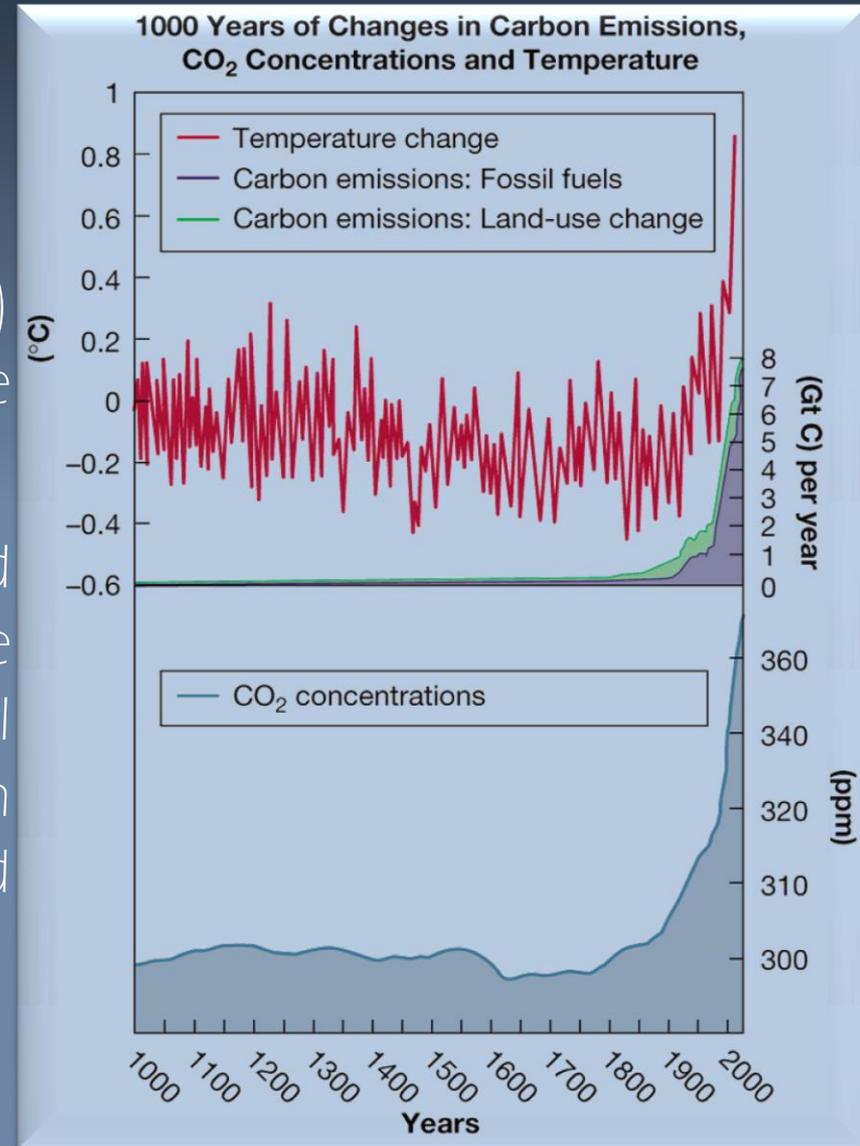
A natural greenhouse effect makes the earth warm enough to support life.





# Causes of Global Warming

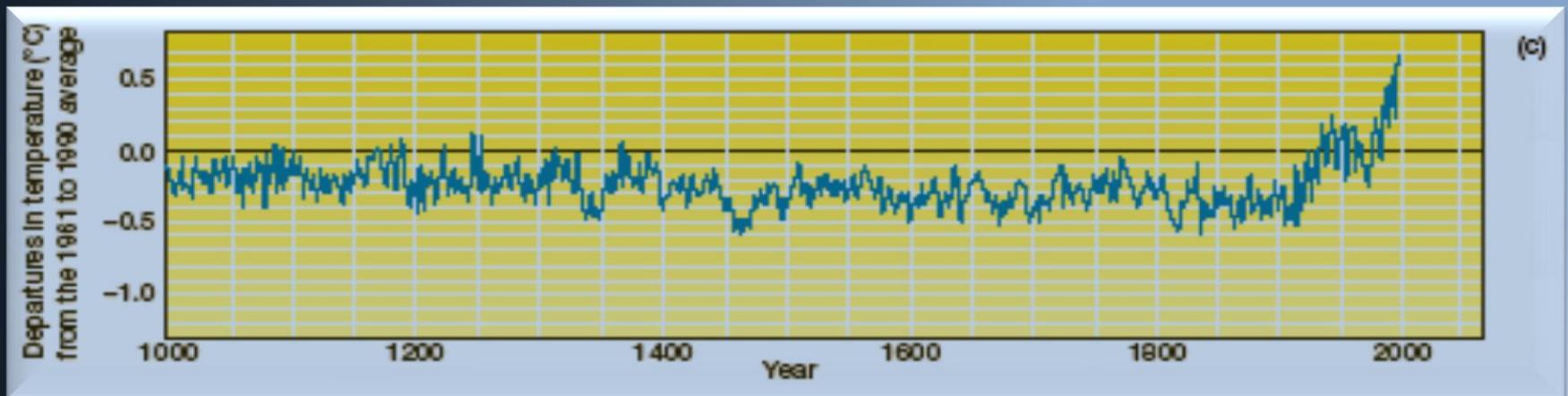
- › increases in CO<sub>2</sub> and temperature
- › Anthropogenic (or human-caused) pollutants increase the greenhouse effect.
- › Graphs go back 1,000 years and show both CO<sub>2</sub> and temperature to have been relatively stable until the modern industrial period when the burning of fossil fuels (coal and oil) began on a large scale.





# The Major Greenhouse Gases

- › **Carbon Dioxide** ( $\text{CO}_2$ ) makes up over 50% of anthropogenic greenhouse gases and comes mainly from burning fossil fuels.
- › **Chlorofluorocarbons** (CFCs), about 25% of human-generated greenhouse gases, come mainly from aerosol sprays, refrigeration and air conditioning.
- › **Methane** ( $\text{CH}_4$ ), about 15%, is caused by the burning of vegetation, by-products of cattle and sheep digestion, leaking natural gas pipelines and refineries.
- › **Nitrous Oxide** ( $\text{N}_2\text{O}$ ), 5% is caused by agricultural chemical fertilizers.





# Greenhouse Gas Producers

China's rush to develop has caused an increase in its greenhouse gas output. Since the figures below were published, it has passed the US and now leads the world in greenhouse gas emissions.

Country	Total CO <sub>2</sub> Emissions, 2004, from Consumption and Flaring of Fossil Fuels (mmt*)	Percent Global Total	Per Capita CO <sub>2</sub> Emissions (metric tons)
United States	5,912.21	21.90	20.18
China	4,707.28	14.40	3.62
Russia	1,684.84	6.38	11.70
Japan	1,262.10	6.20	9.91
India	1,112.84	4.10	1.04
Germany	862.23	3.18	10.46
<i>Global Total (all countries)</i>		<b>27,043.57</b>	<b>56.16</b>

\*million metric tons

Source: Energy Information Administration, International Energy Database, <http://www.eia.doe.gov/emeu/international/carbondioxide.html>.



auto emissions in China



# The Effects of Global Warming

Computer models and scientists are coming to agreement on the effects of global warming.

- › **Increase in average global temperatures:** 2°- 4°F by 2030 and could double by 2100 ... That's the same shift (in the other direction) that caused the Ice Age 30k years ago.
- › **Major shift in agricultural areas:** Wheat belt could become warmer and drier, with a lower grain yield. Canada and Russia could become warmer. Southern regions of the US and Europe could become warmer and drier, requiring irrigation.
- › **Decrease in polar ice:** Sea levels will rise as polar ice caps melt, endangering low-lying islands and coastal areas.

polar bears  
losing habitat





# The International Debate on Limiting Greenhouse Gases

- › Rio de Janeiro Earth Summit (1992)
  - › 1<sup>st</sup> international agreement on global warming (167 states)
  - › US, Japan, India and China failed to meet emissions reductions.
- › Kyoto Protocol (December 1997)
  - › 38 industrialized states agreed to reduce their emissions of greenhouse gases to below 1990 levels.
  - › To become international law, the states emitting 55% of the world's greenhouse gases had to ratify the protocol.



# The International Debate on Limiting Greenhouse Gases

- › President GW Bush opposed the Kyoto Protocol.
  - › Complying could damage the US economy.
  - › Large developing states (India, China) are not *yet* bound to reduce greenhouse gases and so would have a temporary advantage.
- › **Russia** (3<sup>rd</sup> largest source of GHG emissions at that time) finally signed in late 2004.
- › **Kyoto Protocol** became international law in early 2005, despite US opposition.
- › Probably won't solve the problem but it may be better than doing nothing.



CONTINUED IN  
*THE CHANGING GLOBAL ENVIRONMENT*  
*PART II*

