Meteorology

II. Temperature

A. Statistical Analysis

1. **Average Daily** Temperature: Average of the highest and lowest temperature for a day.

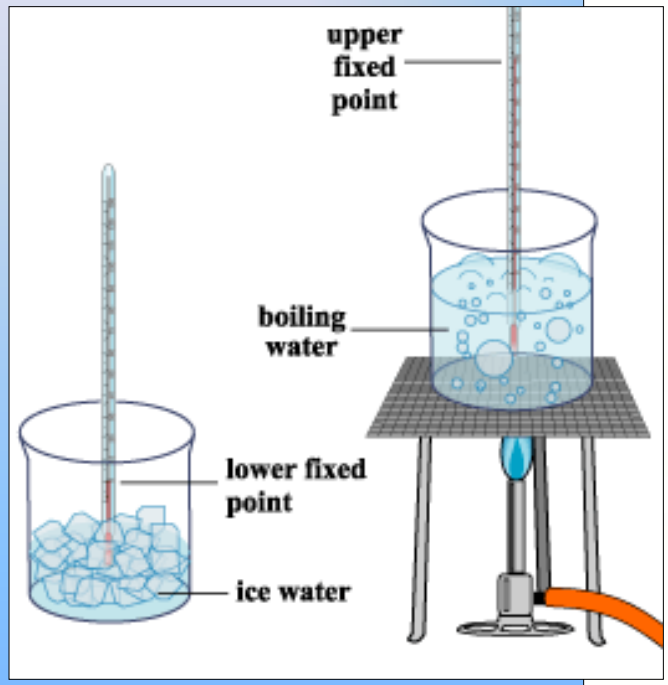
2. **Daily Temperature Range**: Difference between the highest and lowest temperatures for a day.

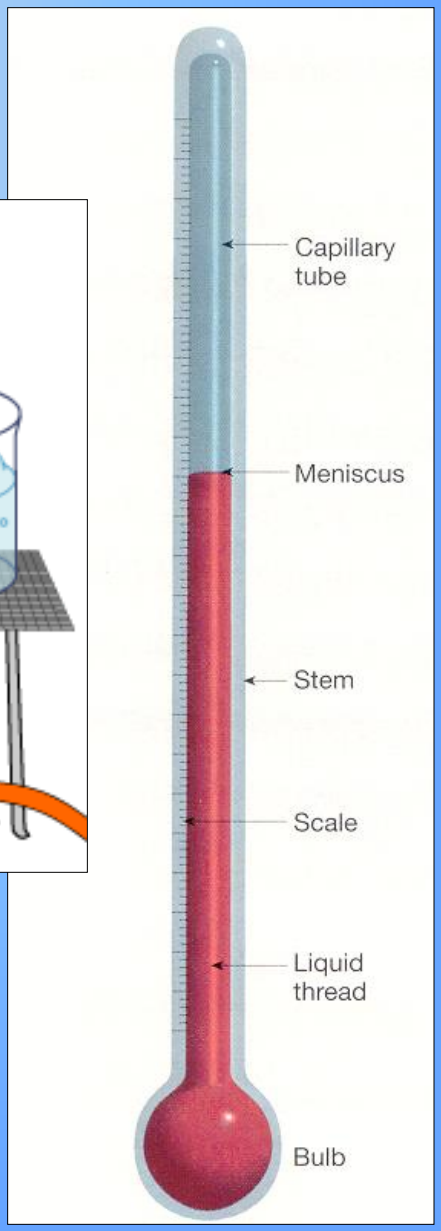
3. **Monthly Average Temperature**: Average of each of the daily average temperatures for a month.

4. **Annual Average Temperature**: Average of the each of the average monthly temperatures for a year.

5. **Annual Temperature Range**: Difference between the highest and lowest average monthly temps for a year.

B. Measuring Temperature



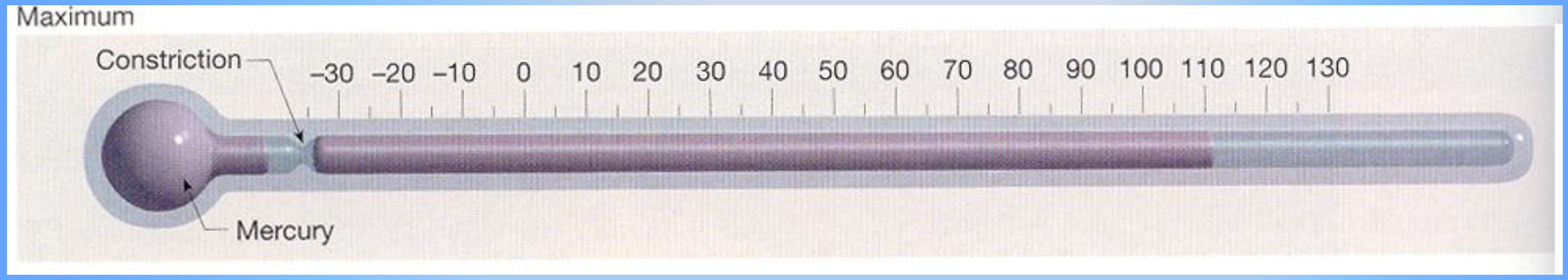


1. **Thermometers**

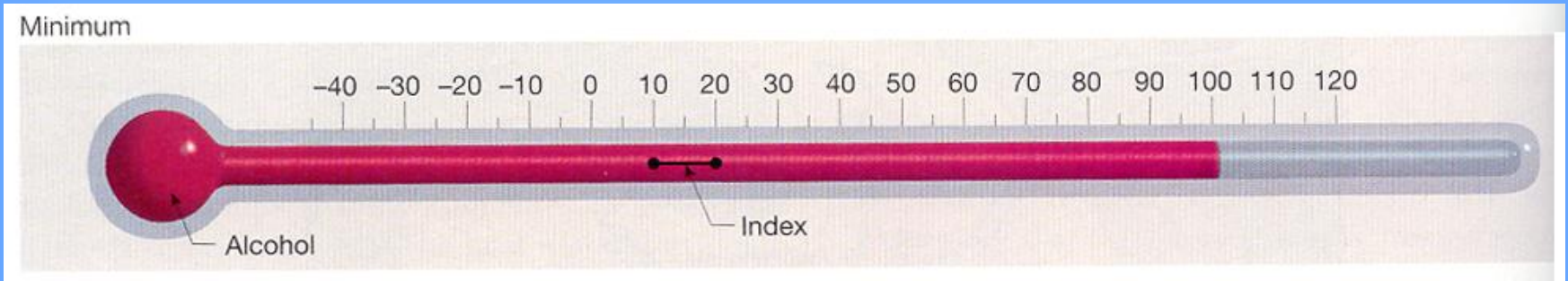
   (a) Different substances react to temperature changes differently.

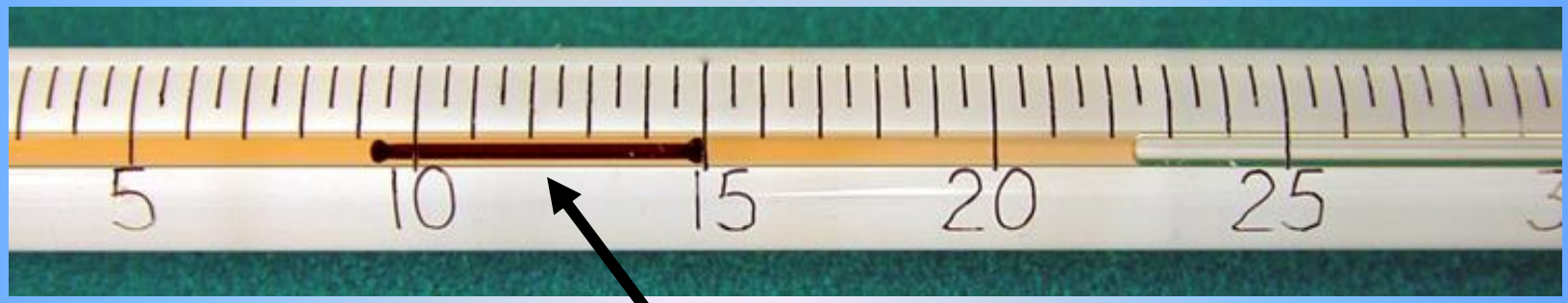
   (b) Liquid-in glass thermometer

c. *Maximum and Minimum* Thermometers



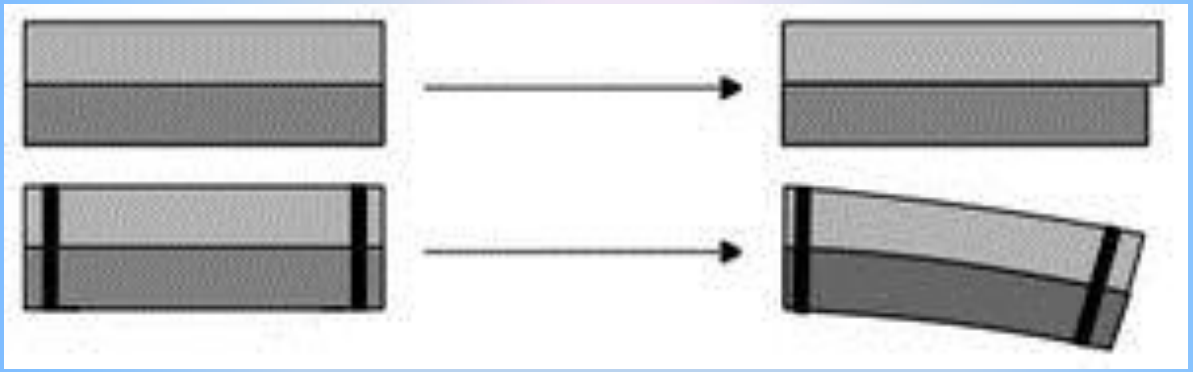
- **Maximum Thermometer:**
  - As temperature rises, mercury expands and is forced through the constriction which prevents a return of mercury into the bulb when temperature falls

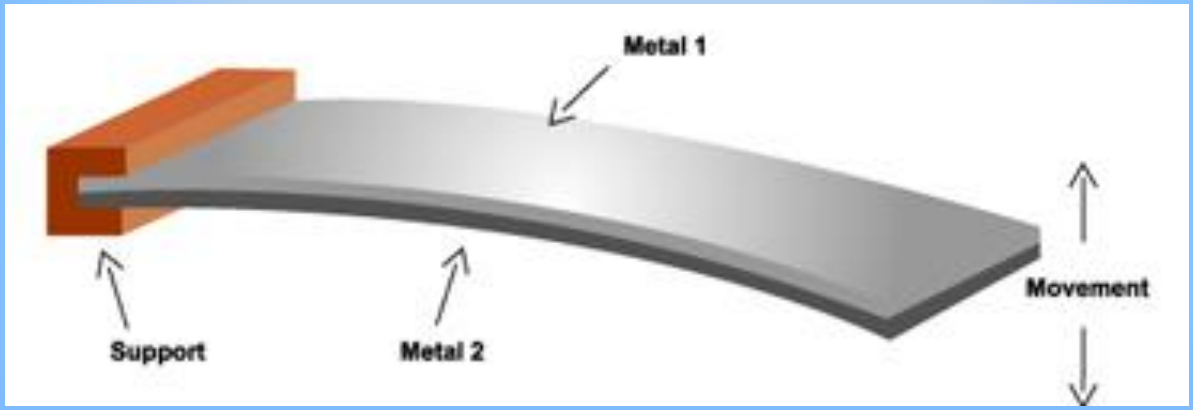




- **Minimum Thermometer:**
  - A small dumbbell-shaped **index** (metal slider) in a low density liquid (alcohol) is pulled toward the bulb as the temperature drops and the column shortens.
  - The **index** remains at the lowest temperature reached as liquid moves past it when temperature rises. It must be mounted horizontally

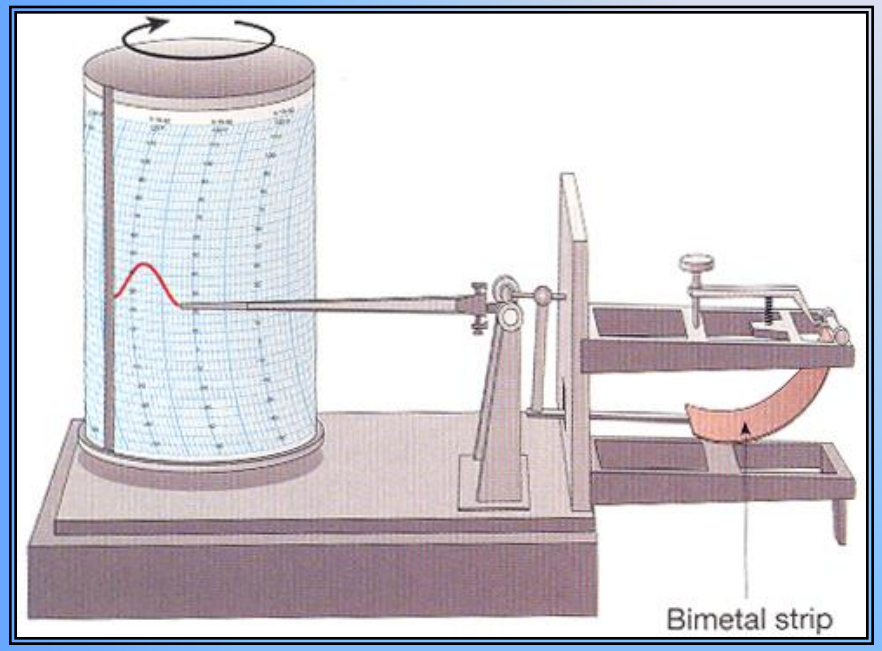
2. **Bimetal** strip:

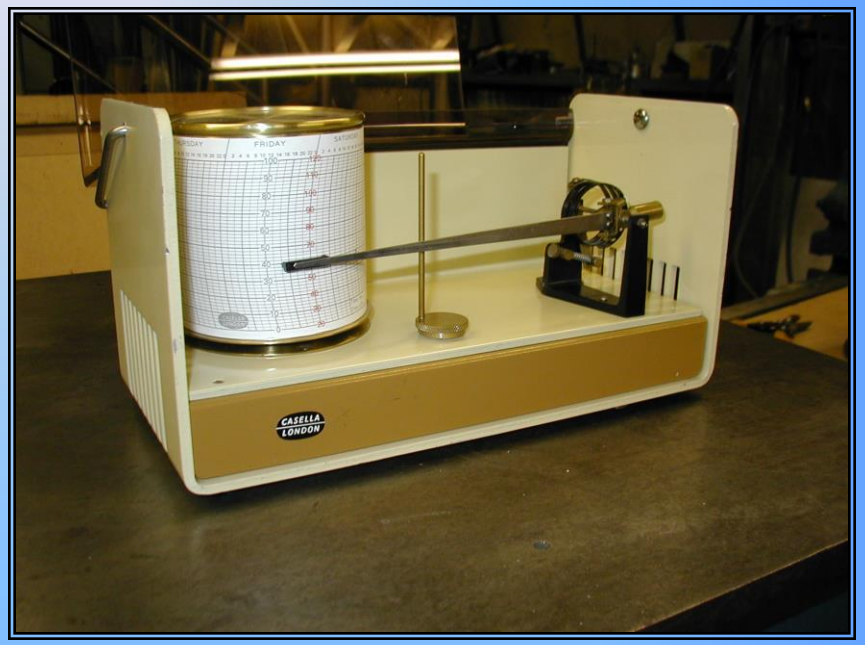




a. Two metals expand and contract unequally when heated or cooled.
b. Causes the strips to curl.
c. The change corresponds to the change in temperature

3. Thermograph



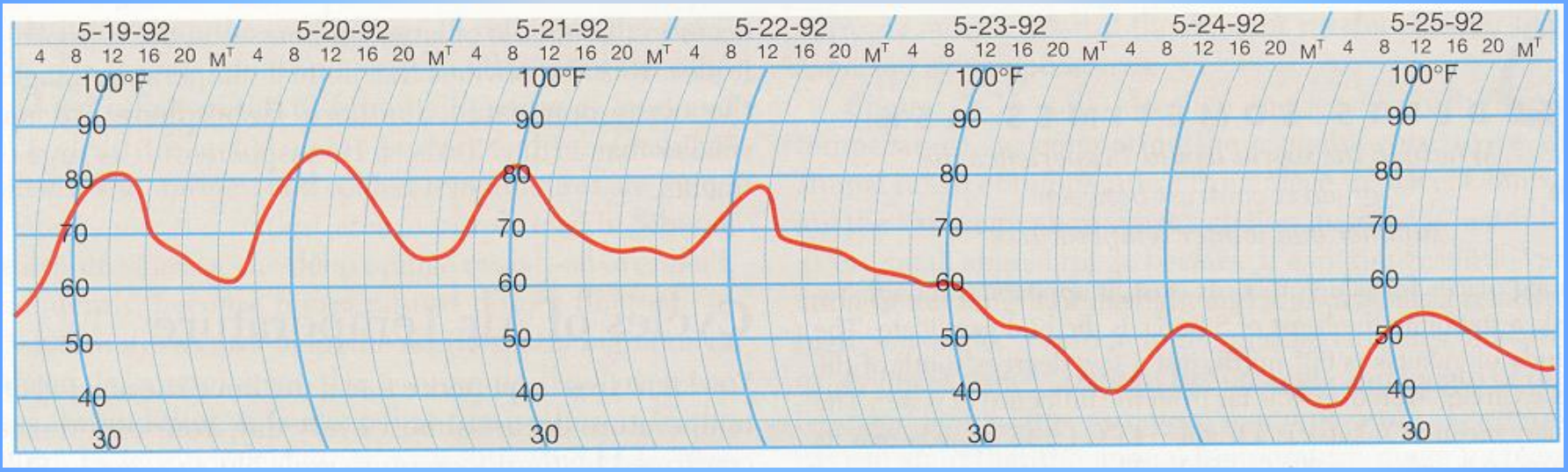


a. A recording thermometer

b. Changes in the curvature of the bimetal strip move a pen arm.

c. Pen marks temperatures on a calibrated chart that is attached to a clock-driven, rotating drum

Thermogram


5-19-92
5-20-92
5-21-92
5-22-92
5-23-92
5-24-92
5-25-92
4 8 12 16 20 MT
100°F
90
80
70
60
50
40
30

4. Electrical Thermometers

a. Thermisters (thermal resister):
   (1) Resistance to current is temperature dependent.
   (2) Higher temp = higher resistance, resulting in a reduction in flow of current
b. Measures flow of electricity which is calibrated in degrees of temperature.
c. Commonly used in *thermostats* and *radiosondes*.

5. Location of Thermometers

- **Standard NWS shelter, provides protection from Sun, wind, and precipitation.**

- **made of wood, painted white, and have louvered sides.**

- elevated to 1.5 meters (about 4.5 feet) by a wooden or metal base.

- electric fan attached to them for better air circulation during light wind conditions.

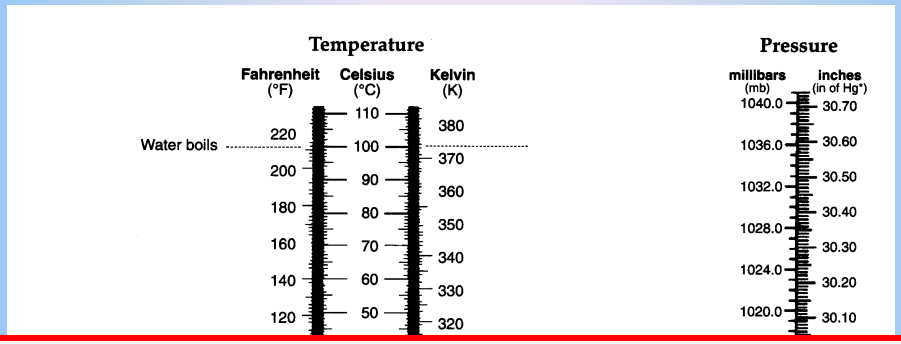
a. Inaccurate readings could result from placement (e.g. near a heat radiating surface or in the Sun)

b. Ideal placement is in an **instrument shelter** .

C. Map Representation of Temperature

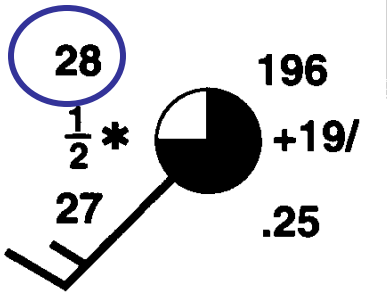
1. **Station** Models
   a. Weather information at a particular point is transmitted and plotted on a surface map at that station's location. The arrangement of the data around the station location is called a station model and is standardized by international agreement.

The Station Model in the *ESRT*



Key to Weather Map Symbols

Station Model



Station Model Explanation

Present weather

Amount of cloud cover (approximately 75% covered)

Temperature (°F) **28**

196 Barometric pressure (1019.6 mb)

Visibility (mi) ½ *

+19/ Barometric trend (a steady 1.9-mb rise in past 3 hours)

Dewpoint (°F) **27**

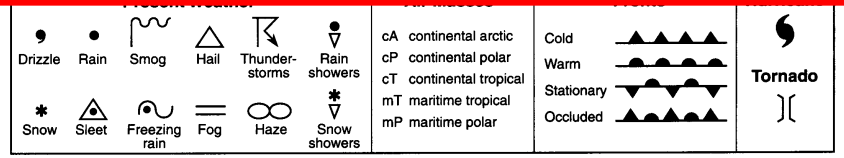
.25 Precipitation (0.25 inches in past 6 hours)

Wind speed

Wind direction (from the southwest)

whole feather = 10 knots
half feather = 5 knots
total = 15 knots

(1 knot = 1.15 mi/h)

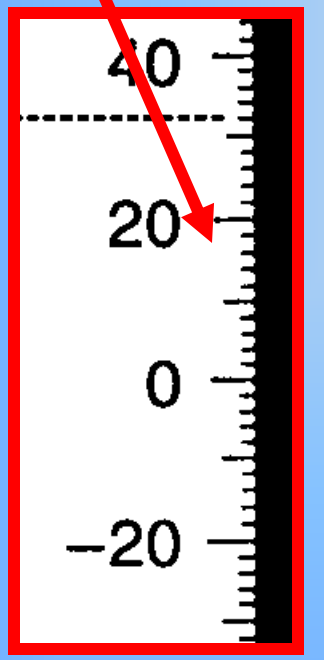


b. Plotting Temperature on a Station Model

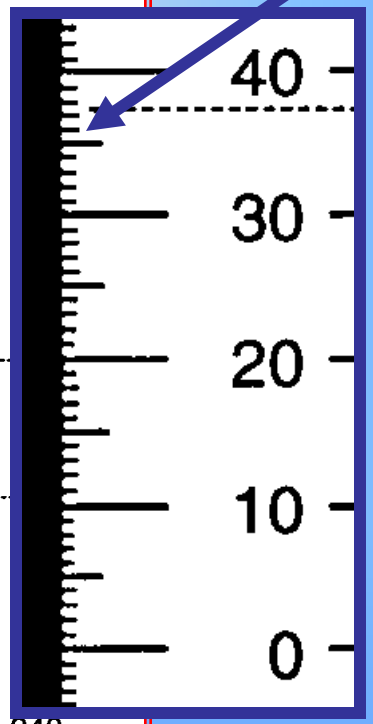
1. Temperature is plotted in the upper **left** of the circle.
2. Always plotted in degrees Fahrenheit
3. Units (ºF) are **omitted**.

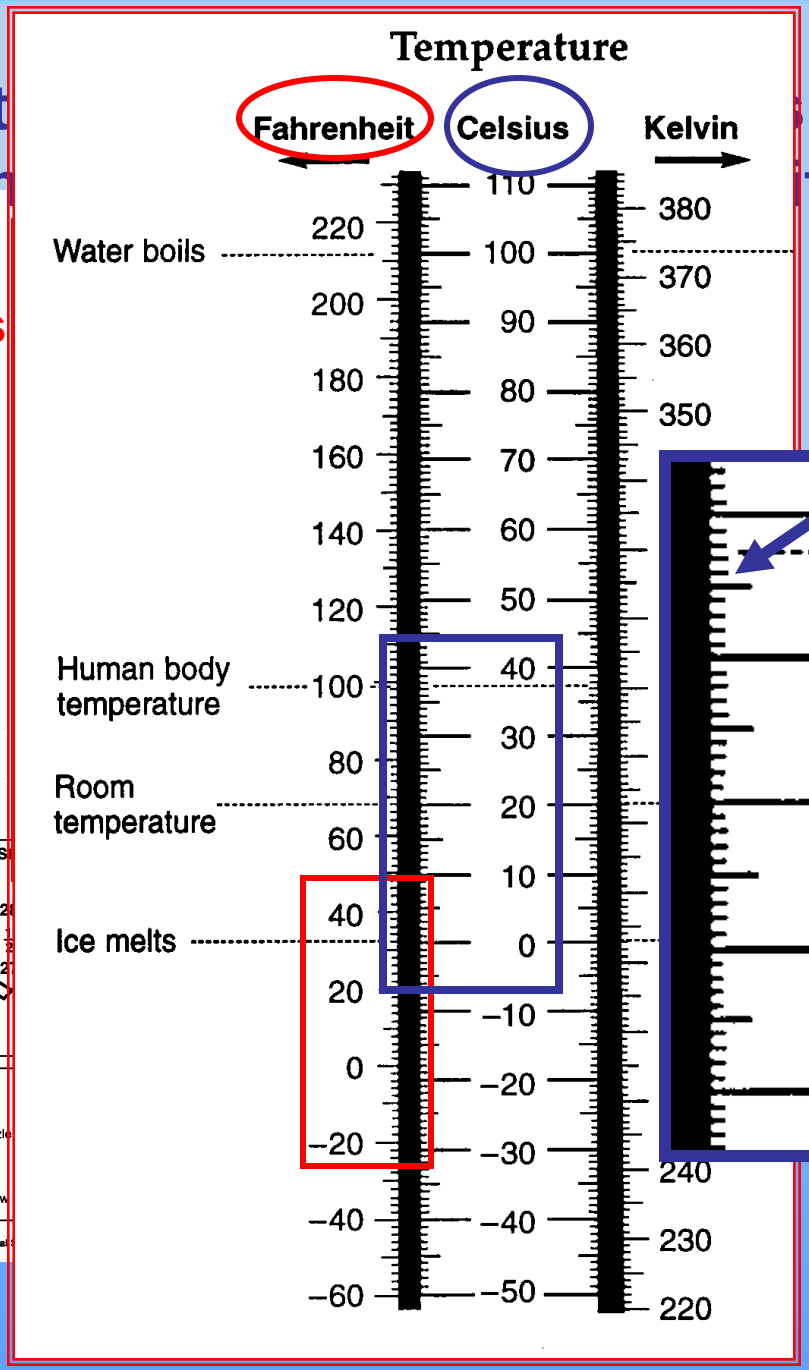
If Temperat… Celsius, con… it

Two degree increments



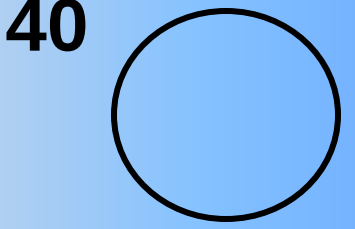
One degree increments



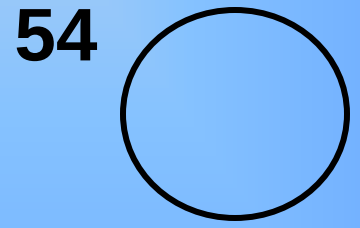


Practice Examples

- Plot a temperature of 40^{o} F.



- Plot a temperature of 12^{o} C.

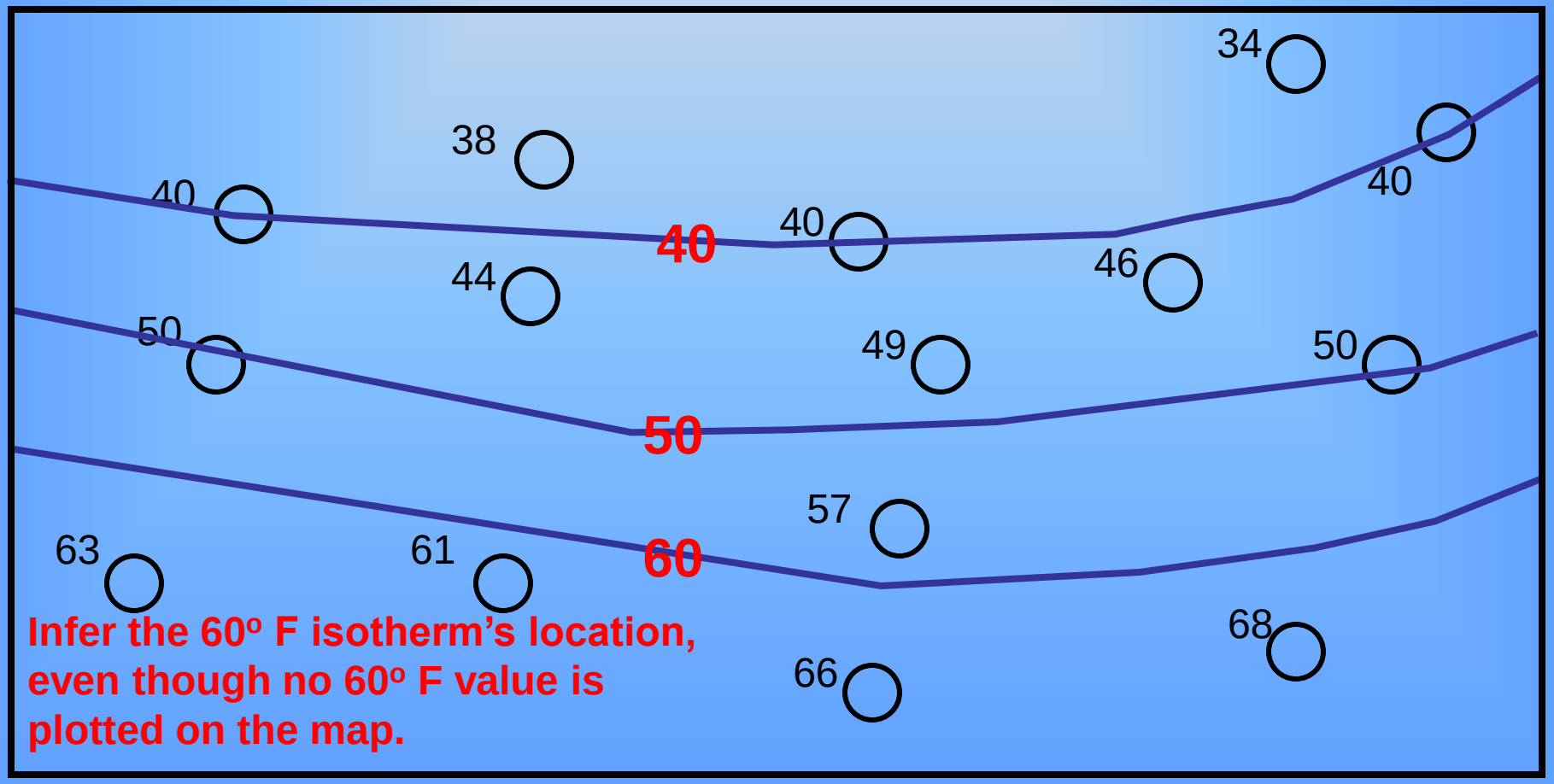


2. Isotherms

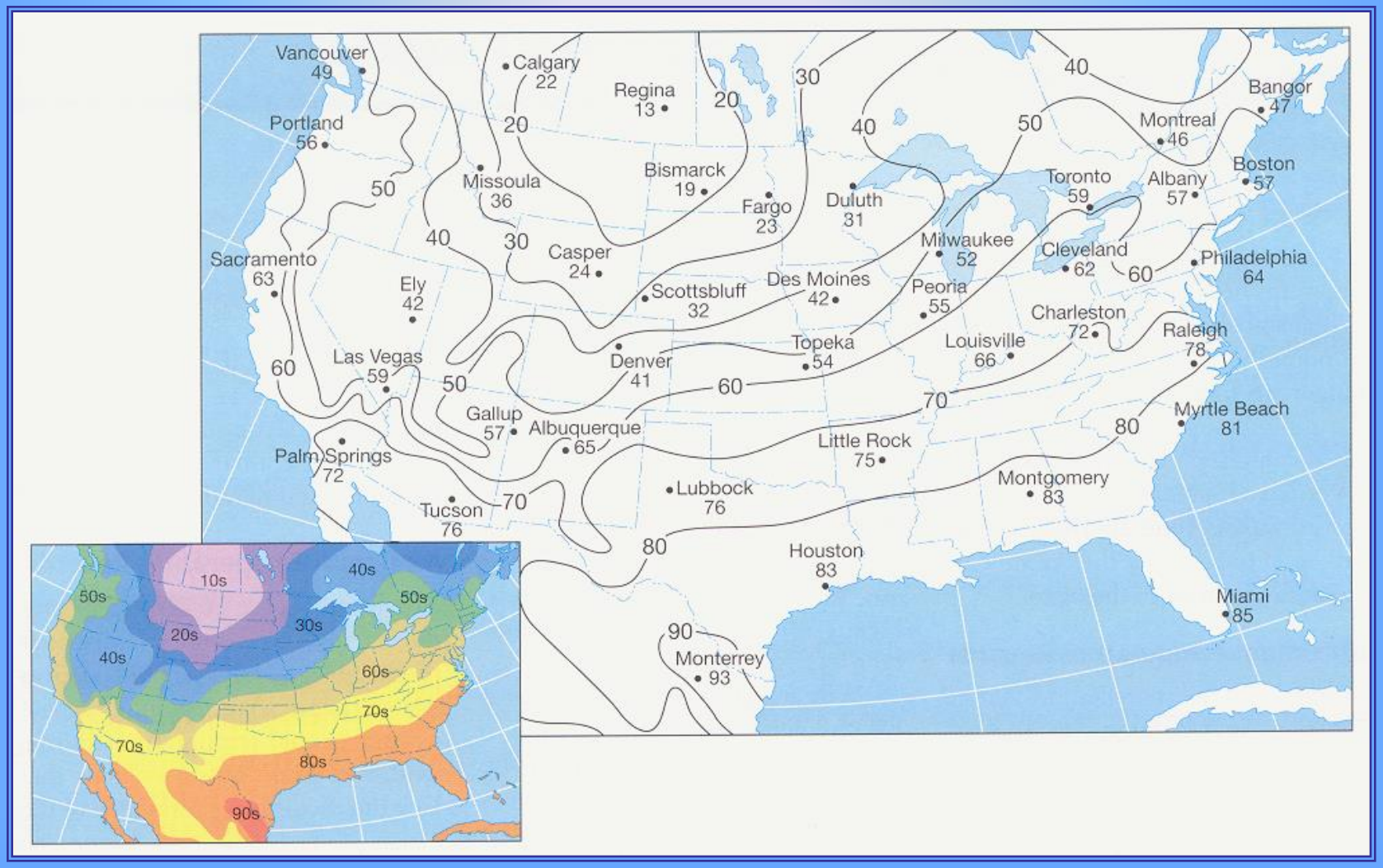
a. Isolines connecting points of equal temperature.

b. The larger the range in temperatures, the larger the interval used on the map.

Example using a 10° F interval



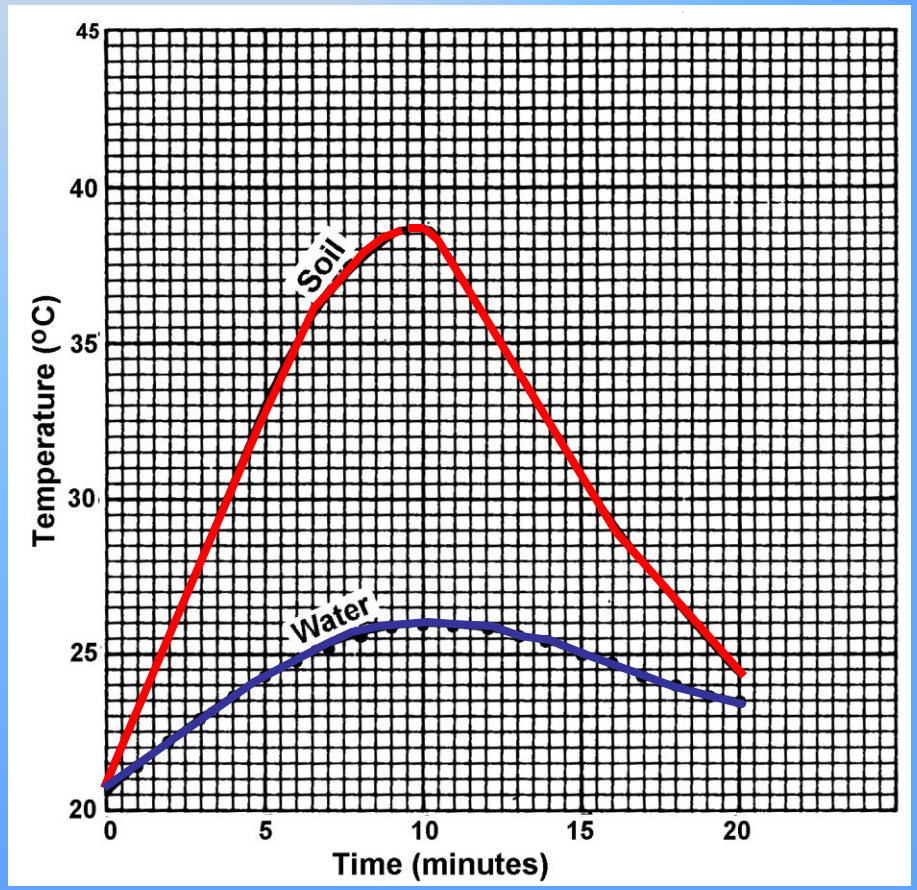
United States Isotherm Map

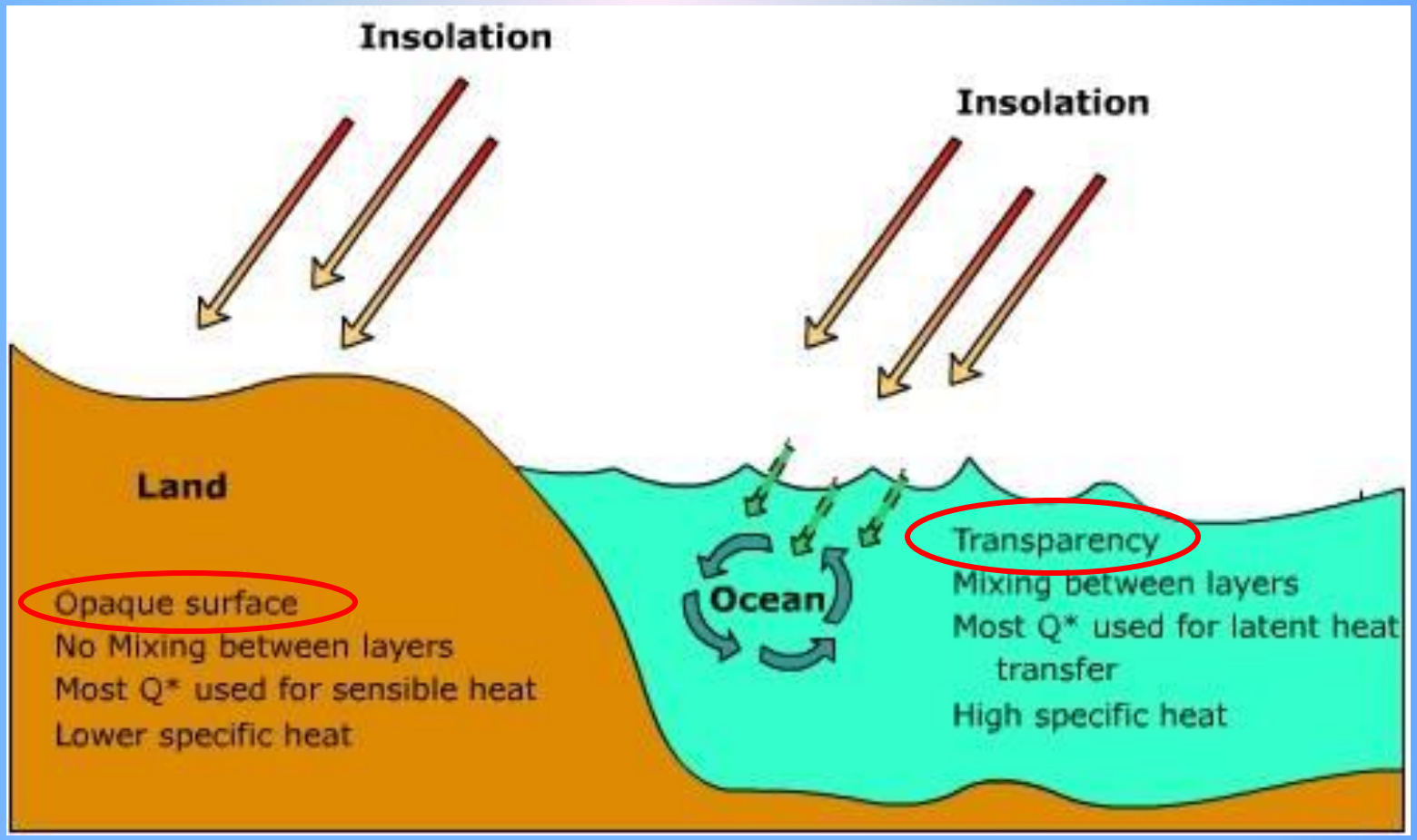


D. Factors that Cause Temperatures to Vary from Place to Place

1. Land and Water

a. Differential **heating and cooling** : A mass of soil heats and cools **faster** than an equal mass of water.



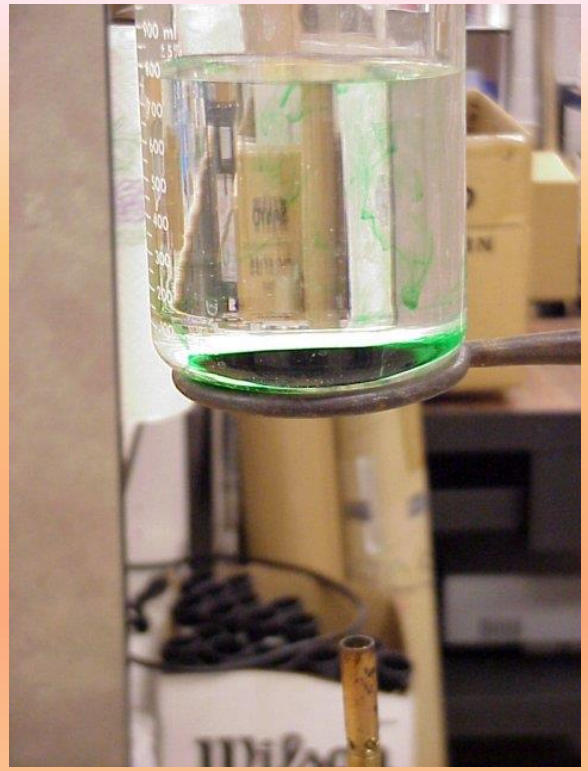


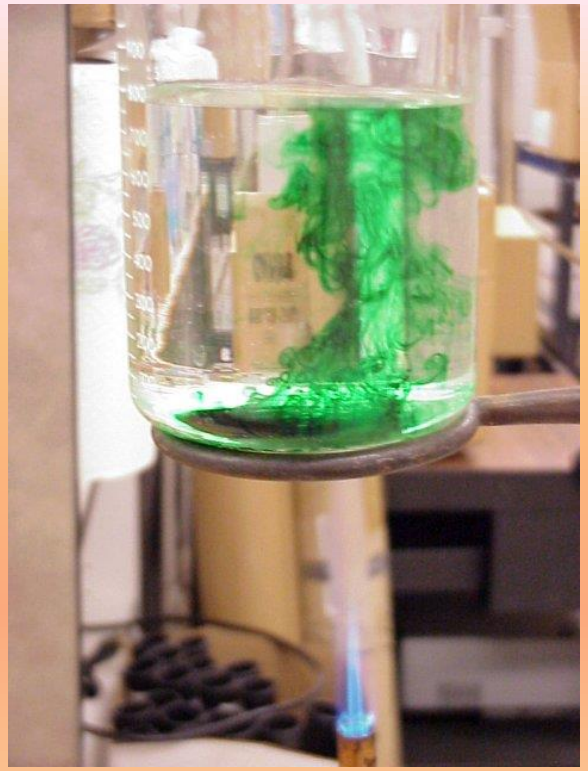
b. Land is opaque and water is more **transparent**

(1) Heat is absorbed by land only at the **surface**, within the top few **centimeters**.

(2) Solar radiation penetrates to greater depths in water, to depths of several **meters**.

C. Water is highly mobile.





(1) __Convection__ currents can distribute heat throughout a __greater__ mass.

(2) Heat remains near the __surface__ of land. No mixing can occur.

d. Specific Heat

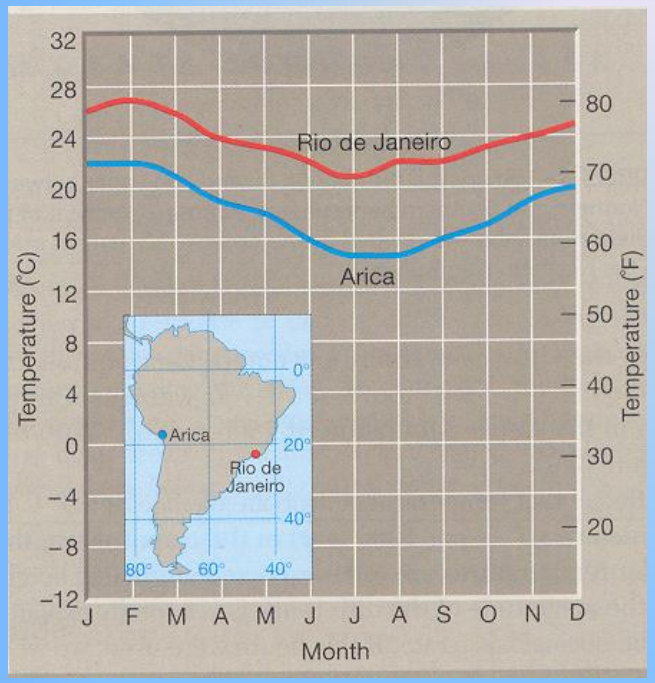
(1) The specific heat of liquid water is more than three times__**greater**__ than for land.

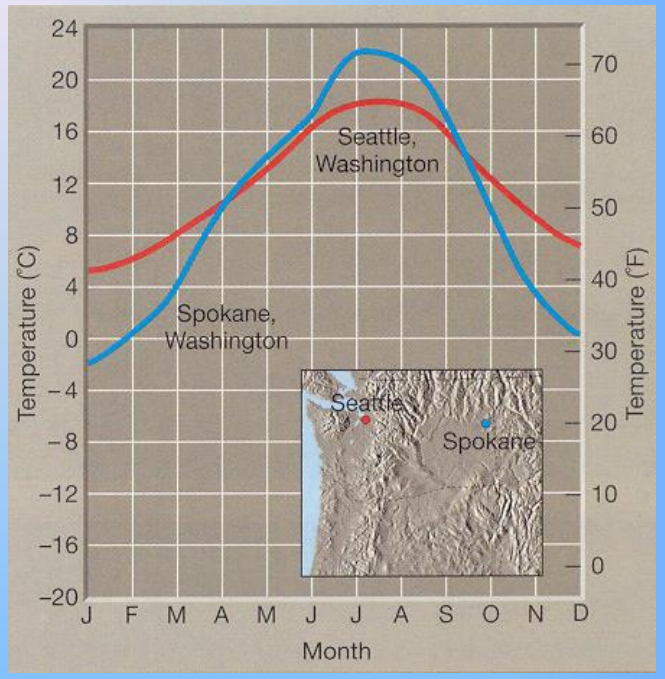
(1) Water requires__**more**__ heat to raise its temperature the same amount as an equal quantity of land

Specific Heats of Common Materials

MATERIAL	SPECIFIC HEAT (Joules/gram • °C)
Liquid water	4.18
Solid water (ice)	2.11
Water vapor	2.00
Dry air	1.01
Basalt	0.84
Granite	0.79
Iron	0.45
Copper	0.38
Lead	0.13

2. Geographic Location





a. Coastal vs. Inland Locations

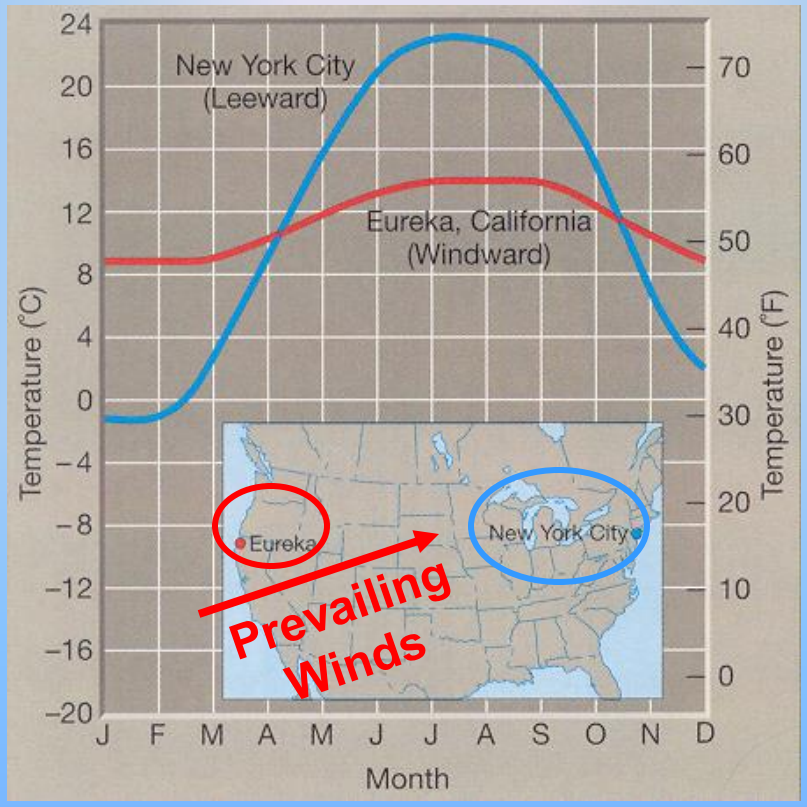
(1) Coastal regions have their yearly temperatures **moderated** by the nearby presence of a body of water.

(2) Coastal regions will have **smaller** yearly temperature ranges than inland regions

(a) **Cooler** summer temperatures

(b) **Warmer** winter temperatures

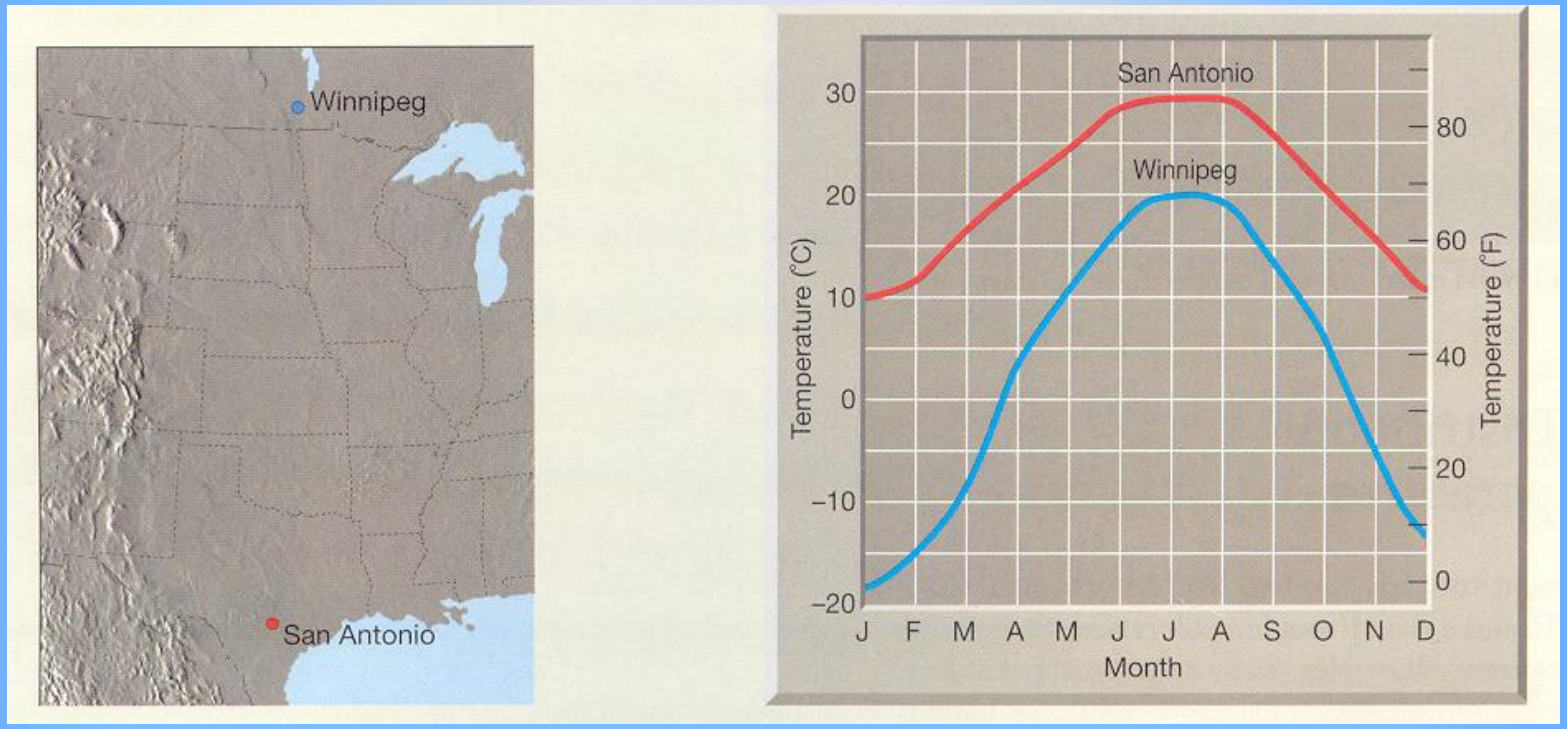
b. Windward Coast vs. Leeward Coast



(1) Windward: Prevailing winds from the ocean will result in a **smaller** annual temperature range.

(2) Leeward: **Larger** temperature range because winds do no carry the ocean's influence on shore.

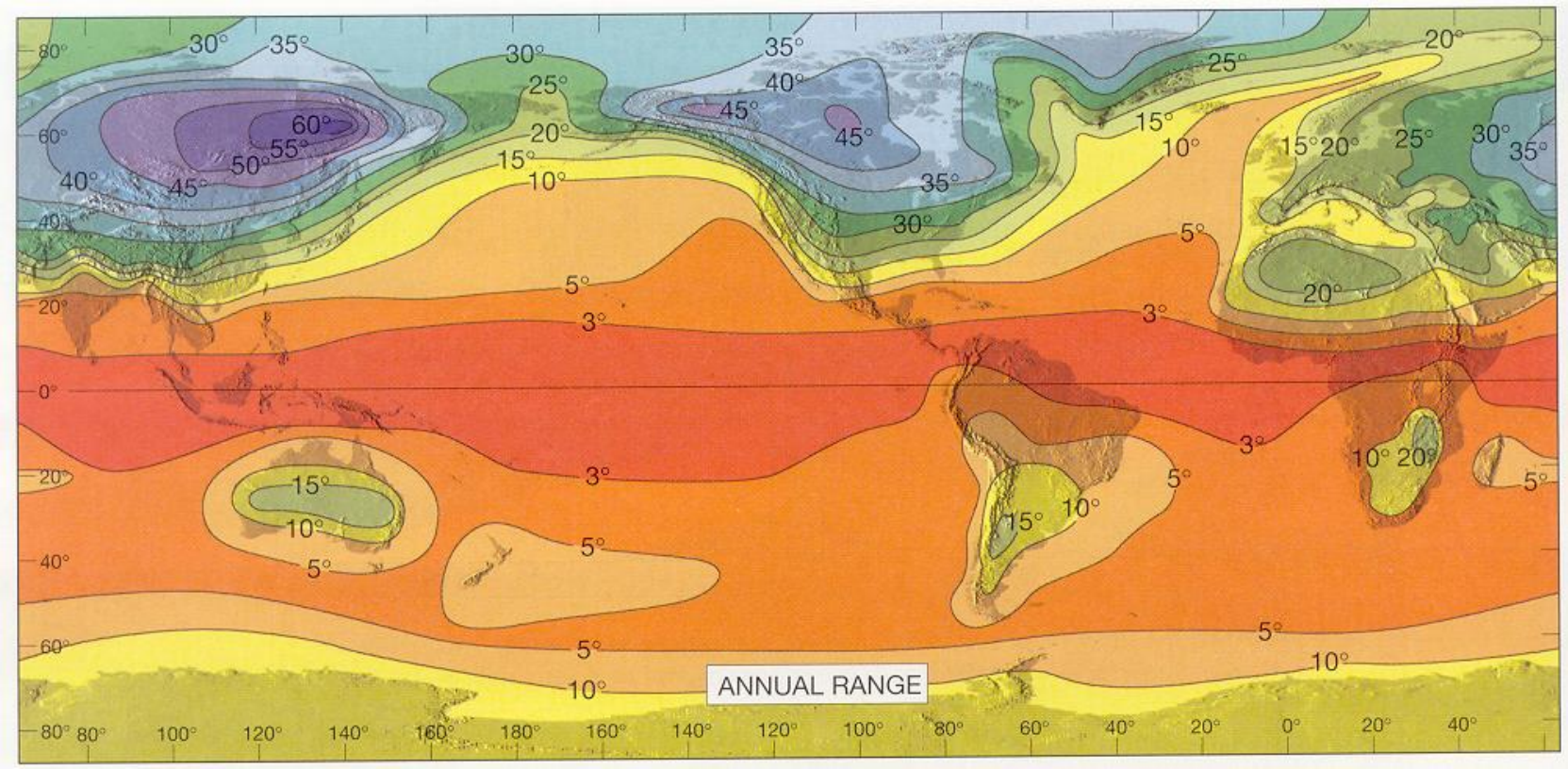
c. Latitude



(1) On the average, as latitude increases average annual temperature **decreases**

(2) Higher latitudes also have a greater annual temperature **range**.

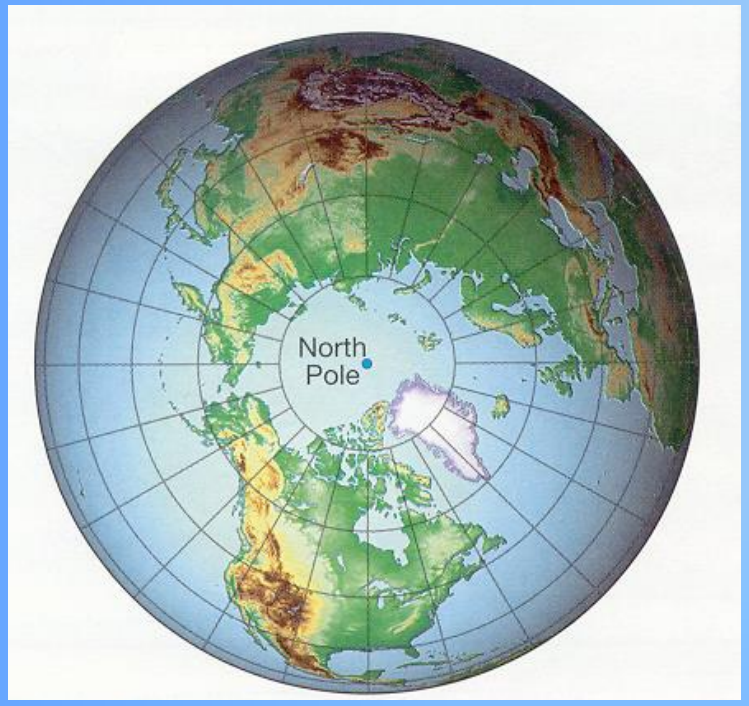
Global Annual Temperature Ranges

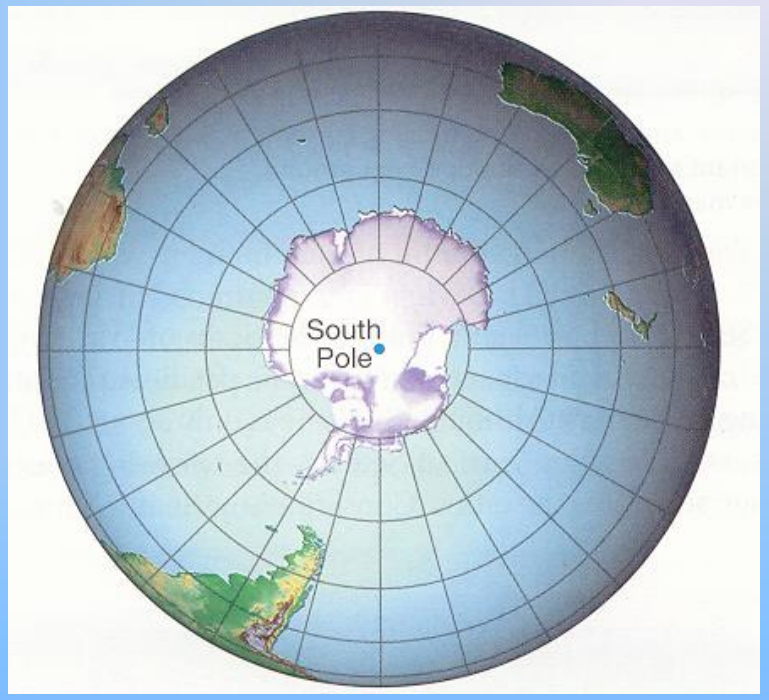


Notice the lower latitudes have smaller ranges (see notes 2c).

Compare the Southern hemisphere to the Northern hemisphere… why are they so different?

d. Northern Hemisphere vs. Southern Hemisphere

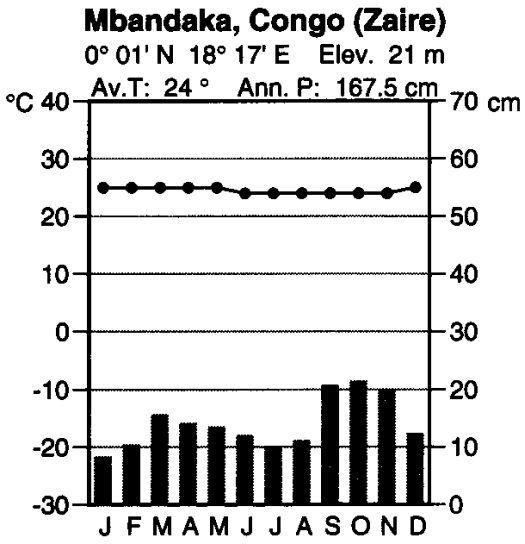


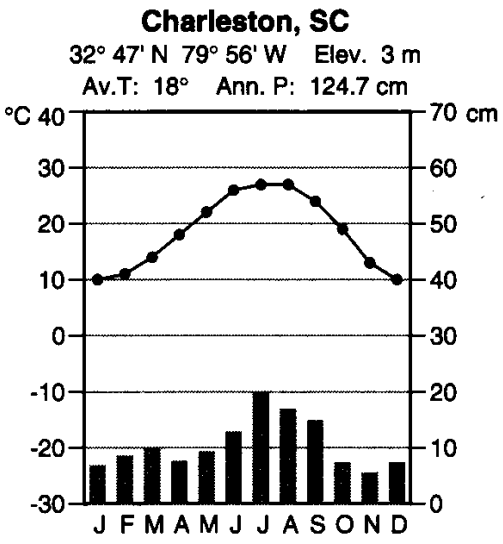


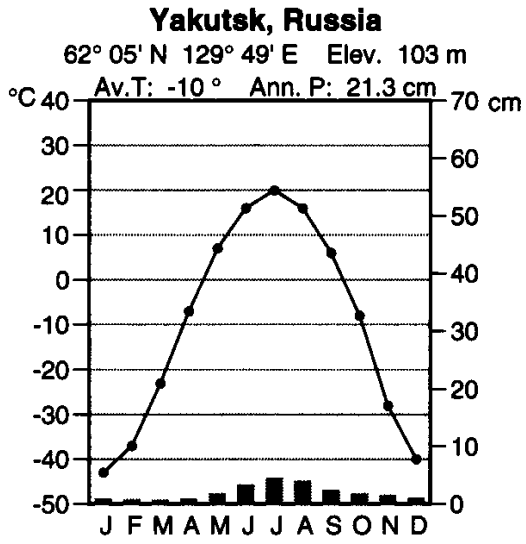
(1) The Southern Hemisphere has a **greater** percentage of water than the Northern Hemisphere (81% covered - 20 percent more than the N. Hemisphere).

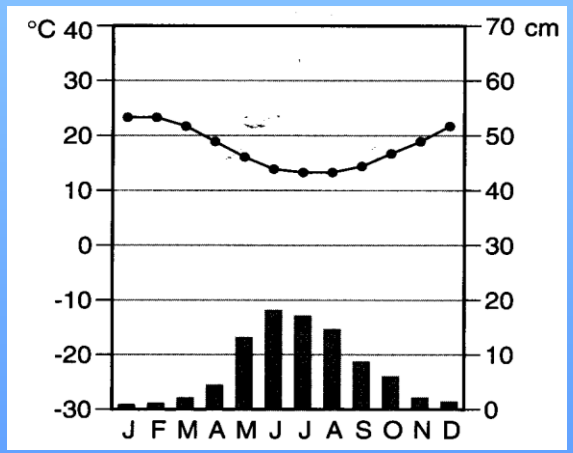
(2) **Smaller** temperature variations in the Southern Hemisphere.

Climographs



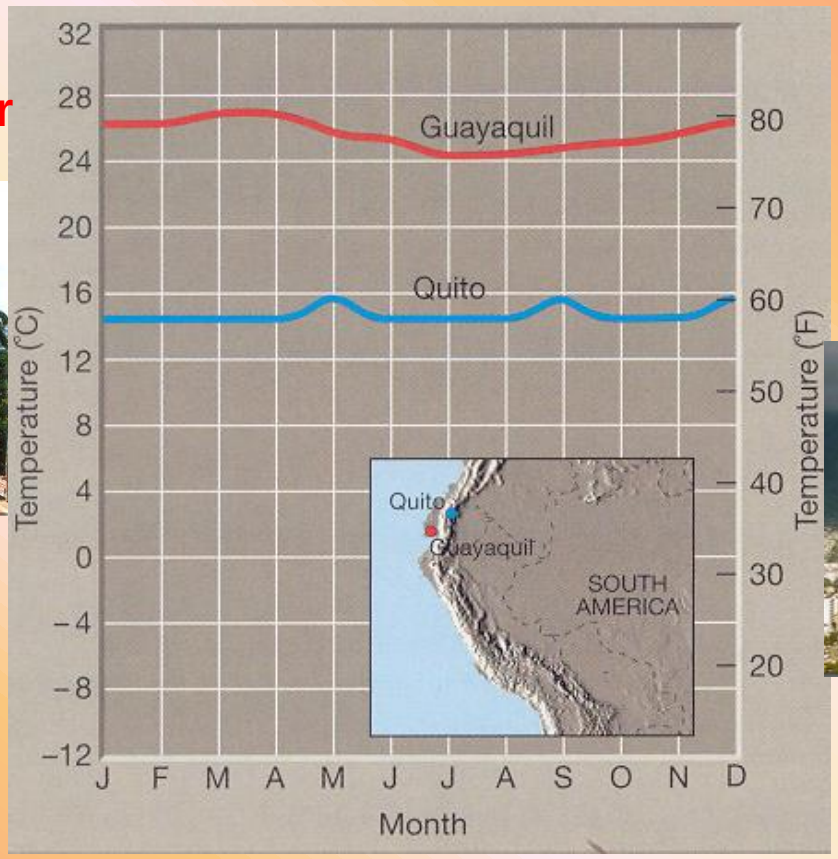






3. Altitude

Guayaquil, Ecuador is near sea level.

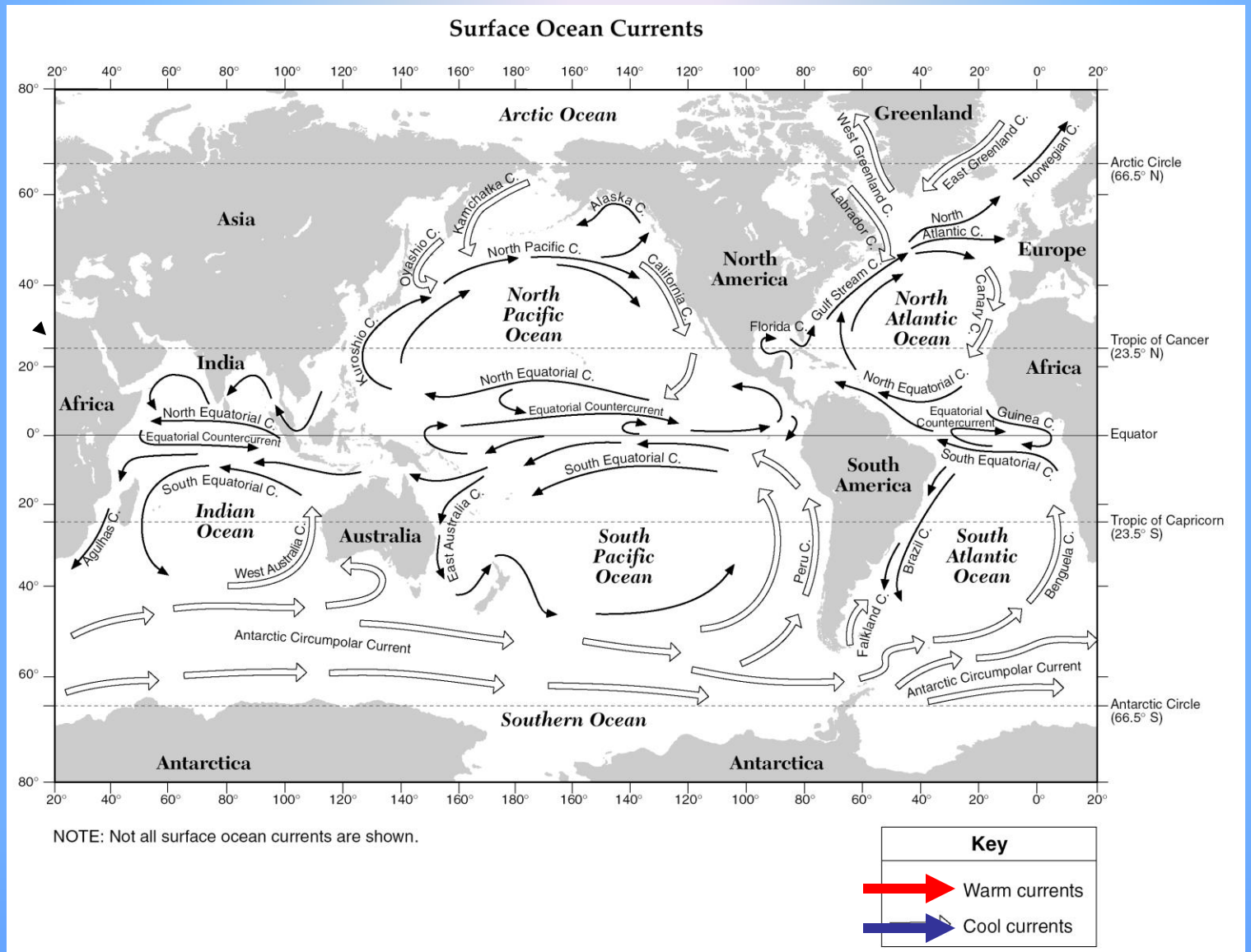


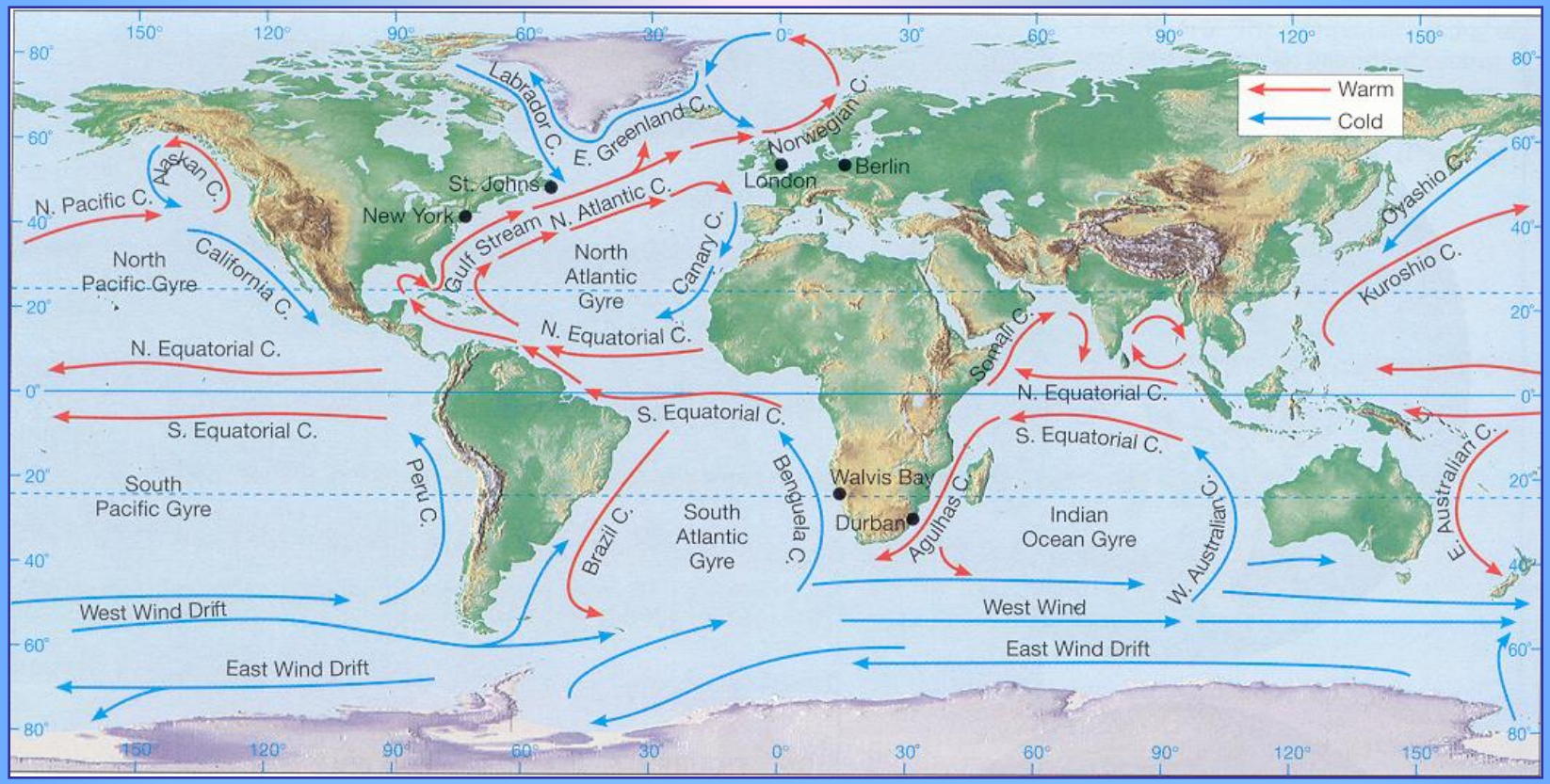
Quito, Ecuador is high in the Andes Mountains

a. As altitude increases, average annual temperature **decreases**.

b. Increased altitude results in a **larger** daily temperature range because the greater intensity of insolation due to the less dense air.

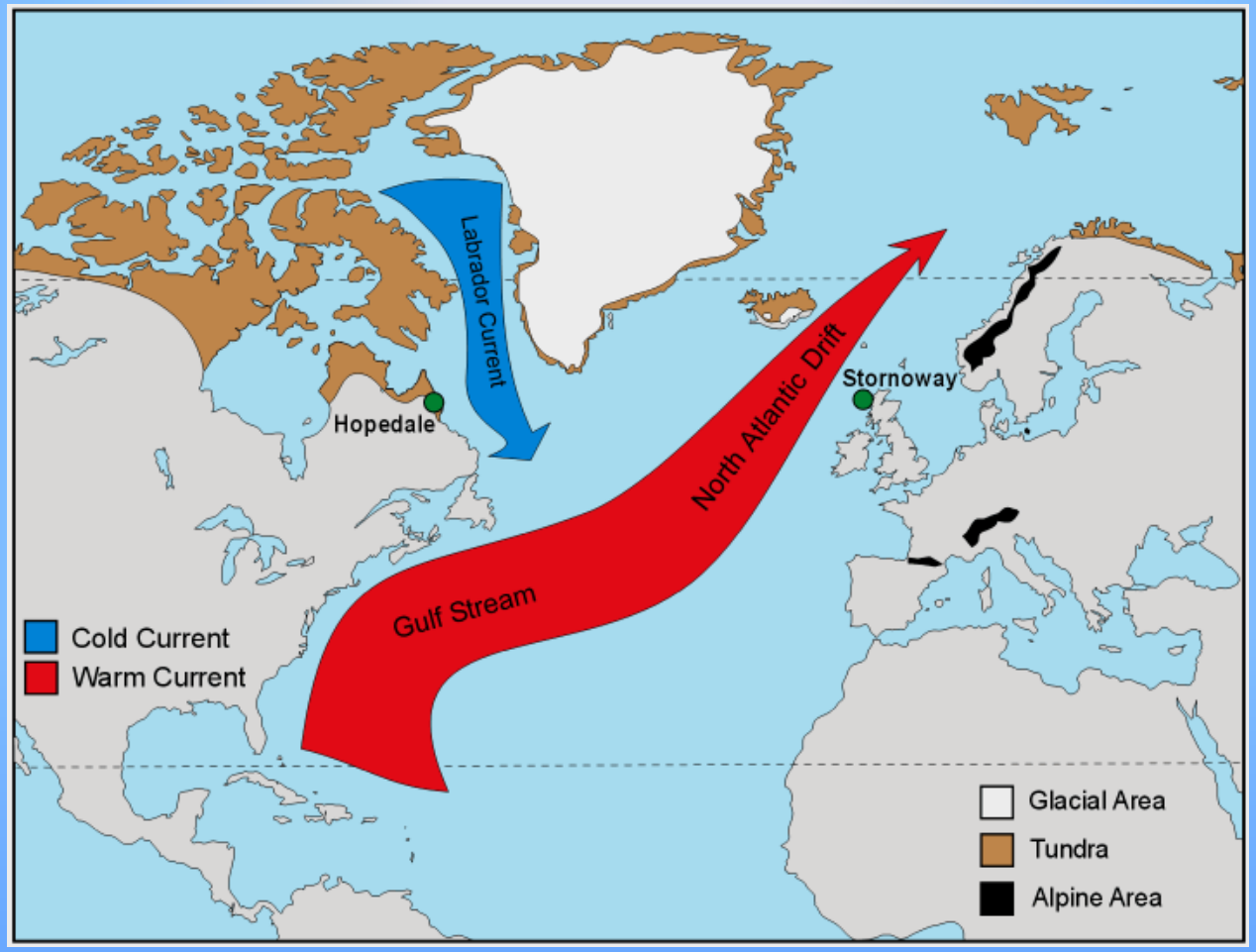
4. Ocean Currents



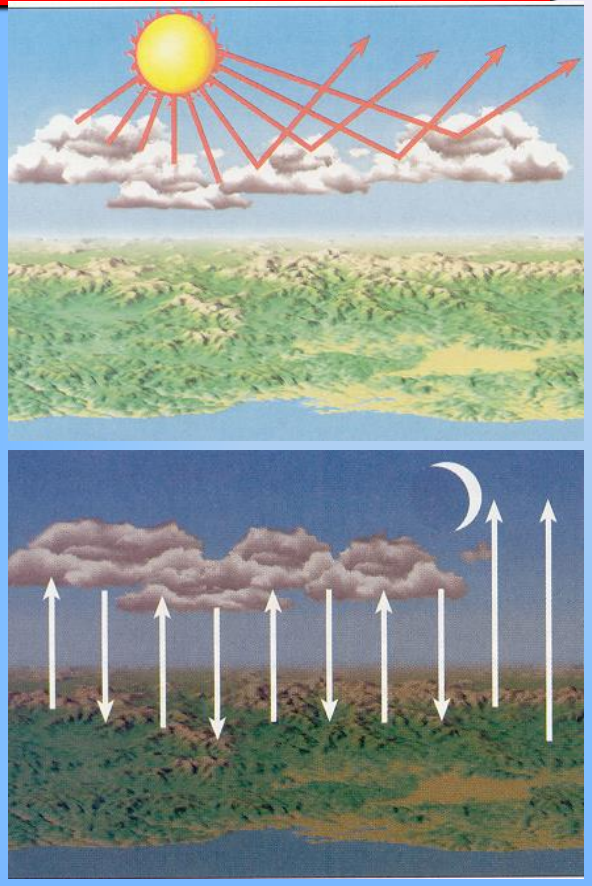


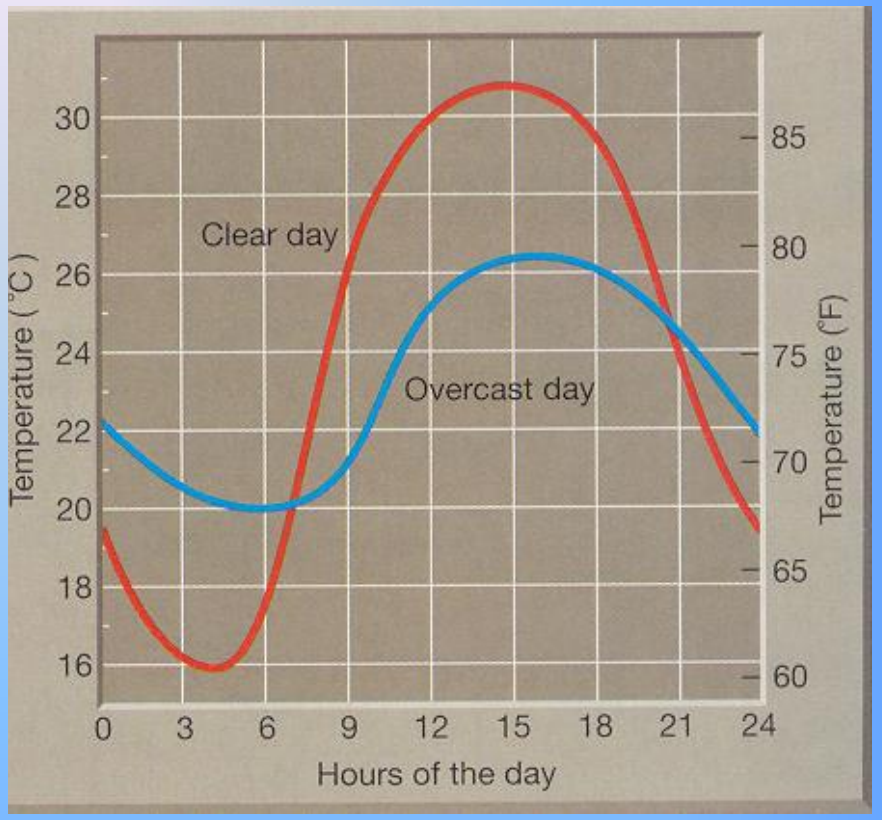
a. Currents moving towards lower latitudes are **cold**.
b. Currents moving away from the equator are **warm**.
c. Caused by frictional drag on the surface by **wind**.
d. Affect coastal areas

Ocean Currents



5. Cloud Cover





a. During the day, clouds **reflect** insolation back to space.

b. At night, minimum temperature will not fall as low. Clouds **absorb** terrestrial radiation and emit a portion of it toward the surface.

c. Clouds **reduce** the daily temperature range.