Lecture 2

Weather and Climate

Weather: The condition of the atmosphere at any particular time and place.

Weather Elements

1. Air temperature
2. Air pressure
3. Humidity
4. Clouds
5. Precipitation
6. Visibility
7. Winds

Climate: Average weather and the range of weather over many years. Can include:

The whole year (mean annual rainfall in Seattle, 1950-present)

A season, e. g. Dec-Jan-Feb (winter), Jun-Jul-Aug (summer)

A month (e. g. mean January snowfall in Seattle)

One particular day of the year (Average and record high, low temps for Jan 1 in Seattle)

Meteorology

The study of the atmosphere

From Aristotle, *Meteorologica* (340 BC)

Meteors: objects seen in air and falling from the sky.

Modern terms:

Meteoroids (extraterrestrial) Hydrometeors (falling water and ice particles)

1500's: thermometer

1600's: barometer

1700's: hygrometer

1800's: ocean commerce → mariners logs

1840's: telegraph → weather maps

1910's: Norwegian school: front, airmass

1940's: aviation → weather balloons → 3D

1950's: computers, weather radar

1960's: weather satellites

3000's: we believe the weather forecast!

Weather From Above - Satellite View

- In visible light, see cloud patterns.
- Looking in other cleverly chosen wavelengths, can deduce cloud-top temperature, moistness, atmospheric temperature profile, sea-surface winds, etc.

Figure 1.10
This satellite picture (taken in visible, reflected light) shows a variety of cloud patterns and storms in the earth's atmosphere.

EOM1.10

Weather From Below: Surface Weather Map

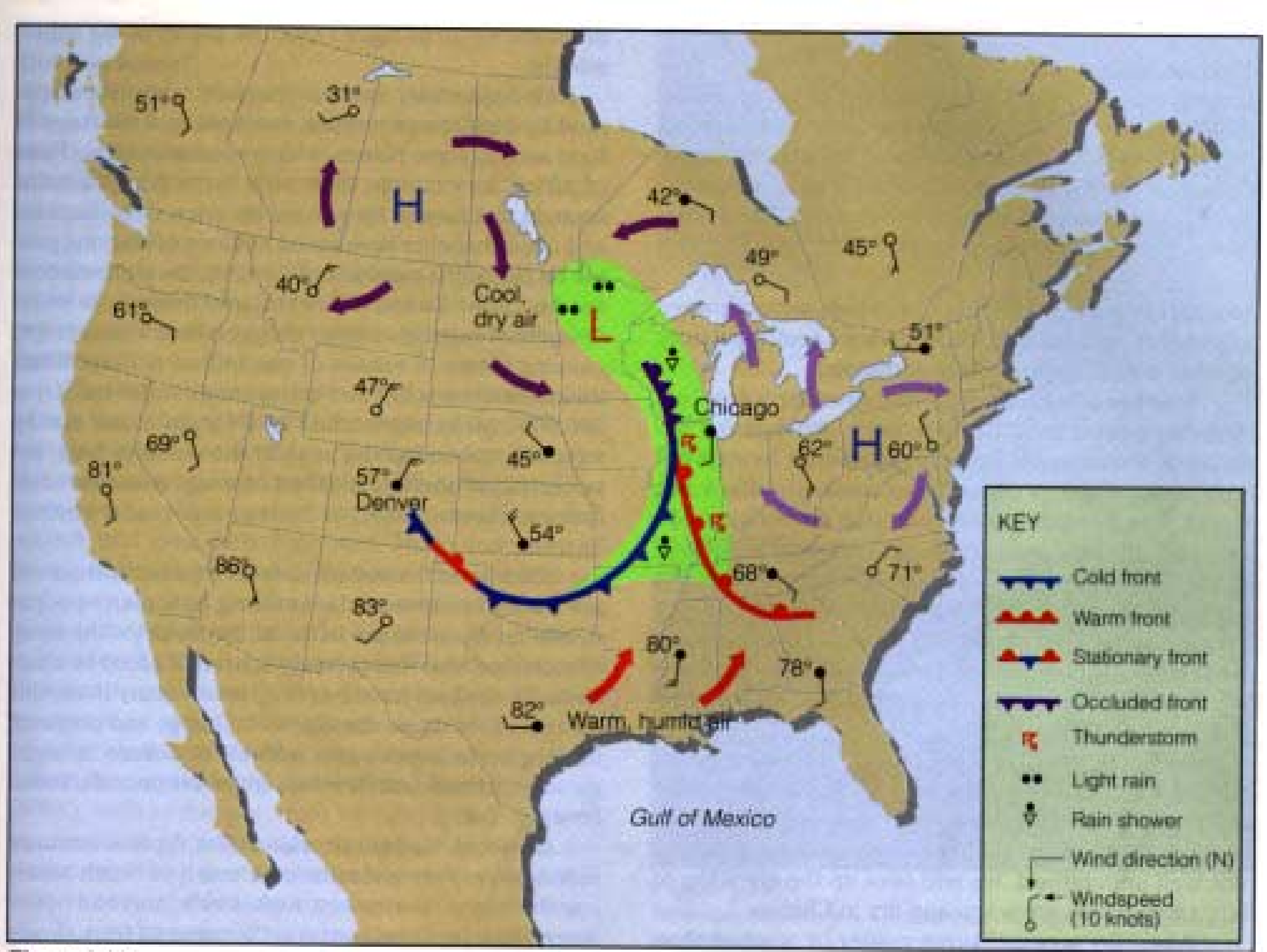


Figure 1.11
Simplified surface weather map that correlates with the satellite picture shown in Fig. 1.10. The shaded green area represents precipitation. Air temperatures are in °F.

EOM 1.12

- Combines compact representation of several weather elements to visualize surface patterns of temperature, air motion, storms, and precipitation.

Weather's Vertical Profile: The Radiosonde

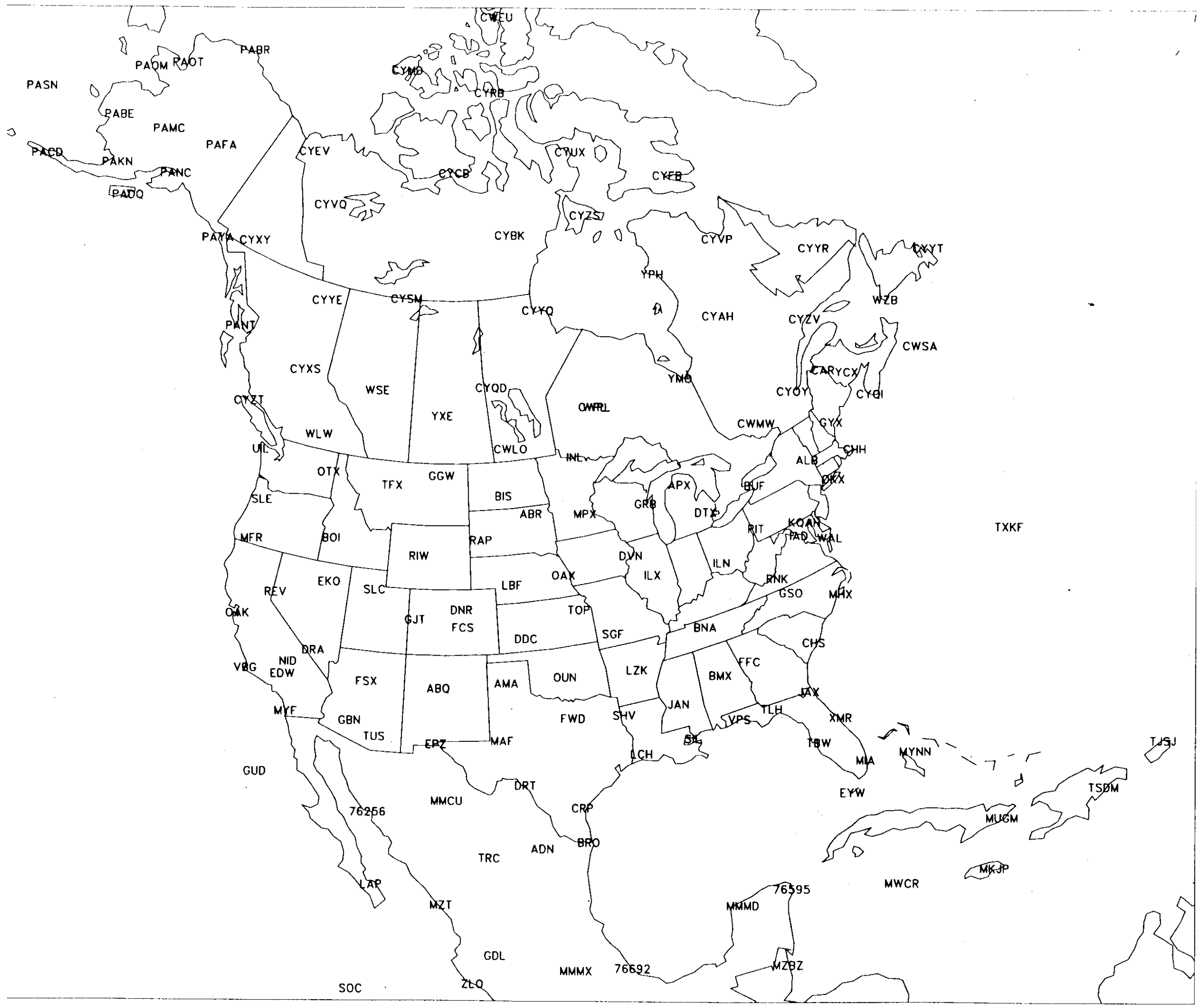
- Weather balloons, called radiosondes, are used to sample the vertical structure of the atmosphere up to about 30 km.
- They measure Temperature
Humidity
Pressure
and are tracked to determine winds.
- Since the 1950s, radiosondes are launched at 00 and 12 GMT every day at a global network of sites for weather forecasting.
- This network has enormous gaps over the oceans, and is sparse to nonexistent in less affluent nations.

Figure 1
The radiosonde with parachute and balloon.

EOM, p 11

The North American Radiosonde Network

- Stations 300-500 km apart
- Nearest stations:
  UIL: Quillayute, WA
  (on Pacific coast)
  OTX: Spokane, WA
  YZT: Pt Hardy , BC
  (N tip Vancouver Island)
  SLE: Salem, OR
  (Oregon coast)



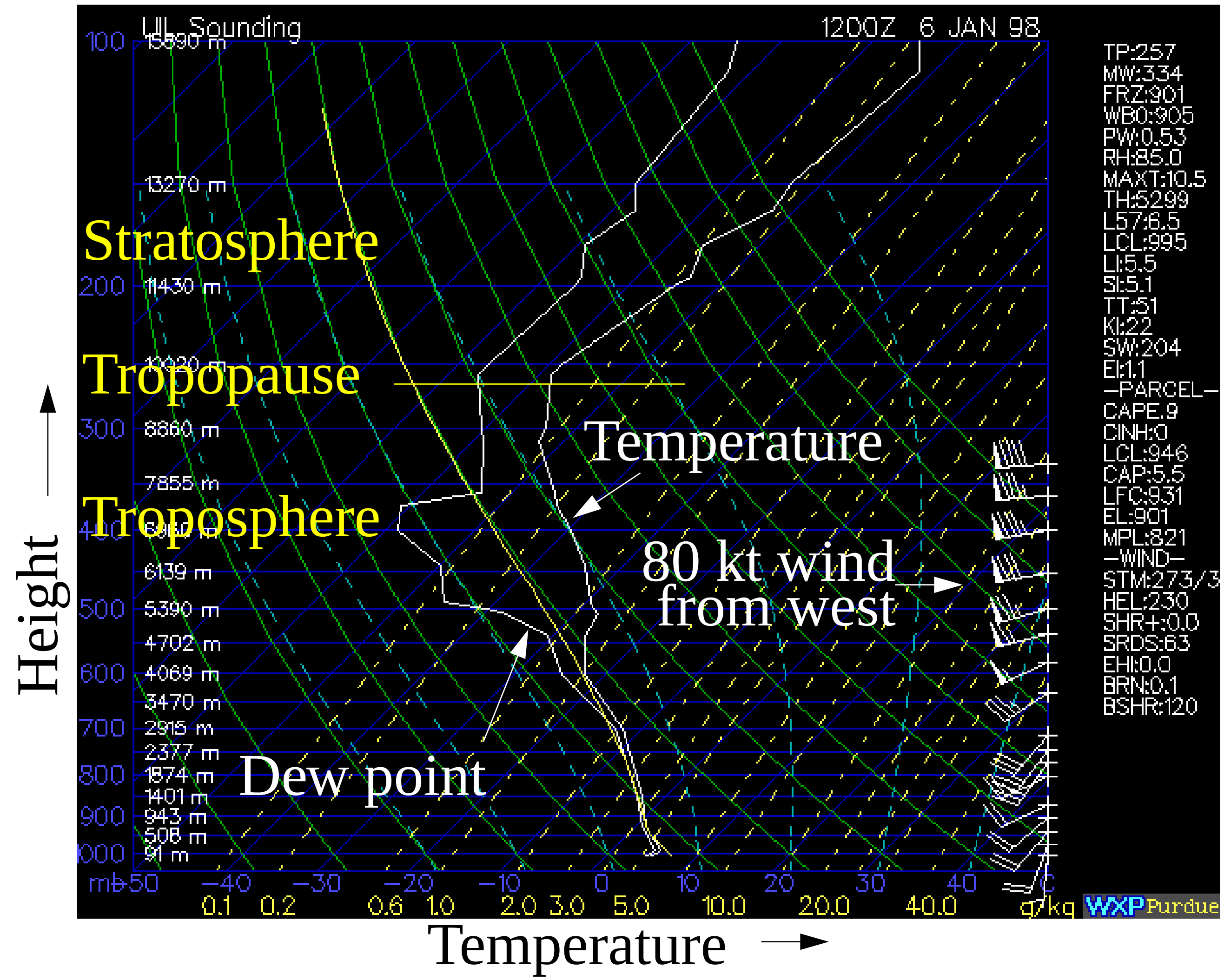
A Radiosonde Sounding

(Quillayute, WA, 1200 GMT 6 Jan 1998)

- Tilted blue lines mark constant temperature. Temperature decreases with height in tropo-sphere up to tropo-pause, nearly constant in stratosphere
- Wind vane indicates direction, barbs indi-cate wind speed - filled triangle = 50 knots (55 mph)

  full line = 10 kts

  half line = 5 kts

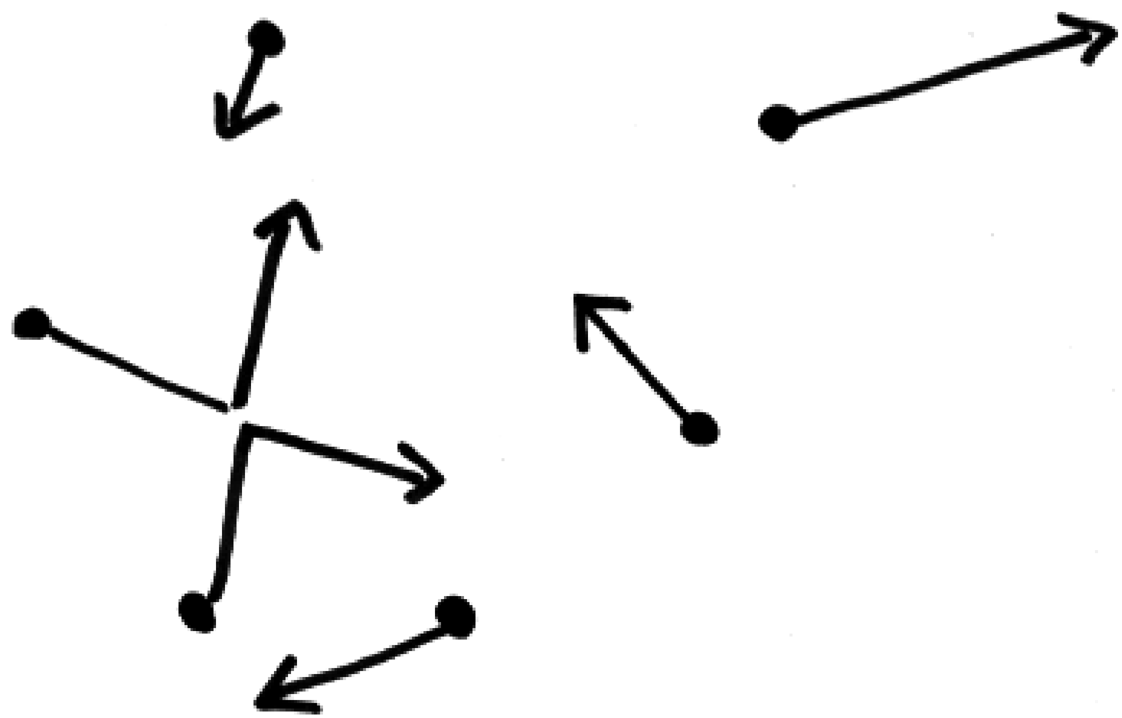


Temperature and Heat

Microscopic View of Temperature:

Energy of Random Jiggling

(related to average molecule velocity = 500 m s^{-1} at room temperature)



Heat: Energy being transferred from one object to another as a result of their temperature difference.

Temperature Scales

Gabriel Fahrenheit (1714):
  0°F= lowest freezing
    point of brine,
  100°F = body temperature

Anders Celsius (1736):
  0°C = freezing point,
  100°C = boiling point
  of water.

Lord Kelvin (1800s): Temperature scale based on absolute zero:
  °K = °C + 273.

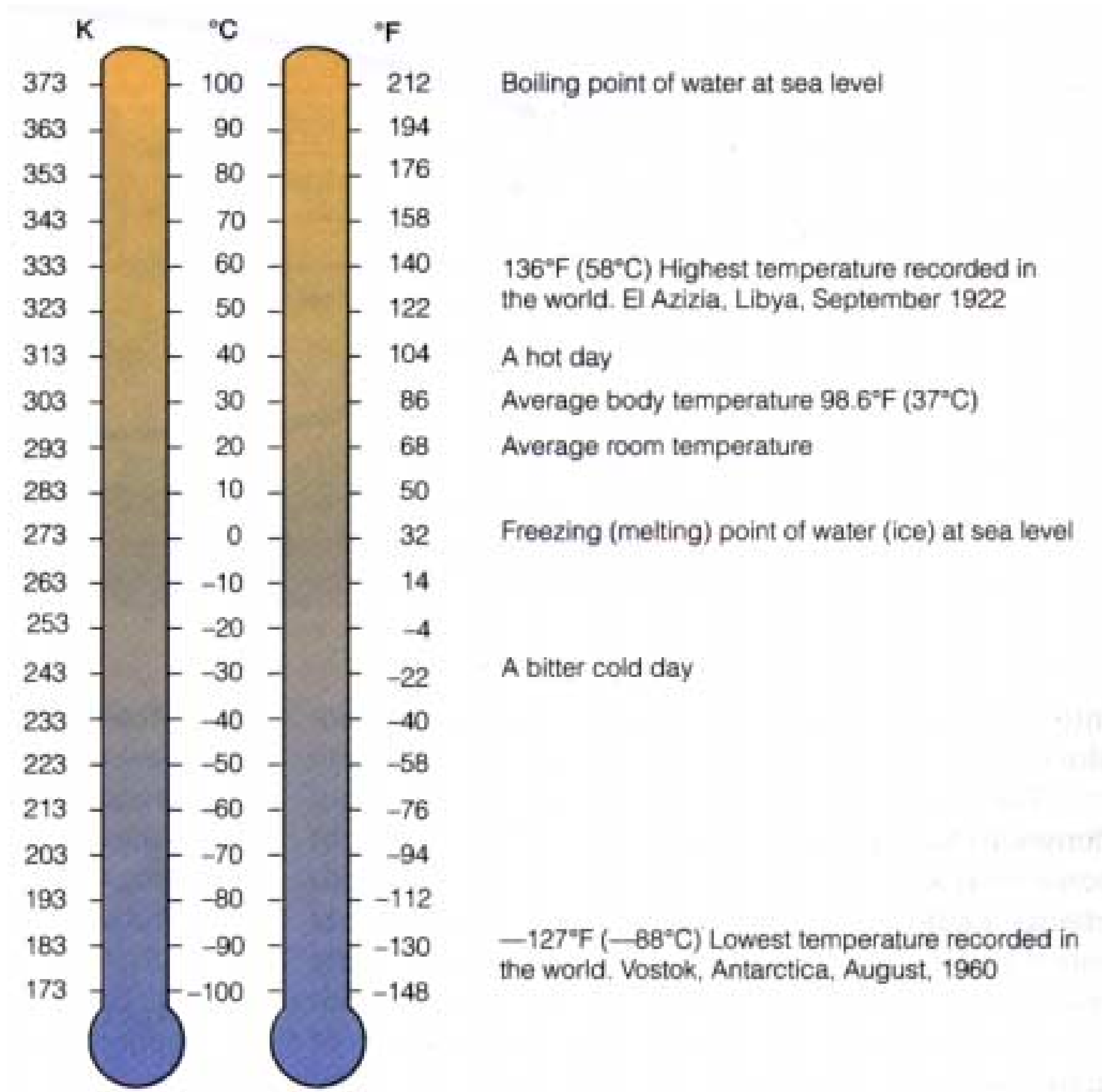


Figure 1
Comparison of Fahrenheit, Celsius, and Kelvin scales.

Heat Capacity

The amount of heat required to raise the temperature of an object 1 C is its heat capacity

- Proportional to the *mass* of object
- Depends somewhat on the *composition*. (liquid water has a ‘specific’ heat capacity (per unit mass) 4-5 times that of sand, rock, or air.

Why is beach sand hot on a tropical summer day while water is comfortable?

- The same energy from sunlight is absorbed in a very shallow layer of sand (a few cm), but a deep layer of water (50 m), so the sand heats up much faster.

This is also why land warms up and cools down faster and more than lakes or oceans as the seasons or time of day changes.