TEMPERATURE MEASUREMENT

- Temperature should be measured in the shade, so that solar radiation does not heat thermometer and give exaggerated readings.
- Temperature should not be measured close to a building, or hot pavement.
- Ideally, an instrument shelter should be used.
- Thermometer types
  - Liquid-in-glass
  - Bimetal strip
  - Thermograph
  - Thermistor

CONTROLS OF TEMPERATURE

- Latitude
- Differential heating of land and water
- Ocean currents
  - East coast of continents have warm currents
  - West coast of continents have cold currents
- Altitude
- Geographic position
  - Windward vs. leeward coast
  - Desert vs. humid area
  - Urban vs. rural – The heat island
- Cloud cover and Albedo
  - During day, clouds lead to cooler temperatures
  - At night, clouds lead to warmer temperatures
  - Snow absorbs less radiation than bare ground, and results in cooler temperatures. Dirty snow absorbs more radiation than fresh snow.
GLOBAL TEMPERATURE DISTRIBUTION

- Temperature decreases from the tropics to the poles
- Spacing of the isotherms (temperature gradient) is not uniform with longitude.
  This is due to:
  - Ocean currents
  - Land-sea contrasts
- Band of maximum temperature migrates with the seasons
- Hottest and coldest temperatures are over land
- Annual temperature range increases with increasing latitude.

TEMPERATURE CYCLES

- Daily
  - Time of daily temperature maximum does not coincide with time of maximum solar radiation.
  - Maximum temperature usually in afternoon
  - Minimum usually after sunrise
- Annual
  - Month of annual temperature maximum does not coincide with month of maximum solar radiation (July and August are usually hottest months in U.S., but max solar radiation is in June).
  - Month of annual temperature minimum does not coincide with month of minimum solar radiation.
- Effect of wind on max and min temp
  - Wind decreases max and increases min temp

WIND CHILL

- Wind-chill factors in the effects of wind on the human sensation of temperature to give a wind-chill equivalent temperature.
- Calculated from temperature and wind speed using the empirical formula\(^1\)

\[ WCT = 35.74 + 0.6215T - (35.75 - 0.4275T)V^{0.16} \]  

(1)

where \( T \) is Fahrenheit temperature and \( V \) is wind speed in mph.

- Calculates the effects on a person’s exposed facial skin.
- Numerous assumptions are made:
  - Person is walking into the wind at a speed of about 3 mph.
  - Wind at face level is 2/3 of the 10m wind speed.
  - Perfectly clear sky
  - No humidity
  - Core body temperature of 38°C
  - Uses ‘typical’ values for the heat transfer rate from the core of a person to the skin.
    - These values are actually highly variable among individuals, but wind chill equivalent temperature assumes everyone is the same.
- Not really significant unless temperatures are less than 40°F and wind greater than about 4 mph.
- A thermometer reads air temperature, NOT the wind-chill equivalent temperature!
- Frostbite does not usually occur until equivalent wind chill temperature is below −19°F.

HEAT INDEX

- Heat index factors in the effect of relative humidity on the human sensation of temperature.
- Calculated from temperature and relative humidity or dew point, with numerous assumptions.
- The empirical formula used by the National Weather Service for heat index is very complicated and long. A simplified formula that yields similar results\(^2\) is

\[ HI = T - 0.9971e^{0.02086T} \left[ 1 - e^{0.0445(D - 57.2)} \right] \]  

(2)

where \( T \) and \( D \) are the temperature and dew point in °F.

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• Heat index not significant unless temperature exceeds 80°F and relative humidity is greater than 40%.

• Heat index can actually be less than the air temperature for temperatures near 80°F under dry conditions. This is due to evaporative cooling.

• Some assumptions:
  o Person is walking at a speed of 1.4 m/s (about 3 mph).
  o Clothing type and % of body coverage are specified and held constant. No variations for time of day, latitude, culture, etc.
  o No wind
  o In full sunshine (no correction for latitude or time of day).
  o Core body temperature is not constant, but varies depending on temperature.
  o As with wind chill equivalent temperature, the heat index assumed a ‘typical’ person, with no variability.

HEATING AND COOLING DEGREE DAYS
• Assume no heating or cooling if temperature is 65°F.

• Find difference between daily mean temperature $\overline{T}$ and 65°F

\[
\delta = \overline{T} - 65°F
\]  
(3)

• Every 1°F difference is a heating degree day if negative, or a cooling degree day if positive.

• Heating and cooling degree days are added up for the year, and are used to estimate energy consumption for heating or cooling a building.