**ESCI 241 – Meteorology**
**Lesson 5 – Surface Temperature**

## 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**
    - **min/max thermometers record min and max temp**
  - **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 <u>after</u> 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]**

[1] From Osczevski, R. and M. Bluestein, 2005: 'The new wind chill equivalent temperature chart', *Bull. Amer. Meteor. Soc.*, **86**, 1453-1458

$$WCT = 35.74 + 0.6215T - (35.75 - 0.4275T)V^{0.16} \quad \textbf{(1)}$$

**where *T* is Fahrenheit temperature and *V* is wind speed in mph.**

- **Calculates the effects on a person's exposed facial skin.**
- **Numerous assumption 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**

$$\begin{aligned} HI = {} & -42.379 + 2.04901523 \times T + 10.14333127 \times RH \\ & - .22475541 \times T \times RH - .00683783 \times T^2 \\ & - .05481717 \times RH^2 + .00122874 \times T^2 \times RH \\ & + .00085282 \times T \times RH^2 - .00000199 \times T^2 \times RH^2 \end{aligned} \quad \textbf{(2)}$$

**where *T* is temperature in °F, and *RH* is relative humidity in percent.**

- **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:**
  - **Person is walking at a speed of 1.4 m/s (about 3 mph).**
  - **Clothing type and % of body coverage are specified and held constant. No variations for time of day, latitude, culture, etc.**
  - **No wind**
  - **In full sunshine (no correction for latitude or time of day).**
  - **Core body temperature is not constant, but varies depending on temperature.**
  - **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 $\bar{T}$ and 65°F**

$$\delta = \bar{T} - 65°\text{F} \qquad \textbf{(3)}$$

- **Every 1° 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.**