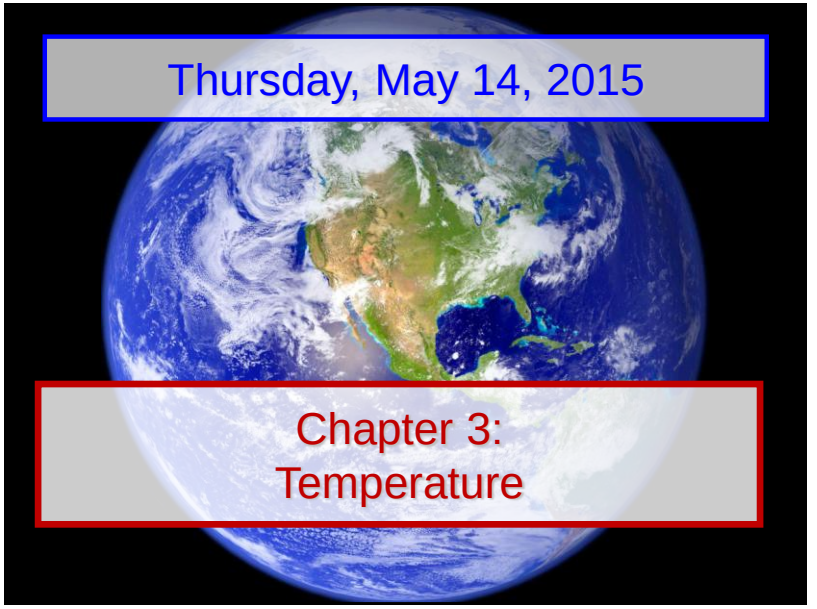


Chapter 3: Temperature

- Using Temperature Data
- Mapping Temperature
- Controls of Temperature
- World Temperatures
- Cycles of Air Temperatures
- Applications of Temperature
- Urban Heat Island

Temperature Data

- Daily Mean Temperature
- Daily Temperature Range
- Monthly Mean Temperature
- Annual Mean Temperature
- Annual Temperature Range

Temperature Data Formulas

Daily Mean Temperature	Total 24 Hourly Readings / 24 or Daily Max + Daily Min / 2
Daily Temperature Range	Daily Max – Daily Min
Monthly Mean Temperature	Total Daily Means / # Days
Annual Mean Temperature	Total Monthly Means / 12
Annual Temperature Range	Max Monthly Mean – Min MM

Let's have some math fun!

Day	Daily Min	Daily Max	Daily Mean	Daily Range
1	45	65		
2	44	67		
3	50	69		
4	55	72		
5	44	55		
6	45	60		
7	50	60		
8	51	68		
9	55	65		
10	44	61		

	Monthly Mean
Jan	22
Feb	26
Mar	30
Apr	35
May	42
Jun	58
Jul	60
Aug	68
Sep	48
Oct	40
Nov	36
Dec	28

Annual Mean Temp	

Annual Temp Range	

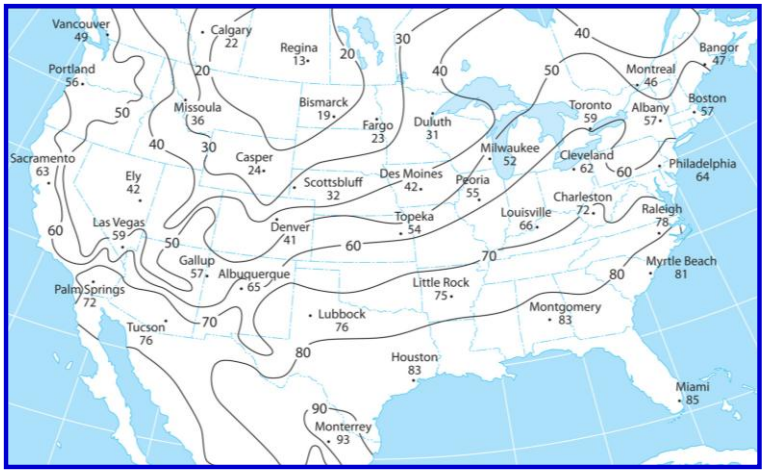
Mapping Temperature

- **Isotherm: Lines of equal temperature**
  - **Iso = Equal**
  - **Therm = Temperature**

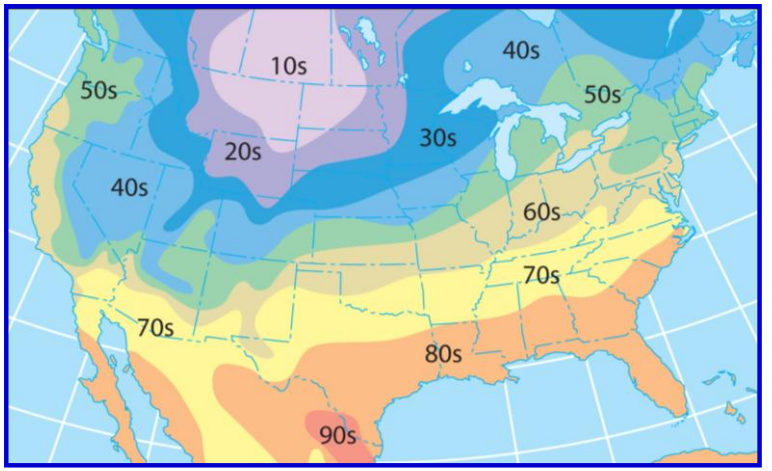
  Standard "look" of a weather map showing temperatures

- **Temperature Gradient: Temperature change per unit of distance**
  - **Closely spaced lines equal rapid rate of change**
  - **Widely spaced = slow temp change**

Isotherm Map



Isotherm Map



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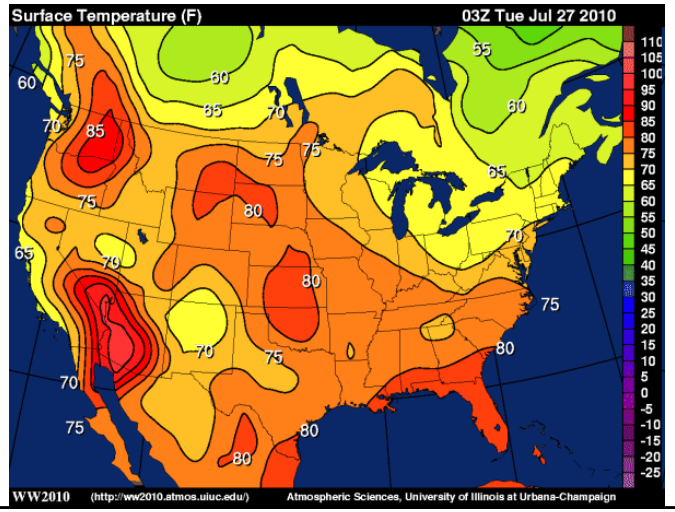


Controls of Temperature

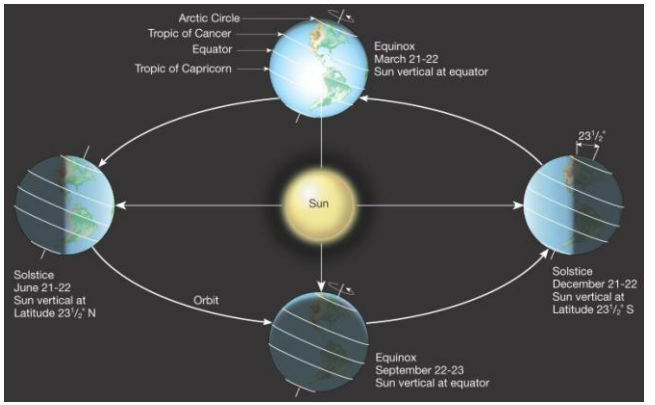
1) Earth/Sun Relationship
   a) Sun Angle
   b) Length of Day
2) Differential Heating of Land and Water
   a) Specific Heat
   b) Amount Heated
   c) Conduction vs. Convection
   d) Evaporation
3) Ocean Currents
   a) Transfer of Heat
   b) Warm and Cold Currents
4) Altitude
   a) Environmental Lapse Rate
5) Cloud Cover
   a) Day / Night
6) Albedo
   a) Reflection
7) Geographic Position
   a) Combination of influences

Controls of Temperature

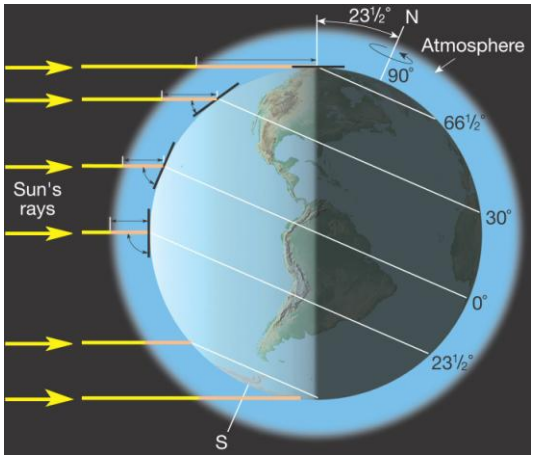
1)Earth/Sun Relationship

- **a) Sun Angle**
- **b) Length of Day**

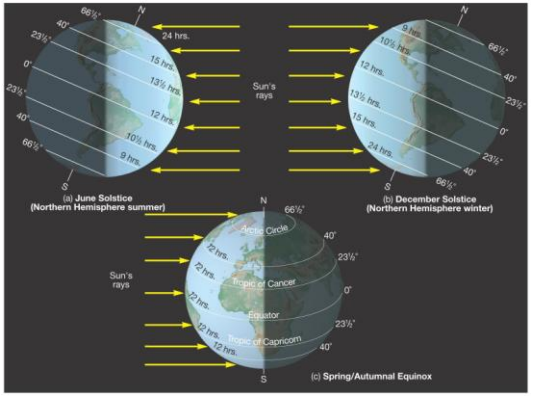
Earth-Sun Relationship: Seasons



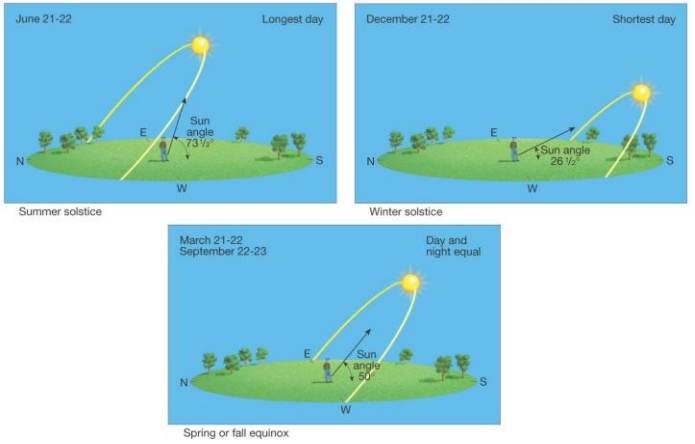
Earth-Sun Relationship: Axial Tilt



Earth-Sun Relationship: Seasons and Axial Tilt



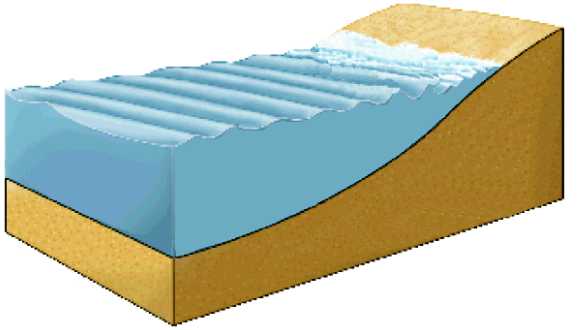
Earth-Sun Relationship:
Sun Angle (Northern Hemisphere)



Controls of Temperature

2) Differential Heating of Land and Water

- **a) Specific Heat**
- **b) Amount Heated**
- **c) Conduction vs. Convection**
- **d) Evaporation**



Differential Heating of Land and Water

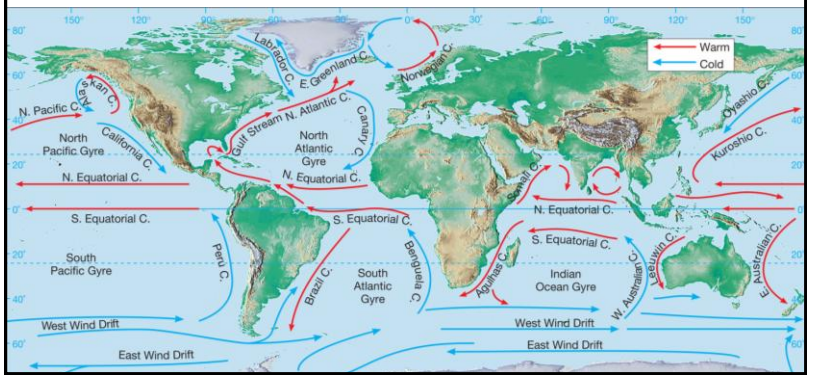
Differential Heating of Land and Water

Controls of Temperature

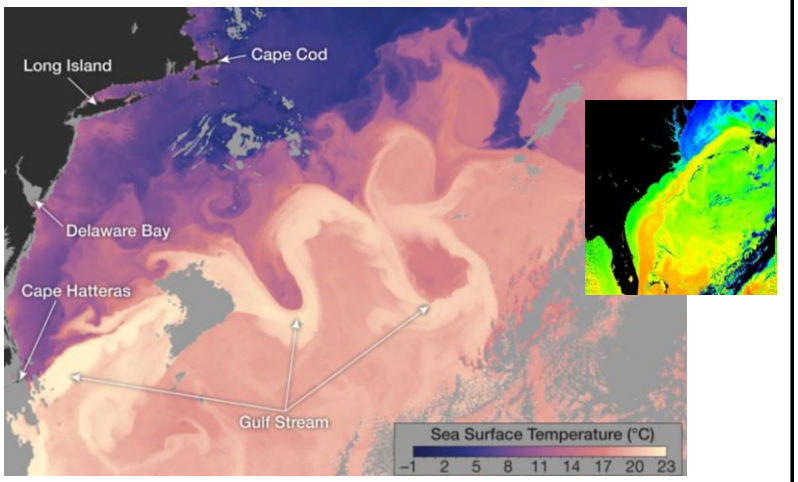
3) Ocean Currents

a) Transfer of Heat

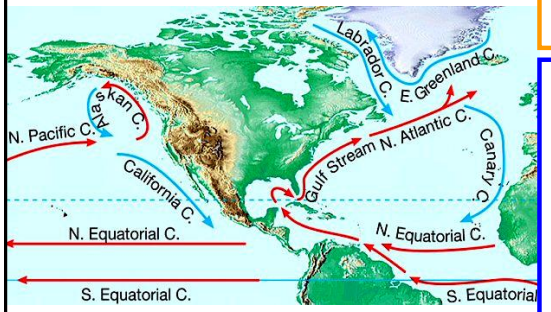
b) Warm and Cold Currents



Ocean Currents



Ocean Currents:
The currents effecting North America



TEMPERATURES
RED → Warm Current
BLUE → Cold Current

- Alaska Current (W)
- Alaska Current (C)
- North Pacific Current
- California Current
- North Equatorial Current
- South Equatorial Current
- Labrador Current
- East Greenland Current
- Gulf Stream
- North Atlantic Current
- Canary Current

Controls of Temperature

4) Altitude

a) Normal Lapse Rate

- **Formulae**
  - **3.5° f / 1000 ft**
  - **6.5° c / 1000 m**

Controls of Temperature

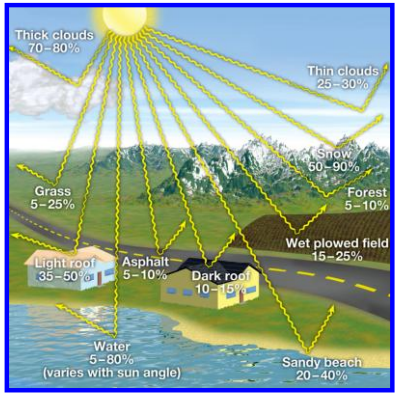
5) Cloud Cover

a) Day / Night

Controls of Temperature

6) Albedo

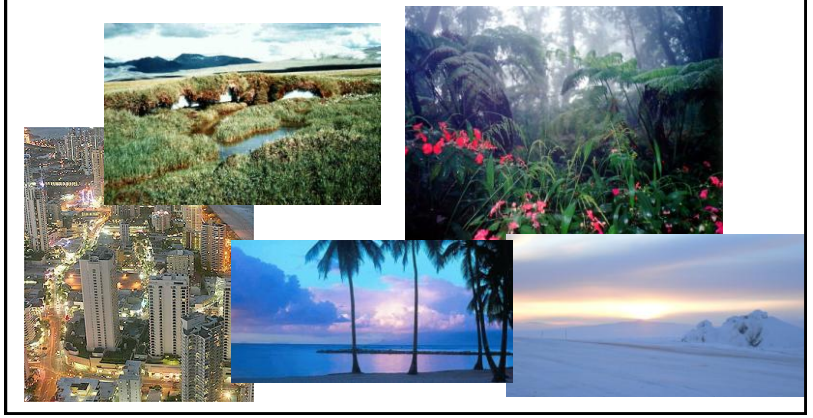
a) Reflection



Controls of Temperature

7) Geographic Position

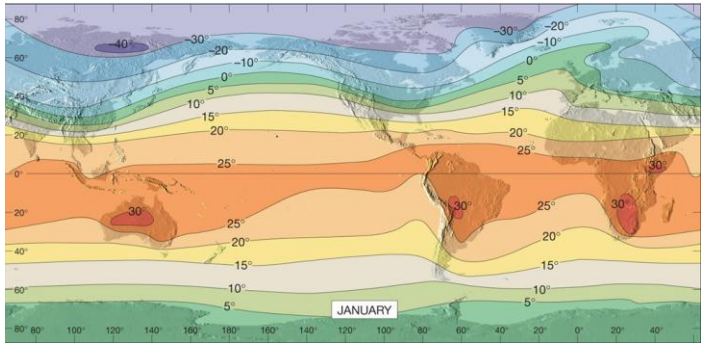
a) Combination of influences



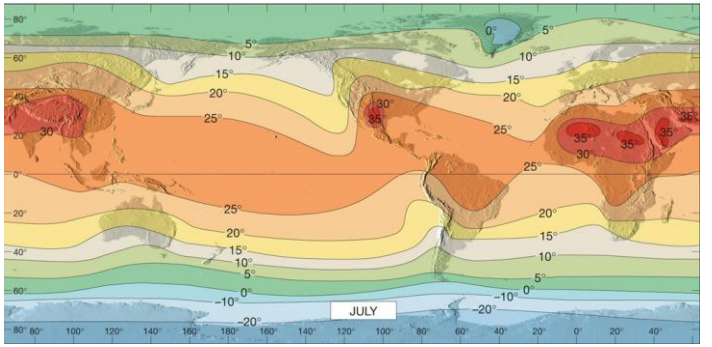
World Temperatures

- **Seasonal Difference**
- **Annual Temperature Range**
- **Northern vs. Southern Hemispheres**

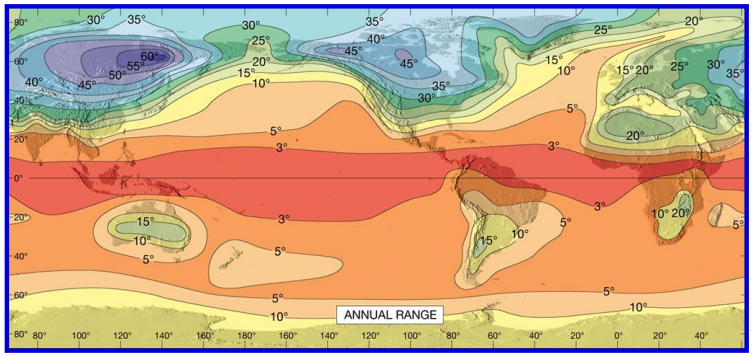
World Temperature: January



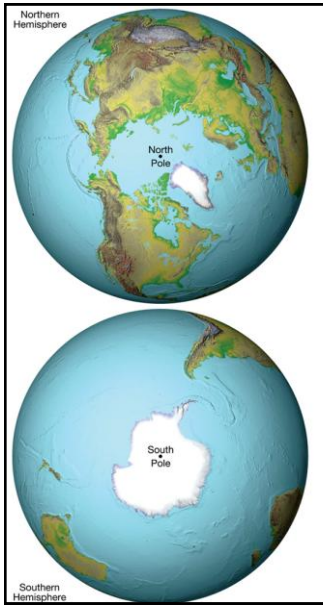
World Temperature: July

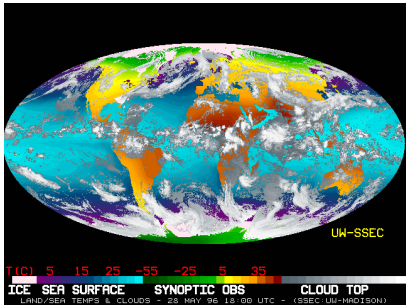


World Temperature Range



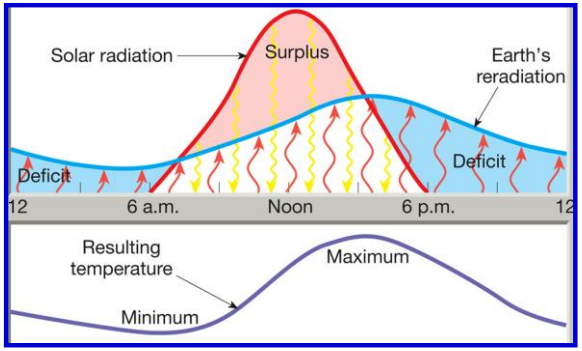
World Temperatures



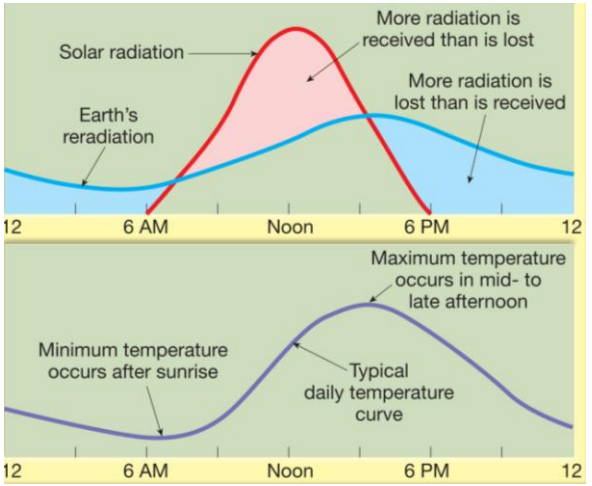


Cycles of Air Temperature

- **Daily March of Temperature**
- **Annual March of Temperature**
- **Lag of the MAXIMUM**

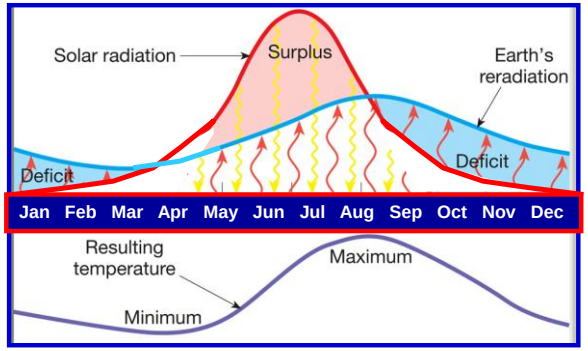


Cycles of Air Temperature



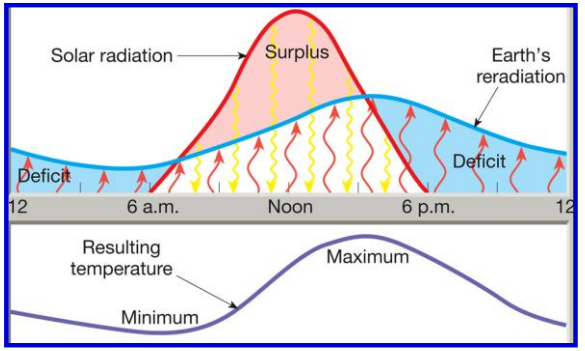
Cycles of Air Temperature

- Daily March of Temperature
- Annual March of Temperature
- Lag of the MAXIMUM



Cycles of Air Temperature

- Lag of the MAXIMUM
  - Surplus continues to exceed deficit until 2:00-3:00 pm
  - Max daily temperature → 2:00-3:00 pm
  - Max annual temperature → late July - early August



Applications of Temperature

1. Heating Degree Days
2. Cooling Degree Days
3. Growing Degree Days
4. Temperature and Comfort
   a) Heat Stress
   b) Wind Chill

Heating Degree Days

- Heating needed up to 65°
- HDD = extra needed to reach 65°
- Example: The mean temperature = 51°
  65° - 51° = 14° or 14 HDDs
- Usually we total degree days for a monthly, seasonally or annual measure
- Heating degree days is a good measure for energy consumption in an area

Cooling Degree Days

- Cooling needed to reach 65°
- CDD = reduction needed to reach 65°
- Example: The mean temperature = 83°
  83° - 65° = 18° or 18 CDDs
- Usually we total degree days for a monthly, seasonally or annual measure
- Cooling degree days is a good measure for air conditioning energy use

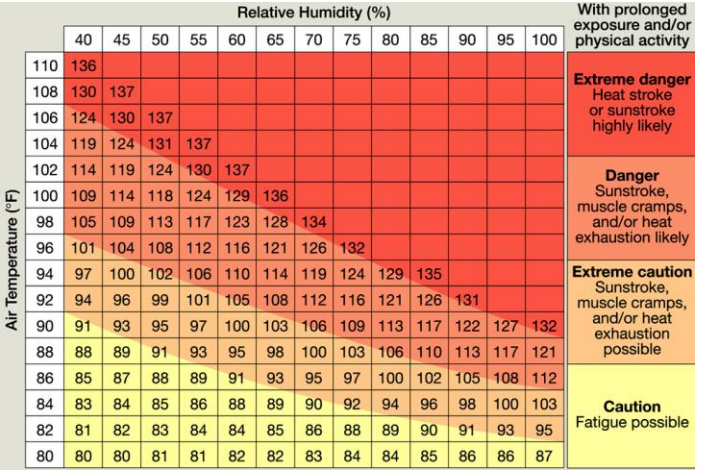
Growing Degree Days

- A "Base" temperature for each crop is determined (min temp for growth)
- GDD = temp diff needed to reach 'base'
- Example: Sweet corn base temp = 50°
  If the temp is 75°
  75° - 50° = 25° or 25 GDDs
- Starting each season, you add these GDDs
- Each crop will have a target GDD total, when reached, it should be ready to harvest

Temperature and Comfort

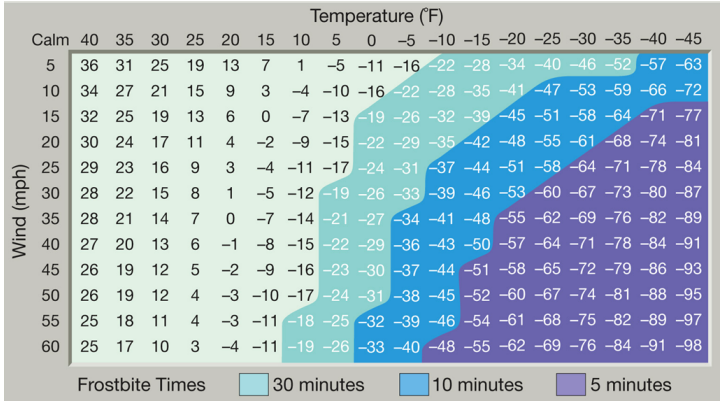
- **Our bodies are susceptible to factors (besides actual temperature) that effect how it "feels" outside**
  - **Relative humidity**
  - **Wind**
  - **Solar Radiation**
- **Heat Stress**
  - **High humidity → less evaporation from skin**
  - **Hot & Humid (muggy) "feels" warmer**
- **Wind Chill**
  - **Wind penetrates clothing → less insulation**
  - **Higher winds "feels" colder**

Heat Stress



Air Temperature (°F)	40	45	50	55	60	65	70	75	80	85	90	95	100
110	136												
108	130	137											
106	124	130	137										
104	119	124	131	137									
102	114	119	124	130	137								
100	109	114	118	124	129	136							
98	105	109	113	117	123	128	134						
96	101	104	108	112	116	121	126	132					
94	97	100	102	106	110	114	119	124	129	135			
92	94	96	99	101	105	108	112	116	121	126	131		
90	91	93	95	97	100	103	106	109	113	117	122	127	132
88	88	89	91	93	95	98	100	103	106	110	113	117	121
86	85	87	88	89	91	93	95	97	100	102	105	108	112
84	83	84	85	86	88	89	90	92	94	96	98	100	103
82	81	82	83	84	84	85	86	88	89	90	91	93	95
80	80	80	81	81	82	82	83	84	84	85	86	86	87

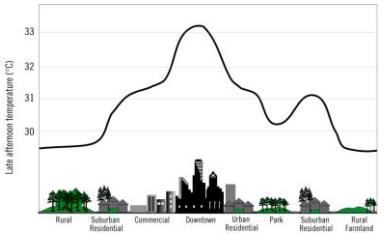
Wind Chill

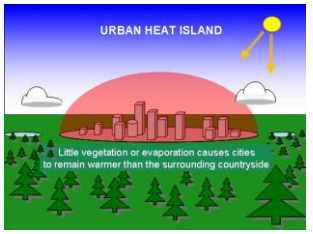


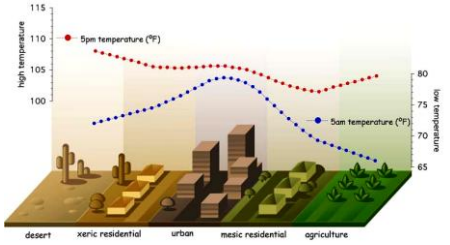
Urban Heat Islands

- **Temperatures within cities are higher than temperatures in surrounding areas**
  - **Building materials absorb, and store, more heat energy**
  - **Less permeable surface area = faster rain runoff = less evaporation**
  - **“Waste Heat” from human energy use**
  - **“Blankets” of pollution trap more heat**

Urban Heat Islands







Urban Heat Islands