Written Assignment 2 Solutions

NATS 101, Sec. 13. Fall 2010

1. The principal factor causing the occurrence of seasons is the Earth's obliquity, or the tilt of the Earth with respect to its orbital plane. The obliquity causes the zenith angle of the sun and the length of day to change (except at the equator) over the course of a year, affecting the net amount of solar radiation received at Earth's surface.

2. Barrow, Alaska, located north of the Arctic Circle is at much higher latitude than Tucson, Arizona. Hence, the zenith angle of the sun in Barrow is much larger than for Tucson (i.e. the sun is very near the horizon all day in Barrow and much higher in the sky in Tucson), even though the day is 24 hours in length. As a result of the increase in the zenith angle of the sun in Barrow, the sun's radiation is much weaker because sunlight has to travel a longer distance through the atmosphere during the course of which it gets more diffuse and more attenuated by gases.

3. In the western U.S., small temperature changes can cause major changes in soil moisture. Because the sun is always located to the south at solar noon in the northern hemisphere, hills that face south receive much more sunshine causing greater rates of evaporation resulting in slightly drier soil conditions. So, the northward facing, shadowed side of a mountain has dense areas of vegetation, while the sunlight south facing side has relatively sparse vegetation. This will hold true for all mountains in the Northern hemisphere. The reverse would be true in the southern hemisphere, as the sun would always be located to the north at solar noon, for example in countries like Argentina and Chile were the Andes are located.

4. Standing in a westward facing Arizona backyard in summertime, you would see the sun set in the northwest. Therefore it would be best to plant a tree to the northwest of the house directly in the path of the direct sunlight to provide the maximum amount of shade.

5. The Cotton region shelter box is elevated to help minimize the effect of the ground on the air temperature reading. During a clear, calm day (night), the temperature would increase (decrease) rapidly near the ground. It is painted white on the sides to reflect solar radiation, so it will not be absorbed by the box.   It has vents to allow circulation of air inside it, further minimizing the absorption of infrared radiation emitted from the walls of the box. The most ideal place to locate the shelter box would be in a open field, far away from large sources of infrared radiation, for example urban surfaces like asphalt parking lots or a concrete buildings.

6. Although the incoming solar radiation decreases in intensity after noon, it still exceeds outgoing longwave radiation emitted from the surface for a time. The maximum temperature occurs when the incoming solar radiation is equal to the outgoing longwave radiation emitted by the surface of the earth. Hence, maximum temperature typically occurs in mid to late afternoon on a day with clear, calm conditions.

7. Clouds absorb the terrestrial radiation emitted by the Earth's surface and re-emit it back to the Earth's surface, thus preventing the more of the energy emitted from the surface from escaping into space. The surface temperature thus typically rises at night when a cloud passes overhead in calm conditions.

8. It is necessary to minimize the effect of low temperatures and freezing conditions in order for grapes to successfully grow. During clear, calm nights, because the surface of the Earth cools by radiational cooling, the air temperature tends to decrease rapidly near the surface. The denser, colder air near the surface sinks into the valleys, making them colder than the surrounding hillsides. Hence, grapes are typically planted on the hillslopes rather than relatively colder valleys.

9. The difference in climate between the two cities is due to land and water distribution. Because water has a high specific heat capacity, relative to land, bodies of water heat and cool much slower than land. The climate of cities near the ocean, like Seattle, is thus substantially moderated, so winters are much milder as compared to comparable cities in the interior of continents at the same latitude, like Fargo.

10. The dew point temperature is the temperature to which air would have to be cooled (with no change in air pressure or moisture content) for saturation to occur. The difference between the air temperature and the dew point temperature gives an indication of the relative humidity. When the air temperature and dew point are relatively far apart the relative humidity is low. When the air temperature is equal to the dew point temperature, the air is completely saturated and the relative humidity is 100%.

11. When outside air is brought indoors on a cold winter day it gets heated. Though the vapor pressure in the air (the actual amount of moisture in the air) stays exactly the same, the saturation vapor pressure (the amount of moisture the air can potentially hold) increases, as the latter is solely a function of temperature. It is the therefore the increase in saturation vapor pressure decreases the relative humidity.

12. Swamp (or evaporative) coolers work on the principle that evaporation of water vapor cools the atmosphere, as this process consumes energy from the surrounding environment. In Arizona, due to its hot and dry climate evaporation takes place easily and swamp coolers work very efficiently. However, in Southeast U.S, the summer climate is quite humid and it is difficult to evaporate more water vapor into the atmosphere because it is already close to being saturated. The process of sweating from the human skin works on exactly the same principle!

13. (a). Oklahoma city
    (b). Atlanta
    (c). Least water vapor: Oklahoma City; Most water vapor: Atlanta.
    (d) Relative humidity is given as the ratio of actual vapor pressure (e) to saturation vapor pressure (e_s). It is expressed in percentage.

    RH = (e / e_s) * 100%

    Atlanta –
    T = 90F -> es = 48.1mb
    Td = 75F -> e = 29.6
    RH = (29.6 / 48.1)*100% = 61.54%

Baltimore –
T = 80F -> es = 35
Td = 70F -> e = 25
RH = (25 / 35)*100% = 71.43%

Oklahoma City –
T = 70F -> es = 25
Td = 65F -> e = 21
RH = (21 / 25)*100% = 84%

14. Omitted because not yet covered in class lectures
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