

Name: _____

NATS 101 Introduction to Weather and Climate, Section 54, Fall 2005
Homework #2: Due at beginning of lecture Thursday, 6 October 2005.

1. When a water droplet forms in a cloud, is heat energy *taken from* or *released into* the air around it? Explain your answer. [5]

When a water droplet forms water vapor is condensing onto CCN, going from a gas to a liquid phase. This phase change releases latent heat into the environment.

2. Which would have a greater impact on the greenhouse effect, removing all the CO₂ from the atmosphere or removing all the H₂O? Explain your answer. (Hint: see Fig. 2.9 in your book.) [5]

Removing all the H₂O would have a greater affect on the greenhouse effect. This is because there is more water vapor than CO₂ in the atmosphere, and because H₂O absorbs across a broader range of the IR spectrum than CO₂.

3. Why is the daily temperature range less on days with low (stratus) clouds than on days with high (cirrostratus) clouds? (Hint: which cloud is colder?) [5]

Stratus clouds are more reflective (have a higher albedo) than cirrostratus clouds, reflecting more radiant energy from the sun during the day from hitting the surface. Therefore, stratus clouds keep daytime maximum temperatures cooler than cirrostratus clouds. Cooler daytime highs reduce the daily temperature range.

Stratus clouds are also warmer (lower) than cirrostratus clouds so they emit more IR radiation than cirrostratus clouds. Therefore, stratus clouds also keep daytime minimum temperatures warmer than cirrostratus clouds by trapping more IR radiation and sending it back to earth. Warmer nighttime lows also reduce the daily temperature range.

4. How is it that air in the Arctic can have a higher relative humidity than air in the desert of Arizona but contain less water vapor? [5]

Arctic air is colder than desert air. Colder air saturates at a lower temperature so less moisture is required to have a high relative humidity in the Arctic than in the desert. The example in the book shows that Arctic air can have 100% RH with a -2°C dew point (low moisture content), while the desert can have 16% RH but have a dew point of 5°C (higher moisture than the -2°C dew point). (p.85)

5. Describe the following cloud types and indicate at what level(s) they are observed in the atmosphere: [18]

a. Cumulus

Cumulus clouds have a puffy, cotton-like appearance with a flat base. The vertical development varies depending on the weather conditions. Generally, however, cumulus clouds are not very high. They are in the category of vertically developed clouds.

b. Stratus

Stratus clouds are very uniform in appearance and scatter and reflect a great deal of sunlight giving them a dark appearance when observed from the surface. These are low clouds, and are found between the surface and 2 km.

c. Cirrus

Wispy clouds appearing as long streamers. Very thin. Found from 5-13 km. These are considered high clouds.

d. Cumulonimbus

A cumulonimbus cloud is a vertically developed (mature) cumulus cloud. These clouds are dark at the base, and extend like tall puffy towers often to the tropopause level. They are always associated with heavy rain, and may also be associated with thunder and lightning, hail, and tornados. Like cumulus clouds, these clouds are in the clouds with vertical extent class. They always have a base at low levels but extend into the region of high clouds.

e. Altostratus

A blanket-like cloud that covers all or a large portion of the sky. Sun is generally not visible through these clouds except for a dim, round disk. These clouds are found between 2 km and 7 km and are considered middle level clouds.

f. Cirrocumulus

Puffy clouds generally cellular in appearance, with cells occurring individually or in rows. Can have a rippled appearance if several cells are together. These clouds are found from 5-13 km and are considered high clouds.

6. Why do you see your breath on a cold morning? (Hint: you cannot see water vapor only liquid water droplets.) [5]

When your breath leaves your mouth it is warm and moist. This breath mixes with the outside air and cools. The lower temperature causes condensation (saturation vapor pressure is reduced increasing relative humidity) which is visible as fog. This is an example of mixing fog. (p. 93)

7. Under which set of conditions would you expect laundry hanging out on a line to dry most quickly? [5]

	<u>Air Temperature (°F)</u>	<u>Relative Humidity</u>	<u>Wind Speed (MPH)</u>
a.	60	75%	20
b.	40	75%	20
c.	60	50%	20
d.	40	50%	10
e.	60	75%	10

8. Why are evaporative coolers popular in Arizona? Why are they *not* as popular during the summer months (monsoon season)? (Hint: Is evaporation a heating or a cooling process?) [6]

Arizona is a desert. Deserts have very dry air. Evaporative coolers work by forcing air over a pool of water. By evaporating water into the air, the air is cooled. They are not as effective during the summer monsoon because the air is humid, and therefore not as much moisture can be evaporated into the air.

9. Which of the following is *not* conserved as a parcel is raised *dry* adiabatically? [5]

- a. mixing ratio
- b. absolute humidity
- c. heat content
- d. relative humidity

10. The percentage of water vapor in the air relative to saturation is [5]

- a. mixing ratio
- b. absolute humidity
- c. relative humidity
- d. specific humidity

11. A high water vapor pressure indicates [5]

- a. a relatively large number of water vapor molecules in the air
- b. a relatively small number of water vapor molecules in the air
- c. a relatively high rate of evaporation
- d. an abundant supply of condensation nuclei in the air

12. Which of the following would cause relative humidity to decrease? [5]

- a. cooling the air
- b. warming the air
- c. increasing the actual water vapor pressure
- d. decreasing the saturation water vapor pressure

13. As the air temperature increases, with no addition of water vapor to the air, the dew point will [5]

- a. remain the same
- b. increase
- c. decrease
- d. increase and become equal to the air temperature

14. The term “cirro” tells you something about a cloud’s [5]

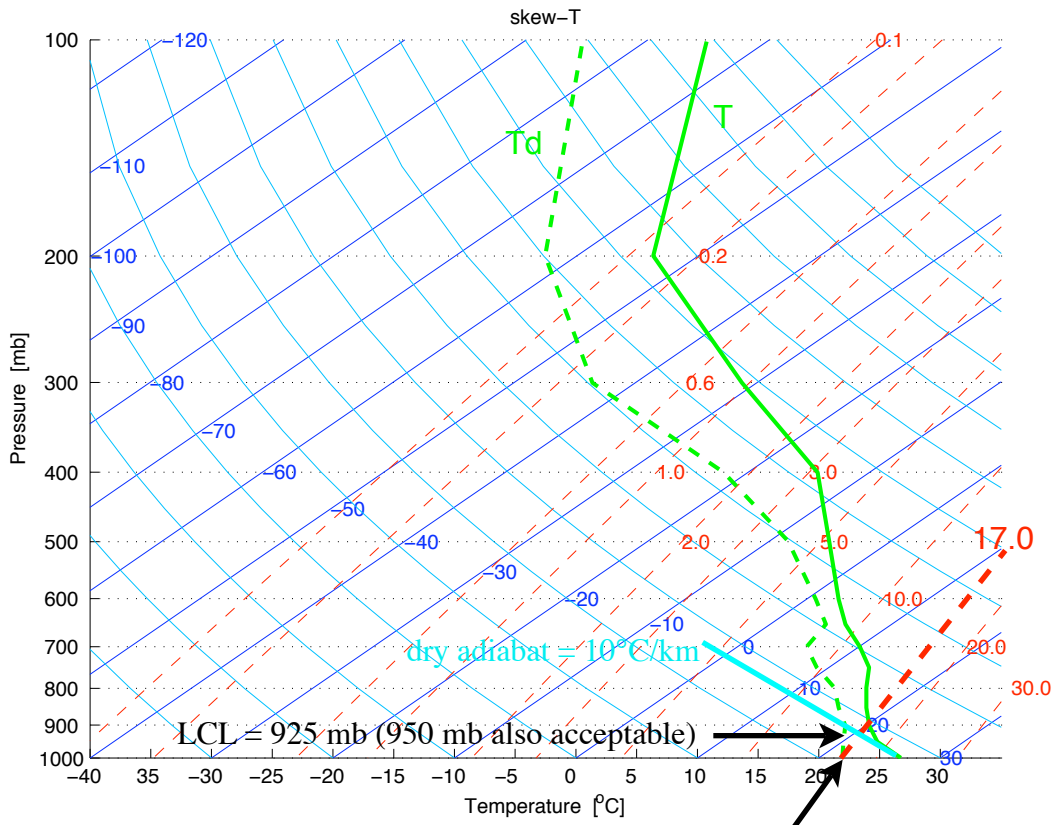
- a. composition
- b. appearance
- c. altitude
- d. motion

15. Which cloud types are associated with rain? What term in their name refers to rain? [5]

Nimbostratus and cumulonimbus. ‘nimbus’ refers to rain.

16. Use the following data to plot the environmental temperature profile on the blank skew-T form provided. Also plot the environmental dew point profile. What is the surface mixing ratio? At what level (in mb) is the condensation level?

Pressure (mb)	Air Temperature (°C)	Dew Point (°C)
1000	26.7	21.9
950	22.9	20.1
902	20.3	18.3
851	17.9	15.6
803	15.8	13.0
750	13.7	9.2
701	10.1	5.7
652	6.2	4.6
602	2.7	0.8
502	-4.7	-8.0
400	-14.3	-22.0
300	-31.2	-43.5
200	-53.7	-62.6
100	-74.5	-84.7



surface $m_r = 17 \text{ g/kg}$ (anywhere from
15 g/kg - 18 g/kg is acceptable)