Homework #4
SOLUTIONS

1)

Since there are only TWO ways to change the relative humidity, there are only two physical processes that can generate fogs. A fog may form as a result of the air cooling to its dewpoint temperature, or it may form if water vapor is added to the air as liquid water evaporates (or frozen water sublimates) into unsaturated air. When warm, moist air flows over a cold surface (such as a snow surface), that air is cooled. Since the air is advected northward over the snow surface, we refer to this type of fog as *advection fog*.

2)

The relative humidity (RH) is defined as either

RH = mixing ratio / saturation mixing ratio

or

RH = vapor pressure / saturation vapor pressure.

In either expression, the ratio describe the actual amount of water vapor *relative* to the total possible amount at the given temperature and pressure. Thus, an RH value of 90% in January means simply that the air on such a day has 90% of the total possible water vapor it could have at the temperature and pressure on that day. The same is true regarding the RH value of 65% for the July day.

Since warm air has a greater capacity for water vapor than cold air, it is very likely that 90% capacity on a cold day means alot less actual water vapor than does 65% capacity on a hot July day. Thus, the actual vapor content, which can be measured by the absolute humidity, defined as

Absolute Humidity = mass of water vapor / volume of air that contains it

is almost certainly greater on the July day.

3)

In your home, upon stepping out of the shower, the dewpoint depression is 10. Upon stepping out of the pool at Palm Springs, CA, the dewpoint depression is 38! This difference indicates that the air in Palm Springs is much drier (has a much lower relative humidity) than the air in your bathroom. Liquid water is covering your body in both cases but is much more readily evaporated in Palm Springs than in your bathroom because the air in Palm Springs is so much drier. When the liquid water evaporates it cools your skin and therefore if it evaporates quickly (as in Palm Springs) it will result in a dramatic cooling of your skin. Thus, you would feel alot cooler in the Palm Springs case despite the higher air temperature.

EXTRA CREDIT:

The problem involves determining the VOLUME of water involved in covering the surface of the Earth with a 1" deep layer. We begin by calculating the surface area of the (nearly) spherical Earth. The surface area of a sphere is given by

$$Area = 4\pi R^2 = 4\pi(6{,}370{,}000 \; m)^2$$

We can express the radius of the Earth (a large number) in scientific notation as 6.37×10^6 m. When we do this, the surface area of the Earth becomes

$$Area = 4\pi(6.37 \, x10^6 \, m)^2 = 5.1 x10^{14} \; m^2$$

or just over 500 trillion square meters!! If we then multiply this AREA by the depth of the water (1" is equal to .0254 m) the we have the VOLUME of water involved.

$$Volume = Area \, x \, Depth = (5.1 x10^{14} \; m^2) \, x \, (.0254 \, m) = 1.29 \, x10^{13} \; m^3$$

or 12.9 trillion cubic meters. Now, since you know the density of liquid water, we just multiply this VOLUME by the density (which is mass/volume) to get the mass of water involved;

$$Mass = Volume \, x \, Density = (1.29 \, x10^{13} \; m^3) \, x \, (1000 \, kg/m^3) = 1.29 \, x10^{16} \; kg$$

Since a 1 kg mass weighs nearly 2.2 lbs, this translates to about 14 trillion tons of water!!