When temperatures climb into the 90s with high humidity levels (dew points in the 70s) you’re likely to hear someone say something like: “The air is really heavy today.” Or, maybe, given today’s delightfully low humidity, you might think the air seems particularly light.

But the assumption that humid air is heavier than dry air is wrong.

In very hot, humid weather you might feel the air is heavier because moving around seems to take more energy than on dry days. Sticky days probably feel “heavier” because heat and high humidity slows the evaporation of perspiration, your body grows hotter and this saps your strength.

You might also say: “Water is heavier than air.” True, a glass of liquid water weighs more than a glass filled only with air. But, humidity is water vapor, not liquid water, and water vapor molecules are lighter than the molecules of nitrogen and oxygen that make up approximately 99% of the atmosphere.

At this stage you could argue: “It doesn’t make any difference that water molecules are lighter than those of oxygen and nitrogen. The water molecules are being added to the oxygen and hydrogen in the air, which makes it heavier.”

You’d be wrong. To see why, we need to go back to 1811 and the work of the Italian scientist Count Lorenzo Romano Amedeo Carlo Avogadro (1776-1856), who hypothesized that equal volumes of gasses at the same temperature and pressure contain equal numbers of molecules.

His hypothesis took a while to be confirmed and accepted by scientists, but by 1860 Avogadro’s law was a bedrock of chemistry as it still is.

In other words, when water molecules evaporate into a cubic foot of air an equal number of other molecules will leave that particular cubic foot of air. Remember, we’re talking about air that can freely move in the atmosphere, it’s not sealed in a bottle.

Each molecule of water that evaporates into a particular parcel of air as vapor will replace a molecule of either nitrogen or oxygen, which account for roughly 99 percent of the air’s gasses. Nitrogen in the air (with two atoms in each molecule) has a
molecular weight of 28 and the oxygen molecules (also two atoms per molecule) a molecular weight of 32.

Water vapor molecules, which are one oxygen atom with a weight of 16 and two hydrogen atoms each with a weight of 1, add up to a molecular weight of 18, which is much lighter than the nitrogen and oxygen they displace when they evaporate into air.

For example, at both 3:52 and 4:52 p.m. on July 19, 2013, the temperature at National Airport was 94 degrees and the dew point 74 degrees. This combination made the air’s density 0.0708 pounds per cubic foot, or in the metric system, 1.134 kilograms per cubic meter.

On a very dry day with the same 94-degree temperature and atmospheric pressure as on the 19th, but a dew point of only 50 degrees, the air’s density would have been 0.0712 pounds per cubic foot or 1.141 kilograms per cubic meter.