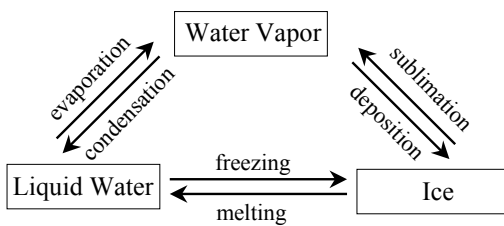


Chapter 5
Atmospheric Moisture

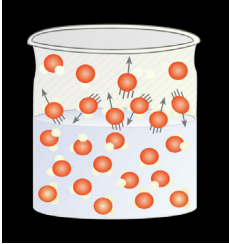
Measures of Humidity

1. Absolute humidity
2. Specific humidity
3. Actual vapor pressure
4. Saturation vapor pressure
5. Relative humidity
6. Dew point

Phases of Water

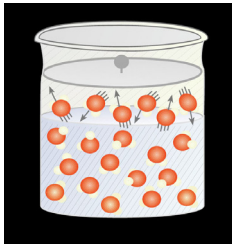


Coexistence of Water & Vapor



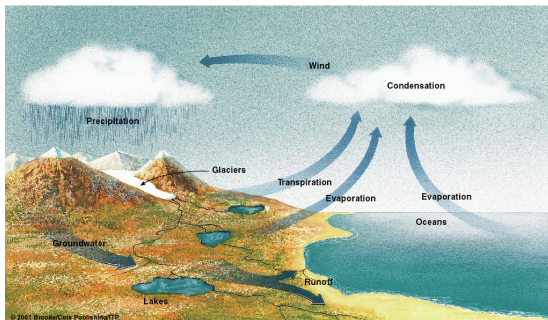
- Even below the boiling point, some water molecules leave the liquid (evaporation).
- Similarly, some water molecules from the air enter the liquid (condense).
- The behavior happens over ice too (sublimation and condensation).

Saturation

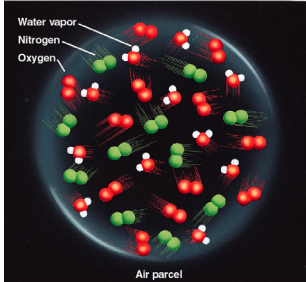


- If we cap the air over the water, then more and more water molecules will enter the air until saturation is reached.
- At saturation there is a balance between the number of water molecules leaving the liquid and entering it.
- Saturation can occur over ice too.

Hydrologic Cycle



Air Parcel



- Enclose a volume of air in an imaginary thin elastic container, which we will call an air parcel.
- It contains oxygen, nitrogen, water vapor, and other molecules in the air.

1. Absolute Humidity

$$\text{Absolute humidity} = \frac{\text{Mass of water vapor}}{\text{Volume of air}}$$

Parcel Size	Mass of H ₂ O Vapor	Absolute Humidity
2 m ³	10 g	5 g/m ³
1 m ³	10 g	10 g/m ³

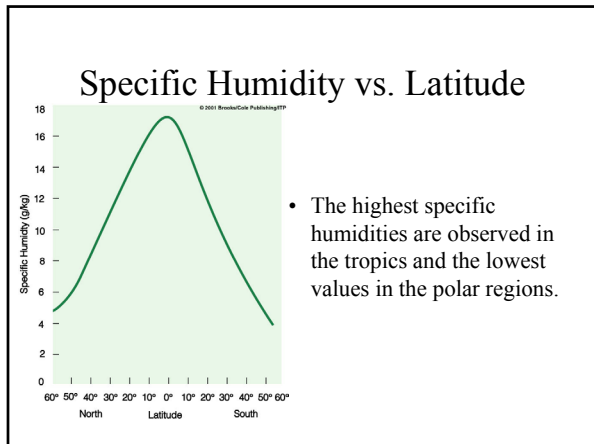
The absolute humidity changes with the volume of the parcel, which can change with temperature or pressure.

2. Specific Humidity

$$\text{Specific humidity} = \frac{\text{Mass of water vapor}}{\text{Total mass of air}}$$

Mass of Parcel	Mass of H ₂ O Vapor	Specific Humidity
1 kg	1 g	1 g/kg
1 kg	1 g	1 g/kg

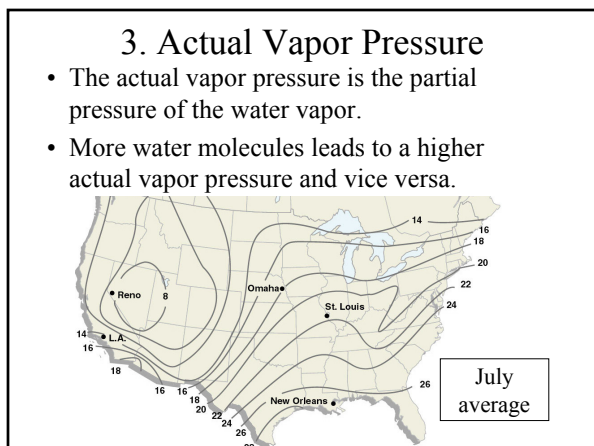
The specific humidity does not change with parcel volume.



Vapor Pressure

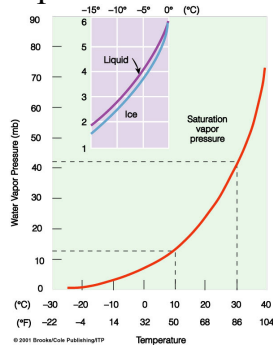
- The total pressure inside a parcel is due to the collisions of all the molecules against the wall of the parcel.
- Dalton's Law: The total pressure is thus due to the sum of the pressures of each gas:

Molecule	Percentage	Partial pressure
Nitrogen	78%	780mb
Oxygen	21%	210mb
Water vapor	1%	10mb
Total	100%	1000mb



4. Saturation Vapor Pressure

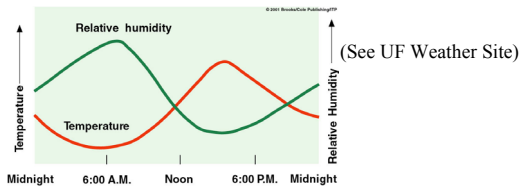
- The saturation vapor pressure is the partial pressure of water vapor when the air is saturated.
- Warm air can hold more water vapor than cold air before saturating.



5. Relative Humidity

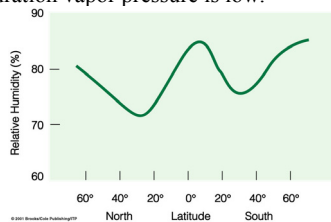
$$\text{Relative humidity (RH)} = \frac{\text{Actual vapor pressure}}{\text{Saturation vapor pressure}} \times 100\%$$

The relative humidity depends on both the water vapor content and the air temperature.



Relative Humidity vs. Latitude

- The relative humidity is high near the equator because the actual vapor pressure is high.
- The relative humidity is high near the poles because the saturation vapor pressure is low.



Dew Point

- Since cold air can hold less moisture than warm air, as we cool the air it will eventually become saturated.
- The dew point is the temperature at which the air becomes saturated.
- The dew point is determined with respect to a flat surface of water.
- If a flat surface of ice is used instead, it is called the frost point.

Dew Point Examples

- The larger the difference between the dew point and the temperature, the lower the relative humidity.



←
T = -2°C
Dew pt. = -2°C
RH = 100%



→
T = 35°C
Dew pt. = 5°C
RH = 16%

Humidity in the Home (Heating)

- Cold air outside is warmed.
- Even if the air outside has a high relative humidity, it has a low specific humidity.
- When the air is warmed, the specific humidity remains unchanged, but the relative humidity goes down.
- The house will seem dry unless some form of a humidifier is used.

Humidity in the Home (Cooling)

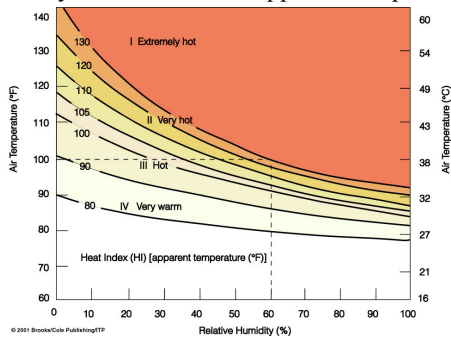
- Warm humid air outside is cooled.
- Cooling increases the relative humidity and eventually the air reaches saturation.
- Water vapor condenses and is carried away, leaving the air with less moisture.
- Consequently, the air in the home has a lower specific humidity than outside and is more comfortable.

Humidity and Discomfort

- The main source of a body's cooling is through perspiration.
- When the perspiration on the skin evaporates, it cools the body (latent heat).
- On dry days the perspiration evaporates quickly, and this is an effective means of cooling.
- On humid days the perspiration evaporates slowly, making it harder to cool off, which can lead to heat exhaustion or heat stroke.

Heat Index

- The heat index combines temperature and humidity to determine the apparent temperature.



Measuring Humidity

- A dry bulb thermometer measures air temperature.
- A wet bulb thermometer has a piece of wet cloth covering it. Because of evaporation it will cool to a lower temperature, called the wet-bulb temperature.
- The difference between the two temperatures is called the wet-bulb depression and can be used to determine relative humidity and dew point (Appendix D).
- A smaller web-bulb depression means a higher humidity.

Summary

- Humidity is a measure of the water vapor content in the air. We have discussed six different measures of humidity:
 - absolute humidity and specific humidity
 - actual vapor pressure & saturation vapor pressure
 - relative humidity and dew point.
- You should understand the differences and similarities between these quantities.
