Monsoon
Global circulation aloft
El Niño
Atmospheric water

Name the surface winds that blow between 0° and 30°
What is the atmospheric pressure at 0°?
What is the atmospheric pressure at 30°?

Name the surface winds that blow between 30° and 60°
What is the atmospheric pressure at 30°?
What is the atmospheric pressure at 60°?

Name the surface winds that blow between 60° and 90°
What is the atmospheric pressure at 60°?
What is the atmospheric pressure at 90°?

Remember: net radiation belts move with seasons
Wind and pressure belts follow this same pattern

Monsoon: seasonal reversal of wind, continental scale
January: dry season
Compare and contrast the monsoon and the land/sea breeze

<table>
<thead>
<tr>
<th>Cycle</th>
<th>Monsoon</th>
<th>Land/Sea</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coverage</td>
<td>Seasonal</td>
<td>Daily</td>
</tr>
<tr>
<td>Wind</td>
<td>Complete reversal of wind direction</td>
<td>Reversal of relative surface pressure</td>
</tr>
<tr>
<td>Pressure</td>
<td>Reversal of relative temperature</td>
<td>Unequal heating of land and water</td>
</tr>
</tbody>
</table>

Atmospheric pressure “aloft” determines flow “aloft”

- **Surface Pressure**
  - Weight of column of air above
- **If really cold air, might be high pressure at surface**
- **If really warm air, might be low pressure at surface**

Jet Streams

- **Polar Easterlies**
- **Subtropical Easterlies**
- **Hadley Cell**
- **Westerlies**
- **Trade winds**
- **Polar Jet**
- **Subtropical Jet**
- **Tropopause**

ENSO = El Niño Southern Oscillation

SEA LEVEL ANOMALY (surface cm) and OCEAN TEMPERATURE ANOMALY (color °C) provided by the NOAA-CIRES Climate Diagnostics Center, Boulder Colorado from their Web site at [http://www.cdc.noaa.gov/](http://www.cdc.noaa.gov/).
Normal Conditions December 1993

El Niño conditions December 1997

SST ANOMALIES °C
JAN 05, 1997

Southern Oscillation Index
1950 to 1999

SOI is sea level pressure at Darwin, Australia – sea level pressure at Tahiti
Currently, we are in a mild La Niña phase.

In El Niño year, Atlantic hurricane frequency is low; in La Niña year, frequency is higher.

Water exists in the atmosphere in all three physical states.

Capacity = amount of water vapor air can hold. As temperature increases, capacity increases.
Precipitable water vapor by latitude

Precipitable water vapor (mm) varies with season because temperature is based on insolation

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Capacity = what air can hold
Content = what air does hold
If actual content = capacity, air is saturated.

Can change capacity by changing temperature. If heat saturated air, increase capacity, no longer saturated.

Amount of water in the air, called “HUMIDITY”

Relative humidity = ratio of amount of water vapor in air to amount of water vapor air can hold at that temperature

Relative humidity = content / capacity x 100%

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<table>
<thead>
<tr>
<th>Temperature</th>
<th>10°C</th>
<th>20°C</th>
<th>30°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potential water vapor capacity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Actual water vapor content</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Relative humidity</td>
<td>9/9 = 100%</td>
<td>9/17 = 53%</td>
<td>9/30 = 30%</td>
</tr>
</tbody>
</table>

Relative humidity varies with
1. Availability of moisture
2. Temperature changes for a given amount of water vapor
Processes that put water into the air
1. Evaporation
2. Transpiration by plants

**Evapotranspiration**

**Conditions of Evaporation**

- **Heat Source:** Energy to change water from liquid to vapor
  - Usually comes from the sun
- **Vapor pressure gradient:**
  - Air not saturated
  - Relative low humidity

**Transpiration**

- Plants lose water through their leaves
- Plants take in water through their roots
- Stomates allow CO₂ in, O₂ and H₂O out

\[
6 \text{ CO}_2 + 6 \text{ H}_2\text{O} + \text{ sunlight} = \text{ C}_6\text{H}_12\text{O}_6 + 6 \text{ O}_2
\]

**ACTUAL EVAPOTRANSPIRATION (AE) affected by...**

1. Availability of water
2. Temperature of air
3. Relative Humidity
4. Wind Speed
5. Vegetative cover

Potential evapotranspiration ... PET

the amount of water that would be added to the atmosphere if there were NO LIMITS on the availability of water. Function of 2, 3, 4, and 5 above...mostly related to latitude (insolation).
If cool saturated air, decrease capacity, air becomes over saturated, water vapor has to get out of air, condensation occurs. Temperature at which condensation occurs = DEWPOINT.

CONDENSATION affected by...
1) Relative humidity
2) Degree of cooling
3) Availability of nuclei

**CONDENSATION → DEW AND FROST**
Water vapor condenses or sublimes on a surface

**CONDENSATION → CLOUDS AND FOG**
Water vapor condenses on nuclei

**Types of fog**

(a) Radiation

(b) Advection

(c) Upslope

(d) Evaporation