Admin:
Finish GW image critique
For now, will keep critique as is. Anonymous posting is allowed, but optional.
Resubmissions of images and reports: Welcome!

CLOUDS
Learning Objectives:
1. Be able to identify cloud types
2. Describe air motion and atmospheric stability that govern the appearance of basic cloud types.
3. Interpret weather data with respect to likely clouds, including Skew-T plots and wind soundings.
   Minute paper, individual: What do you already know about cloud types? List, sketch, describe them.

Best clouds physics book, easy read:

Next, (for free)
   Thomas Carney et al., *AC 00-57 Hazardous Mountain Winds and Their Visual Indicators* (Federal Aviation Administration, 1997),

   Other cloud and atmospheric science books available for checkout; my office.
   Office hours 4:30-5:30 Tuesday, 1-3 Friday
   TONS of online info, most is OK.

Following info partially adapted from Mike Baker, local NOAA Weather Service forecaster.
Cloud types depend primarily on atmospheric stability. Need background to understand how.

Layers of the atmosphere:

All weather happens in troposphere. Driven by what happens at 500 mb level.

O$_3$ absorbs sunlight, heats stratosphere.

http://www.windows2universe.org/earth/Atmosphere/stratosphere.html
Minute paper: In your head, 10 km = X miles, = Y thousand feet. Be approximate, 1 sig fig.

Order of magnitude estimates are VERY USEFUL.

<table>
<thead>
<tr>
<th>Polar</th>
<th>Mid-Latitudes</th>
<th>Tropics</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Middle</td>
<td>2000-4000 m</td>
<td>2000 m</td>
</tr>
<tr>
<td>Low</td>
<td>1000-2000 m</td>
<td>1000 m</td>
</tr>
<tr>
<td></td>
<td>(surface-2000 m)</td>
<td>(surface-2000 m)</td>
</tr>
<tr>
<td>colder, denser</td>
<td>Sea level air pressure = uniform worldwide,</td>
<td>shorter atm.</td>
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<tr>
<td></td>
<td>except +/- 2% due to weather (high, low pressure systems)</td>
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Height of atm goes with seasons too; higher in summer with hot air.

Temperature change with altitude in troposphere:
Minute paper in groups: Why is it colder on top of a mountain than at the foot?
Start with pressure profile in atmospheric column: highest at surface, decreases going up. Comes from hydrostatics; gravity balanced by pressure.

Consider a parcel of air (imaginary little cube). Same temperature as its neighbors. Reduce its pressure (surface forces), while allowing no heat transfer. It expands = adiabatic expansion. In expanding, it does work on its neighbors. Loses internal energy; cools. = Conservation of Energy, 1st Law of Thermo. NOT the Ideal Gas Law.

Rising parcels expand and therefore cool. Vice versa is true too; descending parcels get compressed (work is done on them) and warm up.

Pressure profile in the atmosphere
http://www.engineeringtoolbox.com/air-altitude-pressure-d_462.html

Actual temperature profile in the TROPOSPHERE
Comes from sounding data; weather balloons

Modern radiosondes measure or calculate the following variables:
- Pressure
- Altitude
- Geographical position (Latitude/Longitude)
- Temperature
- Relative humidity
- Wind (both wind speed and wind direction)
- Cosmic ray readings at high altitude

Here's what it looks like: SKEW-T
http://weather.uwyo.edu/upperair/sounding.html
YOU will do this for the date of your image
Temperature in °C
Pressure in millibars

Basics: http://www.theweatherprediction.com/thermo/skewt/
Skew T Mastery: https://www.meted.ucar.edu/loginForm.php?urlPath=mesoprim/skewt#

Definitions

NO VERTICAL GRID?

So many lines! How many kinds?

Horizontal blue: Constant pressure
Angled blue: Constant temperature; isotherm. Angle SKEW T
Angle/curve green: Dry adiabat. A dry parcel will follow this temperature line if cooled adiabatically
Angle/curve blue: Moist, saturated adiabatic lapse rate
Purple: Lines of constant mixing ratio; absolute humidity for saturation.
Heavy black: Right line is temperature profile. Left line is dew point
Light black: Adiabat starting at the top of the boundary layer