Admin:
Today: Clouds, 1 of 3 lectures

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 Monday 2-3, ECME 220
TONS of online info, most is OK.
Also, CloudSpotter phone app.

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:

Cloud types depend primarily on atmospheric stability. Need background to understand how.

All weather happens in troposphere. Driven by what happens at 500 mb level.
Minute paper: In your head, 10 km = X miles, = Y thousand feet. Be approximate, 1 sig fig.

O$_3$ absorbs sunlight, heats stratosphere
Warm over cold
Less dense over more dense = STABLE. Hold that thought.

Back to SCALES; how big....

How big is this?

Do you estimate in metric or in English units?

< Minute paper: In your head, 10 km = X miles, = Y thousand feet.
Be approximate, 1 sig fig.

Order of magnitude estimates are VERY USEFUL.
colder, denser shorter atm. Sea level air pressure = uniform worldwide, except +/- 2% due to weather (high, low pressure systems)

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.
*NOT the Ideal Gas Law*

Rising parcels expand, *do work* and therefore cool.

Vice versa is true too; descending parcels get compressed (work is done on them) and warm.
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

72469 DNR Denver

Pressure in millibars

100 |

200 |

300 |

400 |

500 |

600 |

700 |

800 |

900 |

-40 -30 -20 -10 0 10 20 30 40

12Z 14 Feb 2012

University of Wyoming

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

Basics: http://www.theweatherprediction.com/thermo/skewt/

Skew T Mastery: https://www.meted.ucar.edu/loginForm.php?urlPath=mesoprim/skewt#