

## ATSC 5010 – Physical Meteorology I Lab

### Lab 8 – skewT/LogP diagram...

The standard thermodynamic diagram with logP on the y-axis and temperature on the x-axis is the easiest to understand. However, because all of the lines (theta, theta\_e, and mixing ratio) slant the same direction, interpretation and prediction by hand can be more difficult. To mitigate this, atmospheric scientists often use a SkewT/LogP diagram, similar to above except that the temperature scale is skewed to the right with increasing height (decreasing pressure). The affect of skewing the temperature lines increase the angles between lines of potential temperature, equivalent potential temperature, and mixing ratio.

In today's lab we will build a SkewT/LogP diagram, similar to the thermodynamic diagrams we have built in previous labs. You will be able to use bits and pieces of previous labs to aid in your program design. However, note that in all your previous labs, the yaxis was pressure and the xaxis was temperature. Both were 1-dimensional arrays (vectors). The corresponding values of theta, theta\_e, and mixing ratio were 2D arrays with a value for each pressure/temperature combination.

For your SkewT/LogP, your yaxis will remain pressure (a 1-dimensional array) but your xaxis will represent temperature at a certain level (we will choose 1000 mb). We can call this 1-dimensional array `tarr_1000`. So now temperature will be a two dimensional array with a value for each pressure/1000mb\_temperature combination.

#### Exercise:

1. Create your y-axis (pressure) array to range from 100 mb to 1050 mb with 1 mb resolution.
2. Create your x-axis (temperature at 1000 mb) array to range from -40 to +50 C, with 0.1 C resolution.
3. Create your temperature (2D) array:

$$T(T_{1000}, P) = T_{1000} - \left\{ \log \left( \frac{1000}{P} \right) \times (slant\_factor) \right\}$$

where  $T_{1000}$  represents one of the 901 temperatures at 1000 mb (created in step 2),  $P$  represents the pressure, and  $slant\_factor$  represents the 'slantedness' of the temperature lines (greater the number, more the temperature lines are slanted). For this lab we will use a constant slant factor of 80.

You should be able to create your temperature array using a FOR Loop.

4. Create your theta array using your pressure array (from 1) and your temperature array (from 3).
5. Create your mixing ratio array (first compute vapor pressure, then mixing ratio).
6. Create your theta\_e array.
7. Plot your skewT/LogP with the following characteristics:

- a. Pressure range: 100 mb to 1050 mb, pressure on a log scale, pressure gridlines every 100 mb
  - b. Temperature at 1000mb range: -40 C to +50 C, major tickmarks every 10 C, minor tickmarks every 5 C, no gridlines
  - c. Contour of temperature from -90 to +50 C, every 5 C, label every 10 C, thin black line.
  - d. Contour of potential temperature from -30 to +80 C, every 5 C, label every 10 C, thick dark green line
  - e. Contour of equivalent potential temperature using these values (in Kelvin, do not label): 250, 260, 270, 280, 290, 300, 310, 320, 330, 340, 350, 370, 390, 410, 430, 450, 510, 570, 630, 690, 750, 810, 870, thick, dashed dark green line
  - f. Contour of mixing ratio using these values (in g/kg and label every line): 0.02, 0.05, 0.1, 0.25, 0.5, 1, 2, 3, 4, 6, 8, 11, 15, 20, 30, 50, thin red line
  - g. Your plot title should read: "ATSC5010, Lab 9: Skew T/Log-P Chart"
  - h. Your ytitle should read: "PRESSURE (mb)"
  - i. Your xtitle should read: "Temperature/Theta at 1000 mb (C)"
8. *On your SkewT diagram plot the data that is found in the file 'sounding\_lab8.txt' that is linked from the class webpage. You can use the function 'Read\_Sounding' to read in pressure, temperature and dewpoint.*
9. From the sounding answer the following questions (complete this by hand):
- a. What is the temperature and pressure at the LCL?
  - b. If a parcel at the LCL continues to be lifted, does that parcel ever reach its level of free convection? If so, what is the temperature and pressure of the LFC?
  - c. What is the temperature and pressure of the CCL? What is the convective temperature?
  - d. For a parcel that becomes convective by reaching its convective temperature, what is the (approximate) maximum height (pressure level) that this parcel will reach in the atmosphere?
  - e. Estimate from your diagram the maximum temperature difference between parcel and environment achieved for the parcel in (d).

# SkewT - LogP

