AOSC201: Weather and Climate Lab

Week 6: Atmospheric Instability

Section 103/105

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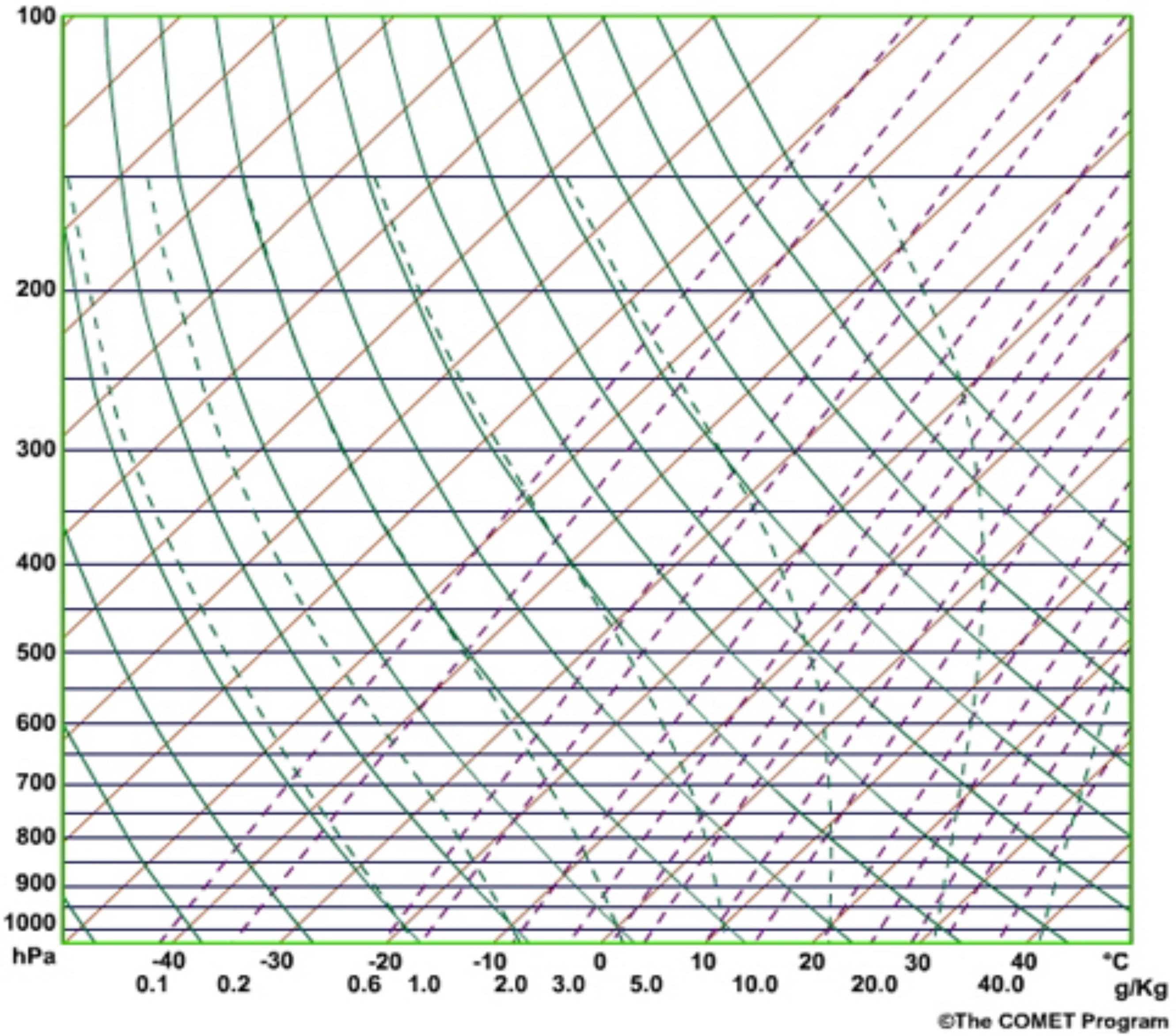
Week 6 Lab: Atmospheric Instability

- Lab #6 of Lab Manual (pages 33-39)
- 50 points in total
- INDIVIDUAL Work for the entire lab

Skew-T diagrams

- *Isobars*
- *Isotherms*
- *Dry adiabats*
- *Moist adiabats*
- *Mixing ratio*

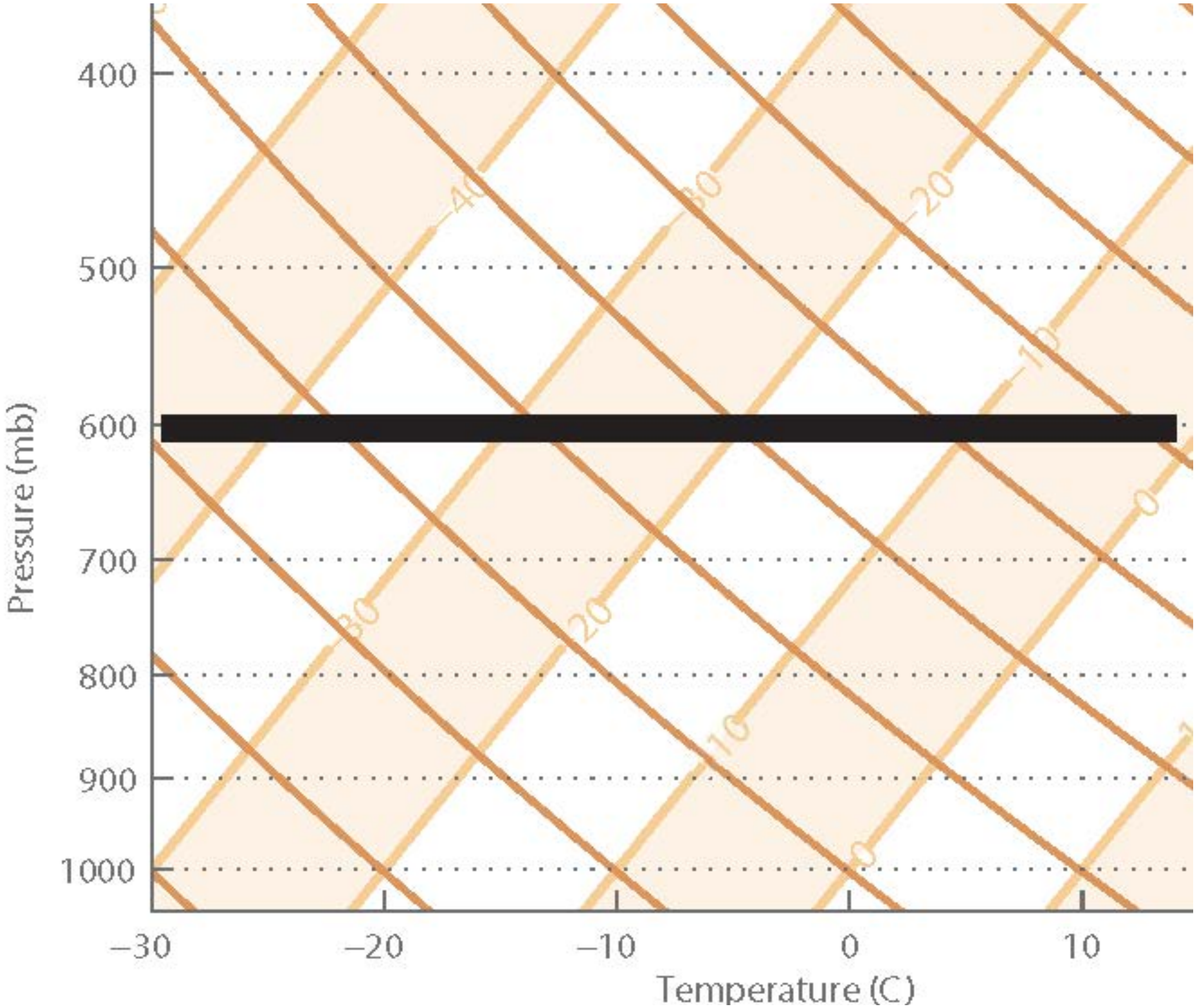


Skew-T diagram: (i) Isobars

- ***Isobars***

- Lines of equal pressure

- Pressure at the surface can be assumed as 1000mb

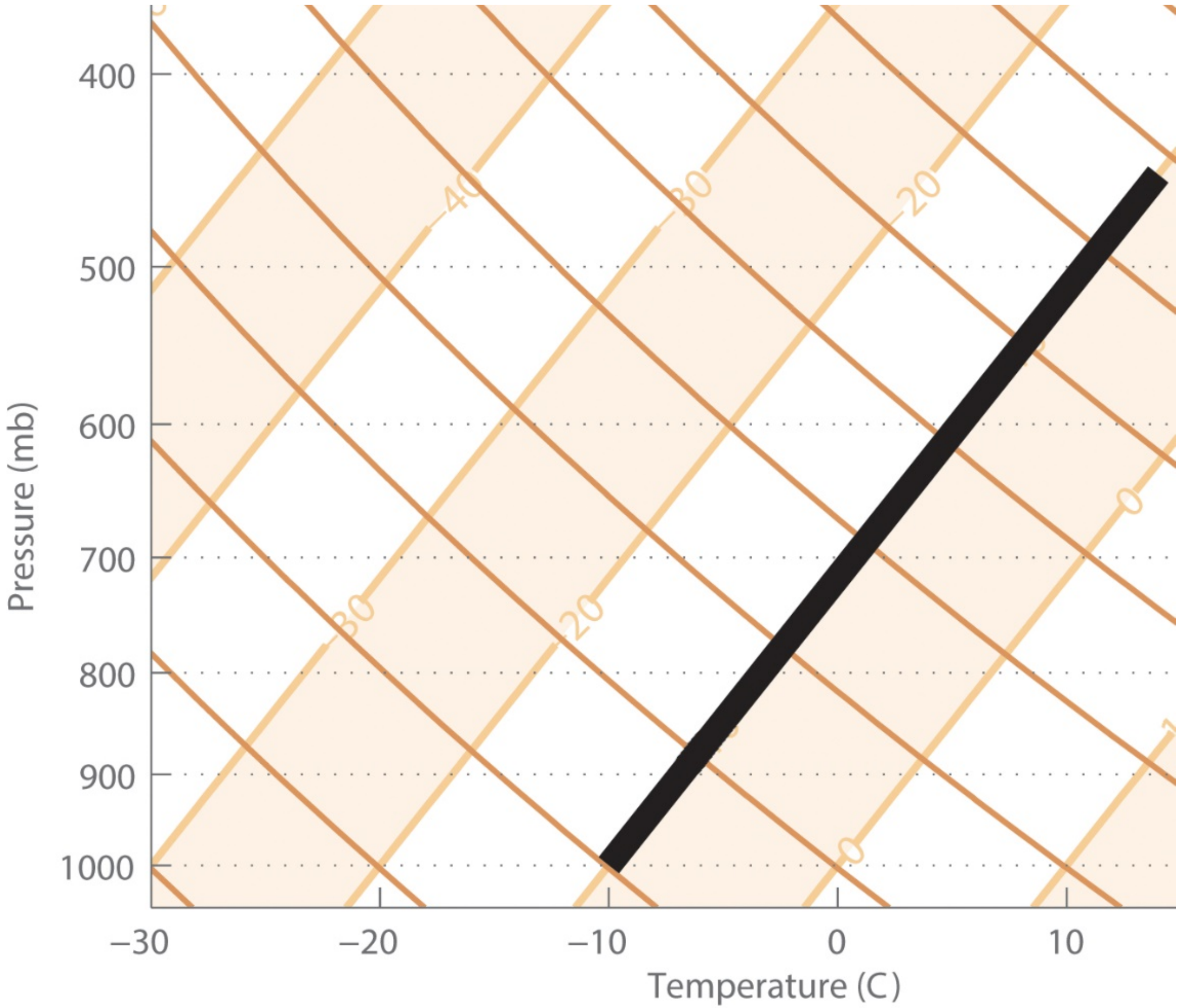


Skew-T diagram: (ii) Isotherms

- ***Isotherms***

- Lines of equal temperature

- Lines are skewed in this case.



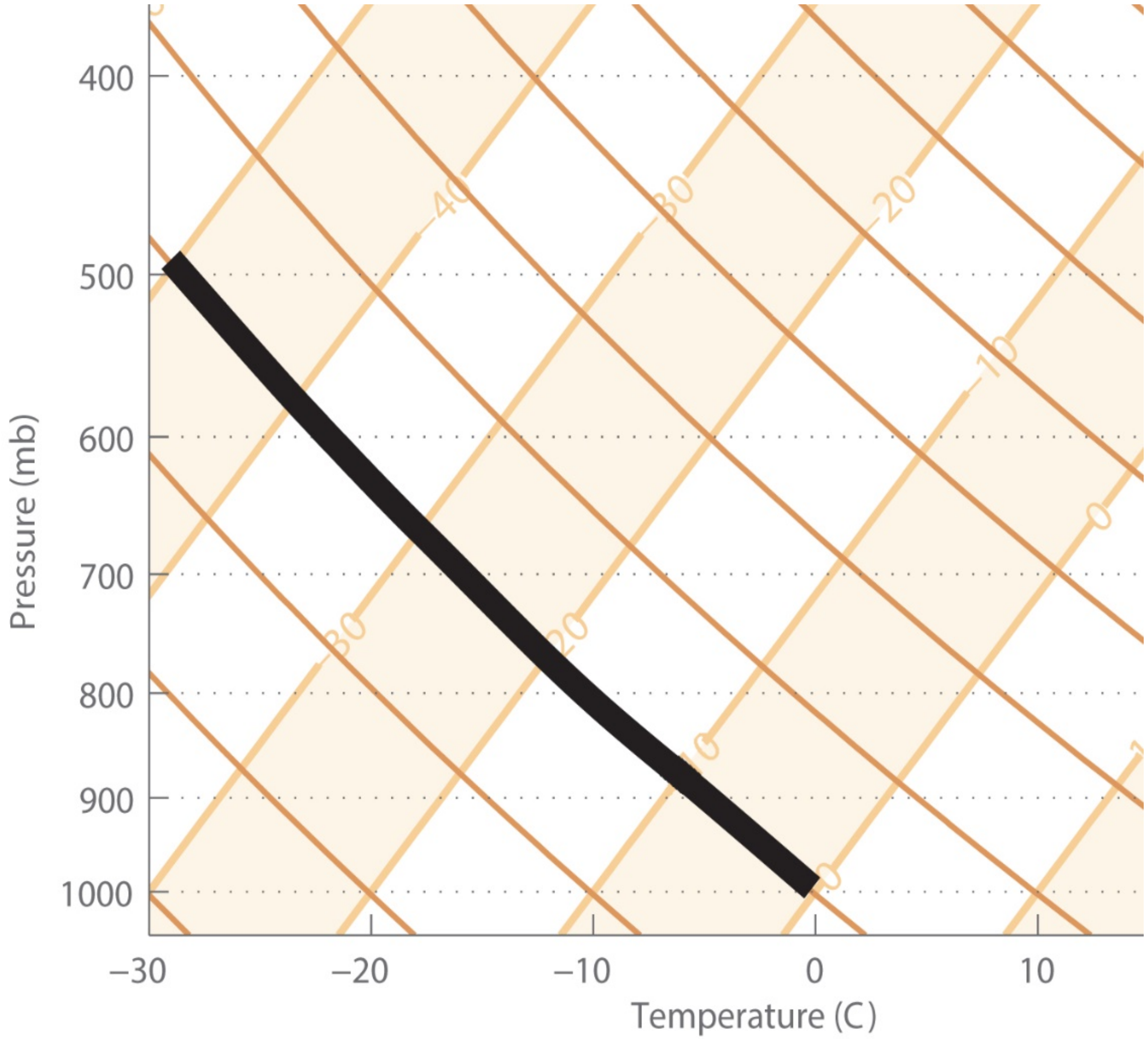
Skew-T diagram: (iii) Dry Adiabats

- ***Dry Adiabats***

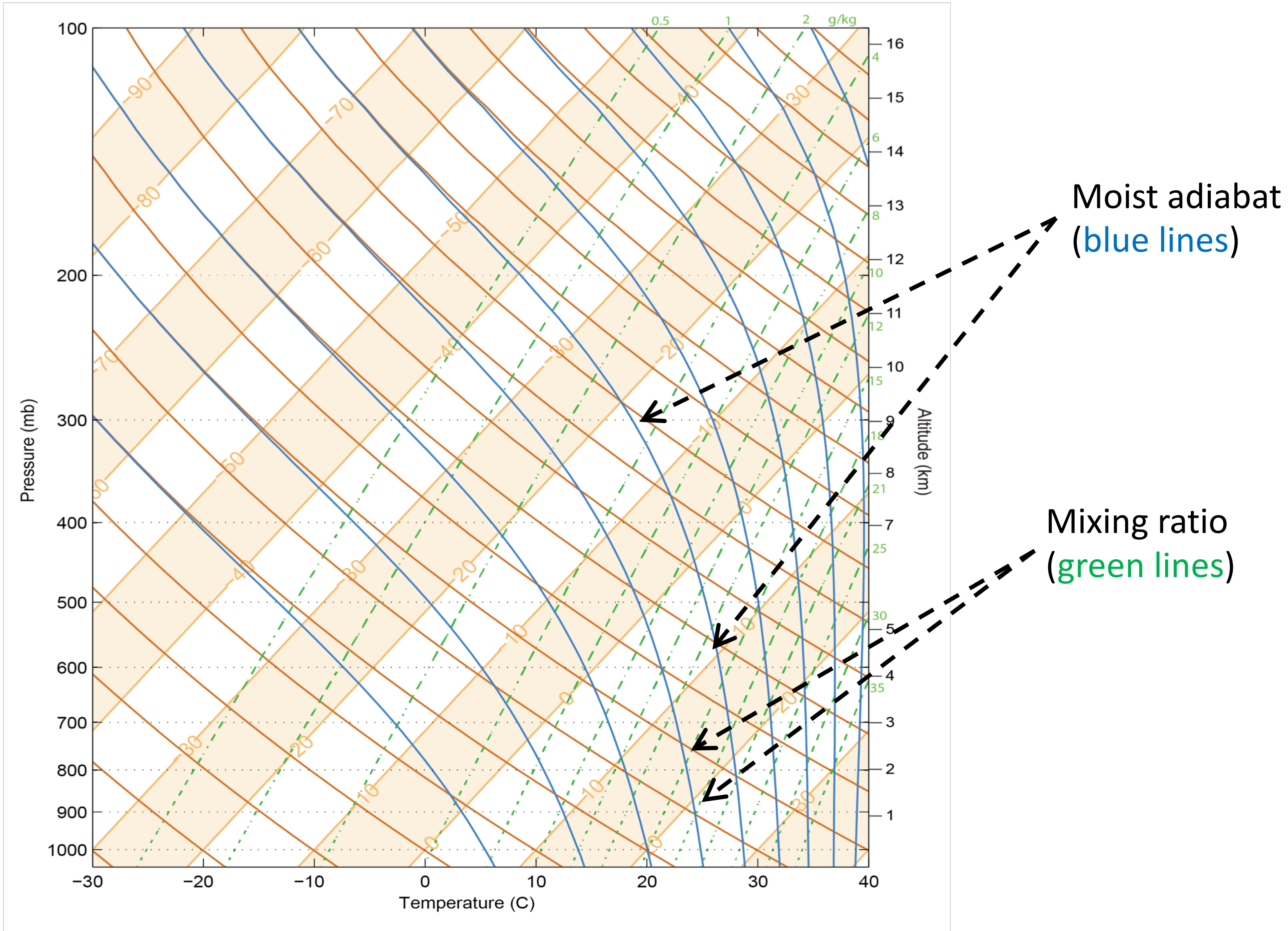
  - Dry adiabatic lapse rate = -10°C per km

  - Rate at which dry air cools with altitude

  - "Adiabatic" means no heat exchange with surroundings

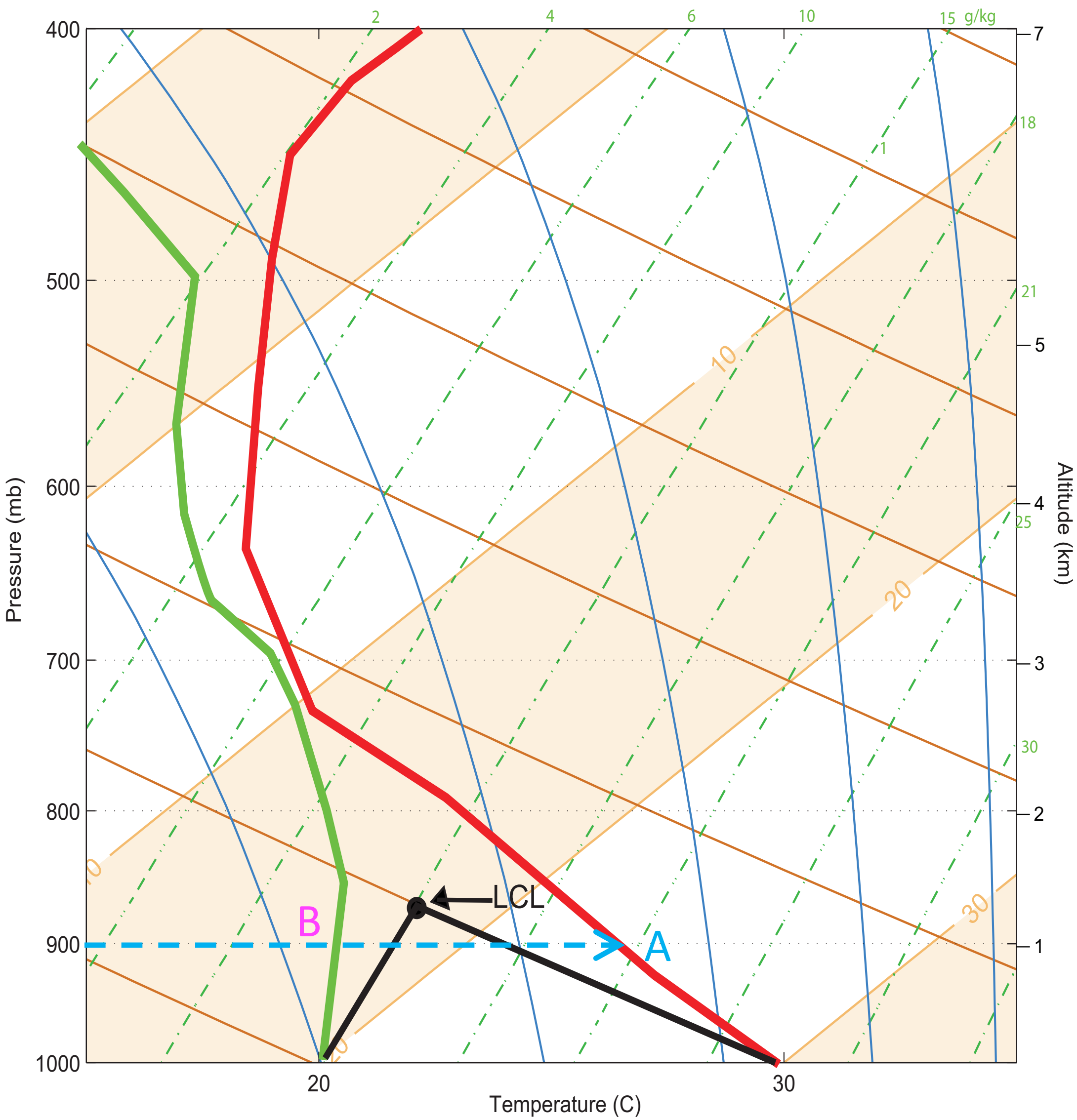


Skew-T diagram: (iv) Moist Adiabat and (v) Mixing ratio



Week 6 Lab: *Atmospheric Instability*

Question 1 – 4 (3 pts each) and Question 5 (1 pt) Directions: *(Use the colored version of Fig. 3 provided here)*



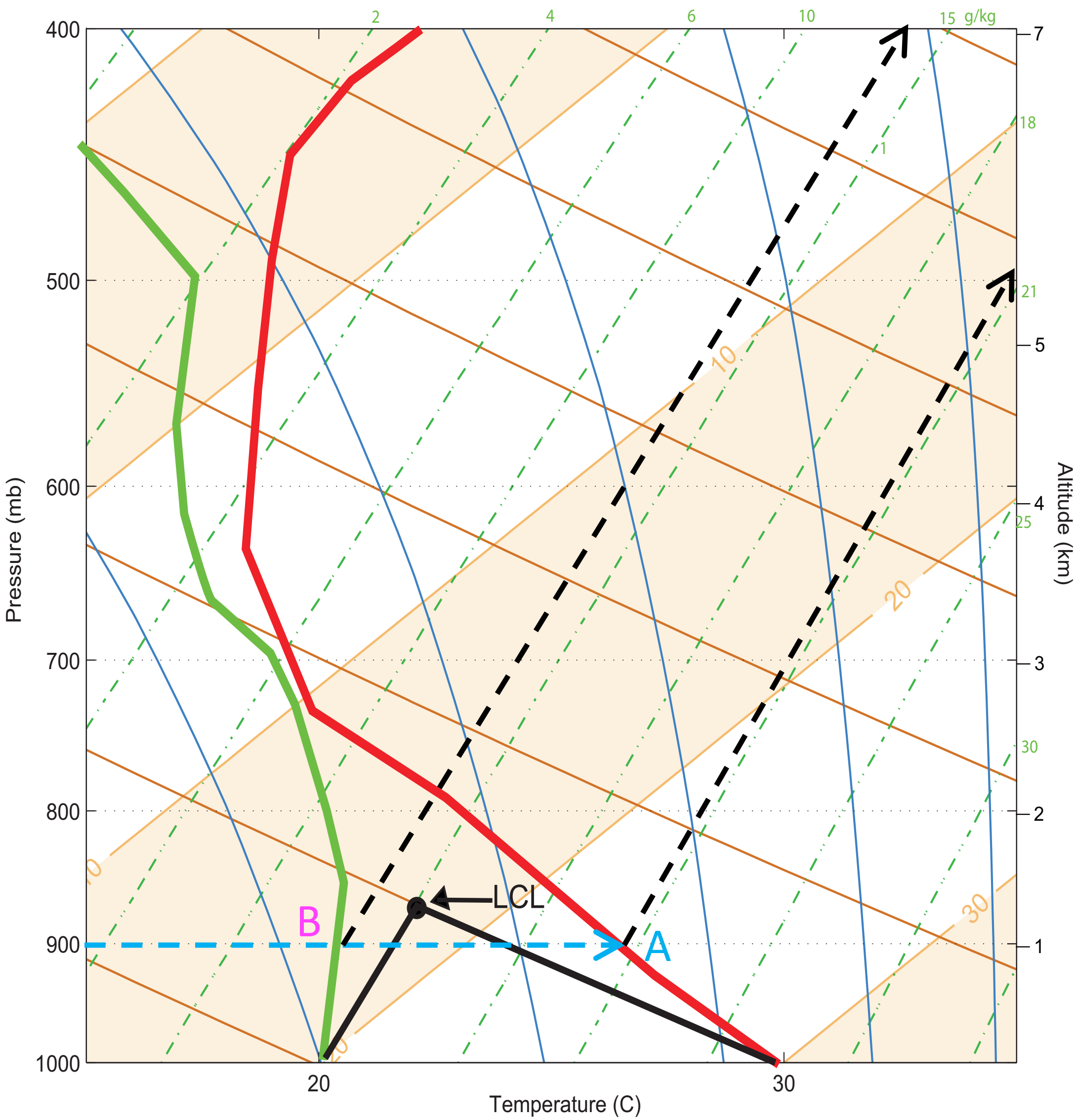
Q. How to find the temperature and dew point at a specific level?

Step 1: Locate where the isobar (say 900 mb) intersects the atmospheric temperature profile (red line). This is point A.

Step 2: Read the temperature at this point from the lines of isotherms (orange slanted lines that go to the right as you go up in altitude). For example, point A is roughly between the 20°C and 30°C isotherms; closer to the 20°C. Thus temperature at 900 mb is roughly 24°C. Similarly, dew point temperature (green line) at 900 mb (point B) is 17°C.

<u>Week 6 Lab: *Atmospheric Instability*</u>

<u>Question 1 – 4 (3 pts each) and Question 5 (1 pt) Directions</u>: *(Use the colored version of Fig. 3 provided here)*



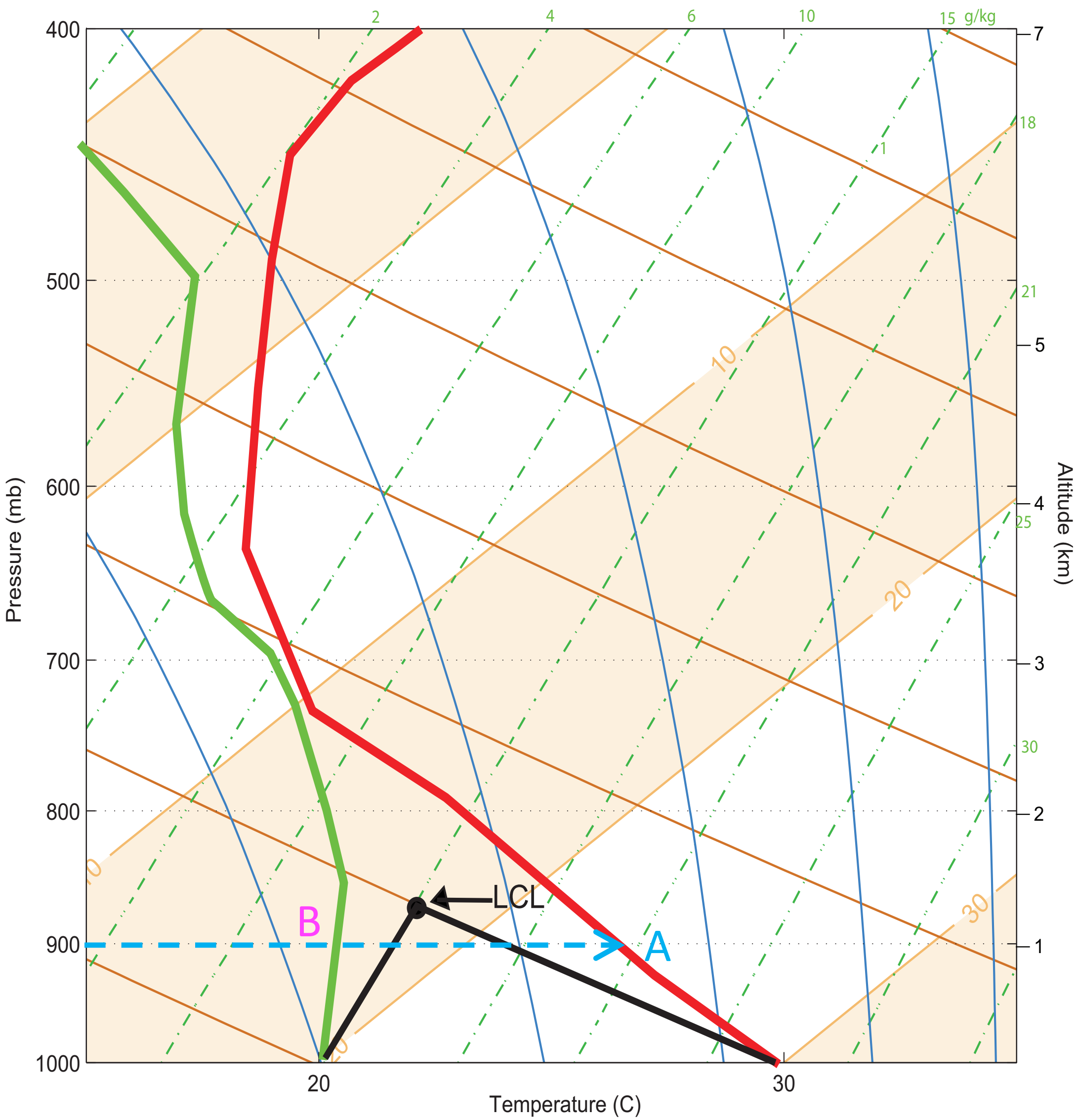
Q. <u>How to find the mixing ratio at a specific level?</u>

<u>Step 1</u>: Locate where the isobar (say 900 mb) intersects the atmospheric temperature profile (red line). This is point A.

<u>Step 2</u>: Read the mixing ratio at this point from the mixing ratio lines (green lines). For example, at point A, the mixing ratio is 20.5 g/kg; at point B, the mixing ratio is 13 g/kg.

Week 6 Lab: *Atmospheric Instability*

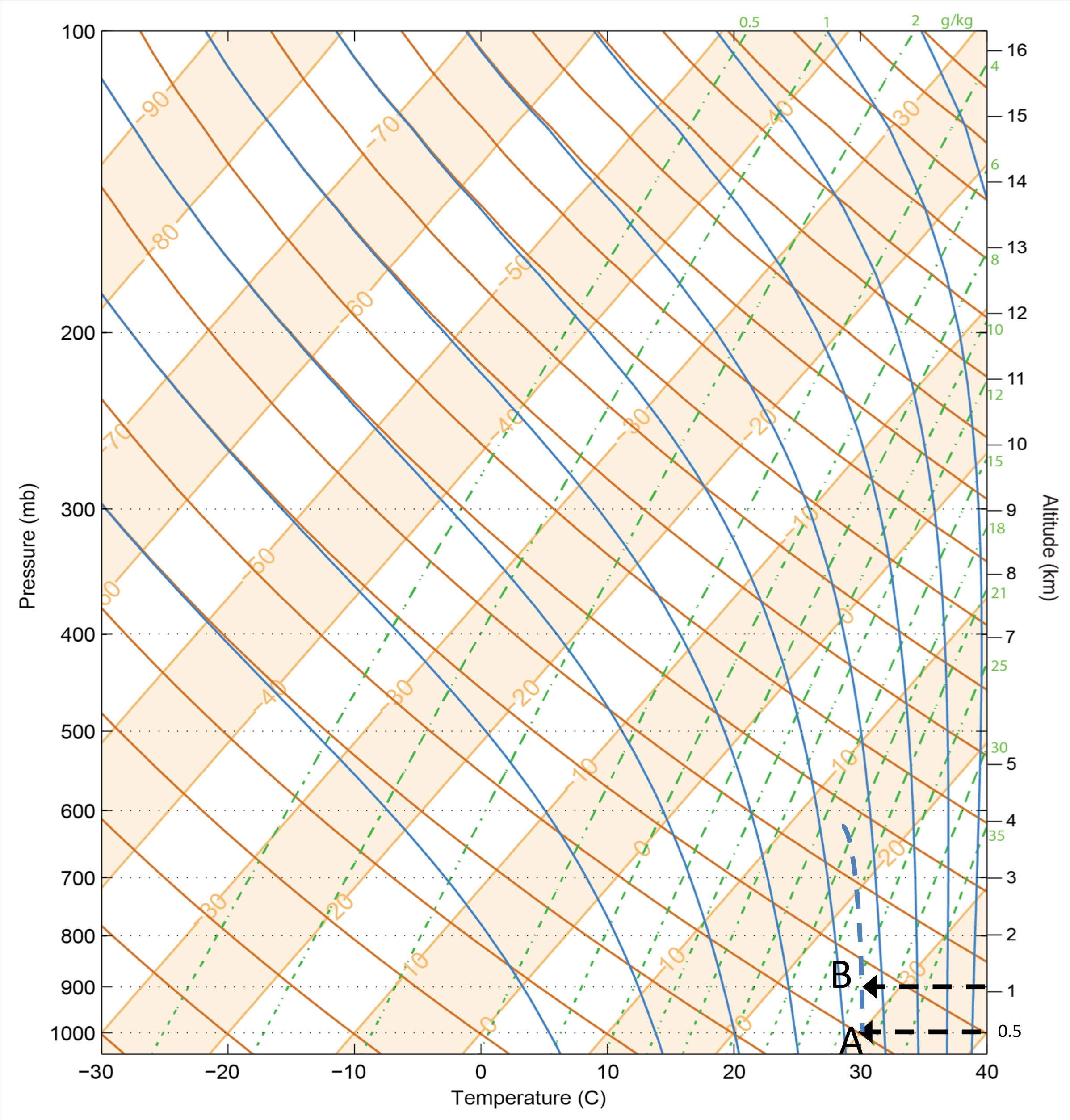
Question 1 – 4 (3 pts each) and Question 5 (1 pt) Directions: *(Use the colored version of Fig. 3 provided here)*



CORRECTIONS:

For Questions #1-4, the pressure levels should be: **950 mb, 750 mb and 550 mb** instead of **1000 mb, 800 mb and 500 mb.**

Question 6 Directions: *(use this Figure)*



Question 6 (4 points):

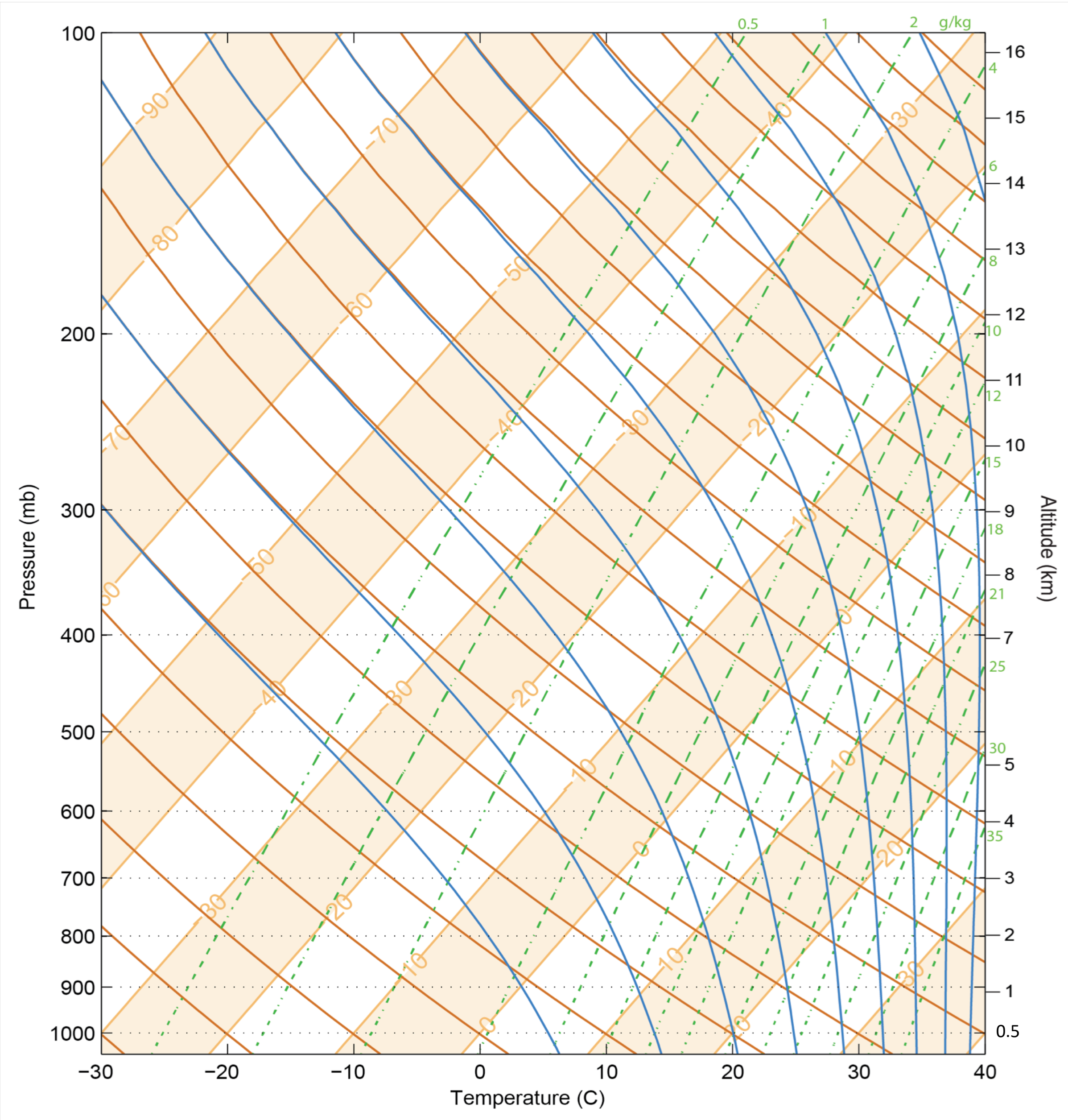
Show all four of your calculations for full credit.

CORRECTION: For the third part, it should read -30°C, not 30 °C.

When you are doing this, you might not always be exactly ON the wet adiabatic line. You have to run parallel to it.

Thus, moist adiabatic lapse rate between points A and B
= (30°C – 27°C)/(0.5km – 1.1km)
= - 5°C/km

Question 7 - 8 Directions:



Question 7 (3 points):

How does the moist adiabatic lapse rate change with an increase or decrease of temperature or pressure?

Is it smaller or larger than the dry adiabatic lapse rate? (Consider magnitude ONLY, not the sign) Explain why!

Question 8 (5 points):

Application-based question on lapse rate.

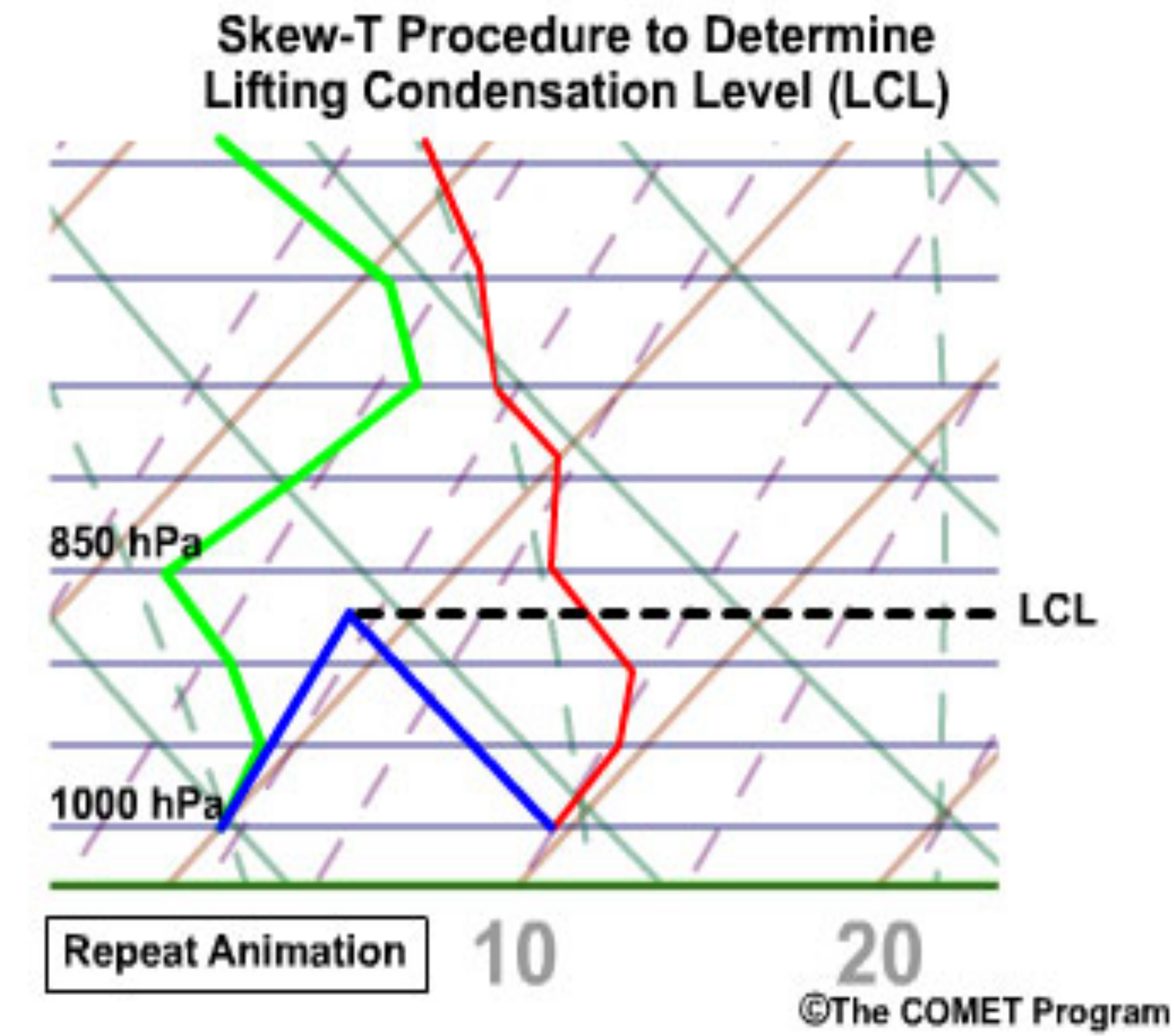
<u>Hint</u>: Refer Figure 2 of the manual and the skew-T to the left here.

Week 6 Lab: *Atmospheric Instability*

Lifting Condensation Level (LCL)

- The lifting condensation level (LCL) is the height at which a parcel of air becomes saturated when it is lifted dry-adiabatically.
- Examples of lifting mechanisms include, cold fronts, sea breeze, etc.

Skew-T Procedure for LCL



Question 9 (2 points):

Correction: "Using the sounding in Figure 6, calculate what the LCL is".

Remember you are using Figure 6 (in the hand out), not Figure 5. Answer this in terms of pressure.

Question 10 (4 points)

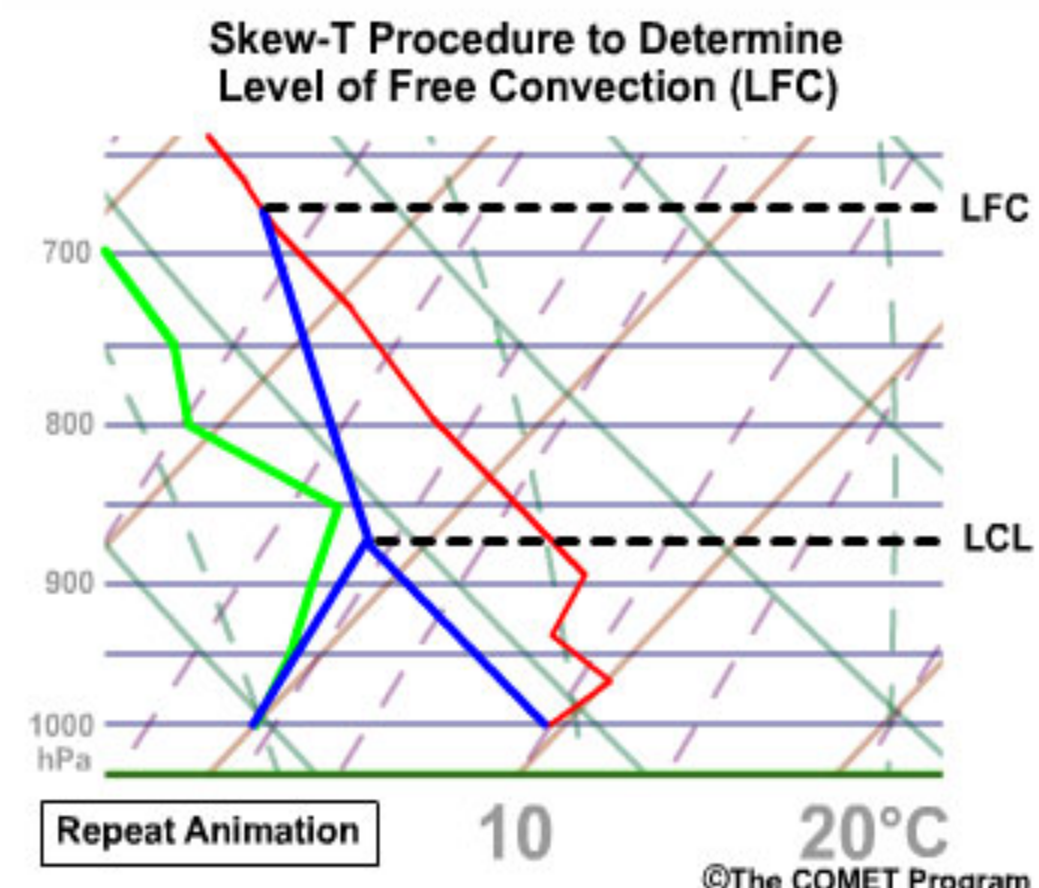
You are basically reiterating how to do this AND what it means conceptually when you find the LCL (but you have to do these things in your own words).

Question 11 (4 points)

Answer the question but also give me the actual temperature of both the parcel and the environment at the pressure level of the LCL.

Level of Free Convection (LFC)

- The height at which a parcel of air, when lifted, becomes warmer than its surroundings and thus convectively buoyant.



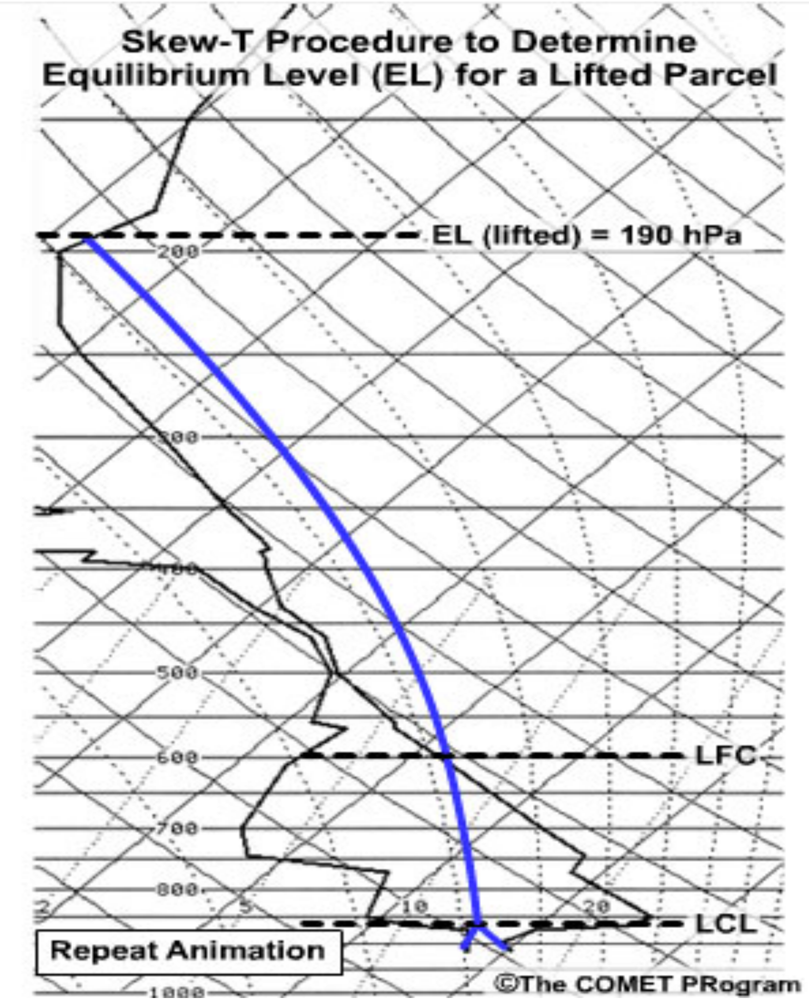
Question 12 (2 points)

Question 13 (2 points)

Equilibrium Level (EL)

- The height where the temperature of a buoyantly rising parcel again equals the temperature of the environment.

Question 14 (4 points)



Question 15 Directions (7 points) :

Question 15:

Do not use today's most recent sounding. Use the one I have provided for you below**. Do not plot this on the Figure 5 in the lab manual, but in the colored blank skew-T I have given you.**

Mark your LCL, EL, and LFC as labeled dots on the graph. The important features I want you to discuss are:

1) Where are there temperature inversions? (Hint: There are two) Where is the Stratosphere?
2) How much water vapor is in the air at 800mb?
3) What is the saturation mixing ratio at 800mb?
4) What could force a cloud to rise above the Lifting Condensation Level (LCL)?

Here is the sounding data:

Pressure (mb)	Temp (°C)	Dew Point (°C)
1000	15	4
900	18	1
800	4	-7
700	-2	-18
600	-13	-32
500	-30	-34
400	-37	-39
300	-48	-53
200	-58	-65
100	-60	-82

Questions ?