

NATS101 (30). Introduction to Weather & Climate

How to use the Pseudoadiabatic Chart

1. Use the accompanying pseudoadiabatic chart to follow the changes in an air parcel as it moves through the atmosphere. In the upper chart, an air parcel is originally located at sea level (1000 mb) at a temperature of 20°C, and contains a little water vapor (dew point temperature = -2°C).

- a. How high would this air parcel have to be lifted in order for a cloud to be formed? In other words, what is the “lifting condensation level” (LCL)?

Lift the air parcel along the dry adiabat (or along a line parallel to the nearest dry adiabat, if there is not one that corresponds to your particular case) until it cools to -2°C. At this point the air parcel temperature = dew point temperature = -2°C, and condensation begins. In this case, the LCL is at 810 mb.

- b. What would the temperature be if the cloudy air parcel continued rising to 600 mb?

The air is now cloudy, i.e., saturated, so you must lift the air parcel along the moist adiabat (or parallel to one). Switching to the red line, we lift to 600 mb then stop and read the temperature, which is -16°C.

- c. What would be the temperature of the air parcel if it were now brought back down to sea level (1000 mb)?

Lower the air parcel along the dry adiabat (or parallel to one) until we reach 1000 mb. The temperature is 30°C. Note we descend along the dry adiabat, not the moist adiabat, because as soon as the parcel begins to sink it will warm and it will no longer be saturated.

In fact, the prefix pseudo-adiabatic comes about because the liquid water that condenses is assumed to be removed as soon as it is formed, by idealized instantaneous precipitation. In other words, mass crosses the air parcel boundary so it is not truly adiabatic.

Note also how warm the air parcel has become after its round trip to 600 mb and back. It began at 20°C and returned at 30°C. The energy needed to warm the air came from the latent heat of condensation that was added to the air when the cloud formed. This non-reversible behavior is typical in cloud formation.

2. In the lower chart, look at the sounding and determine which layers in the atmosphere are stable, unstable or neutral.
 - a. *The lapse rate for layer A-B has a slope that is more positive than the dry (or moist) adiabatic lapse rate. You can see this simply by inspection – the A-B part of the sounding leans more to the right than either of the nearby adiabatic “bench mark” lines. Therefore the A-B layer is STABLE.*
 - b. *By inspection, the lapse rate for layer B-C has a slope that is parallel to the nearest dry adiabatic lapse rate. Therefore the B-C layer is NEUTRAL.*
 - c. *The lapse rate for layer C-D has a slope that is less positive than the dry (or moist) adiabatic lapse rate. This part of the sounding leans more to the left than either of the nearby adiabatic “bench mark” lines. Therefore the C-D layer is UNSTABLE.*

