Lab 9

Altitudinal Zonation and the Adiabatic Lapse Rate

In this lab we will take advantage of the location of the Claremont Colleges to examine an altitudinal transect up Mt. Baldy Canyon. Several years ago, the class installed a series of temperature loggers (essentially a thermometer attached to a computer chip that records temperature at set intervals) at various altitudes along the length of the Mt. Baldy Canyon road. When recovered a few days later, the loggers provide a record of temperature changes over time for each altitude.

The Adiabatic Lapse Rate.

As air rises, pressure drops rapidly and the air mass expands and cools. The relationship between altitude and cooling is known as the adiabatic lapse rate, and it approximates 1^0 c per 100 m elevation change. However, the exact value is a function of both altitude and moisture content (because water vapor has a high heat capacity). Thus the ALR for dry air is higher (air cools faster for any given elevation change) than it is for humid air. In any terrestrial ecosystem, ground-level microclimatic factors may come into play**.**

More technically:

$$p(z)^{\gamma-1}/T(z)^{\gamma} = constant$$

where γ is the heat capacity ratio (γ=7/5, for air) and *z* is the altitude.

A second relation between the pressure and temperature is the equation of hydrostatic equilibrium:

$$\frac{dp}{dz} = -\frac{mpg}{RT}$$

where *g* is the standard gravity, *R* the gas constant, and *m* the molar mass. Combining these two equations to eliminate the pressure, one arrives at the result for the dry ALR

$$-\frac{dT}{dz} = \frac{mg}{R}\frac{\gamma - 1}{\gamma} = 9.8\ ^{\circ}\mathrm{C/km}$$

The Exercize:

Download the data logger data (Excel spreadsheet format) from the course web site. Compare the temperature records for the six elevations. **Calculate the observed ALR** for our Claremont – Mt. Baldy canyon transect. (Think carefully about how best to do this; what times of day will you choose?).

This data includes more than just a pure ALR – **interpret the data accordingly** (i.e what other factors come into play here?)

Optional:

If you have transportation, you might wish to visit Mt Baldy Canyon; a road log is provided below.

Road Log.

This log assumes that you will depart from the Claremont Blvd. exit from the Colleges. Drive carefully – the road is steep and narrow in places. Round trip distance is approximately 30 miles. Set your odometer to zero at the Claremont Blvd exit.

0.0 Exit onto Claremont Blvd. and proceed north. Note the quarry on the right side of the road – is there any solid bedrock visible? Elevation is 1200 feet.

1.3 Note another quarry pit on the right side of the road. Again, is there any solid bedrock visible? Note also that Claremont Blvd. is ascending steadily and smoothly. Why? What feature is the road built on?

1.4 Cross Baseline Road. Claremont Blvd becomes Padua avenue – continue north.

2.7 Note the rock walls on the left side of Padua Avenue. The rocks have been collected from this immediate vicinity. Are they rounded or angular? Why? Where did they come from? How did they get here?

At the junction, turn right onto Mt. Baldy Road.

3.5 Pause here. Note the COASTAL SAGE SCRUB extending to the south (right side of the road), and for a short distance on the north side of the road. At the base of the hills, the CSS gives way to obvious LOWER CHAPARRAL vegetation. Note the difference in appearance. Elevation is **1850 feet.**

3.9 As the road curves left and begins to climb more steeply, you pass through a deep roadcut – is there any evidence of solid rock here?

4.1 Two turn-outs on your right provide a nice view to the south, across the CSS.

4.6 A large turn-out on the right provides a view out over the San Antonio Dam. Note the quantity of water behind the dam, and evidence (or lack therefore) for recent changes. What is the primary function of this dam? How does this relate to your observations on the rocks so far? Looking back across the road, you will notice a few characteristic chaparral plants, although they are not well developed here. The *Yucca* plants are the most distinctive, with their rosette of spear-like leaves. Elevation is **2300 feet.**

5.6 A turn out here provides a nice overlook of the canyon, with obvious RIPARIAN vegetation in the immediate vicinity of the stream. Note the difference in average leaf size of Riparian versus chaparral vegetation.

6.8 beginning in this general vicinity, you will notice small stands of conifer trees to the left of the road. How are these trees distributed; north or south facing slopes?

Why should this be so? The LOWER CHAPARRAL in this area is characterized by small-leaf chamise, *Adenostoma fasiculatum*. Elevation here is **2800 feet.**

7.6 You will pass through the first of two tunnels. Notice that the rock is now solid, albeit very fractured. This rock is Gneiss, i.e. metamorphosed granite of great antiquity (more than 1 billion years, or twice the age of most macroscopic life on this planet).

8.5 A large turn-out here is marked with a Historic Landmark plaque. The area below the turn-out was the site of LA's first hydroelectric plant, built in 1892. Look directly up the canyon and notice the very large debris pile; evidence of the major landslides which occur in this canyon, perhaps in response to past earthquakes.

9.6 The road now begins a short descent to the canyon floor, providing a closer view of riparian vegetation. Elevation here is **3800 feet**.

10.3 Yow now enter Mt. Baldy Village at **4000 feet**.

10.9 The road crosses Mt. Baldy Creek. Note the current flow, and evidence for higher water levels. Notice that the vegetation on the south facing hillsides is subtlety different from the Lower Chaparral – this denser, woodier vegetation is UPPER CHAPARRAL. Manzanita, *Arctostaphylos sp.* and California Lilac, *Ceanthos sp.* Are characteristic species. Elevation here is **4400 feet.**

12.3 The road forks (right to Ice House Canyon); turn left to stay on Mt. Baldy Road. Note the first appearance of significant stands of conifer trees on south facing slopes begin here, at **5000 feet**. This is the beginning of the Yellow Pine Forest, but notice as the road climbs steeply there are still intrusions of Upper Chaparral and even riparian-like trees such as scrub oak, where local microclimates favor them.

13.8 Glacier Picnic Area. At this point the vegetation has transitioned to true Yellow Pine Forest. Elevation here is **5600 feet.**

14.4 The road divides in the vicinity of a campground. Examine the trees here. The dominant species is Yellow Pine, *Pinus ponderosa*, which is distinguished by having its needles arranged in clusters of three. A second common YPF species, but distinctly less numerous than YP itself, is incense cedar *Calocedrus decurrens*. It is distinguished by having frond-like "leaves' instead of needles. Notice the lack of understory vegetation in the YPF; annuals are not a major part of this community. Notice also the air temperature. The elevation here is 6000 feet, so at an approximate adiabatic lapse rate of ~ 1^0C per 300 feet the air temperature should be some 16^0 C lower than it was at the Colleges.

15.0 The divided road merges here. At this point you can continue a short distance to the base of the ski lift, or return directly.