Hydrology

LAB 1: DRAINAGE-BASIN PROPERTIES AND SIMPLE METEOROLOGIC CALCULATIONS

OBJECTIVES:

a. to develop your ability to extract basic drainage-basin data from topographic maps
b. to learn how to make simple meteorologic computations

DRAINAGE-BASIN PROPERTIES

1. (10) Outlining the drainage basin of Jacoby Creek

On the 11 x 17 xerox map of the Jacoby Creek drainage, *carefully* outline the drainage basin of Jacoby Creek starting at the point on the creek I've marked with an **X** (just right of the "a" in the word "Jacoby" map.) Remember that the drainage divide -- for that's what you'll be drawing -- will run along ridgecrests, hilltops, and saddles, and can *never never cross any stream channel* except at the downstream starting starting point.

Use a soft lead pencil to draw the divide, so that you can erase when you make mistakes. When you are satisfied with the boundary, draw it in *darkly*.

2. (15) Determining the drainage area of Jacoby Creek

The area of a drainage basin is a quantity of fundamental hydrologic and geomorphic importance. Among other things, drainage area is strongly correlated with mean annual streamflow, size of flood peaks, sediment yield, and channel geometry.

The area of a drainage basin is determined either by: 1) overlaying the map with a transparent grid and counting the number of small squares or dots that lie within the drainage divide; 2) tracing the basin boundary with a planimeter, a mechanical device which integrates the area inside the basin as you trace it; or 3) digitizing the basin boundary and determining the area using a computer program. We shall use planimeters. The mechanics of using a planimeter will be discussed in lab.

Planimetering the basin gives us the *map* area either in square inches or square centimeters. To get the *actual* area of the basin, we have to convert map area to ground area by using the map scale. The procedure below will help you to do this.

The scale of the map I've given you is **1:62500** (i.e., 1 unit on the map equals 62500 units on the ground). Remember that 1 mile = 5280 feet.

a. (2) How many feet on the ground does 1 inch on the map equal ? Neatly show calculations.

1 in = ________________ ft (round answer to nearest integer)

b. (4) What then does 1 sq. inch on the map equal in square feet on the ground? In square miles on the ground? Neatly show calculations.

1 in^2 = ________________ ft^2 (round answer to nearest integer)

1 in^2 = ________________ mi^2 (round answer to two decimal places)

c. (9) Use a planimeter or dot grid to determine the ***drainage area*** of Jacoby Cr. upstream of the **X** in both sq. mi. and sq. km. You will first have to determine the map area of the basin in sq. in., and then convert it to sq, mi. using your conversion factor from part b above. After you have the area in sq. mi., convert it to sq. km. Neatly show your calculations.

Map area of Jacoby Cr. basin: ________________ in^2 (give to 2 decimal places)

Drainage area of Jacoby Cr: ________________ mi^2 (round to 2 decimals)

Drainage area of Jacoby Cr: ________________ km^2 (round to 1 decimal)

METEOROLOGIC CALCULATIONS

Neatly show all computations in spaces provided below the answer blanks.

3. (10) Dewpoint and cloud formation in rising air

The *relative humidity* of a parcel of air at T= 15˚C at sea level over Humboldt Bay is 80%.

1. Compute its dewpoint.
2. How high will it have to be lifted before clouds start to form? Give in both meters and feet.
3. Will there be a cloud layer in the Jacoby Creek drainage?

Dewpoint: ________________˚C (round to nearest 0.1˚C)

Cloud forming level: ______________m = _______________ ft (round both to nearest integer)

Is there a cloud layer in the Jacoby Cr. drainage? __________ Briefly explain your reasoning:

Dewpoint and cloud level calculations:

4. (10) Cloud formation in a static air mass

An air mass has an environmental lapse rate of 0.8˚C/100 m. At sea level the relative humidity of the air is 80%. What is the elevation of the condensation level if sea level temperature in the air mass is 15˚C? (Note: this question asks for the cloud level in the air mass if no lifting of the air is going on.)

Condensation level: _____________ m = _______________ ft (round both to nearest integer)

Condensation level calculations:

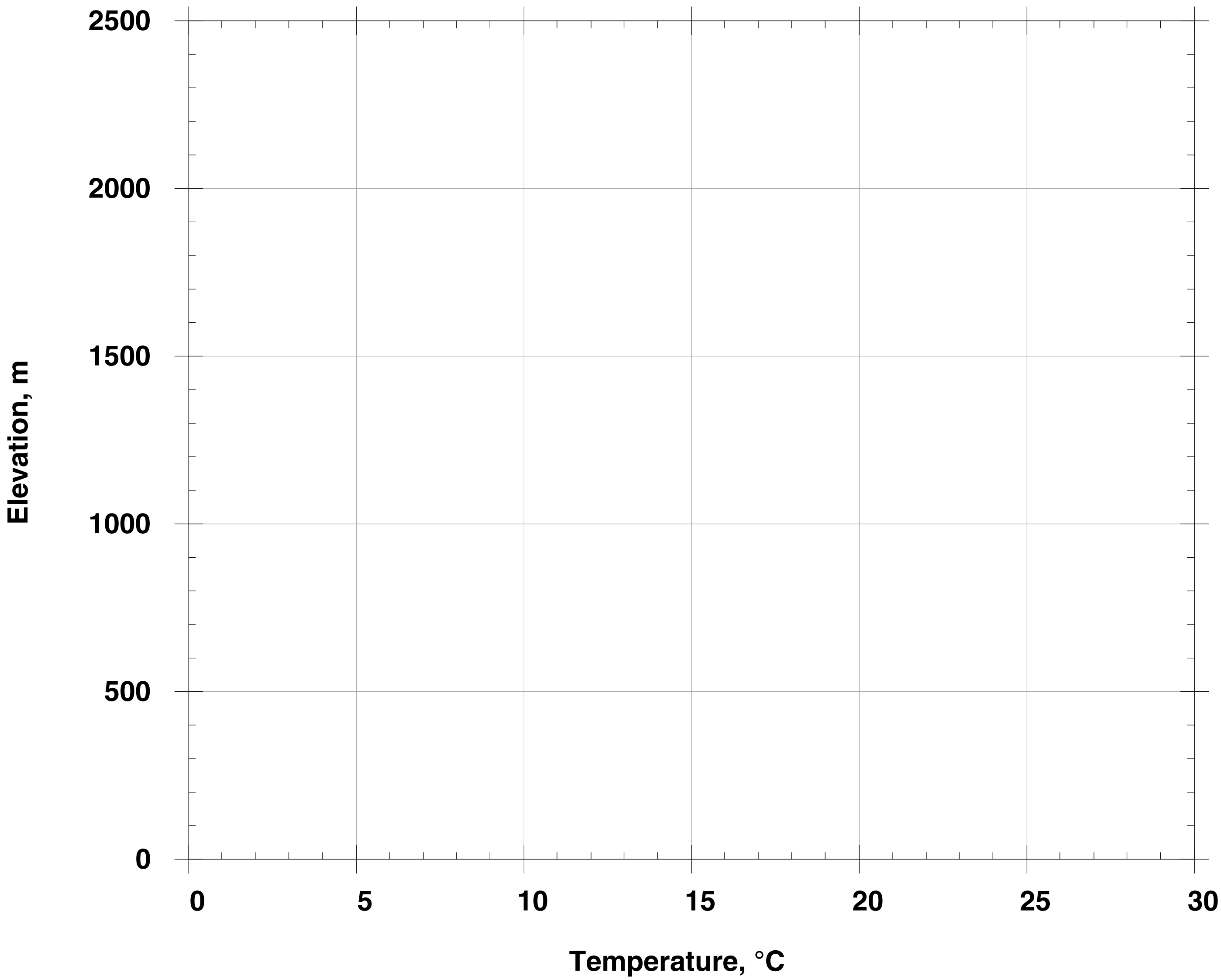
5. (20) Why rain shadows exist

A parcel of moist air at elevation $Z_1 = 600$ m with temperature $T_1 = 20$˚C is forced to pass over a ridge at elevation $Z_3 = 2000$ m and then descends back down to elevation $Z_4 = 600$ m. Assume that a lift of $\Delta Z = 700$ m produces saturation (i.e., the air passes through its dewpoint when it is lifted 700 m above its starting elevation) and will cause precipitation to begin. If the wet-adiabatic lapse rate is equal to one-half the dry adiabatic rate, what is T_4. As part of this answer, make a graph of temperature vs. elevation on the attached paper showing the temperature path the air takes as it rises and descends. State explicitly any assumptions you found it necessary to make.

T_4 = __________˚C (round to nearest 0.1˚C)

Necessary assumptions:

Calculations:


Elevation, m
2500
2000
1500
1000
500
0
0
5
10
15
20
25
30
Temperature, °C

6. (20) Finding the total depth of precipitatable water in an air column

The total amount of water vapor in a column of air is often expressed as the *depth of precipitatable water*, W_p, in mm or inches , even though there is no natural process capable of precipitating the entire moisture content of the column. This number gives an upper limit to the maximum possible precipitation that could be extracted from the air.

A convenient formula for computing W_p *in mm* is:

$$W_p = \sum_{i=1}^{n} 0.01\, \overline{q_{h_i}}\, \Delta P_{a_i} \qquad \text{where}$$

ΔP_{a_i} = difference in atmospheric pressure *in millibars* (mb) between the top and bottom of layer i

$\overline{q_{h_i}}$ = average of specific humidities (in grams/kilogram) at the top and bottom of layer i

The following data was obtained from a balloon sounding in a saturated atmosphere:

T_1 = 16.0˚C at P_1 = 900 mb level
T_2 = 11.6˚C at P_2 = 800 mb level
T_3 = 6.2˚C at P_3 = 700 mb level

a. (10) Compute the maximum precipitable water in the air column between the 900 mb and 700 mb levels. Neatly show computations. Indicate any assumptions you made to solve the problem.

W_p = ___________ mm = ___________ in (round to 1 decimal place)

Assumptions:

Computations:

b. (10) Use fig 2-17 on handout to compute W_p, given the same data as above, and that the 1000 mb dewpoint is 20˚C. Compare this answe with your results in part a. By how much do they differ?

W_p (from graph) = _____________ mm = ___________ in (round to 1 decimal place)

Comparison:

7. (15) How to melt ice and evaporate icewater

a. (5) How many *calories per sq meter* are required to melt a 0.05 meter thick layer of ice with a density of 0.9 g/cm^3 at a temperature of 0˚C? Neatly show computations.

________________ cal/m^2 (two significant figures)

Computations:

b. (5) How many *calories per sq meter* are required to evaporate the resulting meltwater without raising its temperature above 0˚C? Neatly show computations.

________________ cal/m^2 (two significant figures)

Computations:

c. (5) If the average insolation (input of energy from the sun) on the ice and water is 200 cal/cm^2/day, of which 25% is reflected, how long will it take for all the water to disappear? (To simplify this, assume that the water cannot run off or sink into the soil, so that all must be melted and evaporated.)

________________ days (round to nearest 0.1 day)

Computations: