

Name: \_\_\_\_\_ Section: \_\_\_\_\_ Date: \_\_\_\_\_

## EXERCISE B: TEMPERATURE AND EARTH HEAT BUDGET

**REFERENCE:** Textbook: Geosystems: An Introduction to Physical Geography  
Ch.4 Atmosphere and Surface Energy Balances and Ch.5 Global Temperatures  
Website references are within the text, or on the class website under Lab B, List of Websites.

**PURPOSE:** The purpose of this web-based laboratory exercise is to review the fate of solar energy as it passes through the earth's atmosphere and contacts the earth's surface. We know that temperatures at the earth's surface vary in space and time. Here we consider the global and local factors that influence temperature, we compare trends throughout a day and throughout a year, and compare temperatures between Colorado Springs and San Francisco. The processes and patterns relating to Earth's energy budget are visually displayed and expounded upon by the accompanying websites.

### KEY TERMS AND CONCEPTS:

\*Hint: Be able to define and compare-contrast each of these terms for your exams!

insolation	shortwave radiation	longwave radiation
net radiation	solar constant	albedo
transmission	refraction	scattering
reflection	isotherm	heat storage
absorption	heat	specific heat
temperature	continental effect	marine effect
mean	range	climograph

### Part I: Global Energy Patterns

1) The solar energy that reaches the earth's surface is either absorbed or reflected. Go to [http://geography.uoregon.edu/envchange/clim\\_animations/index.html](http://geography.uoregon.edu/envchange/clim_animations/index.html). Take a look at the first image (run the animation), the Net Short-Wave Radiation file. After examining the image, explain the relationship between net shortwave radiation (the images) and insolation?

2) Now look at the Net Radiation on the same website, [http://geography.uoregon.edu/envchange/clim\\_animations/index.html](http://geography.uoregon.edu/envchange/clim_animations/index.html), which combines short and longwave lengths. In the December view, we know from lab A that the Southern hemisphere is tilted towards the sun, and south of the Antarctic circle there is daylight for 24 hours a day, but Antarctica is still barely 'soaking up' the sun. One reason for this is that the angle of the sun on Antarctica is still fairly acute. What is

another reason why Antarctica is only slightly above a positive net radiation at this time of year?

3) The proportion of insolation that is reflected or absorbed varies according to the physical properties (color, texture *etc.*) of the surface. Albedo is a measure of the reflectivity (intrinsic brightness) of a surface. A surface with high albedo will have high reflection and low absorption of insolation.

Use Figure 4.5 on page 96 of your textbook to list some surfaces that have high and low albedo

Low	High
1	1
2	2

## Part II: Global Effects of Water

Now, on [http://geography.uoregon.edu/envchange/clim\\_animations/index.html](http://geography.uoregon.edu/envchange/clim_animations/index.html), go down to the Non-Radiative Components. Read the paragraph next to Change in Heat Storage. Keep in mind, as this paragraph explains, that a positive change in heat storage means that heat is being released from the substance, and a negative change in storage means that the substance is absorbing heat from the atmosphere.

- 4) What is the range of the changes in heat storage of continents throughout the year?
- 5) What's the range of the oceans?

The reason for this difference is the different specific heats of water and soil/rock. Specific heat is the amount of energy necessary to raise 1 cubic cm of a substance 1 degree Celsius.

- 6) So which substance, continents or oceans, have a higher specific heat?
- 7) Which one of these requires more energy to raise its temperature?
- 8) Which one has a higher heat storage capacity?

9) Now, take a look at the Northern Atlantic and Pacific Oceans, and the Arctic Ocean on this website. What is the effect on air temperature of the oceans' change in heat storage in the months of November to February? (Circle the correct two)

- Raising or Lowering
- Moderating or Emphasizing

10) The specific heat of water is one reason for the effect water has on the continents and global weather in general. Using pages 124-126 in your textbook, what are three other reasons for the oceans moderating effect on temperature compared to the continents?

- 1
- 2
- 3.

Imagine what the world would be like if water had a lower specific heat and it did not have these three properties.

11) Write a couple of sentences about this world, talking specifically about at least three of these: temperature maximums, temperature minimums, temperature averages, precipitation maximums, precipitation minimums, precipitation averages, length of the seasons, lags between max/min insulations and max/min temps

Using what you now know about specific heat, take a look at the global temperatures farther down the [http://geography.uoregon.edu/envchange/clim\\_animations/index.html](http://geography.uoregon.edu/envchange/clim_animations/index.html) page. Notice that both the hottest and coldest places throughout the year are landmasses. Isotherms are lines on a map that connect points of equal temperature and are useful to show temperature patterns. Here, the isotherms are delineated by different colors. Compare North America in December and in June.

12) In December, which direction do the isotherms bend when they enter North America from the Pacific Ocean?

North/South

13) Which way do they bend in June?

North/South

This effect on the warmth of the coastal areas relative to the rest of the continent is called the maritime influence, or the marine effect.

14) What is happening?

15) What then is the result of the continental effect or continentality?

16) What's one reason why this pattern is not as clear in the British Columbia/Alaskan panhandle region of North America, or on the South American continent?

### **Part III: Daily Temperature Variations**

Use pages 103-108 in the textbook for help in this section.

17) At what time of day does the maximum insolation normally occur?

18) But, in Boulder in the summer, when is the average maximum daily temperature?

11-1

1-3

3-5

19) Why?

20) The minimum daily temperature generally occurs just at sunrise. Why?

Go back to Changes in Heat Storage animation on

[http://geography.uoregon.edu/envchange/clim\\_animations/index.html](http://geography.uoregon.edu/envchange/clim_animations/index.html).

21) There are images of the twelve months here, but if there was a group of frames that looked at the daily changes of the earth heat storage, what do you think it would look like? If there were 24 frames from one day, what patterns would exist in energy moving into and out of storage throughout the course of the day?

### **Part IV: City Comparisons**

Go to [www.weather.com](http://www.weather.com) Create climographs of the average temperatures for Colorado Springs and San Francisco by entering Colorado Springs into the bar at the top of the page. Then, click on AVERAGES AND RECORDS, which is about two-thirds of the way down the page (it is the eighth link in blue to the right). You should get a climograph with the average minimum and maximum temperatures for 12 months of Colorado Springs weather, and the average precipitation occurring during each month below that. Now, do the same thing for San Francisco in another window, so that you can switch back and forth between the pages.

Colorado Springs: <http://www.weather.com/activities/other/other/weather/climo-monthly-graph.html?locid=USCO0078&from=search>

San Francisco: <http://www.weather.com/activities/other/other/weather/climo-monthly-graph.html?locid=USCA0987&from=search>

22) Fill out the chart for Colorado Springs and San Francisco

	Colorado Springs	San Francisco
Max		
Min		
Range		
Mean		

HINT: Range = Maximum – Minimum

Mean = Average = (Sum of all temperatures, highs and lows) ÷ (Number of months)

23) From Lab A remember that latitude affects temperature; however, Colorado Springs and San Francisco are at roughly the same latitude (38 degrees and 37 degrees, respectively). Describe the annual temperature trend for each location, including their temperature range, and explain the reason for their difference.

24) Just looking at the average maximum temperatures, Colorado Springs and San Francisco have similar monthly means for the May, but conditions for this period are probably not the same.

Describe temperature differences that likely exist between Colorado Springs and San Francisco during this time. Be sure to talk about differences between the beginning and the end of May, as well as the differences in daily temperature fluctuations that are also not readily apparent in the monthly averages.

### Part V: State-Wide Comparisons

Continuing on the theme of spatial influences on temporal differences in temperature, go to <http://instaar.colorado.edu/QGISL/AGCA/> and look at the AGCA temperature.mov file (or [http://instaar.colorado.edu/QGISL/AGCA/AGCA\\_Temperature\\_small.mov](http://instaar.colorado.edu/QGISL/AGCA/AGCA_Temperature_small.mov)).

Starting with January, the movie shows the temperature's cycles through two years of Alaska. On the first round, the color scale is the same throughout the months, and on the second pass, the color scale is particular to each month. The second round highlights the monthly differences between places, and might be more useful for the next questions.

25) What is the temperature range of Cold Bay, Alaska, out on the Aleutian peninsula?

26) What is the temperature Range of Fairbanks, Alaska, in the central-east of the state?

27) Why is the range so different?