Lab 1

The Geographic Grid

Objectives

- Defining latitude and longitude
- Measuring distance
- Finding places on the globe

Introduction

Did you know that the surface area of the earth is approximately 197 million square miles (510 million km^2)? Now imagine being told to find a precise location somewhere on the planet. That could be a very difficult task given the millions of square miles you would have to search over. Luckily for us, there is a simple and easy solution to this problem: the **geographic grid**. The geographic grid is a network of intersecting lines that allow us to pinpoint the exact location of any place on Earth. Let's start by examining the basics of this grid system.

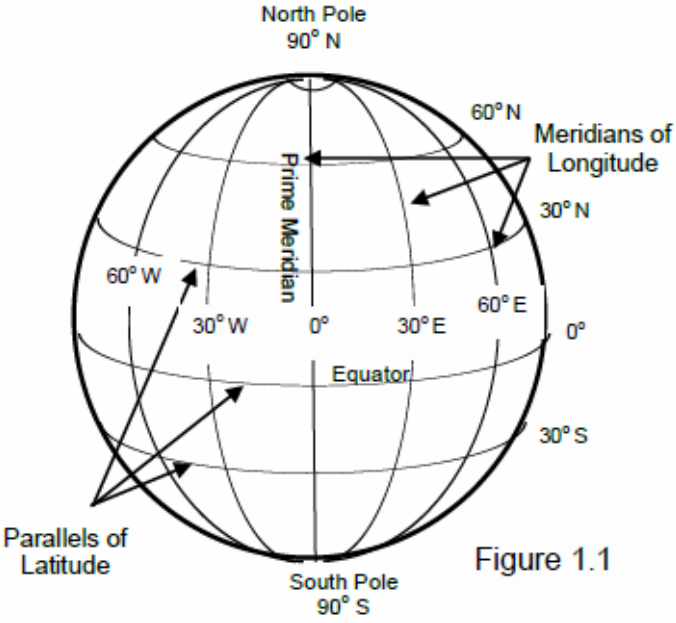

Figure 1.1

There is an imaginary line that runs in the east-west direction and completely encircles the planet. This is known as the **equator** and divides the earth into two hemispheres, the northern hemisphere and the southern hemisphere. The equator (referenced as 0°) is an example of a **parallel of latitude.** Other parallels of latitude (or latitude lines) can be drawn in various distances, or degrees, north and south of the equator (Fig. 1.1). For instance, here in Salem, we sit on the parallel that is 43°N of the equator. The highest latitudes on the planet would be at either the north pole (90°N) or the south pole (90°S); thus all latitudes on the planet will range from 90°S to 90°N, with the equator (0°) marking the mid-point of the range.

There is another imaginary line that runs in the north-south direction and acts in a similar way to the equator as a line of reference. The **prime meridian** runs from the north pole, through the town of Greenwich, England and then terminates at the south pole. The prime meridian (0°) is one of the **meridians of longitude,** and similarly to the many existing parallels of latitude, other meridians measure distances on earth east and west of the prime meridian (Fig. 1.1). Salem is approximately located on the 71°W meridian.

The same principle works for finding distances in the east-west direction using the longitudes of two places. However, there is one small catch to be aware of when calculating this type of distance.

Example 3: Find the distance between Salem (71°W) and Vladivostok, Russia (133°E). Following the rule above:

$$71° + 133° = 204°.$$

This is the distance if we traveled east from Salem, to the prime meridian (0°), and then continued east to 130°E (black arrow in Fig. 1.4). However, we could also travel west from Salem, towards the International Date Line (180°) and then continue west to 130°E (gray arrow in Fig. 1.4). This second option actually creates a shorter distance between these two meridians than the first! The rule of thumb is to always find the shortest distance possible. If the number of degrees between locations is greater than 180° then that means there is a shorter distance that could be traveled. To find this, subtract your distance from 360° (this is the total number of degrees). So for our example above the shortest distance is:

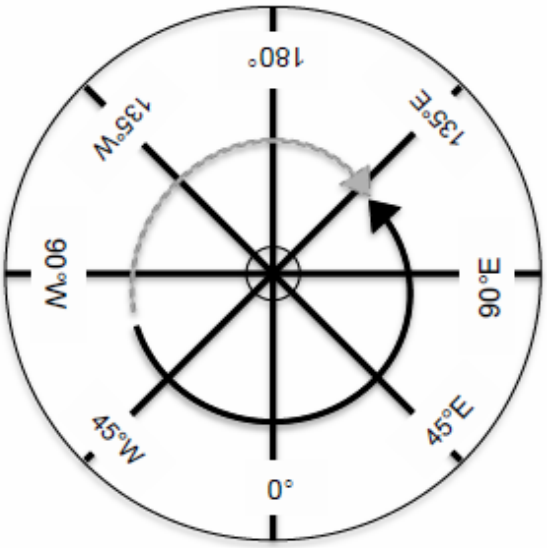

Figure 1.4

$$360° - 204° = 156°.$$

Measuring Distances in Miles and Kilometers

This idea of calculating distance can be extended to determine the number of miles or kilometers between two places based on their distance apart in degrees. The distance (north-south) between two parallels of latitude that are one degree apart is approximately the same everywhere on the planet: 1° of latitude = 111 km (69 miles).

Example 4: How many miles (km) south of Salem is Miami, FL? (see Example 1)

$$\text{Distance in miles} = 18° \times 69 \text{ miles}/1° = 1242 \text{ miles}$$
$$\text{Distance in km} = 18° \times 111 \text{ km}/1° = 1998 \text{ km}$$

This works the same way for mile or kilometer distances in the east-west direction except that the distance between meridians varies from the equator to the poles. For instance, at the equator, 1° of longitude is equal to 69 miles (111 km) the same as for degrees of latitude. However, since the meridians converge when traveling poleward, the distance between degrees shrinks to 60 miles (97 km) at 30° latitude, and at 70° latitude, the distance is merely 23 miles (38 km). So when making calculations of distance in miles or kilometers in the east-west direction, you must know the latitude of the locations in order to choose the proper distance between degrees.

Any location on the planet can be determined by knowing the distance north or south of the equator (**latitude**) and the distance east or west of the prime meridian (**longitude**). The latitude and longitude of a place make up what are known as **geographic coordinates**. For instance, Salem is 43°N of the equator and 71°W of the prime meridian. The coordinates for Salem are 43°N, 71°W (Fig 1.2). In geographic coordinates, the latitude is always given first, followed by the longitude.

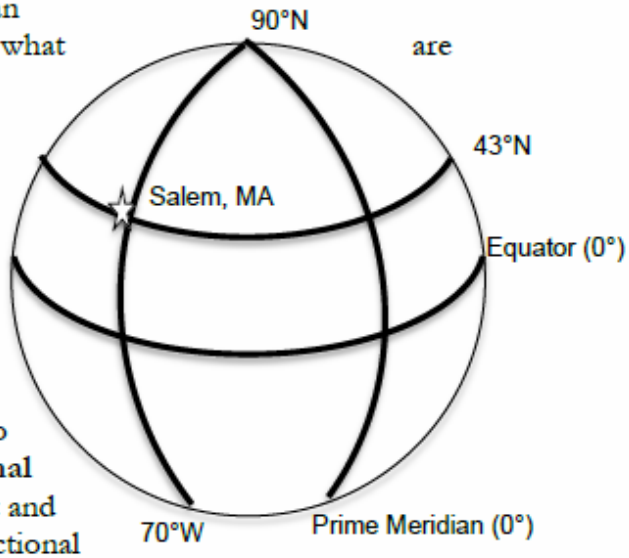

Figure 1.2

The latitude must always show whether the location is north or south of the equator by using the labels N or S. The longitude is the same with the direction from the prime meridian labeled as either W or E. The exception to this is the 180° meridian, also known as the **International Date Line**. Because this line is the same distance both east and west of the prime meridian, it does not need the directional identifier. (Note: The equator and prime meridian are the reference lines for latitude and longitude respectively and are always labeled as 0°.)
The precise coordinates of a location can be broken down into degrees (°), minutes (‘), and seconds (“); 1 degree = 60 minutes and 1 minutes = 60 seconds. These exact coordinates can also be decimalized, which is how the National Weather Service pinpoints exact locations. The geographic coordinates for the intersection of Lafayette and Loring Streets in front of the Sullivan Building on SSU’s North campus are

42° 30’ 23” N, 70° 53’ 28” W or 42.504°N, 70.888°W.

Measuring Distances in Degrees

The distance between two locations can be determined if the geographic coordinates for both places are known. The general rule is that if the places are in the **same** hemisphere, **subtract** to find the distance, and if the places are in **opposite** hemispheres, **add** to find the distance (Fig 1.3).

Example 1: Find the distance in degrees between Salem (43°N) and Miami, FL (25°N).

43° − 25° = 18°

Example 2: Find the distance between Salem (43°N) and Santiago, Chile (33°S).

43° + 33° = 76°

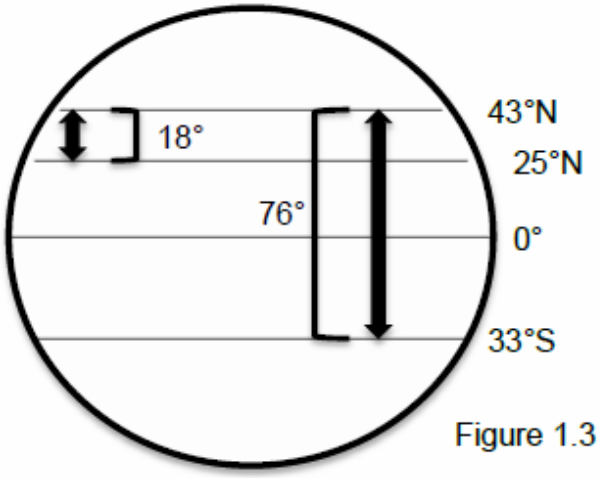

Figure 1.3

Table 1.1: Distances between meridians of longitude at various latitudes

Latitude	Miles per degree	Kilometers per degree
0°	69	111
10°	68	110
20°	65	105
30°	60	96
40°	53	85
50°	45	72
60°	35	56
70°	24	38
80°	12	19
90°	0	0

Example 5: Find the distance in miles (km) between Salem (71°W) and Vladivostok, Russia (133°E) from Example 2. For the latitude just over 40°, the distance will be close to 53 miles (85 km) [by interpolating we will choose 51 miles (80 km)].

$$\text{Distance} = 156° \times 51 \text{ miles}/1° = 7956 \text{ miles}$$
$$\text{Distance} = 156° \times 80 \text{ km}/1° = 12{,}480 \text{ miles}$$

Internet resources for latitude – longitude

1. The Weather Underground is an excellent site to use to follow the daily weather anywhere in the world and can be used to follow any of the sites covered in this lab.
http://www.wunderground.com

2. World Atlas is an Internet site explaining the basics about latitude and longitude as well as providing links to other latitude / longitude sites.
http://worldatlas.com/aatlas/imageg.htm

3. Marine Waypoints Latitude – Longitude Distance Calculator (great Circle distance calculator)
http://www.marinewaypoints.com/learn/greatcircle.shtml

4. View Above Earth – see what any point on earth looks like right now from space.
http://www.fourmilab.ch/earthview/vlatlon.html

5. Google Earth
https://earth.google.com/

Lab 1 Exercise
The Geographic Grid

Name: _____

Lab Section: _____

Please show your work. If necessary please use additional paper to show work.

Latitude and Longitude

1. What name is given to the zero line of latitude? _____

2. What is the zero reference line of longitude called? _____

3. Explain why labels (North or South, East or West) are needed when giving geographic coordinates.

4. Which lines measure distance north and south? _____

5. Which lines measure distance east and west? _____

6. For each of the following sets of geographic coordinates, indicate which are correct and which are incorrect. For those that are incorrect, circle the error and explain why it is not correct.

		Correct	Incorrect	Why incorrect
a.	13°N, 85°E	_____	_____	_____
b.	68°S, 190°W	_____	_____	_____
c.	38°E, 42°S	_____	_____	_____
d.	52°N, 12°W	_____	_____	_____
e.	25°W, 65°E	_____	_____	_____
f.	58°28'S, 79°65'E	_____	_____	_____

7. Using a globe or atlas, determine the geographic coordinates to the nearest degree for the following places.

a. Chicago, IL _____ c. Istanbul, Turkey _____

b. Santiago, Chile _____ d. Sydney, Australia _____

8. Each location below holds a global weather record. Using the coordinates given, determine what city/place is in each location, including the name of the country where applicable.

Record		Coordinates	City/Place
Highest temperature (1913)	134°F	36°27'N, 116°51'W	
Lowest temperature (1983)	-128.5°F	77°32'S, 106°40'E	
Highest annual precipitation	467 in.	25° 18′ N, 91° 35′ E	
Greatest 1-hr rainfall (1947)	12 in.	39°27'N, 94°20'W	
Highest dewpoint (2003)	95°F	26°16'N, 50°09'E	
Longest dry period (1903-18)	173 mo.	18°29'S, 70°18'W	
Highest wind speed (1996)	253 mph	20°49'S, 115°23'E	
Lowest pressure (1979)	870 mb	16°44'N, 137°46'E	

Measuring Distance with the Geographic Grid

Using Figures 1.5a and 1.5b determine the distances.

9. (Figure 1.5a)

A – B = _____ degrees

B + C = _____ degrees

1° latitude = 69 statute miles

(A - B)° * 69 = _____ miles

(B + C)° * 69 = _____ miles

1° latitude = 111 km.

(A - B)° * 111 = _____ km

(B + C)° * 111 = _____ km

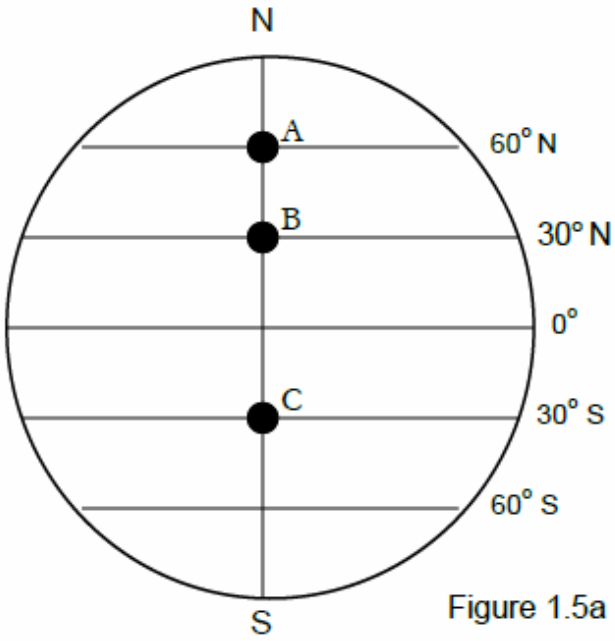

Figure 1.5a

10. (Figure 1.5b)

D – E = _____ degrees

D + F = _____ degrees

1° longitude = 69 statute miles at 0°

(D – E)° * 69 = _____ miles

(D + F)° * 69 = _____ miles

1° longitude = 111 km at 0°

(D – E)° * 111 = _____ km

(D + F)° * 111 = _____ km

G – H =_____ degrees

G + I = _____ degrees

1° longitude = 60 statute miles at 30°

(G – H)° * 60 = _____ miles

(G + I)° * 60 = _____ miles

1° longitude = 96 km at 30°

(G – H)° * 96 = _____ km

(G + I)° * 96 = _____ km

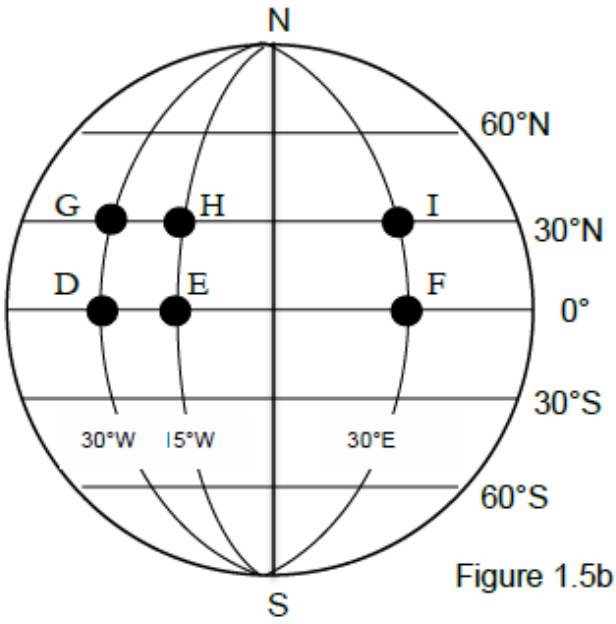

Figure 1.5b

REPLACES LAB PAGES 9 & 10

11) How many degrees of longitude are there (shortest distance) between:

a. 90°E and 170°E _____

b. 75°W and 105°W _____

c. 75°W and 30°E _____

d. 105°W and 105°E _____ (special case involving International Date Line)

12) Find the shortest distance in statute miles and kilometers:

a. Between the Galapagos Islands (0°, 90° W) and the Howland islands (where Amelia Earhart disappeared (0°, 177° W).

Statute Miles _____

Kilometers _____

b. Between Seward, Alaska (60° N, 150° W) and Oslo, Norway (60° N, 12° E)

Statute Miles _____

Kilometers _____

c. Between Camden, NJ (40° N, 75° W) and Beijing, China (40° N, 118° E)

(special case involving International Date Line)

Statute Miles _____

Kilometers _____

d. Distance in Latitude: Between Albuquerque, NM (35° N) and Boulder, CO (40° N)

Statute Miles _____

Kilometers _____

Decimalization of Latitude and Longitude

The National Weather Service (NWS) uses the decimal system with degrees and tenths of degrees not degrees, minutes and seconds. For example, 42° 30' N is equal to 42.5° N. To decimalize a latitude and longitude all you need to do is to divide the minutes reading by 60 (i.e. 30'/60 = 0.5°, 45'/60 = 0.75°).

13) Decimalize the following latitude and longitude readings:

a. 25° 30' N _____

b. 110° 15' E _____

c. 10° 45' S _____

d. 88° 5' N _____

e. 5° 55' N _____

f. 57° 47' 22" S _____