UNITED STATES MARINE CORPS

LESSON PLAN

THE GEOGRAPHIC GRID

INTRODUCTION:

1. Gain Attention. What is "latitude"? What is a "longitude"? Why do we use latitudes and longitudes?

2. Overview. This period of instruction provides an understanding of how the distribution of geographic features over the Earth's surface requires some system for deriving accurate locations. The period of instruction also entails information about the Earth's Geographic Grid system.

3. Introduce Learning Objectives.

a. Terminal Learning Objective. Without the aid of references, but in accordance with the instruction, the student shall successfully explain how lines of latitude and longitude are created, their relevance, and spacing.

b. Enabling Learning Objective(s).

(1) Define the difference between *great circles* and *small circles*.

(2) State how latitude lines are measured and the appropriate angular measurement.

(3) State how longitude lines are measured and the appropriate angular measurement.

(4) Locate the major lines of latitude and longitude: Equator, North and South poles, Tropics of Cancer and Capricorn, and the Artic and Antarctic circles.

4. Method/Media. This period of instruction will be taught using the lecture method with aid of QMMCBT-001 "Introduction to the Dynamics of the Atmosphere".

5. Evaluation. You will not be evaluated at the end of this period of instruction.

TRANSITION. The first notion that must be introduced is the concept of what a geographic grid represents. By defining this concept, it will pave the way for a thorough understanding of the lines of latitude and longitude.

BODY:

1. The Geographic Grid. A geographical grid system needs to be capable of pinpointing, with mathematical precision, the position of any spot on the Earth's surface. The simplest way to complete this task is to design two (2) unvarying sets of lines that intersect at right angles. This permits the location of any point on the surface to be mathematically represented by the appropriate intersection. A network of intersecting lines is referred to as a *grid system*. For purposes of deriving locations on the Earth's surface, a geographic grid consisting of east-west and north-south orientated lines has been devised (Figure 1).

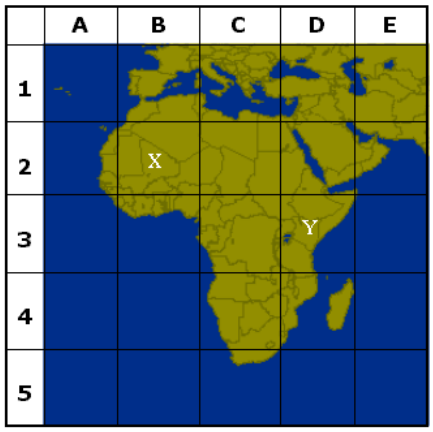

Figure 1 - Grid system.

a. Imagine the difficulty we would face if we were trying to describe the location of a perfectly round ping-pong ball. Because every point on the sphere is identical to every other point, it is impossible to distinguish one point from another. If we were to stick a needle through this ping-pong ball, with the 2 intersecting points being an equal distance from one another, and draw a circle around the ball from each point where the needle pierces the surface, we produce "poles" and an "equator" and thus provide and random reference points for a locational system. This would be the formidable task we would face if we had to try to pinpoint a location on a non-rotating Earth. However, the Earth does in fact rotate, and we use its rotational axis to describe locations on the Earth just as we would using the needle in the ping-pong ball.

b. The Earth's rotational axis is a diameter line that connects the points of maximum flattening of the Earth's surface. We have labeled these points the North and South Poles. If we picture an imaginary plane passing through the Earth halfway between the poles and perpendicular to the axis of rotation, we can come up with another valuable reference feature, the plane of the Equator. Where this plane intersects the Earth's surface is the imaginary line we call the "Equator".

c. We use the North Pole, South Pole, rotational axis, and the equatorial plane as natural reference points for measuring and

describing locations on the Earth's surface. Without these features, a set of reference points would randomly have to be chosen.

d. Any plane that crosses through a sphere, bisects that sphere, or divides it into 2 equal halves. We call these halves "hemispheres". Where these planes intersect the surface of the sphere, the planes create what is called a "great circle". Planes passing through any other part of the sphere create "small circles" where they intersect the surface. Great circles contain two important properties.

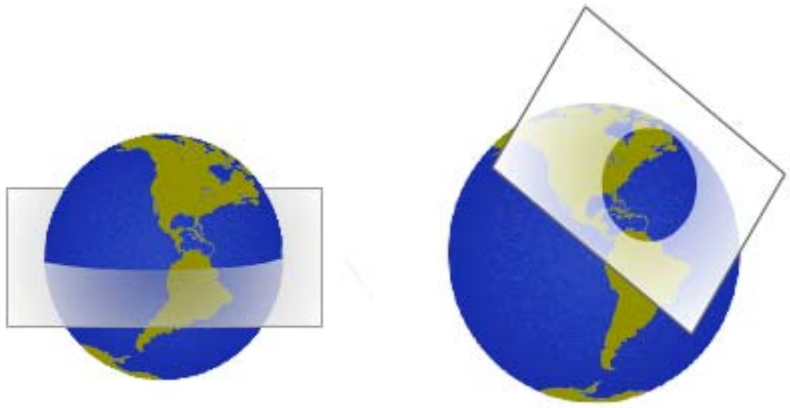

Figure 2 - Forming great and small circles.

(1) A great circle is the largest circle that can be drawn on a sphere. It represents the circumference of that sphere and divides the sphere into 2 equal halves, or hemispheres. For example, the sun illuminates one-half of the Earth at any given moment. The edge of the sunlit hemisphere is called the *"Circle of Illumination"*. It is a great circle that divides the Earth into 2 halves, a lighted half and a darkened half.

(2) Only one great circle can be constructed to include any two given points on the Earth's surface. The segment, or arc, of the great circle connecting those two points is always the shortest route between the points. These routes are known as *great circle routes*.

TRANSITION. The geographical grid is used as the locational system for the Earth's surface and is based on the principles just discussed. The system is closely linked with the various positions assumed by Earth in its orbit around the sun. The earthly grid system is referred to as a graticule and consists of lines of latitude and longitude.

2. Lines of Latitude.

a. Latitude is the distance measured north and south of the equator. We can project a line from a given point on the Earth's surface and intersect the Equator as shown in Figure 3. The angle between this line and the equatorial plane is the latitude of the

point. Latitude is expressed in degrees (°), minutes (‘), and seconds (s). There are 360 degrees in a circle, 60 minutes in a degree, and 60 seconds in a minute. Latitude varies from 0° at the Equator to 90° at the poles. Any position north of the Equator is a north latitude, and any position south of the Equator is a south latitude.

b. A line connecting all points along the same latitude is called a parallel. It is called this because it is parallel to all other lines of latitude. The Equator is the parallel of 0° latitude, and it alone of all other parallels, comprises a great circle. All other parallels of latitude are small circles, and are aligned in true east-west directions on the Earth’s surface. Because these parallels are imaginary lines, there can be an infinite number of them. However, many lines one may visualize, they are all parallel to each other. There are particular parallels that are of significance to the study of the Earth. They are (Figure 3-1) the Equator (0°), Tropic of Cancer (23.5°N), Tropic of Capricorn (23.5°S), Artic Circle (66.5°N), Antarctic Circle (66.5°S), North Pole (90°N), and the South Pole (90°S). While the poles are actually considered reference points vice parallels, they are deemed significant reference points.

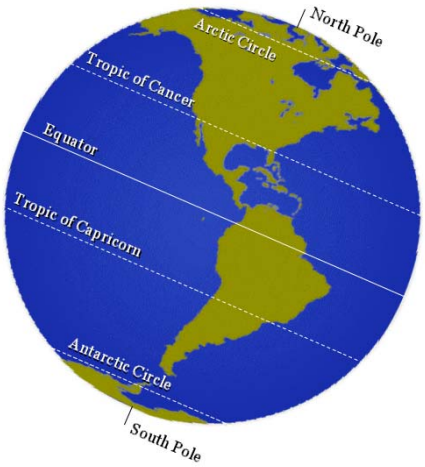

Figure 3 - Seven parallels.

c. Each degree of latitude has a north-south length of approximately 69 miles. The length varies slightly with latitude because of the polar flattening of the Earth.

3. Lines of Longitude.

a. The other half of the Earth’s grid system is comprised of lines of longitude, which is the distance measured east and west on the Earth’s surface. Longitude is also an angular distance and is measured in degrees, minutes, and seconds.

b. Longitude is comprised of imaginary lines extending from pole to pole and crossing all parallels at right angles. These lines

are called meridians, and are not parallel to one another except for where they cross the Equator. Longitude lines are furthest apart at the Equator, becoming increasingly close together as you travel poleward. A meridian, is a great semi-circle that extends from one pole to the other pole crossing all parallels of latitude perpendicularly and aligned in a true north-south direction.

c. The distance between meridians varies significantly but predictably. At the Equator the distance is approximately 69 miles, but since meridians converge at the poles, the distance decreases poleward becoming zero at the poles.

d. The Equator is a natural baseline from which to measure latitude, however there is no natural reference for longitude lines. For most of our history there was no standard "prime meridian", each country had designated their own prime meridians as a reference line for east-west measurement. In the 1880s, there were at least 13 prime meridians used by miscellaneous countries. However, in 1883, the United States and Canada adopted a standard time system for the North American railroads. The following year, an international conference was held in Washington D.C. to achieve the same goal on a global scale. After several weeks of debate, delegates chose the meridian passing through the Royal Observatory at Greenwich, England (east of London) as the standard prime meridian for all longitudinal measurement. The concept that it came down to for accepting this location was the fact that two-thirds of all shipping lines already used this prime meridian as a navigational base. Thus, an imaginary north-south line passing through Greenwich, England and through the axis of the Earth's rotation represents the plane of the prime meridian.

e. The angle that is passed through this plane and a plane passed through any other point and the axis of the Earth is a measure of longitude. Longitude is measured both east and west of the prime meridian to a maximum of 180° in either direction. Halfway around the world, we find the 180th meridian, which is 180° of longitude removed from the prime meridian. All places on Earth will then have a location west or east longitude, except for locations that lie on the prime meridian itself.

TRANSITION: The network of intersecting parallels and meridian composes the geographic grid over the entire surface of the Earth. The location of any place on Earth can be described with great precision by reference to degrees, minutes, and seconds of both latitude and longitude that will change very little with time.

OPPORTUNITY FOR QUESTIONS:

1. Questions from the Class. At this time are there any questions about the material that has just been presented?

2. Questions to the Class.

   a. Question: What are the seven (7) main parallels of the Earth?

b. Answer: Equator (0°), Tropic of Cancer (23.5°N), Tropic of Capricorn (23.5°S), Artic Circle (66.5°N), Antarctic Circle (66.5°S), North Pole (90°N), and the South Pole (90°S).

c. Question: Which two (2) parallel are not technically "parallels"?

d. Answer: North Pole (90°N) and the South Pole (90°S).

e. Question: What is the name for the great circle that separates the Earth's light half from the dark half?

f. Answer: The circle of illumination.

SUMMARY: This period of instruction provided the student with a detailed overview of how the Earth's geographic grid is comprised. It also defined measurements of latitude and longitude that are extensively used in the study of the Earth and its atmosphere.

REFERENCE.

Lutgens, Frederick K. and Tarbuck, Edward J. The Atmosphere, An Introduction to Meteorology. 9th edition. Pearson Education Inc, 2004.

McKnight, Tom L. and Hess, Darrel. Physical Geography, A landscape Appreciation. 7th Edition. Pearson Education, Inc. 2004.