UNITED STATES MARINE CORPS

LESSON PLAN

COORDINATE SYSTEMS

INTRODUCTION:

1. Gain Attention. What is the difference between a comic strip drawn on paper and a cartoon viewed on television? The answer to these questions lies in a system that scientists and mathematicians use to locate points in space, coordinate systems.

2. Overview. During this period of instruction, the student(s) shall learn the different types of coordinate systems that are used in math and science to determine an exact location of a point in space.

3. Introduce Learning Objectives.

a. Terminal Learning Objective. Without the aid of reference, but in accordance with the period of instruction, the student(s) shall identify the location of the object according to each of the coordinate systems.

b. Enabling Learning Objective(s). Without the aid of reference, but in accordance with the period of instruction, the student(s) shall complete the following:

(1) Explain the basic aspects of the Cartesian Coordinate System.

(2) Explain the basic aspects of the Navigational Coordinate system.

(3) Explain the basic aspects of the Meteorological Coordinate System.

(4) Explain the basic aspects of the Natural Coordinate system.

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. The student(s) shall not be evaluated upon completion of this topic of instruction.

TRANSITION. Scientists and Mathematicians use coordinate systems to help identify precise locations of a given object within our spatial environment. Within the coordinate system spectrum, there are four different types of systems used. The following class will go in-depth into these systems.

BODY:

1. Cartesian Coordinate System.

a. The Cartesian Coordinate System was developed by the philosopher Rene Descartes. He stumbled upon this system while he was sick and lying in bed. While lying in bed, Descartes noticed that a fly was buzzing near some ceiling tiles. He suddenly realized "that he could describe the position of the fly by the ceiling he was on." From this, Rene Descartes came up with the idea of a coordinate plane to describe the position of any given object.

b. This type of coordinate system is used by Mathematicians to locate objects on an x, y, and z-axis. This coordinate system (Figure 1) is the basic foundation for our other three coordinate systems.

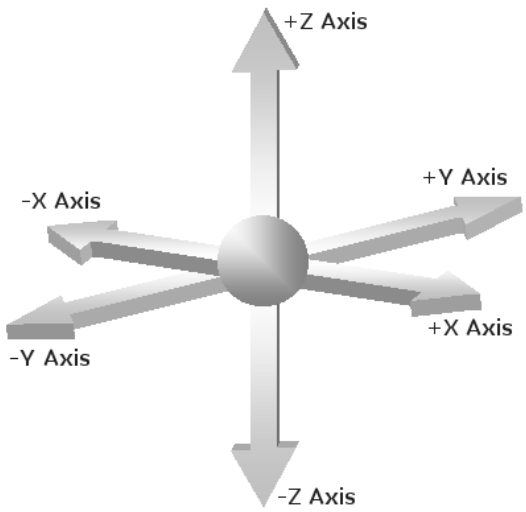

Figure 1 - Cartesian Coordinate System.

c. The coordinates are stated in terms of components along each of the three axes that intersect along the origin of the center. "All axes are perpendicular intersecting at 90 degree angles at the origin."

d. The X-axis is directed east/west. The Y-axis is directed north/south. The Z-axis passes through the origin of the XY plane and is directed at right angles. The Z-axis, to simplify it, makes a two-dimensional object three-dimensional. For example, cartoons that are on television usually look different than the cartoons in a newspaper. The reason for this is because illustrators draw cartoons in a newspaper using only an x and y-axis, while cartoons that appear on television are drawn on an x, y, and z-axis. The newspaper cartoons are two-dimensional objects, and the cartoons on television are three-dimensional objects.

TRANSITION. The 3-dimensional Cartesian Coordinate system is the basis for all other coordinate systems. The first 2-dimensional coordinate system is discussed next.

2. Navigational Coordinate System.

a. The Navigational Coordinate System is a two-dimensional system that doesn't take the vertical into consideration.

b. The direction in a Navigational coordinate System is indicated by the orientation of an arrow and is measured in degrees clockwise from north.

c. The length of the arrows indicates the objects magnitude.

d. We use the suffix "-ward" with the direction in which the object is moving towards. For example, if an object is moving towards 180 degrees, we say that the object is moving southward.

e. To illustrate the Navigation Coordinate System, we will use the picture in Figure 1-2. If we say that one-inch of the arrow equals 5 miles per hour and the arrow is 3 inches long, than we can say that the object has a magnitude of 15 mph. The arrow is pointing in the direction that the object is moving towards; thus, we must say that the object is moving northeastward.

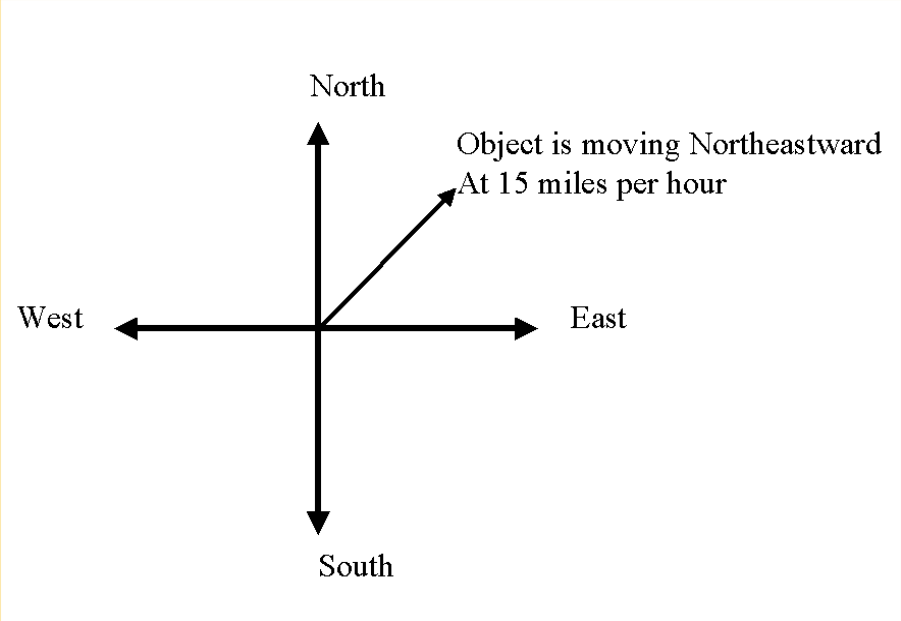

Figure 2 - Navigational Coordinate System.

TRANSITION. While the Navigational Coordinate System was vector-based, the Meteorological Coordinate System is not.

4. Meteorological Coordinate System.

a. This coordinate system is used by Meteorologists to report wind direction and wind magnitude.

b. This coordinate system is a two-dimensional system that doesn't take vertical motion into account.

c. "Directions are indicated by the orientation of shafts measured in degrees clockwise from north." The suffix "ly" is added to the direction of the object to indicate that direction is measured as coming *from* rather than towards. For example, if a car is traveling towards 180 degrees (south), one can say that the car is coming from 360 degrees (north). The car would be moving in a northerly direction.

d. Barbs on the tail end of the arrow indicate the magnitude of the wind. One full line indicates 10 knots; half of a line equals 5 knots; a triangle indicates 50 knots.

e. To illustrate the Meteorological Coordinate System, we will use Figure 3. Looking at the barbs at the end of the arrow, we can see the triangle, which equals 50; the two long tacks, which equals 20; one short tack, which equals 5. If we put all three of these together, we come up with a speed of 75 knots. The wind on the meteorological system is stated as coming from the direction it originated. In figure 3, we can see that the wind is coming from the northeast. To finish this example, we must at the suffix "ly" to the end of northeast to get the wind direction. From figure 3 we can see that the wind is northeasterly at 75 knots.

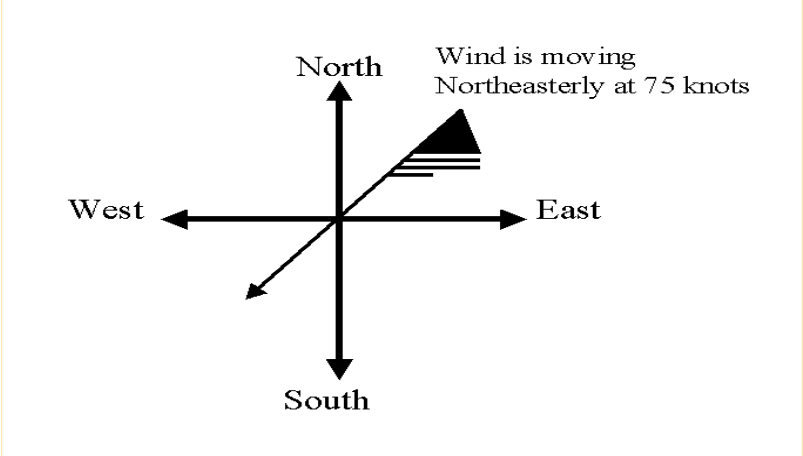

Figure 3 - Meteorological Coordinate System

TRANSITION. The Meteorological Coordinate System is a system that is used on a daily basis in the weather field. There is another type of coordinate system that lets Forecasters relate to atmospheric phenomena three dimensionally.

5. Natural Coordinate System.

a. The Natural Coordinate System is a three dimensional system used by meteorologists to describe an air parcels movement within a jet stream.

b. The Natural Coordinate System describes motion towards which it is going.

c. In the Natural Coordinate System there are three axes that are used (Figure 4). The axes' that are used are the s, n, and z.

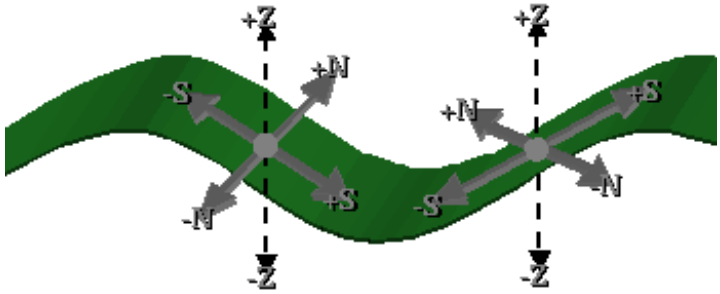

Figure 4 - Natural Coordinate system.

d. S-axis. The S-axis describes whether the parcel of air is oriented upstream or downstream within the jet. For the S axis, there is a +S and -S. The -S indicates that the parcel of air is oriented downstream within the jet; thus, the +S indicates that the parcel of air is oriented upstream within the jet.

e. N-axis. The N-axis is oriented perpendicular to the jet stream flow. For the N-axis, there is a +N and a –N. The +N is oriented to the left of the flow. The –N axis is oriented to the right of the flow.

f. Z-axis. The Z-axis is oriented vertically within the flow of the jet stream. The +Z axis is oriented above the jet stream. The –Z axis is oriented below the jet stream.

g. Use Figure 5 for a three (3) dimensional view of the Natural Coordinate System and how it is used in relation to the jet stream.

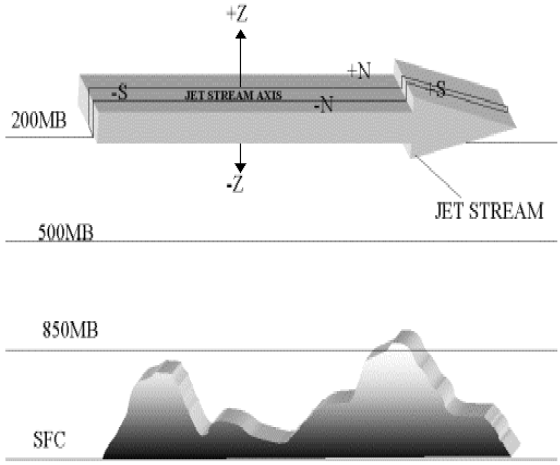

Figure 5 - Example of the Natural Coordinate System.

TRANSITION: The four basic coordinate systems were just presented, the Cartesian, Navigational, Meteorological, and Natural Coordinate Systems.

OPPORTUNITY FOR QUESTIONS:

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

2. Questions to the Class.

   a. QUESTION. What are the four basic coordinate systems?

   b. ANSWER. Cartesian, Navigational, Meteorological, and Natural.

SUMMARY: The coordinate systems that mathematicians and scientists use to determine locations of points in space are very complex, but if we are to get exact locations they must be mastered. Mastering the coordinate systems will help the student understand even more complex mathematical and scientific subjects.

REFERENCE.

Glickman, Todd S. Glossary of Meteorology. American Meteorological Society, 2000.

Introduction to Forecasting, Mathematics. Department of Defense, 1994.

Cartesian Coordinates. WhatIs.Com, 12/2/03. "http://whatis.techtarget.com/definition/0,,sid9_gci82496,00.html"

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