UNITED STATES MARINE CORPS

LESSON PLAN

FOG

INTRODUCTION:

1. Gain Attention. Have you ever been driving in your car and gone in and out of dense areas of fog? Why was the fog thicker in some areas than others?

2. Overview. During the period of instruction, the student(s) shall be introduced to the processes that form and dissipate fog and the different types of fog.

3. Introduce Learning Objectives.

a. Terminal Learning Objective. Without the aid of reference, but in accordance with the instruction, the student(s) shall determine what type of fog is occurring utilizing surface and upper-level atmospheric charts and visual observations to a 97% accuracy.

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

(1) Define and discuss the processes that form fog.

(2) State the different types of fog that can occur.

(3) State what types of fog will occur with relevant synoptic situations.

4. Method/Media. This period of instruction will be taught using the lecture method with the aid of a Macromedia Flash presentation "QMMPH1-Introduction to the Dynamics of the Atmosphere".

5. Evaluation. The student shall be evaluated by successfully demonstrating the terminal learning objective(s).

TRANSITION. Fog is generally considered an atmospheric hazard. Dense fogs may reduce the visibility down to zero and become significant hazards to motor vehicle drivers and aviators. The next subject introduces the processes that fog typically forms under.

BODY:

1. Fog Formation Processes. Fog can be defined as a cloud with its base at or near the surface of the Earth. There is not an actual physical difference between fog and clouds, their appearance and structure are the same. The main difference between the two is the method and place of formation for each. Recall that clouds form when the air is lifted and cooled adiabatically, while fog may result from one of two different processes; cooling and evaporation.

a. Fog formed by cooling. When the temperature of a layer of air near the surface cools to the dew point temperature, condensation produces fog.

b. Fog formed by evaporation. Saturation that occurs primarily to the addition of water vapor.

TRANSITION. There are five (5) different types of fog that may form. The next topic discusses which types of fog develop under the cooling process and which types of fog develop under the evaporation process.

2. Different Types of fog.

a. Fogs formed by cooling. There are three (3) different types of fog that form from cooling of the atmosphere. They are radiation fog, advection fog, and upslope fog.

(1) Radiation Fog. Radiation fog results from radiational cooling of the surface of the Earth and the air that is in contact with it. It is a nocturnal phenomenon that requires a high relative humidity at the surface and high pressure aloft that produces clear skies.

(a) Under these circumstances, the ground and the air immediately above it, cool to the dew point temperature because of the lack of cloud cover associated with converge aloft.

(b) If the surface wind speeds are calm, the fog may be patchy and less than five feet deep. If there is a light breeze, 3-6 knots, there will be enough (but not too much) vertical mixing to carry the fog upward 30 to 100 feet.

Figure 1 – Radiation fog I-40, west of Asheville, North Carolina on September 1976. Photo taken by Ralph F. Kresge

(2) Advection Fog. The term *advection* is the horizontal movement of air. When warm, moist air is blown (or advected) over an area with a colder surface, it becomes mixed and cooled from below. If there is enough cooling, a blanket of fog will develop, advection fog. A classic example of advection fog occurs around San Francisco's Golden gate Bridge.

(a) Unlike radiation fog, advection fog requires a certain amount of mixing for development. Surface wind speeds of 6 to 15 knots are common, since the fog requires some wind in order to develop.

(b) The higher wind speeds will typically provide enough mixing and lift to produce a more extensive layer of fog. Layer thicknesses of 1,000 to 2,00 feet are common.

Figure 2 - photo of Deception Pass, in Washington State, shows the bridge draped in fog by Shannon L. Story.

(3) Upslope Fog. Upslope fog forms when moist air moves up a sloping surface. The air cools to its dew point s it ascends the sloping surface. This is the only type of fog that forms adiabatically.

Figure 3 – Upslope fog.

b. Fogs formed by evaporation. There are two (2) different types of fog that form from the addition of water vapor into the atmosphere; steam fog and frontal fog.

(1) Steam Fog. When cool air moves over warm water, enough moisture may evaporate from the surface of the water to the air immediately above it. As the rising water vapor meets the cold air, it condenses and continues to rise with the air that is being warmed from below. The rising air looks like steam coming from hot liquid and hence, has been termed "steam fog".

(a) Steam fog is common over lakes and rivers on clear mornings, usually in the fall, when the waters are still warmer than the sir above it.

(b) Steam fog is usually shallow in depth because as the air rises, it mixes with the unsaturated air above it.

(c) Steam fog can become pretty dense. Dense steam fog usually occurs in the winter when cold Artic air moves from the continental ice shelves onto the relatively warmer ocean waters. The difference in water temperature has been recorded up to 30°C/54°F. The strong temperature contrast often causes an intense steam fog as the rising water vapor saturates a large portion of air. *Artic Sea smoke* is often used to describe this because of the appearance and source.

Figure 4 - Steam fog reducing the visibility over open waters in the North Atlantic.

(2) Frontal Fog. When a cold frontal system is approaching, it lifts warm air over the cold air. The boundary is typically associated with precipitation. If the cold air is at or close to saturation, then enough rain can evaporate to produce fog. This type of fog is called frontal fog (also commonly called precipitation fog). When this type of fog occurs, it results in a more or less continuous layer of condensed water droplets from the surface to the cloud layer.

Figure 5 - This wall of fog marks the approach of a fast moving cold front.

Figure 6 – Frontal fog producing a continuous layer of water droplets from the ground surface to the over lying cloud layer.

3. Fog Dissipation. Fog and clouds can dissipate by one of two (2) processes; the heating of air or the removal of moisture. A decrease in moisture content can be brought about in the lower layers by turbulent transfer (mixing) of moisture upward, by turbulent mixing of the fog layer with adjacent drier air, or by the condensing-out of water vapor in the form of dew or frost.

OPPORTUNITY FOR QUESTIONS:

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

2. Questions to the Class.

a. QUESTION. What are the different types of fog?

b. ANSWER. Radiation, advection, upslope, steam, and frontal fog.

c. QUESTION. Which types of fog form from the cooling process?

d. ANSWER. Radiation, advection, and upslope fog.

e. QUESTION. Which types of fog form from the evaporation process?

f. ANSWER. Steam and frontal fog.

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