UNITED STATES MARINE CORPS

LESSON PLAN

GLOBAL AND NORTH AMERICAN AIR MASSES

INTRODUCTION:

1. Gain Attention. Air masses throughout the world are what create climates that have constant trends. These air masses all relate to each other in various ways. More specifically, there are several air masses that exist in, and affect North America. To better understand classification and modification of air masses, refer to previous sections.

2. Overview. Throughout this period of instruction the student(s) will reinforce the concept of air masses, locations of respective source regions, and specific air masses that affect the North American continent.

3. Introduce Learning Objectives.

a. Terminal Learning Objective. Without the aid of references, but in accordance with the instruction, the student(s) shall locate all the air masses that affect North America on a given map within a time limit of ten (10) minutes.

b. Enabling Learning Objective(s). Without the aid of references, explain the different global and North American air masses, locations and climatological movements.

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 Earth's Dynamics".

5. Evaluation. The student(s) shall not be evaluated at the conclusion of this period of instruction.

TRANSITION.

BODY:

1. Air Mass Locations and Characteristics.

a. Continental Polar (cP).

(1) Winter. These have their source regions in central Canada and Siberia. Next to the extreme Arctic and Antarctic regions, these are the coldest places on Earth. This is because of the intense radiational cooling and lack of insolational heating in these source regions. The surface is completely frozen and is mostly snow and ice covered. Air masses in these regions are extremely cold and stable and are, therefore, very dry. Clouds are uncommon in the cP air masses, although ice fogs frequently form when temperatures fall below -40°F.

(2) Summer. These have their source regions in the central portion of high-latitude continents. Insolational heating warms the surface substantially, even to the point of dissipating the snow cover and thawing the ground to a noticeable depth. Summertime cP air masses are cool and dry, but not necessarily stable. They are fundamentally changed forms of the wintertime cP air masses that have experienced insolational heating in their lower layers. Generally, their lapse rates are less steep than their wintertime counterparts.

b. Maritime Polar (mP). We find these air masses over open oceans at high latitudes. The cool, moist air masses indigenous to this locale are mainly cP air masses that have moved out over the open ocean. The lower layers are substantially changed by the comparatively warmer, yet still cold, water surface. The mP air masses tend to be moist and unstable in the lower layers, and cold and dry aloft.

(1) Winter. We find these air masses over the open oceans, just south of the polar front, near 30°N latitude. Indeed, mT air-mass source regions extend southward across the near-equatorial trade wind convergence zone (NETWCZ) into the Southern Hemisphere. In North America, the source regions are the semi permanent subtropical high-pressure centers in the southwestern Caribbean. The mT air masses in winter are warm, moist and unstable. In the lower levels, the lapse rates frequently approach the dry adiabatic rate, and the lapse rates are usually steep up to the tropopause. Moisture is fairly well diffused to comparatively high levels.

(2) Summer. These start in basically the same regions as the wintertime mP air masses. For the North American continent, these regions are the Gulf of Alaska and the North Atlantic. Summertime mP air masses resemble their wintertime counterpart; they are cool and moist in the lower layers, and cool and dry aloft. The overall temperature is somewhat higher than in the winter mP air masses. Instability is more general in the lower layers and abrupt change in the lapse rates is found in the moisture discontinuity aloft. An inversion at this level is not uncommon.

c. Maritime Tropical (mT). These have the same source region as the wintertime mT air masses and, additionally, the Caribbean Sea. Those that influence North American weather originate in the semi permanent anticyclones that, during this season, are centered near 15°N latitude. mT air masses in summer are very warm and moist, and markedly unstable. Convective instability frequently occurs.

d. Continental Tropical (cT). These air masses are relevant to North America only during the summer. The source region is confined to Northern Mexico and the extreme southwest deserts of the United States and, are generally centered near 30□ N latitude. The cT air masses are hot, dry, and very unstable. Because of this inherent instability, large-scale upward vertical motions occur. This in turn causes surface pressures to fall, forming weak surface circulations called *heat lows*. The upper levels (usually 700mb and above) are dominated by subsiding air associated with the

convergence between the Hadley and the Ferrell cells.

TRANSITION. We have just extensively reviewed the locations and characteristics of various air masses. The next section focuses on the air masses and their respective properties as they affect North America.

2. North American Air Masses. There are five (5) primary air masses that affect the North American continent. The following is provided as a simplified version of the characteristics.

a. Continental Arctic (cA).

(1) Forms over Arctic Basin and Greenland icecap.
(2) Similar to cP air mass, but colder and drier.
(3) Very cold, dry, stable.
(4) Only reaches central and eastern U.S. in fall, winter, or spring, rarely reaches west of Rocky Mountains.

b. Continental Polar (cP).

(1) Forms over Canada and Alaska.
(2) Cold, dry and Stable.
(3) Dominant air mass over central & eastern U.S. in Winter.
(4) Brings cool sunny days, and clear, cold nights.
(5) In summer brings temporary relief from hot, humid weather.
(6) Rarely reaches west of Rocky Mountains.
(7) In winter causes Lake Effect Snow when cP (or cA) air masses move over relatively warm water and then over land. Air picks up moisture from water. It is also heated from below, which makes it unstable.
(8) Speed convergence (due to increased friction over land) enhances upward motion, and intensifies snow showers. Causes heavy snow showers along leeward lakeshore.

c. Maritime Polar (mP).

(1) Formed over the oceans at high latitudes.
(2) Cool and humid (not as cold as cP) Affects west coast of U.S. year round, especially Northern California, Oregon, and Washington.
(3) This is why the summers on the West Coast of the U.S. are mild, or even chilly.
(4) Brings rain and clouds to West Coast during winter.
(5) Only rarely affects the Northeast U.S.
In winter it is associated with "nor'easters", with lots of snow, sleet, and/or freezing rain.
(6) In summer, it brings very pleasant weather to New England.

d. Maritime Tropical (mT).

(1) Originates over the tropical oceans.
(2) Hot and humid.

(3) Responsible for majority of precipitation over central-eastern U.S.
(4) Dominant air mass over central and eastern U.S. in the summer.
(5) Brings hot, sticky weather.
(6) Becomes very unstable as it moves over hot land, frequently resulting in afternoon thunderstorms.
(7) Occasionally affects central and eastern U.S. in wintertime, producing lots of precipitation as it is forced to rise over cP air.
(8) mT air occasionally affects southern California, Arizona, Nevada, and Utah in the winter, bringing heavy rain to these areas.
(9) mT air also is brought into Arizona during the North American monsoon.

e. Continental Tropical (cT).

(1) cT is the only air mass that has a source region located in U.S. is in desert southwest of U.S. and extends into Northern Mexico.
(2) Hot and dry Unstable, but little moisture, so few clouds and no precipitation.

Table 1 – Characteristics for North American Air Masses.

Air Mass	Source Region	Temperature & Moisture Characteristics	Source Region Stability	Associated Weather
cA	Artic Basin & Greenland Ice Cap	Bitterly Cold & Dry in Winter	Stable	Cold Waves in Winter
cP	Interior Canada & Alaska	Very Cold & Dry in Winter	Stable Entire Year	- Cold Waves in Winter - Modified to cPk in Winter Over great Lakes (Lake Effect Snow on Leeside)
mP	North Pacific	Mildly cool & Humid Entire Year	Unstable in Winter Stable in Summer	- Low Clouds & Showers in Winter - Heavy Precipitation on Windward Side in Winter - Low Stratus & Fog along Coast in Summer, Modified cP inland
mP	Northwestern Atlantic	Cold & Humid in Winter Cool & Humid in Summer	Unstable in Winter Stable in Summer	- Occasional Nor'Easter in Winter - Occasional periods of cool, weather in Summer
cT	Northern Interior Mexico & Southwestern U.S.	Hot & Dry	Unstable	- Hot, Dry, & Cloudless - Rarely influences surrounding areas - Occasional drought to Southern Great Plains
mT	Gulf of Mexico, Caribbean Sea & Western Atlantic	Warm & Humid Entire Year	Unstable Entire Year	- Modified in Winter to mTw over SE US Bringing Widespread Precipitation and Fog - Hot & Humid Summer Conditions - Frequent Air Mass Thunderstorms & Showers
mT	Subtropical Pacific	Warm & Humid Entire Year	Stable Entire Year	- In Winter it brings fog, drizzle, & occasional moderate precip to NW US & Mexico - In Summer occasional source of moisture for infrequent thunderstorms in western US

SUMMARY: We have already discussed the different types of air masses and how they become modified by moving from their source regions. This is a general description of global and North American air masses and their characteristics. This should create a better understanding of how air masses dominate certain regions and therefore create a climates that are favorable to certain trends.

REFERENCES:

Ahrens, Donald C. Meteorology Today. 4th Edition. West Publishing Company, 1991.

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.

Basic Air masses. Jeff Haby. Last Updated 2/2/2004. Last accessed 8/8/2004. "http://www.theweatherprediction.com/basic/airmass/"

2 Understanding the Atmosphere. 10 Feb 2004. http://www.fas.org/spp/military/docops/afwa/atmos-U2.htm

ESCI 107.01 The Atmosphere Chap 8. 10 Feb 2004. http://www.atmos.millersv.edu/~gvanknow/107/08-lec-notes.htm