I Air Masses

Topic 1 Origin of an Air Mass

Air that stays in one area for a long time takes on the weather of that area. For example, if air stays in the Arctic for a few weeks in January, it becomes quite cold. If the air lies over the ocean, it becomes moist.

An **air mass** is a huge section of the lower troposphere that has the same kind of weather throughout. The temperature and humidity are horizontally uniform within an air mass. Air masses may be several thousand kilometers in diameter and several kilometers deep. Two or three air masses can cover all of the continental United States.

How does a huge section of the troposphere become an air mass? It maintains the same position for days or even weeks over a large uniform surface. An air mass over the Gulf of Mexico, for example, would be warm and humid. An air mass over the Great Plains of Canada in winter would be cold and dry.

Air masses originate in parts of the world where winds are light. These are mainly in the polar and subtropical high-pressure belts.

Topic 2 Kinds, Sources, and Paths of Air Masses

The temperature of an air mass depends on whether it comes from the tropics or the polar regions. The humidity of an air mass depends on whether it comes from land or sea.

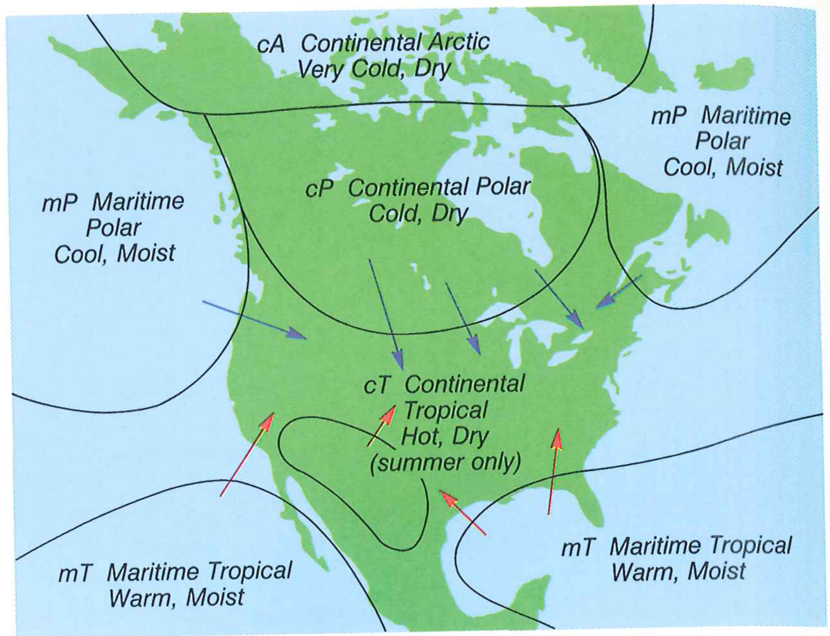
Air masses are named for their *source regions*, or places of origin. A **maritime tropical** (abbreviated **mT**) air mass comes from tropical seas. It is warm and humid. Maritime tropical air comes into the United States from the Pacific and Atlantic oceans and the Gulf of Mexico. A **continental tropical (cT)** air mass comes from tropical land areas. In North America, these hot, dry air masses originate in the summer in the desert areas of southwestern United States.

A **maritime polar (mP)** air mass comes from cold ocean waters. It is cold and humid. A **continental polar (cP)** air mass comes from land areas in high latitudes. It is cold and dry. Maritime polar air masses come to the United States from both the Pacific and Atlantic oceans. Continental polar air masses come from Canada and northward.

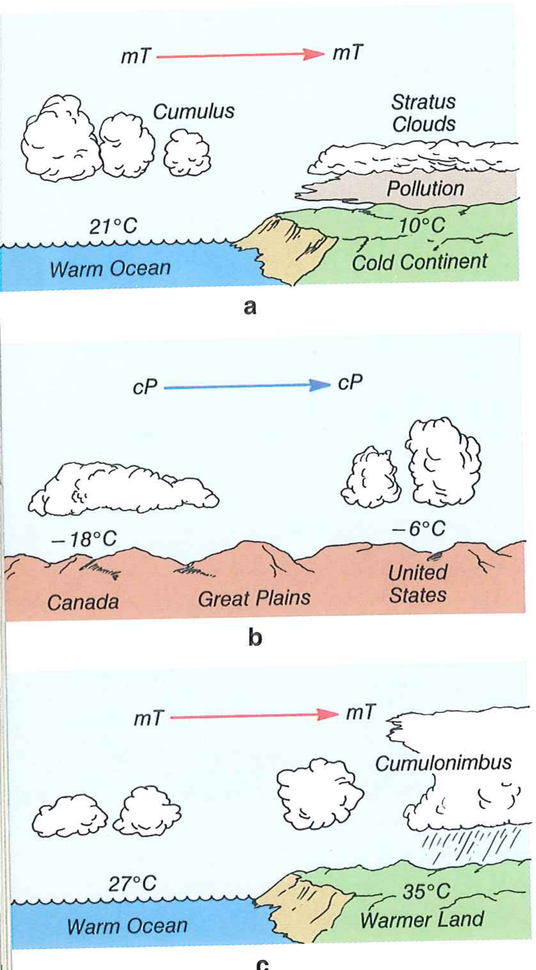
OBJECTIVES

- **A** Explain how air masses form and list the types of air masses.
- **B** Describe the weather and sky conditions that accompany each type of air mass.
- **C** Describe the techniques used to determine air-mass properties.

29.1 In the summertime, this desert area in southern Utah is part of a source region for hot, dry continental tropical air.



29.2 Air mass source regions and the paths air masses follow across North America



29.3 (a) When a maritime tropical air mass moves from warm sea to cooler land, the air near the surface is stable. Stratus clouds, fog, and drizzle may develop. Pollution may become trapped, forming smog. (b) When a continental polar air mass moves from Canada across the warmer Great Plains in wintertime, fair-weather cumulus clouds form. (c) When a maritime tropical air mass moves from sea to warmer land in summer, cumulonimbus clouds and thunderstorms are likely.

Continental Arctic (cA) air masses are very cold and dry. They come from the ice-covered Arctic regions. There is no maritime Arctic air mass because Arctic air is so dry.

Topic 3 Weather in an Air Mass

Air masses are so large that they may take many days to pass a given place. During this time the weather of the place is like the weather of the region where the air mass originated. In winter, cP air usually brings very cold weather. It may reach as far south as Florida. In summer, cP air is felt as a cool spell.

When mP air comes in from the northern oceans, it brings cool, humid weather. The mT air masses bring mild, humid weather in winter. In summer they bring hot, humid spells to central and eastern United States. Maritime tropical air also brings frequent thunderstorms and occasional tornadoes. Continental tropical air masses bring very hot, dry weather.

The weather changes brought by new air masses can be extreme or very slight. Part of the reason for the difference is that air masses change as they move away from their source areas. Polar air masses get warmer as they move southward. Dry air masses become moister over moist ground. Moist air masses become drier over dry ground as water lost due to precipitation is not replaced. Fast-moving air masses spend less time over any one area, so they are usually changed less than slow-moving air masses. Therefore, fast-moving air masses bring more extreme weather changes.

The passage of different air masses is one of the factors that make weather so variable.

Topic 4 Skies in an Air Mass

What kinds of clouds do air masses have? Is the weather fair or rainy, windy or calm?

Meteorologists have found that the conditions in an air mass depend mainly on one thing: Is the surface the air mass lies over warmer or colder than the air mass? If the ground surface is colder, it cools the bottom layer of the air mass, with the following results:

1. The bottom layer of the air is stable. Inversions form. Smoke, dust, and other pollutants do not rise. Visibility is poor. *Smog* may develop.
2. Condensation of water vapor occurs at the surface and in the lower air. This condensation may form dew, fog, stratiform clouds, drizzle, or light rain.

If the ground surface is warmer than the air mass, it warms the bottom layer of the air mass, with these results:

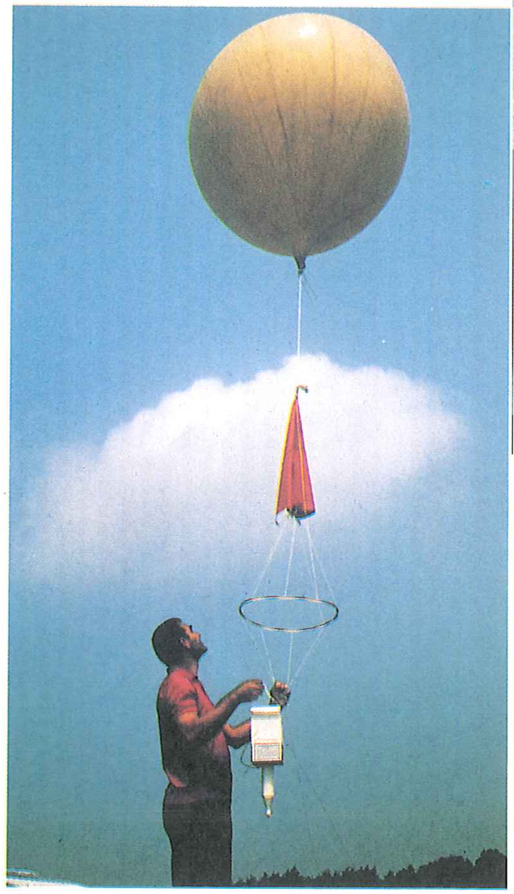
1. The bottom layer is unstable. Convection currents form cumulus clouds. The convection mixes lower-layer air with air at higher levels, so air pollution moves out of the area. Visibility is good.
2. If the air mass is a dry one—such as cP—the weather stays fair. If the air mass is humid or the warm surface is water, showers may form.

Topic 5 Observing an Air Mass

How do meterologists observe the temperature, humidity, and wind at high levels in an air mass? They use a balloon-carried package of instruments called a **rawinsonde**. Rawinsonde measurements are made twice daily, at noon and midnight, Greenwich, England, time (GMT), at weather stations all over the world.

The rawinsonde contains a radio transmitter that sends out signals about the temperature, air pressure, and relative humidity. An automatic radio receiver at the weather station records the signals. The balloon carries the rawinsonde up to a height of more than 30 kilometers, where the balloon bursts. Radar equipment tracks the rawinsonde and determines the speed and direction of the upper-air winds.

Scientists are developing new ways to measure the temperature, humidity, and wind above the surface. The temperature and humidity are estimated by measuring the air's infrared radiation. (Hotter air and more humid air radiate more infrared rays.) These measurements are made both from satellites and from instruments on the ground. The new *radar wind profiler* is a kind of radar that measures the winds through the troposphere. Unlike rawinsondes, the new instruments can take measurements continuously. However, they cannot provide the detail rawinsondes can.



29.4 This rawinsonde, about to be launched, may float upward to an altitude of about 30 kilometers.

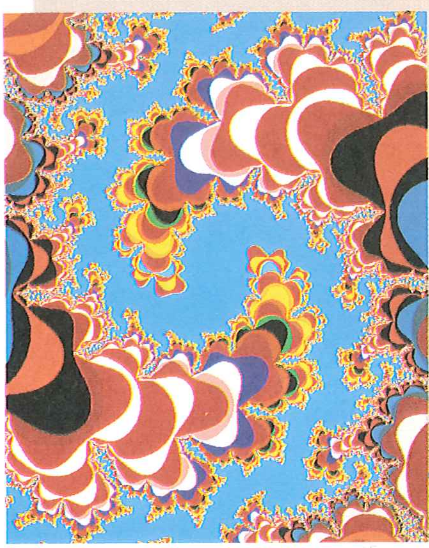
TOPIC QUESTIONS

Each topic question refers to the topic of the same number.

1. **(a)** What is an air mass? **(b)** Explain how an air mass originates.
2. **(a)** How are air masses named? Write the full name, characteristics, and source regions of the North American air masses abbreviated by **(b)** cP, **(c)** mP, **(d)** mT, and **(e)** cT.
3. **(a)** Briefly describe the weather in each of the following air masses: cP, mP, mT. **(b)** How does the speed of the air mass affect the expected weather?
4. **(a)** What is the chief factor that determines the type of skies an air mass will have? **(b)** Describe the sky conditions in an air mass resting on a cooler surface. **(c)** Describe the sky conditions in an air mass resting on a warmer surface.
5. **(a)** How is a rawinsonde used to obtain temperature, humidity, and wind measurements above the surface? **(b)** How are satellites and ground instruments used to estimate temperatures and humidities aloft? **(c)** What is the new instrument for measuring wind at upper levels? **(d)** How do wind measurements made with this instrument differ from wind measurements made with a rawinsonde?

Current RESEARCH

Chaos: Limits of Predictablity



Sometimes it's amazing what scientists can predict with certainty. For example, eclipses can be predicted down to the minute, decades ahead of time. Chemical reactions can be assumed to work the same way, time and time again, given the same conditions. Even the flipping of a coin takes on a certain predictability when viewed statistically.

Will it ever be possible to accurately predict weather weeks or months ahead of time? Think about the types of data needed to predict the weather. The meteorologist needs to know the humidity of air masses at different elevations, temperatures, air pressures, wind speeds and directions, and other information. To know what the weather will be doing even three days in the future, the meteorologist needs to know how and when any of these conditions may change.

Chaos theory says that, in a system like the weather, predictions have no choice but to get less certain over time. A small change in one part of a complex interacting system— a gust of wind caused by a tree falling in someone's yard— can set off an unpredictable chain of events that can actually change the weather hundreds of miles away a few days later. If this is true, then weather forecasting may never be able to give accurate predictions more than several days ahead of time.