

# Unit 11

## Atmospheric Pollution

### Background

---

#### Introduction

The increase in world population and the growth of industry have resulted in an increase in atmospheric pollution. This pollution is the cause of many deaths and serious health problems. To further understand atmospheric pollution, we must study where pollutants come from, how they behave, and how they are globally transported. Then it will be possible to make changes in our society that will allow us to live longer, healthier lives.

#### Essential Questions

Over the course of industrial history, what have we learned about atmospheric pollution?

How does today's increased population and industrial use impact the atmosphere?

What does the future hold in terms of prevention of atmospheric pollution?

#### Content

Unit 11 begins with the health risks associated with atmospheric pollution and the four types of processes that affect air pollution levels: emissions, chemistry, transport, and deposition. This creates the context for the unit, which then provides a detailed description of the identification of primary and secondary pollutants, where they come from, and how they interact with each other.

In Part One of the video for Unit 11, you will be introduced to Charles Kolb and his mobile laboratory, a vehicle equipped with atmospheric pollutant measuring devices. This vehicle has been employed by several cities in the United States to conduct studies of atmospheric pollution. In Part Two of the video you will meet Luisa Molina, who is a lead scientist in the Megacity Initiative Local and Global Research Observation (MILAGRO) project taking place in Mexico City. Over 450 scientists from 50 academic research associations in Europe, Mexico, and the United States have developed instruments to collect and record data that will allow the largest study of its kind to be a model for other megacities around the world.

# Background

---

## Learning Goals

During this session you will have an opportunity to build understandings of the following.

- a. Knowledge
  - i. Atmospheric pollution is affected by emissions, chemistry, transport, and deposition, at a global and local level.
  - ii. Atmospheric pollutants can be primary or secondary.
  - iii. Atmospheric pollution has drastic effects on the health and well-being of people, plants, and animals on Earth.
- b. Skills
  - i. Atmospheric pollution requires interdisciplinary study because of its complex interactions with other Earth systems.
  - ii. When studying atmospheric pollution, a spatial approach is important because of the dynamic nature of Earth.
- c. Dispositions
  - i. Pollution in the atmosphere affects all life on Earth.
  - ii. Ongoing research and study can provide new knowledge that would decrease atmospheric pollution, improving life and enhancing our ability to be stewards of Earth.

## Key Concepts

Acid rain	Mercury	Primary pollutant
Aerosol/particulate matter	Methane	Radical
Ambient	Montreal Protocol	Secondary pollutant
Anion	National ambient air Quality standards	Smog (industrial/photochemical)
Carbon monoxide	Nitrogen oxides	Sulfur dioxide
Cation	Non-attainment areas	Volatile organic compounds/hydrocarbons
Chlorofluorocarbon	Ozone	
Hydroxyl radical	Photodissociation	

**FACILITATOR:** These concepts correspond roughly to the sections of the unit. There are a number of other concepts that could be included. It is best to start with the author's major ideas and then ask for input from the study group for other concepts they would include.

# Background

---

## Misconceptions and Atmospheric Pollution

Many people mistakenly associate the creation of ozone as a positive thing. They may think that because there is an ozone hole, creation of ozone would be beneficial. However, ground-level ozone, which is different from Earth's stratospheric ozone layer, is the most important secondary air pollutant.

Another common misconception is that climate change and the loss of the ozone layer are pretty much the same thing. In fact, climate change and the loss of the ozone layer are two different problems that are not very closely connected. The largest contributor to global warming is carbon dioxide gas released when coal, oil, and natural gas are burned. Chlorofluorocarbons (CFCs), gases that cause stratospheric ozone depletion, play only a minor role in climate change. The depletion of the stratospheric ozone layer, including the ozone hole, is a serious environmental problem because it causes an increase in ultraviolet radiation, which can harm people, animals, and plants. This is a different problem from climate change.

The recent emphasis on ozone and aerosol cans has led to the belief that aerosol spray cans are a major contributor to climate change. However, we know that using aerosol spray cans has almost no effect on climate change. In the past, aerosol spray cans contained CFCs, which contributed to the depletion of the ozone layer (not the same as global warming). Under U.S. law, aerosol spray cans no longer contain CFCs.

Educational research tells us that most people believe that general pollution and toxic chemicals are major contributors to climate change. Scientific research tells us that most forms of pollution play little or no role in climate change. The invisible carbon dioxide released when coal, oil, and gas are burned is the single most important contributor to climate change. The burning of fossil fuels, such as coal and oil, to produce energy for electricity, heat, and transportation is the primary source of carbon dioxide, which is the most important contributor to global warming. Carbon dioxide does not contribute to general air pollution.

## Getting Ready (45 minutes)

---

### Activity One: Assessing Prior Knowledge, Questions, and Related Experiences

**FACILITATOR:** Distribute index cards to the study group. On the first card, participants should indicate something they know about air pollution. On the second, they should write one question they have about atmospheric pollution. And on the third card, they should describe a direct experience that they have had that relates to atmospheric pollution. For example, an individual might write:

Atmospheric pollution affects everyone.

How does air pollution happen?

It's hard to breathe when the atmosphere is polluted.

# Getting Ready

---

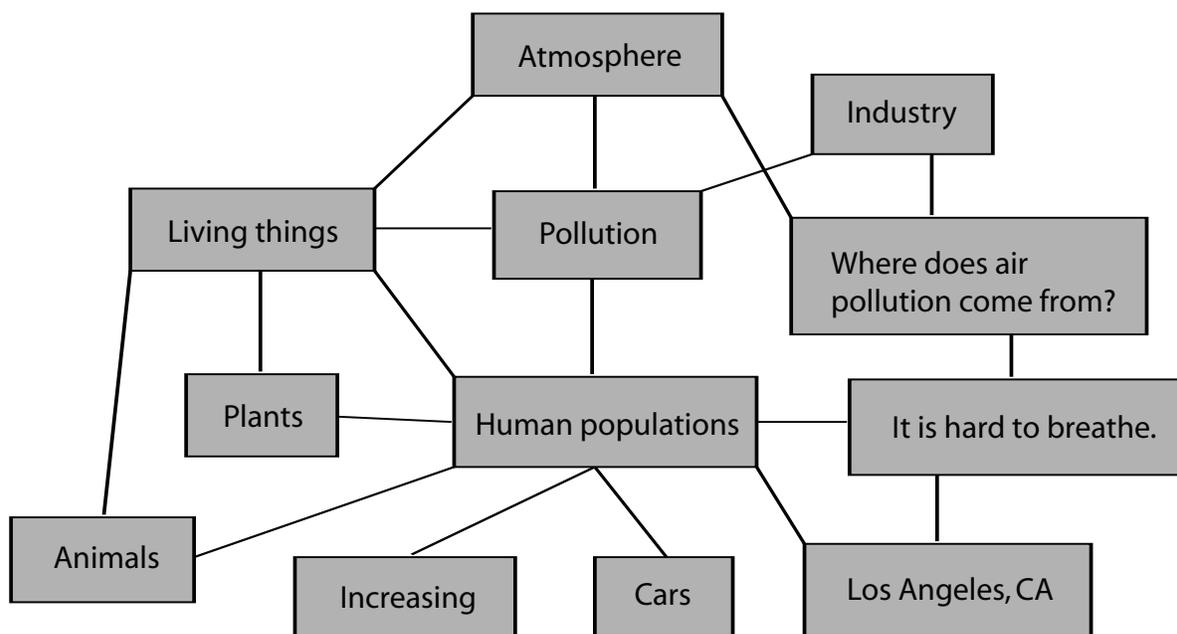


Figure 11.1 An example of a study groups' idea collection, with major subjects identified and the addition of the major focus ideas of the video. This activity links individual pre-existing knowledge with that of other members of the group and the unit content.

## Activity Two: Current Events & Editorial Cartoons

Participants will share an article that they have found that relates to the week's topic. All members of the group will share their headlines for the articles. The leader should ask a few people to summarize their articles and ask for comments from others with related articles. As the group discusses the articles, a participant should record key concepts and make a list. (Participants may choose to bring in a cartoon or an editorial related to the week's topic instead of an article.)

## Activity Three: Tree Leaf Symmetry

This activity creates appreciation for our natural resources by demonstrating to participants one aspect of the biosphere that is affected by atmospheric pollution. It is important to note that this activity is not meant to create understanding for the participant but to assist in the learning process.

**FACILITATOR:** You need to collect a good selection of representative sample leaves from a variety of locations. Keep them organized and bring them to the group meeting.

### Materials

Topographic map of local area of study, areas marked

Leaves

# Getting Ready

---

## Setup

1. Facilitator will collect leaves from a predetermined area and mark a map with the location of the area selected.
2. Facilitator will explain to participants that a normal healthy tree leaf will be bilaterally symmetrical, and that slight variations that occur in the right and left symmetry are usually caused by errors during the development of the tree or leaf. As the stress on the environment increases, so does the asymmetry.

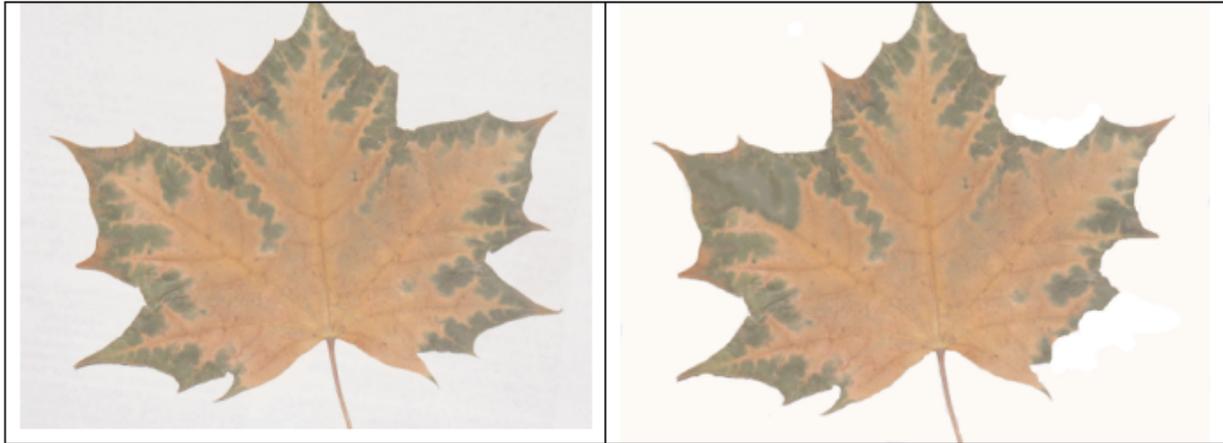


Figure 11.2a and 11.2b Photos of the different types of asymmetry seen in tree leaves

## Procedure

1. Trace an outline of each leaf and label.
2. Fold outline in half to compare the symmetry of each leaf.
3. Rank each leaf tracing in order from most to least symmetrical.
4. Assess the quality of the environment by asymmetry of the leaves that they examine.

## Discussion

1. What type of pollution causes one leaf's symmetry to be so radically different from the normal symmetrical leaf pattern?
2. What type of pollution was in the area where these leaves were collected?
3. Is the asymmetry of leaves found in other polluted areas different or similar?

# Video (45 minutes)

---

## Activity Four: Watch the Video

As you watch the video, think about the following focus questions:

1. Why is it important to study the atmosphere in relation to air pollution?
2. How do primary and secondary pollutants form?
3. What are the names and chemical formulas for three of the most studied pollutants (primary or secondary)?
4. What is MILAGRO?
5. Why is it important that we study Mexico City?
6. What is important about Aerodyne's mobile laboratory?
7. How are atmospheric pollutants measured?
8. What are some of the health risks associated with atmospheric pollution?
9. How long does it take for the global air to circulate once around the world?
10. What are some regional and global effects of atmospheric pollution?

## Activity Five: Discuss the Video (15 minutes)

Discuss the following questions about the video.

1. What implications does Aerodyne's mobile laboratory have for emissions monitoring and control of automobiles?
2. How does the temperature of each of the atmospheric layers affect the behavior or pollution?
3. Why is the creation of ground ozone harmful?
4. What can be done to decrease the air pollution that will be produced by an increasing world population?

**FACILITATOR:** Refer back to the misconception section and Activity One: Assessing Prior Knowledge. Has the video contributed to the participants' new understanding of concepts? Are there any changes the participants would make about the arrangement of their cards from Activity One?

# Going Further (60 minutes)

---

## Activity Six: Discussion of Local and National Air Quality

This activity encourages participants to apply their knowledge from reading the text and watching the video to answer questions related to specific situations and geographical areas. The EPA website located at <http://www.epa.gov/air/data/geosel.html> has various options for generating air quality reports that are region- or state-specific.

# Going Further

---

## Part 1

Generate a report for air quality in cities in the United States. Print out the report found at the EPA Web site for the United States, Air Quality Index Report, Metropolitan Statistical Area (MSA) summary type, for the year of 2006 (or later, if available).

The report includes data on 303 cities throughout the United States. Among the data, the group will find the air quality index, status of air quality, and levels of various pollutants such as carbon monoxide, sulfur dioxide, and ozone. Participants can compare and contrast the various cities. For example, they can compare the number of days the air quality was good, moderate, or unhealthy.

## Discussion

1. To what extent does the population of a city affect the number of days of satisfactory air quality?
2. What is satisfactory air quality?
3. To what extent does the geography of a city affect the number of days of satisfactory air quality?
4. Compare the local air quality conditions to other sites throughout the United States.

## Part 2

Go to the EPA website above and generate reports for the specific location of the group. At the web site:

Select the geographic area for the report.

Select the maps and reports you want for the group.

Select the types of measurements you want to consider.

Participants should examine the reports about their local area and then discuss what contributes to the status of air quality in their community.

## Activity Seven: Return to Essential Questions

The facilitator should draw the attention of the participants back to the essential questions posed in the Background Section of this unit guide. Discuss how the participants' ideas may have changed in regard to the questions. Discuss the most logical and complete answers to the questions.

## Activity Eight: Discuss Classroom Supplementary Activities

Following the Between Sessions section of each unit are Classroom Supplementary Activities. These activities are related to the unit topic and are suitable for middle and secondary science classrooms. If the participants in this study group are teachers, the facilitator should take the time to review these lessons. If participants are familiar with the lessons, they should describe how they have used them. Discuss how the classroom activities might be used in relation to a specific science topic and how the activities can help relate the unit topic to classroom lessons.

# Between Sessions

---

## Next Week's Topic Overview

In Unit 12, the emphasis is on global warming and climate change. You will read about Earth's past climate as well as the impact of human activities on our climate today.

## Read for Next Session

Read the Unit 12 Professional Development Guide background section. Consider the essential questions as you read the text. The misconceptions section will give you some insight into what misunderstandings people may have about global warming. Consider discussing the topic with your friends or students and discussing common misconceptions.

## Current Events

Bring in a current event article or cartoon related to global warming.

# Supplementary Classroom Activity 1

---

## Collecting Atmospheric Particles

### Introduction

This activity allows students to discover how many particles are in the air. This activity can be used to measure the amount of particles in the air at different locations. Examining the particles under a microscope can extend this activity.

### Materials

Circular paper filters

Vaseline

### Procedure

1. Apply a very thin layer of Vaseline on the paper filter.
2. Leave the paper filter in an area undisturbed for a pre-determined amount of time.
3. Examine the paper filter after the time has passed and draw conclusions about the quality of the air based on their findings.

### Results

Students can present their findings to the class or, as mentioned above, use a microscope to examine the particles and continue to do research about air pollution.

# Supplementary Classroom Activity 2

---

## pH and Plant Growth

Students will test plant growth with different pH levels, and, understanding that the pH scale is exponential, draw conclusions about acid rain's effect on plant life.

### Materials

Wisconsin fast plant seeds, or other fast-growing plant seed

Vinegar or lemon juice

Bicarbonate, such as baking soda

Film canisters with hole drilled in bottom

Shallow plastic pan

Re-usable kitchen wipes

Pre-cut "wicks" from kitchen wipe

pH test kit

Soil

### Setup

1. Prepare solution samples of varying acidic pH levels based on research about acid rain.
2. Place the wick through the hole in the bottom of the film canister, then plant the seeds approximately \_ to \_ inch below the surface of the moist soil.

### Procedure

1. Place the film canisters on a moist kitchen wipe that is laid in the bottom of a shallow pan. It is important to place all film canisters that will be watered with the same type of pH water in the same shallow pan; keeping a small amount of water in the shallow pan will water the plants.
2. Keep the plants under growing lights that are on a timer that closely resembles the natural daylight cycle, or keep them in the window to get natural light.
3. Water each group of plants with the designated water. Testing the pH of the water every couple of days would be advantageous.

### Results

Teacher and students should decide together on the format for reporting to the rest of the class. For example, they could create a lab report or present a poster that describes the experiment.

# Notes

---