



# WHERE DOES OUR POLLUTION GO?

**Lesson Concept:** Students will use maps showing global air currents to trace the movement of pollutants around the globe. This will demonstrate how one city's pollution can affect the lives of others around the world.

## Learning Objectives — Students will be able to:

- Identify the major air currents around the world.
- Explain how pollutants travel around the globe.
- Use the major air currents to trace the movement of pollutants generated from Los Angeles; Shanghai, China; London, England; New York; Bogota, Colombia; and Cairo, Egypt.
- Explain how mountain ranges affect wind patterns and movement of pollution.

**Link to *Air -The Search for One Clean Breath*** from Executive Producer Barbara L. Page



In the film, we learn that air currents can transfer pollutants around the globe in just a few days. This is called “transport.” Pollutants that originated in St. Louis can be transported to the Great Smokey Mountains National Park and breathed in by hikers there. Snowboarders in

Whistler, Canada, can breathe in pollution from China’s industrial cities.

## Materials

- Overhead transparency of world map, blank overhead transparency (for 5 groups).
- Large world map showing global mountains (or overhead transparency).
- Copies of the world map for each student.
- Overhead markers (one for each group).
- Two bottles of water. One with blue dye, one with red dye.

## Advanced Preparation

Make all necessary copies of materials.

## Time and Student grouping

Two class periods; Groups of three or four students.

### Teacher Tips

It helps if your students have an understanding of density and gas laws to understand why warmer air rises and colder air sinks. Try all demos before doing them in front of your class.

## Grade Level: 9-12

### California Science Standards

**HS Earth Science, 5 and 5.a.** Heating of Earth’s surface and atmosphere by the sun drives convection within the atmosphere and oceans, producing winds and ocean currents. **5.a.** Students know how differential heating of Earth results in circulation patterns in the atmosphere and oceans that globally distribute the heat.

### National Science Standards

**Grade 9-12 Energy in the Earth System.** Heating of Earth’s surface and atmosphere by the sun drives convection within the atmosphere and oceans, producing winds and ocean currents.

**Grade 9-12 Science in Personal & Social Perspectives.** Science and technology in local, national, and global challenges.

### Education and the Environment Initiative

#### Educational Principles and Concepts

**Principle IV:** The exchange of matter between natural systems and human societies affects the long-term functioning of both. As a basis for understanding this principle:

**Concept a.** Students need to know that the effects of human activities on natural systems are directly related to the quantities of resources consumed and to the quantity and characteristics of the resulting byproducts. **Concept b.** Students need to know that the byproducts of human activity are not readily prevented from entering natural systems and may be beneficial, neutral, or detrimental in their effect.

## Vocabulary

**Trade Winds:** The prevailing pattern of easterly surface winds found in the tropics near the Earth's equator. The trade winds blow predominantly from the northeast in the Northern Hemisphere and from the southeast in the Southern Hemisphere.

**Westerlies:** The prevailing winds in the middle latitudes between 35 and 65 degrees, blowing from the high pressure area around 30-35 degrees latitude, north or south, towards the poles.

**Polar Easterlies:** The dry, cold prevailing winds that blow from the high pressure areas of the polar highs at the north and south poles towards low pressure areas within the westerlies at high latitudes.

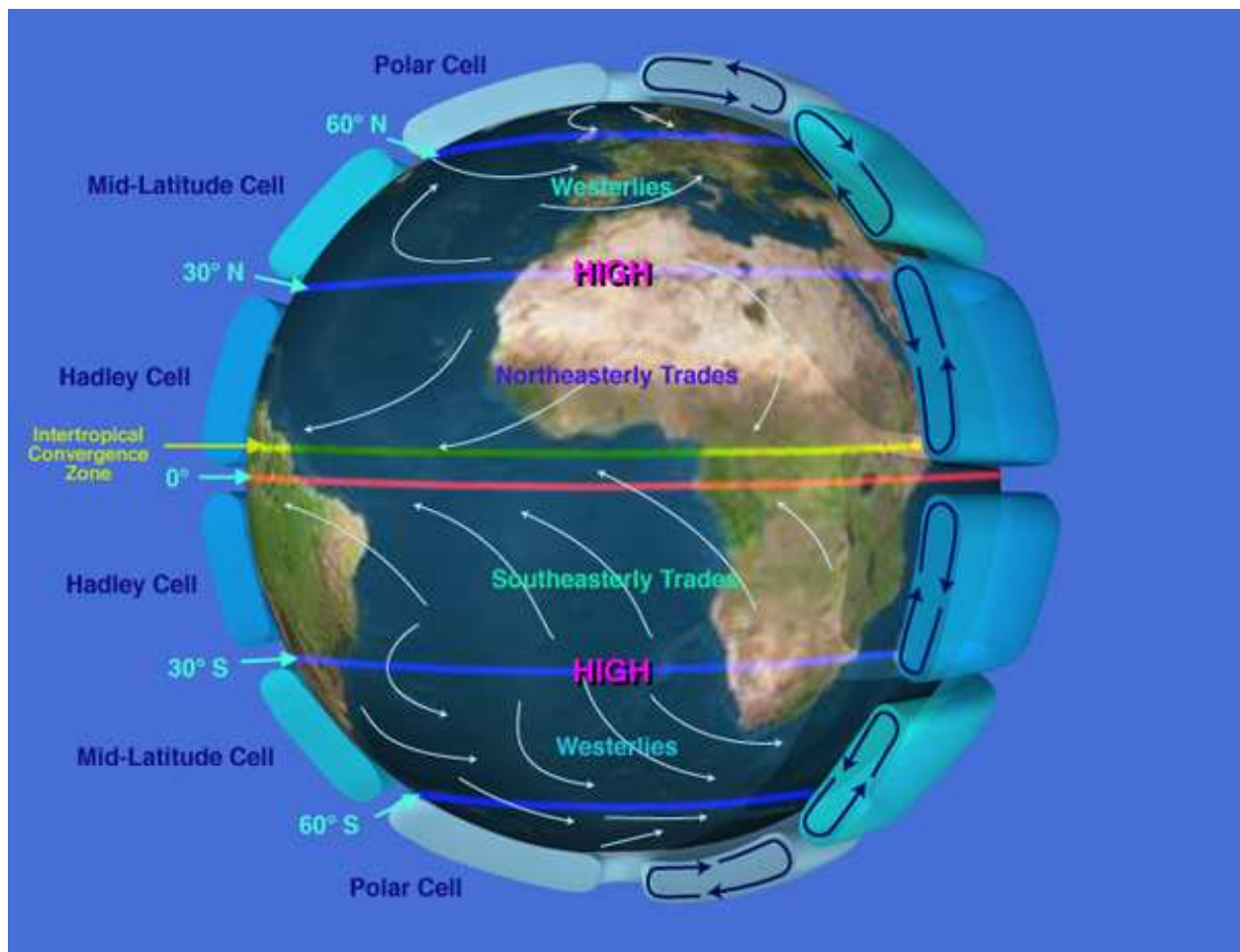
## Teacher Background

Winds can carry pollution around the planet, therefore, all nations are connected by air currents. Winds are caused by an uneven heating of the earth. Because the equator receives more direct sunlight, the air is warmed more, creating a band of warm, less dense air. This air rises and moves away from the equator. As it moves away from the equator, it cools, causing it to become more dense and sink at approximately 30° N and 30° S. As the air sinks, some of it moves back towards the equator and some of it moves towards the poles. At each pole, the air moves towards the equator. At approximately 60° N and 60° S, the cold polar air hits the warmer air that originated from the equator, causing both air masses to rise and re-circulate. This establishes the basic global wind patterns. There is an excellent animation at:

[http://trc.ucdavis.edu/biosci10v/bis10v/media/ch31/global\\_circ\\_v2.html](http://trc.ucdavis.edu/biosci10v/bis10v/media/ch31/global_circ_v2.html). Of course, winds do not move in perfect lines, they curve. This is due to the spinning of the Earth and is called the Coriolis Effect. The combination of the Coriolis Effect and the uneven heating of the Earth establishes the following surface global wind patterns: Polar Easterlies, Westerlies, and the Trade Winds. Winds are named for the direction from which they come. See image below from:

<http://sealevel.jpl.nasa.gov/overview/climate-climatic.html>. Geographical structures also play a large part in wind patterns. Mountains can trap air and pollution in valleys (i.e. Los Angeles, Denver, Mexico City, and Santiago, Chile) as a result of temperature inversions. For more information on inversions:

<http://daphne.palomar.edu/calenvironment/smog.htm>. Mountains can also protect areas from wind and pollution, when they are not on the windward side. Large bodies of water can also affect wind patterns. During the day, land masses heat faster than the water masses causing the air above land masses to rise and be replaced with the colder, denser air above the water mass. This results in winds moving from the water onto the land. At night, there is an opposite effect with winds moving from land out to the water as land cools much faster than water.



## Procedure

### Day 1:

1. Explain to students how air moves on a global scale. Start by showing the students the differential heating of the Earth and how this affects the movement of air. To illustrate the rising of warm air and the sinking of cold air, take two bottles that are completely filled with different temperature water (dye the warm one red and the cold one blue). Place a note card on top of the bottle containing the cold water as a lid. Invert the blue bottle and place on top of the red bottle. Very carefully pull the note card out from between the bottles and allow the water to mix. The warm water will be pushed up by the colder water sinking into the lower bottle. (<http://www.stevespanglerscience.com/content/experiment/00000091>).
2. Show the different global wind patterns, and explain how the Coriolis effect in conjunction with the differential heating has led to their development. Then discuss the effects of geography (mountains and bodies of water) on air movement. To illustrate the effect of temperature inversions, repeat the demo with the bottles of water, but reverse the order so the warm water is on top and the cold water is on the bottom. This time, the water will not mix.
3. Place students into groups of three or four and have them complete the *Where does our Pollution Go?* activity. Have the groups trace their answers onto a blank transparency that can be placed over the world map transparency.

### Day 2:

1. Have students present their source of pollution to the class. While other groups are presenting, students should be adding the pollution from the other cities to their own map and making corrections if mistakes are made. Each source of air pollution should have a different color on the map.
2. After all groups have presented, have students figure out where the pollution from your town goes. (If your town is relatively close to one of the cities presented, have students trace where they are receiving pollution from.)

**Closure:** Have students write a paragraph explaining how this knowledge will change the way they do things or think about things on a daily basis.

**Assessment:** Classroom presentations, Where does our Pollution Go?, closure paragraph.

**Extension:** Students can trace where they are receiving pollution from.

**Homework:** None

### Resources:

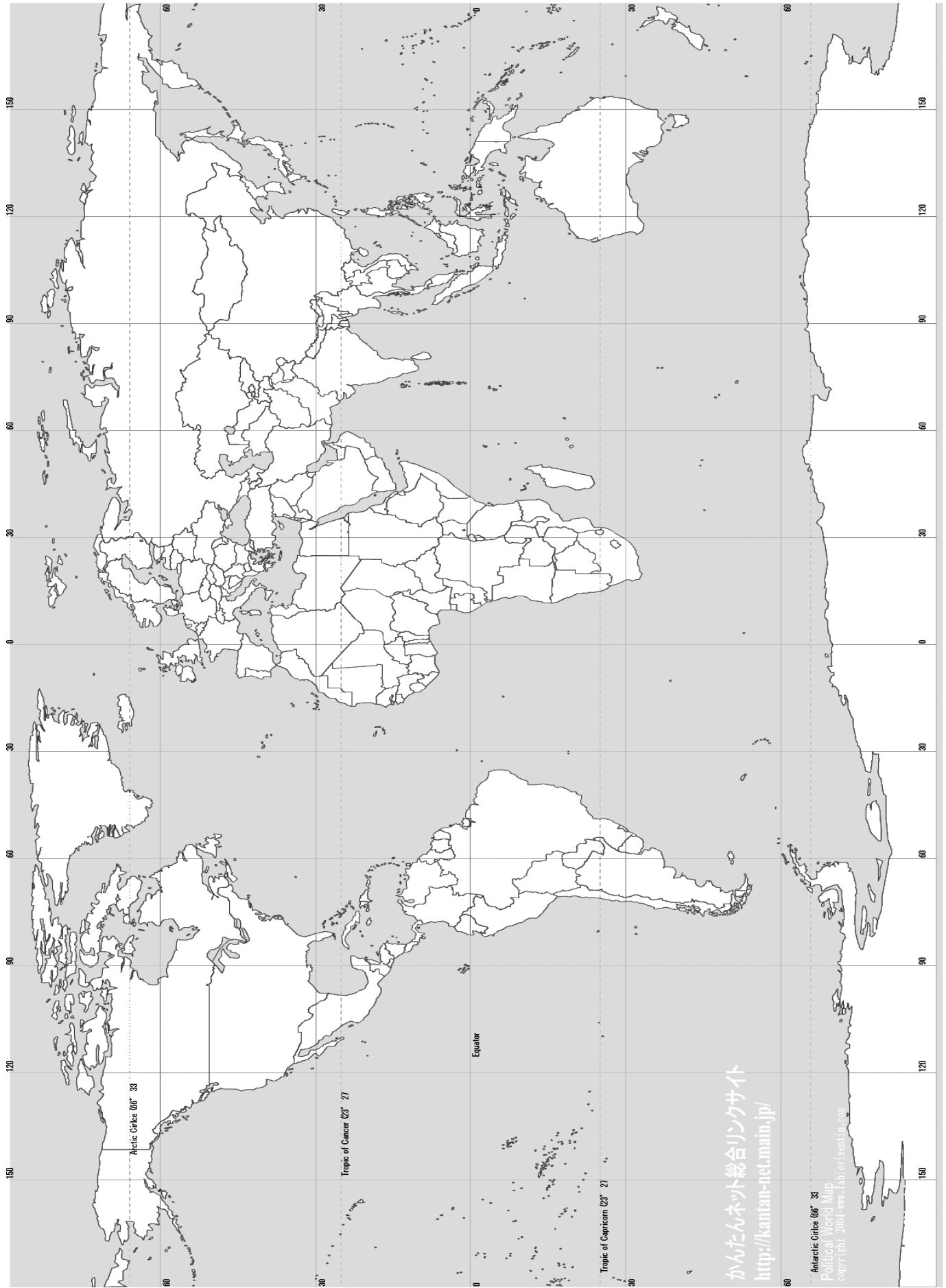
<http://www.stevespanglerscience.com/content/experiment/00000091>  
<http://daphne.palomar.edu/calenvironment/smog.htm>  
<http://sealevel.jpl.nasa.gov/overview/climate-climatic.html>  
[http://trc.ucdavis.edu/biosci10v/bis10v/media/ch31/global\\_circ\\_v2.html](http://trc.ucdavis.edu/biosci10v/bis10v/media/ch31/global_circ_v2.html)  
[http://kantan-net.main.jp/worldmap/world\\_map\\_gif.gif](http://kantan-net.main.jp/worldmap/world_map_gif.gif)  
[http://ww2010.atmos.uiuc.edu/\(Gh\)/home.rxml](http://ww2010.atmos.uiuc.edu/(Gh)/home.rxml)

### Related Web Sites:

[http://science.nasa.gov/headlines/images/dust-quick/dustmovie\\_big.gif](http://science.nasa.gov/headlines/images/dust-quick/dustmovie_big.gif)  
<http://www.ghcc.msfc.nasa.gov/GOES/>  
[http://www.cpc.noaa.gov/products/global\\_precip/html/wpage.gl\\_ir\\_loop.html](http://www.cpc.noaa.gov/products/global_precip/html/wpage.gl_ir_loop.html)  
<http://www.usatoday.com/weather/resources/basics/wworks0.htm>

# Where Does Our Pollution Go?

1. Explain how the shape and movement of the Earth contribute to global wind patterns.
2. On your world map, draw in the following global wind patterns for the northern and southern hemispheres:
  - a. Polar Easterlies
  - b. Westerlies
  - c. Trade Winds
3. On your world map, draw in the following mountain ranges:
  - a. Himalayas: (Northeastern border of India)
  - b. Alps: (Northern border of Italy)
  - c. Andes: (Western border of South America from the equator south)
  - d. Rockies: (Western U.S. and Canada)
  - e. Appalachian Mountains (Eastern U.S)
  - f. Atlas Mountains (Northern Coast of Africa)
  - g. Pyrenees (Northern border of Spain)
  - h. Ural Mountains (60° longitude in Russia)
  - i. Caucasus Mountains (Eastern Border of the Black Sea, 40° longitude)
4. On your world map, use the wind patterns to draw the path taken by pollution for the following cities. You will be responsible for presenting one of these to your class as assigned by your teacher. Plot each city's pollution in a different color.
  - a. Los Angeles, CA (34° N, 118° W)
  - b. Shanghai, China (31° N, 121° E)
  - c. London, England (51° N, 0° E)
  - d. Bogota, Colombia (4° N, 74° W)
  - e. Cairo, Egypt (30° N, 31° E)



# The World and its Major Mountain Ranges

