



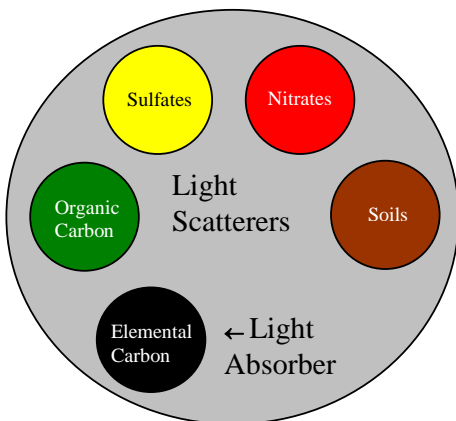
2003 Regional Haze & Visibility

New Jersey Department of Environmental Protection

THE BASICS OF HAZE

Small particles and some gases in the atmosphere can reduce visibility by scattering or absorbing light (see Figure 1). This is sometimes evident by a visible plume from an industrial facility, but when pollutants are well mixed in the atmosphere, they form a more uniform haze. Hazy conditions in New Jersey are primarily the result of fine particles that form in the atmosphere from gases. These are termed "secondary" particulates and are often the result of pollutants that are transported into the area on the prevailing winds.

Figure 1
Contributors to Visibility Impairment



ANATOMY OF REGIONAL HAZE

Data collected over the last decade show that visibility impairment is highest in the more industrial and highly populated areas of northeastern United States than in more rural western states. Sulfate (SO_4) is the dominant contributor to fine particle pollution and the resulting haze in this area. It typically accounts for 40% of the total fine mass in the region on clear days and can account for 60-80% of the total fine particle mass on very hazy days. Organic carbon typically accounts for the next largest portion of fine particle mass, about 20-30% on hazy days. The remainder of the mass comes from nitrate (NO_3), elemental carbon and fine soil particles.

PARTICLES AND VISIBILITY

Figure 2 shows the makeup of fine particles collected at the IMPROVE (Interagency Monitoring of Protected Visual Environments) site located north of Atlantic City in the Brigantine Wilderness Area.

The two charts compare the average pollutant composition on the days with the worst visibility to the days with the best visibility. Most visibility impairment is due to sulfate, which can have a greater effect on light extinction (a measure of visibility impairment) than all other types of fine particles combined. Higher sulfate values in the summer can be attributed to the greater photochemical conversion of SO_2 to SO_4 that results from the increased sunlight during the summertime. (Malm, 1999)

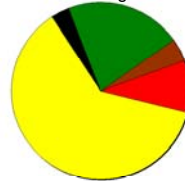
Figure 2
Composition of Fine Particles on Days With Good Visibility Compared to Days with Poor Visibility
Brigantine,
New Jersey, 2003

Average Fine Mass Composition on Days with Good Visibility



Ammonium Nitrate	0.49 $\mu\text{g}/\text{m}^3$	13.70%
Ammonium Sulfate	1.84 $\mu\text{g}/\text{m}^3$	51.70%
Elemental Carbon	0.15 $\mu\text{g}/\text{m}^3$	4.20%
Organic Carbon	0.88 $\mu\text{g}/\text{m}^3$	24.70%
Soils	0.21 $\mu\text{g}/\text{m}^3$	5.80%
Total 3.6 $\mu\text{g}/\text{m}^3$		

Average Fine Mass Composition on Days with Poor Visibility



Ammonium Nitrate	2.00 $\mu\text{g}/\text{m}^3$	9.5%
Ammonium Sulfate	13.1 $\mu\text{g}/\text{m}^3$	61.9%
Elemental Carbon	0.73 $\mu\text{g}/\text{m}^3$	3.4%
Organic Carbon	4.44 $\mu\text{g}/\text{m}^3$	21.0%
Soils	0.89 $\mu\text{g}/\text{m}^3$	4.2%
Total 21.1 $\mu\text{g}/\text{m}^3$		

HOW IS HAZE REGULATED?

In 1999, the U.S. Environmental Protection Agency announced a major effort to improve air quality in national parks and wilderness areas aimed at achieving national visibility goals by 2064. The Regional Haze Rule calls for state and federal agencies to work together to improve visibility in 156 National Parks and wilderness areas such as the Grand Canyon, Yosemite, the Great Smokies and Shenandoah. This "regional haze rule" addresses the combined visibility effects of numerous pollution sources over a wide geographic region and how they impact Class I areas. Class I areas as defined by the Clean Air Act, include national parks greater than 6,000 acres, wilderness areas and national memorial parks greater than 5,000 acres, and international parks that existed as of August 1977. The Wilderness Area located in the Brigantine National Wildlife Refuge is New Jersey's only Class I area. The rule requires the states, in coordination with the Environmental Protection Agency, the National Park Service, U.S. Fish and Wildlife Service, the U.S. Forest Service, and other interested parties, to develop and implement air quality protection plans to reduce the pollution that causes visibility impairment. The first State plans for regional haze is due in the 2003-2008 timeframe. Five multi-state regional planning organizations are working together now to develop the technical basis for these plans.

SOURCE OF HAZE CONTRIBUTORS

The following categories of air pollution are the major contributors to haze:

Sulfate particles form in the air from sulfur dioxide gas. Most of this gas is released from coal-burning power plants and other industrial sources, such as smelters, industrial boilers, and oil refineries. Sulfates are the largest contributor to haze in the eastern U.S., due to the large number of coal-fired power plants that affect the region. In humid environments, sulfate particles grow rapidly to a size that is very efficient at scattering light, thereby exacerbating the problem in the East.

Organic carbon particles are emitted directly into the air and are also formed by the reaction of various gaseous hydrocarbons. Sources of direct and indirect organic carbon particles include vehicle exhaust, vehicle refueling, solvent evaporation (e.g., paints), food cooking,

and various commercial and industrial sources. Gaseous hydrocarbons are also emitted naturally from trees and from fires, but these sources usually have only a small or short-term effect on overall visibility.

Nitrate particles form in the air from nitrogen oxide gas. This gas is released from virtually all combustion activities, especially those involving cars, trucks, off-road engines (e.g., construction equipment, lawn mowers, and boats), power plants, and other industrial sources. Like sulfates, nitrates scatter more light in humid environments.

Elemental carbon particles are very similar to soot. They are smaller than most other particles and tend to absorb rather than scatter light. The "brown clouds" often seen in winter over urban areas and in mountain valleys can be largely attributed to elemental carbon. These particles are emitted directly into the air from virtually all combustion activities, but are especially prevalent in diesel exhaust and smoke from the burning of wood and wastes.

Soils are very similar to dust. It enters the air from dirt roads, fields, and other open spaces as a result of wind, traffic, and other surface activities. Whereas other types of particles form from the condensation and growth of microscopic particles and gasses, crustal material results from the crushing and grinding of larger, earth-born material. Because it is difficult to reduce this material to microscopic sizes, crustal material tends to be larger than other particles and tends to fall from the air sooner, contributing less to the overall effect of haze.

Source – www.hazecam.net

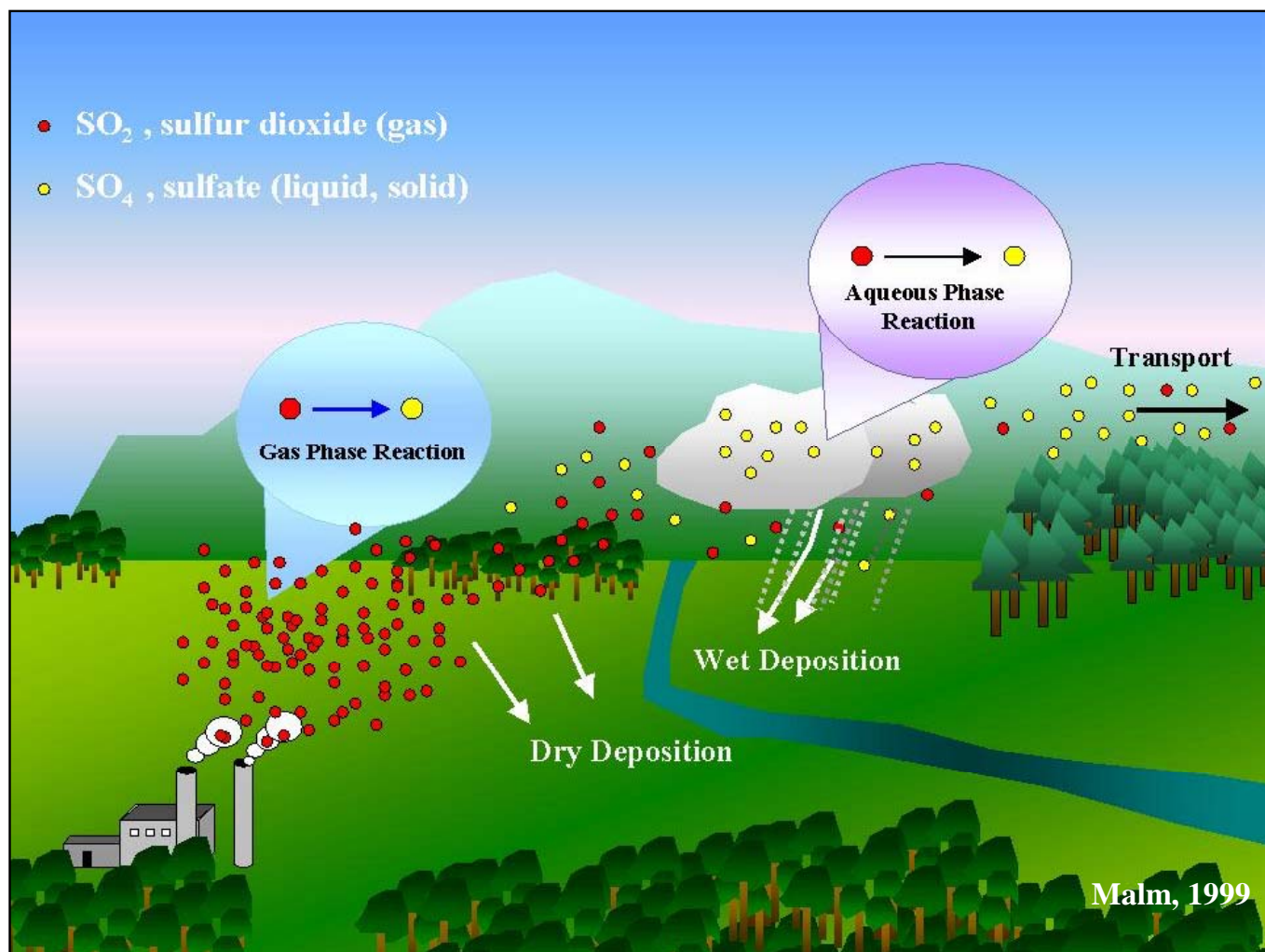
ENVIRONMENTAL EFFECTS

Regional haze is probably most closely associated with its effects on prized vistas such as the Grand Canyon or Acadia National Park. Its impacts may be difficult to quantify but it certainly has a negative overall effect on aesthetics and the outdoors, and how natural areas throughout the nation are enjoyed. But haze also affects urban areas and scenes, and can obscure or eclipse the view of an urban skyline (see Figures 5 and 6) or other important urban landmarks such as the Washington Monument.

The pollution that causes regional haze has additional,

multifaceted effects on the environment. The most abundant contributors to regional haze, sulfates and nitrates, eventually make their way into the ecosystem through deposition - that is, they are transferred from the air into the water and soils (see Figure 4). Too much deposition can have adverse environmental effects, upsetting the delicate balance of the ecosystem. Increased sulfates in the atmosphere leads to acid rain while increased nitrates promote eutrophication of streams and lakes by depleting available oxygen (see section on Atmospheric Deposition).

Figure 4
Illustration of How Sulfates and Nitrates Enter the Ecosystem by way of Deposition



MONITORING OF HAZE IN NEW JERSEY

Typical visual range in the eastern U.S. is 15 to 30 miles, or about one-third of what it would be without man-made air pollution. In the West, the typical visual range is 60 to 90 miles, or about one-half of the visual range under natural conditions. Haze diminishes the natural visual range. (www.hazecam.net)

Visibility and haze are monitored in two locations in New Jersey; Newark and Brigantine. The monitor in Newark measures the impact of haze on visibility by using a digital camera. The camera is located inside the New Jersey Transit building and is pointed at the New York City skyline. On clear days the entire skyline, as well as each individual building, is easily distinguishable (Figure 5). The Manhattan skyline appears nonexistent when conditions conducive to haze formation are in place (Figure 6).

Visibility Camera – New Jersey Transit Building

Figure 5



Figure 6



The IMPROVE site located within the Brigantine National Wildlife Refuge monitors haze and visibility using several types of instruments. Figure 7 below is an example of a clear day in Brigantine as the Atlantic City skyline is easily distinguishable along the horizon. The example of a hazy day in Brigantine is illustrated below in Figure 8 and not only has the skyline disappeared but the water that was visible in the foreground in the clear picture also seems to have vanished in the haze.

Visibility Camera – Brigantine National Wildlife Refuge

Figure 7



Figure 8



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