Fact Sheet SMC070E (1983)

Environment Canada Environnement Canada

ARCTIC HAZE

Historically, the Arctic has been perceived as having clean air and many an explorer has remarked on the ability to see enormous distances across the tundra. This clarity has been the undoing of travelers in the Arctic, as apparently nearby mountain ridges have turned out to be not merely 10 miles off, but 100 miles or more away.

ARCTIC HAZE — POLAR POLLUTION

Man-made pollution reaching the Arctic from the Soviet Union, Europe, and to a lesser extent, North America is adversely affecting the climate of the Northern Hemisphere.

This pollution, originally observed because it reduced visibility, has been labeled: Arctic Haze.

Although scientific research on the subject is very recent and still in progress, our understanding of the chemistry of the polar atmosphere has progressed remarkably in the last five years.

When the air is clear, one can theoretically see as far as 200 kilometres (125 miles) through the atmosphere. But when haze is heavy in the Arctic, visibility is often reduced to 30 kilometres (18 miles) or less. This haze was, in fact, first detected by pilots who reported that visibility was sometimes reduced to less than 20 km in the spring, even when no adverse weather was noted.

In the past five years our view of the Arctic as a clean, unpolluted environment has been drastically altered. Levels of suspended particles, originating from industrial activities further south, were found to be 20 to 40 times higher in winter than in summer. In winter the weekly average concentration of sulfate, a major component of the particles, is 2 to 4 micrograms per cubic metre of air while in summer it drops to 0.1 micrograms.

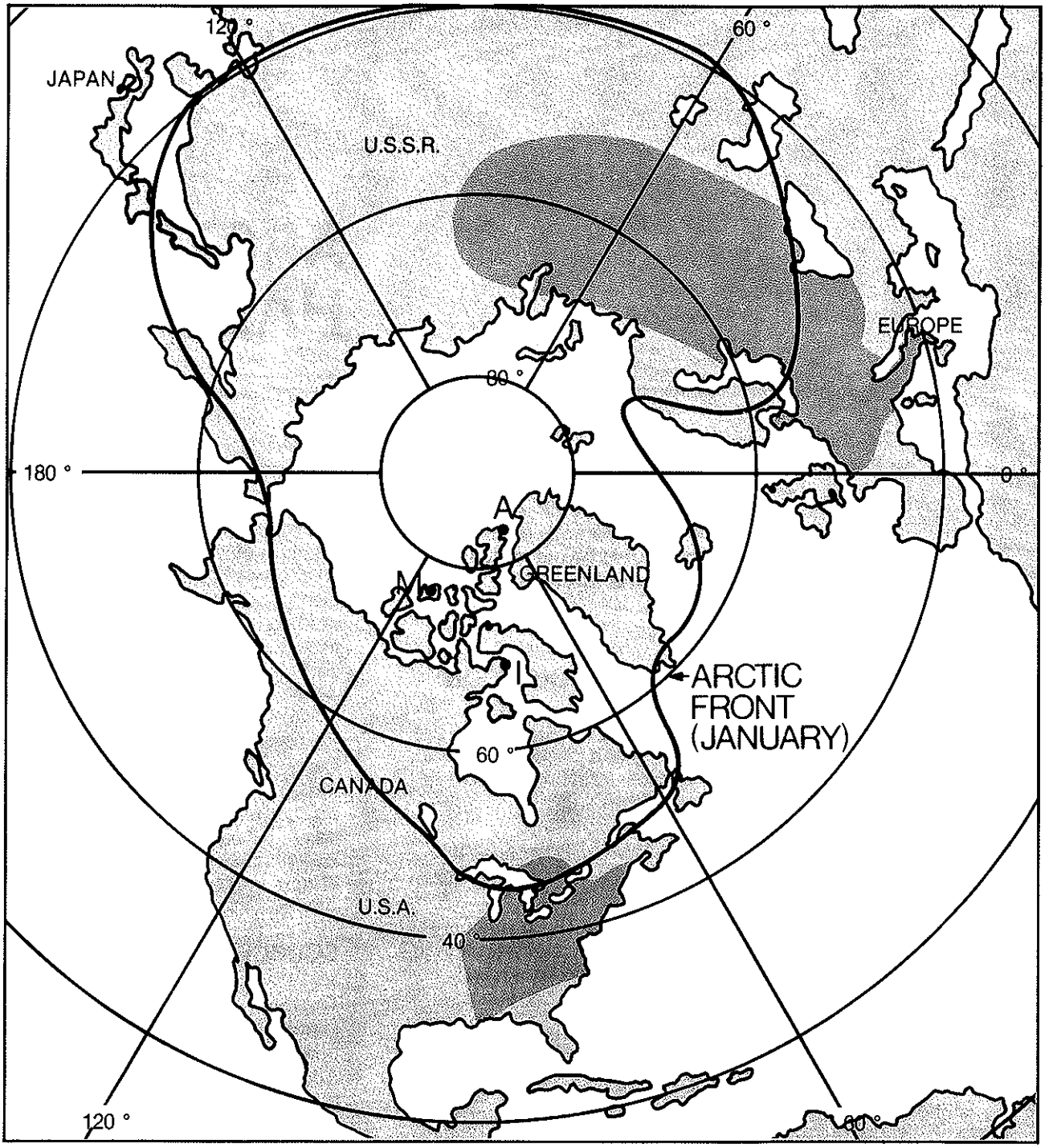
There is no historical record of Arctic haze levels but scientists believe it has paralleled the production rate of pollutants at mid-latitudes (30 to 50 degrees N.); that is, rising rapidly in this century. Certainly its occurrence has only been seriously studied in very recent years. Prior to 1977 very little was known about its extent, its sources, its composition, its pathways, its ultimate fate and deleterious effects.

Recently atmospheric measurements by Americans, Canadians, Norwegians and Danes have confirmed the existence of the haze in winter. Since the publication of such research, the phenomenon has received increasing attention. Scientists are now beginning to better understand that its effects may be highly significant and threatening.

SOURCES

The main sources of air pollution in the Northern Hemisphere that have a bearing on Arctic air quality are shown in the shaded areas of the map. Also shown is the average edge of the Arctic air mass during January and the location of Canadian air quality monitoring stations (M-Mould Bay, A-Alert, and I-Igloolik) operated by Environment Canada.

Prevailing winds pick up the pollution particles and carry them north in the Arctic air mass. For meteorological reasons, the main pathway of polar pollution is from European and Soviet Union sources, toward the north and northeast. Since most North American pollution is generated in the eastern part of the continent and blows eastward in the prevailing westerly winds, it does not greatly influence Arctic air quality.



The position of the Arctic air mass at that time of year (January) when pollution is at its peak. Colored area shows pollutant source areas. A characteristic of the Arctic air mass is that in winter pollutants persist much longer than in summer.

Canadian air quality monitoring stations

M — Mould Bay, Northwest Territories
A — Alert, Northwest Territories
I — Igloolik, Northwest Territories

In early winter, the Arctic air mass does not extend into Europe. Consequently, Soviet Union sources are expected to be the dominant sources. It is only in late winter and early spring that European sources play an important role.

CHEMISTRY

In the atmosphere the haze occurs as an aerosol — fine liquid or minute solid particles — containing roughly one-third sulfate compounds, one-third to one-half soot and hydrocarbons. The remainder is natural oceanic and soil material. Other pollutants are seen in minute amounts.

Sulfate suspended in air as particles consists of sulfuric acid and ammonium. The latter is produced when sulfuric acid reacts with ammonia. Soot seen in the aerosol is produced from combustion of fossil fuels such as oil, coal and wood.

Sulfate concentrations measured in the haze are about 10 percent lower than in highly populated areas in eastern Canada and the U.S. Correspondingly, the levels of acidity in Arctic snow are expected to be no worse than one tenth of the levels seen in eastern Canada.

This would suggest that the pH (the acidity/alkaline scale) of snow in the Arctic should be greater (less acidic) on average than 4.9. Measurements to date have confirmed this.

EFFECTS

There are currently three major potential effects of the haze. These are, in decreasing order of severity:

1) **Climate modification**. A slight warming of the air in the Arctic during the months of March, April and May has been predicted from computer models of sunlight absorption by haze. Even though slight, changes in Arctic air temperatures over areas as vast as the polar region can affect weather patterns in the Northern Hemisphere. This effect may be the most serious, and careful assessments are now being made.

2) **Acidification of land and water ecosystems**. Since levels of acidity are expected to be tenfold lower than those in eastern Canada, this is of less concern than climate modification. However, acid-sensitive areas in the Canadian north are being documented and the effects estimated.

3) **Degradation of visibility**. This is the most obvious and symptomatic effect of Arctic air pollution. Aesthetically, the reduction of visibility is undesirable. But there is little evidence yet to show that air pollution has been hazardous to air navigation in the Arctic.

MONITORING

Since 1979, Canada has been involved in an international Arctic air monitoring study with the United States, Norway, Denmark and, more recently, Iceland. Our participation is through the Atmospheric Environment Service (AES) of Environment Canada that operates a three-station air quality network at Mould Bay, Alert and Igloolik, Northwest Territories. Much of our present understanding of Arctic air pollution in Canada has been attained from information provided by this network.

In addition, intensive research studies have been undertaken. In 1982 at Igloolik, Northwest Territories, Environment Canada conducted a sampling study by aircraft to measure the vertical distribution of the haze and characteristics of particles.

In the spring of 1983 we carried out joint studies by aircraft with the United States and Norway for a program called the Arctic Gas and Aerosol Sampling Program (AGASP).

FUTURE ACTIVITIES

Canada will continue to participate in international studies. In May 1984, Canada will host the Third International Symposium on Arctic Air Chemistry. Reports of current research on the origin and effects of Arctic air pollution presented there should more clearly define the problem of Arctic haze. It may initiate an international effort to curb this potentially threatening polar problem.

In any case, it will widen the collective knowledge of those studying the phenomenon, assisting the embryo research that has been initiated in Canada and elsewhere.

Canada

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