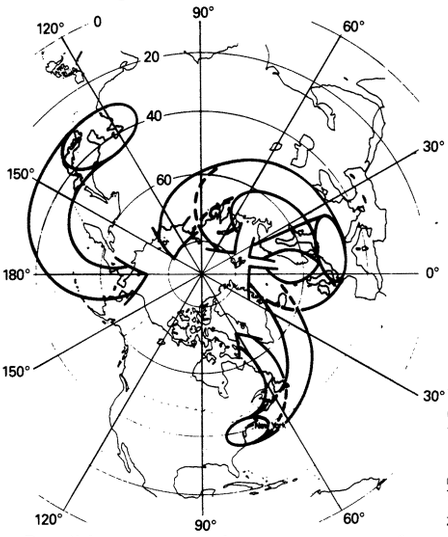
Chilling hints of a warmer Arctic

The Arctic may be remote but it is not pristine. Each spring, a layer of tiny black carbon particles — believed largely generated in the Soviet Union — hovers in the atmosphere in the North American Arctic, where it may cause warmer temperatures. In March and April scientists from the United States and other nations will embark on a study of the layer and the ways it might influence world climate.

The layer, first identified in 1957, is known as "Arctic haze." The project will integrate results taken during flight missions from Barrow, Alaska, Ny Alesund, Norway, and the Canadian Northwest Territories. The program follows six years of research sponsored by the Office of Naval Research (ONR) showing that during winter and early spring, high concentrations of carbon-rich particles appear over regions of the Arctic (SN: 1/27/79, p. 56). The heating effect, estimated to average from a few tenths of a degree to 1°C, is believed to occur in spring when both particles and sunlight are plentiful. During winter particles are also abundant, but because there is no sunlight there is no change in the amount of energy reflected or absorbed. In summer there is no warming effect because no pollutants arrive and precipitation washes the remaining particles from the atmosphere.

Lead researchers on the ONR project are Kenneth A. Rahn of the University of Rhode Island in Kingston, and Glenn E. Shaw of the University of Alaska in Fairbanks. They report in Naval Research Reviews (3/82) that air currents across the North Atlantic are inefficient in transporting pollutants from North America to the Arctic, and that North America's contribution is slight. The main source, they contend, is the central Soviet Union, where industry is based mainly on steel production and on activities through which large amounts of coal are burned.

"We put two and two together and got 3.9," Rahn says. "There are still some uncertainties, but I feel comfortable we're on the right track." The conclusion is based on two lines of inquiry. First the researchers considered the ratio between the elements manganese and vanadium in the airborne particles. The differences, Rahn says, were consistent with "what we saw by studying the differences between particles coming from Europe and what we thought would be coming from the Soviet Union." The researchers then took a careful look at meteorological maps of the periods when particle, or aerosol, concentrations over the Arctic were high. "Now it's very clear, I think, that there is a major pathway out of the central Soviet Union and to a lesser extent out of the western Soviet Union, which plops the aerosol right up in the middle of the Arctic," Rahn says. "Without a whole lot of trouble it can continue a little bit farther to Barrow," where measurements are recorded at the Navy-operated observatory. So far, he says, efforts to involve Soviets in a cooperative research project on Arctic haze have failed. Soviet Embassy officials in Washington said they were unfamiliar with the findings.



Naval Research Reviews

Possible sources and transport routes for airborne pollutants between midlatitudes and the Arctic.

While "no hard cause and effect link" has been found, researchers anticipate that at least two processes will affect Arctic climate, says James T. Peterson of the National Oceanic and Atmospheric Administration in Boulder. The first effect may be a change in the amount of solar energy reflected and absorbed in the Arctic. The carbon-rich particles are efficient absorbers of solar radiation, which may mean that clouds will retain more heat, warming the atmosphere. The second factor is that as the particles settle to the ground, the snow will become dirty and will reflect less light. The total result, he says, will be a warmer Arctic climate.

Rahn also worries that the aerosol ultimately may affect the formation and reflective properties of clouds by providing more nucleants — the particles around which snow and ice crystals form.

A final, and troubling, aspect of the haze is that it occurs at the very latitudes where climate models show the earth is most sensitive to change. The global warming expected to result from build-up of atmospheric carbon dioxide (CO_2) could be compounded by warming caused by Arctic haze. The haze could be a "red herring," says Robert Cess of the State University of New York at Stony Brook. A change that is perceived as a sign of CO_2-induced warming in fact could be regional warming caused by the haze. —*C. Simon*

Obsidian dating: Look ma! No carbon-14!

Archaeologists may now be able to date artifacts sculpted from obsidian — the shining black volcanic glass—by a simple, inexpensive method without using radioisotopes, according to a newly reported study. Since ancient cultures throughout the world used obsidian to manufacture knives, arrowheads and other tools, the method promises to be widely used.

The technique is based on obsidian's tendency to form a hydration rim with passing time. Exposed to the atmosphere, water vapor diffuses through the artifact's surface. Hydrogen ions from the water replace positively charged ions such as sodium in the glass as the rim forms and thickens just below the surface. If scientists know the rate of hydration and measure the thickness of the rim, they can calculate the age of the object. Although archaeologists have known about this method for more than 15 years, they have never been able to get absolute ages directly from the obsidian because the rate of hydration varied from artifact to artifact. They had to calibrate this rate against the absolute ages of samples known by other methods such as carbon-14 dating.

In the Jan. 21 Science, Joseph W. Michels of Pennsylvania State University, Ignatius S.T. Tsong of Arizona State University and Charles M. Nelson of the University of Massachusetts report that they measured obsidian samples' rates of hydration in the laboratory by speeding up those rates at higher temperatures and pressures. They used what Tsong, a physicist, called "a hydrothermal bomb, a kind of pressure cooker." Since the process also depends on composition, which differs from site to site, they tested samples of two different compositions from the Prospect Farm site of southwestern Kenya. After determining the increase in rim thickness as a function of time in each obsidian type, they measured the rim thicknesses of artifacts from the site, determined their ages and compared some of these ages to those measured by carbon-14. The two sets of ages agreed closely.

"The advantage of the method," says Tsong, "is it's cheap. All you need is an optical microscope to measure the hydration rims," once the calibration curve for obsidian from a given site is known. "Second, it has the advantage of dating very old artifacts." Carbon-14 cannot date artifacts older than 14,000 years. In this study, the team measured ages ranging from 250 to 120,000 years old. In some special cases, depending on obsidian's resistance to hydration, the rims could be used to measure artifacts as old as 500,000 years, according to anthropologist Michels. Archaeologists have found obsidian artifacts in the Americas, the Mediterranean Basin, East Africa and the South Seas. —*A. Chen*