

present technological era and during the agricultural and hunting eras is an increase in diversity and rate of change rather than extent."

Regionally, the result of such activities is alteration of runoff, heat transport and surface winds, which in turn affect soil moisture, temperature and erosion rates. But globally, modifications in land use affect the albedo or reflectivity of the earth's surface, which in turn affects global circulation and thereby climate. All changes except urbanization increase the earth's albedo and cool the planet, say the researchers. Climate models suggest that a global albedo change of 0.01 from its value of 0.30 will produce a surface temperature change of about 2°K. Sagan and co-workers estimate the global albedo change of the "past few millennia" at 6×10^{-3} , which is enough, they say, to drop the world's temperature by about 1°K. By contrast, they estimate the global albedo change for the last 25 years at 1×10^{-3} , an amount that suggests a global cooling of about 0.2°K. (According to the researchers, the global average temperature has dropped 0.2°K since 1940, even with the effect of CO₂.)

The leading cause of the change in global albedo is desertification, say the researchers. They estimate that 9 million square kilometers, or 1.8 percent of the earth's area, has been changed by humans to desert by overgrazing or other destruction of vegetation or overpopulation. Altering that much of the earth's surface has caused a 4×10^{-3} change in global albedo. Areas given over to desert by human hand include the Rajasthan Desert of India, the Sahel south of the Sahara, Lebanon and parts of Iraq.

Clearing of tropical forests has altered 7 million square kilometers; that of temperate forests has altered 8 million square kilometers. The resulting albedo change is 1×10^{-3} and 6.5×10^{-4} , respectively. Deforestation, the researchers suggest, may have been responsible for the extreme cold period in the Northern Hemisphere known as the Little Ice Age (1430 to 1850). A fourth process, salinization, changes albedo by exposing bare ground and by creating salt flats. It has affected 600,000 square kilometers and changed albedo by as much as 4×10^{-4} .

But none of this lets modern humans off the hook. For example, continued deforestation — particularly that occurring in the Amazon — may pose a major global climate threat, the researchers suggest. Satellite studies of global land usage and studies of historical land modification are needed, they say. "We believe that the effects of humans on both ancient and modern climates are not insignificant in comparison with other causes of climate change. ... Such work holds the promise not only of elucidating past climate changes and their possible human origin, but also of providing insight into the climate of the future." □

A solid twist for accelerator beams

Particle physics and solid state physics often collaborate. The beams of accelerated protons, electrons, and such that particle physicists use to study the nature and structure of subatomic particles can also be used to study the structure of solids. To a proton or an electron a solid is mostly empty space, and sometimes when the particle beams hit the crystals they go right through.

This transparency phenomenon, called channeling, is being investigated for its possible advantages to both branches of physics by a team of researchers led by Timothy E. Toohig and Richard A. Carrigan of the Fermi National Accelerator Laboratory at Batavia, Ill., and Edward Tsyganov of the Joint Institute for Nuclear Research at Dubna, 70 miles north of Moscow. It will be the first example of United States physicists going to the Soviet Union to do experiments since 1970.

Channeling takes place in extremely perfect crystals, which have a precisely regular array of atoms. This regular array leaves unobstructed channels between planes of atoms. Particles that enter the channels in the right way are constrained to move along them by the forces exerted on them by the atoms in the walls of the channels. And so the particles go right out the other side of the crystal.

Experiments done at Fermilab's Meson Laboratory and at Dubna showed that channeling was indeed an actual phenomenon. It then occurred to Tsyganov to see what would happen if the perfect crystal were carefully bent. Would the particles follow the curve of the channel or would they blast out the side of the

crystal at the curve? He found out that the particles follow the curve.

If this curving phenomenon works at higher energy, it could be very useful in the technology of particle accelerators. "Calculations show that by using crystals in certain applications, we can bend high energy beams by a factor of about 1,000 more than by use of conventional magnets," says Toohig. When accelerators get to the trillion electron-volt energy range, he says, a crystal a meter long could be used for "promising applications in certain parts of accelerators." One such part is the touchy business of extracting beams from accelerators to send them to experiments some distance away. A septum consisting of an array of wires is now used to deviate the beam. A crystal in that place could exert stronger bending forces on the particles. It should also wear better. "If we lose beam on them [the wires], we cut them away like butter," says Toohig.

The high energy experiments will be done at Serpukhov, another physics research center in Russia. The international collaboration was chosen because it seemed efficient to pool material and intellectual resources, especially since the Soviets had perfect crystals readily available, some of which were made in the Salyut space station. Serpukhov is the site of the most powerful Soviet accelerator, a proton synchrotron of 70 billion electron-volts energy. Toohig plans to leave for Serpukhov early in the year. There, he says, in addition to the channel bending, "we plan to explore other aspects of this fascinating marriage between high energy physics and solid state physics." □

Ozone: Worldwide, many-faceted problem

Only international efforts will be able to protect stratospheric ozone against depletion by chlorofluorocarbon emissions, according to the second part of a National Academy of Sciences study. The first part (SN: 11/17/79, p. 340) concluded that if worldwide use of the chemicals continues at current rates, stratospheric ozone will be depleted by 16.5 percent (twice the previous estimates) by late in the next century. The NAS committees say that a "wait and see" approach is not feasible; the United States should take the lead in initiating an international program for control of chlorofluorocarbons.

"Whatever happens, it happens worldwide," John W. Tukey of Bell Laboratories and Princeton University told reporters. The United States now produces less than half of the world's chlorofluorocarbons, since the ban on nonessential use of the chemicals in aerosol spray propellants (SN: 5/21/77, p. 324). "We have shown the way," Tukey says. "It really wasn't very difficult to get rid of them [the propellants]."

However, few other countries have followed suit.

Aerosols, although a major source of emissions, are not the whole problem. The NAS report points out that chlorofluorocarbons are being used in more and more industrial processes, and regulators should consider steps to control other uses. Even if chlorofluorocarbon use as aerosol propellants was eliminated in all countries, nonpropellant uses are growing so rapidly that within ten years they alone could produce the current level of total chlorofluorocarbon emission. Tukey says, "We are now at the place where no one thing, other than banning aerosol propellants, is going to make a vital change. We have to go onto several fronts, many fronts."

Today major emitters of chlorofluorocarbons in the United States are automobile air conditioners, manufacture of plastic foams (such as for cushions or packing material) and industrial processes for cleaning metals. Other chlorofluorocar-

bon uses include home refrigerators, sterilization of medical equipment, clothes cleaning and fast-freezing of foods. Max S. Peters of the University of Colorado says that the committee on alternatives for the reduction of chlorofluorocarbons emissions selected three areas — foam production, metal cleaning and medical instrument sterilization — in which committee members believe chlorofluorocarbon emissions could be reduced within a few years by developing and applying new processes. Currently no adequate alternatives are available for most of the chlorofluorocarbon uses. Options to encourage such changes would include taxes on the chemicals, quotas, public education and bans.

Incentives for containing and recycling the chemicals could also decrease emissions. For instance, automobile air conditioners might be redesigned to reduce the amount of chlorofluorocarbons released. But a new design would have no effect on the millions of air conditioners already on the highway, from which the chemicals are released when they are serviced.

"We are not recommending a ban for anything," says Hugh D. Guthrie of SRI International. "We just want a reasonable understanding of what can be done and a rough estimate of the cost." Peters agrees: "Our job is not to make recommendations, but to present alternatives to the EPA and Congress."

The NAS committee on the impacts of stratospheric change concluded that the clearest threat is to human health. If the ozone in the stratosphere were decreased 16.5 percent, increased ultraviolet radiation would cause several hundred thousand more cases of skin cancer annually in the United States alone. Several thousand of those cases probably would be the severe, untreatable skin cancer called melanoma. Thomas B. Fitzpatrick of Harvard University says, "We are not certain but we have a high degree of suspicion that melanoma is related to ultraviolet light."

The committee also evaluated the much more limited evidence for ozone depletion effects on crops and seafood species (SN: 12/29/79, p. 423) but was unable to make quantitative estimates of potential damage. The overall climatic effect of chlorofluorocarbon release was calculated as only a few tenths of a degree Celsius, a smaller increase than previous estimates.

In a press release issued after the NAS report, DuPont Co., a major manufacturer of chlorofluorocarbons, says the government should wait for completion of the scientific studies now underway before taking action. The company says that the predicted ozone effects are based only on theoretical calculations rather than actual measurements and that within four years research results should permit "the conclusive determination of whether ozone depletion is occurring." □

NCI's saccharin study results

In 1977 President Jimmy Carter signed into law a moratorium on the saccharin ban proposed by the Food and Drug Administration until more knowledge could be obtained about the suspected relationship between saccharin and bladder cancer. The knowledge was to be garnered by two organizations — the National Academy of Sciences and the National Cancer Institute. The NAS was to examine existing scientific data linking saccharin with bladder cancer in animals, and the NCI was to conduct a large epidemiological study to see whether bladder cancer victims were saccharin users.

The NAS reported its results in 1978: Saccharin is a weak carcinogen and is also able to enhance the carcinogenic action of other chemicals. Now the NCI is reporting its preliminary results: They are pretty much the same as those of the NAS.

Specifically, the NCI set up a \$1.5 million study, the largest of its kind ever conducted. From 1978 to June 1979 some 3,000 newly diagnosed bladder cancer patients and some 6,000 control subjects were interviewed about their past and present use of artificial sweeteners (saccharin or cyclamate). (Cyclamate was the predominant artificial sweetener in use during the 1960s; after the FDA banned its use in 1970, saccharin became the only artificial

sweetener available in the United States.) Preliminary findings from the interviews indicate that there was no increased risk of bladder cancer among artificial sweetener users in the overall study population. However, heavy users of an artificial sweetener (those consuming six or more servings of it a day or two or more diet beverages containing it a day) showed a 60 percent increased risk of bladder cancer, and subjects who both heavily consumed an artificial sweetener and who smoked cigarettes heavily (two packs a day for men, more than a pack a day for women) also showed an increased risk of bladder cancer. Although further analysis of study data will be needed to separate with precision the effects of saccharin and cyclamate, scientists conducting the study tentatively conclude (based on these results plus those from previous experiments in lab animals) that while saccharin is not a strong carcinogen it should be regarded as a risk factor for human bladder cancer.

The FDA will now evaluate the NCI study findings. Says Jere E. Goyan, FDA commissioner: "I reiterate my concern about the consumption by so many Americans, especially young people, of large amounts of saccharin. More than half the subjects in this study were 67 years old or older, and therefore consumed much less artificial sweeteners than their children and grandchildren are today. We may have to wait 20 or 30 years to assess the possible effects on our young people of consuming large amounts of a weak carcinogen." □

Hooker Chemical sued for chemical dumps

Happy holidays? Not for the Hooker Chemical Co. and its parent firm, Occidental Petroleum Corp. Both were hit last month in a major salvo launched by the Justice Department at the Environmental Protection Agency's behest. Charging chemical contamination from four inactive chemical dumps in the Niagara Falls, N.Y., vicinity, including one known as Love Canal, the Justice Department is asking more than \$117 million to clean up the sites where Hooker buried wastes and those regions where chemicals migrating from the dumps now jeopardize human health. The suits also seek more than \$7 million for fines and reimbursement of federal agencies that provided emergency aid at Love Canal.

Olin Corp. was indicted on similar charges for a site adjoining Hooker's 102nd Street dump (SN: 5/26/79, p. 348). Having itself dumped some 66,000 tons of chemicals there, Olin would be required to share cleanup costs with Hooker for the 102nd Street site.

EPA scientists found 82 toxic chemicals — including 10 known carcinogens — in air, water and soil samples near the dumps. The four suits charge that chemicals stored at the sites and now found to be migrating from them pose "an immi-

nent and substantial endangerment to health and the environment." For instance, chemicals from the "S" area landfill — one of the four sites — have migrated into the Niagara Falls municipal water-treatment plant, threatening the city's drinking water. High levels of dioxin, a deadly chemical, are flowing down the Bloody Run creek from the Hyde Park site, another of the dumps. And it was only a little more than a year ago that the state health department asked for an evacuation of small children and pregnant women from the 25-square-block Love Canal vicinity. Chemicals buried beneath the community had been found percolating up into the yards and homes of residents.

The Love Canal Homeowners Association just completed an informal "pregnancy outcome" survey for the year ending December 1979. Only two of 12 births to women who lived at Love Canal throughout their pregnancy were normal; the rest resulted in miscarriages, stillbirths or deformities. Hoping to document problems such as those indicated by the survey, the Justice Department is asking that Hooker pay for lifetime-long human-health studies of all Love Canal residents and their children. It would also make Hooker clean up or buy Love Canal homes. □