The agreement lists specific international meetings for presenting results of the Mars probes, as well as of lunar exploration. It also suggests meetings "to recommend experiments to be considered by the two sides in planning their respective research programs . . ." and meetings "to propose complementary activity by one party during planetary investigations conducted by the other. . . ." Taken together, these two suggestions, if fulfilled, would eliminate expensive duplications. For example, if both nations sent spacecraft to Jupiter, one craft could carry a spectrometer, the other, a magnetometer; or, both craft could be atmospheric probes, but in different regions.

The Soviet Union says it will send scientists to give papers at the 3rd Annual Lunar Science Conference in Houston next January. A similar conference will be held in the Soviet Union in February or March 1973.

Lunar maps made by each country to a scale of 1:250,000 will be exchanged by the end of December 1971. All lunar photography, past and future, will be exchanged, the first transfer to be completed by March 31, 1972. And finally the two countries will exchange future lunar samples in the same way they did samples from Luna 16 and Apollo 11 and 12.

In the area of earth resources, the agreement is even more specific.

Two sites in the Soviet Union and two in the United States were selected as analogous sites for aerial and spacecraft observations on land. They are: Tsimlanski—a flat steppe plain, cultivated in the main and composed of friable deposits; Ustyurtski—a desert plateau with some grazing land and some below-sea-level depressions; South Dakota—a relatively flat, dry land agricultural area; and Arizona—a desert area with rapidly growing urban centers. Eleven other sites are designated "complementary"—four in the Soviet Union and seven in the United States.

Each nation will make spectrophotometric, photographic, multispectral, thermal and microwave surveys of the sites from space. Each will make geophysical, spectrometric, meteorological, geological, soil and geobotanic observations and measurements from the ground as well. Both ground testing and the similarity of sites will allow accurate calibration of the sensors. At Tsimlanski and in South Dakota, for example, there will be conducted water and snow inventories, agricultural crop inventories and productivity estimates and studies of hydrogeology, structural geology, microclimatology and soil.

Ocean studies will be concerned primarily with sea-surface temperatures, sea-surface roughness, ocean biological productivity and sea-ice conditions. The Soviet Union plans to deploy several research ships in the eastern tropical Atlantic in 1972 primarily for meteorological purposes. It also has meteorological satellites (Meteors) equipped with infrared radiometers. The U.S.S.R. proposes "to send one oceanographic research vessel to one of the two sites in the North Atlantic in 1973 where large horizontal temperature gradients prevail: the Gulf Stream east of Cape Hatteras and the polar front between Iceland and Canada."

The United States programs are similar. The first meteorological exchange will be of "temperature soundings" from satellites by June 1, 1972. Each nation plans to participate in the Global Atmospheric Research Program's Atlantic Tropical Experiment in 1974.

Exchanges of sounding rocket research data will begin in January 1972.

The recommendations are the result of meetings in Moscow Aug. 2 to 6 by joint study groups set up by the January agreement between the two nations (SN: 5/1/71, p. 303). □

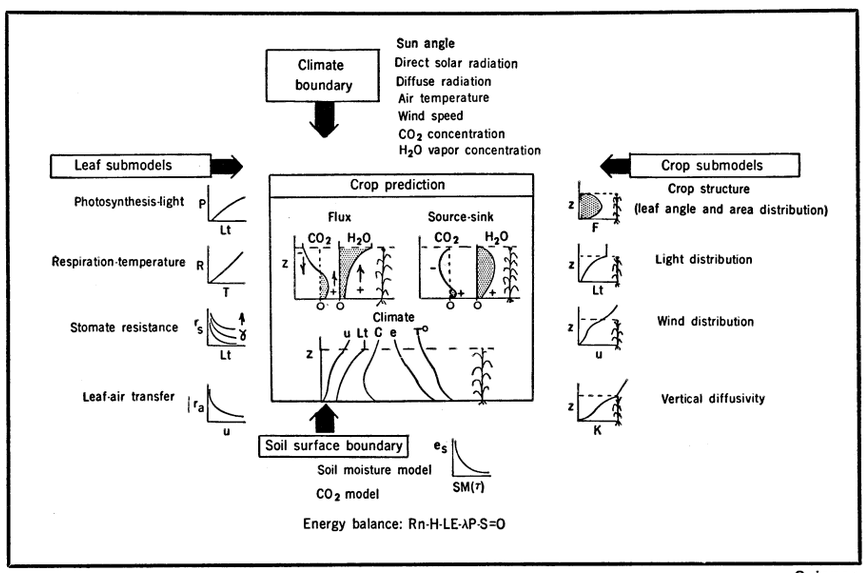
SPAM: A computer views a cornfield

If there is one criticism International Biological Program biome scientists tire of hearing, it is: why haven't the biome studies produced quick tips on crop and land management? To which they testily reply that the biome studies weren't designed to answer such questions (SN: 10/22/71, p. 282). The hope of the critics, however, may now be in sight—a cornfield model that may answer questions not just about cornfields but about other kinds of agricultural environments.

Edgar Lemon and his team at the U.S. Agricultural Research Service in Ithaca, N.Y., have spent a decade carrying out extensive studies in cornfields. They then applied a systems analysis approach to the data they had collected in order to establish various factors in a pecking order of importance within the total ecological picture. What they have come up with is a mathematical model, or computer simulation, of the typical cornfield. They call it SPAM, for soil-plant-atmosphere model. The SPAM effort is reported in the Oct. 22 SCIENCE.

Some of the information that SPAM has pulled together illuminates little-understood plant-soil-air interactions. Most persons, for example, are aware that photosynthesis uses energy from sunlight to fix carbon dioxide into organic materials. When CO_2 and oxygen in both photosynthesis and respiration are transferred across wet surfaces within leaves to the dry external atmosphere, water is unavoidably lost in evaporation. (This process is called transpiration.) SPAM documents what meteorologists and hydrologists have suspected for some time: that transpiration uses most of the energy absorbed by plants from solar radiation. Almost 600 calories are required to evaporate a cubic centimeter of water. Transpiration from leaves and direct evaporation from the soil surface also accounts for a large share of water loss. The tremendous amounts of energy these processes use are directly controlled by plant and soil characteristics.

Essentially SPAM can give answers in two areas. Given the various leaf and plant community traits and the external climate, the model can predict the microclimate in a plant community and at the leaf and soil surfaces. The model can also predict the activity of the leaves and plant community in such processes as photosynthesis, res-



Science

Inputs and predictions of SPAM mathematical soil-plant-atmosphere model.

piration, evaporation, transpiration and heat exchange. SPAM has found, for example, that changing the leaf angle of a crop would not have nearly as much impact on net photosynthesis as some other factors, and plant breeders and agronomists are already putting this discovery to practical use. SPAM predictions about evaporation also hold practical value for hydrology, forestry, agriculture and water-resource planning. But although SPAM can predict net photosynthesis (net carbon dioxide uptake), it cannot serve as a model for plant growth or crop yield. Net photosynthesis is the major component of growth and yield, but not the only relevant factor.

There has been talk in some quarters about using carbon dioxide from sewage or industrial outfalls as a crop fertilizer, provided the compound can be made economically available for this purpose. SPAM has come up with some predictions that could influence any decisions in this direction. While directly fertilizing plants with generous amounts of CO_2 could increase midday photosynthesis up to 45 percent, most of the CO_2 would be lost to the atmosphere. Hence such application would not be economical. The atmosphere supplies crops with 80 to 90 percent of the CO_2 they need for normal growth under normal CO_2 evolution from the soil.

If the carbon dioxide emitted into the atmosphere from burning fossil fuels continues to increase at the rate it is going for the next hundred years, plant photosynthesis at that time, SPAM predicts, would be 10 to 20 percent higher than it is today. Such a bonus for photosynthesis from chemical pollution is also hinted at in a report issued by the Institute of Ecology (SN: 10/9/71, p. 244). This report states that CO_2 levels in the atmosphere are rising and that laboratory studies show a linear relation between photosynthetic rates and CO_2 levels. Hence manmade increases in CO_2 are expected to enhance photosynthesis in terrestrial vegetation. □

A morning-after pill

A morning-after pill has long been sought as an emergency method of contraception. It would be useful in cases of rape and when other means of contraception failed or were not used.

Such a medication may now be possible says Lucile Kirtland Kuchera of the University of Michigan Health Service in Ann Arbor. She reports in the Oct. 25 JOURNAL OF THE AMERICAN MEDICAL ASSOCIATION that 1,000 women of child-bearing age were given, within 72 hours of intercourse, 25 milligrams of diethylstilbestrol twice daily for five days. Of the 1,000, 890 had used no form of contraception. No pregnancies resulted. Under normal circumstances the probability of conception from a single act of coitus is between 1 in 50 and 1 in 25.

The drug however does have side effects in some cases. Among the minor side effects are nausea, headache, vaginal spotting, dizziness and diarrhea. But, the report states, no serious side effect was known in any of the 1,000 cases while taking the drug or afterward. And 45.2 percent of the patients had virtually no side effects. □

Man and marine ecology: Crisis in the estuaries

Much of the world's population is concentrated in coastal cities. The interiors of continents—America, Asia, Africa, Australia—are sparsely populated by comparison. (Europe is a peninsula full of embayments and estuaries.)

This concentration is cited by W. Frank Blair of the University of Texas (and chairman of the U.S. Committee for the International Biological Program) as a conspicuous example of the failure of ecological planning in the past and an important area where the future demands such planning. "It is my firm belief," Blair told the National Biological Conference of the American Institute of Biological Sciences in Miami Beach this week, "that the final three decades of this century will be a crucial period respecting man's future as a passenger on spaceship earth. It must be a period of ecological planning."

Lack of such planning in the past, says Blair, resulted in a system of dams that trap the fresh-water outflow from the continent. The result is an upset of salinity regimes in the estuaries that acts to the detriment of these, the most biologically productive sections of the marine ecosystem.

To add insult to injury, estuarine areas are polluted with municipal and industrial wastes. Much of this pollution comes from petroleum and its products. Although there have been some optimistic reports lately on the long-term effects of specific oil spills, the evidence gathered over the past two years by Max Blumer of Woods Hole Oceanographic Institution after a spill at West Falmouth, Mass., seems still valid (SN: 3/14/70, p. 263): The effects are probably severe and widespread but often subtle and insidious and by no means fully understood.

The problem is that petroleum, though it is an organic material, has been sequestered geologically. According to R. E. Kallio of the University of Illinois, crude oil contains between 50,000 and a million complex organic compounds that may not be amenable to biodegradation. Microorganisms capable of degrading the compounds have never evolved because microorganisms have never been exposed to them.

"Will the organisms be able to evolve the enzymes necessary" to attack these unfamiliar compounds and thus remove them from the marine food chains, Kallio asks. Nobody knows the answer.

If the compounds—particularly the "heavy end" fractions made of large cyclic hydrocarbons—are not degraded, marine biological disasters may result. Blumer turned up strong indications that most petroleum hydrocarbons are quite toxic, but there are so many that it will take a large research effort to identify them all, let alone measure their ecological effects. Some of them are similar to synthetic compounds that are carcinogenic. And Kallio warns that certain of these hydrocarbons even in very small quantities may interfere with chemical signals between say, predators and prey.

Some petroleum compounds that do biodegrade do so over "a much longer time than anticipated," says Kallio, citing recent work at the University of Illinois. Outside the laboratory, in cold Arctic waters for example, the rate of degradation could be slower.

In the face of such problems the outlook for rational land-use planning in estuaries and coastal wetlands is dim, according to George P. Spinner of Deltona Corp. Only Delaware among East Coast states has zoned its coasts for natural-resource protection as well as industrial development, he says. The cost of reclaiming already damaged areas is immense, he adds—about half a million dollars to clean up only 70 miles of the Delaware River for one example.

Lack of data is a serious problem in planning for coastal areas, as it is in other branches of the ecological sciences. "In some parts of the zone no one has even compiled a list of the fish that inhabit the area," Spinner says. In contrast to this approach, engineers have made precise analyses of the "kilowatt-hours or tons of steel or gallons of water" a given population will require. Fisheries scientists must begin to make the same kind of input to the planning process, he opines, by telling planning agencies how many bays, marshes and estuaries must be preserved as breeding grounds for marine animals.

In this—as in other ecological problems—the major obstacle, says Blair, may be that "the ethic that all growth is good and that an equilibrium or steady-state system is bad will die hard in the United States." □