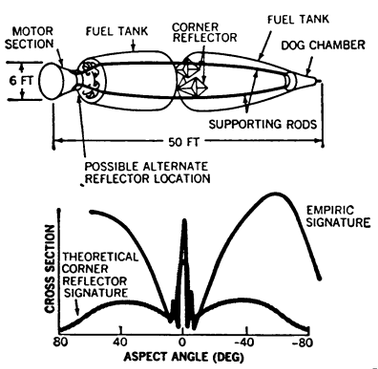
than 12,000 pounds for both the Apollo capsule and for Voskhod 2, the previous Soviet manned flight in 1965.

This means that it was far from the heaviest spacecraft ever launched by the Russians. Proton 1 and 2, described by the Soviet Union as "physics laboratories," each weighed some 27,000 pounds, and the Proton 3 mission is believed to have carried more than 60,000 pounds into orbit around the earth. This is about the combined weight of an Apollo capsule and the rocket that will carry it from its earth orbit to a lunar one. U.S. officials thus reason that a manned mission, perhaps in a Soyuz spacecraft, using the same kind of huge booster that carried Proton 3, would be capable at least of making a non-landing flight around the moon.



UPI

Radar analysis pictured Sputnik 2.

Monitoring of Soviet communications also helps to cut holes in the secrecy screen. NORAD's tracking stations are located in Alaska, Greenland, England and Turkey, but even within the continental United States are listening posts which provide valuable information. Though there were no public Soviet announcements about trouble during the flight, one California outpost overheard a broadcast saying that Komarov fought for control of his spacecraft for three orbits before bringing it down into the atmosphere. The message said that there had been difficulties in attitude control and communications, and that the spacecraft had been using too much power.

The Russians did not announce where the spacecraft had crashed, except to say that it was somewhere in the Ural Mountains. But another listening post caught a piece of a message saying that it was near the city of Sverdlovsk, about 675 miles from the Baikonur space center from which it was launched and about 180 miles from the spot where the previous Soviet manned flight landed.

Though there is a lot of information thus unofficially available to the U.S. space analysts, there is one upcoming plum they'd like to have. Within a day after the tragic end of the flight, Soviet space officials announced that an official review board would investigate the accident in detail. The results of the investigation, if it is indeed a rigorous one, will certainly not be made public, and if it provides the same exhaustive space program survey as appeared in NASA's report of its own tragedy on Jan. 27, the Russian report would be a prize indeed for U.S. spies.

Draft Changes

While draft legislation faces vocal opposition in Congress, the Pentagon is quietly preparing an executive order to do away with the draft deferments for graduate students.

It is not known exactly when the President will issue the order, which complies with recommendations the National Advisory Commission on Selective Service sent to the White House earlier this year (SN : 3/18), but Government officials believe it will not be retroactive.

Whether or not deferments will still be granted to undergraduates remains an open question, or a White House secret, officials say, but the President has definitely decided that when a man finishes college he should stand as much chance of being called into service as anyone else.

Social Science Study

Domestic programs have increasingly aimed at a base in the social sciences in the last five years. Poverty, crime, urban chaos, poor health and education—all will supposedly yield to a well-designed program based on social research.

The aim is fine, but the research is hard to find, a House subcommittee report said last week.

The report came in four volumes and represented the first major investigation into Federally sponsored social research. Put together by sociologist Dr. Harold Orlans of the Brookings Institution, the report charges that too much Federal research is trivial, repetitive or simply not applied to the burning domestic issues.

It also makes clear that both Government and social scientists are responsible for research whose quality and utility is questionable.

The report, however, only raises questions; it makes no recommendations. Public hearings will be held later to determine whether agencies can be prodded into action or if legislation must be proposed.

Federal support for social and behavioral research has increased fivefold since 1960 and this year stands at $380 million. Money is being spent not only by old line agencies, such as Health, Education and Welfare, Defense and Agriculture, but by the newer agencies—the Office of Economic Opportunity, the National Aeronautics and Space Administration, Arms Control and so forth.

Evaluations of how much good this money is doing are hard to come by, the report charges.

Of 21 agencies queried on the relevance and quality of their research, only two had answers of any consequence. Six others claimed they do have procedures for evaluation, but gave little information; seven did not bother to answer at all.

Besides Government agencies, the House investigators sent inquiries to well-known scientists, private researchers and foundations. Their views, published in full by the subcommittee, represent a span of opinions, from endorsement of the kind of research supported by Government to harsh criticism.

Tornadoes, a Mystery

Hundreds of tornadoes maul the surface of the earth every year, taking hundreds of lives and smashing all but the sturdiest of man's works, yet they remain one of the least understood of natural phenomena.

Those that killed more than 50 people and caused more than $20 million worth of damage in Illinois alone on April 21 underscored man's total helplessness against their fury.

Tornadoes, 1966. And no solution.

While meteorologists can predict with fair certainty the broad areas where tornadoes are likely to form, they can neither pinpoint the exact locations of future funnel clouds nor do anything about them once they have formed.

The best anyone can do—as was done in the eight states visited by the April 21 twisters—is issue a tornado watch, a warning to the community that atmospheric conditions are right

for tornado formation. As issued by the Weather Bureau, these usually cover an area of about 100 by 300 miles.

From then on, notes Dr. Edwin Kessler, director of the National Severe Storms Laboratory, Norman, Okla., the only way to tell if a tornado is forming is to watch the sky for a funnel cloud. When one is spotted, the Bureau issues a tornado warning which is broadcast by radio and television stations to the community. It is a signal to take cover immediately.

Last year, the Bureau catalogued 579 tornadoes that raked all but seven states of the Union, causing 100 deaths and a quarter of a billion dollars in damage.

There is plenty of general information on tornadoes, Dr. Kessler observes, but the sort of precise data needed for scientific study is just not available yet. Nonetheless, he believes meteorologists are beginning to develop an understanding of the storms.

This summer, researchers from the center plan to examine Oklahoma tornadoes with the help of two doppler radar units. They hope to zero in on the storms from different angles with the radars, then correlate data from each of them to yield more information on their activities and makeup than could be obtained from a single observation point.

It will be a long time before anyone can predict the point where a twister will form, Dr. Kessler cautions, and longer still before anyone can do anything about them.

"We don't exclude weather modification as an ultimate objective," he says, "but it's not around the corner." (See page 432)

Federov at WMC

An eminent Russian meteorologist foresees, in our time, a scientific victory as colossal as space flight and ocean exploitation: control of climate as well as weather.

Moreover, he warns that the world's scientists better start now to try for climate control. Else all the space, nuclear, and industrial activities—notably pollution—might set off a chain of events that could destroy our climate.

Prof. E. K. Federov, director of the Leningrad Institute for Experimental Meteorology, talked boldly of climate modification within 20 years at the Fifth World Meteorological Congress, which ended last week. As he outlined current Russian activity in his field, it sounded closely parallel to that of the United States (See page 243).

Soviet scientists in several experiments have dissipated clouds over areas of several thousand square kilometers, changing the state of the lower atmosphere, and raising daytime temperatures by 7 or 8 degrees (C). They have created a weak anti-cyclone, dispersing clouds.

The Russians also now have conduced many experiments to protect crops from hail by preventing the growth of large stones. They spray reagents from anti-aircraft shells and rockets in a cloud zone identified by specially designed radar sets. Last year, more than two and a half million acres were protected. The cost is 2 percent of the value of the crops saved.

On climate control, Federov spoke like a surgeon contemplating a patient. He urged global intervention in the process, suggesting several possible operations.

• Destruction of the Arctic Ice Cap: The Soviets believe that once destroyed, the ice cover would not reform. The changed pattern of the atmospheric circulation would keep the naked Arctic Ocean relatively warm, they suspect.

Tass/UPI

Twin cyclones from Russian satellite.

• Deflecting Ocean Currents: "A change lasting for some time in the temperature of the surface waters over a considerable part of the ocean could serve as the jolt needed to alter the circulation of the atmosphere," Federov says. "It will be possible to change this temperature by deflecting ocean currents."

• Altering Snow Cover: By speeding or slowing thawing or by creating snow artificially over large areas, meteorologists could influence the heat exchange between the atmosphere and the earth's surface, the Russian says.

• Interfering in Stratospheric Processes: Artificial changes in the upper layers of the atmosphere could change the activity below. Federov notes that there are only limited quantities of matter up there and small amounts of energy are transferred.

"But major changes in climate will be triggered only if the reactions cause a chain of events in a given direction, leading to planned modifications of the atmospheric circulation pattern," Federov emphasises. "This must be a stable modification, with no mistakes in forecasting it. Here, and not in the technical side of the matter of the expenditure of energy, lies the fundamental difficulty."

Meanwhile, he fears that "the rapid increases in the heating of the lower layer by industries and transport, the introduction of new ingredients, combustion products and industrial pollutants into the atmosphere, the change in moisture circulation due to land improvement and finally important changes in the composition of the upper layers by the rapid developments in space, all inevitably affect the complex of hydrometeorological processes which determine climate."

Deliberate intervention, he believes, will be a bulwark.

"The sooner we intervene deliberately . . . the better chance we have to avoid setting off chain reactions that might affect climate in an undesirable direction."

Pain

The experience of pain appears to be a high level mental affair, not a simple reflex action.

Feelings of pain have been found to be influenced by subjective states, such as expectation and attention. And there is no direct relationship between feeling pain and physiological reactions. In other words, the body may react to hurt while an individual does not feel it.

Moreover, through post-hypnotic suggestion, people can deaden pain from only one part of their body—a single hand for instance. Such discrimination implies a high level process.

Dr. Ernest Hilgard of Stanford University, well known for his work on hypnosis, told a National Academy of Sciences audience in Washington last week that about a tenth of the people