

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 conducted 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,



Tass/UPI  
Twin cyclones from Russian satellite.

the ice cover would not reform. The changed pattern of the atmospheric circulation would keep the naked Arctic Ocean relatively warm, they suspect.

• **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 emphasizes. "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