METEOROLOGY

Weather Next Season?

Not content with foreseeing weather 30 days ahead, the aim of the U.S. Weather Bureau's new research attacks on forecasting is seasonal or yearly outlooks, Ann Ewing reports.

➤ THE WEATHER BUREAU is now prognosticating 30 days ahead but is aiming at outlooks for three months in the future. The first of these maps to be made public, although not routinely issued, was for the winter of 1962-63. For the first part of the winter the prognostication appears good.

The seasonal forecasts will mean intelligent estimates of winter blasts in early December and of summer's heat in early June. Computers, satellites and air mass analyses are the main ingredients of Uncle Sam's improved predictions.

Continuous Research

Back of all U.S. Weather Bureau forecasts, whether for today or tomorrow or five days from now, is a continuing research program to find out how and why the world's weather behaves as it does. This research is two-pronged: one, a blend of theory and operation; the other based on pure theory.

The programs are complementary, and neither would be possible without the use of giant electronic computers. Both also make use of every available bit of weather information, including that garnered by such weather satellites as Tiros VI and its younger brothers.

The aim of both programs is to make all weather forecasts more accurate than ever, as well as to make predictions for the season or, hopefully, even for a year. To do this, more understanding of what happens in the atmosphere is needed since there is an awful lot of weather—two million tons of air for each person on earth.

This ocean of air is always in motion, driven by energy from the sun. Heated more at the equator than at the poles, the atmosphere tries constantly to equalize its temperature and in the effort creates winds and weather. The winds and the weather are steered by the earth's rotation and, as they move around the earth, are also affected by the topography—mountains, plains and oceans.

The result is an amazing complexity of weather events that never repeat themselves exactly.

However, after four years of experiment and study, Jerome Namias and his co-workers at the Weather Bureau's extended forecast branch, which he heads, have had sufficient faith in their ability to see the broad outlines of what is likely to happen weatherwise during this winter that they have allowed the seasonal map of expected temperature patterns to be issued.

The outlook in general was that the East and the Gulf Coast states were in for a tougher than usual winter, with more snow than customary over the northeast quarter of the country and with temperatures mostly below normal and precipitation above normal. For most of the rest of the country, conditions were foreseen to average from about normal to mild.

Weathermen consider December, January and February as the winter season because the weather patterns for these months resemble each other more closely than those for March, when winter officially ends.

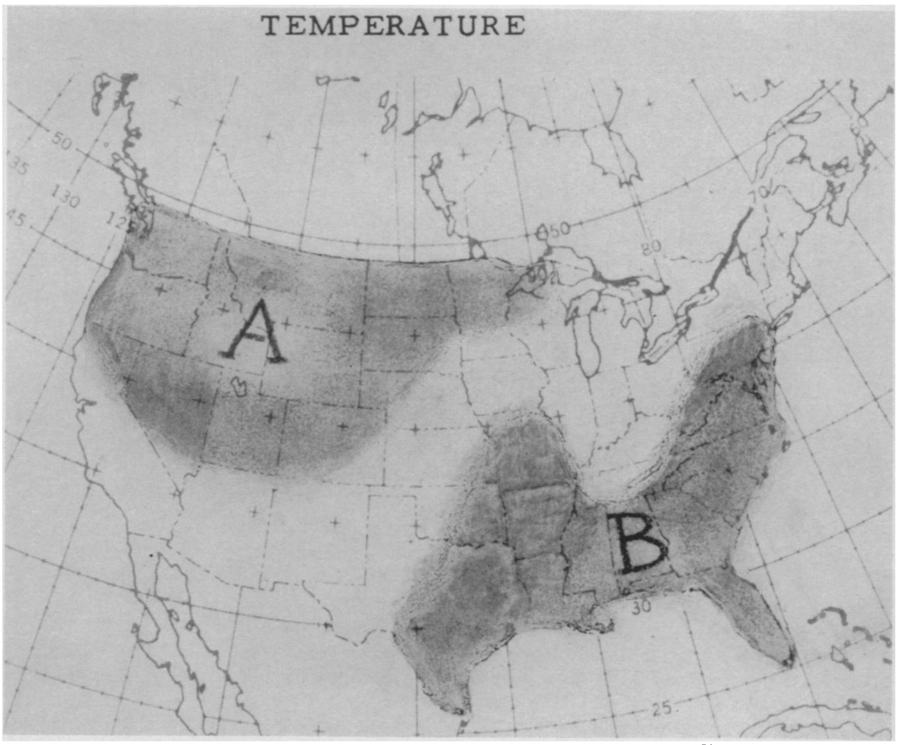
The seasonal outlook is based on the expected patterns for surface weather resulting in part from the changes in positions of crests and troughs in the jet stream. This is a high-altitude band of meandering winds circling the earth with a major effect on movements of storms.

Because so much understanding is needed to make weather forecasting a science rather than an art, Mr. Namias bases his research into long-range forecasting on what he calls a "semi-empirical approach." This means taking into account what is known and observed about the weather and how patterns change and then, after analysis, deciding what would be the most fruitful problems for research.

It is one way of attacking the extremely complex situation the atmosphere presents. A recent development that shows a good deal of promise, called "specification," is the work of William Klein, also of the extended forecast branch. Specification is a technical term for interpreting the upper air wind currents in terms of surface weather. It answers the question of what temperature might be expected if the wind pattern is known.

One important factor that Mr. Namias considers in making five-day forecasts is the effect of ground cover on weather. Large areas of snow, for instance, such as are now blanketing much of the Midwest and Northeast, act to make already cold air masses even chillier.

This abnormal cold can then affect the wind patterns that helped to bring the snow in the first place. Ocean waters warmer than usual can have a corresponding effect on wind patterns, Mr. Namias and his co-workers believe. The interaction between snow cover and long-range weather patterns is a complex one. This kind of interaction is called feedback.



U.S. Weather Bureau

WINTER SEASON'S WEATHER—An experimental prediction of winter weather 1962-1963 for the United States is shown on this temperature map. The "A" shows where temperatures were expected to be above normal, the "B" below normal. In the region between, near normal temperatures were expected.

The extended forecasts section finds clues to what may happen in the future by checking current observations of the atmosphere, which can be made directly. They then apply physical and statistical methods to determine what will happen during a specified time interval in the future. The calculations are so complex, however, that they can be made only with the help of a fast electronic computer.

General Circulation

A different approach in learning about the weather is being taken by Dr. Joseph Smagorinsky, head of the General Circulation Research Laboratory, and his co-workers.

General circulation is the name given to the behavior of the atmosphere as averaged over a long period of time and large distances, often an entire hemisphere. Dr. Smagorinsky and his group try to understand atmospheric motions theoretically.

First they formulate a mathematical framework, or model, containing the very complex equations expressing the physical laws believed to govern weather changes. A computer is instructed to use this mathematical model to make a weather prediction based upon pressure, temperature and other weather factors at a large number of places. This is often for a very short time in the future, such as five minutes.

Then the results of the first prediction are used by the computer to make a second. The second is then used for a third, and so on, until a sufficient series of predictions has been made for final analysis.

Ultimately Dr. Smagorinsky expects the computer to simulate day-to-day weather changes at 10,000 points around the world and up to 20 miles above the surface. To model weather changes for a 24-hour period will require ten billion computations, and is possible now only because the International Business Machines' STRETCH computer is one of the fastest and most powerful yet built.

The same kind of approach Dr. Smagorinsky is using in his research is the basis for most of the weather maps issued routinely by the Weather Bureau in Washington for use by forecasters. The method is called numerical weather prediction. Numerically based forecasts using a relatively simple model of atmospheric motions have been made routinely by electronic computers for several years.

Some of the equations used at the National Meteorological Center for numerical prediction and at the General Circulation Research Laboratory have their origins with Isaac Newton, who formulated the fundamental laws of particle dynamics. Later theorists extended these laws to cover fluid motion and applied them to studies of the atmosphere.

At the beginning of the 20th century, V. Bjerknes of Norway foresaw the possibility of using laws of fluid motion for weather forecasting. In 1922, the English mathematician Lewis Fry Richardson suggested specific means for doing this. However, he estimated that 64,000 persons would be needed to analyze weather observations and prepare forecasts by this method, now called numerical weather prediction.

Since electronic computers did not exist at that time, Richardson's methods could not be used successfully.

In the following 25 years, more sophisticated theories were formulated by many scientists, particularly the late Dr. Carl-Gustaf Rossby, a noted Swedish-American who developed a formula for predicting the speed of westerly waves high in the atmosphere. Simply stated, the speed of a wave depends on the wind speed, the size of the wave and its latitude.

With the development of computers during World War II and the theory of westerly waves, numerical weather prediction became a practical possibility. The actual techniques were developed at the Institute for Advanced Study, Princeton, N. J., under the direction of the late Dr. John von Neumann and Dr. Jule Charney, now at Massachusetts Institute of Technology.

These techniques, developed for short-range weather prediction, soon showed their potential for being used to study longer periods of atmospheric motions. Also at the Institute, Dr. Norman A. Phillips undertook the first numerical study of the atmosphere's general circulation, using hydrodynamical equations to represent motions and an electronic computer.

In addition to the two-pronged Weather Bureau attack on the how and why of long-range weather behavior, meteorologists in other Government departments, many organizations and universities are tackling facets of the problem.

Included among the groups are the National Center for Atmospheric Research at Boulder, Colo., the National Aeronautics and Space Administration, the U. S. Air Force and Navy, Massachusetts Institute of Technology, the University of Chicago, New York University, the University of California at Los Angeles, Florida State University, Colorado State University and the University of Washington.

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AGRICULTURE

Frost Penetration Statisticians—Morticians

➤ THE WEATHERMAN now is working with the undertaker.

Figures on the amount of frost penetration throughout Wisconsin are now obtained from some 250 funeral directors and cemetery officials, in a joint project of the University of Wisconsin, the Weather Bureau and state agriculture officials.

Arthur Peterson, of the University's soils department, said this new method was much easier and made possible accurate reports from widely scattered points.

The previous system had been to drive a King soil tube into the ground with a hammer, a laborious and time-consuming process.

He pointed out that frost penetration data are important to a wide variety of persons, including farmers, contractors, conservationists, hydrologists, flood forecasters, insurance companies that have a frost protection rider, the highway departments, and army engineers—and of course gravediggers.

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