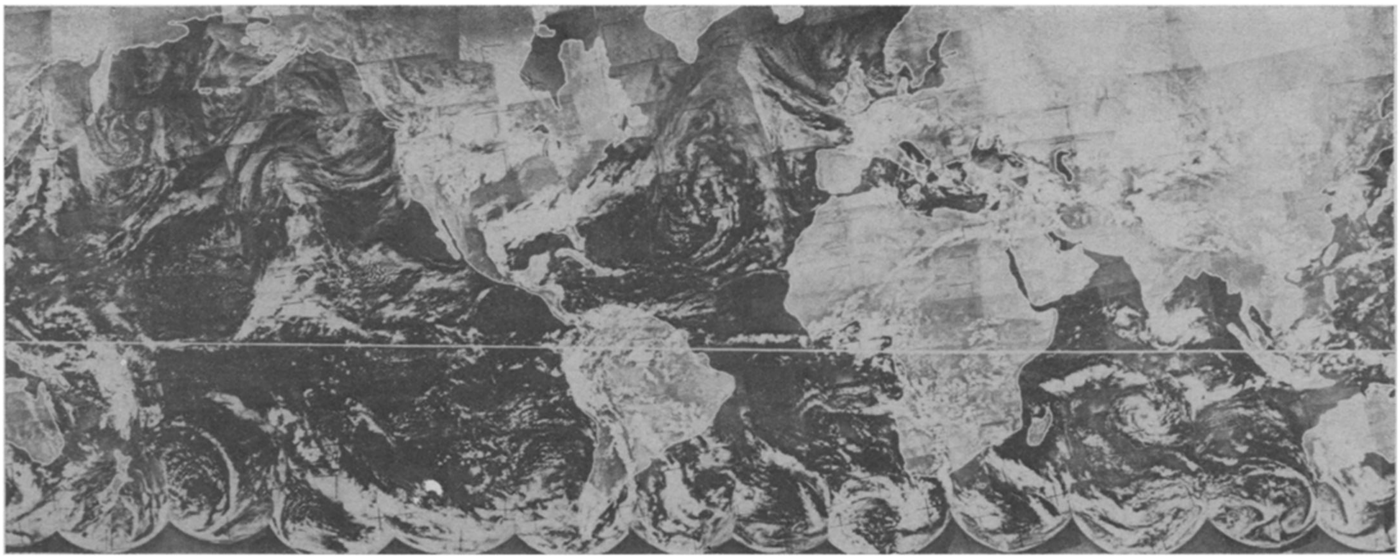

ESSA

WORLD'S WEATHER AT A GLANCE—This global photomosaic—the first complete view of the world's weather—was assembled from 450 pictures taken by Tiros 9 during a 24-hour period in 1965. The equator is marked by a white line. Special photographic processing was used to increase the contrast between major land areas, outlined in white, and the surrounding oceans.

METEOROLOGY

Computing the Weather

Mix information from satellites, balloons and ocean buoys with conventional atmospheric observations; blend in fantastically fast computers for long-range weather predictions

By Ann Ewing

➤ RECIPE for a better understanding of what makes the weather and more accurate forecasts for 10 days, a month or a season in the future:

Blend information gathered from satellites, world-circling balloons, free-floating ocean buoys and long-tested observational methods with mathematical models of the atmosphere derived from highly dissimilar sources. Mix thoroughly in fantastically fast electronic computers.

No one yet knows exactly how to "cook" these ingredients for more than five or six days in advance. Nevertheless, the recipe promises a new revolution in long-range weather prediction rivaling that made some 10 years ago with the introduction of electronic computers into routine daily and short-range forecasts.

Although the revolution is now only simmering, it could well boil to the surface in the near future. Already meteorologists are actually modifying large-scale weather patterns, although so far only in a crude way in their computers.

At the U.S. Weather Bureau, for instance, scientists have found that when sea surface temperatures and the solar radiation reflected into space by earth are included in the computer calculations, the resulting pattern is much closer to actual average monthly weather than without these two factors.

Meteorologists can also make rough calculations of how the world's long-range weather would be affected by removing the Rocky Mountains. However, to make such computations conform more closely to reality, the world's weather picture must be taken on a global scale for at least several months.

More Accurate Forecasts

Such an experiment is now being planned—the World Weather Watch. During the watch, meteorologists will gather sufficient information about how the world's weather is actually behaving so that they can then modify their basic recipes to forecast its future behavior more accurately.

The observations would show the large-scale motions of the ocean of air blanketing the earth in quantitative measurements that can be used in computers. With such information, gathered on a worldwide basis instead of from only the 10% of the earth's surface now adequately covered, meteorologists believe they could predict weather two weeks in advance as accurately as is now possible for two- and three-day forecasts.

A start is now being made to obtain planetary observations from regions where little or no data is available. Since early March of this year, globe-girdling balloons launched from Christchurch, New Zealand, have been floating around the world in a program known as GHOST, for Global HOrizontal Sounding Technique.

The information from these miniature weather stations drifting at constant altitude — temperature, pressure, humidity—is transmitted to ground stations. In the future, however, meteorologist hope to interrogate each of some 10,000 similar balloons at five or six elevations from high-altitude satellites that would also check out free-floating ocean buoys located in strategic areas of the Pacific, Atlantic and other main oceans.

The satellites would store the data collected until a ground station requested it be sent earthward. The pilot test of GHOST, conducted in the Southern Hemisphere by the National Center for Atmospheric Research, Boulder, Colo., is supported by the Environmental Science Services Administration of the Department of Commerce and the National Science Foundation.

Still in the planning state is an even more sophisticated method of obtaining some of the same information using satellites. In this system, the radio signal from one satellite many thousands of miles from earth's surface would be cut off by other satellites circling earth at various lower altitudes. Exactly how and when the very high satellite's signal was interrupted as the lower ones passed between it and earth would tell meteorologists much about the atmosphere between, since atmospheric conditions affect the transmission of radio waves.

One advantage of this system is that it would give continuous coverage. An essentially similar system, although involving much greater distances, was used to learn about the atmosphere of Mars from the radio signals of Mariner IV.

Circulation Patterns Alike

The pattern of atmospheric circulation for all planets, despite the difference in composition, may be much the same. This is a theory now being investigated by Dr. Jule Charney of Massachusetts Institute of Technology, who spent the summer doing research at the University of California, La Jolla.

The late Dr. John von Neumann and Dr. Charney were pioneers in showing how computers could be used to predict daily weather when they were at the Institute for Advanced Study, Princeton, N.J., some 15 years ago.

The general weather circulation for earth, as well as for Mars and other planets, consists of a very narrow warm band centered around the equator from which heat is transferred toward both poles.

Using equations governing the general circulation of the atmosphere for earth or other planets is one way of building a mathematical model of weather patterns. Another way is to start with the weather as it is observed at any moment—now—then use different equations governing air movement, heat transfer and exchange of water vapor to calculate what the weather pattern will be five minutes in the future, using that result to compute again the next five minutes until 24 or 72 hours is reached.

This latter system works very well for up to three or four days in the future, and has recently been adopted as the routine way for making 36- and 48-hour forecasts at the National Weather Center in Suitland, Md. Using it, scientists predict weather patterns at the surface and six other atmospheric levels, up to a height of 80,000 feet.

However, the problem is that after about five days, the weather calculated with this model has little, if any, resemblance to the real weather. The reason lies not in the computer, which can do only as it is told, but in the equations themselves.

Different factors and, therefore, different equations are involved when computing short-range weather and weather for a longer term, whether 10 days, a month, a season or a year.

To get around this difficulty, Jerome Namias and a group of long-range weather experts at the U.S. Weather Bureau's extended forecast division, also in Suitland, are using what they call a "semi-empirical method."

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 another way of attacking the extremely complex interactions of the atmosphere, of which there is two million tons for each person on earth, all of it constantly in motion.

Mr. Namias and his co-workers have found that ground cover, such as snow or ice, and ocean temperatures have a very decided effect on long-range weather patterns. They are able, in effect, to modify the weather by changing these factors in the computer calculations, then seeing what the long-term effects are. These effects, as well as those of other ingredients in the great mixing bowl of earth's atmosphere, are much closer to understanding than even the most optimistic meteorologist would have predicted 25 years ago. Credit for the unexpectedly large strides goes mainly to human brains and the fast computers that calculate for them.

SPACE

Astronauts May Return To Land, Not Sea

➤ FUTURE astronauts may be "talked back from space" for a safe return to land by use of a new Terminal Landing System (TLS).

A portable ground-control system from which spaceflight controllers may "talk" manned spacecraft to a safe landing on land rather than on the oceans has been developed by the Philco Houston Operations of the Ford Motor Company for the National Aeronautics and Space Administration's Manned Spacecraft Center in Houston.

TLS is designed to utilize multiple tracking sites which allow continuous spacecraft tracking and communications, even during the reentry "blackout" period.

As a spacecraft reenters the atmosphere for return to a land recovery area, the TLS computes its predicted landing point and "footprint" and continually displays these on a display console for comparison with desired target areas.

PHILCO CORPORATION

LAND LANDING—Engineer Denis Bukowski checks out a display console that is part of the new manned spacecraft terminal landing system developed by Philco Houston Operations for NASA's Manned Spacecraft Center. The system will provide on-the-spot ground control for manned spacecraft during the last phase of a mission returning to a recovery site on land.