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over a field of view somewhat greater than 180 degrees, so the full horizon would be available for ascertaining the orientation of the satellite even when it was librating (rocking) because of gravitational perturbations. These satellites could be solar powered in the manner of TIROS; hopefully, reduced power consumption would permit reduction in the weight of the power supply components.

No provision would be made in this system for the storage of data on board the satellite. The simplest mode of transmission of pictures to the ground involves interrogation of the satellite by a ground station beneath it. This could cause it to take a single picture, or possibly a sequence of pictures, to be directly televised to the same ground station. In this fashion, a ground station could obtain a detailed view of the clouds in the atmosphere for a distance of 1,000 or more miles around it, which is ample coverage for short-range forecasting. Assembly of reports from a number of such ground stations could give very nearly complete coverage of the globe.

The frequency at which such observations could be made would be determined by the number of satellites in orbit. Because of the low orbit and cheap construction, 30 or so satellites could be in orbit simultaneously; failure of one or a few would not be catastrophic. A central data processor would have to keep track of the individual satellites, however, so that each ground station would know when to expect a satellite in its area for interrogation.

A more complex system of weather satellite communications would be possible with the network of low-flying active communications relay satellites that has been projected. In this case satellite interrogation could occur from a central station, the interrogation signal being relayed through the satellite communication network to the vicinity of the meteorological satellite assigned to take an observation. The transmission of its televised observation, slowed down to fit the capacity of the available communication channel, would return over the same route as the interrogation signal. Such a system would permit complete flexibility of operation, since irregular but frequent reports could be obtained from the entire earth and be available at one or a number of central stations.

Let us assume now that the mechanical and electronic problems of establishing full and frequent meteorological satellite coverage of the earth have been solved. What, then, may we expect from the forecasters? It may readily be predicted that, in general, forecasts will be improved. The degree of improvement to be expected, however, is still open to question.

Since the TIROS satellites survey the same region at best once each 24 hours, attention has been focused largely on forecasts of that period. For these short-range forecasts, the value of the satellite meteorological observer is almost self-obvious. The pictures show graphically the cyclones, fronts, and other major meteorological features of consequence in forecasting. They are shown so clearly that a mosaic of TIROS pictures has been called a "self-analyzed weather map."

For forecasts for periods shorter than 24 hours, the outlook is even more encouraging. The TIROS pictures present structural details of meteorological features that were never before available to the forecaster. In general, the lifetime of a structural element of the


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atmospheric circulation (a "system") is proportional to its size. The conventional meteorological network has been far too coarse to define details of size much smaller than major cyclonic elements or entire frontal systems. The weather radar, on the other hand, has proven itself of value only in precipitation forecasts of an hour or two at best. The meteorological satellite, then, appears to provide the density of data coverage needed to supply detailed forecasts for periods of interest to most of us-one day down to a few hours.

The utility of the meteorological satellite in longer range forecasting is by no means as clear. The restricted coverage of the TIROS satellites has made it difficult to assess the feasibility of the interpretation of giant-scale cloud systems (cyclone "families") in terms of the long-range forecast.

Once we consider the problems of forecasting for periods greater then five days or so, we must abandon simple extrapolation of existing systems or groups of systems and consider the basic energetics of the atmosphere. Here the infrared observations of the meteorological satellite may prove of value. Techniques for using these observations for such purposes are being explored, but it is far too early to judge whether our grasp of the workings of the atmospheric heat engine is sufficient for such long-range forecasts.

As for forecasts in excess of a month or so, it would appear that we must depend upon the fascinating discoveries being made by those who are studying the relation between manifestations on the sun and the weather on earth. It may well be that special sensors on board the meteorological satellites to measure the behavior of the far ultraviolet and x-ray emission of the sun may make such far-extended forecasts possible.

After such a cautiously optimistic evaluation of the potential of the meteorological satellite the question may well arise, "Is it worth it?" But how does one evaluate man's increasing knowledge of, and control of, his environment? The economic value of accurate forecasting has been so well established that no one questions the continuous expenditure for our excellent network of conventional observations, both on the surface and in the upper atmosphere. By the use of this network, the U.S. Weather Bureau has achieved a level of proficiency of forecasting usually described pessimistically as "85 per cent accurate." It is quite impossible to estimate the value of even a small increase in that accuracy. Any substantial increase could bring enormous economic benefits.

Even if it should be found that the complex network of satellites and communications required for a full operational meteorological satellite system is not economically feasible for some time to come, we have collected a tremendous amount of new information already about the nature of the atmosphere, its storms and its clouds-and this flow of information is continuing. The new knowledge gained has already started to make itself felt in forecasting. Soon we may expect to see the quality, the scope, and the imaginativeness of weather forecasting improved to the point where the investment we have made will seem amply repaid.

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