WEATHER FORECASTS FOR AERIAL PHOTOGRAPHERS*

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ABSTRACT

This paper discusses in general how a national weather service operates and explains some of the fundamental operations leading to making of weather forecasts for aerial photographers. The results of joint effort by photogrammetrists and meteorologists in more carefully establishing the weather forecast requirements of aerial photographers are described. The paper is purposely kept non-technical since the subject may be new to some.

YOUR speaker's introduction to photogrammetry came five or six years ago as the result of seeing some of the photogrammetry industries' films on the subject. In more recent years he has been engaged in the development of specialized weather forecast services for the aerial photographer.

It is recognized that among the Members of the Society are pilots, photographers and others who have meteorological training and experience. However, it is understood that meteorology may not be a familiar subject to all Members. For these reasons this paper was prepared with the intention of describing briefly how a national weather service operates, some of the fundamental steps necessary to making weather forecasts and, in particular, how meteorology can contribute to the planning of aerial photographic missions.

In a brief paper of this nature it is possible to only touch the highlights, but it is hoped that the illustrations will serve to explain some of the operations.

FIG. 1. Inside a weather observing station.

As a pre-requisite to making a weather forecast, it is necessary that the meteorologist know in considerable detail the present state of the weather over a very large area. This knowledge becomes a sort of jumping off place; the point from which he takes the present weather as reported from many stations on land and sea; using all his meteorological knowledge and experience, he arrives at a prognostication of the weather for some time in advance.

Figure 1 shows a typical weather station with the observer in process of preparing the weather observation which he takes each hour. In each of these reports he includes information on such items as the amount of clouds, the height of the various cloud layers, the visibility, the temperature, the amount of moisture in the air, the wind direction and speed and, of course, the barometer reading. A similar observation is made each hour of the day and night, at about 500 places in the U. S.

In Figure 2 a weather observer is shown tracking the path of a helium-filled free balloon by means of a theodolite, in order to measure the wind conditions in the upper air. In this work the theodolite is used to take a series of readings of the azimuth and vertical angle of the balloon as its flight progresses. Since the

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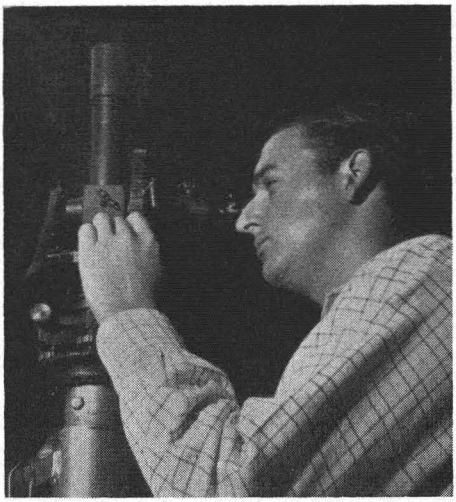

FIG. 2. Determining upper wind conditions.

balloon is inflated to a pre-determined value of free lift, and because the standard ascentional rates are known, it becomes a very simple problem in trigonometry to determine the direction of horizontal motion of the balloon and its speed for each of the levels in which one may be interested. These observations have a great many uses and it is customary for pilots to use them, along with the wind forecasts, in planning their photographic flights.

At a number of weather stations the theodolite has been replaced by modern electronic devices which make possible taking readings to much greater heights. Also, the electronic aids permit the observer to determine wind conditions above a solid overcast. This is, of course, impossible with the theodolite method.

A typical electronic installation for making upper wind observations is shown in Figure 3. The instrument shown is the very successful SCR-658 radio direction finding set of World War II vintage, developed for military purposes but now adapted to civil use. In this system, a small radio transmitter is attached to the balloon and the SCR-658 is then used as a signal source tracking device. With this equipment, readings to heights of 40,000 to 50,000 feet are not uncommon.

Observations of the temperature and humidity in the upper air are also made at some 50 locations in the U. S. Making these observations requires the use of a balloon some eight feet in diameter to which meteorological instruments are attached as well as a small radio transmitter which sends weather data to the ground station as the flight progresses. By this means data on the temperature and humidity to heights of 70,000 to 80,000 feet are often obtained. Figure 4 shows one of the balloons in flight. The meteorological instruments and radio transmitter are contained in the small box suspended from the balloon, the combined unit being known as a "radiosonde."

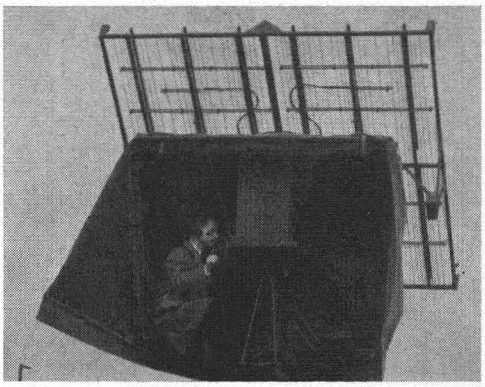

FIG. 3. Radio direction finding set used for determining upper winds.

The ground equipment shown in Figure 5 is used to receive the signals from the radiosonde in flight and to record the data on a moving roll of paper. It is now general practice to combine the electronic method of determining the wind direction and speed, and the radiosonde—that is, the measurement of temperature, pressure and humidity—into one operation. Thus the one balloon and its attached transmitter serve a dual function.

Weather observations are made not only on land, and in the air, but also at sea. The observations made at sea by merchant vessels help complete the charting of the weather throughout the world.

For making the more detailed meteorological measurements at sea, Coast Guard vessels have been specially outfitted as floating weather stations. The observers aboard the ships, such as shown in Figure 6, make frequent observations of the weather conditions as may be measured from the ground. They also make upper air soundings of wind direction and speed and the radiosonde observations explained earlier.

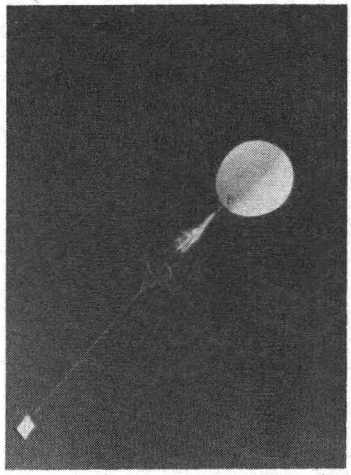

FIG. 4. Radiosonde balloon with instruments in flight.

The preceding discussion was intended to briefly review the almost continuous job of keeping track of the existing weather.

All of the information on the observed weather is of no value to weather forecasting unless it is transmitted to the forecasting centers in a minimum of time. Weather can change rapidly, and weather observations become history in a matter of a few hours. In the early days, meteorologists depended upon the telegraph operator to handle the relatively few weather reports they were able to collect. Today meteorologists use teletype, radio-teletype, and facsimile.

Facsimile is being used to a considerable extent in meteorology and Figure 7 shows one of the receiving units. The meteorologist is holding a completed weather map that was received via this machine. The original maps are plotted and analyzed in a central weather analysis center and disseminated via the facsimile circuit, thus saving considerable manpower at many field stations that otherwise would be required to chart the same weather conditions.

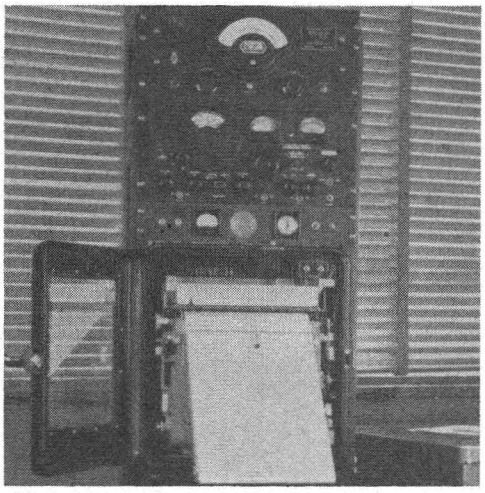

FIG. 5. Radiosonde ground receiving station.

All of the operations discussed so far are essential to making a weather forecast and this observing and communications work must precede the actual work of the man who prepares the forecasts used in planning the photographic massions.

Figure 8 is a scene inside a weather forecasting office showing a meteorologist at work with his weather charts.

To many, it may appear that a weather forecast is simply a weather forecast, but it is surprising how many different fields of specialization can be developed within the one occupation of weather forecasting. The aerial photographer is interested mainly in whether or not cloud conditions and visibility will permit him to work. But, there are such problems as forecasting the amount of rain that will fall in a given area. This information is useful to the hydrologic engineers in determining the probable run-off, which in turn affects river stages, reservoirs and such things as the electric power potential of the reservoir. Then there are light intensity forecasts. These are used by the electric companies in anticipating power loads.

FIG. 6. Floating weather station in North Atlantic.

During certain times of the year the Weather Bureau operates a frost warning service in such sections of the country as the Florida and Texas winter garden areas, and for the cranberry bogs of Maine and Wisconsin. One might add that the demand made by housewives for wash-day forecasts is no small item!

In particular, it should be noted that in the same way the photogrammetrist has found continually increasing demands for his services, the meteorologist has experienced greater application of his product to additional fields of endeavor. In fact, there are now so many uses of weather forecasts and climatological records in industry and the demands for specialized weather services are so great, that there are now quite a number of private weather consulting firms. Also, many industrial corporations have found it advantageous to hire their own meteorologists who can then devote their full time and energies to the very specialized needs of the company.

The Weather Bureau performs a great variety of services in addition to just Weather Forecasting. The weather observing program has already been described, but there is another service that should be mentioned, and that is "Climatological Services." One might think of it as "weather statistics." This is a very large and important field with seemingly endless possibilities, and one in which the private meteorologists also have a definite place. It was from the weather records processed by the climatologists that Mr. J. F. Sette, whose work is well known to persons in photogrammetry, developed his map and charts on the frequency of occurrence of weather suitable for aerial photography.

FIG. 7. Receiving weather maps via facsimile.

Meteorologists have in recent years learned much about the kinds of weather situations that are favorable for aerial photography and of ways to improve their forecasts for these operations. Through the excellent cooperation of some of the officers of the Photogrammetry Society, meteorologists have learned to have a greater appreciation of the very exacting nature of the photogrammetrists' work and how it is necessary that some entirely new concepts be recognized in writing forecasts for their use. For example, a few cirrus clouds (the very high, thin, milky clouds composed entirely of ice crystals) are of no importance whatsoever to the farmer or the hydrologist. As far as these men are concerned it is a clear day. Similarly, clouds of this kind are of no operational significance to the movement of conventional air traffic, and as far as the pilots of these aircraft are concerned, it matters little whether the forecasters call for clear skies or scattered cirrus clouds, or even a high thin overcast. But,

the amount and density of these very high and thin clouds has a pronounced effect on carrying out aerial survey operations, mainly because of their effects on light intensity. With the help of officers of the Society, the Weather Bureau has been able to develop during the last year a rather complete list of the very critical weather service requirements of the aerial photographer and has made this information available to all its forecast offices. The information is, of course, also available to other meteorologists who may be interested in this type of work.

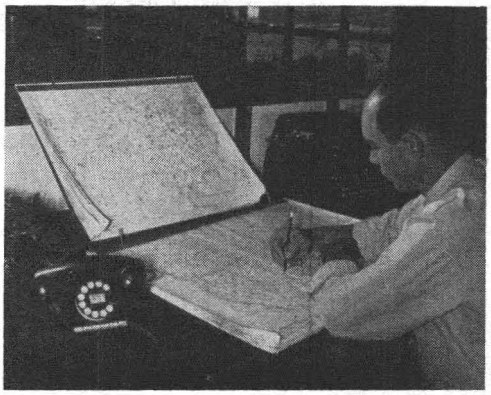

FIG. 8. Meteorologist at forecasting position.

There is much to be done, however. Further studies on the physical processes causing cirrus clouds, on determination of their heights and their horizontal and vertical stratification, and on development of methods to better forecast their occurrence are needed. There is also need for further study of haze in the upper air and the forecasting of air-to-ground visibilities.

With the many advancements being made in the field of photogrammetry, both technically and in application, it seems quite obvious that these developments will certainly add impetus to meteorological research and study of weather conditions of importance to the aerial photographer.