MICRO-PHOTOGRAPHIC RECORD OF WEATHER MAPS

by

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INTRODUCTION

The project of recording well analyzed weather maps on film was undertaken so that there would always be a record available for Meteorological students. The manner in which a record could be maintained for many students necessarily entails some means of duplicating the original weather maps. One method of duplication would be that of manual transcription. This, however, would take several hours for each copy and would cost a considerable amount. The other method would be some variety of photographic reproduction. Of these, the most suitable method was found to be that of microfilm reproduction, i.e., photographing the original maps with a high grade lens onto an extremely fine-grain sensitized emulsion. For convenience of space and economy, 35 millimeter film was chosen.

The writers wish to express their appreciation to Dr. Irving P. Krick of the California Institute of Technology for the use of his weather maps. They wish to thank Mr. Erwin F. Morkisch of The Henry E. Huntington Library who photographed and helped print the many pictures involved. They also wish to thank the many people who through suggestions and backing made this project possible.

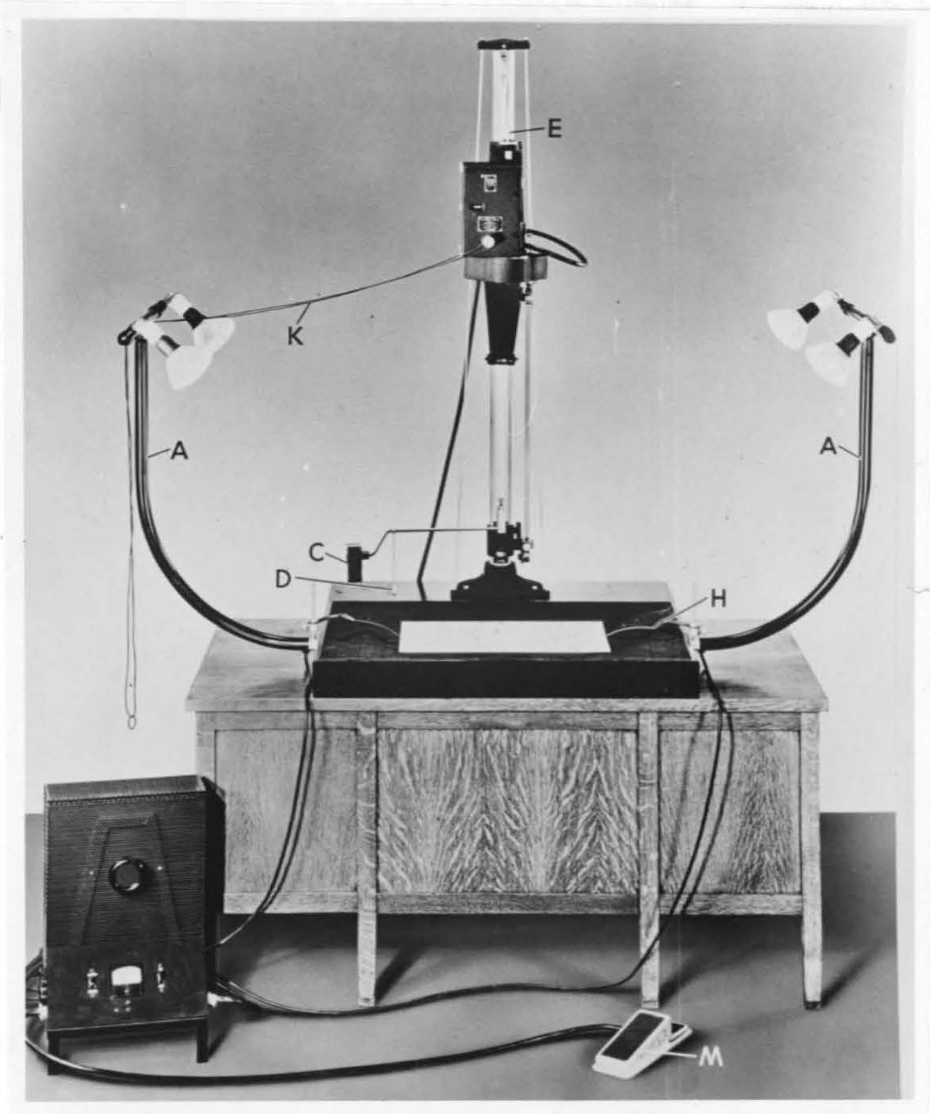
APPARATUS AND MATERIAL

The film to be used must have accurate tonal or contrast renditions and be of the finest grain compatible with the requirements of permanency, bulk, and economy. Such a film, 'Microfile', is manufactured by the Eastman Kodak Company, Rochester, New York. This film is designed especially for copy work of line drawings and similar pieces. It is as fine-grain an emulsion as is commercially available and has a high degree of contrast required for the proper reproduction of a line drawing such as a weather map.

In order to obtain optimum results the developer recommended by the manufacturer was used. This is Eastman D-11. A good quality acid-hardening fixing bath was used and the film washed throughly and dried.

The camera(Fig. 1) used was designed especially for the purpose of copying by the Recordak Corporation, 350 Madison Avenue, New York, New York. It uses a Bausch and Lomb lens of exceptionally high quality and has a fixed shutter speed and diaphragm. The exposure is controlled by the variation of intensity of illumination.

The reduction ratio necessary to include the narrow width of the map across the 35 millimeter film was found to be 22/1. This camera has a special curtain masking the length of the exposed portion of the film and may be adjusted to cover a film length of from 3/8 inch to 1 11/16 inches.



Recordak Camera - Model D

FIG. 1

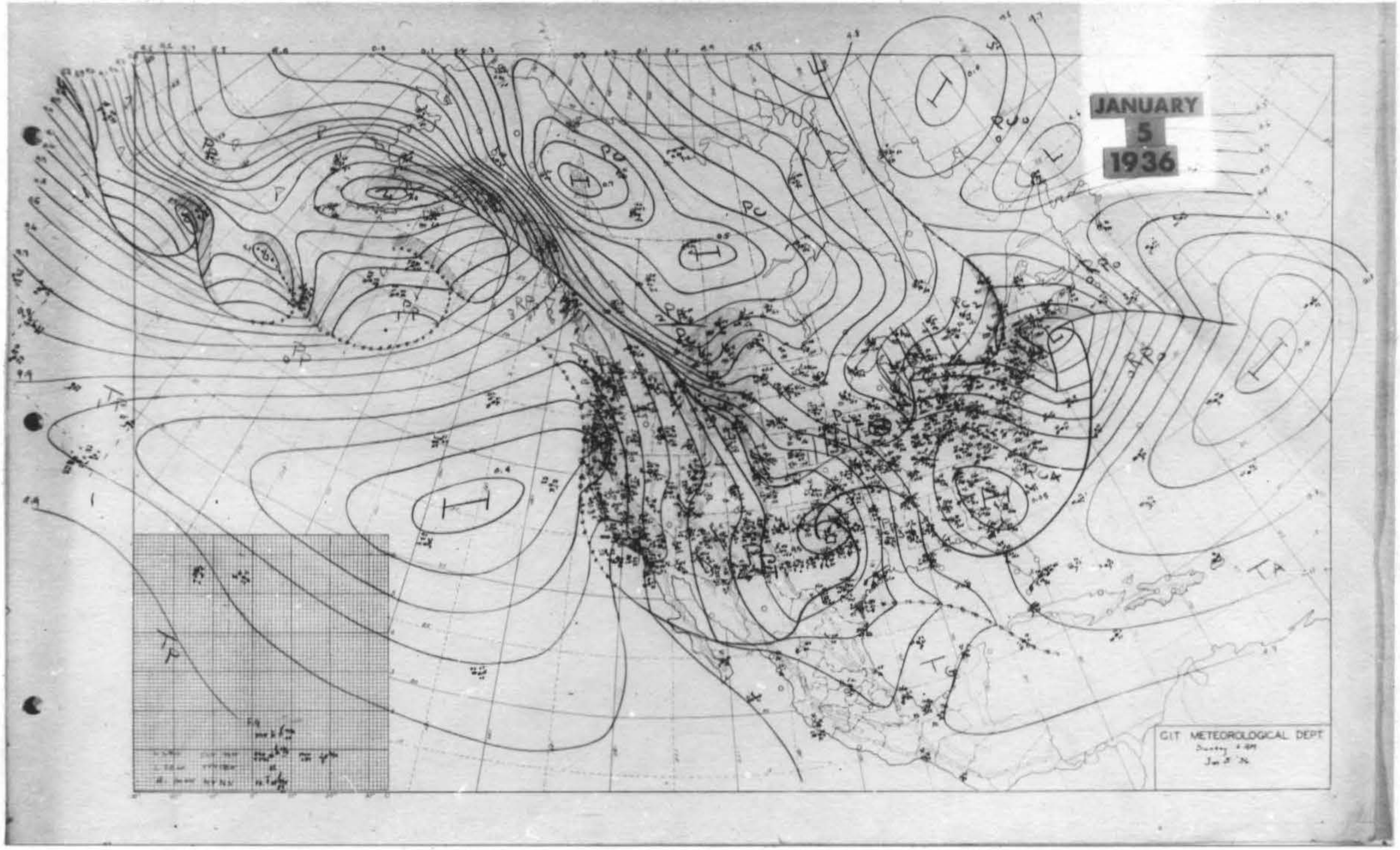
The longest maps could not be completely included in the longest frame which is longer than the usual 1 7/16 inches of the regular double frame as used in Leica, Contax, and Retina cameras. It was, therefore, necessary to exclude a portion of one end of the maps.

The results attained by photography were excellent, as most of the smallest printing could be read under a microscope. However, it appeared that the limit of resolution of the lens and film combination was very nearly reached. The average numeral used in entering the weather data for the stations covers an area of about one millimeter square so that the reduction of 22/1 would result in twenty-two numerals per millimeter square of the film. The width of the individual lines composing the letters is seldom as great as 1/5 the width of the letter. Therefore, there would be about 100 to 150 lines per millimeter. As the resolving power of the film is listed at 130 lines per millimeter the limit of resolution must be reached and in some cases even passed.

DUPLICATION OF NEGATIVES

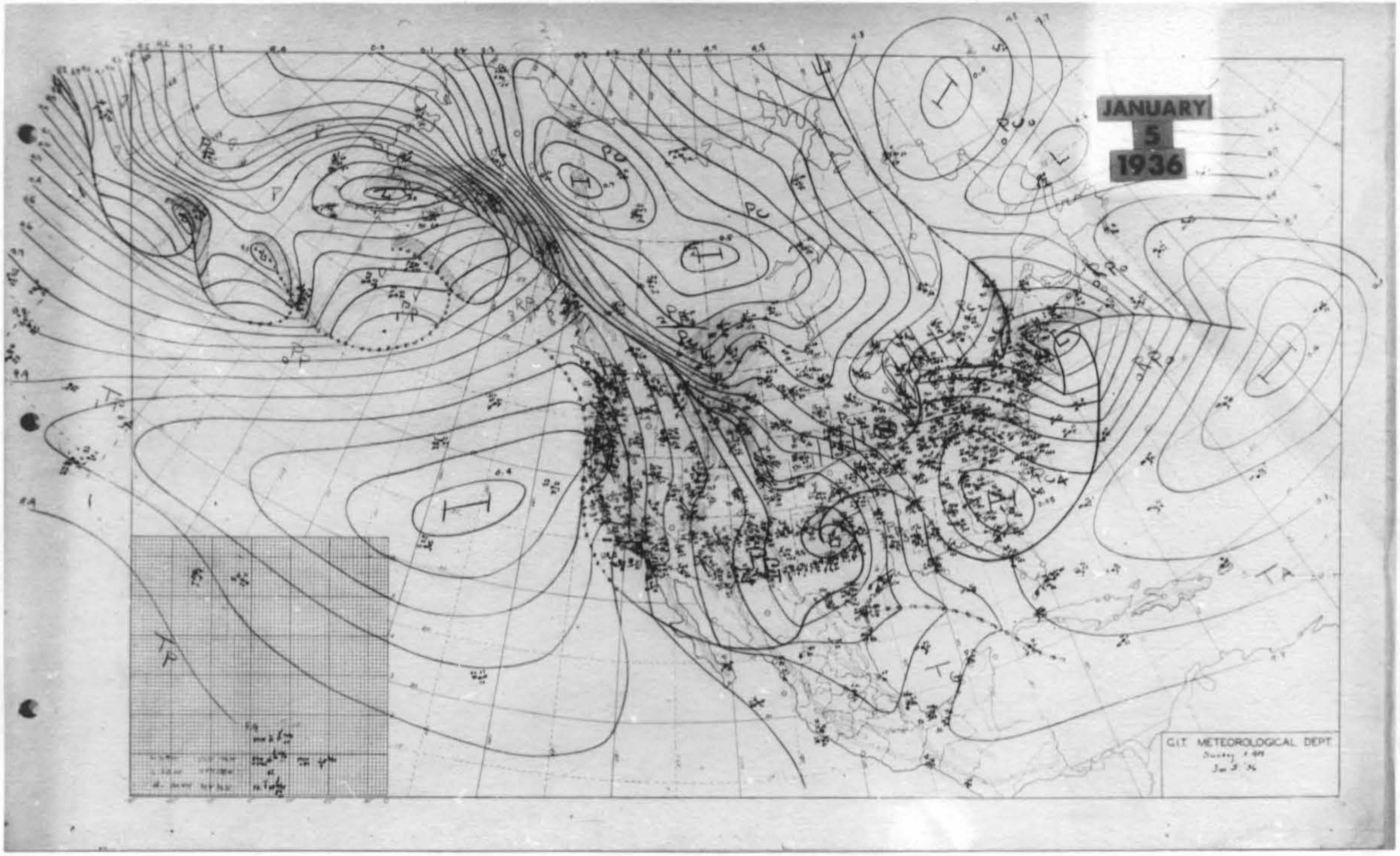
In order to make the copies of the weather maps available to the most people there are two methods; by enlargement prints and by duplicate films.

The duplication was done by University Microfilms in Ann Arbor, Michigan. They have undertaken a great deal of experimentation in order to produce the best possible results. In all duplication work, even though the duplicates are made by emulsion contact printing, there is a loss in definition so that the final results will never be as fine as the originals. Since the original negatives were on the very edge of the resolving power of the film some of the data on the duplicate negatives will be lost. In spite of this, much of the data on the duplicate can be read under a powerful magnifying glass or microscope. In making prints by enlargement from these negatives there will be some additional loss in definition so that in the final prints there will be a noticable difference between those made from the originals and those made from the duplicates. However, the results appear eminently satisfactory. Fig. 2 is an enlargement from the original and Fig. 3 is an enlargement from the duplicate negative.



Five diameter enlargment from the original negative

FIG. 2



Five diameter enlargment from the duplicate negative

FIG. 3

ENLARGEMENTS

The prints, to be useful, must be large enough for one to read easily the isobaric and frontal analyses but not so large as to be bulky and inconvenient to handle. They must be very durable so as to withstand constant usage over a period of several years. Finally, they must be economical. With these points in mind, many types of papers and emulsions were studied. It was concluded that the best base possible would be some variety of linen rag ledger paper. This paper with sensitized emulsion made for photostat work appeared to be the optimum available. It is relatively inexpensive when compared to the normal price for equivalent weight sensitive papers and is the toughest variety of paper. The greatest objection is the roughness of the surface which tends to reduce the definition of the image. However, as the principal objective of the duplicates is not to read the station data but rather to observe the analysis, it was deemed more advisable to use a tough base paper with a matte finish. The ideal would be a linen rag paper specially coated so as to furnish a smooth base for the emulsion. Because of the present emergency of defense the companies supplying such papers could not experiment. As a final selection the papers used are those manufactured by the Haloid Corporation and are their HB44 and HB28 Brown Linen Ledger Record Stock. The weights chosen correspond to ordinary double and single weight papers respectively. For most purposes the double weight paper is recommended because of its greater resistance to creasing or curling, especially if used in a card filing box. The size to be used was chosen by making enlargements to as large a size as was necessary to comfortably observe the analysis at a distance of three to four feet, and yet sufficiently small so as to be of easy handling. The minimum enlargement was five diameters. The best dimensions for this enlargment would be 5" x 7" and 5" x 9" for the regular double frame and for the extra long double frame. As the prints would be used primarily as individual cards, the use of a filing box was indicated. The nearest standard size to optimum print size was 5" x 8" and, therefore, the size of the prints was chosen to be 5" x 8".

The developer and fixing bath were those recommended and sold by the Haloid Company.

The costs of this project can be broken into the cost of the materials, apparatus, and the cost of the labor as shown in Table 1.

EXPLANATION OF COSTS

The cost of filming the maps was based on the charge of $35.00 per thousand for at least one thousand maps.

The charges for duplicating the films on fine-grain film are 6.5 cents($0.065) for large orders and seven cents ($0.070) for regular orders per linear foot of film. The short length maps had 7.33 frames per foot and the long length maps had 6.65 frames per foot.

The calculation of the cost of the duplicate negatives allotted the cost of the original negatives and the duplicating positives in proportion to the number of duplicate negatives in proportion to the number of prints.

COSTS OF FILMING

	Number of Copies				
	1	5	10	20	50
Original negatives					
per map	$00.0350				
per year	12.80				
Duplicating positives					
short length maps					
per map	$00.0095				
per year	3.50				
long length maps					
per map	$00.0105				
per year	3.85				
Duplicate negatives					
short length maps					
per map	$00.0540	$00.0184	$00.0140	$00.0118	$00.0104
per year	19.70	6.75	5.10	4.30	3.80
long length maps					
per map	$00.0560	$00.0196	$00.0151	$00.0128	$00.0114
per year	20.45	7.15	5.50	4.65	4.15

TABLE 1a

COSTS OF PRINTING

	Number of copies				
	1	5	10	20	50
Print paper -- 5"x8"					
HB44 -- double weight					
20,000 sheets cut					
per map	$00.0213				
per year	7.75				
8.5"x 150' roll					
per map	$00.0261				
per year	9.50				
HB28 -- single weight					
5,000 sheets cut					
per map	$00.0160				
per year	5.85				
8.5"x 350' roll					
per map	$00.0136				
per year	4.95				
8"x10" in reams					
per map	$00.0230				
per year	8.40				
Developer					
20 quarts/1000 prints					
per map	$00.0012				
per year	0.44				

TABLE 1b

COSTS OF PRINTING

	Number of Copies				
	1	5	10	20	50
Fixing bath					
30 quarts/1000 prints					
per map	$00.0013				
per year	0.48				
Print cost -- including original negatives					
HB44 -- double weight					
20,000 sheets cut					
per map	$00.0588	$00.0308	$00.0273	$00.0256	$00.0245
per year	21.40	11.20	9.95	9.35	8.95
per map * 2.5%	$00.0603	$00.0316	$00.0280	$00.0262	$00.0251
per year + 2.5%	22.00	11.50	10.20	9.55	9.15
HB28 -- single weight					
5,000 sheets cut					
per map	$00.0510	$00.0230	$00.0195	$00.0178	$00.0167
per year	18.60	8.40	7.10	6.50	6.10
per map + 2.5%	$00.0523	$00.0236	$00.0200	$00.0182	$00.0171
per year + 2.5%	19.10	8.60	7.30	6.65	6.25

TABLE 1c

SUGGESTIONS FOR FUTURE IMPROVEMENTS

The improvements in film and paper are beyond the scope of the average experimenter, but the best use of the materials commercially available is within the realm of experimentation. The proper control of exposure and development has a great effect on the quality of results obtained. Experiments to obtain the optimum should be carried out by some person well equiped for careful control of all the steps involved.

Possible improvements in the construction of the weather map must be considered for the best style for photography compatible with the speed of construction necessary to the forecaster using the map. In drawing frontal systems the use of colors alone does not serve as a distinguishing factor for photography because of black and white reproduction. The convention used in printing weather maps in black and white would serve the photographic purpose well but is not as rapid as the coloring of frontal systems. If the time and personnel were available the drawing of the maps in this manner would be desirable. However, in a good analysis the frontal systems are easily distinguishable by placement alone. If any data to be plotted on the map can be distinguished only by its color and not by position, some method of differentiating should be used. As an example, the use of broken or dotted lines for different levels of winds aloft. This would take a relatively small amount of additional time and should be feasible, if they are plotted on the same map as the synoptic data, because the winds aloft are received several hours prior to the synoptic data.

The placing of isallobars in different colors would be aided by the addition of a small plus(+) or minus(-) or a 'R' or 'F' beside the tendency amount to indicate a net rise or fall in the pressure.

The best ink to use for legibility of station data should be as nearly black as is possible and still permit free flow of the ink while plotting the data. Blue or blue green tends to photograph white and red photographs black so that an ink with a deep red rather than a blue or green base would render the data more visible. This may not be extremely desirable as the tendency of the film is to equalize the intensity of all lines so that the isobars might be confused in the maze of station data on the print. If it were desirable to slightly suppress, but not obscure the station data it would appear that the ink to use should have a blue or green base. Further experiments should be undertaken to determine the color of ink which would render the best results for visual observations of the original map as well as for the photographic copy.

If the object of the photography is to make prints or positive films for projection, the maps should have a date large enough to be easily read at a distance. For the prints filed in a box the date should be at the top of the map. The smallest size of numerals that can be easily read on a projection or print is about one-half inch in height. There should be as great a photographic contrast between the numerals and the background as is possible. This dating could be done with a stamp inked with a suitable color.

For the greatest legibility the station data should be much larger than it is now plotted. If possible the lettering should not be smaller than nine or ten point type, i.e., about seventeen or eighteen letters per inch. To enter data this large the scale of the map should be increased in order to have the space in which to write. If the same area of the earth were to be covered the map would be too large for convenient handling in the original and would be too large for reduction to the size of the 35 millimeter films by the Recordak camera. As most forecasting is for a small specific area, an increase scale would be desirable and the map area need not be so large. This would require two maps; a large scale for short periods and a small scale for longer periods. The large scale map should cover a region such as the North American Continent and the small scale map should cover a large area and show the general aspects of the progression of centers of action and storms, but not the specific phenomena at each station. The most suitable small scale map would be one similar to the U.S. Army Northern Hemisphere map and of a scale of about 1 inch equal to 300 miles.

To improve the photographic contrast between the background and drawings, the former should be as white a base paper as is economically possible to obtain. The drawings should be as dark and as distinctly drawn as possible with the isallobars and precipitation areas of a slightly less density than isobars and fronts.

If the original map were traced on a blank map and a representative small proportion of the original data entered thereon, the photograph would be much more legible. The stations and times chosen should be such that the temperatures and dew points are most representative.

It would be advantageous for the copying of the maps to be undertaken at short regular intervals so as to have the immediate availability of prints and negatives which are nearly up to date at all times. For periods of a year or more the difficulty of handling the map files involves a greater proportional effort than the copying of a small lot such as one month or three months. This of course, depends upon the availability of the necessary time.

Arrangements have been made for the continuation of the file. Every three months Mr. Morkisch will photograph the maps and make the necessary prints. As the job will be done on a smaller scale the costs will be slightly higher than those of the present project.