THE ESTABLISHMENT AND OPERATION OF A CLOSE GRID PIBAL NETWORK IN NORTHEASTERN COLORADO

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ABSTRACT

A procedure is described for the establishment and operation of a fourteen station single theodolite pibal network in northeastern Colorado. This network operating for thirty-one days ran 646 pibals at a cost of $7.90 per run. No major problems were encountered during the establishment or operation of this network.

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INTRODUCTION

During the past five years, data on severe storms in the northeastern Colorado plains area have been collected from a hailstorm network operated by Colorado State University. Considerable information on the nature and characteristics of hailfalls has been obtained and published previously (1), (2), and (3).* However, detailed winds aloft data, which are of interest in the hailfall study, have not been taken within the network area.

This paper outlines the procedures utilized in establishing and operating a fourteen station single theodolite pibal network in northeastern Colorado. The work described was initiated while the author was on an Academic Year Extension and completed during the 1965 Summer Research Participation Program sponsored jointly by the National Science Foundation and Colorado State University.

PURPOSE

The United States Weather Bureau (USWB) obtains regular upper wind data from stations at Denver, Colorado; Cheyenne, Wyoming; Goodland, Kansas; and North Platte, Nebraska. Since these stations are not in the network area and because of the density and number of stations, the meso-scale changes in the winds aloft over northeastern Colorado cannot be accurately determined from USWB data. To obtain upper wind information in this area, a fourteen station pibal (pilot balloon) network with stations approximately

*Numbers in parenthesis refer to list of references.

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thirty miles apart was established. Upper wind data from this pibal network, analyzed with respect to vorticity and divergence fields, may help determine factors which contribute to thunderstorm genesis, development, and movement.

NETWORK ESTABLISHMENT

The pibal network was composed of three east-west lines each approximately one hundred miles long. Logistical and geographical considerations suggested that these lines be located along major highways. The northern most line extended from Fort Collins east to Sterling, the middle line from Longmont to Akron, and the southern most line from Golden east to Anton. It was originally planned that there would be five stations approximately equally spaced along each of these three lines. It was later decided, however, to drop the Fort Lupton station because of its close proximity to the Longmont and Keenesburg stations. The final network was composed of the fourteen stations shown in Figure 1.

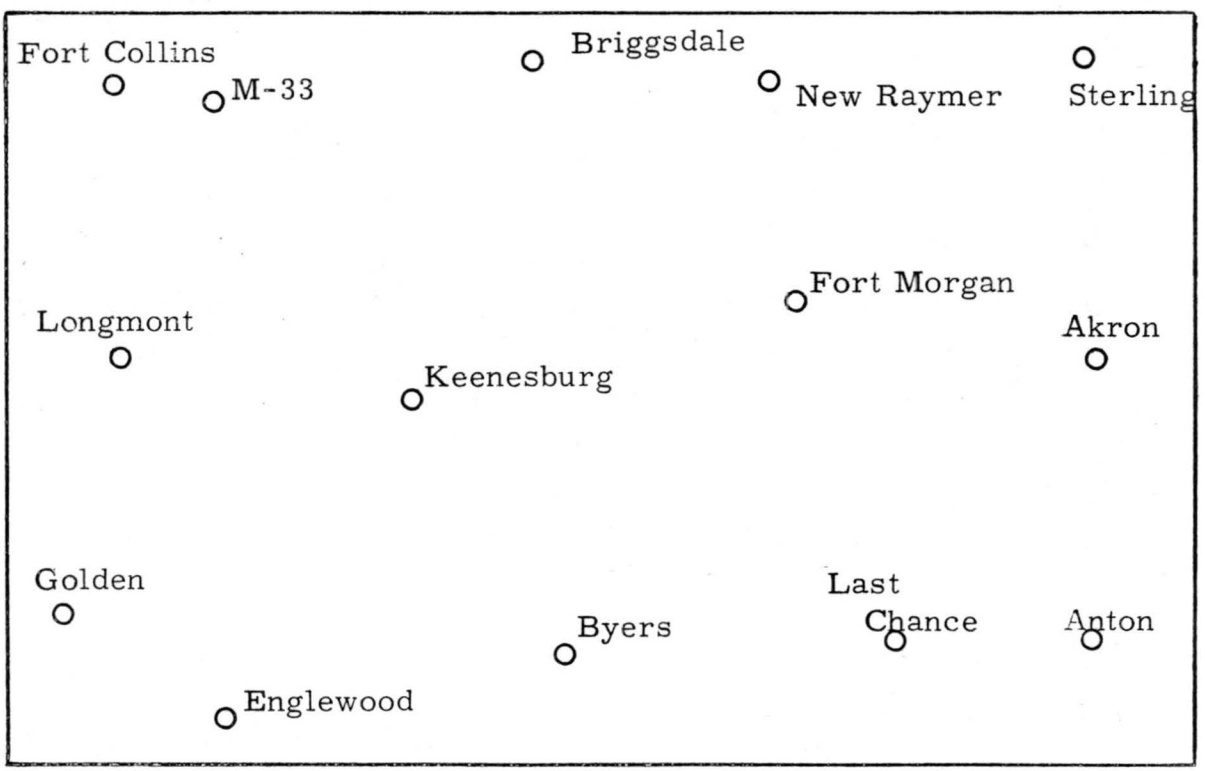

Figure 1 Pibal Network

Each pibal station was manned by two observers, one to track the balloon by theodolite and the second to record azimuth and elevation angles. These observers were selected from lists of outstanding mathematics and science high school students who indicated an interest in the project.

Initial contacts for observer selection were made via letter (see Appendix 1) to the mathematics and science teachers of schools in the area under consideration. Teachers recommendations and/or personal interviews were held between March and May of 1965. The lists of twenty-two primary and twenty alternate observers were finalized June 23, 1965 (see Appendix 2). Of the 14 stations, 3 were manned by hail project personnel from Colorado State University. In general, good response and cooperation was obtained from the high school teachers. In only two cases was it necessary to visit the school to obtain observers. Four schools were visited to interview students where the number of recommended students was large. Observers ranged in age from 15 to 18 years, both boys and girls were included and a majority lived on the farm. There were no major personnel problems during selection or operation of the entire project. Only one observer resigned during the summer and this because her parents moved from the area.

Each of the 14 pibal stations was equipped with a theodolite, an electrical pibal timer, two tanks of helium, an inflation nozzle, a pressure regular assembly, and a supply of red 30-gram pilot balloons. Data sheets designed primarily for this project (see Appendix 3) were printed and supplied to each station.

The theodolites, timers, regulator assemblies, and inflation nozzles were provided on a loan basis to Colorado State University by the U. S. Weather Bureau.

To instruct observers in the operation of a theodolite and the procedures for running a pibal, an instruction mannual was compliled

(see Appendix 4). A training session for all observers was held June 25 at New Raymer, Colorado. At this time, observers were instructed in the use of the pibal equipment and were required to track several balloons. While at this training session, the pibal equipment for each individual station was checked and issued to the observers at that station.

Inflating, launching, and tracking positions were selected at each station and a true north-south line determined by compass or star sightings. These north-south lines were later checked and in only two cases were minor corrections necessary. Each station ran a few practice pibals to be certain the observers were thoroughly familiar with the procedure and that the equipment was working properly.

NETWORK OPERATION

Pibal observers were instructed to launch a balloon at 12 o'clock noon (MDT) each day Tuesday through Friday from July 2 through July 30, 1965. On specified days, which were determined by CSU personnel, serial pibals were taken at 0600, 0900, 1200, 1500, and 1800 MDT. Pibal observers were notified by telephone of serial runs on the day prior to these runs. These serial pibals provided supplemental winds aloft data for days when significant meteorological changes were occurring rapidly over the network, e.g. frontal passages.

On July 16, pibal observers were notified that scientists at the National Center for Atmospheric Research (NCAR) wanted additional data from the network. The launch schedule was thus changed to include Mondays and Saturdays and observations were continued through August 7, 1965. This change caused one minor problem at one station.

The procedures used in making pibal observations were the same as those adapted for use by the USWB (see Appendix 4).

From June 27 through August 7, a total of 646 pibal observations were taken from 14 stations. Of this total, 39 were taken in the practice phase of the project which ended July 1, 1965. From the eleven stations manned by high school students, over 96 percent of the scheduled runs were made. Of the runs missed, nine were omitted because of no balloons, nine because of no helium, two because of our inability to notify observers in time, and two because of observer error. At the radar stations, 15 scheduled runs were missed because the observers at these stations had other higher priority duties to perform. Forty-two percent of all runs lasted 35 minutes or more. The average observation length for all stations (excluding CSU stations at M-33 and New Raymer)was 29.5 minutes. Statistics describing individual station performance are presented in Table 1.

Station and No.		Total Points	No. of runs completed	Average length of run in minutes	No. runs 35 min. or more
1. Longmont	#6	2553	50	29	24
2. Byers	#13	2521	50	32	23
3. Keenesburg	#8	2481	50	30	25
4. Anton	#15	2459	49	36	27
5. Sterling	#5	2431	48	27	23
6. Denver	#12	2301	41	33	17
7. Fort Morgan	#9	2299	48	34	23
8. Briggsdale	#3	2218	50	30	18
9. Golden	#11	2165	46	24	11
10. Akron	#10	2147	49	29	19
12. Last Chance	#14	2105	43	24	13
Fort Collins	#1	--	44	26	19

Table 1.

All loaned equipment was received in good condition. Theodolites were set up and leveled before issue. The only equipment difficulty encountered during the 31 days of operation was a faulty horizontal tangent screw on one theodolite. Red 30-gram balloons, Darex model J-30, from the W. R. Grace Company were used. Approximately 3 percent of these had pinholes or other manufacturer's defects. Pibals accounting for an additional 5 percent were lost because of improper inflation and/or handling, or poor tracking techniques necessitating a second release. Helium tanks containing approximately 240 cubic feet of gas at 2400 psig were utilized on the project. Considerable variation among observers was found in the number of balloons that could be filled from a tank. This variation is apparently due to various inflation techniques. It was found that between 20 and 28 balloons could be filled from one tank.

A contest to determine the best station was held from July 6 through August 7, 1975. Points in this contest were awarded on the following basis:

One point per minute of good data to a maximum of 45 per run.

Maximum of 10 points per run for neatness and accuracy of data sheets.

Maximum of 10 points per run for promptly submitting data.

Maximum of 250 points for astute weather observations.

The pibal station at Longmont, Colorado won this contest. Complete final results in this contest are included in Table 1.

The cost of operating the 14 station pibal network for 31 days with 5 serial run days was $5,102.62. The average cost per pibal was $7.90. The cost breakdown on this pibal project is given on the following page.

Supplies		
Balloons 685 at $.28	$ 192.00	
Helium 26 tanks at $17.	442.00	
Miscellaneous	20.00	
		$ 654.00
Salaries		
Professional 6 wks at $165.	990.00	
Technician 80 hrs. at $3.	240.00	
Secretarial 7 days at $15.	105.00	
Pibal Observers 1289 hrs. at $2.	2,578.00	
Per diem to instruction site	137.92	
		4,050.92
Services		
Telephone 85 calls at $.62	52.70	
Field trips 2,500 miles at $.10	250.00	
Publications	50.00	
Equipment repair	25.00	
Miscellaneous	20.00	
		379.70
	TOTAL	$5,102.62

CONCLUSIONS

On the basis of this study, it can be concluded that:

1. Good high school science students properly motviated can do an outstanding job as pibal observers.
2. Teacher recommendation and personal interviews are an effective means of observer selection.
3. Pibal observations can be made at a cost of $7.90 per run.
4. The equipment used was very reliable requiring a minimum of down time.
5. Approximately 8 percent of the balloons were either defective or not properly used.
6. Between 20 and 28 balloons could be filled from one tank of helium.

RECOMMENDATIONS

It is recommended that:

1. Data collected from this study be analyzed, and upon the basis of this information, a decision made as to the desirability of continuing the study.

If studies similar to this one are conducted in the future, it is recommended that:

1. All stations be manned by two outstanding high school students selected by the procedure utilized in this study.
2. Adequate consideration be given the number of runs to be made and all supplies ordered and received well in advance of the proposed starting data.
3. The equipment and method of operation utilized in this study be continued without change.
4. The pibal observation data sheet be modified to facilitate recording runs that exceed 35 minutes.
5. Primary and secondary telephone numbers be obtained from all observers.

ACKNOWLEDGMENTS

A vote of thanks for loaning the pibal equipment is given the U. S. Weather Bureau. Without this valuable help, the project would not have been possible.

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