ARCAS TEMPERATURE DATA IN THE MESOSPHERE

D. E. OGDEN* and D. B. SWINTON*

Headquarters, Pacific Missile Range, Point Mugu, Calif.

[Manuscript received April 25, 1960; revised June 6, 1960]

ABSTRACT

The purpose of this paper is to report the preliminary results depicting some of the direct measurements made by sounding rockets at Point Mugu, Calif. The data show good correlation with theoretical standards and high level balloon soundings.

1. INTRODUCTION

The Headquarters, Pacific Missile Range initiated active participation in the Meteorological Rocket Network [1] in the fall of 1959. The primary purpose of this network is to collect upper-atmosphere meteorological data on a quasi-synoptic basis by scheduling daily rocketsonde launches for a 1-month period in each season. In the past, a number of rockets (e.g., VIKING, AEROBEE, NIKE-CAJUN, etc.) have been used to gather valuable meteorological information above the heights normally attained by weather balloons. However, all the above mentioned vehicles are relatively complicated, yield "smoothed" data because of their high velocities, and are too expensive to be used on a synoptic basis at a large number of stations. Consequently, they do not meet the need for a simple, relatively inexpensive, semi-mobile rocket sounding system whereby launches can be made on a schedule approaching a synoptic basis without the imposition of overly severe safety limitations.

2. THE ARCAS ROCKET

The ARCAS (all-purpose rocket for the collection of atmospheric soundings) is one of the first all-purpose, low-cost rockets used to measure both temperature and winds in the upper atmosphere. It is a single-stage, unguided, solid propellant vehicle with an altitude capability in excess of 200,000 ft. Highly desirable features of the launcher are that it is mobile, has a closed breech, and can be moved and reassembled in four man-hours. Relatively slow acceleration is used to minimize instrumentation shock while a long burning time is used to provide thrust well above the lower, denser atmospheric regions. By utilizing the additional thrust that the closed-breech launcher provides, the rocket accelerates continuously to a burn-out speed of 3,865 ft. sec.$^{-1}$.

The problem of chute design was formidable; however, recent firings indicate successful deployment at altitudes in excess of 200,000 ft. At present, a 15-ft., mylarized chute (ejected at apogee) is used both as a radar target for obtaining winds, and as a carrier for the telemetering package. Fall rates vary from in excess of 20,000 ft. min.$^{-1}$ at 200,000 ft. to less than 500 ft. min.$^{-1}$ in the lower troposphere with a 5-lb. package.

3. INSTRUMENTATION

During the first series of firings at Point Mugu, Calif. in the fall of 1959, the so-called "Alpha" package developed by the Missile Geophysics Division, United States Army Signal Missile Support Agency, White Sands, N. Mex. [2], was used as payload. This package was essentially a T304/AMT–4 radiosonde modified to fit in the ARCAS nose cone. Due to numerous technical difficulties, no temperature data were obtained during this series although some excellent wind soundings were made [3].

Prior to the winter (1959–60) series of firings, one of the authors redesigned several of the White Sands Alpha packages; and these ultimately yielded good temperature

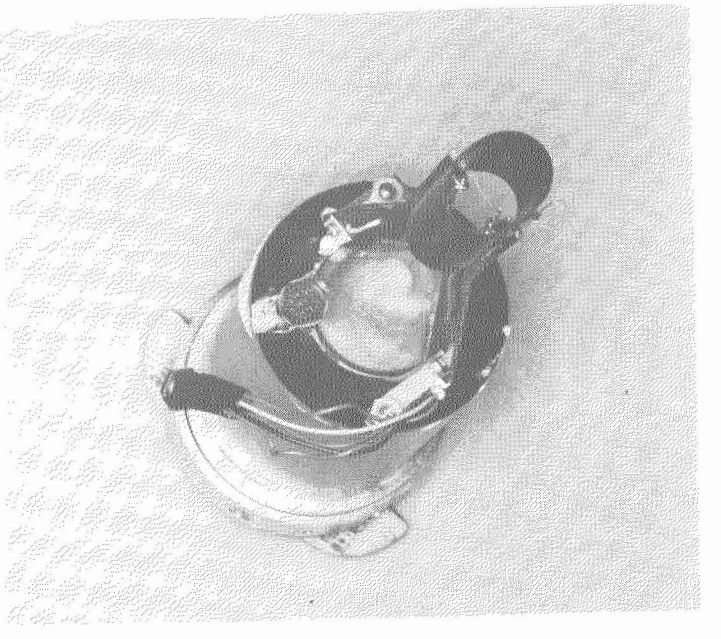

FIGURE 1.—Pacific Missile Range instrument package completely potted in polyurethane just prior to being inserted in nose cone.

*Any opinions expressed by the authors are their own and do not necessarily reflect the views of the Navy Department at large.

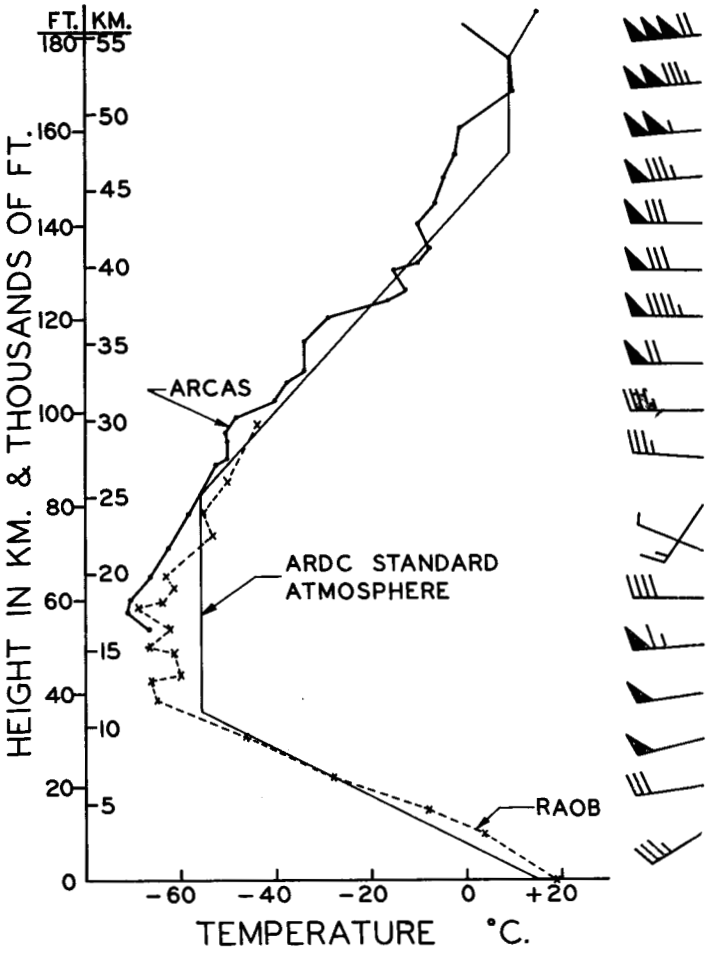

FIGURE 2.—Sounding obtained from ARCAS rocket (heavy solid line) February 15, 1960, compared with that from a balloon-borne AMT–4 radiosonde (dashed line) launched shortly afterward, and with the ARDC standard atmosphere curve (thin solid line).

measurements in the mesosphere. The same glass-coated bead thermistor (VECO 43A6) was used as a sensor, but the most significant changes made in the redesigning involved using: (1) more reliable electronic components, (2) dry-cell batteries, and (3) plastic foam potting for better thermal and shock insulation. A typical PMR instrument package is pictured in figure 1.

4. RESULTS

The best sounding obtained during the spring series was made on February 15, 1960, and is shown in figure 2. The heavy solid line represents the ARCAS rocket temperatures; the dashed line depicts temperatures obtained from a balloon-borne AMT–4 radiosonde launched within a few hours of the ARCAS firing and the thin solid line shows the theoretical ARDC Standard Atmosphere curve [4]. The comparison with the ARDC Standard is remarkable, and the paralleling of the radiosonde (although on the lower side) is also most encouraging, especially in the vicinity of the tropopause. Lift-off occurred at 1914 GMT and the radiosonde was launched at 2155 GMT.

TABLE 1.—*A summary of* ARCAS *temperatures for three firings in February 1960*

Altitude	Feb. 1, 1960	Feb. 5, 1960	Feb. 15, 1960
feet	° *C.*	° *C.*	° *C.*
135,000	−13	−27	−7
130,000	−20	−33	−14
125,000	−26	−34	−13
120,000	−32	−40	−25
115,000	−30	−40	−3?
110,000	−38	−41	−33
105,000	−34	−43	−37
100,000	−45	−43	−45
95,000	−50	−45	−51
90,000	−53	−52	−50

Above 175,000 ft. the ARCAS temperatures were considerably higher than Standard Atmosphere due to the heat generated both from the batteries while the instrument was in the launcher and from skin friction during ascent. Environmental response appeared to be quite rapid, however, and reasonable data resulted after a fall of about 1 minute. Tracking of the ARCAS was terminated as range time had expired.

Two more partial soundings (shortened by battery failure using the PMR package) were obtained on February 1 and 5, 1960. Again the temperature comparisons at levels which overlapped with radiosonde data were very good. A summary of the temperatures available from all these soundings is given in table 1. It is interesting to note, that at the lower levels there was little change during the period covered, while greater fluctuations apparently occurred at higher elevations in the mesosphere.

The soundings of February 1 and 5 were fired at an elevation of 82°, whereas the sounding of February 15 was fired at an elevation of 85°, consequently rather disappointing altitudes were reached.

5. CONCLUSIONS

The data collected to date are very sketchy but agree quite well with both radiosonde observations and theoretical curves. There is a hint that we can expect rather large temperature variations in the mesosphere. It is hoped that rapidly improving instrumentation will yield more soundings during the Meteorological Rocket Network spring series in April and May of 1960.

REFERENCES

1. W. L. Webb, W. E. Hubert, R. L. Miller, and J. F. Spurling, "Initiation of Meteorological Rocket Network," to be presented at 187th National Meeting, American Meteorological Society, June 14–16, 1960, Eugene, Oreg.
2. G. Q. Clark, "Nose Cone Beta," Missile Geophysics Division, U.S. Army Signal Missile Support Agency, White Sands Missile Range, N. Mex., 1959.
3. C. L. Armstrong and R. D. Garrett, "High Altitude Wind Data from Meteorological Rockets," *Monthly Weather Review*, vol. 88, No. 5, May 1960, pp. 187–190.
4. *Handbook of Geophysics for Air Force Designers*, Geophysics Research Directorate, Air Force Cambridge Research Center, Air Research and Development Command, United States Air Force, First Edition, 1957.