OPERATIONAL CLIMATOLOGY FOR RESEARCH BALLOONING
IN
SOUTH CENTRAL NEW MEXICO

## 1. INTRODUCTION

Specific details of this report apply to the primary launch area of the Air Force Geophysics Laboratory (AFSC) Balloon R&D Test Branch, located at Holloman Air Force Base, New Mexico on the edge of White Sands Missile Range, and to plastic, constant-level (Skyhook) balloons. However, most of the upper air parameters are applicable within a 100 mile radius and very generally for much of the Southwestern United States. Furthermore, supplementary information pertaining to remote launch sites includes a good deal of the entire state of New Mexico. Research flights with stratofilm or any other species of balloon would be effected by much of the included climatology. A variety of test programs located at or near White Sands Missile Range, may find areas of particular interest within the subject matter.

The initial discussions are of primary interest to flight schedulers and project officers planning research balloon operations in the area. Operational logistics can be substantially simplified, if well in advance, periods of optimum weather conditions are determined by competent climatological analysis, and the flights scheduled accordingly. The vital importance of advance flight scheduling has been covered in previous reports.

The remainder of the material is designed to be utilized as climatological aids for supplementing balloon flight forecasts.

The layman may wonder at the detailed preparations and forethought dedicated to an apparently uncomplicated vehicle. Modern plastic balloon operations however, involve cells larger than a football field not much thicker than a sandwich bag, carrying as much as a million dollars worth of payload. Gross loads have exceeded six tons and special breeds exhibit flight durations of more than a day.

## 2. GENERAL CLIMATOLOGY

The White Sands Missile Range is located in the Tularosa Basin of southern New Mexico. It is bordered by the Sacramento Mountains on the east, varying from 4000 to 8000 feet above the valley floor, and by the San Andres Mountains to the west, standing from 3000 to 5000 feet high. (Fig 1) The Oscuro Mountains and a high mesa partially close off the north, and the south opens up into Mexico. The basin area is approximately 80 nm by 30 nm.

The launch site for the largest balloons is most frequently at Holloman Air Force Base, which is within ten miles of the Sacramento Mountains.

The basin is located at a southerly latitude ($33^{o}$) and usually sees only the weak tail end of frontal activity. Even during the winter all but the most virulent polar outbreaks are shunted aside by the eastern slopes of the Rocky Mountains. Frontal activity therefore, generally represents more of a surface wind and downwind landing problem. Cloud problems are furthermore alleviated by surrounding restricted air spaces where many of the FAA regulations pertaining to climb out of research balloons do not apply.

SACRAMENTO
CARRIZO MOUNTAIN
RUIDOSO
SIERRA BLANCA
LONE MOUNTAIN
NOGAL PEAK
SACRAMENTO
CARRIZOZO
CLOUDCROFT
ALAMO PEAK
SAC PEAK
HIGH ROLLS
MULE PEAK
LONG RIDGE
LA LUZ
ALAMOGORDO
THE MALPAIS
ROSE PEAK
TULAROSA CANYON
TULAROSA
THREE RIVERS
OSCURO
SOUTHERN PACIFIC R.R.
FORT BLISS
HUECO MOUNTAINS
NAVILLE MOUNTAIN
NEW MEXICO
TEXAS
BUCKHORN
HOLLOMAN AIR FORCE BASE
WHITE SANDS MISSILE RANGE
JARILLA MOUNTAINS
MILITARY RESERVATION
ORO GRANDE RANGE CAMP
MILITARY
OSCURA RANGE CENTER
THE MALPAIS
70 MI AREA
50 MI AREA
OTERO CO
SIERRA CO
WHITE SANDS NATIONAL MONUMENT
Figure Page 3
30 MI AREA
FORT BLISS MILITARY RESERVATION
RESERVATION
X-500,000
W.S.T.M
ALA-5
ALA-3
NBH
ALA-1
ALA-2
SMALL MISSILE RANGE
CONDRON FIELD
OTERO CO
DONA ANA CO
BIGGS AIRFIELD
EL PASO
LAKE LUCERO
HAZARDOUS TEST AREA
OSCURO MOUNTAINS
NORTH OSCURA RANGE CENTER
MOCKINGBIRD GAP
RHODES CANYON RANGE CENTER
POST AREA, WSMR
DONA ANA RANGE CAMP
FRANKLIN MOUNTAINS
WHITE SANDS MISSILE RANGE MILITARY RESERVATION
WSMR RANGE EXTENSION (CO-USE)
90 MI. AREA
SALINAS PEAK
SAN ANDRES NATIONAL WILDLIFE REFUGE
SAN ANDRES MOUNTAINS
ORGAN MOUNTAINS
ORGAN
SAN AUGUSTIN PASS
ANTHONY
CIUDAD JUAREZ
SKILLET KNOB
STALLION RANGE CENTER
SOCORRO CO
SIERRA CO
JORNADA
WHITE SANDS MISSILE RANGE
SAN ANDRES MILITARY RESERVATION
JORNADA EXPERIMENTAL
LA MESA
LAS CRUCES
DONA ANA
SIERRA
RIO GRANDE

In addition to the artificial aid donated by restricted areas, the low incidence of cloud coverage in general is perhaps the most positive credential of the area. In Figure 2 we note that the area of minimum cloudiness for the United States includes the Tularosa Basin. During May for instance, the skies at dawn are clear to scattered 80% of the time. The extreme case is 0500 in November, when the percentage reaches 87%.

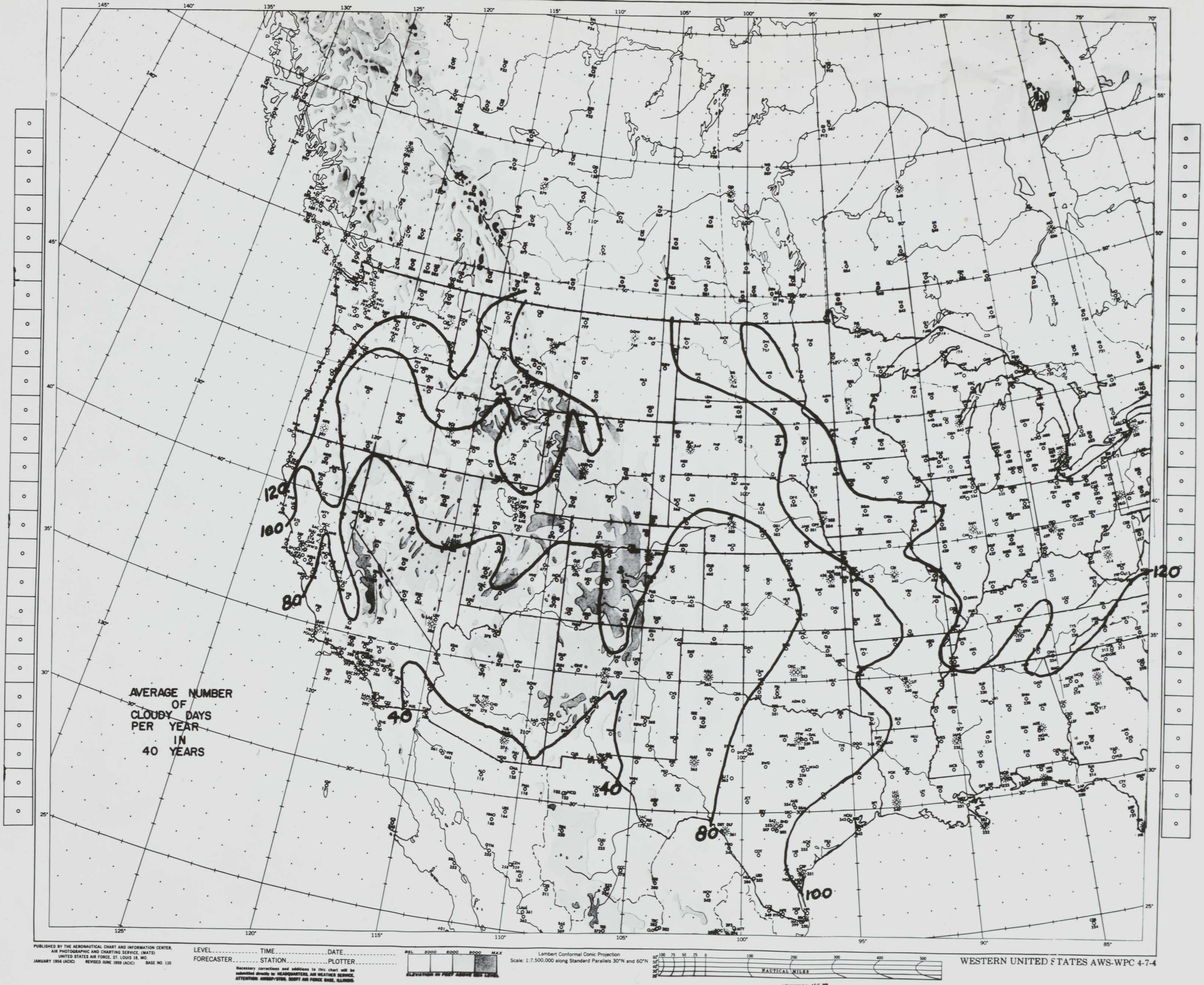
The protective effect of the Sacramento Mountains, are illustrated by cloud cover statistics for May, where Roswell, just on the east side of the mountains, shows 15% fewer cases of clear to scattered, than White Sands Missile Range.

Three hundred miles of moisture absorbing mountains to the west, also aid in generating arid and semi-arid conditions. Even in May which includes some of the dust storm season, visibilities are unlimited 90% of the time, up through noon. Humidities and fog frequencies are correspondently low.

The mountains help to break up pressure gradients and thereby decrease the potential for surface winds. Winds for 900 feet at Holloman Air Force Base, for instance, are on a monthly basis, always better than the 500 foot winds east of the mountains. In August, the 500 foot winds at Forth Worth, are less than 10 knots 17% of the time, and the Holloman 900 foot winds show 53% for the same category.

Although the mountains are generally protective, the complex terrain does generate complex wind patterns. Launch sites ten miles apart can have radically different conditions. Canyons may volley

# U.S. AIR FORCE WEATHER PLOTTING CHART

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AIR PHOTOGRAPHIC AND CHARTING SERVICE, (MATS)
UNITED STATES AIR FORCE, ST. LOUIS 18, MO.
JANUARY 1956 (ACIC) REVISED JUNE 1959 (ACIC) BASE NO. 110

LEVEL.............. TIME.............. DATE..............
FORECASTER.......... STATION.............. PLOTTER..............

Necessary corrections and additions to this chart will be submitted directly to: HEADQUARTERS, AIR WEATHER SERVICE, ATTENTION: AWSOP/STDS, SCOTT AIR FORCE BASE, ILLINOIS.

Lambert Conformal Conic Projection
Scale: 1:7,500,000 along Standard Parallels 30°N and 60°N



Figure 2
Page 5

OFFICIAL PHOTOGRAPH
UNITED STATES AIR FORCE

Photographic Branch
Holloman A. F. B.
New Mexico.

Neg. No.________Print No.________of________Prints

Photo Proj. Control No. ____________________

unexpected gusts, and drainage from the mountains can amplify a light gradient wind.

A survey of flight cancellations by AFGL at Holloman AFB, kept spradically over seven years domonstrated the following break down by cause:

| Cause | No Cases |
|---|---|
| Surface Winds | 65 |
| Jet Stream | 15 * |
| Minimum Temperature on Climb Out | 14* |
| Cloud Coverage | 76 |

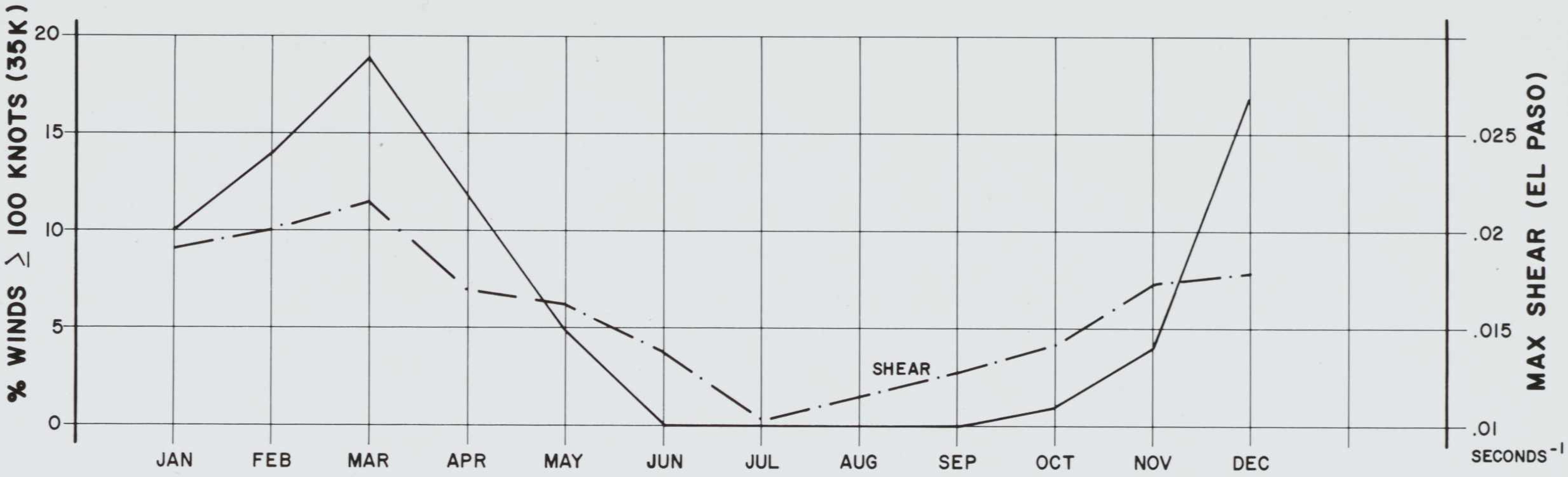
* NOT AS BIG A PROBLEM WITH BETTER balloons

The cloud coverage figure includes downwind stations and is also biased by requirements for almost clear conditions on certain target missions. However, it does indicate that surface winds are not necessarily on over riding factor. Nominating an average of 6 knots with gusts to 9, at 60 feet (roughly the centroid of the gas bubble during inflation) as the limiting launch wind, 63% of 128 work days during the last year were acceptable.

Very generally, White Sands Missile Range is halfway between a national surface wind minimum running through the Western New Mexico, Arizona, Nevada and California desert regions, and a maximum ranging from south central Texas into Kansas.

Jet stream activity is less than average. The region is 400 miles west of the national maximum, but receives occasional visitations from the subtropical jet, which compensates for conspicuous absence in summer.

## JET STREAM PARAMETERS




## TROPOPAUSE PARAMETERS

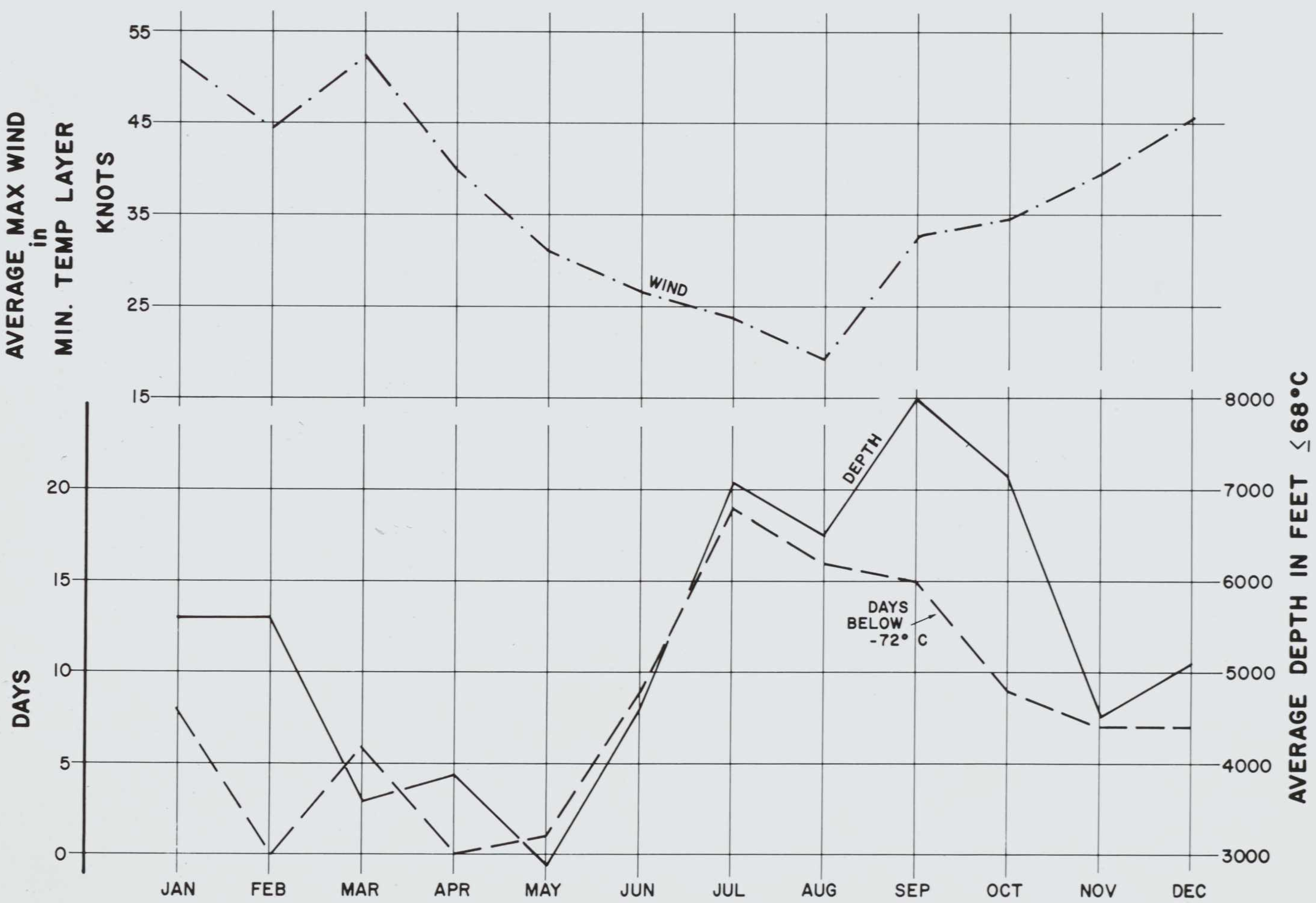



Figure 5

The minimum temperature found at or near the tropopause can be a problem for balloons of certain materials. The temperature decreases systematically towards the south, at these levels and White Sands Missile Range temperatures average about ten degrees centigrade colder than standard.

Thunderstorm activity is restricted to the summer months, and nurtured by the surrounding mountains. The moisture comes up from the Gulf of Mexico, and the most intense activity is triggered by very weak summer fronts or easterly waves. Primarily, however, the activity is diurnal. One can usually depend upon launching after the night time activity is diminished, and before new vertical development commences. Downwind afternoon activity is the major problem in these months.

## 2.1. Monthly Climatology

Seasonal changes obstinately prefer to overlap months, but since data is normally summarized in monthly form, these become the most convenient time intervals for describing trends.

The best criteria for evaluating monthly weather would be by actual cancellation. One can look at daily reports for the whole year, and define limits. On an actual flight, however, compromises and adjustments are made which impart more degrees of freedom. The primary weakness of rating months by actual cancellations, is the flight frequency, which is biased by other factors, such as climatological recommendations, and the winter holidays when White Sands Missile Range closes down. Nevertheless, the record of cancellations is a good starting point for monthly ratings.

In seven years, from 1957 to 1964, there were 1147 days with flights scheduled, and 274 cancellations for weather. Break down is as follows:

| | Total Scheduled | Per Cent Cancellations | Rating by Month |
|---|---|---|---|
| January | 118 | 25 | 5 |
| February | 119 | 33 | 12 |
| March | 94 | 29 | 8 |
| April | 97 | 30 | 10 |
| May | 94 | 5 | 1 |
| June | 88 | 28 | 7 |
| July | 106 | 16 | 3 |
| August | 95 | 15 | 2 |
| September | 82 | 29 | 9 |
| October | 101 | 27 | 6 |
| November | 72 | 18 | 4 |
| December | 81 | 31 | 11 |

Overall cancellation rate was 24 per cent. This period was heavily populated by target missions, where the balloon was launched upwind and terminated over White Sands Missile Range. In Figure 3, we see a statistical study over three years, which considered launch site conditions only. May is again verified as an outstanding month but March deteriates significantally. However, a break down of parameters for the seven year study shows March to have the most cancellations for cloud coverage.

MONTHLY DISTRIBUTION OF FAVORABLE LAUNCH DAYS
HMN 1954-1958

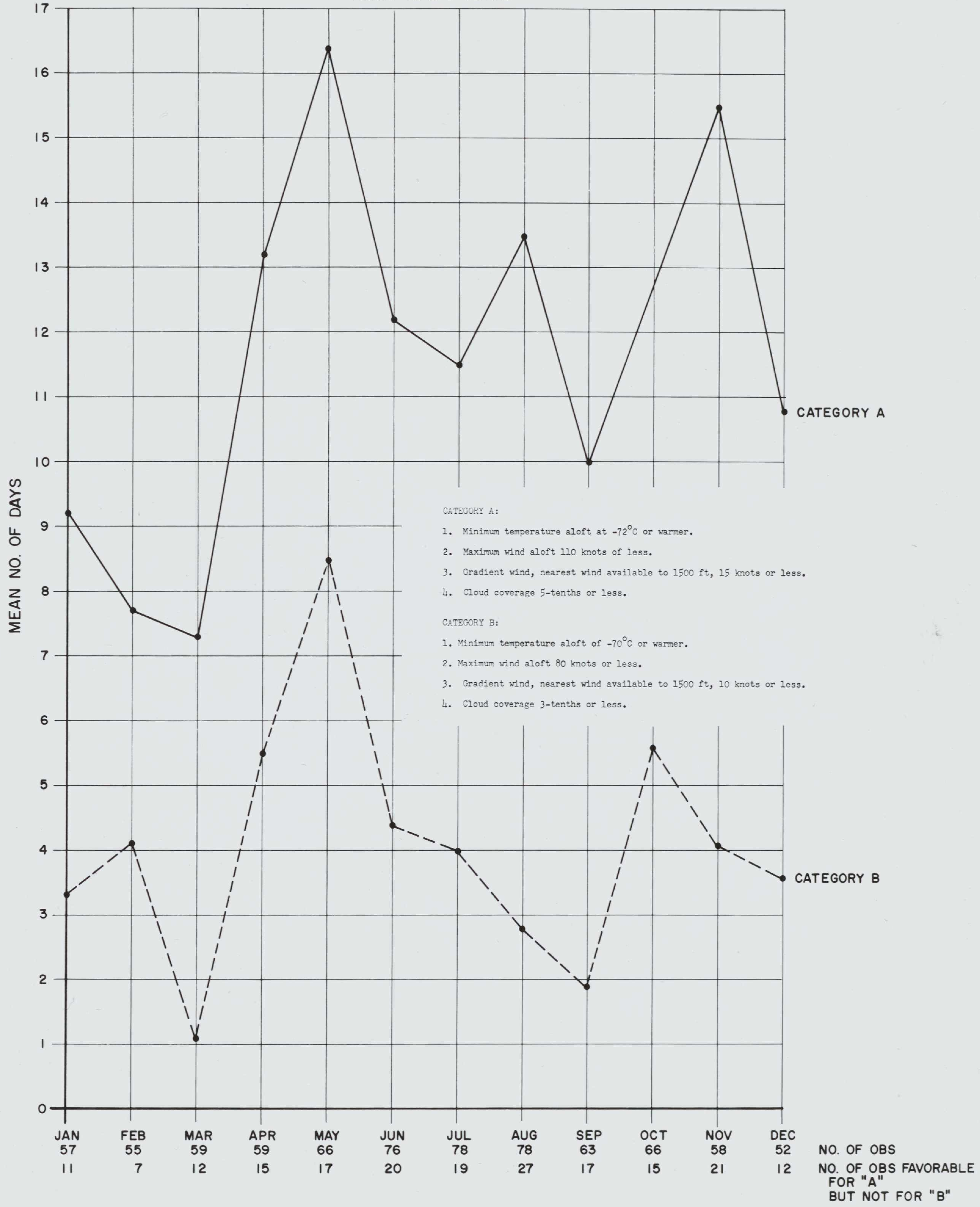



Fig. 3.

CANCELLATION PARAMETER

| | Surface Wind | Clouds | Jet Stream | Minimum Temperature | General Weather |
|---|---|---|---|---|---|
| January | 7 | 3 | 1 | 0 | 18 |
| February | 3 | 8 | 11 | 2 | 15 |
| March | 10 | 14 | 0 | 0 | 3 |
| April | 12 | 12 | 0 | 0 | 5 |
| May | 5 | 0 | 0 | 0 | 0 |
| June | 11 | 7 | 1 | 4 | 2 |
| July | 2 | 12 | 0 | 3 | 0 |
| August | 1 | 6 | 0 | 0 | 7 |
| September | 2 | 9 | 0 | 3 | 10 |
| October | 7 | 5 | 0 | 0 | 15 |
| November | 3 | 4 | 0 | 1 | 5 |
| December | 2 | 8 | 2 | 1 | 12 |

Another statistical study performed for only one year, but including downwind weather rated August the best month with December and March the worst. November was sharply compromised by downwind weather. Over a 17 year period, the greatest number of launches have been in July and August, the least in November and December.

2.1.1. Individual parameters by Month

Figures 4, 5 and 6 break down some of the individual parameters effecting balloon operations. On Figure 4, 0 to 4 knots may seem like an exorbitantly low value even for balloons, but the data is taken at the standard level of 13 feet above the ground. Most of the balloon gas bubbles have centroids about 50 feet, where the wind speeds would

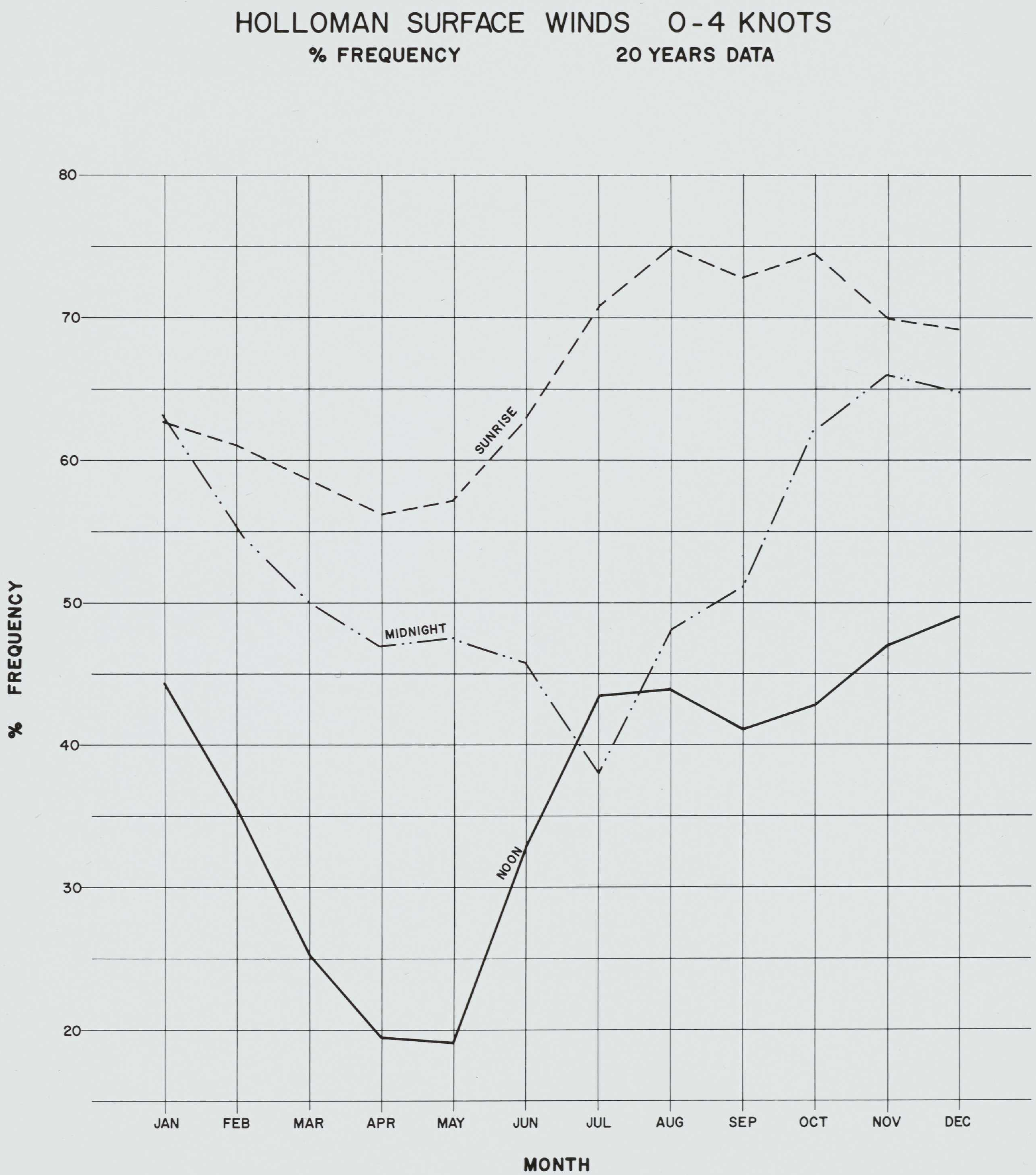

HOLLOMAN SURFACE WINDS 0-4 KNOTS
% FREQUENCY
20 YEARS DATA
% FREQUENCY
80
70
60
50
40
30
20
SUNRISE
MIDNIGHT
NOON
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
MONTH

Figure 4

be a few knots greater. Note that the best season for noon launches is the winter, when inversions can persist most of the day. January is the one month where the minimum wind is as likely to occur at midnight, as at sunrise. The dip in midnight winds in July is due to nocturnal thunderstorm activity. September sunrise winds deteriorate because the pressure gradiant is tighting up after the bland summer systems exit, yet it is still not cool enough to cap off the gradiant wind with surface inversions.

In Figure 5, we see that March exhibits the maximum jet stream speeds, shear and wind in the tropopause. Note that the wind speeds in the minimum temperature layers are luckily out of phase with cold temperature months.

Figure 6, illustrates cloud coverage, with a launchable surface wind contingency. The 1500 MST curve is an attempt to calibrate landing conditions, but only significant for short trajectories. Although Fall looks especially good at this time, Texas can offer considerable cloud problems. On the other hand in summer, the desert areas west of Tucson and Phoenix are drier than New Mexico. Figure 7 provides a visual integration of these parameters, adding 100K float speeds.

### 2.1.2 Overall Monthly Profiles

January: Finds the strongest float winds and the most frontal systems. It ranks last in the integrated cloud and surface wind rating and for free balloons can be the worst month of the year, in a severe winter. Yet the cancellation rate is less than average, and mostly due

# WSMR CLOUD COVERAGE w/0-5 KNOT SURFACE WINDS

% FREQUENCY 20 YEARS DATA

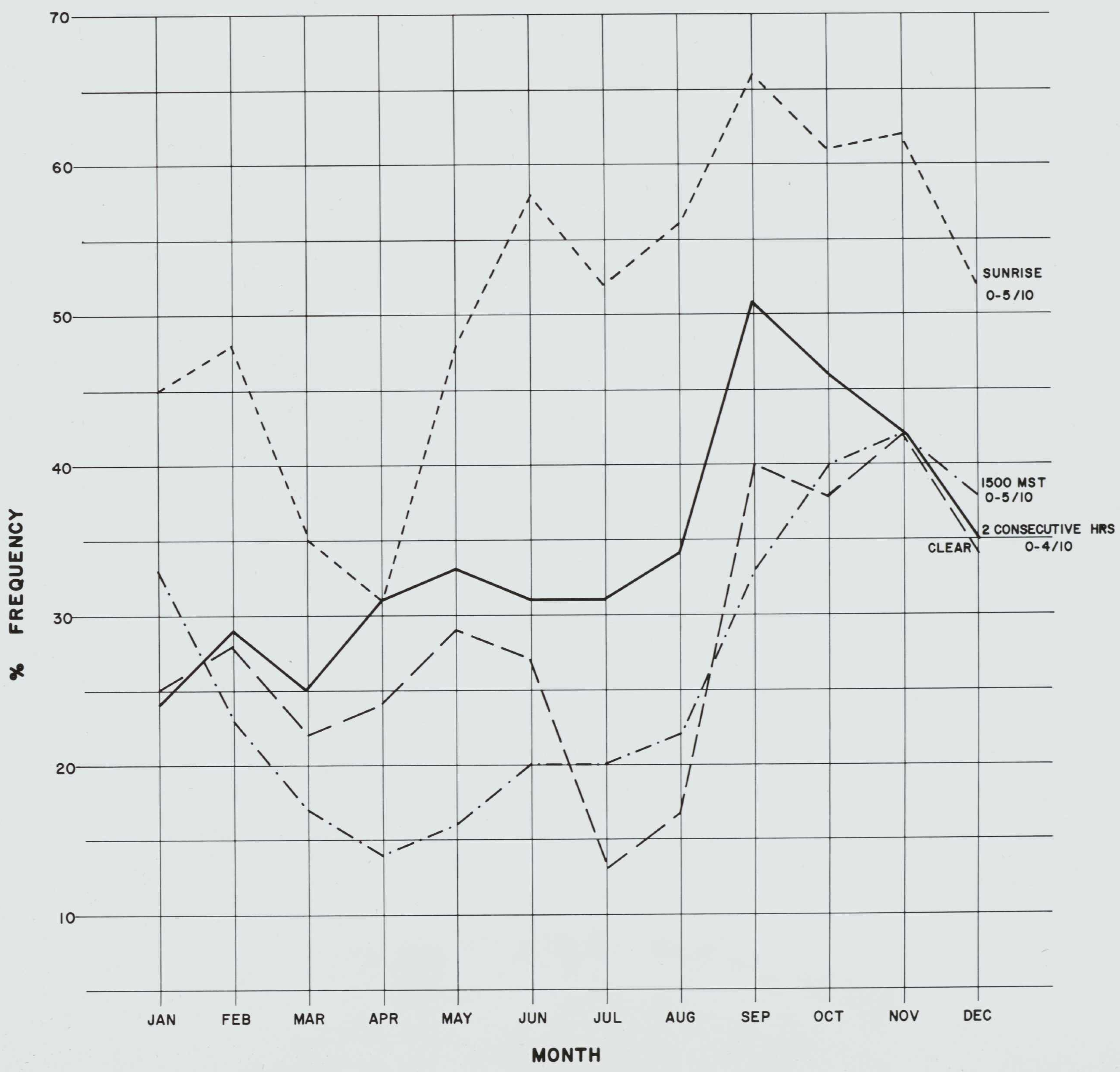
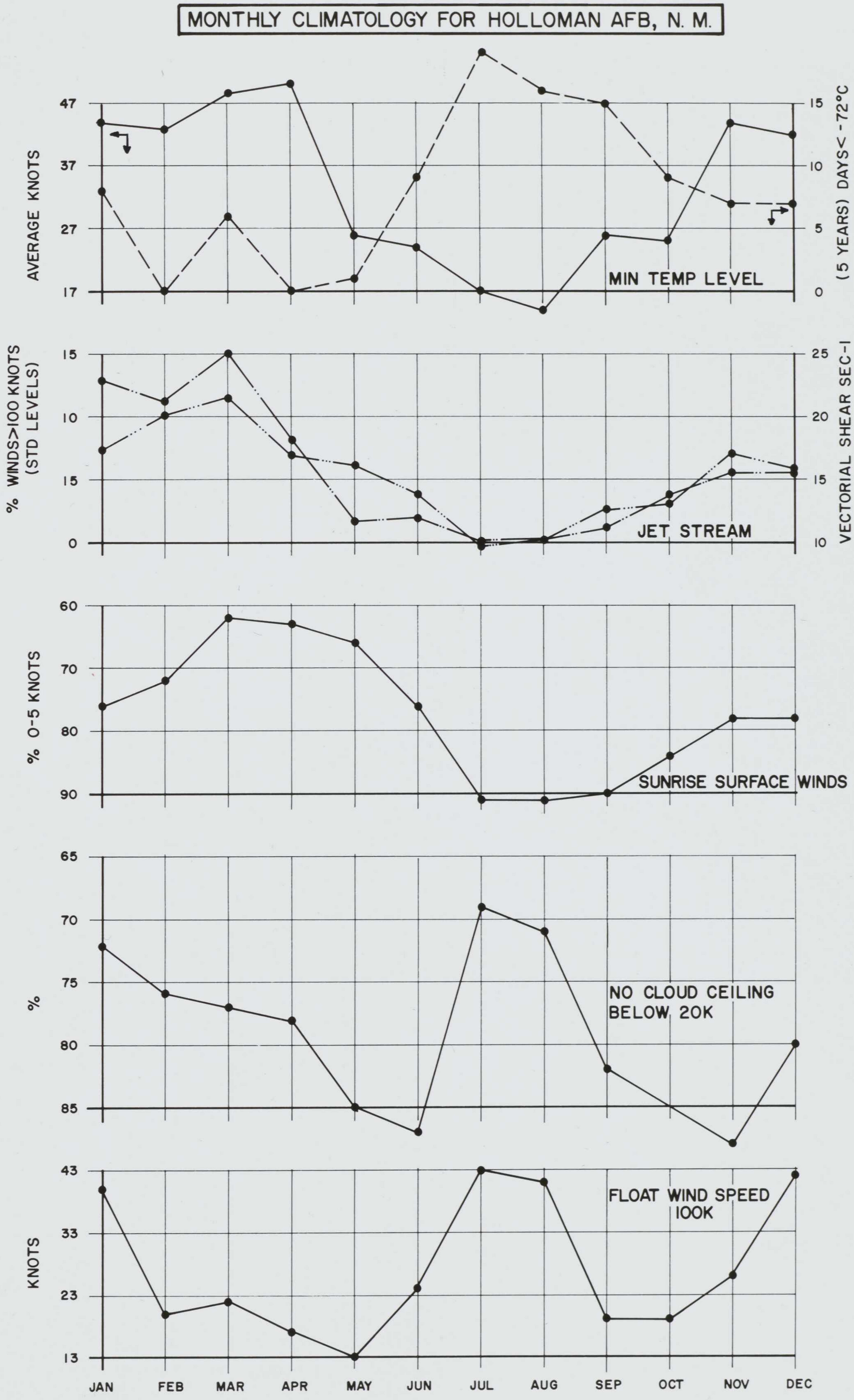



Figure 6
Page 14


WSMR CLOUD COVERAGE w/0-5 KNOT SURFACE WINDS
% FREQUENCY
20 YEARS DATA
70
60
50
40
30
20
10
% FREQUENCY
SUNRISE
0-5/10
1500 MST
0-5/10
2 CONSECUTIVE HRS
CLEAR
0-4/10
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
MONTH


MONTHLY CLIMATOLOGY FOR HOLLOMAN AFB, N. M.
AVERAGE KNOTS
47
37
27
17
15
10
5
0
(5 YEARS) DAYS< -72°C
MIN TEMP LEVEL
% WINDS>100 KNOTS (STD LEVELS)
15
10
15
0
25
20
15
10
VECTORIAL SHEAR SEC-1
JET STREAM
% 0-5 KNOTS
60
70
80
90
SUNRISE SURFACE WINDS
%
65
70
75
80
85
NO CLOUD CEILING BELOW 20K
KNOTS
43
33
23
13
FLOAT WIND SPEED 100K
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC

to downwind weather. For captive balloon operations below 3000 feet it may be the best month, since inversions can persist all day. Predominate float winds are westerly.

February: Had the worst cancellation rate in the seven year survey. Westerly float winds begin to decrease in speed, and there is increasing probability of sporadic easterly flow.

March: Exhibits the strongest jet stream activity and in turn the longest climb outs. It demonstrated the worst cancellation record, along with December, in the one year study. Surface winds are poor, but the highest percentage of winter easterlies occur in this month.

April: Shows the maximum surface winds at sunrise and the most cloud coverage, but a warm tropopause. Float winds improve sharply in the second half of the month.

May: One of the best months of the year, except for surface winds. There were only five cancellations in seven years. It has the lightest float winds swtiching from westerly to easterly direction and a warm, shallow tropopause.

June: Marks the end of the jet stream season, a cooling tropopause and the shortest climb out trajectories. It is the best month for day long absence of clouds, but the low level jet in the last ten days is at maximum activity. Float winds are easterly.

July: Has minimum jet stream activity and shear, and climb outs completely within the White Sands Missile Range restricted areas negate launch cloudiness. Maximum thunderstorm activity make afternoons and evenings prohibitive for launches and recoveries, but there is a well defined minimum from 0800 to 1200 MST. Float winds are very strong, but this aids in drifting out for landings in drier western Arizona, July sees the coldest tropopause.

August: Rated Number 1 and 2 in the cancellation studies, with only one cancellation for surface winds in 95 attempts. It exhibits gradual improvement over July in most variables.

September: Thunderstorm activity depletes rapidly after the first ten days, but the hurricane season can make downwind cloudiness marginal. It has the deepest tropopause but is second to May in light float winds and ranks most favorable in combined surface winds and cloud coverage. Float winds begin to switch back near end.

October: Has long duration clams, a warming tropopause and light float winds in the low stratosphere. Above 100K, the winds pick up rapidly in the second half of the month from the west.

November: The best month in the year for night launches, a very erratic month, ranking supreme some years, except for downwind weather.

December: Deteriorates in all variables except in afternoon surface winds. Like November, it can vary markedly from year to year, and a 24 hour manned stratosphere flight was made in the middle of the month, with easterly flow aloft.

## 3. FLIGHT CATEGORIES

### 3.1. The Basic Research Flight

The most common species of CLB mission, sees a simple ascent to altitude, with a float at peak altitude, encompassing all available daylight hours. The launch is performed at the time of minimum surface winds, generally close to sunrise. Flight termination is planned, allowing 30 minutes for parachute descent, and about two additional hours of sunlight for the recovery crews to be guided in. Assuming

2.5 hours of ascent time to a nominal 100K (Kiloft MSL), with the 2.5 hour cushion after termination, average float duration for the various months, would be as follows:

| | | | |
|---|---|---|---|
| January | 5.5 hours | July | 9.0 hours |
| February | 6.5 hours | August | 8.5 hours |
| March | 7.0 hours | September | 7.5 hours |
| April | 8.5 hours | October | 6.5 hours |
| May | 9.0 hours | November | 5.5 hours |
| June | 9.5 hours | December | 5.5 hours |

The values were rounded out to the nearest half hour, since time of sunrise varies throughout a month, since one can launch 30 minutes prior to sunrise without generally compromising balloon performance and finally, longitudinal displacements can vary the sunset time by almost 30 minutes.

Associated mean displacements, including climb out and parachute drift, would be as follows:

| | Distance Out NM | Vicinity Of |
|---|---|---|
| January | 400 East | Wichita Falls, TX |
| February | 285 East | Childress, TX |
| March | 295 East | Childress, TX |
| April | 220 East | Lubbock, TX |
| May | 115 West | Silver City, NM |
| June | 215 West | Tucson, AZ |
| July | 390 West | Gila Bend, AZ |
| August | 260 West | Tucson, AZ |

| | | |
|---|---|---|
| September | 135 West | Lordsburg, NM |
| October | 225 East | Lubbock, TX |
| November | 230 East | Lubbock, TX |
| December | 325 East | Abilene, TX |

Ratings by month for various parameters related to this flight profile, as as follows:

| | Distance Out | Launch Surface Winds & Clouds | Landing Area Cloudiness | Min Temp | Jet Stream | Integrated Rating |
|---|---|---|---|---|---|---|
| January | 12 | 12 | 11 | 5 | 10 | 12 |
| February | 8 | 10 | 8 | 4 | 9 | 10 |
| March | 9 | 11 | 10 | 2 | 12 | 11 |
| April | 4 | 9 | 9 | 1 | 11 | 8 |
| May | 1 | 5 | 2 | 3 | 5 | 1 |
| June | 3 | 7 | 1 | 9 | 3 | 3 |
| July | 11 | 8 | 4 | 12 | 1 | 9 |
| August | 7 | 6 | 5 | 10 | 2 | 5 |
| September | 2 | 1 | 3 | 11 | 4 | 2 |
| October | 5 | 2 | 7 | 8 | 6 | 4 |
| November | 6 | 3 | 8 | 6 | 7 | 6 |
| December | 10 | 4 | 12 | 7 | 8 | 7 |

Low numbers represent the most favorable months. The launch surface winds and clouds are based on an integrated value, where both acceptable winds and cloud coverage must coexist. Ideally of course, one would want this factor ties in with the landing area cloudiness.

These values should be used as a relative guide, since they deal with averages. January has sporadic outbreaks of easterlies, which would then match it with May in trajectory shortness. July and August trajectories are consistently long. The transition months of May and September ideally should be broken down into half months.

The last half of December, through the end of March, is marked by frontal activity which deteriorates the averages, but it can provide some of the finest launch days in the year, when very cold but clear weather generates long duration calms.

May has superb conditions aloft, but the first few weeks are occasionally marred by tail end of dust storm season. Likewise, the first week of September is compromised by residue of thunderstorm season.

3.2. Climb-out Parameters

On some flights the contractor desires data only on ascent, with float time required only to maneuver into a favorable landing area. With no floating the total distance out, with a 900fpm ascent rate, to 100Kft would be as follows: (also see Figures 8-11).

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| January: | 64 NM | East-Northeast | (97) | July: | 25 NM | West | (31) |
| February: | 61 NM | East | (91) | August: | 16 NM | West-Northwest | (22) |
| March: | 68 NM | East-Northeast | (97) | September: | 13 NM | Northeast | (20) |
| April: | 52 NM | East-Northeast | (79) | October: | 36 NM | East-Northeast | (54) |
| May: | 32 NM | Northeast | (45) | November: | 52 NM | East | (82) |
| June: | 9 NM | Northeast | (17) | December: | 55 NM | East | (85) |

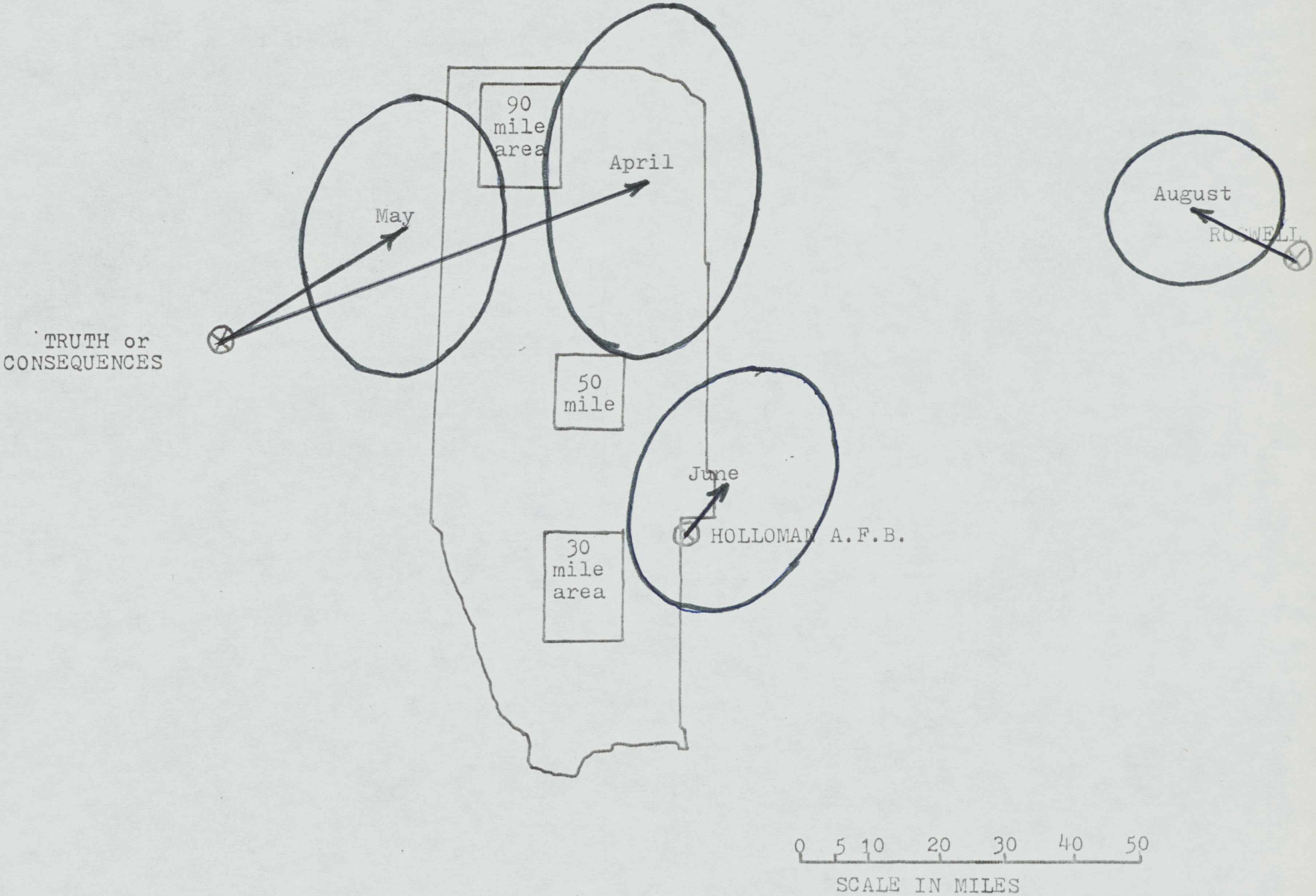



Figure 8 : April, May, June, and August 50% Probability Trajectory Dispersion Patterns. (900fpm)

206.

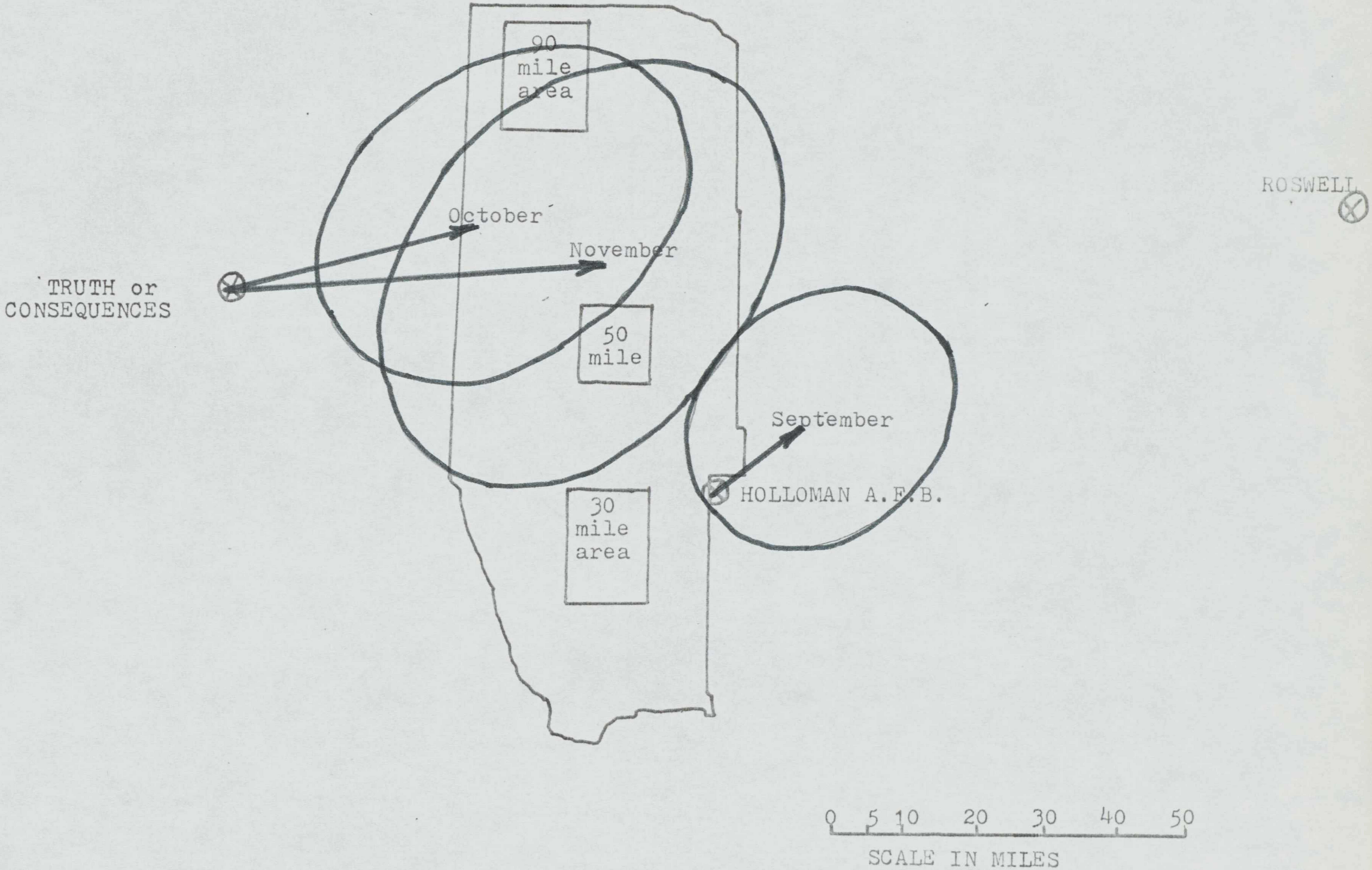



Figure 9 : September, October, and November 50% Probability Trajectory Patterns. (900fpm)

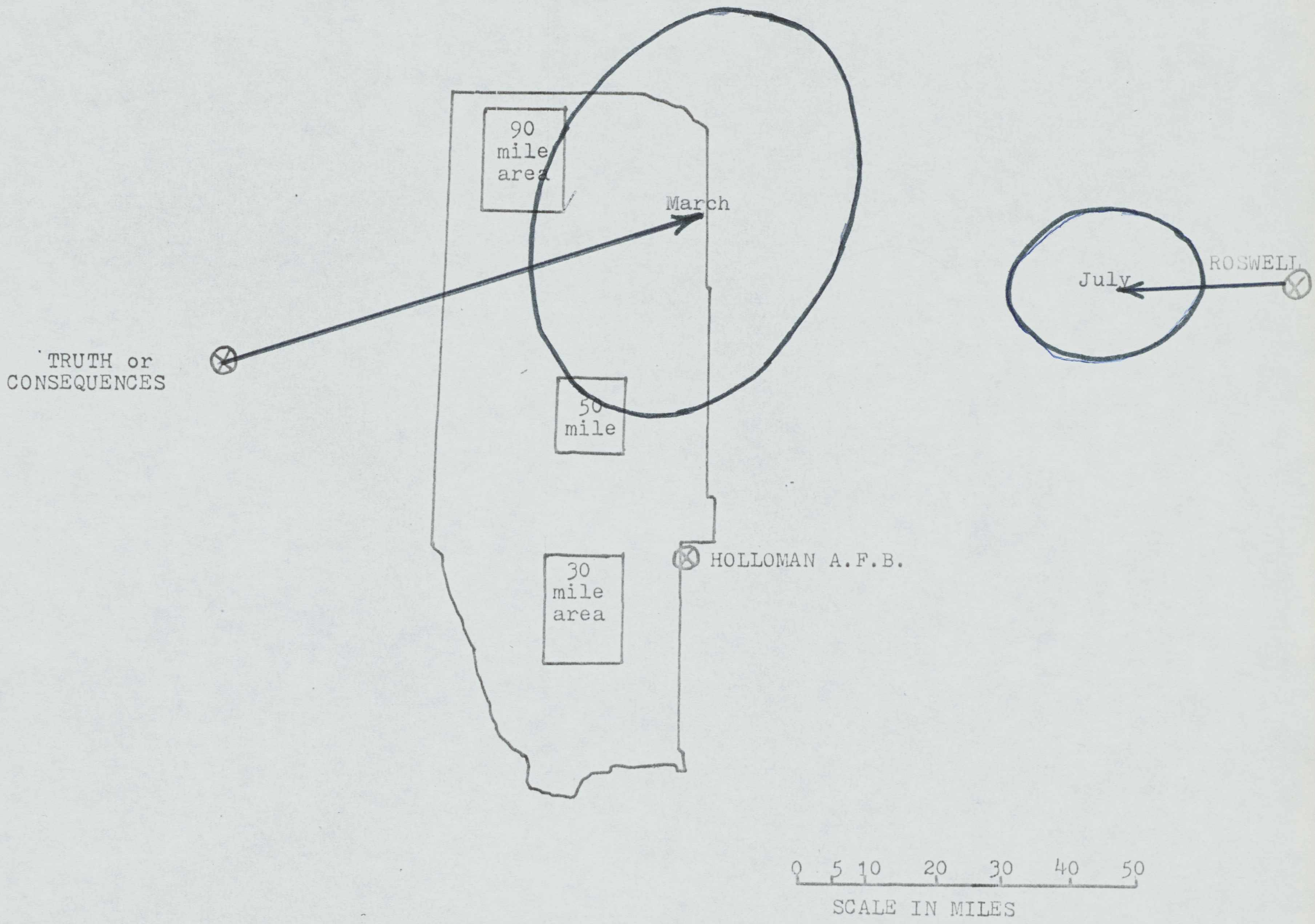
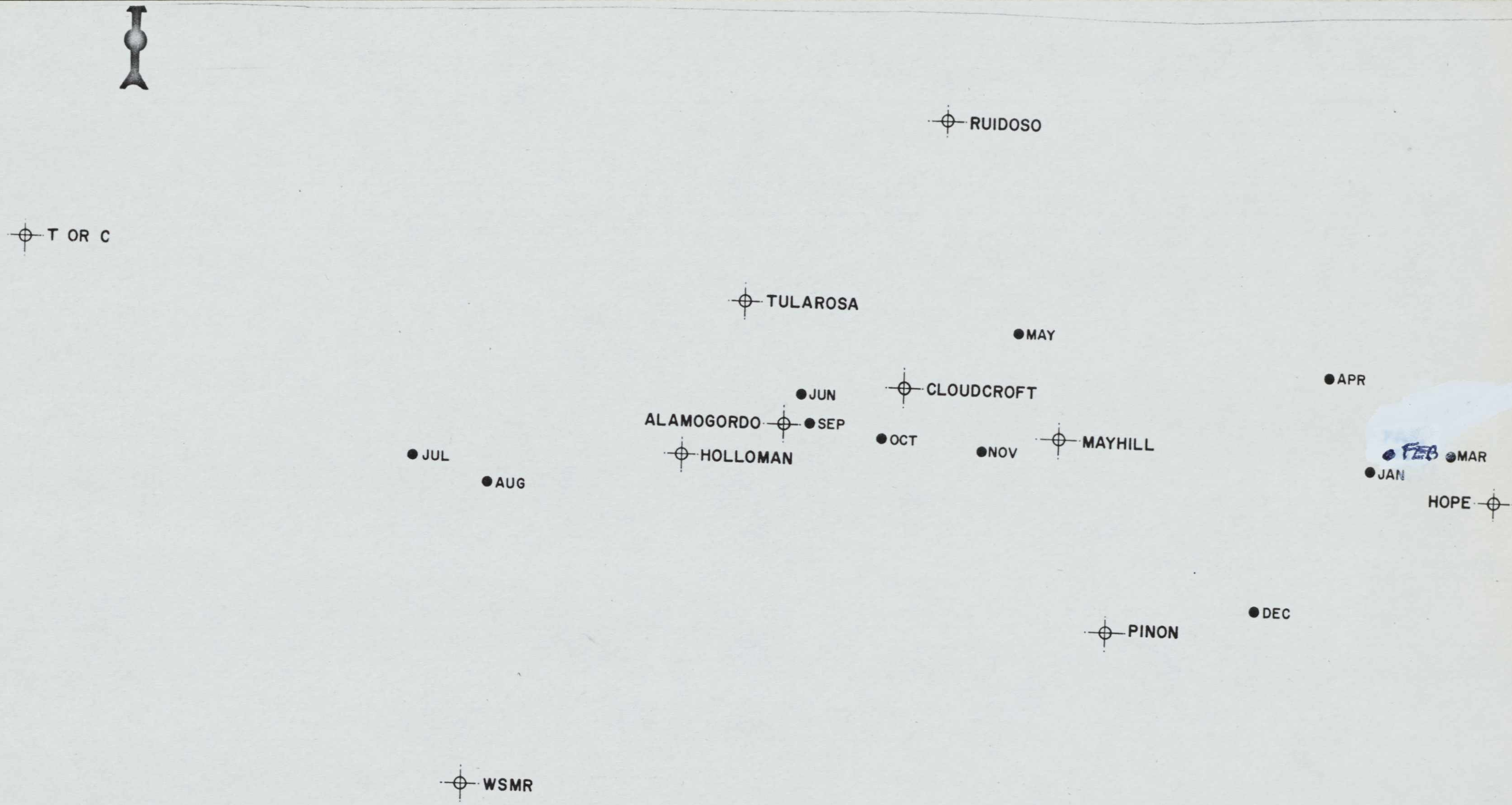



Figure 10: March and July 50% Probalility Trajectory Dispersion Patterns. (900fpm)

20.d.




MONTHLY CLIMB OUT TRAJECTORIES
TO 90K, 833 FPM

0 5 10
SCALE NM

Figure 11,

Complete spectrum is as follows; rating is by month:

| | Climb out Distance | Launch Winds & Clouds | Landing Area Clouds | Min. Temp. | Jet Stream | Integrated Rating |
|---|---|---|---|---|---|---|
| January | 11 | 12 | 10 | 5 | 10 | 12 |
| February | 12 | 10 | 12 | 4 | 9 | 11 |
| March | 9 | 11 | 5 | 2 | 12 | 10 |
| April | 10 | 9 | 2 | 1 | 11 | 8 |
| May | 6 | 5 | 3 | 3 | 5 | 2 |
| June | 2 | 7 | 1 | 9 | 3 | 1 |
| July | 5 | 8 | 4 | 12 | 1 | 6 |
| August | 3 | 6 | 7 | 10 | 2 | 4 |
| September | 1 | 1 | 6 | 11 | 4 | 5 |
| October | 4 | 2 | 8 | 8 | 6 | 3 |
| November | 7 | 3 | 9 | 6 | 7 | 7 |
| December | 8 | 4 | 11 | 7 | 8 | 9 |

The last two weeks of June are marred by the intrusion of the leading edge of the Gulf of Mexico anticyclone, which produces a low level jet in the morning.

3.3. Flight Tests of New Balloon Designs

Generally, the project engineer prefers optimum launch and climb out conditions, with less emphasis on the trajectory. Long duration surface wind lulls are especially desirable. Accordingly, the surface wind ratings are based on an average of three consecutive hours with light winds. The parenthese include a percentage frequency for the 0-4 knots interval.

| | Surface Winds | Jet Stream | Minimum Temperature | Rating |
|---|---|---|---|---|
| January | 7 (63%) | 10 | 5 | 10 |
| February | 8 (62%) | 9 | 4 | 9 |
| March | 11 (56.5%) | 12 | 2 | 12 |
| April | 12(55%) | 11 | 1 | 6 |
| May | 10 (57.5%) | 5 | 3 | 6 |
| June | 9 (61%) | 3 | 9 | 7 |
| July | 4 (69%) | 1 | 12 | 4 |
| August | 3 (70%) | 2 | 10 | 2 |
| September | 2 (72%) | 4 | 11 | 3 |
| October | 1 (72.5%) | 6 | 8 | 1 |
| November | 5 (68.5%) | 7 | 6 | 5 |
| December | 6 (68.4%) | 8 | 7 | 8 |

3.4 WSMR Target Flights

This category is intended to cover missions requiring a rendezvous over the WSMR target areas at pre-selected times and altitudes. The new parameter which is introduced and emphasized is cloud coverage at rendezvous or X-time. Even scattered cirrus can compromise data collection in such an exercise, which includes ground based optics. The surface wind rating is based on the average location of the launch site for each month, which will be upwind of the target areas.

| | Surface Winds | Clouds At X-Time | Climb Out Distance | Integrated Rating |
|---|---|---|---|---|
| January | 5 | 10 | 12 | 11 |
| February | 7 | 9 | 10 | 9 |
| March | 9 | 11 | 11 | 12 |
| April | 10 | 7 | 9 | 8 |
| May | 6 | 3 | 5 | 4 |
| June | 8 | 2 | 3 | 3 |
| July | 11 | 12 | 4 | 10 |
| August | 12 | 6 | 1 | 6 |
| September | 1 | 1 | 2 | 1 |
| October | 2 | 4 | 6 | 2 |
| November | 3 | 5 | 7 | 5 |
| December | 4 | 8 | 8 | 7 |

The most anomalous statistic here is July, which often sees about one dry week in the middle of the month. (More see Part B)

3.5. Hovering Flights

This terminology is related to fights in excess of 24 hours, which are purposely flown at the altitude of minimum winds. They may even be varied in altitude, in order to pursue this minimum flow level as the latter varies, or to take advantage of wind direction reversals between different levels.

Standard wind data in the stratosphere is in 5000 foot increments. However, computer processed radiosondes for WSMR, in 1000 foot increments, indicate lesser speeds within these standard layers. The monthly distribution is as follows:

AVERAGE MINIMUM PER RUN

| | Wind Speed 1000 Foot Intervals | Wind Speed 5000 Foot Intervals | Altitudes of Maximum Frequency Kiloft MSL |
|---|---|---|---|
| January | 06 | 18 | 75, 85 |
| February | 09 | 16 | 75, 70 |
| March | 06 | 14 | 70, 80 |
| April | 03.5 | 11 | 70, 85 |
| May | 03 | 10 | 80, 75 |
| June | 03 | 14 | 55, 60 |
| July | 07 | 13 | 50, 60 |
| August | 06.5 | 12.5 | 55, 60 |
| September | 04 | 10.5 | 55, 60 |
| October | 03 | 10 | 65, 70 |
| November | 06.5 | 16 | 70, 75 |
| December | 07 | 16 | 70, 75 |

At higher altitudes, the same phenomena may be seen over shorter periods, during the stratosphere reversal. At 100K, the interval covers from 7 to 21 May, and roughly from 25 September to 10 October.

June is the best month for cycling a flight in the westerly flow at 50K and the stratosphere easterlies. Frequency of this pattern is over 80%. May and October follow with about 45%.

The same technique can be inversely worked for short periods, with westerlies in the high stratosphere, versus easterlies in the mid stratosphere.

| | | | |
|---|---|---|---|
| Mid-April | Easterlies | 75 to 85K | Westerlies above 100K |
| May | Easterlies | 75 to 85K | Westerlies above 110K |
| Mid-September, & October | easterlies | 75 to 85K | Westerlies above 100K |

An additional opportunity for such cycling is seen in the outbreaks of winter stratosphere easterlies which occur, possible systematically in certain years. In 1959 and 1963 it was over 50% of the time, from 80 to 100K.

### 3.6 Miscellaneous Information.

a. Balloon Statistics:

1. Stratofilm [1964 through 1991]:

Some of the balloon success records.

| Manufacturer | Size | Numbers sucessful/total | Percentage Rate |
|---|---|---|---|
| Winzen | 108' | 18/19 | 95% |
| Winzen | 114' | 9/10 | 90% |
| Raven | 114' | 1/1 | 100% |
| Winzen | .274mcf | 63/69 | 91% |
| Raven | .274mcf | 22/23 | 96% |
| Winzen | .355mcf | 6/6 | 100% |
| Raven | .355mcf | 5/7 | 71% |
| Winzen | .628mcf | 7/7 | 100% |
| Raven | .803mcf | 1/2 | 50% |
| Raven | .804mcf | 4/4 | 100% |
| Raven | .859mcf | 1/1 | 100% |
| Winzen | 1.33 mcf | 1/1 | 100% |
| Winzen | 1.151mcf | 1/1 | 100% |
| Winzen | 2.01 mcf | 103/106 | 97% |
| Raven | 2.01 mcf | 12/14 | 86% |
| Winzen | 2.9 mcf | 33/36 | 92% |
| Raven | 2.9 mcf | 14/17 | 82% |
| Winzen | 3.02 mcf | 0/2 | 0% |
| Raven | 3.69 mcf | 0/1 | 0% |
| Winzen | 3.69 mcf | 10/12 | 83% |
| Winzen | 4.89 mcf | 26/36 | 72% |
| Raven | 4.89 mcf | 4/4 | 100% |
| Winzen | 5.025mcf | 34/36 | 94% |
| Winzen | 5.142mcf | 6/7 | 86% |
| Raven | 5.142mcf | 7/9 | 78% |
| Winzen | 8.74 mcf | 4/4 | 100% |
| Winzen | 10.6 mcf | 23/31 | 74% |
| Winzen | 11.62 mcf | 25/26 | 96% |
| Raven | 11.62 mcf | 4/6 | 67% |
| Raven | 11.66 mcf | 0/1 | 0% |
| Winzen | 15.8 mcf | 1/1 | 100% |
| Winzen | 18.75 mcf | 0/1 | 0% |
| Overall average: | | 447/502 | 89% |

2. Astrofilm E or E2 [1986 through 1991]:

| | | | |
|---|---|---|---|
| Raven | 1.23 mcf | 1/1 | 100% |
| Raven | 2.9 mcf | 2/3 | 67% |
| Raven | 3.69 mcf | 1/1 | 100% |
| Raven | 5.025mcf | 3/4 | 75% |
| Winzen | 11.82 mcf | 1/1 | 100% |
| Overall Average | | 8/10 | 80% |

| Manufacturer | Size | Numbers sucessful/total | Percentage Rate |
|---|---|---|---|
| 3. Stratofilm 372 [1988-1991]: | | | |
| Winzen | 2.9 mcf | 2/2 | 100% |
| Winzen | 3.69 mcf | 3/3 | 100% |
| Overall Average | | 5/5 | 100% |

Approx. missions [free & tether]: 2814

b. Success percentages last 14 years: [Free Launches ONLY until 1982]

| Year | OL-AB [#] | PSL[#] | Total | Tethers |
|---|---|---|---|---|
| 1978 | 86.3%[22] | 100%[29] | 94%[51] | 6 |
| 1979 | 84.2%[19] | 92%[28] | 89.3%[47] | 15 |
| 1980 | 100%[12] | 88.2%[17] | 93.1%[29] | 9 |
| 1981 | 100%[8] | 78.5%[14] | 86.3%[22] | 5 |
| 1982 | 91.7%[12] | 77.8%[9] | 85.7%[21] | 5 |
| 1983 | 77%[13] | --- | 92%[21] | 8 |
| 1984 | 71%[14] | --- | 91%[25] | 11 |
| 1985 | 64%[11] | --- | 81.6%[16] | 5 |
| 1986 | 100%[8] | --- | 100%[17] | 9 |
| 1987 | 75%[4] | --- | 89%[9] | 5 |
| 1988 | 80%[10] | | 88%[17] | 7 |
| 1989 | 71%[17] | | 86%[22] | 4 |
| 1990 | 71%[14] | | 75%[16] | 2 |
| 1991 | 100%[3] | | 100%[7] | 4 |

```
MCF    MODEL             MFR     CONTRACT          ITEM UN OF SN  REMARKS

18.750 SV-100            WINZEN  NR779383                 1  1   1
       H84-20 29JUL84    2389 LB 100 KFT FAILURE BALLOON FAILURE AFTAC/JPL

15.800 SF351.91-050NSC   WINZEN  N00014-73-C0383          1  3   7 NAVY PURCHASE
       H85-19 05OCT85    1846 LB 131 KFT SUCCESS BIMS

11.820 AF317.60-080NSC   WINZEN  PO 07490-87       0001   1  2 001 ASTROFILM E
       H88-01 08JAN88    2453 LB 118 KFT SUCCESS GRAD, MCMURDO SOUND, ANTARCTICA

11.660 SV-102            RAVEN   F29651-84-C0040 0001   1  1 101
       H85-07 06JUN85    1855 LB  57 KFT FAILURE BALLOON FAILED NEAR TOP OF TROP

11.620 SV-020            RAVEN   F29651-82-C0055 0001   1  3 101
       H82-23 04OCT82    1776 LB 127 KFT SUCCESS BIMS
11.620 SV-020            RAVEN   F29651-82-C0055 0001   2  3 102
       H83-08 20APR83    1383 LB 129 KFT SUCCESS HALL SOLAR UV
11.620 SV-020            RAVEN   F29651-82-C0055 0001   3  3 103
       H83-09 16MAY83    1831 LB 128 KFT SUCCESS BIMS EXPERIMENT FAILED
11.620 SV-020            WINZEN  F29651-83-C0031 0001   1  4   6
       H83-18 06OCT83    2064 LB 125 KFT SUCCESS BIMS NORTHROP STRIP NO DATA
11.620 SV-020            WINZEN  F29651-83-C0031 0001   2  4   7
       H84-17 29JUN84    1866 LB 124 KFT SUCCESS ROSWELL BIMS EXPERIMENT FAILED
11.620 SV-020            WINZEN  F29651-83-C0031 0001   3  4   8
       H84-21 04AUG84    2194 LB 126 KFT SUCCESS AFTAC/JPL
11.620 SV-020            WINZEN  F29651-83-C0031 0001   4  4   9
       H85-08 13JUN85    1855 LB 129 KFT SUCCESS BIMS
11.620 SV-020A           RAVEN   F29651-84-C0040 0002   1  2 104
       H85-05 24MAY85    1855 LB     KFT FAILURE HOLE IN BALLOON AFTER INFLATION
11.620 SV-020A           RAVEN   F29651-84-C0040 0002   2  2 105
       H85-06 28MAY85    1865 LB     KFT FAILURE BALLOON TORE ON LAUNCH RUN
11.620 SV-016A           WINZEN  PO-16849                 1  1 123
       H83-02 23JAN83    1599 LB 129 KFT SUCCESS ASHCAN

 8.740 SF277.88-100NSC   WINZEN  PO-24342                 5  5   5 HOWELL
       H87-07 31AUG87    3017 LB 108 KFT SUCCESS ABLE, ROSWELL, NM
 8.740 SF277.88-100NSC   WINZEN  PO-M42476                3  3   8
       H84-22 24AUG84    2931 LB 109 KFT SUCCESS ABLE ROSWELL

 5.142 SV-017B           RAVEN   F19650-81-C0054 0002   2  8 102
       H82-18 17JUL82    3550 LB 104 KFT SUCCESS NASA/GALILEO ROSWELL, NM
 5.142 SV-017B           RAVEN   F19650-81-C0054 0002   3  8 103
       H83-16 25JUL83    3512 LB  99 KFT SUCCESS NASA/GALILEO ROSWELL, NM
 5.142 SV-017B           RAVEN   F19650-81-C0054 0002   4  8 104
       H85-02 30APR85    2284 LB 104 KFT SUCCESS DENVER
 5.142 SV-017B           RAVEN   F19650-81-C0054 0002   5  8 105
       H84-03 16FEB84    2817 LB 101 KFT SUCCESS SHARP MID-AIR RECOVERY TEST
 5.142 SV-017B           RAVEN   F19650-81-C0054 0002   6  8 106
       H84-14 24MAY84    3655 LB     KFT FAILURE CORPUS CHRISTI FAILED AT LAUNCH
 5.142 SV-017B           RAVEN   F19650-81-C0054 0002   7  8 107
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MCF    MODEL            MFR     CONTRACT         ITEM UN OF SN  REMARKS

       H84-15 31MAY84  3642 LB     KFT FAILURE CORPUS CHRISTI INFLATION FAIL
 5.142 SV-017B          RAVEN   F19650-81-C0054 0002  8  8 108
       H84-16 01JUN84  3645 LB  98 KFT SUCCESS CORPUS CHRISTI, TX BAMM
 5.142 SF234.29-100NSC WINZEN  M-25015          0002  5  5   5
       H85-09 21JUN85  2927 LB  73 KFT NO TEST LAUNCH PROBLEM BALLOON DAMAGED

 5.025 SV-001B          WINZEN  F29651-81-C0088 0003  2  3  94
       H83-20 23OCT83  2937 LB 101 KFT FAILURE SCRIBE/VANASSE LEAKY BALLOON
 5.025 SV-001B          WINZEN  F29651-81-C0088 0003  3  3  95
       H83-12 21JUN83  2092 LB     KFT FAILURE BIMS, BALLOON BURST
 5.025 SV-001B          RAVEN   F29651-82-C0055 0002  1  1 101
       H83-13 24JUN83  1968 LB 106 KFT SUCCESS REEFING SLEEVE HUNG UP, BIMS
 5.025 SV-001B          WINZEN  F29651-83-C0031 0002  1  2  96
       H84-08 13MAR84  1785 LB 106 KFT SUCCESS ASHCAN
 5.025 SV-001B          WINZEN  F29651-83-C0031 0002  2  2  97
       H84-18 05JUL84  2808 LB 103 KFT SUCCESS ROSWELL, NM SCRIBE/VANASSE
 5.025 SV-001C          RAVEN   F29651-86-C0018 0002  1  3 103 ASTROFILM E
       H86-13 14NOV86  3844 LB  89 KFT SUCCESS RAMOMA, CA, KESTREL/LLNL
 5.025 SV-001C          RAVEN   F29651-86-C0018 0002  3  3 105 ASTROFILM E
       H87-06 25JUN87  3105 LB  97 KFT SUCCESS SCRIBE, ROSWELL, NM, EXP FAILED

 4.890 LTV-012B         RAVEN   F29651-78-C0046 0002  3  5 103
       H84-04 28FEB84  1001 LB 119 KFT SUCCESS ASHCAN/COSMOS

 3.690 SV-018           WINZEN  F19650-78-C0060 0003  5  6  14
       H85-04 15MAY85  1751 LB 106 KFT SUCCESS DENVER
 3.690 SV-018           RAVEN   F19650-85-C0067 0002  1  2 101 ASTROFILM E
       H86-03 22MAR86  1492 LB 110 KFT SUCCESS ASTROFILM E TEST, ASHCAN
 3.690 SV-018           RAVEN   F19650-85-C0067 0002  2  2 102 ASTROFILM E
       H86-08 17JUN86  1712 LB 104 KFT SUCCESS ASTROFILM E TEST

 2.900 LTV-013A         WINZEN  F19650-78-C0060 0002  5  5 112
       H85-20 24OCT85  1852 LB  98 KFT SUCCESS GRAVITY GRADIOMETER
 2.900 LTV-013A         WINZEN  F29651-80-C0058 0002  1  2 113
       H83-21 07NOV83  2429 LB  97 KFT SUCCESS SHAD/ONR
 2.900 LTV-013A         WINZEN  F29651-80-C0058 0002  2  2 114
       H82-25 05NOV82  1802 LB  98 KFT SUCCESS ASHCAN
 2.900 LTV-013A         WINZEN  F29651-81-C0088 0001  1  2 115
       H83-17 19SEP83  1563 LB     KFT FAILURE GRAVITY GRADIOMETER LAUNCH FAIL
 2.900 LTV-0013A        WINZEN  F29651-81-C0088 0001  2  2 116
       H83-19 11OCT83  1573 LB 100 KFT SUCCESS GRAVITY GRADIOMETER
 2.900 LTV-013A         RAVEN   F29651-84-C0040 0004  3  3 116 ASTROFILM C
       H85-21 04DEC85  2535 LB  51 KFT FAILURE BURST GOING THRU TOP OF TROP
 2.900 LTV-013A         RAVEN   F29651-86-C0018 0003  1  2 117 ASTROFILM E
       H86-14 12DEC86  2623 LB  99 KFT SUCCESS ASTROFILM E TEST, NASA U-2
 2.900 LTV-013A         RAVEN   F29651-86-C0018 0003  2  2 118 ASTROFILM E
       H87-01 14JAN87  2796 LB  93 KFT SUCCESS CHUTE FAILED TO OPEN ON CUTDOWN

 2.010 LTV-007          RAVEN   F19650-72-C0377 0004  6  9 115
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MCF    MODEL             MFR     CONTRACT          ITEM UN OF SN  REMARKS

       H82-17 09JUL82    1173 LB  97 KFT SUCCESS NASA/GALILEO PATHFINDER ROSWELL
 2.010 LTV-007           RAVEN    F19650-76-90024 0003  3  4 121
       H82-20 17AUG82    1728 LB  80 KFT SUCCESS ASHCAN
 2.010 LTV-007           RAVEN    F19650-76-90024 0003  4  4 122
       H82-19 05AUG82    1610 LB  90 KFT SUCCESS ASHCAN
 2.010 LTV-007           WINZEN   F29651-82-C0087 0002  1  4  89
       H83-05 18FEB83     988 LB 100 KFT SUCCESS 7659 DIGITAL CMD & TM TEST
 2.010 LTV-007           WINZEN   F29651-82-C0087 0002  2  4  90
       H83-11 20MAY83    1388 LB  95 KFT SUCCESS SHARP IIA, ROTATOR/DME/TV TEST
 2.010 LTV-007           WINZEN   PO-32987              6  6 181
       H82-24 29OCT82    1562 LB  95 KFT SUCCESS ASHCAN

 1.330 SF145.67          WINZEN   PO-9641-86            1  2   1 SCRIBE99
       H86-10 30JUL86    3008 LB  76 KFT SUCCESS ROSWELL, NM, SCRIBE99
 1.330 SF145.67          WINZEN   PO-9641-86            2  2   2 SCRIBE99
       H86-12 10AUG86    3058 LB  76 KFT SUCCESS ROSWELL, NM, SCRIBE99

 1.150 LTV-027           WINZEN   F19650-82-C0062 0002  1  3   1
       H85-01 06MAR85     730 LB  96 KFT SUCCESS 7659 PROFICIENCY

  .804 TT-001D           GEN MIL  AF19(628)-3284  0001  6 20
       H84-02 31JAN84      76 LB     KFT NO TEST 7659 PROFICIENCY NO RELEASE
  .804 TT-001D           GEN MIL  AF19(628)-3284  0001  7 20     NO VLVE TNG ONLY
       H88-02 07MAR88     N/A LB N/A KFT NO TEST HIGH LAUNCH WIND TEST
  .804 TT-001D           GEN MIL  AF19(628)-3284  0001 11 20     NO VLVE TNG ONLY
       H88-03 10MAR88     N/A LB N/A KFT NO TEST HIGH LAUNCH WIND TEST
  .804 TT-001D           WINZEN   AF19(628)-3295  0001 13 20 110 NO VLVE TNG ONLY
       H87-09 19NOV87     N/A LB N/A KFT NO TEST OVER THE SHOULDER LAUNCH TEST
  .804 TT-001D           WINZEN   AF19(628)-3295  0001 17 20 114 NO VLVE TNG ONLY
       H87-08 08OCT87     N/A LB N/A KFT NO TEST OVER THE SHOULDER LAUNCH TEST

  .628 LTV-019           RAVEN    F29651-80-C0017 0003  4  5 104
       H86-09 21JUL86    1347 LB  78 KFT SUCCESS ROSWELL, NM, SCRIBE99 PATHFINDR

  .355 LTV-018           RAVEN    F29651-80-C0017 0002  3  5 103
       H84-10 05APR84    1430 LB  65 KFT SUCCESS 7670/BROWN
  .355 LTV-018           RAVEN    F29651-80-C0017 0002  4  5 104
       H86-11 04AUG86     918 LB  72 KFT SUCCESS ROSWELL, NM, ALFAN/TURTLE

  .274 LTV-008           RAVEN    F29651-79-C0020 0001  2  4 115 NO C/RNG TOP CON
       H87-03 16MAY87     906 LB  67 KFT SUCCESS ALFAN/TURTLE

  .010                   RAVEN                             *   *14990 PATHFINDR
       H86-02 12MAR86     3.5 LB  85 KFT SUCCESS TEST PATHFINDER & LAPING TIMER

  .003 N30-GL-0.003150 RAVEN      PO-85619              1 19 101 PATHFINDER
       H86-04 12APR86     4.5 LB     KFT NO TEST NOT TRACKED
  .003 N30-GL-0.003150 RAVEN      PO-85619              9 19 109 PATHFINDER
       H86-07 12JUN86     3.3 LB  78 KFT SUCCESS MODIFIED VENT
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| MCF | MODEL | MFR | CONTRACT | ITEM UN OF SN | REMARKS |
|---|---|---|---|---|---|
| .000 | 1000 GM | | | | RAOB |
| | H84-23 26SEP84 | 1 LB | 80 KFT SUCCESS | PATHFINDER TEST | |
| .000 | 1000 GM | | | | RAOB |
| | H84-24 27SEP84 | 1 LB | 96 KFT SUCCESS | PATHFINDER TEST | |
| .000 | ML-537-A/UM | KAYSAM | DAAB07-79-C0807 | * | *11366/1715 |
| | H83-22 ** | 10/7 LB | *** KFT SUCCESS | **2 FLTS 08/09NOV83 | ***80/90 |
| .000 | ML-537-A/UM | KAYSAM | DAAB07-79-C0807 | * | *1723-1135064 |
| | H83-10 ** | 4.25 LB | 95 KFT SUCCESS | **4 FLTS 11/12/19MAY83 | BROWN |
| .000 | ML-537-A/UM | KAYSAM | DAAB07-79-C0807 | * | *11157 |
| | H83-03 09FEB83 | 4.25 LB | 100 KFT SUCCESS | HANSCOM, BROWN | |
| .000 | ML-537-A/UM | KAYSAM | DAAB07-79-C0807 | * | *11158 |
| | H83-04 10FEB83 | 4.25 LB | 100 KFT SUCCESS | HANSCOM BROWN | |
| .000 | ML-537-A/UM | KAYSAM | DAAB07-79-C0807 | * | *11378 |
| | H82-27 27DEC82 | 3 LB | 93 KFT SUCCESS | HANSCOM BROWN | |
| .000 | ML-537-A/UM | KAYSAM | DAAB07-79-C0807 | * | *11376 |
| | H82-28 30DEC82 | 3 LB | 93 KFT SUCCESS | HANSCOM BROWN | |
| .000 | 2335-536-888 | RAVEN | F19650-72-C0591 | 3 11 117 | |
| | H83-14 23JUL83 | 25 LB | 90 KFT SUCCESS | NASA/GALILEO PATHFINDER | ROSWELL |
| .000 | 2335-536-888 | RAVEN | F19650-72-C0591 | 4 11 118 | |
| | H83-15 24JUL83 | 26 LB | 90 KFT SUCCESS | NASA/GALILEO PATHFINDER | ROSWELL |

DEPARTMENT OF THE AIR FORCE
AIR FORCE CAMBRIDGE RESEARCH LABORATORIES (AFSC)
LAURENCE G. HANSCOM FIELD, BEDFORD, MASSACHUSETTS 01730

REPLY TO ATTN OF: LCA

15 May 1973

SUBJECT: Ballast (8 May telecon with Mr. Gildenberg)

TO: LCD (Attn: Mr. Gildenberg)

1. Iron Shot
We currently buy iron shot in accordance with Mil-S-851B, Type II, Class 2, size S-230. The SAE specification for particle size S-230 is as follows:

| | | |
|---|---|---|
| #18 Screen | (.0394 in.) | All Pass |
| #20 Screen | (.0331 in.) | 10% Max. on Screen |
| #30 Screen | (.0232 in. ) | 85% Min. on Screen |
| #35 Screen | (.0197 in.) | 97% Min. on Screen |

Pan 3% Max.

Density 280#/ft$^3$

2. Glass Beads
The last purchase (1967) of glass ballast from Ballatini included several particle sizes:

Classification I

| | | |
|---|---|---|
| Size C | Screen #40-60 | (.0165-.0098) |
| Size D | Screen #50-70 | (.0117-.0083) |
| Size G | Screen #80-120 | (.0070-.0049) |

Density 80#/ft$^3$

3. Lead Shot
The lead shot purchased for Viking was a 50% mixture of size S-110 and S-230. The SAE specification for size S-230 is given in paragraph 1, S-110 as follows:

| | | |
|---|---|---|
| #30 Screen | (.0232 in.) | All Pass |
| #35 Screen | (.0179 in.) | 10% Max. on Screen |
| #50 Screen | (.0117 in.) | 70% Min. on Screen |
| #80 Screen | (.007 in.) | 90% Min. on Screen |

Density 454 #/ft$^3$

Thomas J. Danaher

THOMAS J. DANAHER, Chief
Balloon Flight Requirements
Analysis Branch
Aerospace Instrumentation Laboratory

cc: LCE

DEPARTMENT OF THE AIR FORCE
DET 1, AIR FORCE CAMBRIDGE RESEARCH LABORATORIES (AFSC)
HOLLOMAN AIR FORCE BASE, NEW MEXICO 88330

REPLY TO
ATTN OF: LCD (Mr. Gildenberg/4421)

6 August 1973

SUBJECT: Trans-sunset Ballast Profiles

TO: LCC/Mr. J. Payne

1. A graph was made from all available data for overnight flights at LCD, for the past 20 years. (See attachment 1)

2. The interim notch on the legend indicates the night time equilibrium float when it was higher than the minimum altitude.

3. The most obvious conclusion is that the closer to ceiling a flight was maintained, the more ballast required. The graph indicates that from 9 to 30% is required for remaining within 2000 feet of float, and 30% within 1000 feet. On the other hand, if one allows a balloon floating near 100K to drop all the way to the top of the tropopause, 3% may be adequate.

4. The rule of thumb for for an average overnight flight has been 10% ballast required to compensate for the sunset. However, in this summary, for altitude drops of more than 5K, 86% required less than 10% ballast, and 83% less than 8%.

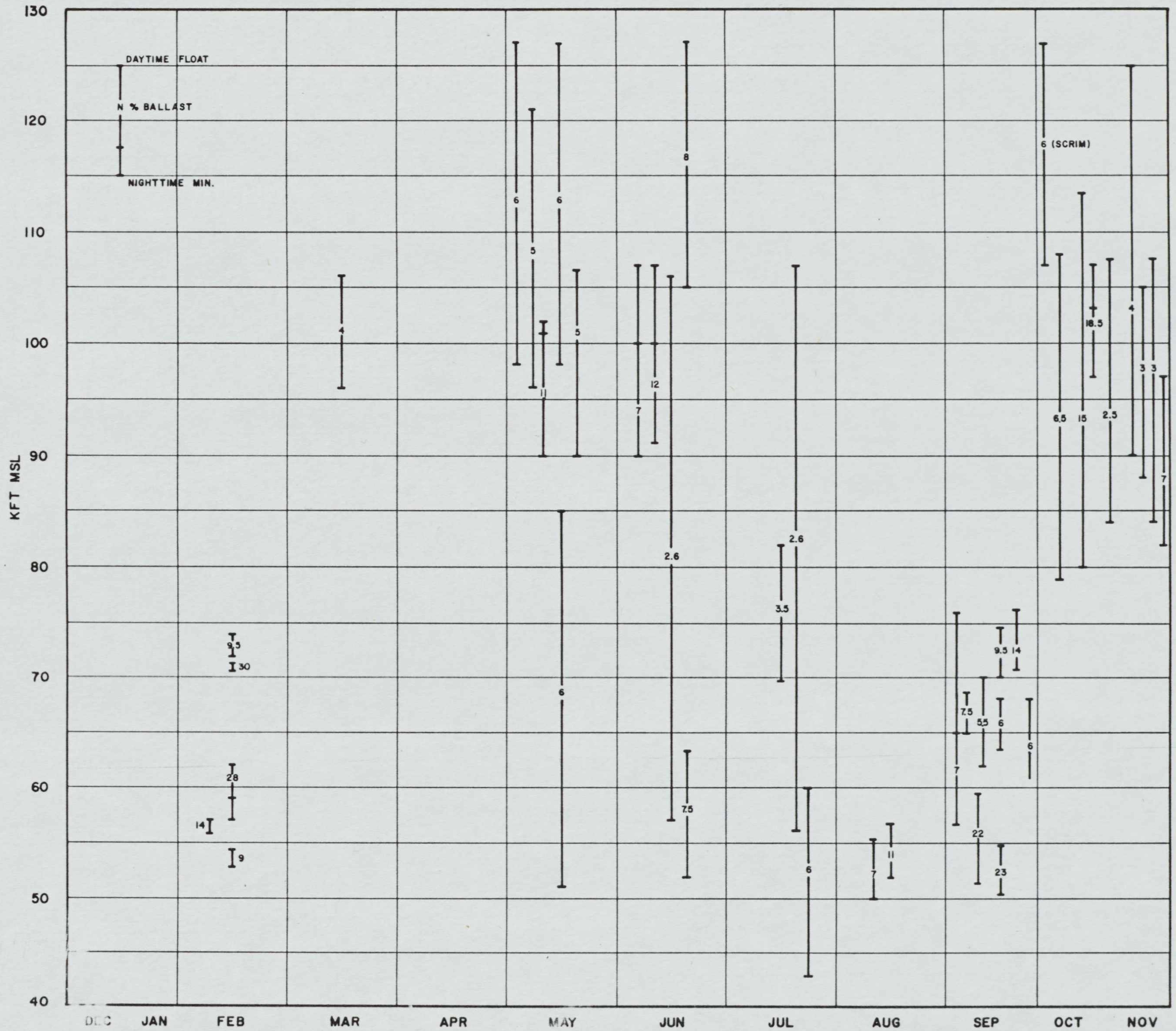
5. If similar data is available form Chico, Vernalis Flights, it might be worth while to add them to the master drawing for this graph.

B O Gildenberg
BERNARD L. GILDENBERG, GS-14
Det 1, AFCRL (AFSC)

Copies to Mr. G. Nolan
Mr. J. Dwyer

File / Misc

# TRANS-SUNSET BALLAST PROFILES
## HOLLOMAN 1952-72




25a

THE AIR TEMPERATURE WAS 10 DEGREES ABOVE ZERO...AND THE WIND SPEED WAS 25 MPH...WOULD BE -29 DEGREES.

| | AIR TEMPERATURE ...FAHRENHEIT... | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| WIND SPEED MPH | 35 | 30 | 25 | 20 | 15 | 10 | 5 | 0 | -5 | -10 | -15 | -20 |
| CALM- | 35 | 30 | 25 | 20 | 15 | 10 | 5 | 0 | -5 | -10 | -15 | -20 |
| 5 - | 33 | 27 | 21 | 16 | 12 | 7 | 1 | -6 | -11 | -15 | -20 | -26 |
| 10 - | 21 | 16 | 9 | 2 | -2 | -9 | -15 | -22 | -27 | -31 | -38 | -45 |
| 15 - | 16 | 11 | 1 | -6 | -11 | -18 | -25 | -33 | -40 | -45 | -51 | -60 |
| 20 - | 13 | 3 | -4 | -9 | -17 | -24 | -32 | -40 | -46 | -52 | -60 | -68 |
| 25 - | 7 | 0 | -7 | -15 | -22 | -29 | -37 | -45 | -52 | -58 | -67 | -75 |
| 30 - | 5 | -2 | -11 | -18 | -26 | -33 | -41 | -49 | -56 | -63 | -70 | -78 |
| 35 - | 3 | -4 | -13 | -20 | -27 | -35 | -43 | -52 | -60 | -67 | -72 | -83 |
| 40 - | 1 | -4 | -15 | -22 | -29 | -36 | -45 | -54 | -62 | -69 | -76 | -87 |

WIND SPEED GREATER THAN 40 MPH HAVE LITTLE ADDITIONAL COOLING EFFECT.

+