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PROPERTIES OF THE UPPER ATMOSPHERE

Rocketsonde and Satellite Measurements of
Pressure, Temperature, Density, and Composition
through Early 1960

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PROPERTIES OF THE UPPER ATMOSPHERE

Rocketsonde and Satellite Measurements of
Pressure, Temperature, Density, and Composition
Through Early 1960

PROJECT ARIES

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PROPERTIES OF THE UPPER ATMOSPHERE

Rocketsonde and Satellite Measurements of
Pressure, Temperature, Density, and Composition
Through Early 1960

INFORMATION SOURCES AND TREATMENT

The data given in this compilation were obtained from reports, publications, and direct communication with scientists who have made upper atmosphere structure measurements with sounding rockets and satellites. Data are reported for the 30 to 300 kilometer altitude range. It is estimated that over 90 per cent of the data available through the Spring of 1960 are presented in this tabulation. Only data considered "publishable" by the authors (i.e., technically suitable for general use) are included.

An effort has been made to provide an accurate compilation and to present information about the experimental circumstances associated with the measurement. Should the reader encounter technical errors, corrections will be gratefully received and an errata sheet issued.

The compilers have not "evaluated" data obtained.

Those who wish to make critical discrimination among the tabular entries are urged to review the appropriate abstract-references and instrumentation discussions cited in this report.

The data are presented in two tables. The first presents temperature, pressure, and density. The second presents composition measurements. Both are arranged by altitude.

Abstract-bibliographies of key source documents are presented in Appendix B. An abstract-bibliography of general review publication on the upper atmosphere is provided in Appendix C.

The functional principles, an illustrative description, and key references for the instruments employed in the measurements reported are described in Appendix A. The instrument discussions place particular emphasis on sources of error.

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Contract Nonr 3071(00)
Final Report
1 August 1960

-2-

Properties of the Upper Atmosphere

NOTATIONS IN TABLES

Errors

The "e" columns immediately to the right of the Pressure, Temperature, and Density columns are the probable errors of the measurement, as obtained from the author. The notation (nf) (in this section and elsewhere) indicates that the information was "not found".

Flight Number

Most of the entries in the "Number" column are IGY rocket flight code numbers. The system is described in the conversion aids at the end of this introductory section. Various designations were used for rocket flights made before the IGY program, and are included whenever they were available.

Time

Flight times are given in local time (to communicate diurnal significance), following the practice in research reports and papers. A time-zone conversion table is given in the conversion aids section.

Altitude

Altitude is given in kilometers. Altitude measurements at all launch sites were made by the DOVAP system, which has an estimated accuracy of 1 meter. An altitude conversion table (kilometers - miles - feet) is given in the conversion aids section.

Temperature

Temperature is presented in degrees Kelvin. A temperature conversion table ($^{\circ}\text{K}$ - $^{\circ}\text{C}$ - $^{\circ}\text{F}$) is given in the conversions aids sections that follows.

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Project ARIES - Contract Nomr 3071(00)

Final Report

1 August 1960

-4-

IGY Rocket Numbering Code

Flight Number:

Example: A M 3 07 F

Place 1. Directing Agency

Place 2. Instrumenting Agency

Place 3. Type of Vehicle

Place 4. Directing Agency's Serial Number

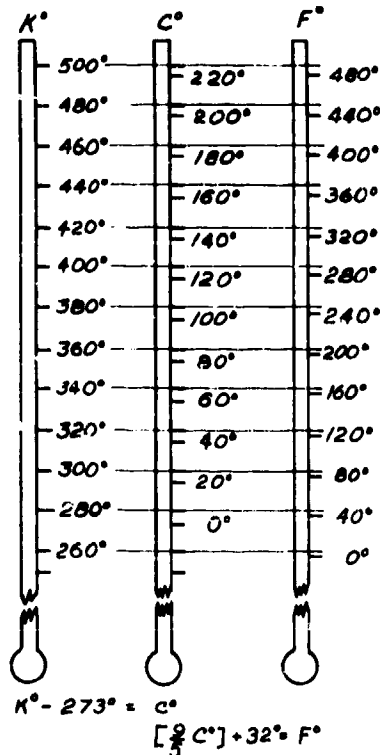
Place 5. Purchaser of Vehicle, if not Directing Agency

Symbols used in Places 1, 2, and 5

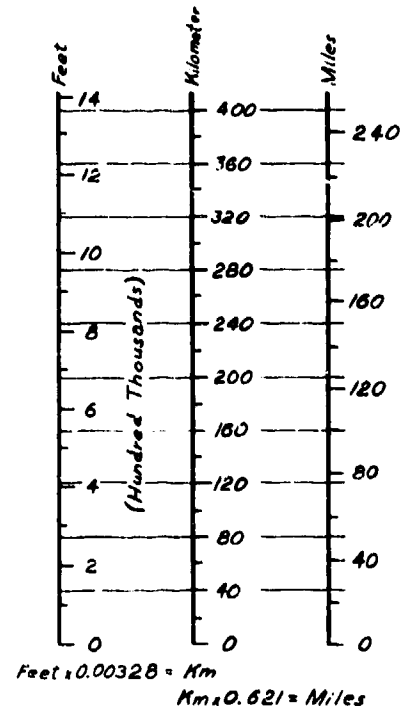
- A. Air Force Cambridge Research Center
- B. Ballistic Research Laboratories
- F. National Science Foundation
- M. University of Michigan
- N. Naval Research Laboratory
- S. Army Signal Corps

Symbols used in Place 3

- 1. & 2. Aerobee
- 3. & 4. Aerobee-H1
- 5. Balloon-rocket (Rockoon)
- 6. Nike-Cajun
- 7. Nike-Deacon (DAN)
- 8. Nike-Asp
- 9. Loki II-Dart
- 10. Spacerobee
- 12. Aerobee 75



Temperature Conversion Table



Height Conversion Table

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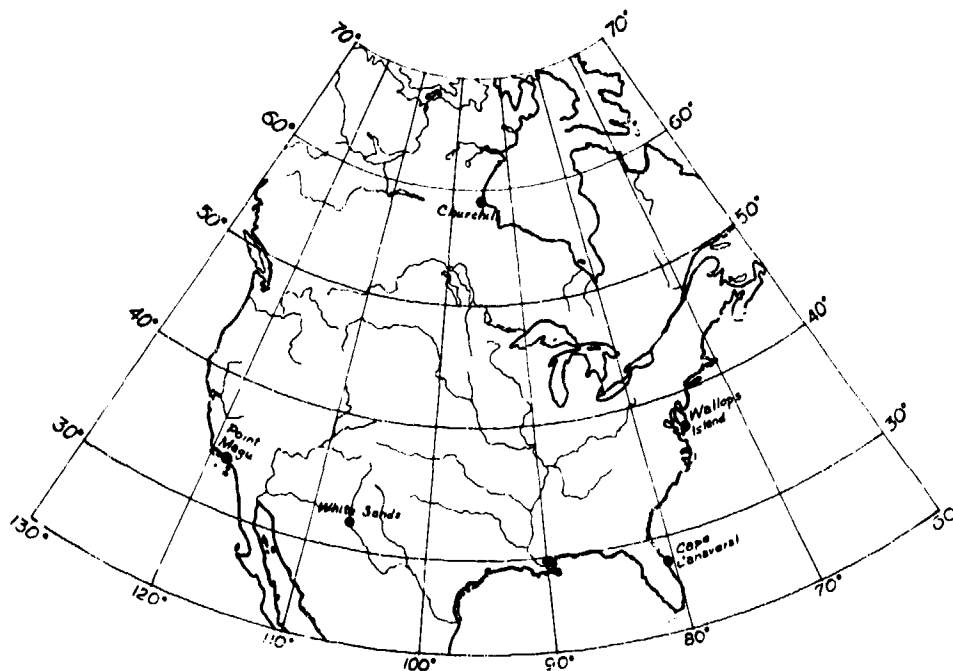
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Final Report

1 August 1960

-3-



PLACE	ZONE	TIME									
Greenwich	GMT	0000	0300	0600	0900	1200	1500	1800	2100	2400	
Wallops Island	EST	1800	2100	2400	0300	0600	0900	1200	1500	1800	
Fort Churchill	CST	1700	2000	2300	0200	0500	0800	1100	1400	1700	
White Sands	MST	1600	1900	2200	0100	0400	0700	1000	1300	1600	
Point Mugu	PST	1500	1800	2100	2400	0300	0600	0900	1200	1500	

TIME CONVERSION TABLE

Altitude	Pressure		Density		Temperature		Instrumentation	Vehicle	Number
Km.	mm.Hg.	o. %	g/m ³	o. %	°K	o. °K			
ALTITUDE RANGE 30-40 Km.									
30	3.0 (p)		- -		- -		Pirani gage*	V-2	28
30	1.2 (nf)		- -		- -		Alphatron*	Aerobee	(nf)
30	- -		- -		234.6 3.0		Grenade	Aerobee	SC-18
30	1.2 (nf)		- -		230 3.0		Alphatron*	Aerobee	(nf)
30	- -		- -		226 8.0		Alphatron*	Aerobee	(nf)
30	- -		1.8 2		- -		Sphere*	Aerobee	SC-31
30	- -		1.8 (p)		- -		Ionization gage*	Aerobee	AM2.21
30	- -		1.8 2		213 4.2		Sphere*	Nike-Cajun	AM5.10
30	- -		1.4 2		213 4.2		Sphere*	Nike-Cajun	AM5.12
30	4.3 (nf)		10.3 (nf)		220 2.0		Grenade	Aerobee	SM1.01
30	8.0 (nf)		17 (nf)		237 2.0		Grenade	Aerobee	SM1.03
30	(nf)		21 (nf)		236 2.0		Grenade	Aerobee	SM1.04
30	6.8 (nf)		14 (nf)		236 2.0		Grenade	Aerobee	SM1.05
30	7.0 (nf)		17 (nf)		201 2.0		Grenade	Aerobee	SM1.07
30	- -		- -		208 2.0		Grenade	Aerobee	SM1.08
30	- -		1.8 2		200 4.0		Sphere*	Nike-Cajun	AM5.02
30	- -		1.4 2		213 4.2		Sphere*	Aerobee	SM2.10
30	4.6 (nf)		11 (nf)		204 2.0		Grenade	Aerobee	SM2.10
30	1.9 (nf)		18 (nf)		208 2.0		Grenade	Aerobee	SM1.09
30	- -		1.8 2		210 4.2		Sphere*	Nike-Cajun	AM5.03
30	- -		1.8 2		223 4.3		Sphere*	Nike-Cajun	AM5.03
30	- -		1.8 2		213 4.2		Sphere*	Nike-Cajun	AM5.09
-	-		-		-		-	-	-
-	-		-		-		-	-	-
-	-		-		-		-	-	-

* These entries are taken from a published

ATMOSPHERE STRUCTURE DATA As Reported Through Early 1960

Project ARIES — Contract Nona 3071(00)

Vehicle	Number	Place Fired	Date	Time	Zone	Reference Data	Notes	Altitude Range, Km
ALTITUDE RANGE 30-40 Km.								300
V-2	28	WSPG	8 Dec '47	14.42	MST	Spencer 54	(nf) - not found	
Aerobee	(nf)	WSPG	20 Jun '50	08.38	MST	Sicinski 54	(p) - Preliminary, see reference	
Aerobee	8C-18	WSPG	8 Jun '51	23.11	MST	Stroud 56		
Aerobee	(nf)	WSPG	13 Sep '51	04.37	MST	Sicinski 54		
Aerobee	(nf)	WSPG	26 Sep '51	(nf)	-	Spencer 54		200
Aerobee	8C-31	WSPG	29 Sep '53	13.50	MST	Jones 58		
Aerobee	AM2.21	Churchill	23 Oct '56	02.40	CST	Spencer 58-1		
Nike-Cajun	AM6.10	N.Atlantic	4 Nov '56	12.54	GMT	Jones 59	37°46'N 46°41'W	
Nike-Cajun	AM6.12	N.Atlantic	10 Nov '56	07.17	GMT	Jones 59	65°36'N 58°03'W	
Aerobee	SM1.01	Churchill	12 Nov '56	05.48	CST	Stroud 60 & Bandeen		200
Aerobee	SM1.03	Churchill	23 Jul '57	23.30	CST	Stroud 60 & Bandeen		
Aerobee	SM1.04	Churchill	12 Aug '57	10.00	CST	Stroud 60 & Bandeen		
Aerobee	SM1.05	Churchill	19 Aug '57	20.30	CST	Stroud 60 & Bandeen		
Aerobee	SM1.07	Churchill	11 Dec '57	22.00	CST	Stroud 60 & Bandeen		
Aerobee	SM1.08	Churchill	14 Dec '57	15.00	CST	Stroud 60		
Nike-Cajun	AM6.02	Churchill	25 Jan '58	13.12	CST	Jones 59		100
Aerobee	SM1.10	Churchill	27 Jan '58	12.48	CST	Jones 58		
Aerobee	SM2.10	Churchill	27 Jan '58	12.49	CST	Stroud 60 & Bandeen		
Aerobee	SM1.09	Churchill	27 Jan '58	00.04	CST	Stroud 60 & Bandeen		
Nike-Cajun	AM6.03	Churchill	29 Jan '58	13.06	CST	Jones 59		
Nike-Cajun	AM6.05	Churchill	4 Mar '58	13.30	CST	Jones 59		100
Nike-Cajun	AM6.09	N.Atlantic	2 Nov '59	12.50	GMT	Jones 59	48°57'N 48°22'W	
_____	_____	_____	_____	_____	_____	_____		
_____	_____	_____	_____	_____	_____	_____		
_____	_____	_____	_____	_____	_____	_____		

are taken from a published curve. Interpolation for tabular presentation may have introduced an error of $\pm 5\%$.

Altitude			Pressure		Density		Temperature		Instrumentation	Vehicle	Number
Km.	mm.Hg.	e. %	g/m ³	e. %	°K	e. °K					
ALTITUDE RANGE 30-40 Km.							(C				
31	11	(nf)	34	(nf)	239	2.0	Grenade	Aerobee	SM1.02		
32.1	-	-	1.8	.22	239	5.0	Sphere*	DAN-2	AM7.02		
33.3	-	-	-	-	231.5	4.5	Grenade	Aerobee	SC-16		
33.7	-	-	-	-	229	2.1	Grenade	Aerobee	SC-20		
35	-	-	-	-	260	2.0	Grenade	Aerobee	SC-8		
35	-	-	-	-	235	2.0	Grenade	Aerobee	SC-14		
35	-	-	-	-	242	2.0	Grenade	Aerobee	SM2.06		
35.4	-	-	-	-	260.7	1.4	Grenade	Aerobee	SC-8		
35.9	-	-	-	-	234.9	1.4	Grenade	Aerobee	SC-14		
38.7	-	-	-	-	253.0	1.4	Grenade	Aerobee	SC-18		
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* These entries are taken from a published curve

SPHERE STRUCTURE DATA

Reported Through Early 1960

Project ARIES — Contract Nonr 3071(00)

Vehicle	Number	Place Fired	Date	Time	Zone	Reference Data	Notes	Altitude Range, Km
LE RANGE 30-40 Km. (Concluded)								300
Aerobee	SM1.02	Churchill	21 Jul '57	22.16	CST	Stroud 60		
DAN-2	AK7.02	Wallops	24 Jun '55	13.04	EST	Jones 56		
Aerobee	SC-16	WSPG	12 Dec '50	02.10	MST	Stroud 56		
Aerobee	SC-20	WSPG	1 Nov '51	02.46	MST	Stroud 56		
Aerobee	SC-8	WSPG	14 Jul '50	01.37	MST	Weisner 54		250
Aerobee	SC-14	WSPG	11 Dec '50	21.06	MST	Weisner 54		
Aerobee	SM2.06	Churchill	25 Aug '57	08.08	CST	Stroud 60		
Aerobee	SC-8	WSPG	14 Jul '50	01.37	MST	Stroud 56		
Aerobee	SC-14	WSPG	11 Dec '50	20.06	MST	Stroud 56		
Aerobee	SC-18	WSPG	8 Jun '51	23.11	MST	Stroud 56		200
_____	_____	_____	_____	_____	_____	_____		
_____	_____	_____	_____	_____	_____	_____		
_____	_____	_____	_____	_____	_____	_____		



ken from a published curve. Interpolation for tabular presentation may have introduced an error of $\pm 5\%$.

Altitude Km.	Pressure		Density		Temperature		Instrumentation	Vehicle	Number
	mm.Hg.	e. %	g/m ³	e. %	°K	e. °K			
ALTITUDE RANGE 40-50 Km.									
40	2.0	10	-	-	-	-	Phillips gage*	V-2	21
40	3.0	(nf)	-	-	-	-	Pirani gage*	V-2	28
40	2.0	10	-	-	-	-	Phillips gage*	V-2	45
40	3.0	(nf)	-	-	265	5.0	Alphatron*	Aerobee	(nf)
40	3.0	(nf)	-	-	271	5.0	Alphatron*	Aerobee	(nf)
40	-	-	-	-	277	8.0	Alphatron*	Aerobee	(nf)
40	-	-	4.5	(nf)	-	-	Sphere*	Aerobee	SC-29
40	-	-	4.5	(nf)	-	-	Sphere*	Aerobee	SC-30
40	-	-	4.5	2	-	-	Sphere*	Aerobee	SC-31
40	-	-	3.8	.28	272	16	Sphere*	DAN-2	AM7.02
40	-	-	3.0	(nf)	-	-	Ionization gage*	Aerobee	AM2.21
40	-	-	3.2	2	240	4.8	Sphere*	Nike-Cajun	AM6.10
40	-	-	3.2	2	233	4.6	Sphere*	Nike-Cajun	AM6.12
40	8.0x10 ⁻¹		1.71	(nf)	240	3.0	Grenade	Aerobee	SM1.01
40	1.7	(nf)	3.3	(nf)	265	3.0	Grenade	Aerobee	SM1.02
40	2.1	(nf)	4.1	(nf)	256	3.0	Grenade	Aerobee	SM1.03
40	2.0	(nf)	3.8	(nf)	260	3.0	Grenade	Aerobee	SM1.04
40	2.5	(nf)	5.1	(nf)	258	3.0	Grenade	Aerobee	SM1.05
40	-	-	-	-	252	3.0	Grenade	Aerobee	SM2.06
40	-	-	-	-	245	3.0	Grenade	Aerobee	SM1.07
40	1.2	(nf)	2.2	(nf)	227	3.0	Grenade	Aerobee	SM1.08
40	-	-	3.7	2	223	4.5	Sphere*	Nike-Cajun	AM6.02
40	-	-	2.3	2	250	5.0	Sphere*	Aerobee	SM2.10
40	1.0	(nf)	2.1	(nf)	233	3.0	Grenade	Aerobee	SM2.10
40	1.5	(nf)	3.1	(nf)	225	3.0	Grenade	Aerobee	SM1.09
40	-	-	2.0	2	282	5.6	Sphere*	Nike-Cajun	AM6.03

* These entries are taken from published sur



OSPHERE STRUCTURE DATA

Reported Through Early 1960

Project ARIES — Contract Nonr 3071(00)

Vehicle	Number	Place Fired	Date	Time	Zone	Reference Data	Notes	Altitude Range, Km
ALTITUDE RANGE 40-50 Km.								
V-2	21	WSPG	7 Mar '47	11.23	MST	LaGow 54		
V-2	28	WSPG	8 Dec '47	14.42	MST	Spencer 54	(nf) - not found	
V-2	45	WSPG	28 Jan '49	10.20	MST	LaGow 54		
Aerobee	(nf)	WSPG	20 Jun '50	08.38	MST	Sicinski 54		
Aerobee	(nf)	WSPG	13 Sep '51	04.37	MST	Sicinski 54		250
Aerobee	(nf)	WSPG	26 Sep '51	(nf)	-	Spencer 54		
Aerobee	SC-29	WSPG	11 Dec '52	(nf)	-	Jones 58		
Aerobee	SC-30	WSPG	23 Apr '53	(nf)	-	Jones 58		
Aerobee	SC-31	WSPG	29 Sep '53	(nf)	-	Jones 58		
DAN-2	AM7.02	Wallops	24 Jun '55	13.04	EST	Jones 56		200
Aerobee	AM2.21	Churchill	23 Oct '56	02.40	CST	Spencer 58-1		
Nike-Cajun	AM6.10	N.Atlantic	4 Nov '56	12.54	GMT	Jones 59	57°46'N 46°41'W	
Nike-Cajun	AM6.12	N.Atlantic	10 Nov '56	07.17	GMT	Jones 59	65°36'N 58°03'W	
Aerobee	SM1.01	Churchill	12 Nov '56	05.48	CST	Stroud 60 & Bandeen		
Aerobee	SM1.02	Churchill	21 Jul '57	22.16	CST	Stroud 60 & Bandeen		
Aerobee	SM1.03	Churchill	23 Jul '57	23.30	CST	Stroud 60 & Bandeen		150
Aerobee	SM1.04	Churchill	12 Aug '57	10.00	CST	Stroud 60 & Bandeen		
Aerobee	SM1.05	Churchill	19 Aug '57	20.30	CST	Stroud 60 & Bandeen		
Aerobee	SM2.06	Churchill	25 Aug '57	08.08	CST	Stroud 60		
Aerobee	SM1.07	Churchill	11 Dec '57	22.00	CST	Stroud 60		
Aerobee	SM1.08	Churchill	14 Dec '57	15.00	CST	Stroud 60 & Bandeen		100
Nike-Cajun	AM6.02	Churchill	25 Jan '58	13.12	CST	Jones 59		
Aerobee	SM2.10	Churchill	27 Jan '58	12.48	CST	Jones 58		
Aerobee	SM2.10	Churchill	27 Jan '58	12.49	CST	Stroud 60 & Bandeen		
Aerobee	SM1.09	Churchill	27 Jan '58	00.04	CST	Stroud 60 & Bandeen		
Nike-Cajun	AM6.03	Churchill	29 Jan '58	13.06	CST	Jones 59		

are taken from published curve. Interpolation for tabular presentation may have introduced an error of $\pm 5\%$.

Altitude Km.	Pressure		Density		Temperature		Instrumentation	Vehicle	Number
	mm.Hg.	o. %	g/m ³	o. %	°K	o. °K			
ALTITUDE RANGE 40-50 Km.									
40	-	-	4.0	2	245	4.9	Sphere*	Nike-Cajun	AM6.0
40	-	-	5.0	2	240	4.8	Sphere*	Nike-Cajun	AM6.0
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40.5	-	-	-	-	255.4	2.3	Grenade	Aerobee	SC-20
41	2.1	(nf)	-	-	-	-	Phillips gage*	Aerobee	(nf)
41.6	-	-	-	-	251.4	1.4	Grenade	Aerobee	SC-8
41.8	-	-	-	-	261.5	1.6	Grenade	Aerobee	SC-14
42	1.7	(nf)	-	-	-	-	Phillips gage*	V-2	34
42	2.0	(nf)	-	-	-	-	Pressure gage*	V-2	43
42	-	-	-	-	262	5.0	Grenade	Aerobee	SC-14
42.1	-	-	-	-	266.5	3.2	Grenade	Aerobee	(nf)
43.5	-	-	-	-	266.5	1.1	Grenade	Aerobee	SC-16
45	1.44	(p)	1.8	(p)	-	-	Ionization gage*	Aerobee	31
45.11	-	-	-	-	311	(p)	Ionization gage*	Aerobee	31
46.3	-	-	-	-	265	2.7	Grenade	Aerobee	SC-20
46.9	-	-	-	-	264.2	2.3	Grenade	Aerobee	SC-18
47.1	-	-	-	-	257.3	0.4	Grenade	Aerobee	(nf)
47.3	-	-	-	-	267.5	1.5	Grenade	Aerobee	SC-8
47.5	-	-	-	-	255.6	3.1	Grenade	Aerobee	(nf)
48	9.0x10 ⁻¹	(nf)	-	-	-	-	Phillips gage*	(nf)	(nf)
48.1	-	-	-	-	266	1.4	Grenade	Aerobee	SC-14
48.2	-	-	-	-	270	3.6	Grenade	Aerobee	(nf)
48.3	-	-	-	-	262.6	1.4	Grenade	Aerobee	(nf)

* These entries are taken from a published

1

OSPHERE STRUCTURE DATA **ts Reported Through Early 1960**

Project ARIES — Contract Nonr 3071(00)

Vehicle	Number	Place Fired	Date	Time	Zone	Reference Data	Notes	Altitude Range, Km
ALTITUDE RANGE 40-50 Km.		(cont.)						300
Nike-Cajun	AM6.05	Churchill	4 Mar '58	13.30	CST	Jones 59		
Nike-Cajun	AM6.09	N.Atlantic	2 Nov '59	12.40	GMT	Jones 59	48°57'N 48°22'W	
_____	_____	_____	_____	_____	_____	_____		250
_____	_____	_____	_____	_____	_____	_____		
_____	_____	_____	_____	_____	_____	_____		
Aerobee	8C-20	WSPG	1 Nov '51	02.46	MST	Stroud 56		
Aerobee	(nf)	WSPG	3 May '49	09.14	MST	Havens 52	(n) - not found	
Aerobee	8C-8	WSPG	14 Jul '50	01.37	MST	Stroud 56		
Aerobee	8C-14	WSPG	11 Dec '50	21.06	MST	Stroud 56		
V-2	34	WSPG	22 Jan '48	13.13	MST	Havens 52 & LaGow 54		200
V-2	43	WSPG	5 Aug '48	18.37	MST	Havens 52 & LaGow 54		
Aerobee	8C-14	WSPG	11 Dec '50	21.06	MST	Weisner 54		
Aerobee	(nf)	WSPG	24 Sep '52	20.50	MST	Stroud 56		
Aerobee	8C-16	WSPG	12 Dec '50	02.10	MST	Stroud 56		
Aerobee	31	Holloman	22 Oct '52	07.21	MST	Spencer 58-2	(p) - Preliminary, see reference	150
Aerobee	31	Holloman	22 Oct '52	07.21	MST	Spencer 58-2		
Aerobee	8C-20	WSPG	1 Nov '51	02.46	MST	Stroud 56		
Aerobee	8C-18	WSPG	8 Jun '51	23.11	MST	Stroud 56		
Aerobee	(nf)	WSPG	24 Apr '53	03.19	MST	Stroud 56		
Aerobee	8C-8	WSPG	14 Jul '50	01.37	MST	Stroud 56		
Aerobee	(nf)	WSPG	22 Oct '52	20.45	MST	Stroud 56		100
(nf)	(nf)	Equator	11 May '50	16.00	MST	Havens 52	near Christmas Island	
Aerobee	8C-14	WSPG	11 Dec '50	21.06	MST	Stroud 56		
Aerobee	(nf)	WSPG	24 Sep '52	20.50	MST	Stroud 56		
Aerobee	(nf)	WSPG	17 Feb '53	24.00	MST	Stroud 56		

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are taken from a published curve. Interpolation for tabular presentation may have introduced an error of ± 5%

Altitude			Pressure		Density		Temperature		Instrumentation	Vehicle	Num
Km.	mm.Hg.	e. %	g/m ³	e. %	°K	e. °K					

ALTITUDE RANGE 40-50 Km.

49.9	-	-	-	-	283.7	2.2	Granade	Aerobee	(12)
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Project ARIES — Contract Nonr 3071(00)

30

-3-

Altitude Km.	Pressure		Density		Temperature		Instrumentation	Vehicle	Number
	mm.Hg.	o. %	g/m ³	o. %	°K	o. °K			
ALTITUDE RANGE 50-60 Km.									
50	-	-	-	-	315	25	(nf)	V-2	21
50	7.5x10 ⁻¹	10	-	-	-	-	Phillips gage*	V-2	21
50	9.0x10 ⁻¹	(nf)	-	-	220	(nf)	Pirani gage*	V-2	28
50	7.5x10 ⁻¹	(nf)	-	-	-	-	Phillips gage*	V-2	34
50	8.5x10 ⁻¹	(nf)	3.9x10 ⁻¹	(nf)	-	-	Pressure gage*	V-2	43
50	6.0x10 ⁻¹	10	-	-	-	-	Phillips gage*	V-2	45
50	6.4x10 ⁻¹	(nf)	-	-	-	-	Phillips gage*	Aerobee	(nf)
50	9.0x10 ⁻¹	(nf)	-	-	270	5.0	Alphatron*	Aerobee	(nf)
50	-	-	-	-	265	3.0	Grenade	Aerobee	SC-10
50	9.5x10 ⁻¹	(nf)	-	-	268	5.0	Alphatron*	Aerobee	(nf)
50	-	-	-	-	269	9.0	Alphatron*	Aerobee	(nf)
50	-	-	1.0	(nf)	-	-	Sphere*	Aerobee	SC-23
50	0.79	(p)	8.5	(p)	-	-	Alphatron*	Aerobee	31
50	-	-	1.0	(nf)	-	-	Sphere*	Aerobee	SC-29
50	-	-	1.0	(nf)	-	-	Sphere*	Aerobee	SC-30
50	-	-	1.0	2	-	-	Sphere*	Aerobee	SC-31
50	-	-	8.0x10 ⁻¹	.3	262	5.0	Sphere*	DAN-2	AM7.0
50	-	-	1.0	(nf)	283	(nf)	Sphere*	Nike-Cajun	AM6.0
50	-	-	1.0	(p)	-	-	Ionisation gage*	Aerobee	AM2.2
50	-	-	6.0x10 ⁻¹	2	285	5.7	Sphere*	Nike-Cajun	AM6.1
50	-	-	6.5x10 ⁻¹	2	260	5.2	Sphere*	Nike-Cajun	AM6.1
50	2.2x10 ⁻¹	(nf)	4.5x10 ⁻¹	(nf)	260	4.0	Grenade	Aerobee	SM1.0
50	7.6x10 ⁻¹	(nf)	1.3	(nf)	270	4.0	Grenade	Aerobee	SM1.0
50	5.0x10 ⁻¹	(nf)	9.2x10 ⁻¹	(nf)	275	4.0	Grenade	Aerobee	SM1.0
50	6.8x10 ⁻¹	(nf)	1.2	(nf)	272	4.0	Grenade	Aerobee	SM1.0
50	6.6x10 ⁻¹	(nf)	1.2	(nf)	265	4.0	Grenade	Aerobee	SM1.0

* These entries are taken from a published source.



HERE STRUCTURE DATA orted Through Early 1960

Project ARIES — Contract Nonr 3071(00)

icle	Number	Place Fired	Date	Time	Zone	Reference Data	Notes	Altitude Range, Km
RANGE 50-60 Km.								
2	21	WSPC	7 Mar '47	(nf)		Best 47	(nf) - not found	300
2	21	WSPC	7 Mar '47	11.23	MST	LaGov 54		
2	28	WSPC	8 Dec '47	14.42	MST	Spencer 54		
2	34	WSPC	22 Jan '48	13.13	MST	Havens 52		
2	43	WSPC	3 Aug '48	18.37	MST	Havens 52 & LaGov 54		200
2	45	WSPC	28 Jan '49	10.20	MST	LaGov 54		
robee	(nf)	WSPC	3 May '49	09.14	MST	Havens 52		
robee	(nf)	WSPC	20 Jun '50	08.38	MST	Sicinski 54		
robee	SC-10	WSPC	16 Oct '50	21.00	MST	Weissner 54		
robee	(nf)	WSPC	13 Sep '51	04.37	MST	Sicinski 54		200
robee	(nf)	WSPC	26 Sep '51	(nf)		Spencer 54		
robee	SC-23	WSPC	14 May '52	(nf)		Jones 58		
robee	1	Holloman	22 Oct '52	07.21	MST	Spencer 58-2	(p) preliminary; see reference	
robee	SC-29	WSPC	11 Dec '52	(nf)		Jones 58		
robee	SC-30	WSPC	23 Apr '53	(nf)		Jones 58		
robee	SC-31	WSPC	29 Sep '53	13.50	MST	Jones 58		100
1-2	AM7.02	Wallops	24 Jun '55	13.04	EST	Jones 56		
de-Cajun	AM6.01	Wallops	6 Jul '56	13.00	EST	Jones 59		
robee	AM2.21	Churchill	23 Oct '56	02.40	CST	Spencer 58-1		
de-Cajun	AM6.10	N. Atlantic	4 Nov '56	12.54	GMT	Jones 59	57°46'N 46°41'W	
de-Cajun	AM6.12	N. Atlantic	10 Nov '56	07.17	GMT	Jones 59	65°36'N 58°03'W	100
robee	SM1.01	Churchill	12 Nov '56	05.48	CST	Stroud 60 & Banteen		
robee	SM1.02	Churchill	21 Jul '57	22.16	CST	Stroud 60 & Banteen		
robee	SM1.03	Churchill	23 Jul '57	23.50	CST	Stroud 60 & Banteen		
robee	SM1.04	Churchill	12 Aug '57	10.00	CST	Stroud 60 & Banteen		
robee	SM1.05	Churchill	19 Aug '57	20.30	CST	Stroud 60 & Banteen		

taken from a published curve. Interpolation for tabular presentation may have introduced an error of ± 5%.



Altitude Km.	Pressure		Density		Temperature		Instrumentation	Vehicle	Number
	mm.Hg.	e. %	g/m ³	e. %	°K	e. °K			
ALTITUDE RANGE 50-60 Km. (1)									
50	-	-	-	-	265	4.0	Grenade	Aerobee	SM 2.0
50	-	-	-	-	255	4.0	Grenade	Aerobee	SM1.07
50	2.4x10 ⁻¹	(nf)	4.9x10 ⁻¹	(nf)	256	4.0	Grenade	Aerobee	SM1.08
50	-	-	7.5x10 ⁻¹	2	253	5.1	Sphere*	Nike-Cajun	AM6.02
50	-	-	1.0	2	255	5.1	Sphere*	Aerobee	SM2.10
50	2.8x10 ⁻¹	(nf)	5.5x10 ⁻¹	(nf)	257	(nf)	Grenade	Aerobee	SM2.10
50	3.0x10 ⁻¹	(nf)	6.2x10 ⁻¹	(nf)	252	4.0	Grenade	Aerobee	SM1.09
50	-	-	9.5x10 ⁻¹	2	280	5.6	Sphere*	Nike-Cajun	AM6.03
50	-	-	1.0	2	263	5.2	Sphere*	Nike-Cajun	AM6.05
50	-	-	8.5x10 ⁻¹	2	255	5.1	Sphere*	Nike-Cajun	AM6.09
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50.11	-	-	-	-	309	(P)	Alphatron*	Aerobee	31
51	-	-	6.0x10 ⁻¹	(P)	-	-	Ionisation gage*	Nike-Cajun	AM6.38
51.5	-	-	-	-	260.4	1.7	Grenade	Aerobee	SC-18
52	5.7x10 ⁻¹	4.1	-	-	-	-	Phillips gage*	Aerobee	(nf)
53.1	-	-	-	-	261	5.3	Grenade	Aerobee	SC-16
53.3	-	-	-	-	263.4	1.7	Grenade	Aerobee	SC-20
53.3	-	-	-	-	278.2	3.7	Grenade	Aerobee	(nf)
54	-	-	-	-	271.1	4.0	Grenade	Aeroben	(nf)
54	-	-	6.0x10 ⁻¹	(P)	-	-	Ionisation gage*	Nike-Cajun	AM6.37
54.7	-	-	-	-	251.5	1.7	Grenade	Aerobee	SC-14
54.7	-	-	-	-	262.5	0.4	Grenade	Aerobee	(nf)

* These entries are taken from a published



RE STRUCTURE DATA ed Through Early 1960

Project ARIES — Contract Nonr 3071(00)

	Number	Place Fired	Date	Time	Zone	Reference Data	Notes	Altitude Range, Km
E 50-60 Km. (cont.)								
	SM 2.06	Churchill	25 Aug '57	08.08	CST	Stroud 60		200
	SM2.07	Churchill	11 Dec '57	22.00	CST	Stroud 60		
	SM1.08	Churchill	14 Dec '57	15.00	CST	Stroud 60 & Bandeen		
jun	AM6.02	Churchill	25 Jan '58	13.12	CST	Jones 59		
	SM2.10	Churchill	27 Jan '58	12.48	CST	Jones 58		250
	SM2.10	Churchill	27 Jan '58	12.49	CST	Stroud 60 & Bandeen		
	SM1.09	Churchill	27 Jan '58	00.04	CST	Stroud 60 & Bandeen	(nf) - not found	
jun	AM6.03	Churchill	29 Jan '58	13.06	CST	Jones 59		
jun	AM5.05	Churchill	4 Mar '58	15.30	CST	Jones 59		
jun	AM6.09	N. Atlantic	2 Nov '59	12.40	JMT	Jones 59	48°57' N; 48°22' W	200
	_____	_____	_____	_____	_____	_____		
	_____	_____	_____	_____	_____	_____		
	_____	_____	_____	_____	_____	_____		
	31	Holloman	22 Oct '52	07.21	MST	Spencer 58-2	(p) preliminary, see reference	
jun	AM6.38	Churchill	24 Mar '58	12.30	CST	Spencer 58-1		150
	SC-18	WEPG	8 Jun '51	23.11	MST	Stroud 56		
	(nf)	WEPG	6 Sep '49	09.57	MST	Havens 52		
	SC-16	WEPG	12 Dec '50	02.10	MST	Stroud 56		
	SC-20	WEPG	1 Nov '51	02.46	MST	Stroud 56		
	(nf)	WEPG	22 Oct '52	20.45	MST	Stroud 56		
	(nf)	WEPG	24 Sep '52	20.50	MST	Stroud 56		100
jun	AM6.37	Churchill	24 Feb '58	01.35	CST	Spencer 58-1		
	SC-14	WEPG	11 Dec '50	21.06	MST	Stroud 56		
	(nf)	WEPG	24 Apr '53	03.19	MST	Stroud 56		

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on a published curve. Interpolation for tabular presentation may have introduced an error of $\pm 5\%$.

Altitude	Pressure		Density		Temperature		Instrumentation	Vehicle	Number
Km.	mm.Hg.	e. %	g/m ³	e. %	°K	e. °K			
ALTITUDE RANGE 50-60 Km									
55	-	-	-	-	252	4.0	Grenade	Aerobee	SC-14
55.4	-	-	-	-	265.6	4.6	Grenade	Aerobee	SC-15
56	-	-	-	-	249.7	3.8	Grenade	Aerobee	SC-8
58	3.0x10 ⁻¹	(nf)	-	-	-	-	Pressure gage*	V-2	43
58	-	-	-	-	262	3.6	Grenade	Aerobee	SC-10
58.1	-	-	-	-	259.9	1.9	Grenade	Aerobee	(nf)
58.5	-	-	-	-	259	1.6	Grenade	Aerobee	(nf)
58.7	-	-	-	-	258.9	7.2	Grenade	Aerobee	SC-18
59	2.0x10 ⁻¹	(nf)	-	-	-	-	Phillips gage*	Aerobee	(nf)
59	2.3x10 ⁻¹	(nf)	-	-	-	-	Phillips gage*	(nf)	(nf)
59	-	-	-	-	263.9	4.2	Grenade	Aerobee	(nf)
59.3	-	-	-	-	246.2	1.8	Grenade	Aerobee	(nf)
59.6	-	-	-	-	254.3	3.8	Grenade	Aerobee	(nf)
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* These entries are taken from a published source.

RE STRUCTURE DATA rted Through Early 1960

Project ARIES — Contract Nonr 3071(00)

Number	Place Fired	Date	Time	Zone	Reference Data	Notes	Altitude Range, Km
RANGE 50-60 Km. (concluded)							300
SC-14	WSPG	11 Dec '50	21.06	MST	Weisner 54		
SC-18	WSPG	8 Jun '51	23.11	MST	Stroud 56		
SC-8	WSPG	14 Jul '50	0.137	MST	Stroud 56		
43	WSPG	5 Aug '48	18.37	MST	Havens 52 & LaGow 54	(nf) not found	
SC-10	WSPG	10 Oct '50	21.00	MST	Weisner 54		280
(nf)	WSPG	31 Aug '53	22.05	MST	Stroud 56		
(nf)	WSPG	4 Sep '53	22.36	MST	Stroud 56		
SC-18	WSPG	8 Jun '51	23.11	MST	Stroud 56		
(nf)	WSPG	3 May '49	09.14	MST	Havens 52		
(nf)	Equator	11 May '50	16.00	MST	Havens 52	near Christmas Island	260
(nf)	WSPG	22 Oct '52	20.45	MST	Stroud 56		
(nf)	WSPG	17 Feb '53	23.50	MST	Stroud 56		
(nf)	WSPG	24 Sep '52	20.50	MST	Stroud 56		
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rom a published curve. Interpolation for tabular presentation may have introduced an error of $\pm 5\%$.

80

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Altitude Km.	Pressure		Density		Temperature		Instrumentation	Vehicle	Number
	mm.Hg.	e. %	g/m ³	e. %	°K	e. °K			
ALTITUDE RANGE 60-70 Km.									
60	-	-	-	-	312	25	(nf)	V-2	21
60	2.2x10 ⁻¹	(nf)	-	-	250	(nf)	Pirani gage*	V-2	28
60	-	-	5.0x10 ⁻¹	(nf)	-	-	Pressure gage*	V-2	43
60	2.5x10 ⁻¹	(nf)	-	-	240	7.0	Alphatron*	Aerobee	(nf)
60	-	-	-	-	250	5.0	Grenade	Aerobee	SC-14
60	2.5x10 ⁻¹	(nf)	-	-	238	5.0	Alphatron*	Aerobee	(nf)
60	-	-	-	-	240	12	Alphatron*	Aerobee	(nf)
60	-	-	3.5x10 ⁻¹	(nf)	-	-	Sphere*	Aerobee	SC-23
60	2.5x10 ⁻¹	(p)	2.8	(p)	277	(p)	Alphatron*	Aerobee	31
60	-	-	4.5x10 ⁻¹	(nf)	-	-	Sphere*	Aerobee	SC-29
60	-	-	3.0x10 ⁻¹	(nf)	-	-	Sphere*	Aerobee	SC-30
60	-	-	2.0x10 ⁻¹	2	-	-	Sphere*	Aerobee	SC-31
60	-	-	3.17x10 ⁻¹	1	242	4.0	Sphere*	DAN-2	AM7.0
60	-	-	4.0x10 ⁻¹	(nf)	-	-	Sphere*	Nike-Cajun	AM6.0
60	-	-	2.9x10 ⁻¹	(p)	-	-	Ionization gage*	Aerobee	AM2.2
60	-	-	2.0x10 ⁻¹	2	273	5.5	Sphere*	Nike-Cajun	AM6.1
60	-	-	2.0x10 ⁻¹	2	240	4.8	Sphere*	Nike-Cajun	AM6.1
60	6.6x10 ⁻²	(nf)	1.1x10 ⁻¹	(nf)	260	5.0	Grenade	Aerobee	SM1.0
60	2.1x10 ⁻¹	(nf)	4.2x10 ⁻¹	(nf)	260	5.0	Grenade	Aerobee	SM1.0
60	1.8x10 ⁻¹	(nf)	3.5x10 ⁻¹	(nf)	260	5.0	Grenade	Aerobee	SM1.0
60	1.7x10 ⁻¹	(nf)	2.7x10 ⁻¹	(nf)	258	5.0	Grenade	Aerobee	SM1.0
60	1.8x10 ⁻¹	(nf)	3.5x10 ⁻¹	(nf)	255	5.0	Grenade	Aerobee	SM1.0
60	-	-	-	-	255	5.0	Grenade	Aerobee	SM2.0
60	-	-	4.0x10 ⁻¹	(p)	-	-	Ionization gage*	Aerobee-Hi	AM4.0
60	-	-	-	-	242	5.0	Grenade	Aerobee	SM1.0

* These entries are taken from a published



STRUCTURE DATA Through Early 1960

Project ARIES — Contract Nonr 3071(00)

Number	Place Fired	Date	Time	Zone	Reference Data	Notes	Altitude Range, Km
21	WSPG	7 Mar '47	11.23	MST	Best 47	(nf) - not found	300
28	WSPG	8 Dec '47	14.42	MST	Spencer 54		
43	WSPG	5 Aug '48	18.37	MST	Havens 52 & LaGow 54		
(nf)	WSPG	20 Jun '50	08.38	MST	Sicinski 54		
SC-14	WSPG	11 Dec '50	21.06	MST	Stroud 56		250
(nf)	WSPG	13 Sep '51	04.37	MST	Sicinski 54		
(nf)	WSPG	26 Sep '51	(nf)	-	Spencer 54		
SC-23	WSPG	14 May '52	(nf)	-	Jones 58		
31	Holloman	22 Oct '52	07.21	MST	Spencer 58-1	(p) Preliminary; see reference	
SC-29	WSPG	11 Dec '52	(nf)	-	Jones 58		200
SC-30	WSPG	23 Apr '53	(nf)	-	Jones 58		
SC-31	WSPG	29 Sep '53	13.50	MST	Jones 58		
AM7.02	Wallops	24 Jun '55	13.04	EST	Jones 56		
AM6.01	Wallops	6 Jul '56	13.00	EST	Jones 59		
AM2.21	Churchill	23 Oct '56	02.40	CST	Spencer 58-1		
AM6.10	N.Atlantic	4 Nov '56	12.54	GMT	Jones 59	57°46'N 46°41'W	150
AM6.12	N.Atlantic	10 Nov '56	07.17	GMT	Jones 59	65°36'N 58°03'W	
SM1.01	Churchill	12 Nov '56	05.48	CST	Stroud 60 & Barden		
SM1.02	Churchill	21 Jul '57	22.16	CST	Stroud 60 & Barden		
SM1.03	Churchill	23 Jul '57	23.30	CST	Stroud 60 & Barden		
SM1.04	Churchill	12 Aug '57	10.00	CST	Stroud 60 & Barden		100
SM1.05	Churchill	19 Aug '57	20.30	CST	Stroud 60 & Barden		
SM2.06	Churchill	25 Aug '57	08.08	CST	Stroud 60		
AM4.01	Churchill	1 Sep '57	16.28	CST	Spencer 58-1		
SM1.07	Churchill	11 Dec '57	22.00	CST	Stroud 60		

published curve. Interpolation for tabular presentation may have introduced an error of $\pm 5\%$.

Science Communication
Washington, D. C.

UPPER ATMOSPHERE STRUCTURE
Measurements Reported Through

Altitude Km.	Pressure		Density		Temperature		Instrumentation	Vehicle	Number
	mm.Hg.	e. %	g/cm ³	e. %	°K	e. °K			
ALTITUDE RANGE 60-70 Km. (c)									
60	5.7×10^{-2}	(nf)	1.2×10^{-1}	(nf)	230	5.0	Grenade	Aerobee	SM1.08
60	-	-	1.9×10^{-1}	2	263	5.2	Sphere*	Nike-Cajun	AM6.02
60	-	-	1.5×10^{-1}	2	253	5.0	Sphere*	Aerobee	SM2.10
60	1.1×10^{-1}	(nf)	2.2×10^{-1}	(nf)	255	5.0	Grenade	Aerobee	SM2.10
60	7.8×10^{-2}	(nf)	1.5×10^{-1}	(nf)	250	5.0	Grenade	Aerobee	SM1.09
60	-	-	3.0×10^{-1}	2	258	5.1	Sphere*	Nike-Cajun	AM6.03
60	-	-	2.8×10^{-1}	(p)	-	-	Ionization gage*	Nike-Cajun	AM6.37
60	-	-	2.5×10^{-1}	2	258	4.7	Sphere*	Nike-Cajun	AM6.05
60	-	-	2.0×10^{-1}	(p)	-	-	Ionization gage*	Nike-Cajun	AM6.38
60	-	-	2.9×10^{-1}	2	-	-	Sphere*	Nike-Cajun	AM6.09
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60.1	-	-	-	-	249	2.1	Grenade	Aerobee	SC-14
60.5	-	-	-	-	241.8	5.8	Grenade	Aerobee	SC-20
61	1.8×10^{-1}	10	-	-	-	-	Phillips gage*	V-2	45
61.2	-	-	-	-	211.6	1.4	Grenade	Aerobee	SC-16
61.8	-	-	-	-	244.6	0.4	Grenade	Aerobee	(nf)
61.9	-	-	-	-	252.2	1.3	Grenade	Aerobee	SC-18
63	1.4×10^{-1}	(nf)	-	-	-	-	Phillips gage*	V-2	12
64	-	-	-	-	234	5.0	Grenade	Aerobee	SC-10
64.4	-	-	-	-	233.5	4.0	Grenade	Aerobee	SC-10
64.5	-	-	-	-	244.7	2.3	Grenade	Aerobee	SC-14
65	-	-	-	-	245	5.0	Grenade	Aerobee	SC-14

* These entries are taken from a published



OSPHERE STRUCTURE DATA

s Reported Through Early 1960

Project ARIES — Contract Nonr 3071(00)

Vehicle	Number	Place Fired	Date	Time	Zone	Reference Data	Notes	Altitude Range, Km
TITULR RANGE 60-70 Km. (cont.)								300
Aerobee	SM1.08	Churchill	14 Dec '57	15.06	CST	Stroud 60 & Barden		
Nike-Cajun	AM6.02	Churchill	25 Jan '58	13.12	CST	Jones 59		
Aerobee	SM2.10	Churchill	27 Jan '58	12.48	CST	Jones 58		
Aerobee	SM2.10	Churchill	27 Jan '58	12.49	CST	Stroud 60 & Barden		
Aerobee	SM1.09	Churchill	27 Jan '58	00.04	CST	Stroud 60 & Barden		250
Nike-Cajun	AM6.03	Churchill	29 Jan '58	13.06	CST	Jones 59		
Nike-Cajun	AM6.37	Churchill	24 Feb '58	01.35	CST	Spencer 58-1	(p) Preliminary: see reference	
Nike-Cajun	AM6.05	Churchill	4 Mar '58	13.30	CST	Jones 59		
Nike-Cajun	AM6.38	Churchill	24 Mar '58	12.30	CST	Spencer 58-1	(nf) - not found	
Nike-Cajun	AM6.09	N. Atlantic	2 Nov '59	12.40	GMT	Jones 59	48°57'N 48°22'W	200
_____	_____	_____	_____	_____	_____	_____		
_____	_____	_____	_____	_____	_____	_____		
_____	_____	_____	_____	_____	_____	_____		
Aerobee	SC-14	WSPG	11 Dec '50	21.06	MST	Stroud 56		
Aerobee	SC-20	WSPG	1 Nov '51	02.46	MST	Stroud 56		150
V-2	45	WSPG	28 Jan '49	10.20	MST	LaGow 54		
Aerobee	SC-16	WSPG	12 Dec '50	02.10	MST	Stroud 56		
Aerobee	(nf)	WSPG	24 Apr '53	03.19	MST	Stroud 56		
Aerobee	SC-18	WSPG	8 Jun '51	23.11	MST	Stroud 56		
V-2	12	WSPG	10 Oct '46	11.02	MST	Havens 52		
Aerobee	SC-10	WSPG	16 Oct '50	21.00	MST	Stroud 56		100
Aerobee	SC-10	WSPG	16 Oct '50	21.00	MST	Stroud 56		
Aerobee	SC-14	WSPG	11 Dec '50	21.06	MST	Stroud 56		
Aerobee	SC-14	WSPG	11 Dec '50	21.06	MST	Stroud 56		

are taken from a published curve. Interpolation for tabular presentation may have introduced an error of $\pm 5\%$.

Altitude Km.	Pressure		Density		Temperature		Instrumentation	Vehicle	Number
	mm.Hg.	e. %	g/m ³	e. %	°K	e. °K			
ALTITUDE RANGE 60-70 Km.									
65	1.09x10 ⁻¹	(nf)	-	-	-	-	Phillips gage*	(nf)	(nf)
65.7	-	-	-	-	236	1.9	Grenade	Aerobee	(nf)
65.8	-	-	-	-	224.5	1.4	Grenade	Aerobee	(nf)
66.6	-	-	-	-	223.4	1.8	Grenade	Aerobee	(nf)
67.3	-	-	-	-	222.1	1.8	Grenade	Aerobee	(nf)
68	7.0x10 ⁻²	(nf)	-	-	-	-	Phillips gage*	(nf)	(nf)
68.1	-	-	-	-	222.6	0.4	Grenade	Aerobee	(nf)
69.3	-	-	-	-	235.3	1.8	Grenade	Aerobee	(nf)
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* These entries are taken from a published

OSPHERE STRUCTURE DATA

s Reported Through Earl / 1960

Project ARIES — Contract Nonr 3071(00)

Vehicle	Number	Place Fired	Date	Time	Zone	Reference Data	Notes	Altitude Range, Km.
LATITUDE RANGE 60-70 Km. (concluded)								300
(nf)	(nf)	WSPG	12 Dec '50	24.00	MST	Havens 52	(nf) - not found	
Aerobee	(nf)	WSPG	31 Aug '55	22.05	MST	Stroud 56		
Aerobee	(nf)	WSPG	4 Sep '55	22.36	MST	Stroud 56		
Aerobee	(nf)	WSPG	22 Oct '52	20.45	MST	Atrous 56		
Aerobee	(nf)	WSPG	24 Sep '52	20.50	MST	Stroud 56		250
(nf)	(nf)	Equator	11 May '50	16.00	MST	Havens 52	near Christmas Island	
Aerobee	(nf)	WSPG	24 Apr '55	03.19	MST	Stroud 56		
Aerobee	(nf)	WSPG	17 Feb '55	23.50	MST	Stroud 56		
_____	_____	_____	_____	_____	_____	_____		
_____	_____	_____	_____	_____	_____	_____		200
_____	_____	_____	_____	_____	_____	_____		

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are taken from a published curve. Interpolation for tabular presentation may have introduced an error of $\pm 5\%$.

Science Communication
Washington, D. C.

UPPER ATMOSPHERE STRU
Measurements Reported Thro

Altitude Km.	Pressure		Density		Temperature		Instrumentation	Vehicle	Numb
	mm.Hg.	e. %	γ/m^3	e. %	°K	e. °K			
ALTITUDE RANGE 70-80 Km.									
70	6.0×10^{-2}	(nf)	-	-	-	-	Phillips gage*	V-2	12
70	3.5×10^{-3}	(p)	-	-	-	-	Ionization gage*	V-2	15
70	-	-	-	-	240	15	(nf)	V-2	21
70	5.2×10^{-2}	10	1.29×10^{-1}	20	-	-	Phillips gage*	V-2	21
70	9.0×10^{-2}	(p)	-	-	260	(p)	Pirani gage*	V-2	28
70	5.0×10^{-2}	(nf)	-	-	-	-	Phillips gage*	V-2	34
70	4.8×10^{-2}	(nf)	-	-	187	10	Alphatron*	Aerobee	(nf)
70	-	-	-	-	225	6.0	Grenade	Aerobee	SC-10
70	-	-	-	-	189	7.0	Alphatron*	Aerobee	(nf)
70	5.0×10^{-2}	(p)	8.0×10^{-2}	(p)	216	(p)	Alphatron*	Aerobee	31
70	-	-	1.0×10^{-1}	(nf)	-	-	Sphere*	Aerobee	SC-29
70	-	-	9.8×10^{-2}	(nf)	-	-	Sphere*	Aerobee	SC-30
70	-	-	5.5×10^{-2}	2	-	-	Sphere*	DAN-2	AM7.0
70	-	-	1.0×10^{-2}	2	-	-	Sphere*	Nike-Cajun	AM6.0
70	-	-	5.0×10^{-2}	2	245	4.9	Sphere*	Nike-Cajun	AM6.1
70	-	-	6.0×10^{-2}	2	-	-	Sphere*	Nike-Cajun	AM6.1
70	4.0×10^{-2}	(nf)	9.9×10^{-2}	(nf)	215	6.0	Grenade	Aerobee	SM1.0
70	4.6×10^{-2}	(nf)	1.04×10^{-1}	(nf)	220	6.0	Grenade	Aerobee	SM1.0
70	4.2×10^{-2}	(nf)	9.8×10^{-2}	(nf)	215	6.0	Grenade	Aerobee	SM1.0
70	-	-	-	-	210	5.0	Grenade	Aerobee	SM2.0
70	-	-	9.5×10^{-2}	(p)	-	-	Ionization gage*	Aerobee-hi	AM4.0
70	-	-	-	-	280	6.0	Grenade	Aerobee	SM1.0
70	2.0×10^{-2}	(nf)	2.5×10^{-2}	(nf)	240	6.0	Grenade	Aerobee	SM1.0
70	-	-	5.5×10^{-2}	2	243	4.9	Sphere*	Nike-Cajun	AM6.0
70	-	-	4.0×10^{-2}	2	233	4.6	Sphere*	Aerobee	SM2.1

* These entries are taken from a published

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ATMOSPHERE STRUCTURE DATA

Data Reported Through Early 1960

Project ARIES — Contract Nonr 3071(0C)

Vehicle	Number	Place Fired	Date	Time	Zone	Reference Data	Notes	Altitude Range, Km
ALTITUDE RANGE 70-80 Km.								300
V-2	12	WSPG	10 Oct '46	11.02	MST	Havens 52	(nf) not found	
V-2	15	WSPG	21 Nov '46	09.55	MST	Spencer 54	(p) preliminary see reference	
V-2	21	WSPG	7 Mar '47	11.23	MST	Best 47		
V-2	21	WSPG	7 Mar '47	11.23	MST	LaGow 54		
V-2	28	WSPG	8 Dec '47	14.42	MST	Spencer 54		200
V-2	34	WSPG	22 Jan '48	13.13	MST	Havens 52		
Aerobee	(nf)	WSPG	20 Jun '50	08.38	MST	Sicinski 54		
Aerobee	SC-10	WSPG	16 Oct '50	21.00	MST	Stroud 56		
Aerobee	(nf)	WSPG	13 Sep '51	04.37	MST	Sicinski 54		
Aerobee	31	Holloman	22 Oct '52	07.21	MST	Spencer 58-2		200
Aerobee	SC-29	WSPG	11 Dec '52	(nf)		Jones 58		
Aerobee	SC-30	WSPG	23 Apr '53	(nf)		Jones 58		
DAW-2	AM7.02	Wallops	24 Jun '55	13.04	EST	Jones 56		
Nike-Cajun	AM6.01	Wallops	6 Jul '56	13.00	EST	Jones 59		
Nike-Cajun	AM6.10	N. Atlantic	4 Nov '56	12.54	GMT	Jones 59	57°46'N 46°41'W	100
Nike-Cajun	AM6.12	N. Atlantic	10 Nov '56	07.17	GMT	Jones 59	65°36'N 58°03'W	100
Aerobee	SM1.02	Churchill	21 Jul '57	22.16	CST	Stroud 60 & Bandeen		
Aerobee	SM1.03	Churchill	23 Jul '57	23.30	CST	Stroud 60 & Bandeen		
Aerobee	SM1.05	Churchill	19 Aug '57	20.30	CST	Stroud 60 & Bandeen		
Aerobee	SM2.06	Churchill	25 Aug '57	08.08	CST	Stroud 60		
Aerobee-hi	AM4.01	Churchill	1 Sep '57	16.28	CST	Spencer 58-1		100
Aerobee	SM1.07	Churchill	11 Dec '57	22.00	CST	Stroud 60		
Aerobee	SM1.08	Churchill	14 Dec '57	15.00	CST	Stroud 60 & Bandeen		
Nike-Cajun	AM6.02	Churchill	25 Jan '58	13.12	CST	Jones 59		
Aerobee	SM2.10	Churchill	27 Jan '58	12.48	CST	Jones 58		

Data are taken from a published curve. Interpolation for tabular presentation may have introduced an error of $\pm 5\%$.

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Altitude Km.	Pressure		Density		Temperature		Instrumentation	Vehicle	Number
	mm.Hg.	g. %	g/m ³	g. %	°K	g. °K			
ALTITUDE RANGE 70-80 Km.									
70	3.0x10 ⁻²	(nf)	6.1x10 ⁻²	(nf)	238	6.0	Grenade	Aerobee	SC-10
70	1.7x10 ⁻²	(nf)	3.7x10 ⁻²	(nf)	235	6.0	Grenade	Aerobee	SC-10
70	-	-	8.3x10 ⁻²	2	242	4.8	Sphere*	Nike-Cajun	AMC.
70	-	-	1.2x10 ⁻¹	(p)	-	-	Ionization gage*	Nike-Cajun	AMC.
70	-	-	1.0x10 ⁻¹	2	247	4.9	Sphere*	Nike-Cajun	AMC.
70	-	-	5.0x10 ⁻²	(p)	-	-	Ionization gage*	Nike-Cajun	AMC.
70	-	-	6.3x10 ⁻²	(nf)	-	-	Sphere*	Nike-Cajun	AMC.
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70.2	-	-	-	-	224.4	4.8	Grenade	Aerobee	SC-10
72.5	-	-	-	-	207.1	2.1	Grenade	Aerobee	(nf)
72.7	-	-	-	-	240.6	4.4	Grenade	Aerobee	(nf)
75	-	-	-	-	226.0	6.0	Grenade	Aerobee	SC-10
75.4	-	-	-	-	225.5	6.0	Grenade	Aerobee	SC-10
76.5	-	-	-	-	204.3	2.8	Grenade	Aerobee	(nf)
77	2.6x10 ⁻¹	(nf)	-	-	-	-	Phillips gage*	Aerobee	(nf)
77.8	-	-	-	-	214.5	1.8	Grenade	Aerobee	(nf)
78.7	-	-	-	-	203.4	3.0	Grenade	Aerobee	(nf)
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* These entries are taken from a published

SPHERE STRUCTURE DATA **Reported Through Early 1960**

Project ARIES — Contract Nonr 3071(00)

Vehicle	Number	Place Fired	Date	Time	Zone	Reference Data	Notes	Altitude Range, Km
RANGE 70-80 Km. (concluded)								200
Probee	SM2.10	Churchill	27 Jan '58	12.49	CST	Stroud 60 & Bandeen		
Probee	SM1.09	Churchill	27 Jan '58	00.04	CST	Stroud 60 & Bandeen		
Like-Cajun	AM6.03	Churchill	29 Jan '58	13.06	CST	Jones 59		
Like-Cajun	AM6.57	Churchill	24 Feb '58	01.55	CST	Spencer 58-1	(p) preliminary see reference	
Like-Cajun	AM6.05	Churchill	4 Mar '58	13.50	CST	Jones 59		200
Like-Cajun	AM6.58	Churchill	24 Mar '58	12.30	CST	Spencer 58-1		
Like-Cajun	AM6.09	N. Atlantic	2 Nov '59	12.40	CST	Jones 59	(nf) not found 48°57'N 48°22'W	
_____	_____	_____	_____	_____	_____	_____		
_____	_____	_____	_____	_____	_____	_____		
_____	_____	_____	_____	_____	_____	_____		200
Probee	SC-10	WSPG	16 Oct '50	21.00	MST	Stroud 56		
Probee	(nf)	WSPG	4 Sep '53	22.36	MST	Stroud 56		
Probee	(nf)	WSPG	31 Aug '53	22.05	MST	Stroud 56		
Probee	SC-10	WSPG	16 Oct '50	21.00	MST	Stroud 56		
Probee	SC-10	WSPG	16 Oct '50	21.00	MST	Stroud 56		100
Probee	(nf)	WSPG	25 Sep '52	20.50	MST	Stroud 56		
Probee	(nf)	WSPG	3 May '49	19.14	MST	Havens 52		
Probee	(nf)	WSPG	17 Feb '53	23.50	MST	Stroud 56		
Probee	(nf)	WSPG	4 Sep '53	22.36	MST	Stroud 56		
_____	_____	_____	_____	_____	_____	_____		
_____	_____	_____	_____	_____	_____	_____		
_____	_____	_____	_____	_____	_____	_____		100

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_____ taken from a published curve. Interpolation for tabular presentation may have introduced an error of $\pm 5\%$.

Altitude Km.	Pressure		Density		Temperature		Instrumentation	Vehicle	Number
	mm.Hg.	e. %	g/m ³	e. %	°K	e. °K			
ALTITUDE RANGE 80-90 Km.									
80	1.0x10 ⁻³	(p)	-	-	-	-	Ionization gage*	V-2	15
80	-	-	-	-	200	20	(nf)	V-2	21
80	-	-	3.5x10 ⁻²	20	-	-	Phillips gage*	V-2	21
80	1.3x10 ⁻²	(nf)	-	-	220	(nf)	Pirani gage*	V-2	28
80	-	-	-	-	210	7.0	Grenade	Aerobee	SM-10
80	-	-	3.0x10 ⁻²	(nf)	-	-	Sphere*	Aerobee	SM-30
80	-	-	2.0x10 ⁻²	(nf)	-	-	Sphere*	Nike-Cajun	AM6.01
80	-	-	1.8x10 ⁻²	5	-	-	Sphere*	Nike-Cajun	AM6.10
80	-	-	2.5x10 ⁻²	5	-	-	Sphere*	Nike-Cajun	AM6.12
80	8.7x10 ⁻²	(nf)	2.5x10 ⁻²	(nf)	174	7.0	Grenade	Aerobee	SM1.02
80	9.0x10 ⁻³	(nf)	2.6x10 ⁻²	(nf)	170	7.0	Grenade	Aerobee	SM1.03
80	7.4x10 ⁻³	(nf)	2.1x10 ⁻²	(nf)	172	7.0	Grenade	Aerobee	SM1.05
80	-	-	-	-	180	7.0	Grenade	Aerobee	SM2.06
80	-	-	-	-	222	7.0	Grenade	Aerobee	SM1.08
80	-	-	1.5x10 ⁻²	2	-	-	Sphere*	Nike-Cajun	AM6.02
80	-	-	1.0x10 ⁻²	2	-	-	Sphere*	Aerobee	SM2.10
80	5.5x10 ⁻³	(nf)	1.1x10 ⁻²	(nf)	245	7.0	Grenade	Aerobee	SM2.10
80	6.1x10 ⁻³	(nf)	7.5x10 ⁻³	(nf)	245	7.0	Grenade	Aerobee	SM1.09
80	-	-	2.5x10 ⁻²	2	-	-	Sphere*	Nike-Cajun	AM6.03
80	-	-	3.5x10 ⁻²	(p)	-	-	Ionization gage*	Nike-Cajun	AM6.37
80	-	-	2.0x10 ⁻²	(p)	-	-	Sphere*	Nike-Cajun	AM6.05
80	-	-	1.3x10 ⁻²	(p)	-	-	Ionization gage*	Nike-Cajun	AM6.38
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* These entries are taken from a published source.



RE STRUCTURE DATA orted Through Early 1960

Project ARIES — Contract Nonr 3071(00)

Number	Place Fixed	Date	Time	Zone	Reference Data	Notes	Altitude Range, Km
RE 80-90 Km.							800
15	WEPG	21 Nov '46	09.55	MST	Spencer 54	(p) preliminary; see reference	
21	WEPG	7 Mar '47	11.23	MST	Best 47	(nf) not found	
21	WEPG	7 Mar '47	11.23	MST	Laflow 54		
28	WEPG	8 Dec '47	14.42	MST	Spencer 54		
80-10	WEPG	16 Oct '50	21.00	MST	Stroud 56		200
80-30	WEPG	23 Apr '53	(nf)		Jones 58		
AM6.01	Wallops	6 Jul '56	13.00	MST	Jones 59		
AM6.10	N. Atlantic	4 Nov '56	12.54	GMT	Jones 59	57°46'N 46°41'W	
AM6.12	N. Atlantic	10 Nov '56	07.17	GMT	Jones 59	65°36'N 58°03'W	
SM1.02	Churchill	21 Jul '57	22.16	CST	Stroud 60 & Bandeen		200
SM1.03	Churchill	23 Jul '57	23.30	CST	Stroud 60 & Bandeen		
SM1.05	Churchill	19 Aug '57	20.30	CST	Stroud 60 & Bandeen		
SM2.06	Churchill	25 Aug '57	08.08	CST	Stroud 60		
SM1.08	Churchill	14 Dec '57	15.00	CST	Stroud 60		
AM6.02	Churchill	25 Jan '58	13.12	CST	Jones 59		100
SM2.10	Churchill	27 Jan '58	12.48	CST	Jones 58		
SM2.10	Churchill	27 Jan '58	12.49	CST	Stroud 60 & Bandeen		
SM1.09	Churchill	27 Jan '58	00.04	CST	Stroud 60 & Bandeen		
AM6.03	Churchill	29 Jan '58	13.06	CST	Jones 59		
AM6.37	Churchill	24 Feb '58	01.35	CST	Spencer 58-1		
AM6.05	Churchill	4 Mar '58	13.30	CST	Jones 59		100
AM6.38	Churchill	24 Mar '58	12.30	CST	Spencer 58-1		
_____	_____	_____	_____	_____	_____		
_____	_____	_____	_____	_____	_____		
_____	_____	_____	_____	_____	_____		

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from a published curve. Interpolation for tabular presentation may have introduced an error of $\pm 1\%$.

Altitude	Pressure		Density		Temperature		Instrumentation	Vehicle	Number
Km.	mm.Hg.	e. %	g/m ³	e. %	°K	e. °K			
ALTITUDE RANGE 80-90 Km.									
80.3	-	-	-	-	211.5	7.2	Grenade	Aerobee	80-10
80.95	-	-	-	-	169	(P)	Alphatron*	Aerobee	31
82.4	7.0x10 ⁻³	30	-	-	-	-	Phillips gage*	Aerobee	(nf)
83	-	-	5.5x10 ⁻³	(P)	-	-	Ionization gage*	Nike-Cajun	AM6.38
87	2.8x10 ⁻³	(P)	3.0x10 ⁻³	(P)	309	(P)	Alphatron*	Aerobee	31
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ALTITUDE RANGE 90-100 Km.									
90	3.0x10 ⁻⁴	(P)	-	-	-	-	Ionization gage*	V-2	15
90	-	-	-	-	130	(P)	Alphatron	V-2	20
90	-	-	-	-	200	40	Pirani gage*	V-2	21
90	3.5x10 ⁻³	(nf)	-	-	220	(nf)	Pirani gage*	V-2	28
90	-	-	-	-	180	8.0	Grenade	Aerobee	802.06
90	-	-	4.0x10 ⁻³	(nf)	-	-	Sphere*	Nike-Cajun	AM6.02
90	-	-	1.9x10 ⁻³	(nf)	-	-	Sphere*	Aerobee	802.10
90	-	-	4.2x10 ⁻³	(nf)	-	-	Sphere*	Nike-Cajun	AM6.03
90	-	-	4.0x10 ⁻³	(nf)	-	-	Sphere*	Nike-Cajun	AM6.03
94	1.2x10 ⁻³	(nf)	-	-	-	-	Phillips gage*	V-2	34
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* These entries are taken from a published



SPHERIC STRUCTURE DATA

Reported Through Early 1960

Project ARIES -- Contract Nonr 3071(00)

Reported through Early 1960							Altitude
Number	Place Fired	Date	Time	Zone	Reference Data	Notes	Km.
							300
80-90 Km.							
80-10	WSPG	16 Oct '50	21.00	MST	Stroud 56		
31	Holloman	22 Oct '52	07.21	MST	Spencer 58-2	(p) preliminary see reference	
(nf)	WSPG	3 May '49	09.14	MST	Havens 52	(nf) not found	
AM6.38	Churchill	24 Mar '58	12.30	CST	Spencer 58-1		
31	Holloman	22 Oct '52	07.21	MST	Spencer 58-2		250
_____	_____	_____	_____	_____	_____		
_____	_____	_____	_____	_____	_____		
_____	_____	_____	_____	_____	_____		
90-100 Km.							200
15	WSPG	21 Nov '46	09.55	MST	Spencer 54		
20	WSPG	20 Feb '47	11.16	MST	Spencer 54		
21	WSPG	7 Mar '47	11.23	MST	Best 47		
28	WSPG	8 Dec '47	14.42	MST	Spencer 54		
SM2.06	Churchill	25 Aug '57	08.08	CST	Stroud 60		150
AM6.02	Churchill	25 Jan '58	13.12	CST	Jones 59		
SM2.10	Churchill	27 Jan '58	12.48	CST	Jones 58		
AM6.03	Churchill	29 Jan '58	13.06	CST	Jones 59		
AM6.05	Churchill	4 Mar '58	13.30	CST	Jones 59		
54	WSPG	22 Jan '48	13.13	MST	Havens 52 & LaGow 54		100
_____	_____	_____	_____	_____	_____		
_____	_____	_____	_____	_____	_____		
_____	_____	_____	_____	_____	_____		
as a published curve. Interpolation for tabular presentation may have introduced an error of $\pm 5\%$.							50
							30

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-15-



Altitude	Pressure		Density		Temperature		Instrumentation	Vehicle	Number
Km.	mm.Hg.	e. %	g/m ³	e. %	°K	e. °K			
ALTITUDE RANGE 100-110 Km.									
100	6.0x10 ⁻³	(p)	-	-	-	-	Ionization gage*	V-2	15
100	-	-	-	-	190	(mf)	Alphatron	V-2	20
100	-	-	-	-	225	40	Phillips gage*	V-2	21
100	1.2x10 ⁻³	(p)	-	-	228	(mf)	Pirani gage*	V-2	28
100	1.1x10 ⁻⁴	30	2.3x10 ⁻⁴	50	210	(mf)	Phillips gage*	Viking	7
100	-	-	-	-	198	(mf)	Phillips gage*	Aerobee-H1	NH3.13
100	3.0x10 ⁻⁴	20	7.2x10 ⁻⁴	30	-	-	"	"	"
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ALTITUDE RANGE 110-120 Km.

110	-	-	-	-	248	(p)	Alphatron	V-2	20
110	1.0×10^{-4}	10	-	-	275	40	Phillips gage*	V-2	21
110	1.4×10^{-4}	(nf)	2.0×10^{-4}	(nf)	-	-	Phillips gage*	V-2	34
110	2.6×10^{-3}	30	5.0×10^{-3}	30	228	(nf)	Ionization gage*	Viking	7
110	-	-	1.0×10^{-4}	25	-	-	Mass Spectrometer	Aerobee-H1	NH3.17
110	-	-	-	-	230	(nf)	Phillips gages*	Aerobee-H1	NH3.15
110	6.5×10^{-3}	20	1.3×10^{-4}	30	-	-	"	"	"
110	-	-	4.5×10^{-3}	25	-	-	Mass Spectrometer	Aerobee-H1	NH3.19
115	-	-	-	-	1500	500	Langmuir Probe	Specrobes	ARM10.5
118	-	-	-	-	1900	600	Langmuir Probe	Specrobes	ARM10.5
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* These entries are taken from a published

STRUCTURE DATA Through Early 1960

Project ARIES — Contract Nonr 3071(00)

Number	Place Fired	Date	Time	Zone	Reference Data	Notes	Altitude Range, Km
110 Km.							300
15	WSPG	21 Nov '46	09.55	MST	Spencer 54	(p) preliminary see reference	
20	WSPG	20 Feb '47	11.16	MST	Spencer 54	(nf) not round	
21	WSPG	7 Mar '47	11.23	MST	Best 47		
28	WSPG	8 Dec '47	14.42	MST	Spencer 54		
7	WSPG	7 Aug '51	11.00	MST	Horowitz 57		250
WN3.17	Churchill	29 Jul '57	15.59	CST	Horowitz 58		
"	"	"	"	"	LaGov 58		
_____	_____	_____	_____	_____	_____		
_____	_____	_____	_____	_____	_____		
_____	_____	_____	_____	_____	_____		200
120 Km.							
20	WSPG	20 Feb '47	11.16	MST	Spencer 54		
21	WSPG	7 Mar '47	11.23	MST	LaGov 54		
34	WSPG	22 Jan '48	13.13	MST	Havens 52 & LaGov 54		150
7	WSPG	7 Aug '51	11.00	MST	Horowitz 57		
WN3.17	Churchill	20 Nov '56	23.21	CST	Meadows 60		
WN3.17	Churchill	29 Jul '57	15.59	CST	Horowitz 58		
"	"	"	"	"	LaGov 58		100
WN3.19	Churchill	23 Mar '58	12.07	CST	Meadows 60		
ABM10.200	Churchill	30 Nov '58	12.36	CST	Bogges 59		
ABM10.200	Churchill	30 Nov '58	12.36	CST	Bogges 59		
_____	_____	_____	_____	_____	_____		

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published curve. Interpolation for tabular presentation may have introduced an error of $\pm 5\%$.

Science Communication
Washington, D. C.

UPPER ATMOSPHERE STRUCTURE
Measurements Reported Through

Altitude	Pressure		Density		Temperature		Instrumentation	Vehicle	Number
Km.	mm.Hg.	e. %	g/m ³	e. %	°K	e. °K			
ALTITUDE RANGE 120-130 Km.									
120	3.5x10 ⁻⁵	10	-	-	-	-	Phillips gage*	V-2	21
120	-	-	-	-	335	40	"	"	"
120	8.0x10 ⁻⁶	30	1.2x10 ⁻⁵	50	270	(mf)	Ionisation gage*	Viking	7
120	-	-	2.9x10 ⁻⁵	25	-	-	Mass Spectrometer	Aerobee-H1	NN3.17
120	-	-	-	-	370	(mf)	Phillips gage*	Aerobee-H1	NN3.15
120	2.1x10 ⁻⁵	20	2.6x10 ⁻⁵	30	-	-	"	"	"
120	-	-	4.0x10 ⁻⁵	25	-	-	Mass Spectrometer	Aerobee-H1	NN3.18
120	-	-	1.0x10 ⁻⁵	25	-	-	Mass Spectrometer	Aerobee-H1	NN3.19
120	-	-	6.5x10 ⁻⁵	(mf)	-	-	Satellite Orbits	(2) 1957α, 1957β	
125	-	--	1.0x10 ⁻⁵	(mf)	-	-	Phillips gage*	V-2	34

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ALTITUDE RANGE 130-140 Km.

130	3.5×10^{-6}	30	3.5×10^{-6}	50	428	(mf)	Ionization gage*	Viking	7
130	-	-	6.0×10^{-6}	25	-	-	Mass Spectrometer	Aerobee-H1	NN3.17
130	-	-	-	-	950	(mf)	Phillips gage*	Aerobee-H1	NN3.15
130	1.3×10^{-5}	20	6.4×10^{-6}	30	-	-	"	"	"
130	-	-	1.2×10^{-5}	25	-	-	Mass Spectrometer	Aerobee-H1	NN3.18
130	-	-	3.0×10^{-6}	25	-	-	Mass Spectrometer	Aerobee-H1	NN3.19
130	-	-	3.01×10^{-5}	(mf)	-	-	Satellite Orbits	(2) 1957 α , 1957 β	
138	-	-	-	-	1800	600	Langmuir Probe	Spaerobee	ABM10.20

* These entries are taken from a published

ATMOSPHERE STRUCTURE DATA Reported Through Early 1960

Project ARIES — Contract Nonr 3071(00)

Vehicle	Number	Place Fired	Date	Time	Zono	Reference Data	Notes	Altitude Range, Km
RANGE 120-130 Km.								300
V-2	21	WSPG	7 Mar '47	11.23	MST	LaGow 54		
"	"	"	"	"	"	Best 47		
Viking	7	WSPG	7 Aug '51	11.00	MST	Horowitz 57	(nf) - not found	
Aerobee-H1	NN3.17	Churchill	20 Nov '56	23.21	CST	Meadows 60		
Aerobee-H1	NN3.17F	Churchill	29 Jul '57	15.59	CST	Horowitz 58		250
"	"	"	"	"	"	LaGow 58		
Aerobee-H1	NN3.18F	Churchill	21 Feb '58	20.02	CST	Meadows 60		
Aerobee-H1	NN3.19F	Churchill	23 Mar '58	12.07	CST	Meadows 60		
(2) 1957α, 1957β		-	-	-	-	Mikhnevich	Entries marked with (2) are based on drag data for satellites and carrier rockets.	
V-2	34	WSPG	22 Jan '48	13.13	MST	Havens 52		200
RANGE 130-140 Km.								150
Viking	7	WSPG	7 Aug '51	11.00	MST	Horowitz 57		
Aerobee-H1	NN3.17	Churchill	20 Nov '56	23.21	CST	Meadows 60		
Aerobee-H1	NN3.17F	Churchill	29 Jul '57	15.59	CST	Horowitz 58		
"	"	"	"	"	"	LaGow 58		
Aerobee-H1	NN3.18F	Churchill	21 Feb '58	20.02	CST	Meadows 60		100
Aerobee-H1	NN3.19F	Churchill	23 Mar '58	12.07	CST	Meadows 60		
(2) 1957α, 1957β		-	-	-	-	Mikhnevich		
Spaerobee	ABM10.200	Churchill	30 Nov '58	12.36	CST	Bogges 59		

are taken from a published curve. Interpolation for tabular presentation may have introduced an error of $\pm 5\%$.

Altitude Km.	Pressure		Density		Temperature		Instrumentation	Vehicle	Number
	mm.Hg.	o. %	g/m ³	o. %	°K	o. °K			

ALTITUDE RANGE 140-150 Km.

140	-	-	2.0×10^{-6}	(nf)	-	-	Phillips gage*	V-2	34
140	2.1×10^{-6}	30	1.2×10^{-6}	30	700	(nf)	Ionization gage*	Viking	7
140	-	-	1.2×10^{-6}	25	-	-	Mass Spectrometer	Aerobee-H1	NN3.17
140	-	-	-	-	1530	(nf)	Phillips gage*	Aerobee-H1	NN3.15
140	9.9×10^{-6}	20	3.0×10^{-6}	30	-	-	"	"	"
140	-	-	5.0×10^{-6}	25	-	-	Mass Spectrometer	Aerobee-H1	NN3.18
140	-	-	1.1×10^{-6}	25	-	-	Mass Spectrometer	Aerobee-H1	NN3.19
140	-	-	-	-	1800	350	Langmuir Probe	Spacrobe	ABM10.
140	-	-	1.49×10^{-5}	(nf)	-	-	Satellite Orbits	(2) 1957 α , 1957 β	



ALTITUDE RANGE 150-160 Km.

150	-	-	2.0×10^{-6}	(nf)	-	-	Phillips gage*	V-2	34
150	1.5×10^{-6}	30	6.6×10^{-7}	30	880	(nf)	Ionization gage*	Viking	7
150	-	-	5.0×10^{-7}	25	-	-	Mass Spectrometer	Aerobee-H1	NN3.17
150	-	-	-	-	2030	(nf)	Phillips gage*	Aerobee-H1	NN3.15
150	8.2×10^{-6}	20	1.9×10^{-6}	30	-	-	"	"	"
150	-	-	5.5×10^{-7}	25	-	-	Mass Spectrometer	Aerobee-H1	NN3.18
150	-	-	2.0×10^{-6}	25	-	-	Mass Spectrometer	Aerobee-H1	NN3.19
150	-	-	8.07×10^{-6}	(nf)	-	-	Satellite Orbits	(2) 1957 α , 1957 β	
156	-	-	2.0×10^{-6}	30	-	-	Phillips Gage*	V-2	21

* These entries are taken from a published

OSPHERE STRUCTURE DATA **as Reported Through Early 1960**

Project ARIES — Contract Nonr 3071(00)

Vehicle	Number	Place Fired	Date	Time	Zone	Reference Data	Notes	Altitude Range, Km
ALTITUDE RANGE 140-150 Km.								300
V-2	34	WSFO	22 Jan '48	13.13	MST	Havens 52 LaGow 54	(nf) - not found	
Viking	7	WSFO	7 Aug '51	11.00	MST	Horowitz 57		
Aerobee-H1	NN3.17	Churchill	20 Nov '56	23.21	CST	Meadows 60		
Aerobee-H1	NN3.15F	Churchill	29 Jul '57	15.59	CST	Horowitz 58		
"	"	"	"	"	"	LaGow 58		200
Aerobee-H1	NN3.18F	Churchill	21 Feb '58	20.02	CST	Meadows 60		
Aerobee-H1	NN3.19F	Churchill	23 Mar '58	12.07	CST	Meadows 60		
Spaerobee	ABM10.200	Churchill	30 Nov '58	12.36	CST	Bogges 59		
(2) 1957 α , 1957 β	-	-	-	-	-	Mikhnevich	Entries marked with (2) are based on drag data for satellite and carrier rockets.	200
_____	_____	_____	_____	_____	_____	_____		
_____	_____	_____	_____	_____	_____	_____		

ALTITUDE RANGE 150-160 Km.

V-2	34	WSFO	22 Jan '48	13.13	MST	Havens 52 and LaGow 54		150
Viking	7	WSFO	7 Aug '51	11.00	MST	Horowitz 57		
Aerobee-H1	NN3.17	Churchill	20 Nov '56	23.21	CST	Meadows 60		
Aerobee-H1	NN3.15F	Churchill	29 Jul '57	15.59	CST	Horowitz 58		
"	"	"	"	"	"	LaGow 58		
Aerobee-H1	NN3.18F	Churchill	21 Feb '58	20.02	CST	Meadows 60		
Aerobee-H1	NN3.19F	Churchill	23 Mar '58	12.07	CST	Meadows 60		100
(2) 1957 α , 1957 β	-	-	-	-	-	Mikhnevich		
V-2	21	WSFO	7 Mar '47	11.23	MST	LaGow 54		
_____	_____	_____	_____	_____	_____	_____		
_____	_____	_____	_____	_____	_____	_____		

are taken from a published curve. Interpolation for tabular presentation may have introduced an error of $\pm 5\%$.

2

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UPPER ATMOSPHERE STRUCTURE
Measurements Reported Through

Altitude Km.	Pressure		Density		Temperature		Instrumentation	Vehicle	Number
	mm.Hg.	e. %	g/m ³	e. %	°K	e. °K			
ALTITUDE RANGE 160-170 Km.									
160	-	-	1.5x10 ⁻⁶	(nf)	-	-	Phillips gage*	V-2	34
160	1.1x10 ⁻⁶	30	4.3x10 ⁻⁷	50	980	(nf)	Ionisation gage*	Viking	7
160	-	-	1.5x10 ⁻⁷	25	-	-	Mass Spectrometer	Aerobee-H1	NN3.17
160	-	-	-	-	2470	(nf)	Phillips gage*	Aerobee-H1	NN3.17
160	7.1x10 ⁻⁶	20	1.4x10 ⁻⁶	30	-	-	"	"	"
160	-	-	8.0x10 ⁻⁷	25	-	-	Mass Spectrometer	Aerobee-H1	NN3.17
160	-	-	3.0x10 ⁻⁷	25	-	-	Mass Spectrometer	Aerobee-H1	NN3.17
160	-	-	-	-	1900	500	Langmuir Probe	Spaerobee	ABM10.7
160	-	-	4.7x10 ⁻⁶	(nf)	-	-	Satellite Orbits	(2) 1957 α , 1957 β	
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ALTITUDE RANGE 170-180 Km.

170	8.6×10^{-7}	30	3.0×10^{-7}	50	1070	(nf)	Ionization gage*	Viking	7
170	-	-	8.0×10^{-8}	25	-	-	Mass Spectrometer	Aerobee-H1	NN3.17
170	-	-	-	-	2750	(nf)	Phillips gage*	Aerobee-H1	NN3.17
170	6.3×10^{-6}	20	1.1×10^{-6}	30	-	-	"	"	"
170	-	-	4.0×10^{-7}	25	-	-	Mass Spectrometer	Aerobee-H1	NN3.17
170	-	-	1.9×10^{-7}	25	-	-	Mass Spectrometer	Aerobee-H1	NN3.17
170	-	-	2.89×10^{-6}	(nf)	-	-	Satellite Orbits	(2) 1957 α , 1957 β	
178	-	-	-	-	1400	400	Langmuir Probe	Spaerobee	ABM10.2
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* These entries are taken from a published



OSPHERE STRUCTURE DATA

Reported Through Early 1960

Project ARIES — Contract Nonr 3071(00)

Vehicle	Number	Place Fired	Date	Time	Zone	Reference Data	Notes	Altitude Range, Km
ALTITUDE RANGE 160-170 Km.								300
V-2	34	WFO	22 Jan '48	13.13	MST	Ravens 52 LaGov 54	(12) - not found	
Viking	7	WFO	7 Aug '51	11.00	MST	Horowitz 57		
Aerobee-H1	NN3.17	Churchill	20 Nov '56	23.21	CST	Meadows 60		
Aerobee-H1	NN3.13W	Churchill	29 Jul '57	15.59	CST	Horowitz 58		
"	"	"	"	"	"	LaGov 58		200
Aerobee-H1	NN3.18W	Churchill	21 Feb '58	20.02	CST	Meadows 60		
Aerobee-H1	NN3.19W	Churchill	23 Mar '58	12.07	CST	Meadows 60		
Spaerobee	ABM10.200	Churchill	30 Nov '58	12.36	CST	Boggers 59		
(2) 1957α, 1957β	-	-	-	-	-	Mikhnevich	Entries marked with (2) are based on drag data for satellites and carrier rockets.	200
_____	_____	_____	_____	_____	_____	_____		
_____	_____	_____	_____	_____	_____	_____		

ALTITUDE RANGE 170-180 Km.

Viking	7	WFO	7 Aug '51	11.00	MST	Horowitz 57		
Aerobee-H1	NN3.17	Churchill	20 Nov '56	23.21	CST	Meadows 60		
Aerobee-H1	NN3.13W	Churchill	29 Jul '57	15.59	CST	Horowitz 58		
"	"	"	"	"	"	LaGov 58		
Aerobee-H1	NN3.18W	Churchill	21 Feb '58	20.02	CST	Meadows 60		
Aerobee-H1	NN3.19W	Churchill	23 Mar '58	12.07	CST	Meadows 60		
(2) 1957α, 1957β	-	-	-	-	-	Mikhnevich		
Spaerobee	ABM10.200	Churchill	30 Nov '58	12.36	CST	Boggers 59		
_____	_____	_____	_____	_____	_____	_____		
_____	_____	_____	_____	_____	_____	_____		

are taken from a published curve. Interpolation for tabular presentation may have introduced an error of $\pm 5\%$.

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Altitude Km.	Pressure mm.Hg.	e. %	Density g/m ³	e. %	Temperature °K e. °K		Instrumentation	Vehicle	Number
ALTITUDE RANGE 180-190 Km.									
180	6.9x10 ⁻⁷	30	2.3x10 ⁻⁷	30	1070	(mf)	Ionization gage*	Viking	7
180	-	-	5.5x10 ⁻⁸	25	-	"	Mass Spectrometer	Aerobee-E1	HN3.17
180	-	-	-	-	2940	(mf)	Phillips gage*	Aerobee-E1	HN3.15
180	5.7x10 ⁻⁶	20	8.9x10 ⁻⁷	30	-	-	"	"	"
180	-	-	2.5x10 ⁻⁷	25	-	-	Mass Spectrometer	Aerobee-E1	HN3.18
180	-	-	1.5x10 ⁻⁷	25	-	-	Mass Spectrometer	Aerobee-E1	HN3.19
180	-	-	1.87x10 ⁻⁶	(mf)	-	-	Satellite Orbits	(2) 1957α, 1957β	
186	-	-	6.7x10 ⁻⁷	(mf)	-	-	Satellite drag	1958α	-
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ALTITUDE RANGE 190-200 Km.

190	5.5×10^{-7}	30	1.8×10^{-7}	30	1070	(mf)	Ionisation gage*	Viking	7
190	-	-	4.0×10^{-8}	25	-	-	Mass Spectrometer	Aerobee-E1	HN3.17
190	-	-	-	-	2970	(mf)	Phillips gage*	Aerobee-E1	HN3.15
190	5.1×10^{-6}	20	7.9×10^{-7}	30	-	-	"	"	"
190	-	-	2.0×10^{-7}	25	-	-	Mass Spectrometer	Aerobee-E1	HN3.18
190	-	-	1.85×10^{-6}	(mf)	-	-	Satellite Orbits	(2) 1957 α , 1957 β	
197	-	-	7.0×10^{-7}	(mf)	-	-	Satellite drag	1957 β	-
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* These entries are taken from a published

SPHERE STRUCTURE DATA

Reported Through Early 1960

Project ARIES — Contract Nonr 3071(00)

Vehicle	Number	Place Fired	Date	Time	Zone	Reference Data	Notes	Altitude Range, Km
RANGE 180-190 Km.								
Viking	7	WSPC	7 Aug '51	11.00	MST	Korovits 57	(nf) - not found	
Aerobee-H1	NN3.17	Churchill	20 Nov '56	23.21	CST	Meadows 60		
Aerobee-H1	NN3.13F	Churchill	29 Jul '57	15.59	CST	Korovits 58		
"	"	"	"	"	"	LaGow 58		
Aerobee-H1	NN3.18F	Churchill	21 Feb '58	20.02	CST	Meadows 60		
Aerobee-H1	NN3.19F	Churchill	23 Mar '58	12.07	CST	Meadows 60		
(2) 1957α, 1957β	-	-	-	-	-	Mikhnevich	Entries marked with (2) are based on drag data for satellites and carrier rockets.	
1958α	-	-	-	-	-	Schilling 59		
_____	_____	_____	_____	_____	_____	_____		
_____	_____	_____	_____	_____	_____	_____		
RANGE 190-200 Km.								
Viking	7	WSPC	7 Aug '51	11.00	MST	Korovits 57		
Aerobee-H1	NN3.17	Churchill	20 Nov '56	23.21	CST	Meadows 60		
Aerobee-H1	NN3.13F	Churchill	29 Jul '57	15.59	CST	Korovits 58		
"	"	"	"	"	"	LaGow 58		
Aerobee-H1	NN3.18F	Churchill	21 Feb '58	20.02	CST	Meadows 60		
(2) 1957α, 1957β	-	-	-	-	-	Mikhnevich		
1957δ	-	-	-	-	-	Schilling 59		
_____	_____	_____	_____	_____	_____	_____		
_____	_____	_____	_____	_____	_____	_____		

2

taken from a published curve. Interpolation for tabular presentation may have introduced an error of $\pm 5\%$.

Altitude	Pressure		Density		Temperature		Instrumentation	Vehicle	Number
km.	mm. Hg.	μ.	g/m ³	μ.	°K	°K			

ALTITUDE RANGE 200-210 km.

200	4.2×10^{-7}	30	1.4×10^{-7}	30	1070	(mf)	Ionization gage*	Viking	7
200	-	-	2.5×10^{-8}	25	-	-	Mass Spectrometer	Aerobee-hi	NH3.1
200	-	-	-	-	3010	(mf)	Phillips gage*	Aerobee-hi	NH3.1
200	4.6×10^{-6}	20	7.0×10^{-7}	30	-	-	"	"	"
200	-	-	1.5×10^{-7}	25	-	-	Mass Spectrometer	Aerobee-hi	NH3.1
200	-	-	$5-8.6 \times 10^{-7}$	(mf)	-	-	Satellite Orbits	(2) 1957α, 1957β	
201	-	-	6.7×10^{-7}	(mf)	-	-	Satellite Orbits	1957β	-
---	---	---	---	---	---	---	---	---	---
---	---	---	---	---	---	---	---	---	---

ALTITUDE RANGE 210-220 km.

210	3.3×10^{-7}	30	1.1×10^{-7}	30	1070	(mf)	Ionization	Viking	7
210	-	-	3.2×10^{-8}	25	-	-	Mass Spectrometer	Aerobee-hi	NH3.17
210	-	-	-	-	3030	(mf)	Phillips gage*	Aerobee-hi	NH3.15
210	4.1×10^{-6}	20	6.2×10^{-7}	30	-	-	"	"	"
210	-	-	1.5×10^{-7}	25	-	-	Mass Spectrometer	Aerobee-hi	NH3.18
210	-	-	6.0×10^{-7}	(mf)	-	-	Satellite Orbits	(2) 1957α, 1957β	
211	-	-	4.6×10^{-7}	(mf)	-	-	Satellite drag	1957β	-
211	-	-	4.6×10^{-7}	(mf)	-	-	Satellite Orbits	1957α 2	-
212	-	-	4.8×10^{-7}	(mf)	-	-	Satellite drag	1957β 1	-
215	-	-	1.0×10^{-7}	(mf)	-	-	Mass Spectrometer	Aerobee-hi	NH3.18
---	---	---	---	---	---	---	---	---	---
---	---	---	---	---	---	---	---	---	---

* These entries are taken from a published



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icle	Number	Place Fired	Date	Time	Zone	Reference Data	Notes	Altitude Range, Km
ARMS 200-210 Km.								200
log	7	WFO	7 Aug '51	11.00	MST	Norovits 57	(nf) - not found	
bee-hi	HN3.17	Churchill	20 Nov '56	23.21	CST	Meadows 60		
bee-hi	HN3.17F	Churchill	29 Jul '57	15.59	CST	Norovits 58		
	"	"	"	"	"	LaGow 58		
bee-hi	HN3.18F	Churchill	21 Feb '58	20.02	CST	Meadows 60		200
1957 α , 1957 β	-	-	-	-	-	Mikhnevich	Entries marked with (2) are based on drag data for satellite and carrier rockets.	
β	-	-	-	-	-	Schilling 59		
ARMS 210-220 Km.								200
log	7	WFO	7 Aug '51	11.00	MST	Norovits 57		
bee-hi	HN3.17	Churchill	20 Nov '56	23.21	CST	Meadows 60		
bee-hi	HN3.17F	Churchill	29 Jul '57	15.59	CST	Norovits 58		
	"	"	"	"	"	LaGow 58		180
bee-hi	HN3.18F	Churchill	21 Feb '58	20.02	CST	Meadows 60		
1957 α , 1957 β	-	-	-	-	-	Mikhnevich	2	
β	-	-	-	-	-	Schilling 59		
α 2	-	-	-	-	-	Schilling 59		
β 1	-	-	-	-	-	Schilling 59		180
bee-hi	HN3.18F	Churchill	21 Feb '58	20.02	CST	Meadows 60		

n from a published curve. Interpolation for tabular presentation may have introduced an error of $\pm 5\%$.

Altitude		Pressure		Density		Temperature		Instrumentation	Vehicle	Number
Km.		mm.Hg.	e. %	g/m ³	e. %	°K	e. °K			

ALTITUDE RANGE 220-230 Km.

220	2.7×10^{-8}	30		9.0×10^{-8}	50	1070	(nf)	Ionization gage*	Viking	
220	-	-		$5.5-5.7 \times 10^{-6}$	(nf)	-	-	Satellite Orbits	(2) 1957 α , 1957 β	
220	-	-		4.0×10^{-7}	(nf)	-	-	Satellite Orbits	1957 α 2	-
220	-	-		5.7×10^{-7}	(nf)	-	-	Satellite Orbits	1957 α 1	-
220	-	-		4.5×10^{-7}	(nf)	-	-	Satellite Orbits	1957 α 2	-

* These entries are taken from a published source.

ALTITUDE RANGE 230-240 Km.

230	-	-		5.32×10^{-7}	(nf)	-	-	Satellite Orbits	(2) 1957 α , 1957 β	
230	5.54×10^{-7}	(nf)		1.79×10^{-7}	(nf)	938	(nf)	Discharge Manometer	1957 β 6	-
232	-	-		1.5×10^{-7}	(nf)	-	-	Satellite Orbits	1957 α 2	-
233	-	-		2.2×10^{-7}	(nf)	-	-	Satellite Orbits	(2) 1957 β	-
233	-	-		2.2×10^{-7}	(nf)	-	-	Satellite drag	1957 β 1	-



ALTITUDE RANGE 240-250 Km.

240	-	-		2.51×10^{-7}	(nf)	-	-	Satellite Orbits	(2) 1957 α , 1957 β	
240	1.42×10^{-7}	(nf)		-	-	946	(nf)	Discharge Manometer	1957 β 6	-
241	-	-		2.5×10^{-7}	(nf)	-	-	Satellite Orbits	1957 α 2	-

ERE STRUCTURE DATA orted Through Early 1960

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	Number	Place Fired	Date	Time	Zone	Reference Data	Notes	Altitude Range, Km.
DE 220-230 Km.								300
B	7	WSPG	7 Aug '51	11.00	MST	Horowitz 57	(mf) - not found	
1957 α , 1957 β	-	-	-	-	-	Mikhnevich	Entries marked with (2) are based on drag data for satellite and carrier rockets.	
2	-	-	-	-	-	Schilling 59		
1	-	-	-	-	-	Sterne 58		
2	-	-	-	-	-	Sterne 58		250
from a published curve. Interpolation for tabular presentation may have introduced an error of $\pm 5\%$.								
DE 230-240 Km.								200
1957 α , 1957 β	-	-	-	-	-	Mikhnevich		
5	-	-	-	-	-	Mikhnevich		
2	-	-	-	-	-	Schilling 59		
1957 β	-	-	-	-	-	Sterne 58		
1	-	-	-	-	-	Schilling 59		150
DE 240-250 Km.								100
1957 α , 1957 β	-	-	-	-	-	Mikhnevich		
	-	-	-	-	-	Mikhnevich		
2	-	-	-	-	-	Schilling 59		
								50
								20

2

-22-

2

UPPER ATMOSPHERE STRUC

Measurements Reported Throu

ALTITUDE RANGE 250-260 Km.

ALTITUDE RANGE 260-270 Km.

ALTITUDE RANGE 270-280 Km.

1

ALTIMETER RANGE 280-290 Km.				
280	-	-	9.51×10^{-8} (mf)	- - Satellite-Orbits (2) 1957 α , 1957 β
280	1.95×10^{-7} (mf)	5.44×10^{-8} (mf)	1005 (mf)	Discharge Manometer 1957 6 -
---	---	---	---	---
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STRUCTURE DATA

Through Early 1960

Project ARIES — Contract Nonr 3071(00)

Number	Place Fired	Date	Time	Zone	Reference Data	Notes	Altitude Range, Km
-260 Km.							300
1957 β	-	-	-	-	Mikhnevich	(nf) - not found Entries marked with (2) are based on drag data for satellites and carrier rockets.	
-	-	-	-	-	Mikhnevich		
_____	_____	_____	_____	_____	_____		
_____	_____	_____	_____	_____	_____		
-270 Km.							280
1957 β	-	-	-	-	Mikhnevich		
-	-	-	-	-	Mikhnevich		
_____	_____	_____	_____	_____	_____		
_____	_____	_____	_____	_____	_____		
-280 Km.							260
1957 β	-	-	-	-	Mikhnevich		
-	-	-	-	-	Mikhnevich		
-	-	-	-	-	Schilling		
_____	_____	_____	_____	_____	_____		
_____	_____	_____	_____	_____	_____		
-290 Km.							240
1957 β	-	-	-	-	Mikhnevich		
-	-	-	-	-	Mikhnevich		
_____	_____	_____	_____	_____	_____		
_____	_____	_____	_____	_____	_____		

2

-23-

2

Altitude	Pressure		Density		Temperature		Instrumentation	Vehicle	Number
Km.	mm.Hg.	e. %	g/m ³	e. %	°K	e. °K			
ALTITUDE RANGE 290-300 Km.									
290	-	-	7.68×10^{-8} (nf)	-	-	-	Satellite Orbits	(2) 1957 α , 1957 β	-
290	1.62×10^{-7} (nf)	-	4.36×10^{-8} (nf)	-	1026	(nf)	Discharge Manometer	1957 β	-
---	---	---	---	---	---	---	---	---	---
---	---	---	---	---	---	---	---	---	---
ALTITUDE RANGE 300-310 Km.									
300	-	-	$5-6.27 \times 10^{-8}$ (nf)	-	-	-	Satellite Orbits	(2) 1957 α , 1957 β	-
300	1.37×10^{-7} (nf)	-	3.53×10^{-8} (nf)	-	1048	(nf)	Discharge Manometer	1957 β	-
---	---	---	---	---	---	---	---	---	---
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ATMOSPHERE STRUCTURE DATA **as Reported Through Early 1960**

Project ARIES — Contract Nonr 3071(00)

Vehicle	Number	Place Fired	Date	Time	Zone	Reference Data	Notes	Altitude Range, Km
ALTITUDE RANGE 290-300 Km.								300
(2) 1957 α , 1957 β	-	-	-	-	-	Mikhnevich	(nf) - not found	
er 1957 δ	-	-	-	-	-	Mikhnevich	Entries marked with (2) are based on drag data for satellites and carrier rockets.	
_____	_____	_____	_____	_____	_____	_____		
_____	_____	_____	_____	_____	_____	_____		
ALTITUDE RANGE 300-310 Km.								280
(2) 1957 α , 1957 β	-	-	-	-	-	Mikhnevich		
er 1957 δ	-	-	-	-	-	Mikhnevich		
_____	_____	_____	_____	_____	_____	_____		200
_____	_____	_____	_____	_____	_____	_____		
								180
								160
								140
								120
								100
								80
								60
								40
								20

2

Altitude	Composition/Component			Instrumentation	Vehicle	Number
Km.	Ratio, relative to N					
	He	Ne	A			
57.4	0.998	1.005	1.001	Sampling	Aerobee	SC-21
59.7	1.035	1.008	0.996	"	"	"
62.3	1.133	1.040	0.962	"	V-2	59
65.6	1.44	1.08	0.93	"	Aerobee	SC-17
68.3	2.02	1.18	0.89	"	"	"
69.8	1.570	1.232	0.90	"	V-2	59
70.6	2.41	1.20	0.85	"	Aerobee	SC-17
82.5	3.14	1.34	-	"	"	SC-34
83.4	2.943	1.395	0.82	"	V-2	59
Separation Ratios						
120	0.98			Radio frequency Mass Spectrometer	Aerobee-hi	NN3.19F
120	0.42			"	"	NN3.17
130	0.60			"	"	NN3.19F
130	0.45			"	"	NN3.18F
130	0.30			"	"	NN3.17
140	0.40			"	"	NN3.19F
140	0.30			"	"	NN3.18F
140	0.20			"	"	NN3.17
150	0.30			"	"	NN3.19F
150	0.20			"	"	NN3.18F
150	0.20			"	"	NN3.17
160	0.30			"	"	NN3.19F



PER ATMOSPHERE COMPOSITION DATA

Measurements Reported Through Early 1960

Project ARIES — Contract Nonr 3071(00)

Vehicle	Number	Place Fired	Date	Time	Zone	Reference Data	Remarks
Aerobee	80-21	WSPG	26 Sep '51	-	-	Jones 54	
"	"	"	"	-	-	"	
V-2	59	"	20 May '52	-	-	"	
Aerobee	80-17	"	19 Dec '50	-	-	"	Recovered sample bottles were analyzed in laboratory for amount of Helium, Neon, and Argon relative to Nitrogen. These results were compared with the relative concentration of the gases at sea level.
"	"	"	"	-	-	"	
V-2	59	"	20 May '52	-	-	"	
Aerobee	80-17	"	19 Dec '50	-	-	"	
"	80-34	"	9 Aug '56	08.53	MST	Wenzel 58	
V-2	59	"	20 May '52	-	-	Jones 54	
Aerobee-hi	NN3.19F	Churchill	23 Mar '58	12.07	GMT	Meadows 60	
"	NN3.17	"	20 Nov '56	23.21	"	"	
"	NN3.19F	"	23 Mar '58	12.07	"	"	
"	NN3.18F	"	21 Feb '58	20.02	"	"	Separation Ratio based on: <u>Argon/molecular Nitrogen at altitude</u> <u>Argon/molecular Nitrogen at sea level</u>
"	NN3.17	"	20 Nov '56	23.21	"	"	
"	NN3.19F	"	23 Mar '58	12.07	"	"	
"	NN3.18F	"	21 Feb '58	20.02	"	"	
"	NN3.17	"	20 Nov '56	23.21	"	"	
"	NN3.19F	"	23 Mar '58	12.07	"	"	
"	NN3.18F	"	21 Feb '58	20.02	"	"	
"	NN3.17	"	20 Nov '56	23.21	"	"	
"	NN3.19F	"	23 Mar '58	12.07	"	"	

2

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Washington, D. C.

UPPER ATMOSPHERE
Measurements Report

Altitude

Km.

Composition/Component

Instrumentation

Vehicle

Number

Mean Molecular Weight
NN3.17 NN3.18 NN3.19

135	28.2	28.2	28.6	Mass Spectrometer	Aerobee-hi	NN3.17
140	27.9	28.1	28.6	Mass Spectrometer	Aerobee-hi	NN3.18
150	27.8	-	28.2	Mass Spectrometer	Aerobee-hi	NN3.19
160	27.8	-	-			
170	27.8	27.5	27.5			
180	-	27.5	27.5			
190	-	27.5	27.2			
200	-	26.7	-			
210	-	26.8	-			
220	-	25.8	-			

1

PER ATMOSPHERE COMPOSITION DATA
Measurements Reported Through Early 1960

Project ARIES — Contract Nonr 3071(00)

Vehicle	Number	Place Fired	Date	Time	Zone	Reference Data	Remarks
Aerobee-hi	NN3.17	Churchill	20 Nov '56	23.21	CST	Meadows 60	Data from curve.
Aerobee-hi	NN3.18	Churchill	21 Feb '58	20.02	CST	Meadows 60	See reference, figure 7.
Aerobee-hi	NN3.19	Churchill	23 Mar '58	12.07	CST	Meadows 60	

2

Altitude

Km.

Composition/Component

Instrumentation

Vehicle

Number

Ozone, Molecules/cc

30	5.0×10^{12}	U. V. Spectrograph	-	-
40	5.0×10^{11}	"	-	-
50	8.0×10^{10}	"	-	-
60	9.0×10^9	"	-	-
70	9.0×10^8	"	-	-

% Dissociation of O_2

120	67	Photon Counters	Aerobee	A-35
130	65	"	"	"
160	70	"	"	"

Oxygen Molecules/cc

110	16.0×10^{10}	Photon Counter	Aerobee	A-16
114	12.0×10^{10}	"	"	A-34
116	9.0×10^{10}	"	"	"
118	2.3×10^{10}	"	"	"
120	1.8×10^{10}	"	"	"
120	3.0×10^{10}	"	"	A-16
130	1.0×10^{10}	"	"	"
150	4.0×10^9	"	"	A-35
160	1.4×10^9	"	"	"
170	8.0×10^8	"	"	"
180	4.0×10^8	"	"	"



PHASE COMPOSITION DATA
Reported Through Early 1960

Project ARIES — Contract Nonr 3071(00)

Number	Place Fired	Date	Time	Zone	Reference Data	Remarks
-	WFG	14 Jun '49	7.03	MBT	Johnson 54	
-	"	"	"	"	"	
-	"	"	"	"	"	
-	"	"	"	"	"	
-	"	"	"	"	"	
A-35	-	21 Oct '55	17.15	-	Byram 57	Discoriation based on density of molecular Oxygen measured by ultraviolet absorption relative to density of Air at altitude, measured by x-ray absorption.
"	-	"	"	-	"	
"	-	"	"	-	"	
A-16	-	1 Dec '53	08.29	-	Byram 57	
A-34	-	18 Oct '55	15.50	-	"	
"	-	"	"	-	"	
"	-	"	"	-	"	
"	-	"	"	-	"	
"	-	"	"	-	"	Based on 44-60 Å absorption of Molecular Oxygen at altitude.
A-16	-	1 Dec '53	08.29	-	"	
"	-	"	"	-	"	
A-35	-	21 Oct '55	17.15	-	"	
"	-	"	"	-	"	
"	-	"	"	-	"	
"	-	"	"	-	"	

2

Altitude	Composition/Component			Instrumentation	Vehicle	Number
Km.	Ion Detected Mass					
100	46 ⁺			Ion Spectrometer	Aerobee	NRL-24
110	"			"	"	"
120	"			"	"	"
130	"			"	"	"
	Ion Detected Mass					
100	28 ⁺			Ion Spectrometer	Aerobee	NRL-24
110	"			"	"	"
115	"			"	"	"
	Mass Peaks					
115	30 ⁺ ; 26 ⁺	32 ⁺	16 ⁺	Ion Spectrometer	Viking	10
150	"	"	"	"	"	"
220	"	"	"	"	"	"
	Ratio of Ion Peak Currents			N ⁺ /O ⁺ , Per Cent		
220-240	9-2 ^(b)			Mass Spectrometer	1958 α	-
250-270	4-2 ^(a)			"	"	-

ATMOSPHERE COMPOSITION DATA

ments Reported Through Early 1960

Project ARIES — Contract Nonr 3071(00)

to	Number	Place Fired	Date	Time	Zone	Reference Data	Remarks
see	HRL-24	WSPG	29 Nov '57	10.16	MST	Johnson 58	See paper for discussion of relative amplitudes of atomic mass units.
	"	"	"	"	"	"	
	"	"	"	"	"	"	
	"	"	"	"	"	"	
see	HRL-23	WSPG	8 Jul '55	01.39	MST	Johnson 58	" " "
	"	"	"	"	"	"	
	"	"	"	"	"	"	
10	10	WSPG	7 May '54	10.00	MST	Johnson 55	
	"	"	"	"	"	"	
	"	"	"	"	"	"	
DC	-	-	22 May '58	-	-	Istomin	From curve of changing relative intensity. Ratios are also affected by latitude.
	-	-	"	-	-	"	(a) North latitudes (b) South latitudes

2

Properties of the Upper Atmosphere

APPENDIX A

Metacological Instrumentation Employed for
Pressure, Temperature, Density, and Composition

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Contract Nonr 3071(00)

Final Report

1 August 1960

App. A-1

THE DOVAP SYSTEM FOR ROCKET ALTITUDE MEASUREMENT

The DOVAP (Doppler Velocity And Position) system is used to determine the altitude and trajectory of research rockets. The system is represented schematically in Figure 1.

The ground transmitter radiates a signal on a reference frequency. This signal is received by both the tracking receivers and the rocket vehicle. A transponder in the rocket vehicle retransmits the reference signal at double the reference frequency. This signal is compared to the original reference signal also received at each of the tracking stations. The Doppler shift of the rocket's signal will be a function of the velocity of the rocket, and the altitude and azimuth of the incoming signal from the rocket determine the position of the transponder and its rocket vehicle.

The DOVAP system operates with an accuracy of 1 foot in position and 1 foot-second in velocity.

Literature Citation:

Massey, H.S.W., and R.L.F. Boyd, The Upper Atmosphere, pp. 66-70, Philosophical Library, New York, N. Y. 1959.

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Washington, D. C.

Project ARIES - Contract Nomr 3071(00)

Final Report

1 August 1960

App. A-2

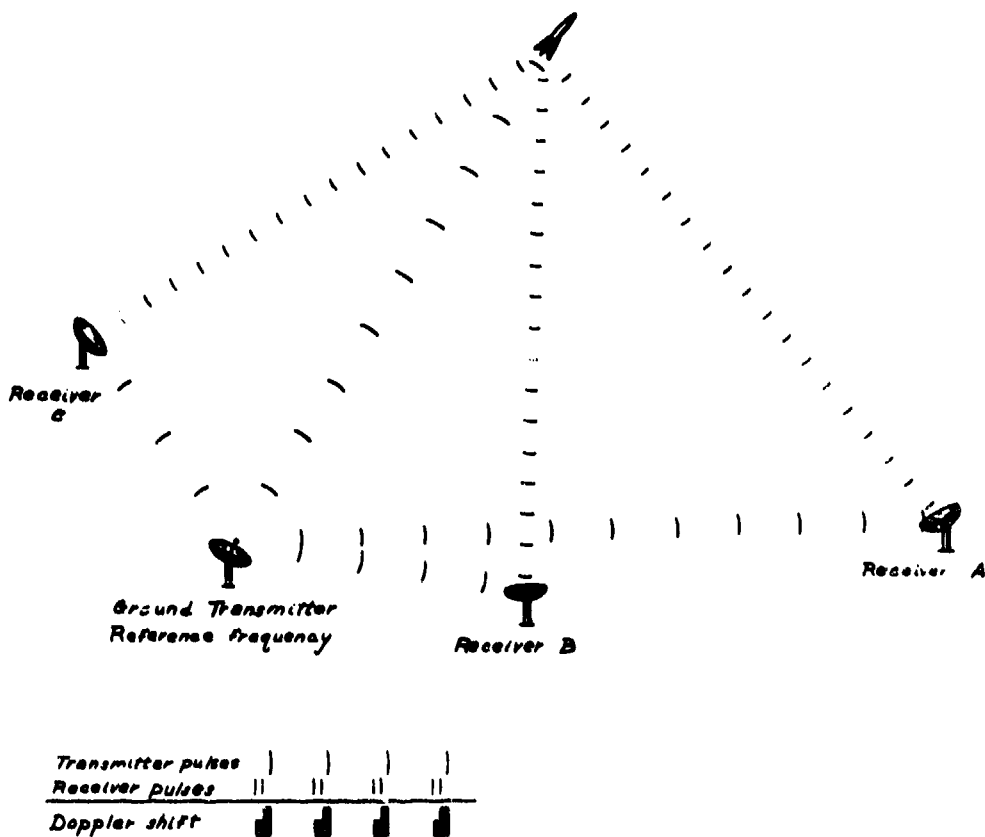


Figure 1

Contract Nonr 3071(00)
Final Report
1 August 1960

App. A-3

IONIZATION GAGES
(Alphatron)

Ionization gages measure the number of free ions produced by a flow of electrons in a diffuse gas. The relative number of free ions formed by a constant electron source is a function of the density and composition of the gas within the ionization gage.

The Alphatron is typical of the radioactive, cold-cathode type of ionization gage. A radioactive isotope within the gage provides a constant source of ionizing radiation. The instrument is essentially a modification of the electrostatic detectors used to count radioactive particles.

In the operating instrument (see Figure 2) a voltage is applied to both the wall and wire electrode of the gage. Gas atoms entering the gage are ionized by the radioactive isotope, and the ionized gas atoms are then attracted to the wall of the gage. The drift of these ionized particles lowers the voltage between the two charged elements of the gage. When this voltage drops to a pre-set point, the chamber is recharged to its original voltage. The frequency of recharge is proportional to the rate of ion formation.

The use of ionization gages of the Alphatron type is based on the following assumptions:

The devices are insensitive to acceleration changes.

They provide rapid discrete responses to density changes of a homogenous medium.

By suitably switching the voltage drops for recharging the instrument, it can be used to measure density directly to altitudes of about 200 kilometers.

Sources of error in the technique include:

The devices measure only the relative number of ions formed.

Ion formation is affected by the composition as well as the density of the gas being measured (see Figure 3).

Science Communication

Washington, D. C.

Contract Nonr 3071(00)

Final Report

1 August 1960

App. A-4

Ionization Gage (cont.)

External ion sources (e.g., the ions in the F and D layers of the upper atmosphere) will interfere with the ion counts obtained by the instrument.

Gas density is temperature dependent.

The instrument may not be at temperature equilibrium with the atmosphere.

Density measurements are probably correct to within an order of magnitude up to 250 kilometers.

Literature Citations:

LaGow, H., "Arctic Atmosphere Structure to 250 Km," IGY Rocket Report Series, No. 1., pp. 38-46, 30 July 1958.

Non-N 60921-5608, Wright Instruments, Inc., "A Survey of Pressure and Density Sensors and Associated Problems for the N. O. L. HASP Program," April 1959.

Spencer, N. W. and W. G. Dow, "Density Gauge Methods for Measuring Upper-Air Temperature, Pressure, and Winds," Rocket Exploration of the Upper Atmosphere, pp. 82-97, Pergamon Press Ltd., London, 1954.

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Project ARIES - Contract Nonr 3071(00)

Final Report

1 August 1960

App. A-5

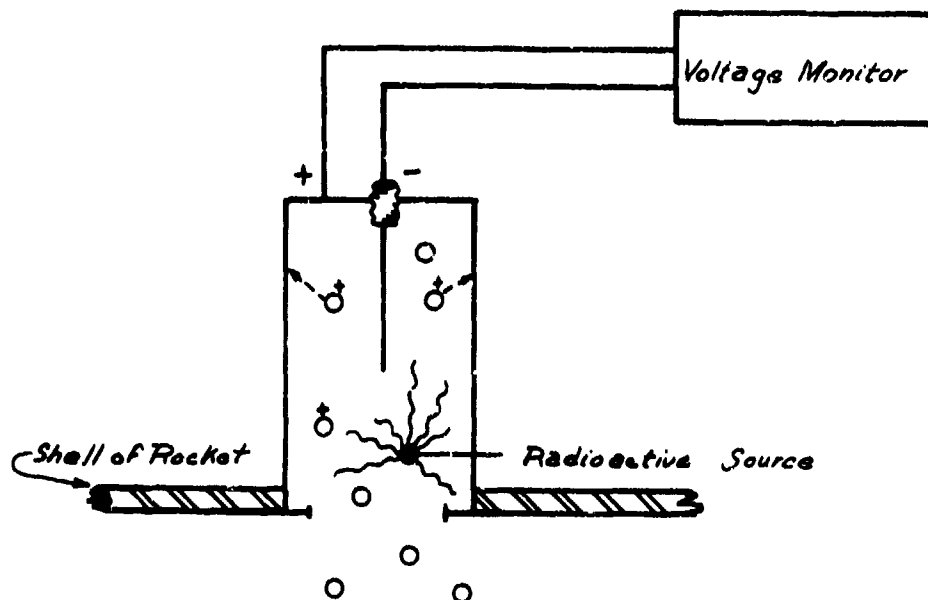


Figure 2



Figure 3

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Contract Nonr 3071(00)
Final Report
1 August 1960

App. A-6

THERMAL CONDUCTIVITY GAGES
(Pirani Gage, Havens Gage)

Pirani Gage

Thermal conductivity, or Pirani gages, measure pressure by monitoring the resistance change of a heated wire element. Changes in air pressure surrounding the wire element change the rate at which heat is lost by the element. Pirani gages are commercially available which measure pressure down to 10^{-3} mm/Hg.

Havens Gage

The Havens¹ gage, developed at the Naval Research Laboratory, is a modification of the thermal conductivity gage. It measures pressures down to 10^{-5} mm/Hg.

The gage works on the principle that an alternating current signal can be obtained from the normally direct-current Pirani gage by cyclically changing the pressure at a given frequency. At low ambient pressures, the compression of the bellows does not affect the temperature of the gas within the bellows significantly. The cyclical changes of the bellows will result in alternating voltage output from the resistance element, and the amplitude of the alternating voltage will be proportional to the change in ambient pressure. The eccentric shaft of the small motor, Figure 4, changes the volume of the bellows about 20 per cent at a frequency of about 20 cycles per second.

The use of two bellows assures that the eccentric shaft is working against the same pressure in each bellow, regardless of the outside pressure. The outside pressure is communicated to the pressure chambers by small holes which restrict the rate of gas flow so that the gas does not flow completely out of the chamber when the bellows are compressed. Since the pressure inside the bellows chamber is changed about 40 times per second, the average pressure within the bellows will be at equilibrium with the outside pressure. The peak-to-peak alternating voltage developed across the resistance elements within the bellows will vary directly with the outside pressure. At a pressure of 0.6 mm/Hg, a change of

Science Communication
Washington, D. C.

Contract Nonr 3071(00)
Final Report
1 August 1960

App. A-7

Thermal Conductivity Gages (cont.)

20 percent in the bellows pressure changes the voltage across the resistance by 0.27 volts. Figure 5 is a schematic of the calibration curve for a bellows gage in which the pressure is changing about 40 times per second.

Pressure measurements by thermal conductivity gages are subject to error due to the variation of atmospheric composition, with the resulting variations of specific heat of the gas surrounding the heated wire.

Literature Citations:

Havens, R., R. Koll, and H. LaGow, "A New Vacuum Gauge," Rev. Sci. Instr., 21, 596-598 (1950).

Science Communication

Washington, D. C.

Project ARIES - Contract Numr 3071(00)

Final Report

1 August 1960

App. A-8

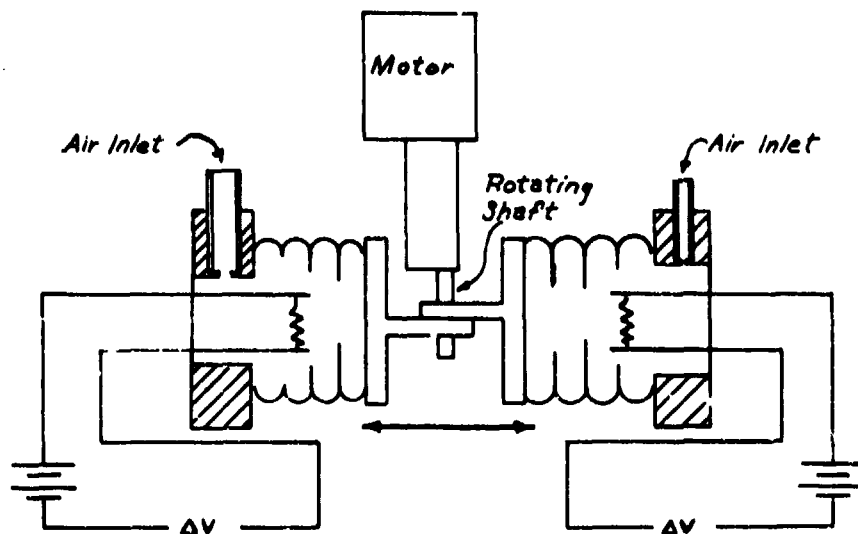


Figure 4

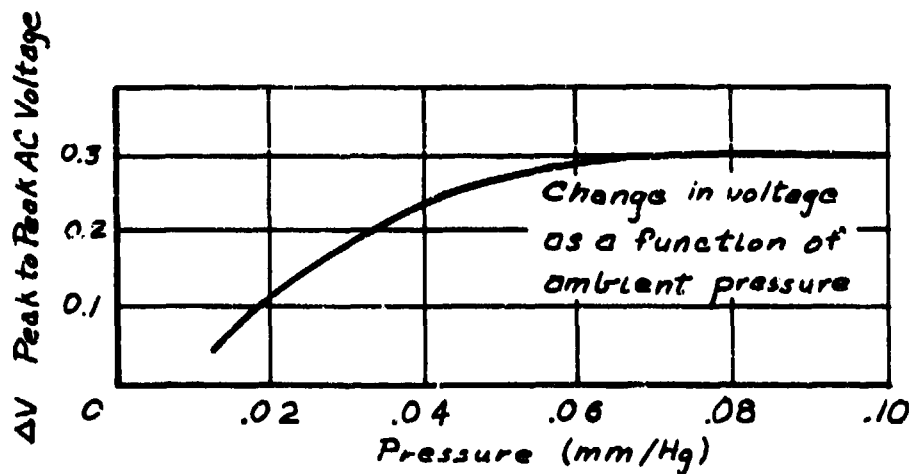


Figure 5

Science Communication
Washington, D. C.

Contract Nonr 3071(00)
Final Report
1 August 1960

App. A-9

THE FALLING SPHERE

The technique of measuring the drag on a falling sphere, ejected from a rocket at peak altitude, to obtain upper air density and temperature was developed at the University of Michigan. The most recent form of the experiment uses a small sphere about seven inches in diameter.

Air density of the atmosphere is calculated from the velocity of the falling sphere using the drag equation:

$$\rho = \frac{2 m a_D}{V^2 A C_D}$$

ρ = density
 m = mass of sphere
 a_D = drag acceleration
 V = velocity of sphere
 A = cross-sectional area of sphere
 C_D = coefficient of drag of sphere

Pressure and temperature at altitude are derived from the drag data by substitution in the hydrostatic equation:

$$T_h = \frac{\int_h^{h_0} \rho h g dh}{\rho h \frac{R}{M}} + \frac{P_0}{P_h} T_0$$

T = temperature °kelvin
 ρ = density
 g = acceleration of gravity
 h = altitude
 R = gas constant
 M = molecular weight of air

An initial temperature is assumed for the beginning of the trajectory.

Early versions of the falling sphere experiment relied on Doppler radar tracking to derive the trajectory of the falling sphere. The more recent versions include an accelerometer and telemetering transmitter within the sphere to measure and transmit the drag acceleration from the sphere.

Science Communication
Washington, D. C.

Contract Nonr 3071(00)
Final Report
1 August 1960

App. A-10

The Falling Sphere (cont.)

The falling sphere experiment for determining atmospheric parameters is based on the following assumptions:

1. The hydrostatic barometric equation is valid for the region of the sphere trajectory.
2. The atmospheric composition is constant, and its mean molecular weight is fixed.

Possible errors for this method include:

1. The neglect of winds in the trajectory calculations.
2. The errors of measurement of the drag acceleration and the coefficient of drag for the sphere.
3. Possible errors in the calculation of the trajectory.

In addition, the assumed temperature at the beginning of the trajectory introduces a possible error in the first 15 kilometers of the trajectory.

Literature Citation:

Bartman, F.L., "The Falling Sphere for Upper Air Density and Temperature," Rocket Exploration of the Upper Atmosphere, R.L.F. Boyd and M.J. Seaton, editors, Pergamon Press, Ltd., London, 1954.

Jones, L.M., "Upper-Air Density and Temperature: Some Variations and Abrupt Warming in the Mesosphere," J. Geophys. Res., 64, 2331-40 (1959).

Science Communication
Washington, D. C.

Contract Nonr 3071(00)
Final Report
1 August 1960

App. A-11

THE GRENADE EXPERIMENT

The grenade experiment is based on measuring the average velocity of sound, traveling to the ground, when produced by a grenade exploded at various altitudes. The atmospheric temperature in the region of the grenade explosion is determined by the variation of sound velocity with the altitude of the grenade explosion. A schematic of the experiment is outlined in Figure 6.

The velocity of sound is calculated thus:

$$C = \sqrt{\frac{\gamma R}{M} T}$$

$$\frac{\gamma R}{M} = K \text{ (constant)}$$

Thus: $C = \sqrt{KT}$

C = velocity of sound, dry air

γ = ratio of specific
heats of air

R = gas constant

T = temperature °kelvin

M = molecular weight of air

The average temperature of the region between two grenade explosions is calculated from the variation of the sound velocity from these explosions. Wind effects on the path of sound transmission are determined by a sound-ranging network which measures the directional position of the sound wave arriving on the ground. This direction yields the apparent position of the grenade explosion which is then compared with the true position, obtained by a DOVAP telemetering device.

The use of the grenade experiment for determining atmospheric temperature is based on the following assumptions:

1. Vertical wind components are negligible compared with acoustic velocity in the region of measurement.
2. The composition of the atmosphere is constant up to about 90 kilometers, the region measured by the experiment.

Science Communication

Washington, D. C.

Contract Nonr 3071(00)

Final Report

1 August 1960

App. A-12

The Grenade Experiment (cont.)

The calculation for the experiment yield only the average temperature in the layer at which the grenade is detonated. This average temperature is assumed to exist throughout the layer.

Possible errors for the grenade experiment include:

1. Variations with altitude of the specific heat or water vapor of the atmosphere introduce errors in the calculation of temperature, from the above equation.
2. The accuracy of the measurements is limited by the sound-ranging network's accuracy to determine the time of arrival of the sound waves at the individual microphones.
3. The grenade experiment is probably accurate to about 5° for determination of temperature to an altitude of about 90 kilometers. Above about 95 kilometers, sound waves cannot be generated with sufficient energy to reach ground stations.

Literature Citations:

Stroud, W.G., W.R. Bandeen, W. Nordberg, F.L. Bartman, J. Ottorman, and P. Titus, "Temperature and Winds in the Arctic Obtained by the Rocket Grenade Experiment," IGY Rocket Report Series, 1, pp. 58-79, July 1958.

Science Communication

Washington, D. C.

Project ARIES - Contract Nonr 3071(00)

Final Report

1 August 1960

App. A-13

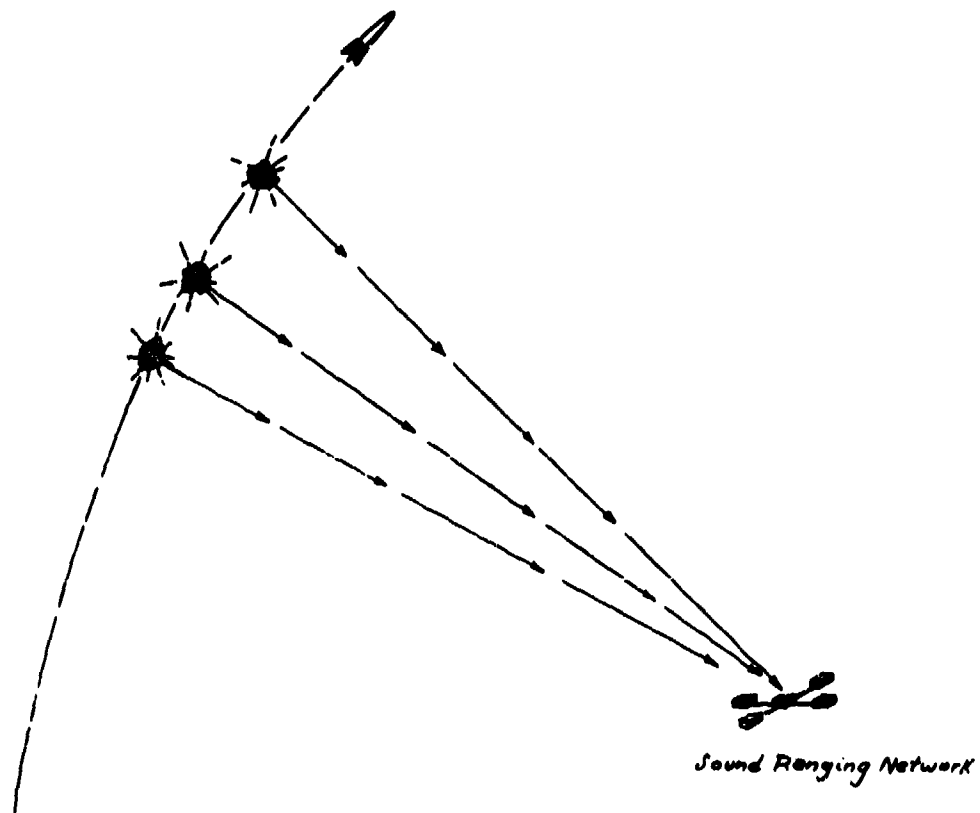


Figure 6

Science Communication

Washington, D. C.

Contract Nonr 3071(00)

Final Report

1 August 1960

App. A-14

THE COMPOSITION-MASS SPECTROMETER

The Bennet radio-frequency mass spectrometer can be used to obtain spectra of atmospheric composition above 100 kilometers. A diagram of the device is shown in Figure 7. Ions are formed by the bombardment of air molecules with 45-volt electrons in the ion cage. These ions, drawn out and collimated by grids at points 3 and 4, are accelerated by a negative sweep potential into the analyzer section. This negative sweep potential is modified by a small constant-bias voltage applied to grids at points 5 and 7. Ions not receiving the maximum incremental energy per state in the analyzer are turned back by a positive stopping potential applied to grid at point 8. The desired ions have sufficient energy to overcome this positive potential and reach the collector.

The mass of the ions arriving in the collecting assembly can be represented as follows:

$$M = \frac{0.266 V}{s^2 f^2}$$

M = mass in atomic mass units

s = spacing between grids of
analyzer section in
centimeters.

f = frequency in megacycles

V = voltage

Variation of either frequency or voltage will sweep the tube over a range of atomic mass units. The sweep rate is limited to the frequency response of the telemetering system in use. With a radio-frequency of 3.9 megacycles and a sweep varying between -250 and -25 volts, the instrument will cover the range between 48 and 5 atomic mass units.

Literature Citation:

Townsend, J.W., JR., Radiofrequency Mass Spectrometer for Upper Air Research, Naval Research Laboratory, Washington 20, D.C., 8 January 1952.

Science Communication

Washington, D. C.

Project ARIES - Contract Nomr 3071(00)

Final Report

1 August 1960

App. A-16

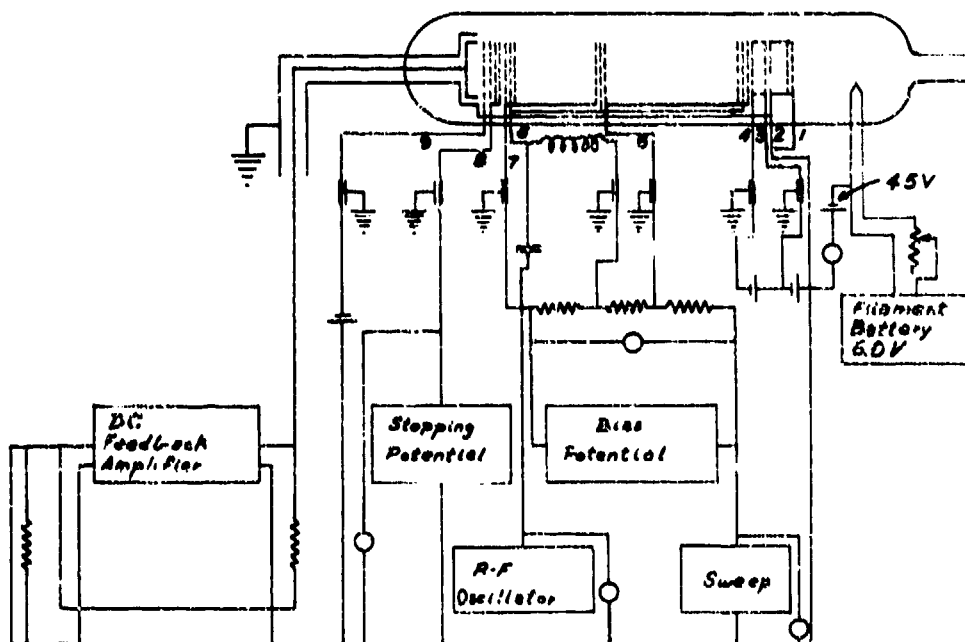


Figure 7

Properties of the Upper Atmosphere

APPENDIX B

Abstract Bibliography of Data Sources

Science Communication

Washington, D. C.

Contract Nonr 3071(00)

Final Report

1 August 1960

Upper Atmosphere Structure Data

REFERENCES

Bandeem

Bandeem, W.R., Griffith, R.M., Nordberg, W., Stroud, W.G., The Measurement of Temperatures, Densities, Pressures and Winds over Fort Churchill, Canada, by means of The Rocket Grenade Experiment, USASRDL Technical Report, 2076, U. S. Army Signal Research and Development Laboratory, Fort Monmouth, New Jersey, 1959.

Reports results of ten successful Aerobee firings at Fort Churchill.

Boggess 59

Boggess, R.L., Brace, L.H., Spencer, N.W., "Langmuir Probe Measurements in the Ionosphere," J. Geophys. Res., 64, 1627 (1959).

Letter report of design of a Langmuir probe which is ejected from rocket at peak altitude. Preliminary electron temperature from 1 rocket flight are presented.

Havens 52

Havens, R.R., Koll, R., LaGow, H.E., "Pressure, Density, and Temperature of the Earth's Atmosphere," J. Geophys. Res., 57, 59-72 (1952).

Describes instrumentation for density measurements and presents data from 3 V-2, Viking flights.

Horowitz 57

Horowitz, R., LaGow, H.E., "Upper Air Pressure and Density Measurements from 90-220 Kilometers with Viking 7 Rocket," J. Geophys. Res., 62, 57-77 (1957).

Presents pressure and density data from a 1951 Viking flight, the highest altitude from which structure data have been obtained by rockets.

Horowitz 58

Horowitz, R., LaGow, H.E., "Upper Air Pressure and Density Measurements from 90-220 Kilometers with Viking 7 Rocket," J. Geophys. Res., 62, 57-77 (1957).

Pressure, temperature, and density data from an Aerobee flight at Ft. Churchill are compared with that obtained by the Viking 7 at White Sands.

Jones 58

Jones, L.M., Fischbach, F.F., Peterson, J.W., "Seasonal and Latitude Variations in Upper Air Density," IGY Rocket Report Series, 1, pp. 47-58, 1958.

Presents results of air density and temperature determination by falling sphere technique for 6 Nike-Cajun, 1 DAN, and 6 Aerobee rocket flights to July 1958.

Jones 59

Jones, L.M., Peterson, J.W., Schaeffer, E.J., Schulte, H.F., "Upper Air Densities and Temperature: Some Variations and an Abrupt Warming in the Mesosphere," J. Geophys. Res., 64, 2331-40 (1959).

Presents temperature and density data obtained in 8 Nike-Cajun rocket flights.

Science Communication

Washington, D. C.

Contract Nonr 3071(00)

App. B-2

Final Report

1 August 1960

Upper Atmosphere Structure Data (cont.)

REFERENCES

LaGow 54

LaGow, H.E., "Physical Properties of the Atmosphere into the F₁-Layer," Rocket Explorations of the Upper Atmosphere, R.L.F. Boyd and M. Seaton, editors, pp. 73-81, Pergamon Press, Ltd., London, 1954.

Review of results from early NRL V-2, Viking Program at White Sands. Presents pressure, temperature, and density data obtained from 13 rocket flights.

Meadows 60

Meadows, E.B., Townsend, J.W., "IGY Rocket Measurements of Arctic Atmospheric Composition Above 100 Km.," Paper presented at COSPAR meeting in Nice, France, to be published in: Proceedings of the Symposium of the Committee of Space Science (COSPAR), North-Holland Publishing Co., Amsterdam, Late Summer, 1960 (Western Representative Interscience Publishers, New York).

Presents density data from 3 Aerobee-H1 flights based on mass spectrometer determinations.

Mikhnevich 60

Mikhnevich, V.V., Denilin, B.S., Repnev, A.I., Sokolov, V.A., "Some Results of the Determination of the Structural Parameters of the Atmosphere Using the Third Soviet Artificial Earth Satellite," J. Am. Rock. Soc., Russian Supplement, 30, 407-416 (1960).

Presents density, pressure, and temperature data to 500 kilometers obtained by instrumentation in the Soviet satellite launched 15 May 1958, 1958 6. Also presents density data to 720 kilometers based on analysis of drag from orbits of Soviet satellites and carrier rockets launched 4 Oct. 1957 and 3 Nov. 1957.

Schilling 59

Schilling, G.F., Sterne, T.E., "Densities of the Upper Atmosphere Derived from Satellite Observations," Special Report No. 12, pp. 37-43, Smithsonian Astrophysical Observatory, Cambridge, 1958.

Summary of density values to 400 Kilometers inferred from satellite observations and drag calculations.

Sicinski 54

Sicinski, H.S., Spencer, N.W., Dow, W.G., "Rocket Measurements of the Upper Atmosphere. Ambient Temperature and Pressure in the 30-75 Km. Region," J. Appl. Phys., 25, 161-163 (1954).

Describes method for determination of ambient pressures and temperature based on ratio of pressure at nose cone tip to nose cone wall. Pressure and temperature data from 2 flights are presented.

Science Communication

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Contract Nonr 3071(00)

Final Report

1 August 1960

App. B-3

Upper Atmosphere Structure Data (cont.)

REFERENCES

Spencer 54

Spencer, N.W., Dow, W.G., "Density-Gauge Methods for Measuring Upper-Air Temperature, Pressure, and Winds," Rocket Exploration of the Upper Atmosphere, R.L.F. Boyd and M. Seaton, editors, pp. 82, Pergamon Press, Ltd., London, 1954.

Describes ionization gage instrumentation for determination of temperature, pressure, and density. Data from 3 V-2 and 1 Aerobee rocket flights are presented.

Spencer 58-1

Spencer, N.W., Boggess, R.L., Taeusch, D., "Pressure, Temperature and Density at 90 Km. over Ft. Churchill," IGY Rocket Report Series, 1, pp. 80-91, 1958.

Review of experiments conducted by Dept. Electrical Engineering at University of Michigan in development of pressure sensing instrumentation. Presents results from preliminary data reduction from 2 Aerobee and 2 Nike-Cajun rocket flights.

Spencer 58-2

Spencer, N.W., Research in the Measurement of Ambient Pressure, Temperature, and Density of the Upper Atmosphere by means of Rockets, Final Report, Engineering Research Institute Project 2096, University of Michigan, June 1958.

Summary of research activities on radioactive ionization gage pressure measurement systems containing final report of "Air Force T-Day" experiment, and revised temperature data for Aerobee rocket flight.

Sterne 58

Sterne, T.E., Schilling, G.F., "Some Preliminary Values of Upper Atmosphere Density from Observations of USSR Satellites," Smithsonian Contrib. Astrophys., 2, 207-211 (1958).

Density values at altitude of 220-233 kilometers based on orbital data of 1957 $\alpha 1$, $\alpha 2$, and $\beta 1$.

Stroud 56

Stroud, W.G., Nordberg, W., Walsh, J.R., "Atmosphere Temperatures and Winds between 30 and 80 Km.," J. Geophys. Res., 61, 45 (1956).

Reviews results obtained with 12 Aerobee flights at White Sands.

Science Communication

Washington, D. C.

Contract Nonr 3071(00)

Final Report

1 August 1960

App. B-4

Upper Atmosphere Structure Data (cont.)

REFERENCES

Stroud 60

Stroud, W.G., Nordberg, W., "Rocket Grenade Measurements of Temperature and Winds Over Churchill, Canada," Paper presented at COSPAR meeting in Nice, France, to be published in: Proceedings of the Symposium of the Committee of Space Science (COSPAR), North-Holland Publishing Co., Amsterdam, late Summer, 1960 (Western Representative Interscience Publishers, New York).

Presents results of grenade experiments in 10 Aerobee rocket flights at Ft. Churchill between 1956 and 1958.

Weisner 54

Weisner, A.G., "The Determination of Temperatures and Winds Above 30 Km.," Rocket Exploration of the Upper Atmosphere, R.L.F. Boyd and M. Seaton, editors, pp. 133-142, Pergamon Press, Ltd., London, 1954.

Describes the instrumentation for grenade experiment and presents some data obtained from 6 Aerobee flights at White Sands.

Science Communication
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Contract Nonr 3071(00)
Final Report
1 August 1960

App. B-5

Upper Atmosphere Composition Data Bibliography

Byram

Byram, E.T., Chubb, T.A., Friedman, H., "The Dissociation of Oxygen at High Altitudes," The Threshold of Space, M. Zelikoff, editor, pp. 211-216, Pergamon Press, Ltd., New York, 1957.

Presents composition data on molecular oxygen concentration for 3 Aerobee flights to an altitude of 180 kilometers.

Havens 52

Havens, R.R., Koll, R., LaGow, H.E., "Pressure, Density, and Temperature of the Earth's Atmosphere," J. Geophys. Res., 57, 59-72 (1952).

Describes instrumentation for density measurements and presents data from 3 V-2, Viking flights.

Horowitz 57

Horowitz, R., LaGow, H.E., "Upper Air Pressure and Density Measurements from 90-220 Km. with Viking 7 Rocket," J. Geophys. Res., 62, 57-77 (1957).

Presents pressure and density data from 2 1951 Viking flights. The highest altitude from which structure data have been obtained by rockets.

Horowitz 58

Horowitz, R., LaGow, H.E., "Summer Day Auroral-Zone Atmospheric Structure Measurements from 100-210 Km.," J. Geophys. Res., 63, 757-773 (1958).

Pressure, temperature and density data from an Aerobee flight at Ft. Churchill are compared with that obtained by the Viking 7 at White Sands.

Istomin

Istomin, V.G., "Some Results of the Measurements of the Spectrum Mass of Positive Ions by the 3rd Artificial Satellite," (Translated from Russian) NASA TECHNICAL TRANSLATION F-7, April 1960.

Presents radio frequency mass spectrometer data obtained from 225-980 kilometers. The composition data are strongly influenced by latitude of the orbiting satellite.

Johnson 54

Johnson, F.S., Purcell, J.D., Touey, R., "Studies of the Ozone Layer Above New Mexico," Rocket Exploration of the Upper Atmosphere, R.L.F. Boyd and M. Seaton, editors, pp. 189-201, Pergamon Press, Ltd., New York, 1954.

Paper summarizes and discusses data obtained by solar spectroscopy on vertical distribution of Ozone. Presents Ozone composition data to an altitude of 70 kilometers obtained by a NRL rocket.

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Contract Nonr 3071(00)

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App. B-6

Upper Atmosphere Composition Data Bibliography (cont.)

Jones 54

Jones, L.M., "The Measurement of Diffuse Separation in the Upper Atmosphere," Rocket Exploration of the Upper Atmosphere, R.L.F. Boyd and M. Seaton, editors, pp. 143-157, Pergamon Press, Ltd., London, 1954.

Describes devices for collecting samples from upper atmosphere. Samples, returned in steel bottles, were analyzed in laboratories for Helium, Neon, Argon, and Nitrogen. Data from 7 Aerobee and 5 V-2 flights are presented.

Meadows 60

Meadows, E.B., Townsend, J.W., "IGY Rocket Measurements of Arctic Atmospheric Composition Above 100 Km.," Paper presented at COSPAR meeting in Nice, France, to be published in: Proceedings of the Symposium of the Committee of Space Science (COSPAR), North-Holland Publishing Co., Amsterdam, Late Summer, 1960 (Western Representative Interscience Publishers, New York).

Presents composition data obtained on 4 Aerobee-Hi rocket flights instrumented with radio-frequency mass spectrometers. Instrumentation techniques and possible errors are discussed.

Wenzel 58

Wenzel, E.A., Loh, L.T., Nichols, M.H., Jones, L.M., "Diffusive Separation in the Upper Atmosphere," IGY Rocket Report Series, 1, pp. 91-107, 1958.

Reviews results of upper atmosphere sampling program. Composition data from 2 Aerobee flights are presented.

Science Communication
Washington, D. C.

Properties of the Upper Atmosphere

APPENDIX C

Abstract Bibliography of Books, Review Articles, and Bibliographies
on the Upper Atmosphere

Science Communication

Washington, D. C.

Contract Nonr 3071(00)

Final Report

1 August 1960

Abstract Bibliography of Books, Review Articles, and Bibliographies on the Upper Atmosphere

The publications listed below are recommended as background references in the field of upper atmosphere research.

Benson, O.O., Strughold, H., editors, Physics and Medicine of the Atmosphere and Space, John Wiley & Sons, Inc., New York, 1960.

Papers presented at 2nd International Symposium on Physics and Medicine of the Atmosphere and Space. Several review articles on upper atmosphere, but most of the papers are directed to problems of space flight.

Benton, M., editor, The Use of High-Altitude Rockets for Scientific Investigations, An Annotated Bibliography, U. S. Naval Research Laboratory, Washington, D. C., Bibliography No. 16, Oct. 1959.

This is an extensive bibliography of publications in the field of upper atmosphere research. Foreign as well as U. S. publications are included from 1946 to June 1959.

Boyd, R.L.F., Seaton, M.J., editors, Rocket Exploration of the Upper Atmosphere, Pergamon Press, Ltd., London, 1954.

Report of 1st major international conference concerned with rocket exploration of the upper atmosphere. The papers present a summary of experimental data to 1954.

Hanessian, J., Guttmacher, I., editors, IGY Rocket Report Series, 1, Experimental Results of the U. S. Rocket Program for the International Geophysical Year to 1 July 1958, National Academy of Sciences, Washington, D. C., July 1958.

This compilation of research papers presents the results obtained during the first 12 months of the U. S. IGY program. The bulk of these papers were presented at the CSAGI Assembly held in Moscow in the summer of 1958.

Kniper, G.F., editor, The Earth as a Planet, University of Chicago Press, Chicago, 1954.

This book contains several lengthy review articles on the structure and composition of the atmosphere.

Massey, H.S.W., Boyd, R.L.F., editors, The Upper Atmosphere, Philosophical Library, New York, 1959.

A general discussion of upper atmosphere phenomena studied during IGY; few experimental data, but good generalized summaries.

Science Communication

Washington, D. C.

Contract Nonr 3071(00)

Final Report

1 August 1960

App. C App. C-4

Abstract Bibliography of Books, Review Article, (cont.)

Newell, R.E., editor, Sounding Rockets, McGraw-Hill, New York, 1959. 1959.

This book presents performance characteristics of the principal atmospheric research rockets developed since the end of World War II.

Proceedings of the Symposium of the Committee of Space Sciences (COSPAR) (COSPAR), to be published by North-Holland Publishing Co., Amsterdam, Late Summer 1960 (or 1960 (Western Representative Interscience Publishers, New York).

This book, to be published in the late summer of 1960, contains the papers presented at the First International Space Science Symposium held in Nice, France, Jan. 1960. The papers include the results obtained by the upper atmospheric research programs of most of the countries participating in the IGY program.

Wright Instruments, Inc., Vestal, New York, A Survey of Pressure & Density & Density Sensors & Associated Problems for The NOL Hasp Program, Final Report, April 1959. April 1959.

A survey of "state of the art" in development of miniature pressure and density sensors.

Zelikoff, M., editor, The Threshold of Space, Pergamon Press, Ltd., New York, New York, 1957.

Proceedings of Conference on Chemical Aeronomy at Cambridge, Mass. in June 1956, sponsored by the Geophysics Research Directorate of the Air Force, Cambridge Research Center. This book contains papers by most of the active research workers in the fields of atmospheric composition and photochemistry.



Defense Threat Reduction Agency

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May 6, 1999

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- DASA-1298, AD-285252, STATEMENT A ✓
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- DASA-1271, AD-276892, STATEMENT A ✓
- DASA-1279, AD-281597, STATEMENT A ✓
- DASA-1237, AD-272653, STATEMENT A ✓
- DASA-1246, AD-279670, STATEMENT A ✓
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- DASA-1221, AD-243886, STATEMENT A ✓
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- DASA-1285-5, AD-443589, STATEMENT A ✓
- DASA-1714, AD-473132, STATEMENT A ✓
- DASA-2214, AD-854912, STATEMENT A ✓
- DASA-2627, AD-514934, STATEMENT A ✓
- DASA-2651, AD-514615, STATEMENT A ✓
- ~~DASA-2536, AD-876697, STATEMENT A~~
- DASA-2722T-V3, AD-518506, STATEMENT A ✓
- DNA-3042F, AD-525631, STATEMENT A ✓
- DNA-2821Z-1, AD-522555, STATEMENT A ✓

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If you have any questions, please call me at 703-325-1034.

Arldith Jarrett

ARDITH JARRETT
Chief, Technical Resource Center