PROJECT 10073 RECORD CARD

1. DATE	2. LOCATION		12. CONCLUSIONS
28 Feb 58	Lake City-Powell Station, Tenn		☐ Was Balloon ☐ Probably Balloon ☐ Possibly Balloon
3. DATE-TIME GROUP Local ____ GMT 01/0030Z	4. TYPE OF OBSERVATION ☒ Ground-Visual ☐ Ground-Radar ☐ Air-Visual ☐ Air-Intercept Radar		☐ Was Aircraft ☐ Probably Aircraft ☐ Possibly Aircraft
5. PHOTOS ☐ Yes ☐ No	6. SOURCE Civilian		☒ Was Astronomical Meteor ☐ Probably Astronomical ☐ Possibly Astronomical
7. LENGTH OF OBSERVATION few secs	8. NUMBER OF OBJECTS one	9. COURSE E to W	☐ Other ____ ☐ Insufficient Data for Evaluation ☐ Unknown

10. BRIEF SUMMARY OF SIGHTING	11. COMMENTS
Rnd, firey red obj w/firey tail about same size of obj, traveling at terrific speed & very high.	Characteristics of meteor sighting duration, description etc, constant with this analysis.

ATIC FORM 329 (REV 26 SEP 52)

STATUS REPORTS ON OPTICAL OBSERVATIONS
OF SATELLITES 1958 ALPHA AND 1958 BETA

Table of Contents

Table of Contents

CHAPTER I

PRELIMINARY RESULTS FROM OPTICAL TRACKING OF U. S. EARTH SATELLITES

by

J. Allen Hynek* and Fred L. Whipple**

In the satellite program of the International Geophysical Year the complex operations performed by the Optical Satellite Tracking Program of the Smithsonian Astrophysical Observatory are a result of teamwork in the fullest sense of the word. The manifold tasks include the visual acquisition of the artificial earth satellites, the computation of search ephemerides and predictions, the operation of a world-wide network of precision tracking cameras capable of photographing small objects at distances of hundreds of miles and timing these photographs to better than a thousandth of a second, the screening, reduction, and analysis of incoming data, and last but not least, the dissemination of the reduced data to the scientific community.

Remembering that since October 4, 1957, there has been a total of eight objects projected into satellite orbits, we hardly need to point out that the efforts expended by thousands of persons, including the volunteer Moonwatch team members, in the Optical Tracking Program alone are outstanding. With great scientific enthusiasm and satisfaction, our staff members have participated in this undertaking, often well beyond the normal call of duty. We have not noted similar dedication save in times of national emergency.

The cooperation of the U. S. Naval Research Laboratory in furnishing us with critical prediction data for satellites with live radios has been of major importance. Also, the computation of ephemerides and orbital data would have been virtually impossible without the generous cooperation of the International Business Machines Corporation and the Computations Laboratory at the Massachusetts Institute of Technology in Cambridge.

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* Associate Director, Smithsonian Astrophysical Observatory, in charge of the Optical Satellite Tracking Program

** Director, Smithsonian Astrophysical Observatory

The subsequent sections of this collection have been prepared individually by members of the Smithsonian Astrophysical Observatory who are actively working in this particular field and therefore best able to present a factual and informative account of the respective aspects of the program. In this initial chapter, we wish to summarize as well as outline from an overall point of view the orbital data and results which we have been able to obtain with regard to Satellites 1958 Alpha, 1958 Beta One, and 1958 Gamma.

The mainstay of the long-range optical tracking program is the worldwide network of precision photographic stations, employing at each observing station a 3-axis, 20-inch aperture, f/1 camera designed especially for the photographic tracking of artificial earth satellites. The optics for these cameras were designed by Dr. James G. Baker, and constructed by the Perkin-Elmer Corporation. They employ a unique 3-corrector lens system having 4 aspherical surfaces, in combination with a 31-inch conventional spherical mirror, providing a useable field of 30°. The motor-driven mechanical drive provides sequential tracking of a satellite and of star background on the same 250 x 55 mm. film frame, in cyclical succession so that many individual photographs can be obtained during a given satellite passage. The unique mechanical system was designed by Mr. Joseph Nunn and fabricated by Boller and Chivens, Inc., all of South Pasadena, California.

The urgency imposed upon the optical tracking program by the launching of the Russian satellites made it desirable to expedite the construction of the stations and to obtain the use of auxillary cameras to go into operation before the arrival of the Baker-Nunn cameras. Through the excellent cooperation of the Ballistic Research Laboratory we have obtained the use of two S M T (Small Missiles Telecamera) instruments. In addition, several phototheodolites have been furnished through the courtesy of the U. S. Air Force, thus making possible the completion at any earlier date than otherwise possible an effective tracking network. As discussed by Karl G. Henize in his report, the full complement of Baker-Nunn cameras is expected to be in operation by mid June.

For an artificial satellite to be tracked most effectively for scientific purposes, the tracking accuracy must be of the order of seconds of arc and of 0.001 seconds of time. A crystal clock of extreme precision has been built by the Ernst Norrman Laboratories, Williams Bay, Wisconsin, for each of the twelve observing stations. The time presentation within each camera is photographed on each frame.

It can be stated that the scientific value of a satellite for many geophysical purposes rises greatly with its longevity. Precision observations of non-aspherical, close artificial satellites are of little value in solving major geodetic problems because of the variable motion introduced by varying orientation and the consequent irregular drag. Hence the present schedule in establishing the precision camera programs has occasioned little scientific loss. This more leisurely program has more than offset this loss, in terms of improved optical and mechanical performance.

The successful photographs of the first two American satellites by several of the network stations is a gratifying signal of the routine tracking soon to be effected.

The establishment of the photographic network would not have been possible without the cooperation of several foreign governments. Particular note must be taken of the great assistance received through the respective I.G.Y. committees from the governments of Argentina, Australia, India, Iran, Japan, Netherlands Antilles, Peru and the Union of South Africa. Their sympathetic appreciation of the urgency of the total program has been indispensible, and our work in those several countries has been carried out in a thoroughly cooperative manner appropriate to the spirit of the International Geophysical Year.

An integral part of the optical tracking program, complementary to the precision program, is the far-flung visual observing project termed MOONWATCH. Conceived primarily as an acquisition and reconnaissance mission to cover periods immediately after launching and shortly before demise, in final stages of the existence of a satellite, MOONWATCH teams have served continuously as interim tracking stations during the period of final preparation of the photographic tracking stations. The exemplary work of the several thousands of persons involved in this program stands out as a significant contribution to the satellite program, and an outstanding example of lay participation in an international scientific venture.

Largely through the use of MOONWATCH observations, the computations and analysis division of Smithsonian Astrophysical Observatory has been able to derive significant, even through preliminary, scientific results. These are treated in Chapter III and include the orbit determination of 1958α and an evaluation of the variable acceleration of this satellite and of its life expectancy With respect to 1958β_2, the perigee distance is so relatively high that little can be said of its life expectancy save that in all probability it must be counted in decades. Its rocket carrier, 1958β_1 will probably have a significantly shorter lifetime, but still perhaps a decade or more.

Various computational programs have been devised, and others are in process, for the utilization of satellite observations for prediction purposes as contrasted to their use for results of geophysical interest. Ephemerides for general use as well as for specific use at given geographical points have been programed; an example of the latter is the program which prints out actual Baker-Nunn camera settings which can be cabled directly to the network stations.

Implicit in the prediction program is the objective to disseminate not only specific predictions but general satellite information of an astronomical character to the public through the several mass media. This we have recognized and met by concise statements to the press and by the preparation of charts illustrating visible passages of satellites over the United States.

CHAPTER II

OPTICAL SATELLITE OBSERVATIONS

The Network of Precision Photographic Satellite Tracking Stations

by

Karl G. Henize*

1. Station Operation

On the date of this report, nine photographic satellite-tracking stations of the planned twelve-station network are in operation. These stations are listed below in Table One together with their dates of first useful operation and with the instrument now installed at each station.

TABLE ONE

Stations in Operation

Station No.	Location	Date	Instrument
9001	New Mexico	5 Nov. '57	Baker-Nunn
9002	South Africa	20 Feb. '58	Baker-Nunn
9003	Australia	12 Mar. '58	Baker-Nunn
9004	Spain	17 Mar. '58	Baker-Nunn
9005	Japan	*27 Mar. '58 partial	Baker-Nunn
9009	Curacao	12 Mar. '58	SMT
9010	Florida	18 Mar. '58	SMT
9011	Argentina	**25 Mar. '58 est.	Super Schmidt
9012	Hawaii	23 Dec. '57	Super Schmidt

* Japan reports partial operation only, and we may anticipate full operation within two to three days.

** A cable from Argentina 21 March estimated this 25 March operation date.

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* Senior Astronomer, in charge of photographic tracking stations, Optical Satellite Tracking Program, Smithsonian Astrophysical Observatory

At four of the stations listed above, Super Schmidt meteor cameras or Small Missile Telecameras have been installed on an interim basis. As shown in Table Two, these instruments will eventually be replaced by Baker-Nunn cameras, thus resulting in a twelve-station network equipped with identical instruments of superior precision and accuracy.

The dates in Table One are dates of actual accomplishment. The dates listed below in Table Two represent our present schedule for the remaining Baker-Nunn cameras.

TABLE TWO

Scheduled Operational Dates of Additional Baker Nunn Cameras

Station No.	Location	Shipping Date	Date in Operation
9006	India	29 Mar. '58	15 May '58
9007	Peru	8 Apr. '58	28 Apr. '58
9008	Iran	18 Apr. '58	8 May '58
9009	Curacao	28 Apr. '58	8 May '58
9010	Florida	8 May '58	18 May '58
9011	Argentina	18 May '58	7 June '58
9012	Hawaii	28 May '58	12 June '58

2. Photographic Reduction

Photographs of American satellites 1958 α and 1958 $\beta 1$ were first obtained during the visibility period around March 18, 1958, at our photographic tracking stations. Successful photography continues and the films showing satellites, after immediate field reading, are being reduced for precise data evaluation. The image quality is such that we may be able, with further efforts, to obtain also precise photographs of Satellite 1958 $\beta 2$. This program for precise data reduction at Cambridge is under the supervision of Dr. George Van Biesbroeck, Consultant. Special precision measuring engines for film reading and search are used, resulting in highly accurate position information. It is expected that a catalogue of precision data from the tracking cameras can be issued soon in a nature similar to the catalogues of MOONWATCH data.

3. Reduction of PHOTOTRACK Observations

A considerable number of photographs of the Soviet satellites have been received from PHOTOTRACK stations and amateur photographers and are being reduced in an analogous manner. No such photographs have as yet been received here of the U. S. satellites.

Moonwatch Observations of Satellites 1958 Alpha, 1958 Beta One, 1958 Beta Two, and 1958 Gamma

By

Leon Campbell, Jr.*

Since the launchings of the U.S. artificial earth satellites, 13 MOONWATCH stations participating in the Smithsonian Astrophysical Observatory's visual observing program have reported a total of 59 observations. These were made between February 3 and March 24 of 1958α and between March 19 and March 26 of 1958β1. In addition, the first sighting of $1958\beta_2$ was made on March 20, 1958 and the first sighting of 1958γ was reported on March 27, 1958.

All observations listed in the following Catalogue were used in the Smithsonian Observatory's computer program for determining subsatellite points. Some very few other observations are not listed here because the timing of the observations was not to the second or the position to one degree of arc. However, these unlisted observations were useful since, having been made during very early orbiting of the satellites, they served as checks on preliminary orbital elements.

It will be understood that at this time, only days after the 1958β and 1958γ launchings, the observations reported of satellites $1958\beta_2$ and 1958γ are preliminary values and not yet confirmed by our Computations and Analysis Section. It may easily develop that some of these sightings must be discarded later.

The catalogued observations were reported (by telephone and cable) from MOONWATCH stations, in the United States, Australia, Union of South Africa, and Japan. The faintness of the objects and the small inclination of their orbits to the equator account for the fact that only 13 stations have made observations to date (March 27, 1958). There are, as of March 27, a total of 230 stations associated in the Smithsonian Observatory's MOONWATCH network, with 126 of these located in the United States and its territories, and 104 in other countries. These observations of

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* In Charge MOONWATCH Project

the U.S. satellites were made during a period in which many of the 230 stations were engaged in observing 1957β_1 as well.

Two MOONWATCH teams reported unique observing experiences. Alamogordo station 102 on March 19 observed 1957β_1, 1958α and 1958β_1; the latter two objects were about $13^m\ 30^s$ apart. Albuquerque station 103 on March 20 observed 1958β_1, 1958β_2 and 1958α in that order.

The Catalogue lists the observations by object, and in chronological order. The Key to MOONWATCH Station Code Numbers gives the geographical coordinates of the stations listed in the Catalogue.

It will be noted that the position of the satellites is given either in right ascension and declination or in azimuth and altitude. Azimuth is measured clockwise from north through 360°. The Catalogue and Key to Station Code Numbers follow:

1 Witness

01/0030Z

4 MAR 58 09 55
ATIC

1-RIF
V 4E4
3-4ND... 7C7...

SQH22E SQB064 YMD615FLA049
MM RJEDDN RJEDWP RJEPHQ
DE RJEDFL 3K

KEY TO MOONWATCH STATION CODE NUMBERS

Code Number	Station Name	Longitude		Latitude	
027	Manhattan, Kansas	96°28'51"	W	39°09'45"	N
065	Bryan, Texas	96 20 01.4	W	30 38 14.7	N
069	Fort Worth, Texas	97 22 09	W	32 42 42	N
098	China Lake, California	117 39 46.8	W	35 39 25.2	N
102	Alamogordo, New Mexico	105 57 01.9	W	32 52 24.3	N
103	Albuquerque, New Mexico	106 36 29.2	W	39 03 18.3	N
210	Higashimatsuyama, Japan	139 23 54	E	36 02 22	N
226	Kure, Japan	132 33 44	E	34 14 57	N
258	Yokkaichi, Japan	136 39 00	E	35 00 15	N
401	Bloemfontein, S. Africa	26 13 35.6	E	29 06 19.5	S
402	Cape Town, S. Africa	18 28 37.9	E	33 56 00.4	S
403	Johannesburg, S. Africa	28 04 30	E	26 10 55.3	S
600	Adelaide, S. Australia	138 36 14	E	34 55 14	S

1958 Alpha

CATALOGUE OF MOONWATCH OBSERVATIONS

February, 1958

Station No.	Name	Time (UT) d	h	m	s	Right Ascen.	Azi-muth	Decli-nation	Alti-tude	Direction of Travel	Ang. Vel.	Magni-tude	Color
102	Alamogordo, N.M.	03	03	46	10	05 23	180	+14 54	73	W-E		+8max	
098	China Lake, Calif	06	02	24	42		177 15		71	W-E	1		White
103	Albuquerque, N.M.	07	01	22	02		180		76 30			+7+8	
258	Yokkaichi, Japan	08	09	57	34	04 10		+08 00				+7	
402	Cape Town, S.A.	08	02	54	34		72 20		00 24				
226	Kure, Japan	08	09	56	32		180 00		74			+8	
210	Hig'sh'ma, Japan	08	09	58	17	04 28		-05 14				+8	
402	Cape Town, S.A.	10	02	45	20		00 24		79 24				
098	China Lake, Calif.	11	03	03	25		180		37 30	W-E			
102	Alamogordo, N.M.	12	02	00	30	03 49	180	-05 30	49	W-E		+7	Yellow
402	Cape Town, S.A.	12	02	35	38		00 24		84 00				
402	Cape Town, S.A.	15	03	21	17		00 24		76 00				
600	Adelaide, Aus.	15	18	36	30		320 20		69 30			6.5	
600	Adelaide, Aus.	15	18	37	02		03 20		74 20			6.5	
402	Cape Town, S.A.	16	02	14	57		00 24		82 55				
600	Adelaide, Aus.	17	18	25	52		337 30		65 00			+7+8	
403	Johannesburg, S.A.	20	01	55	30	13 45 48		-49 42				+8.5	
401	Bloemfontein, S.A.	21	02	50	50		00 24		46 42			6.5	
401	Bloemfontein, S.A.	23	02	39	38		00 24		30 06			+8	
401	Bloemfontein, S.A.	25	02	28	12		00 24		17 54				
401	Bloemfontein, S.A.	26	18	09	22		00 24		43 06				
401	Bloemfontein, S.A.	28	17	57	12		00 24		63 06				

1958 Alpha

March, 1958

Station No.	Name	Time (UT) d h m s	Right Ascen.	Azimuth	Declination	Altitude	Direction of Travel	Ang. Vel.	Magnitude	Color
401	Bloemfontein, S.A.	02 17 44 34		00 24		83 06				
403	Johannesburg, S.A.	02 17 45 06	06 19 24		-46 50				+9.5	
402	Cape Town, S.A.	03 18 37 16		00 24		66 15				
403	Johannesburg, S.A.	03 18 39 41	07 48 54		-74 04				+10	
403	Johannesburg, S.A.	04 17 32 06	06 22		-56 12					
402	Cape Town, S.A.	07 18 10 07		00 24		82 50				
403	Johannesburg, S.A.	07 18 12 32	06 58		-71 41					
403	Johannesburg, S.A.	07 18 12 34	07 05		-71 35				+10	
098	China Lake, Calif	09 12 50 40		180 24		39 42		1.5		
403	Johannesburg, S.A.	12 18 37 28		180		69 30			+10	
402	Cape Town, S.A.	14 18 19 26		00 24		67 39				
403	Johannesburg, S.A.	14 18 22 18	07 47		-32 42				+9	
	Not at station.	Coordinates:	26 12S		28 08E					
103	Albuquerque, N.M.	15 12 08 54		180		73		.5	+7+8	White
069	Ft Worth, Texas	16 11 02 34	15 37 30		+37 30		W-E	1.3	+6	
	Not at station.	Coordinates:	97 22 09W		32 42 42N					
069	Ft Worth, Texas	16 11 02 35	16 06		+37 30		W-E	1.3	+6	
	Not at station.	Coordinates:	97 22 09W		32 42 42N					
069	Ft Worth, Texas	16 11 02 40	16 23		+37 30		W-E	1.3	+6	
	Not at station.	Coordinates:	97 22 09W		32 42 42N					
401	Bloemfontein, S.A.	16 18 06 03		00 24		69 30			+6	
098	China Lake, Calif	18 12 43 09		180 24		64 00	W-E	1	+9	White
403	Johannesburg, S.A.	18 17 50 36	07 25 48		-04 16				+8.5	
103	Albuquerque, N.M.	19 11 36 58		180		68			+5+6	
102	Alamogordo, N.M.	19 11 37 08		0		79	W-E		+9	Yellow
102	Alamogordo, N.M.	19 11 43 08	16 25		+40		W-E		+9	Yellow
098	China Lake, Calif	20 12 26 49		180 48		57 06	W-E	1	+9	White

1958 Alpha

March, 1958

Station No.	Name	Time (UT) d	h	m	s	Right Ascen.	Azimuth	Declination	Altitude	Direction of Travel	Ang. Vel.	Magnitude	Color
103	Albuquerque, N.M.	20	12	29	22		180		51			+6	
401	Bloemfontein, S.A.	20	17	33	27		00 24		49				
403	Johannesburg, S.A.	20	17	34	11	07 15		+07 30				+9	
401	Bloemfontein, S.A.	22	17	16	33		00 24		40 24				
403	Johannesburg, S.A.	22	17	17	18	07 08 54		+18 03				+10	
103	Albuquerque, N.M.	24	11	55	43		180		27 30	W-E		+5+6	

1958 Beta One

March, 1958

Station No. Name	Time (UT) d h m s	Right Ascen.	Azi-muth	Decli-nation	Alti-tude	Direction of Travel	Ang. Vel.	Magni-tude	Color
102 Alamogordo, N.M.	19 11 13 38	16 10	0	+41	79	W-E		+6	Yellow
103 Albuquerque, N.M.	19 11 15 20		180		80			+8	
103 Albuquerque, N.M.	20 11 52 07		180		78 30			+6	White
065 Bryan, Texas	21 11 28 38	17 13		-07 36		W-E		+4.5+5	Or.-Wh.
027 Manhattan, Kan.	26 11 07 34	19 08		-29 18		W-E	0.5	+7.5	White

1958 Beta Two

March, 1958

Station No. Name	Time (UT) d h m s	Right Ascen.	Azi-muth	Decli-nation	Alti-tude	Direction of Travel	Ang. Vel.	Magni-tude	Color
103 Albuquerque, N.M.	20 11 54 42		180		75			+8	

1958 Gamma

March, 1958

Station No. Name	Time (UT) d h m s	Right Ascen.	Azi-muth	Decli-nation	Alti-tude	Direction of Travel	Ang. Vel.	Magni-tude	Color
102 Alamogordo, N.M.	27 11 45 20	16 25		-17		NW-SE	2	+6	Reddish

An additional 1958 Gamma observation was reported by Albuquerque, N.M., station 103, for the same day, but it has not yet been possible to evaluate it.

CHAPTER III

SCIENTIFIC RESULTS

The Orbit and Variable Acceleration of Satellite 1958 Alpha

By

Charles A. Whitney*

1. The Orbital Parameters

There is no need at present to alter significantly the orbital elements of satellite 1958 Alpha as published in the Harvard Announcement Card 1404, reproduced in Chapter V. It should be noted that the value of Ω is empirical and ω is derived from it using the theoretical ratio.

2. The Variable Acceleration

During launching, the final stages of 1958 Alpha were given a spin about the body axis. This spin has been expected to stabilize the body axis parallel to the velocity of the rocket at burnout.

However, such an orientation was soon discovered to be inconsistent with Smithsonian data on the variations of acceleration of the rocket. Dr. Charles Lundquist of the Army Ballistic Missile Agency informed the writer that radio-signal strength measurements of the Jet Propulsion Laboratory, California Institute of Technology, indicate tumbling with a period of about 7 seconds. This period is consistent with the suggestion that a slight dissipation of energy and near-conservation of angular momentum very rapidly led to a reorientation of the body axis into a plane perpendicular to the axis of rotation. The rocket now rotates about the axis of greatest moment of inertia, its angular momentum having been essentially unaltered.

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* Physicist, Smithsonian Astrophysical Observatory

In an effort to test this suggestion, the period-changes of 1958 Alpha have been re-examined.

Table I lists normal points for the perigee times as a function of revolution number, counting from the first passage through perigee and computed for the perigee given on H.A.C. 1404. Times are given in 1958 year days and decimals taking January 1.0 = 366.0.

TABLE I

Perigee Times of 1958 Alpha

Normal Points

N	T	(O-C)	N	T	
0	397.1619(8)	+.00009	350	425.07758	-.00013
50	401.15290	-.00007	400	429.06215	.00000
100	405.14304	+.00004	450	433.04572	+.00007
150	409.13187	.00000	500	437.02806	-.00001
200	413.11963	+.00001	550	441.00932	+.00001
250	417.10645	-.00001	600	444.98940	-.00002
300	421.09246	+.00002			

Changes of anomalistic period are derived by double differentiation of this table. To facilitate the differentiation and to smooth the data, the following representation of the time of perigee has been derived:

$$T = 397.16189 + 0.07982705N - 1.91 \times 10^{-7}N^2$$
$$+ 0.00037 \sin (0.0153N) - 0.000062 \sin (0.0112N).$$

This expression replaces that given on H. A. C. 1404. Differences (O-C) between the normal points and this expression are given in Table I, and the fit is within the uncertainties.

The acceleration is then

$$\frac{dP}{dN} = -3.82 \times 10^{-7} - 0.87\ 10^{-7} \sin (.0153N) + 0.078\ 10^{-7} \sin (.0119N)$$

Table II lists values of this acceleration.

TABLE II

Acceleration of 1958 Alpha

($\frac{dP}{dN} \times 10^{7}$ in days/Rev^2)

N	Obs.	Theo.	N	Obs.	Theo.
0	-3.8	---	350	-3.2	-3.78
50	-4.4	-4.09	400	-3.8	-4.95
100	-4.6	-4.77	450	-4.4	-5.58
150	-4.4	-4.70	500	-4.7	-5.31
200	-3.8	-3.95	550	-4.6	-4.40
250	-3.25	-3.17	600	-3.7	-3.50
300	-3.0	-3.06			

Lundquist has kindly made available a numerical integration of the equations of motion--drag included--starting with initial conditions specified by the writer. A value of acceleration some 5.8 times the observed value was obtained, through choice of parameters. By adjusting the mean value to the observed mean, the column of theoretical accelerations in Table II is obtained.

The agreement is adequate to confirm the suggested rocket attitude. It is easily shown that the observed accelerations are not compatible with the body axis and the spin axis parallel.

Such a direct scaling of the theoretical accelerations is not strictly legitimate because long-period variations are improperly manipulated. However, these latter appear smaller than the air-drag term so the comparison is probably not misleading. Further, it should be noted that the perigee drops too fast in the integration, accounting for the increase in the mean of the theoretical acceleration.

The Density of the Upper Atmosphere*

By

Theodore E. Sterne**

1. Introduction

I shall present a formula for the inference of air density from the orbital motion and physical characteristics of artificial earth satellites, and then I shall apply it to orbital data, for the American earth satellite 1958 Alpha, kindly provided me by Dr. Charles A. Whitney.

2. A Formula for Inferring Atmospheric Density from the Motion of Artificial Earth Satellites

In a paper in press[1] the author has made a basic theoretical study of the effects of air resistance upon the motion of close earth satellites. The first equation of Section 2 of that paper is

$$\Delta \frac{a}{a_e} = - c'\left(\frac{a}{a_e}\right)^2 2 \int_0^{\pi} \frac{\rho}{\rho_o} \frac{(1+e \cos E)^{3/2}}{(1-e \cos E)^{1/2}} dE \qquad (1)$$

where $\underline{a}$ and $\underline{e}$ are the mean distance of the satellite orbit and its eccentricity, respectively; where Δ is an operator denoting the increase in one revolution of the quantity upon which it operates, where a_e is the earth's equatorial radius, where $\rho(r)$ is the atmospheric density at geocentric distance $\underline{r}$, and where $\underline{E}$ is the eccentric anomaly. In equation (1) $\underline{c}'$ is the

* The formula and conclusions about atmospheric density, in this article, have been communicated to Science.

** Associate Director, Smithsonian Astrophysical Observatory, and Professor of Astrophysics, Harvard University.

1 T. E. Sterne, "An Atmospheric Model, and some Remarks on the Inference of Density from the Orbit of a Close Earth Satellite", Astronomical Journal (in press).

1 Witness

01/0030Z

4 MAR 58 09 55
ATIC

1-RIF
V 454

SQH028 SQB064 YMD015FLA049

MM RJEDDN RJEDWP RJEPHQ

DE RJEDFL 3K

dimensionless quantity $C_D A \rho_o a_e/m$, where A is the satellite's cross-sectional area, m its mass, C_D the dimensionless aerodynamic drag coefficient that is believed on theoretical grounds to be approximately 2, and ρ_o is the atmospheric density at sea level.

Now $\dot{a}$, the time derivative of $\underline{a}$, is clearly $\Delta a/P$ where $\underline{P}$ is the orbital period. Moreover, Kepler's second law states that P varies like $a^{3/2}$. Therefore $\dot{P}/P = (3/2)\dot{a}/a$, and therefore $\dot{P} = 3\Delta a/2a$.

The only important contributions to the integral in (1) come from portions of the orbit near perigee because of the rapid decrease of density with increasing height. If the density $\rho(r)$ is approximated, through a region near perigee and above it, by

$$\rho = \rho_\pi e^{-Kz}$$

where ρ_π is the density at perigee, $\underline{z}$ is the altitude above perigee, and $\underline{K}$ is the logarithmic gradient of density near perigee

$$K = -2.3026\ (d/dz)\ \log_{10}\rho, \tag{2}$$

then the integral can be shown to be given approximately but closely by

$$\pi \frac{\rho_\pi}{\rho_o} e^{-c}\left\{\left[1+\frac{3}{2}e^2 - \frac{e^3}{c} + ..\right] I_o(c) + \left[2e - \frac{3e^2}{2c} + e^3\left(1+\frac{2}{c^2}\right) + ..\right] \times I_1(c)\right\}$$

where c = Kae, and where I_o and I_1 are Bessel functions of purely imaginary argument. It follow that

$$\dot{P} = -3\pi\frac{AC_D}{m}\rho_\pi a e^{-c}\left\{(1+\text{etc.})\ I_o(c) + (2e+\text{etc.})\ I_1(c)\right\} \tag{3}$$

with rather high accuracy under all conditions.

The Bessel functions can be expanded asymptotically in descending powers of $\underline{c}$, and if this is done equation (3) becomes

$$\dot{P} = -3C_D\frac{A}{m}a_e\ \rho_\pi\ \left(\frac{a}{a_e}\right)\sqrt{\frac{\pi}{2c}}\ f\ (c,e) \tag{4}$$

where

$$f(c,e) = 1+2e + (3e^2/2) + \frac{1-6e-10.5e^2}{8c} + \frac{9+30e+85.5e^2}{128c^2} \qquad (5)$$

correctly to a few percent when e lies between 0.02 and 0.20 and K exceeds 0.01. Outside these limits, equation (3) is still valid, and may always be used.

If a is measured in units of a_e, 6378 kilometers, there results from (4) the practical formula

$$\rho_\Pi = - 4.826 \times 10^{-15} \dot{P} \; \frac{m}{A\, C_D} \; \frac{c^{1/2}}{a\, f\,(c,e)} \; gm/cm^3, \qquad (6)$$

where $\dot{P}$ is the rate of change of period in seconds per day, m is the mass of the satellite in grams, A is the satellite's area in square centimeters projected on a plane normal to the direction of motion, C_D is the dimensionless aerodynamic drag coefficient, believed to be approximately 2; a is the mean distance expressed in earth radii of 6378 kilometers; c is 6878 Kae if z, in (2), is in kilometers; and $f(c,e)$ is given by (5).

An average value of the A of a non-spherical satellite should be used in (2), and for a convex satellite of which all orientations occur with equal frequency the average A is one fourth of its total superficial area. The value of K, somewhat dependent on perigee height, can be approximated by applying equation (1) somewhat above perigee to a model atmosphere like the ARDC[2]. Alternatively, K may be determined without reference to assumed models by applying equation (5), or (3), to two or more satellites with different perigee heights and adjusting K until it is consistent with the resulting perigee densities.

I am indebted to Dr. G. F. Schilling for urging me to develop some simple, approximate, formula.

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[2] R. A. Minzner and W. S. Ripley, "The ARDC Model Atmosphere, 1956". Air Force Surveys in Geophysics, No. 86, Geophysics Research Directorate, AFCRC, ARDC, December 1956.

3. <u>Density inferred from 1958 Alpha</u>.

Dr. Charles A. Whitney provided orbital data for the American artificial satellite 1958 Alpha, as of February 1, 1958. The data,[3] which he obtained from an analysis of "Moonwatch" (visual) and "Minitrack" (radio) observations, were: eccentricity 0.139, inclination $33^\circ.2$, argument of perigee $120^\circ.0$, anomalistic period $0^d.0798274$, rate of decrease of period 3.9×10^{-7} days per period or about $0^s.42$ per day. From these data I have inferred a mean distance of 1.22757 earth radii, corresponding to a perigee height above the international ellipsoid of 368 kilometers.

The satellite is[4] a cylinder 6 inches in diameter and 80 inches long, with a mass of about 14 kilograms. The area $\underline{A}$ of such an object, relevant to its air resistance, is its area projected on a plane normal to its direction of motion. The average over all possible orientations for random tumbling is 1/4 of the total superficial area, or 2520 cm^2. The same value is obtained if it is considered that the cylinder spins about a transverse axis, randomly oriented with respect to the orbital plane, and gradual orbital changes influence the orientation of the spin axis near perigee from passage to passage. Averaged over a spin period, over orientations of the spin axis with respect to the orbit plane, and over the motion of perigee the same average value is obtained as for random tumbling, 2520 cm^2; this value has been employed as $\underline{A}$ in equation (6).

The aerodynamic drag coefficient has been taken to be 2. The density has been inferred by the method described in Section 2 of this article from this value, the mass, the average area, the eccentricity, the mean distance, the rate of decrease of period, and the logarithmic derivative of density near perigee given by the ARDC model atmosphere.

The density thus found, about 1.5×10^{-14} gm/cm^3 at a geometric altitude of 368 kilometers (348 geopotential) is about 14 times that predicted at such an altitude by the

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[3] See also Harvard College Observatory, <u>Announcement Card</u> 1404 (1958).

[4] Harvard College Observatory, <u>Announcement Card</u> 1390 (1958).

ARDC model. It falls nearly on the middle curve, No. 2, in a study[5] that tentatively suggested a modification of the ARDC atmospheric model to satisfy a density of 4.5×10^{-13} gm/cm^3 at 220 kilometers (213 geopotential) that had been inferred[6] from observations of the USSR satellite 1957 Alpha 2. This value was about 9 times the ARDC density.

The values 4.5×10^{-13} gm/cm^3 and 1.5×10^{-14} gm/cm^3 depend somewhat, although not strongly, upon the gradients of density of the ARDC model employed in the reductions. It seems better to adjust the model so as to render it consistent with the perigee densities that result from the K's of the adjusted model. A formal least-squares adjustment has not yet seemed warranted but a non-least-squares adjustment, allowing for the effect of the adjustment upon K, has indicated densities of about 4.0×10^{-13} gm/cm^3 at 220 kilometers (geometric) and about 1.4×10^{-14} gm/cm^3 at 368 kilometers (geometric). These values do not agree well with the densities predicted by Harris and Jastrow[7] as extrapolations from altitudes of about 220 kilometers and below. They appear to be in unexpectedly good agreement with curve No. 2 of reference 5, do not involve any very implausible temperature gradients, and I prefer them.

4. Adjustment of the ARDC Atmosphere

The preferred values at 220 and 368 kilometers can be represented by an additive correction to the common logarithm of the density of the ARDC model, of roughly

$$0.89 + 0.0016\ (\underline{z} - 220)$$

where $\underline{z}$ is the geometric altitude in kilometers above sea-level.

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[5] T. E. Sterne, G. F. Schilling, and B. M. Folkart, Special Report No. 7, IGY Project No. 30.10, Smithsonian Astrophysical Observatory, Cambridge (1957), Figure 2.

[6] T. E. Sterne and G. F. Schilling, Special Report No. 3, IGY Project No. 30.10, Smithsonian Astrophysical Observatory, Cambridge (1957).

[7] I. Harris and R. Jastrow, Science 127, 451 (1958).

Life Expectancy of Satellite 1958 Alpha

By

Luigi G. Jacchia*

Dr. D. G. King-Hele of the Royal Aircraft Establishments, Farnborough, England, has kindly transmitted to us a useful formula developed by Dr. D. C. M. Leslie for computing the lifetime of a satellite. At a given time t let P be the period of the satellite, $\dot{P}$ the rate of change of the period, and e the orbital eccentricity. The life expectancy of the satellite at time t can then be expressed as

$$T = \frac{3}{4} e \left[1 + O(e)\right] \frac{P}{\dot{P}} \qquad \left[O(e) = \text{errors of order } e\right]$$

This equation gives excellent results when applied to satellites 1957 $\alpha 1$, 1957 $\alpha 2$ and 1957 β.

According to Dr. Charles A. Whitney,[1] on February 1, 1958 we had for satellite 1958 α:

$$P = 0^{d}\!.07983; \quad \dot{P} = -4^{d}\!.78 \times 10^{-6}/\text{day}; \quad e = 0.139.$$

From these data Leslie's formula yields a life expectancy of 1740 days, or 4 years and 9 months; the satellite should then fall toward the end of 1962.

Before the value of $\dot{P}$ became accurately known from observations, a rough calculation of the drag to be expected on the basis of the physical characteristics of the rocket satellite and of the Smithsonian Interim Atmosphere[2] densities had given a predicted value of $-5^{d}\!.7 \times 10^{-6}$/day for $\dot{P}$, from which a life expectancy of 3 to 5 years was deduced.

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*Physicist, Smithsonian Astrophysical Observatory

[1] Harvard Announcement Card No. 1404; March 17, 1958.

[2] T. E. Sterne, B. M. Folkart, and G. F. Schilling: "An Interim Model Atmosphere Fitted to Preliminary Densities Inferred from USSR Satellites". Special Report No. 7, IGY Project No. 30.10, Smithsonian Astrophysical Observatory, Cambridge, December 31, 1957.

CHAPTER IV

USE AND DISTRIBUTION OF SATELLITE PREDICTIONS

by

R. M. Adams*

The individual sections of this Chapter discuss in detail the various ephemerides, or computer programs, used by the Smithsonian Astrophysical Observatory for the analysis of incoming observational data.

The sub-satellite program, developed by Dr. L. G. Jacchia, is a computer program used internally to rapidly analyze incoming observations and to derive the basic information for the computation of search ephemerides. The program was devised by Dr. Jacchia and originally programed for the IBM type 650 computer by R. E. Briggs. It was later translated for use with an IBM type 704 Calculator by C. T. Apple.

Ephemeris 5, described by John Gaustad, produces satellite predictions of a nature which are useful for Moonwatch and other observing teams and, in addition, are also of interest to the general public. These predictions are easily obtained and can be distributed readily. Normal operating procedure consists of mailing these predictions to Moonwatch teams, astronomical observatories, and other groups of interested observers on a regular basis. The predictions are normally accompanied by the orbital elements used in making the predictions. These predictions are also used for constructing the charts described by Fairman and Veis.

Ephemeris 4, discussed by Charles Moore and Don Lautman, is designed to produce precise predictions for the twelve photographic tracking stations established throughout the world by the Smithsonian Astrophysical Observatory. These predictions are sent in coded form by telecommunication channels on a day by day basis.

Ephemeris 3, discussed by R. Briggs, is designed to produce a sequence of predictions for particular stations in the nature of time, azimuth, altitude, height, and distance for the latitude crossing, and time, altitude, and distance for the meridian crossing. Although it was ori-

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ginally felt that predictions of this nature would be necessary for the individual observing stations, this has not proved to be the case. Due to the comparatively large amount of machine time required for these predictions, it is now felt that they will be made only in particular applications when the situation warrants.

The charts of predicted satellite positions, described by Jean B. Fairman and George Veis, were originally intended for internal use and, incidentally, for presenting predictions to interested news agencies in a form convenient for public use. However, the use of these charts has been extended. They now provide information which is broadcast over the Civil Air Patrol Communications Network, thus enabling rapid dissemination of predictions. Arrangements have been made whereby observing teams are contacted daily by CAP units providing the most recent predictions of satellite passages. To a great extent, this arrangement alleviates the problem encountered in distributing predictions by mail. This is particularly true, of course, in those instances in which it is impossible to make accurate predictions for more than 3 or 4 days in advance due to fluctuations in the rate of a satellite's acceleration.

Program for Determination of Geographic Sub-Satellite Points

by

Luigi G. Jacchia*

The sub-satellite-point routine was devised for the double purpose of rapidly analyzing incoming observations and of obtaining from them the basic results necessary to compute a search ephemeris. Osculating equatorial elements are assumed for a time t_o (either an ascending node or a perigee crossing) and instantaneous elements are derived from them for any time t, using empirical equations to account for secular perturbations and drag.

The elements are given in the following form:

$$t_{\Omega} \text{ (or } t_{\pi}) = t_o + c_1 n + c_2 n^2 + c_3 n^3$$

$$\omega = d_o + d_1 t + d_2 t^2 + d_3 t^3$$

$$i = \text{constant}$$

$$q = \text{constant}$$

Here t_{Ω} is the time of ascending-node crossings, t_{π} the time of perigee crossings, ω the argument of perigee, i the orbital inclination, q the perigee distance, and n the number of revolutions elapsed since t_o; c_1, c_2, c_3, d_o, d_1, d_2, d_3 are constants. The right ascension of the ascending node, α_{Ω}, is given only in crude form ($\alpha_{\Omega} = \alpha_o + \alpha_1 t$), since it is required only to know whether the observation was made on the ascending or the descending half of the orbit.

Every observation consist of two spherical co-ordinates (right ascension and declination, or azimuth and altitude) referred to a time t and to a set of station co-ordinates, which are fed into the machine program as input data. First the machine computes the value of n at the node or perigee crossing immediately preceding t, then computes the nodal or anomalistic period for that value of n by differentiation of t_{Ω} or t_{π}, and proceeds to compute from it the

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instantaneous major axis a and the eccentricity e. The height above the sea level at the time of observation is obtained by an iterative process - first it is computed for an orbital point at the latitude of the observing station; using this height, an approximate sub-satellite point is computed, for which in turn a new height is obtained using its latitude; this gives a new approximation to the sub-satellite point, and so on.

Once the sub-satellite point is stabilized, instantaneous values of α_{Ω} and t_{Ω} are computed from it using the orbital elements; residuals are taken for both quantities from empirical equations to facilitate the task of plotting their values on large-scale diagrams.

The program gives somewhat uncertain results when the observations are made near the orbital apex (the point of highest or lowest latitude). In those cases, if a_{Ω} is well known from other observations, the iteration for the sub-satellite point can be made to start from $\alpha_s - \alpha_{\Omega}$ instead of φ_s' (α_s = right ascension of station, φ_s' = geocentric latitude of station). The times $t_{\circ}$ and t_{π} will still be useable, although no independent value of α_{Ω} can thus be obtained.

Predictions for Crossings of Given Latitude Parallels -- APO Ephemeris 5

by

John Gaustad*

Ephemeris 5 is a general satellite prediction program written for the IBM 704 computer. It is designed to prepare a concise summary of predictions in a form easily usable by observing teams and other interested parties and yet general enough for quick production and distribution. It is not intended to have the specific applicability of Ephemerides 3 and 4 to individual MOONWATCH or camera tracking stations, but because of its generality it takes relatively little computer time.

The program produces as its primary output a list of all crossings of a parallel of latitude in a specified period of time. It lists for both the south-north and the north-south crossings the time of crossing, the longitude, and the height of the satellite above the earth's surface. The angle at the point of crossing between the meridian and the trace of the satellite path on the earth's surface is also computed.

The program is general enough so that it can be used for any satellite and any parallel of latitude. For the Russian satellites, 1957 Alpha and 1957 Beta, the most useful information was the crossings of the 40th parallel, this being about the middle of the United States. For the American satellites, because of their lower inclination, 30th parallel crossings are the most generally used. The program can also be used in making predictions for the southern hemisphere.

The format of the predictions can be varied by the use of code numbers on the input cards. Times may be computed and printed in either Universal Time (UT) or Eastern Standard Time (EST), longitudes in degrees west or east of Greenwich, and heights in either miles or kilometers.

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*Physical Science Aide, Optical Satellite Tracking Program, Smithsonian Astrophysical Observatory.

M CONDR 663RD ACWRON LAKE CITY TENN

O RJEDDN/COMDR ADC ENT AFB COLORADO

JEDFLCOMDR 58TH AIR DIV WPAFB OHIO

JEDWPCOMDR AIR TECH INTELLIGENCE CENTER WPAFB OHIO

JEPHQ/DIRECTOR OF INTELLIGENCE HEADQUARTERS USAF WASH D C

T

CLASS OPERATIONS INTELLIGENCE 249. SUBJECT:

Note color and time of Day (Dusk)

Note

FOB REPORT; IR 3-58. REFERENCE PARAGRAPH 7D, AFR 200-2. ITEM
(1)(A) ROUND, (1)(B) NONE, (1)(C) FIREY RED, (1)(D) ONE, (1)(E)
N/A, (1)(F) TERRIFFIC SPEED, (1)(G) FIREY TAIL ABOUT SAME SIZE OF
BJECT, (1)(H) NONE, (1)(I) TERRIFFIC SPEED AND VERY HIGH, ITEM
(2)(A) LOOKOUG OUT OF WINDOW, (2)(B) NONE, (2)(C) NONE, (2)(D) EAST
TO WEST, (2)(E) SAME AS APPEARANCE, (2)(F) FEW SECONDS, ITEM (3)(A)
ROUND VISUAL, (3)(B) NONE, (3)(C) NONE, ITEM
(4)(A) 01/0030Z (4)(B) DUSK, ITEM (5) GJGF 4908. ITEM (6) NONE,
(6)(A) MR [redacted], 52, LAKE CITY TENNESSEE, RETIRED MINER,

Location

Note!

Time of day or night

0030 - 5 = 1930 hrs

(7:30 Local time)

Teletype operator says could be error in Time

AGE TWO RJEDFL 3K

(6)(B) NONE, ITEM (7)(A) VERY GOOD, (7)(B) NONE, (7)(C) UNLIMITED,
(7)(D) 15 MILES, (7)(E) NONE, (7)(F) NONE. ITEM (8) N/A.
TEM (9) N/A. ITEM (10) NONE. ITEM (11) 1ST LT. WILLIAM D.
URY, OPERATIONS OFFICER, NONE. ITEM (12) NONE.

/1544Z MAR RJEDFL

No Winds given. But Wx says some terrific to down there.

Also (See Report

In addition the results may be rounded to the nearest minute, tenth of a degree, and mile, or one hundredth of a minute, one thousandth of a degree, and one hundredth of a mile, for time, longitude, and height, respectively.

The elements necessary as input data for the program are as follows: an equation either for the time of crossing the ascending node or of passage through perigee as a function of the number of revolutions, quadratic equations in time for the argument of perigee and the right ascension of the ascending node; the inclination; and the perigee distance. The perigee distance is assumed to be constant over the range of prediction. From these elements the predictions are made using the standard equations for an elliptic orbit.

Secular and long period perturbations causing changes in the argument of perigee and right ascension of the node are accounted for in the quadratic equations for these elements. Atmospheric drag is accounted for empirically in the equation for time of nodal crossing or perigee passage. Short period perturbations are not included. The semi-major axis is computed directly from Kepler's Third Law, using either the nodal or anomalistic period, depending on the form of the time equation. This leads to some error in the heights, but for the present satellites, this does not exceed one mile.

A secondary part of the program is concerned with producing a "situation" report which gives the most pertinent facts about a satellite's orbit. Computed for any day are the period, rate of change of period, latitude of perigee, rate of change of latitude of perigee, height of perigee, height of apogee, rate of change of height of apogee, and height over a specific parallel of latitude (40th for 1957 Alpha and 1957 Beta, 30th for 1958 Alpha and 1958 Beta) for both the south-north and north-south crossings.

The program is in operating condition and has been used successfully for the past several weeks in making predictions for the U S. satellites. Changes are contemplated in the future to incorporate a more accurate method of determining the heights. Tests will be made to insure that the program works properly for special cases such as inclinations greater than ninety degrees (retrograde satellites).

Predictions for Photographic Satellite Tracking Stations -- APO Ephemeris 4

by

Charles H. Moore* and Don A. Lautman**

Ephemeris 4 is the computer program for predicting satellite positions for the Baker-Nunn camera stations. The present formulation utilizes the currently best set of elements available, accounting for the drag by means of a polynomial in the mean motion, and including only secular perturbations. The prediction subroutine is a numerical integration which includes the effects of oblateness and drag exactly. In the case of satellites which are high enough so that drag can be neglected, a complete first-order perturbation theory including periodic perturbations can be used.

The basic requirements demanded of predictions intended for camera stations are: (1) predictions must be limited to observable passes and (2) predictions must be made for the point of culmination. The optimum approach would be to integrate the equation of motion for the satellite, obtaining these predictions, as well as other data, directly. However, a quicker, though less accurate, method is discussed here, which has been developed in an attempt to obtain predictions as soon as possible.

This program for the IBM EDPM 704 employs the orbital elements of the satellite and transforms them by graphical (trigonometric) means into specific predictions. The accuracy of the predictions is well within the accuracy of the orbital elements employed, and is probably the best that can be gotten without employing more sophisticated methods, and is fitted to the requirements of the Baker-Nunn tracking cameras.

The input to the computer consists basically of the coordinates of the stations (latitude, longitude and height above sea level) and the orbital elements. The latter include the time at which the satellite is at the ascending

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** Mathematician, Optical Satellite Tracking Program, Smithsonian Astrophysical Observatory

node (or at perigee), the right ascension of the ascending node, the argument of perigee, the inclination of the orbit to the equatorial plane, the value of perigee, and the eccentricity of the orbit. Time is given as a polynomial in the number of revolutions, from which the period can be determined; position of the ascending node and perigee are polynomials in time; the other elements are instantaneous values at an arbitrary, specified time. Additional input data includes positions of the vernal equinox and the sun for January 0 of the current year, and the dates for which predictions are desired.

The program follows the general outline listed below:

(1) Reduces the station coordinates to more convenient form.
(2) Updates the instantaneous values of the orbital elements. This is done each revolution.
(3) Computes the point of entry into and exit from the earth's shadow. This data may be printed out if desired. It is useful for general predictions where great accuracy is not expected.
(4) Computes the position of culmination for each station, determines whether the conditions for visibility from the stations are fulfilled, and if so prints that information.

There are three distinct portions of the output. First, the latitude, longitude and time of entry into or exit from the earth's shadow. Second, the altitude, azimuth, range, angular velocity, and time of culmination of visible passes for each station. The conditions for visibility employed require that the satellite be visible at least 15° above the horizon and be illuminated by the sun, while the station is inside the earth's shadow. No restriction is placed upon the photographic magnitude of the satellite. Hence, the range is printed to be taken into consideration when using the predictions. Angular velocity is useful for tracking purposes.

The third portion of the output is essentially the station prediction described above, however, it is put into a code suitable for teletype transmission, which may be sent directly without further reworking.

Thus, the program computes predictions over a specified interval of time and supplies the following information at each visible passage of a station:

(1) Altitude and azimuth of the point of closest approach.

(2) Time of closest approach.
(3) Apparent angular velocity.
(4) Angle between point of closest approach and passage into or out of the earth's shadow.
(5) Time of intersection with the earth's shadow.
(6) Distance of the satellite.
(7) Zenith angle of the sun.

The advantages of the program are an expected minimum of computation time, and the elimination of superfluous data, namely non-observable predictions. With such a program, predictions can be made to the necessary accuracy as soon as orbital elements are available. The disadvantage of the program is its dependence upon the independently determined orbital elements.

Program of Spot Predictions for Specific Observing Sites -- APO Ephemeris 3

by

R. Briggs*

This program computes for a given observing station a sequence of satellite positions in altitude-azimuth and corresponding times. This sequence comprises all the observable (visual or otherwise) latitude and meridian crossings which will occur within a specified interval of time. Accuracy is limited at the present to the use of first and second derivatives of the nodal period, to the use of first derivatives in the motions of perigee and the node, and to the assumption of constant perigee distance. When the effects of air drag are included under these restrictions, experience has shown that over two weeks the positions may be in error by at most four degrees and the times in error by a few seconds.

As yet, Ephemeris 3 has not been used for the American satellites. It is planned to make minor revisions in the program so that the anomalistic period of the satellite can be used in place of the nodal period. Further, derivatives of the anomalistic period will include trigonometric and/or exponential terms. These changes are presently being developed and the program will see use when the operational situation warrants the comparatively large amount of machine time required.

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* Mathematician, Smithsonian Astrophysical Observatory

Charts of Predicted Satellite Positions

by

Jean B. Fairman* and George Veis**

In an effort to provide more information in forms immediately useful, without considerable computation, for observers in the U.S. and readily understandable to the general public, we have made our prediction data available in several forms other than the formal Ephemerides, the primary prediction material sent by mail.

1. Visibility Maps

The first of these additional distribution operations was our production for the newspapers, wire services, and networks of daily maps of the northern hemiphere showing the visible passes of the satellites. The aim of this distribution has been to encourage the publishing of these maps and/or satellite predictions on a daily basis by the papers both for the specific information of our many observers and for the interest of the general reader, as a supplement to the sometimes delayed mail deliveries. To date, they have been regularly picked up by the Associated Press and sent to New York for distribution, although their correspondent reports a general lack of interest among subscribing papers. A sample of these maps is shown.following this section.

Each map contains all visible passages of the satellite for the morning or evening twilight period of a given day, and shows in an easy to grasp fashion the time, location and direction of the pass relative to the observer, who can locate himself easily on the map. The maps are designed to appear as simple as possible, with a legend briefly explaining the meaning of the outlines (omitted in the samples).

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**Consultant, Optical Satellite Tracking Program, Smithsonian Astrophysical Observatory.

The visible portion of each passage is shown as a solid line, and its dashed extension represents the non-visible interval of the orbit which lies within the area of general visibility. Each of the cross bars on the satellite path represents a minute of travel, so that the time of the satellite's passage over any point can easily be determined. The dot separating the solid and dashed orbit locates the point at which the satellite enters or leaves the earth's shadow, and the line which interrupts the opposite end of the visible orbit represents the 6° twilight (Civil Twilight) boundary. The closed dotted or dashed form encloses the complete area within which the satellite may be seen above 15° altitude. In addition to the twilight boundary, the other sides of the area show the distance from which the satellite may be seen, as a function of its height.

In spite of the relative simplicity of the diagram, its construction incorporates corrections for the following factors, which give it a reasonably good degree of accuracy:

(1) Inclination of the orbit.

(2) Period or speed of the satellite--this affects the time markings on the satellite path.

(3) Eccentricity and true anomaly. Corrections for these factors further refine the time intervals.

(4) Height of the satellite. Distances of visibility and location of the earth's shadow depend on this factor.

(5) Rotation of the earth. This affects the longitude of the sub-satellite points.

(6) Regression of the ascending node. This correction further locates the points over which the satellite will pass.

(7) Changes in the coordinates of perigee. Correction for this adds to the accuracy of the height and period adjustments.

(8) Changes in the declination of the sun. This revision updates the twilight time limits and position of the earth's shadow.

(9) Changes in the Greenwich Hour Angle of the sun. This correction refines the time designations around the earth.

The production of these maps was begun for Satellite 1958 Alpha on February 26, in anticipation of the visibility period which lasted from about February 27 to March 27. The maps have been produced and distributed regularly throughout the period, including a total of 30 daily projections of visible passages of 1958 Alpha.

2. Modified Maps

In a further effort to encourage the regular publishing of satellite data, we have cooperated with various publications in drawing up modifications of the standard, individual maps. The most successful venture of this sort to date have been the modified maps carried by the New York Times from March 19, when visibility of all the satellites was at its peak, through March 22, when visibility from the U. S. was diminishing.

These particular modified maps combined in one illustration the visible paths of all the satellites, showing the time intervals of visibility for each passage, but omitting for simplicity the areas of visibility. In this map, Satellite 1958 Alpha is represented by the heavier orbital paths, the lighter paths describing Satellite 1957 Beta one. Those visible passages which terminate in an arrow actually move out of visibility beyond the margins of the page. The particular map included here, for comparison with the first, was sent to the Times before Satellite 1958 Beta was launched and so does not include it, although it was added by the paper before publication.

We hope to establish this sort of regular publication even more firmly during the next visibility period.

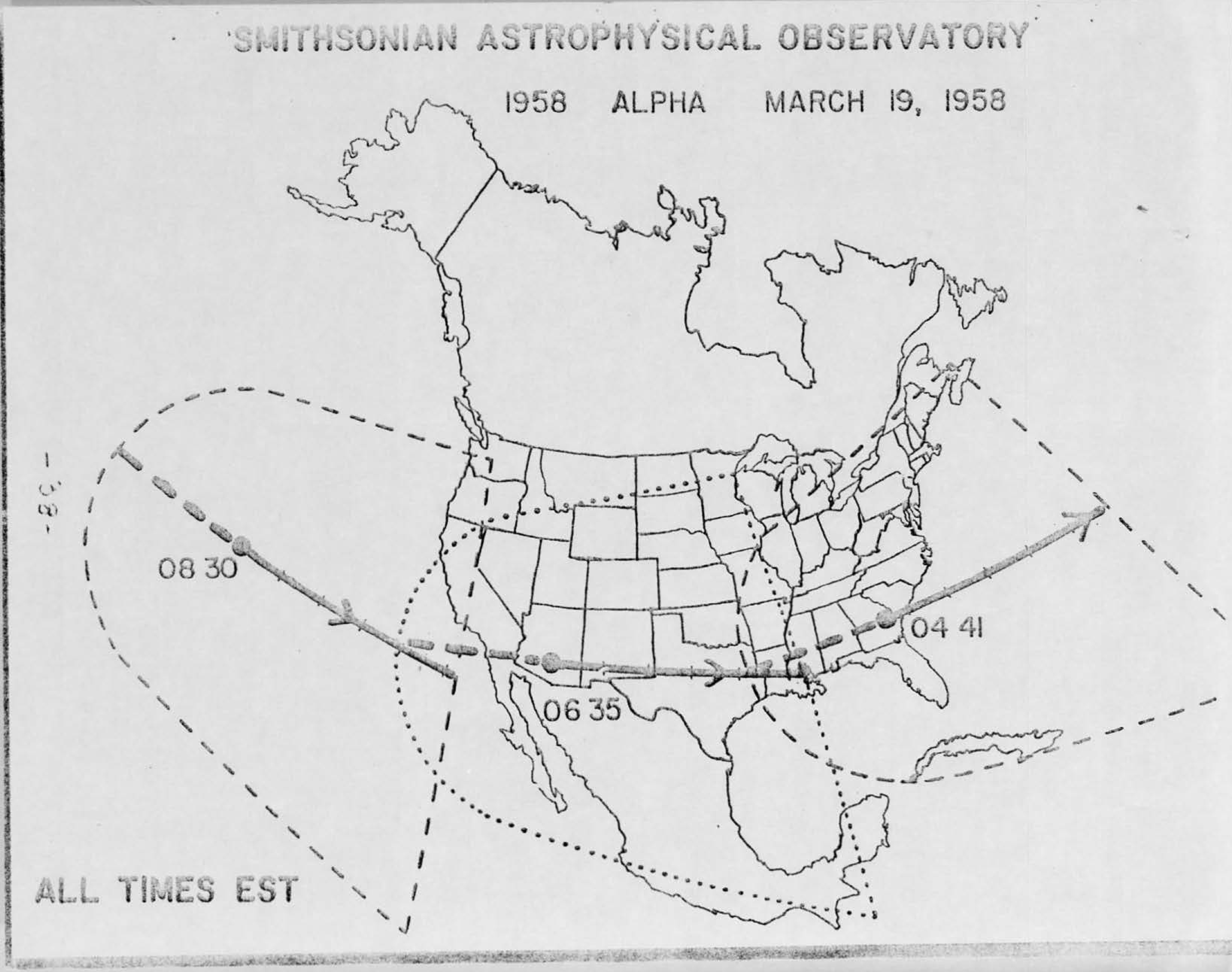
3. Broadcast Releases

Realizing that even if a large percentage of newspapers published the maps, that some observers would still not be reached, we have arranged through the efforts of the U. S. National Committee for the International Geophysical Year and the cooperation and facilities of the Civil Air Patrol, to get our predictions to the observing teams and the public through the Civil Air Patrol's scheduled shortwave broadcasts. This program operates hand-in-hand with the "Relative Position Grid" kit issued by the U.S.National Committee of the I.G.Y. to all observing teams, which allows these observers with the addition of our specially tailored prediction messages, to produce for themselves "maps" giving the same sort of information which our regular maps would otherwise supply.

In addition to the channels of communication supplied by the Civil Air Patrol, we have been aided in getting these predictions onto the air by the American Radio Relay League.

When the last visibility period began on February 27, we started sending these special predictions to the National Academy of Sciences for relay to the Civil Air Patrol broadcast stations, and are now sending the predictions directly to four Civil Air Patrol Stations, across the country. These predictions were issued regularly for Satellite 1958 Alpha throughout the last visibility period until March 27. During the subsequent period of no visibility, a statement is substituted for the regular messages to that effect.

These three areas of activity, then, are the means by which we have to date attempted to supplement the mailings of standard 30th Parallel Crossings in order to get the needed information to observing teams in this country in an easy to use form, which can readily be revised and corrected without time lapse to provide the very latest information, on time. We have had an encouraging measure of success in this area, and anticipate further benefits from these efforts.


SMITHSONIAN ASTROPHYSICAL OBSERVATORY
1958 ALPHA MARCH 19, 1958
08 30
06 35
04 41
ALL TIMES EST

Lake City - Powell St, Tenn

Comment:

1. Check with Wx shows pretty strong winds at those locations. Winds general S - SW (from)

2. Object red, funnel or round shape and seen at dusk. (This is a well-known characteristic of balloon at/or near dusk or dawn)

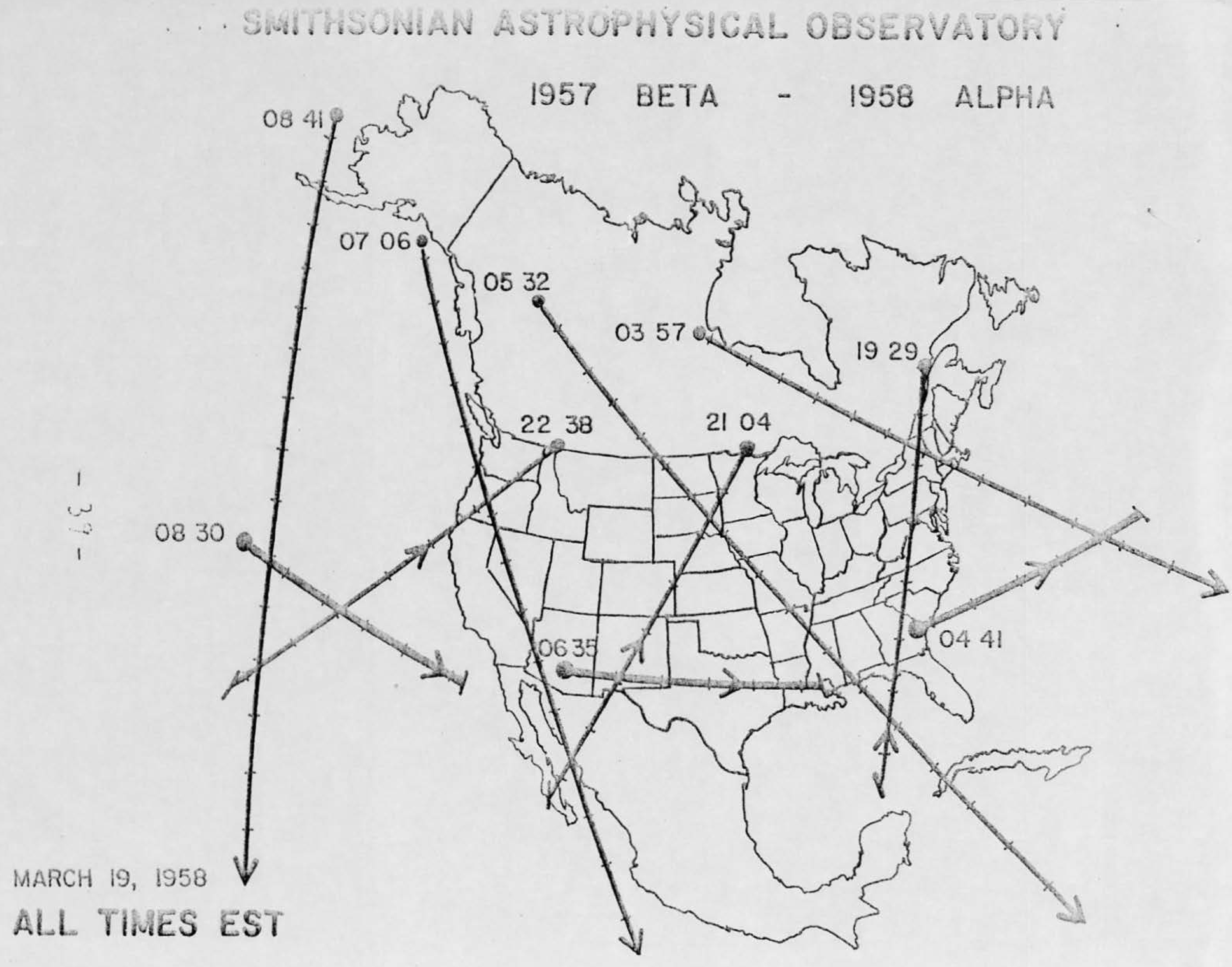
3. Speed to high for balloon. However, if seen out of a window (as both sources state) and wind was fast enough - it would seem to flash by.

3. Object was seen a few minutes ~~apart~~ near the same locality. This would ~~[illegible]~~ overrule high speed and large distances covered.

4. Also possible - one object was a ~~balloon~~ while the funnel shaped object (60 miles) was a meteorite.

5. On basis of the brief data given -

Possibly balloons - observed under limiting conditions (window) (darkness) (moving platform, etc)



SMITHSONIAN ASTROPHYSICAL OBSERVATORY
1957 BETA - 1958 ALPHA
08 41
07 06
05 32
03 57
19 29
22 38
21 04
08 30
06 35
04 41
MARCH 19, 1958
ALL TIMES EST

CHAPTER V

HARVARD ANNOUNCEMENT CARDS

Announcement Card 1390

Satellite 1958α. -- The U.S.A. National Committee for the International Geophysical Year has announced that an instrumented earth satellite was placed in orbit on February 1, $3^h55^m05^s$ U.T. at a point approximately $25^\circ.84$ N and $73^\circ.61$ W. It was launched by a U.S. Army Jupiter C rocket on February 1, 3^h48^m U.T. from Cape Canaveral, Florida at $28^\circ.5$ N and $80^\circ.6$ W.

Including the empty rocket casing of the last stage, the satellite weighs about 30 lbs, is cylindrical in shape with a length of 80 inches and a diameter of 6 inches. It contains two radio transmitters; amplitude modulated transmission at 108.03 mc with power level of 50 milliwatts; phase modulated transmission at 108.0 mc with power level of 10 milliwatts; telemetry of data by both transmitters.

The surface of the satellite is white and may be visible with binoculars under optimum conditions. Scientific experiments include cosmic ray observations, meteoric impact, and temperature measurements.

February 1, 1958 Fred L. Whipple

Announcement Card 1393

Satellite 1958α. -- Dr. Paul Herget and Dr. Raynor L. Duncombe of the Naval Research Laboratory in Washington, D.C. have obtained the following preliminary orbital elements for Satellite 1958α from analysis of Minitrack observations extending over the first 32 revolutions, for 3^h58^m U.T. on February 1, 1958:

Minimum Height	219 miles
Maximum Height	1587 miles
Period	114.95 minutes
Eccentricity	0.14052
Inclination	$33^\circ.58$
Longitude of Ascending Node	$342^\circ.95$ (motion -4.26 per day)
Argument of Perigee	$120^\circ.76$ (motion +6.31 per day)
Mean Anomaly at Epoch	$14^\circ.68$
Semi-major Axis	1.2278 earth radii

The following optical observations of Satellite 1958α have been received from Moonwatch teams:

Date February	Time U.T.	Position R.A.	Dec.	Type of Obs.
		Alamogordo, New Mexico (Lat. 32° 52' 24" N Long. 105° 57' 02" W)		
2	$2^h 45^m 54^s$	$4^h 54^m \pm 5^m$	$+33°06'$	vis. +8 mag.
		Manhattan, Kansas (Lat. 39° 09'.75 N Long. 96° 28'.85 W)		
3	$1^h 44^m 16^s$	$5^h 37^m$	$-1°40'$	vis. +5 mag.
		Alamogordo, New Mexico (Lat. 32° 52' 24" N Long. 105° 57' 02" W)		
3	$3^h 46^m 10^s$	$5^h 23^m$	$+14°54'$	vis. +8 mag.

China Lake, California

(Lat. 35°.657 N Long. 117°.663 W)

6 $2^h 24^m 42^s$ Az. N 177°.25 E Alt. 71° vis.

February 5, 1958 Fred L. Whipple

Announcement Card 1404

Satellite 1958α. -- Dr. Charles A. Whitney of the Smithsonian Astrophysical Observatory has obtained the following orbital elements for Satellite 1958α from an analysis of MOONWATCH and Minitrack observations through March 3, 1958:

Epoch and Time at Perigee 1958 Feb. $1^d\ 3^h\ 52^m\ 53^s$

$e = .139 \quad q = 1.0566 \quad Q = 1.3985$ (apogee distance)

$i = 33°.19 \quad \Omega = 343°.4 \quad \omega = 120°.0$

Times at Perigee Feb. $1.16182 + 0.798274\ N - 1.910 \times 10^{-7} N^2 + 0.00025 \sin .0177\ (N - 20)$

Motion of Perigee and Ascending Node (deg/day)

$\dot{\omega} = 6.334 + 0.00084\ (T - \text{Feb. } 1.0)$

$\dot{\Omega} = -4.237 - 0.00059\ (T - \text{Feb. } 1.0)$

March 17, 1958 Fred L. Whipple

E FIELDS

BACTERIOLOGY

Unique Bird Digests Wax With Help of Bacterium

➤ PART OF the honey-guides' secret is out. Studies of this unusual family of African birds show that they digest bees' wax with the help of a bacterium found in their intestinal tract.

Scientists are hopeful the discovery may offer a clue to a new attack against tuberculosis.

The new bacterium was discovered by Drs. Herbert Friedmann, curator of birds at the Smithsonian Institution, and Jerome Kern, formerly of the department of bacteriology at the Walter Reed Medical Center's Army Medical Services Graduate School. It has been found to have some "degree of interference" with the tuberculosis-causing bacterium.

For years, scientists have been searching for ways to destroy the lipoidal or waxy content of the disease organism. It is this waxy content that very likely protects the organism against therapeutic attack. Further studies are planned to see how the waxy content is affected by the new bacterium.

Micrococcus cerolyticus, as the "wax-breaking" bacterium is called, was described to the Johns Hopkins University's Society of Hygiene meeting in Baltimore, Md. Identification of the bacterium is the result of more than three years' study of the honey-guides and their behavior and biology. Dr. Samuel J. Ajl, Walter Reed Medical Center, has assisted in the research.

Science News Letter, January 25, 1958

MEDICINE

Allergies May Be Factor In Childhood Leukemia

➤ ALLERGIES in mothers and children may be an important factor in the development of childhood leukemia.

This has been indicated by an epidemiological study of the cancerous blood disease by Dr. Miriam D. Manning, and Benjamin F. Carroll, Children's Cancer Research Foundation, Boston, Mass., and the National Cancer Institute, reported in the *Journal of the National Cancer Institute* (Dec. 1957).

The scientists found a significantly larger number of mothers of children with both leukemia and lymphatic cancer had a history of hay fever, asthma or hives, compared with control groups or with those having other types of cancer. Their children also had a higher incidence of allergy, often appearing as eczema.

Another significant finding was that almost twice as many mothers of leukemic children had been exposed to X-rays before the birth of their child compared with other groups. The X-ray exposure included any and all "therapeutic irradiation" both before or during pregnancy, without relation to the site or dosage of exposure.

The mothers and children did not as a rule have the same allergy. This might indicate that the child of an allergic mother starts life with a greater susceptibility, though not necessarily the same form of allergy, to sensitizing agents that may later damage the blood-forming ability of bone marrow.

Other researchers have already shown that hypersensitivity can be transmitted between mother and unborn child.

It may be that the child receives a hypersensitive state from the mother which turns into leukemia only upon later exposure to bone-marrow depressing agents.

"We believe that the data presented justify and should stimulate further investigation along this line of approach to the problem of acute leukemia in children," they conclude.

Science News Letter, January 25, 1958

ANTHROPOLOGY

Big Chest, More Blood Help Indian on Andes

➤ ADAPTATION through heredity and further adaptation during the individual's lifetime work together to make the big-chested, stocky little Andean Indians able to live and work hard two miles or more above the level of the sea.

The changes that these two forces of adaptation have made in the Indian's body were studied at Hacienda Vicos, high in the Peruvian Andes, by Dr. Marshall T. Newman, physical anthropologist of the Smithsonian Institution, Washington.

Most striking is the enormous size of the Vicos Indian's chest and the lungs inside it. There is a decided enlargement of the lower part of the rib cage so that the Indian can breathe deep and the diaphragm is also set low. An expanded inner lining of the lungs makes it possible to pick up the maximum of oxygen from the thin mountain air.

The Andean Indian also has more blood than the man at sea level—on the average two extra quarts. The red cells in his blood are larger, providing more surface for taking up oxygen, Dr. Newman reports in *Natural History* (Jan.).

With this larger quantity of thicker blood, the Indians also have a larger, more powerful heart to pump it. They seem to have a better blood supply in their extremities, because even in the intense cold of the mountain top before sunrise, their bare feet and hands are warm.

Another adaptation that protects them both from the strains of altitude and the intense cold is their stocky build. This reduces the distance that blood must circulate to the extremities and also reduces the surface area of the body which can cause loss of body heat by radiation.

Dr. Newman learned the effects of high altitude during a study of the Vicos Indians' blood pressure. Much of the data presented in his report is the work of the Institute of Andean Biology, Lima, Peru.

Science News Letter, January 25, 1958

MEDICINE

Blood and Glass Create Pain-Producing Chemical

➤ A PAIN-PRODUCING substance formed when blood plasma is brought into contact with glass is described by Dr. J. Margolis of Middlesex Hospital Medical School, London, England, in *Nature* (Dec. 28, 1957).

The pain-producing substance appears to be formed by the action of an enzyme in the plasma, but it is rapidly destroyed by another type of chemical substance in the plasma, called a peptidase.

The formation of the pain-producing substance is similar to the initiation of blood clotting by glass.

Chemical analysis showed that the pain-producing substance is formed in several steps. When the plasma is exposed to glass, a substance that has been called "contact factor" is first formed. This "contact factor" then starts further reactions which lead to formation of the pain-producing substance.

The "contact factor" is most active after two minutes, but within 20 to 30 minutes its activity has decreased to negligible values, Dr. Margolis reports.

The "contact factor" develops normally in the plasma of persons with certain blood disorders, such as hemophilia and Christmas disease, in which the blood has lost much of its ability to clot.

Apart from glass, certain other surfaces are capable of activating both pain-producing substance and blood clotting. The exact surface conditions that are involved are still being studied but a clue to the mechanism may lie in the behavior of dried silica gel and alumina.

These are both inactive to begin with, but become quite active after being heated to above 1,000 degrees centigrade.

Science News Letter, January 25, 1958

ANTHROPOLOGY

New Dates Add to Man's Antiquity in America

➤ MAN IS now known to have lived in what is now Alabama close to 9,000 years ago. This is the oldest radiocarbon date for material associated with man's tools in the eastern United States.

The date, 7,950 plus or minus 200 years ago, is published in *Science* (Dec. 27, 1957) by Drs. W. S. Broecker and J. L. Kulp of the Lamont Geological Observatory, Columbia University, Palisades, N. Y.

The date was obtained from charcoal found 13 feet below ground level in Russel Cave, Jackson County.

The radiocarbon dates reported from Lamont Observatory also suggest that man occupied the west coast of North America much longer ago. Charred dwarf mammoth bones found 36 feet below the top of the alluvium were dated at 29,700 years ago plus or minus 3,000.

"This suggests," the scientists say, "that man occupied the west coast of North America before the major ice advance of the latter part of the Wisconsin glacial period."

Science News Letter, January 25, 1958

UNIVERSE

ASTRONOMY

Dog Star Shines in South

While none of the five planets usually visible to the naked eye can be seen on February evenings, there are a number of first magnitude stars visible, Sirius the brightest of all.

By JAMES STOKLEY

➤ BRIGHTEST STAR of the February evening sky is Sirius, which shines in the south in the constellation of Canis Major, the great dog. Because of this, Sirius is often called the dog star. Also, it is associated with the so-called "dog days" of midsummer. About that time of year the sun passes rather close to Sirius. Ancient peoples thought, mistakenly, that the rays of this star combined with the heat of the sun to produce the sultry weather which, they supposed, caused dogs to go mad.

Sirius is shown on the accompanying maps, which give the appearance of the skies at about 10:00 p.m., your own kind of standard time, at the beginning of February, an hour earlier at the middle of the month and about 8:00 p.m. as it comes to an end.

Around Sirius are the other bright stars of the winter evening. Above and right you can see the constellation of Orion, the warrior, with two first magnitude stars: Betelgeuse and Rigel. Between these are the three stars named Anilam, Alnitak and Mintaka, that form the warrior's belt. A little higher is Bellatrix, in his shoulder.

Still higher and farther right we come to Taurus, the bull. In this group stands red Aldebaran, another star of the first magnitude.

Auriga, the charioteer, is directly overhead, with brilliant Capella. Below this group, toward the southeast, you come to Gemini, the twins. In it are two prominent stars, Castor and Pollux, which were the names of the twins, favorite gods in the ancient Roman mythology. However, only Pollux is of the first magnitude; Castor, a little fainter, is of the second. And below the twins, in the direction of the big dog, we come to Canis Minor, the lesser dog, in which Procyon stands.

Still another first magnitude star appears to the east, in Leo, the lion. This is Regulus, at the end of the handle of the "sickle," a smaller star group. The blade of the implement curves around the word "Leo" shown on the map.

Planets Invisible in February

No planets are visible to the naked eye on February evenings. Mercury is nearly in the same direction as the sun, and cannot be seen at all in February. Venus, which shone so brightly in the evening sky until a few weeks ago, is now passing in front of the sun and is similarly invisible. By the end of February, however, it will appear low in the southeast just before sunrise. In brightness, it will be of magnitude minus 4.3, making it the brightest object in the sky. Hence, Venus will continue to be visible even after the sky has gotten quite bright, and other stars and planets have vanished.

Around midnight the planet Jupiter, now slightly brighter than Sirius, will rise in the east, in the constellation of Virgo, the virgin. This group is not shown on the maps, but it is next to Leo, and appears after that group has risen higher. For a few hours before sunrise Mars can be seen low in the southeast, in Sagittarius, the archer. This planet is considerably fainter than those already mentioned; it is about 1.5 magnitude, or a little brighter than the stars of Orion's belt.

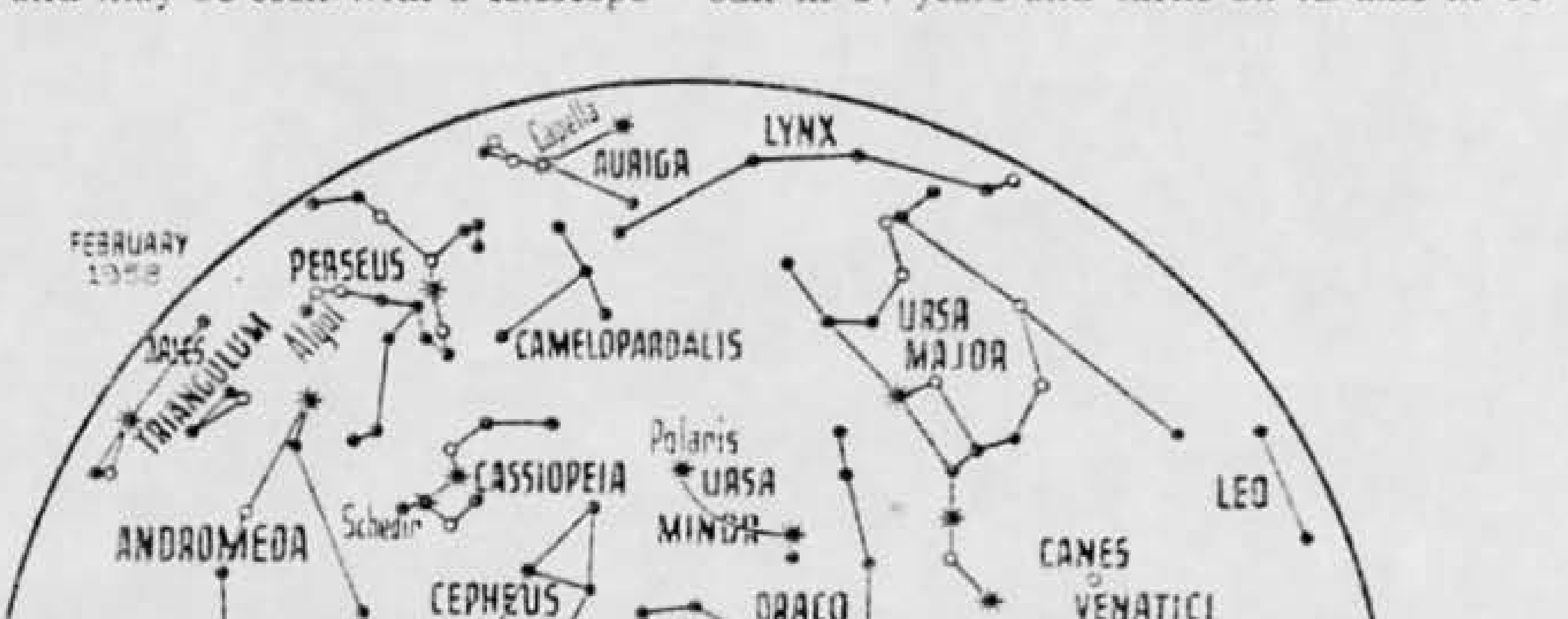
Saturn also rises in the early morning hours, even ahead of Mars, and is in Ophiuchus, just east of red Antares, which is in Scorpius, the scorpion. In brightness Saturn is about equal to a typical first magnitude star.

Although none of the five planets that are visible to the naked eye—Mercury, Venus, Mars, Jupiter and Saturn—are now in the evening sky, two of the other three are there, and may be seen with a telescope of sufficient power. One of these is Uranus, which is now in Cancer, the crab, a group between Leo and Gemini. The approximate position of Uranus is shown by a small X, under the letter "A" in the name of the constellation. At present its magnitude is 5.8, which makes it less than a sixtieth of the brightness of Regulus, standing nearby.

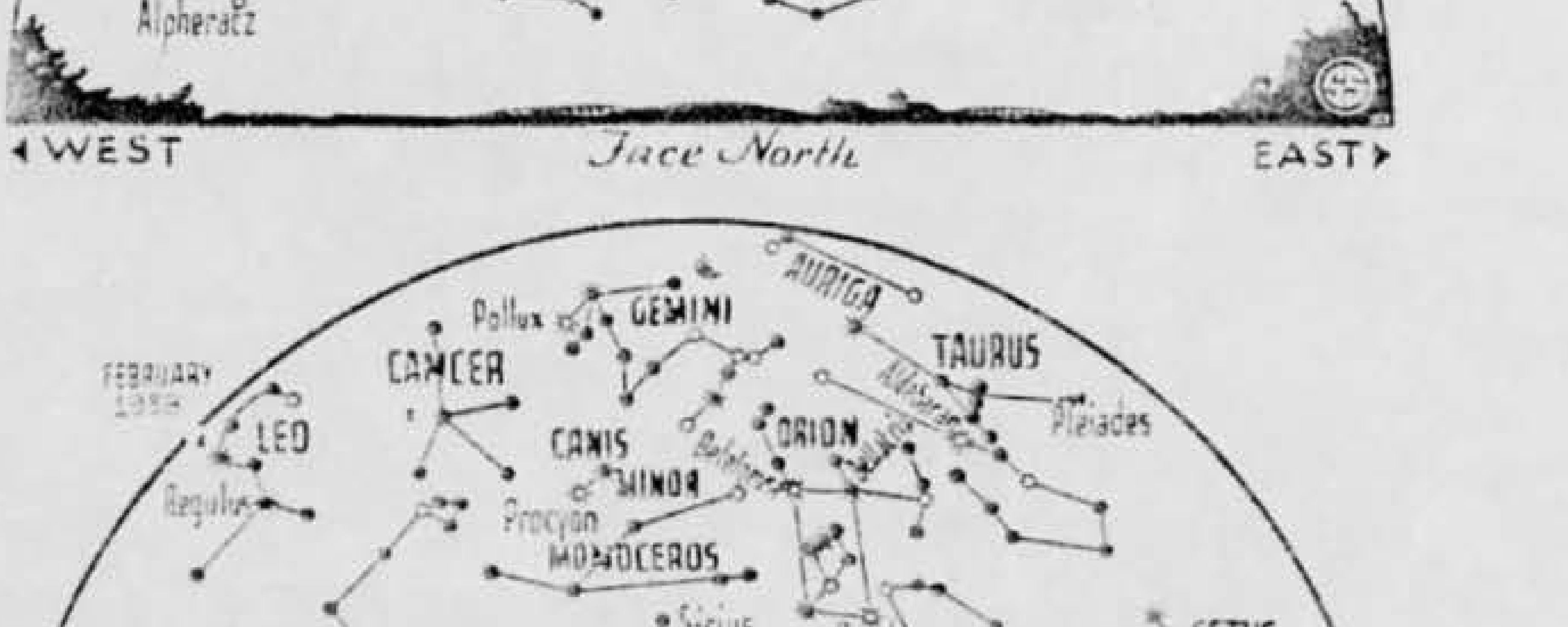
It is generally considered that stars as faint as the sixth magnitude can just be seen with the naked eye, under the most favorable conditions of a clear, dark sky. Theoretically, it is thus possible to see Uranus without a telescope, but this is very difficult, unless you are far from the city's glare and smoky atmosphere.

Uranus' Discovery

Uranus was discovered in 1781 by an English amateur astronomer, William Herschel. When he first saw it, with a telescope that he had made himself, equipped with a concave mirror 6.5 inches in diameter, he realized that it did not look like a star. A few days later, when he saw it again, Uranus had moved a little, so he concluded that he had found a new comet—and so announced it. Computations showed it to be another planet, more than 19,000,000 miles from the sun, about twice as far as Saturn. It revolves around the sun in 84 years and turns on its axis in 11



◂ WEST *Face North* EAST ▸



◂ EAST *Face South* WEST ▸

SYMBOLS FOR STARS IN ORDER OF BRIGHTNESS

he Week

…ived for review since last week's issue are listed. …d a remittance to cover retail price (postage will … Street, N.W., Washington 6, D. C. Request free …

…tended for the amateur enthusiast as well as the technician.

THE EVOLUTION OF THE IGNEOUS ROCKS—N. L. Bowen, introduction by J. F. Schairer—*Dover*, 334 p., illus., paper, $1.85. New student …ition of a book first published in 1928 and …ng out of print.

H. M. STANLEY: UNPUBLISHED LETTERS—Albert Maurice with preface by Denzil M. Stanley—*Philosophical Lib.*, 153 p., illus., $7.50. These rare documents describe the famous Stanley's experiences in opening up the Belgian Congo.

HOW TO IMPROVE YOUR MEMORY—James D. Weinland—*Barnes & Noble*, 149 p., illus., paper, $1. Helpful to the student who finds he must cram at the last minute before an exam or to the busy executive who simply cannot remember to put in a phone call to Mr. X at exactly ten o'clock.

HOW TO MAKE A TELESCOPE—Jean Texereau, translated and adapted from the French by Allen Strickler, forewords by André Couder and Albert G. Ingalls—*Interscience*, 191 p., illus., $4.50. For the painstaking amateur, not for the person the foreword calls a "skitterer who is content with a lick and a dab."

INSECTS—HUNTERS AND TRAPPERS—Ross E. Hutchins—*Rand McNally*, 96 p., illus. with photos by the author, $2.95. Introducing young people to a new world which includes the "pursuit planes" among the insects as well as those that can pull 66 times their own weight.

JAPAN DICTIONARY: Japanalia—Lewis Bush—*Philosophical Lib.*, 226 p., illus., $10. A …ntiful book of information about the life and customs of Japan.

THE MEDICAL AND VETERINARY IMPORTANCE OF COCKROACHES—Louis M. Roth and Edwin R. Willis—*Smithsonian*, 147 p., illus., paper, …25. Showing that these insects are much more than an unpleasant nuisance; they are …ghly dangerous.

NUCLEAR POWER AND ITALY'S ENERGY POSITION—I. M. D. Little and P. N. Rosenstein-Rodan—*Nat. Planning Assn.*, 79 p., paper, …. Italy, more than any other country in Europe, critically needs nuclear power.

NUCLEAR RADIATION IN FOOD AND AGRICULTURE—W. Ralph Singleton, Ed.—*Van Nostrand*, … p., illus., $8.50. Based on papers presented at the Geneva Conference on Peaceful Uses of Atomic Energy in 1955.

PHYSICO-CHEMICAL EFFECTS OF PRESSURE—… D. Hamann—*Academic*, 246 p., illus., $8.50. … the most part concerned with changes brought about by pressures above a hundred …mospheres.

PLANETS, STARS AND SPACE—Joseph Miles Chamberlain and Thomas D. Nicholson—*…ance Educ.* in cooperation with the Am. Mus. of Natural Hist., 223 p., illus., $2.95. A …utifully illustrated book for the beginner in astronomy.

PRIMITIVE RELIGION: Its Nature and Origin—Paul Radin—*Dover*, 322 p., $1.85. Inexpensive student edition of an anthropology [illegible]

PRINCIPLES OF ELECTRICAL MEASUREMENTS—… Buckingham and E. M. Price—*Philosophical Lib.*, … p., illus., [illegible] For advanced students and engineers.

PROJECT VANGUARD REPORT No. 21: Minitrack Report No. 3 The Mark II Minitrack …—Roger L. Easton—*Naval Research Lab.*, *Office of Tech. Services*, 27 p., illus., hours. Uranus has five moons, visible only through large telescopes. Herschel himself discovered two, which he named Titania and Oberon. Two more, Ariel and Umbriel, were found in 1851 by another English astronomer. The last, Miranda, was first detected by Dr. G. P. Kuiper, an American astronomer, at the McDonald Observatory in Texas in 1948.

During the early years of the 19th century astronomers found Uranus was not moving according to their predictions, and decided there must be another planet still farther out, which was pulling on it. Neptune was responsible. It was found in 1846, close to the place where it was expected to be.

At present Neptune is in the constellation of Virgo, not far from Jupiter, and rises about midnight. Neptune is about 2,791,000,000 miles from the sun, which it goes around in 165 years, and it has two satellites: Triton, discovered in 1846, and Nereid. The latter was also discovered by Dr. Kuiper, in 1949.

The most distant known planet is Pluto, discovered by C. W. Tombaugh, at the Lowell Observatory at Flagstaff, Ariz., in 1930. Its average distance from the sun is 3,671,000,000 miles: it goes around in 248 years. Probably it is no larger than the earth, and no satellites have yet been discovered. At present it is in the evening sky, in Leo, alongside the sickle. Its position also is shown by a small X on our map. However, only a very large telescope will reveal this planet, which is about the 15th magnitude. It has been suggested that Pluto was originally formed as a satellite of Neptune, then later escaped.

On Feb. 19 at midnight, Pluto and the earth will be lined up in the same direction from the sun. It is then said to be in opposition with the sun, i.e., Pluto and the sun are in opposite directions from the earth. At such a time an outer planet is closer to the earth than at any other time during the year. Pluto will then be 3,095,000,000 miles away.

Celestial Time Table for February

Feb.	EST	
1	11:23 p.m.	Algol (variable star in Perseus) at minimum brightness.
4	3:05 a.m.	Full moon.
	8:12 p.m.	Algol at minimum.
5	6:00 p.m.	Moon nearest; distance 224,200 miles.
9	8:45 a.m.	Moon passes Jupiter.
10	6:34 p.m.	Moon in last quarter.
13	3:59 a.m.	Moon passes Saturn.
14	6:49 a.m.	Moon passes Mars.
18	10:38 a.m.	New moon.
19	midnight	Pluto in opposition and nearest earth; distance 3,095,000,000 miles.
21	10:00 a.m.	Moon farthest; distance 252,300 miles.
22	1:08 a.m.	Algol at minimum.
24	9:57 p.m.	Algol at minimum.
26	3:51 p.m.	Moon in first quarter.

Subtract one hour for CST, two hours for MST, and three for PST.

Science News Letter, January 25, 1958

NORTHERN HEMISPHERE AWS-WPC 63-1

(NORTH OF LATITUDE 20°)

160°W
150°
145°
140°
135°
130°
125
120°
115°
40°
30°
20°
25°
10
GEO

AACS - ——

ASD TRACK TO R57

Down Position ——— ⊕

NAVY FLT 77

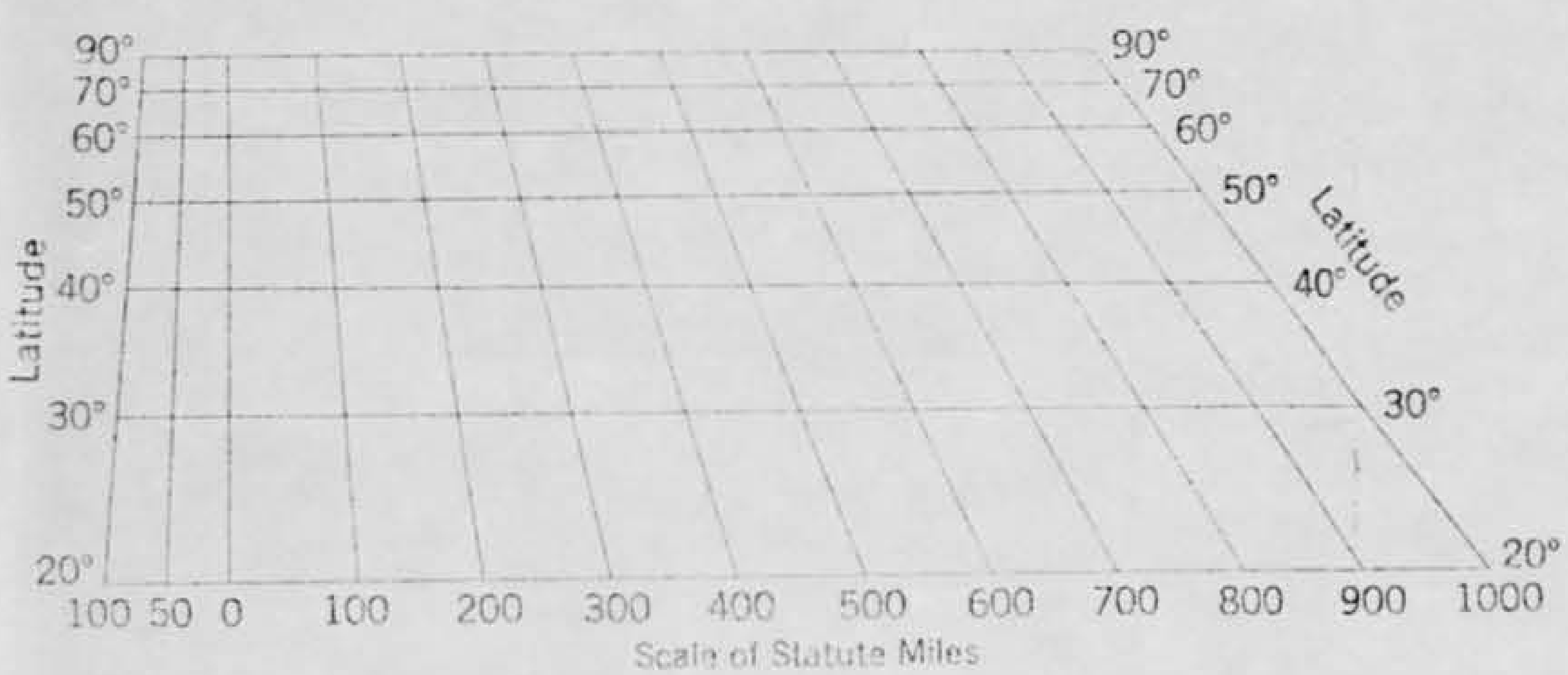
ENTERED AREA 05/1345Z FEB 58

SD Down 08/0215Z Impact 08/0?1?Z

ALT 3 n/m

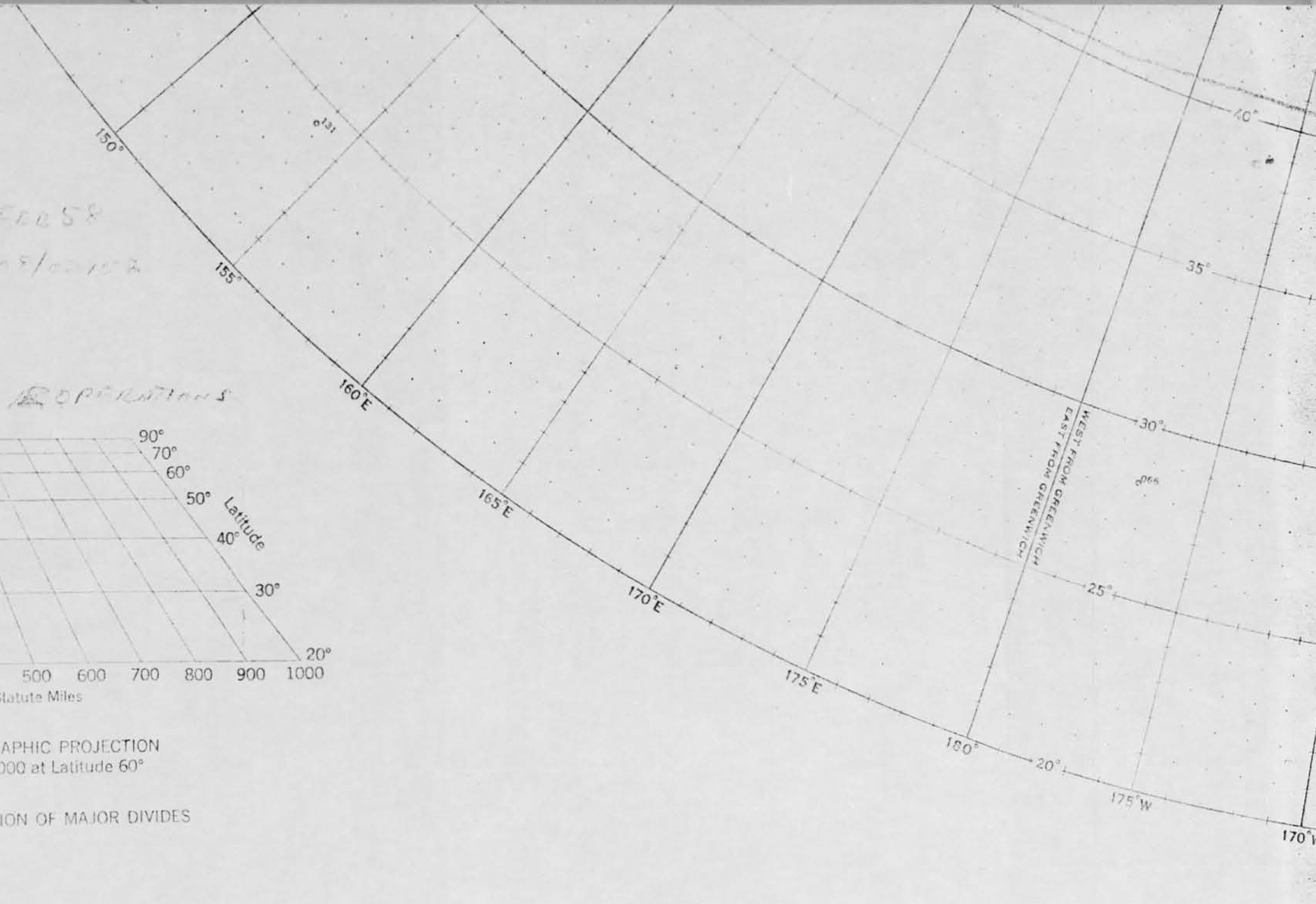
SIZE 40 FT

MISSION - TRANSOCEANIC OPERATIONS



POLAR STEREOGRAPHIC PROJECTION
Scale 1:20,000,000 at Latitude 60°

.... APPROXIMATE LOCATION OF MAJOR DIVIDES



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ARY 1950 (ACIC-WP) BASE NO. 1

STATION .... TIME .... Z DATE .... TYPE OF LEVEL
ANALYST .... UNIT .... PLOTTED BY ....

ABSTRACT
(AB)

ABSTRACT CLASSIFICATION

- [x] UNCLASSIFIED
- [ ] CONFIDENTIAL
- [ ] SECRET
- [ ] TOP SECRET

THE TITLE OF THIS REPORT IS [STATUS REPORTS ON OPTICAL OBSERVATIONS OF SATELLITES 1956 ALPHA AND 1956 BETA]. THE PROJECT DIRECTOR FOR THIS REPORT WAS ~~J. ALLEN HYNEK~~ FRED L. WHIPPLE, AND THE ASSOCIATE DIRECTOR WAS J. ALLEN HYNEK. THE REPORT GIVES ORBITAL INFORMATION ON AND ~~AND~~ RESULTS OF DATA ANALYSES OF ARTIFICIAL EARTH [SATELLITES]. OTHER TRACERS ARE: [HYNEK, J. ALLEN], ~~AND~~ [WHIPPLE, FRED L.], AND [SMITHSONIAN INSTITUTION ASTROPHYSICAL OBSERVATORY].

YAKUTSK
HARBIN
VLADIVOSTOK
MUKDEN
HAKODATE
TOKYO
NANKING
SHANGHAI
HONG KONG
70°
60°
50°
40°
30°
20°
120°
130°
140°
150°
160°E
120°
125°
130°
135°
140°


GEOSTROPHIC WIND SCALE
Isobaric Interval 5 mb.
Sea Level Density
Latitude

140°
130°
120°
110°
100°
90°
80°
75°
70°
65°
60°
55°
50°
45°
40°
30°
25°


0°
75°
10°
70°
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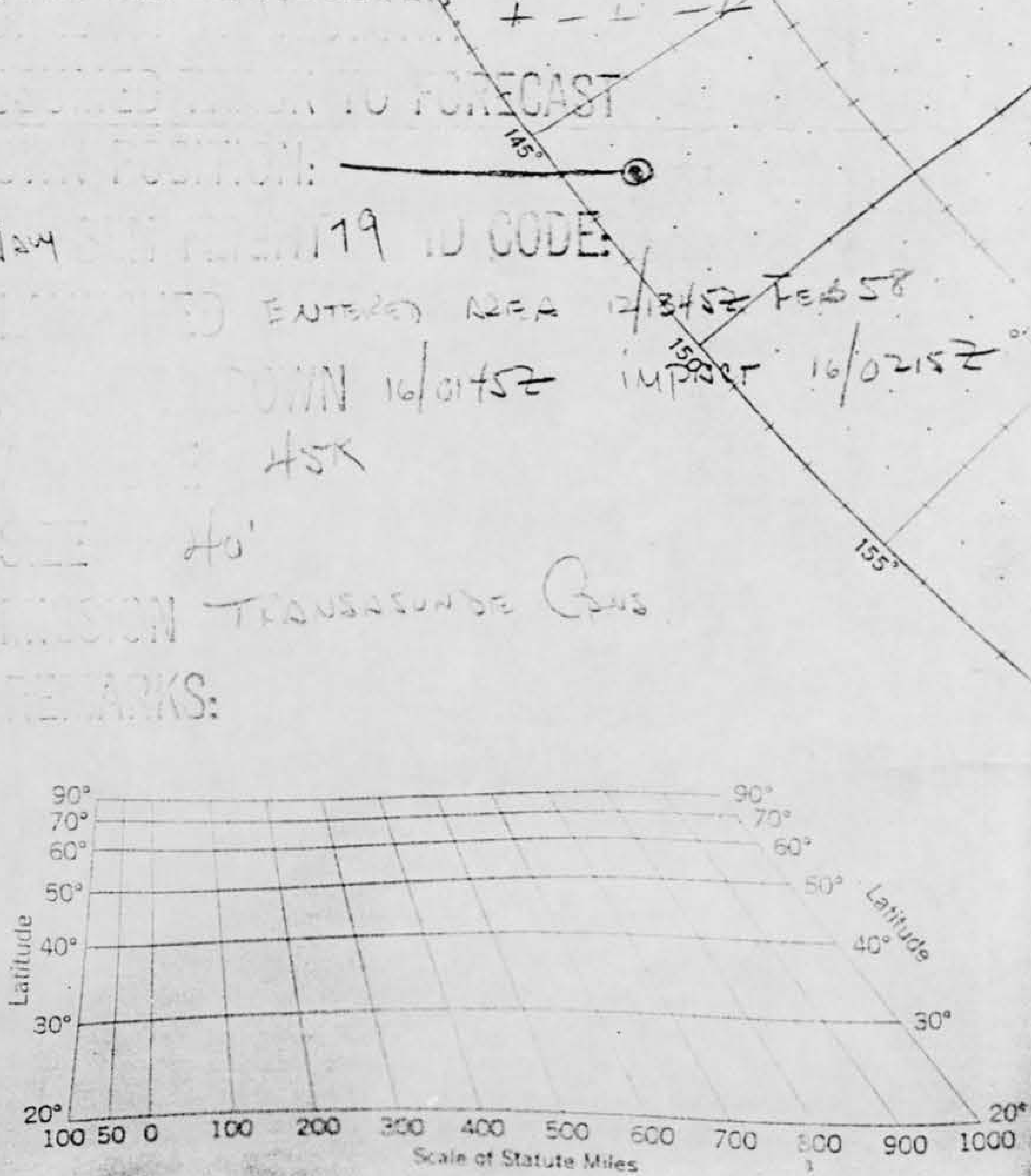
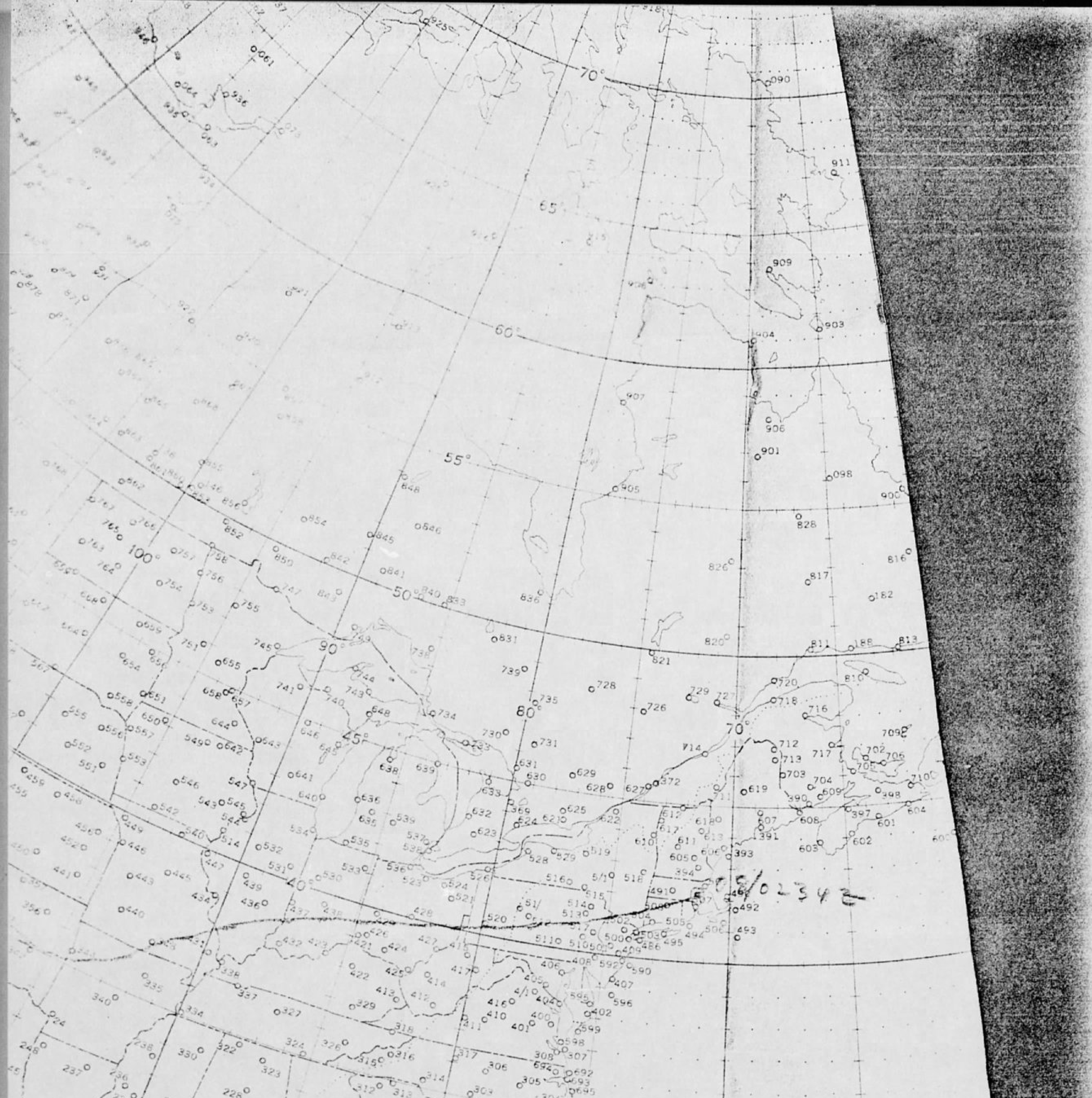
TCO: N/A
ACCS: —
FORECAST TRAJECTORY
ASSUMED ERROR TO FORECAST
DOWN POSITION:
A. NAVY 19 ID CODE:
B. ENTERED AREA 17/1345Z FEB 58
C. DOWN 16/0145Z IMPACT 16/0215Z
45K
E. SIZE 40'
F. MISSION TRANSONDE Gnus
G. REMARKS:



POLAR STEREOGRAPHIC PROJECTION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90°
80°
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75

No Case (Information Only)

8 February 1958
Micro, North Carolina

Ivan Sanderson Sees Green Fireball: On the night of Saturday, February 8, the well-known zoologist, author, TV star, and CSI Vice President, [redacted], was driving back to New York from the South, with three friends. At 10:35 p.m. they were heading northeast on Route 301 in southern North Carolina, and had just passed the tiny village of Micro (about 30 miles southeast of Raleigh). Robert Duncan, in the back seat, noticed a bright "peacock-green" luminous object rising behind the trees in the southwest and catching up with the car. A moment later the brakes were slammed on as it was seen by Ivan and Richard Florimont, in the front seat. Not quite one-third the size of a full moon, it had a blunt front and a tapering sharp tail, from which spurted a few orange sparks that forked like those struck from a flint. It appeared like a rounded, three-dimensional thing, not a mere glaring light. It passed over, to their left, and within four seconds was lost to view behind pine trees in the north-northeast. No sound was heard. Ivan had the impression that it was a good many miles away. (The appearance and horizontal course of this object seem to put it in the general class of the enigmatic "green fireballs.")

CSI Bu 1958.

INFO FEB 9-13

US

n Dail

), TUESDAY, FEBRUARY [illegible], 1958

Northern Lights Give Bright, Colorful Show

Shimmering arcs and fiery curtains of red, green and white blazed across the sky in a dazzling phenomenon known as the northern lights or aurora borealis Monday night.

Sky-gazers throughout Fairborn and most of the nation observed the northern lights which normally are seen at high latitudes.

The lights were observed in points as scattered as Boston, New York, Des Moines, Ia., Albuquerque, N.M., Tulsa, Okla., Nashville, Tenn., Seattle, Los Angeles, Chicago and as far south as Vero Beach, Fla.

One person living in the Wright View area called the Daily Herald after noting the red sky to know if Fairborn had a big fire.

The unusually intense display had marked effect on radio transmission and teletype wires. Radio hams in the Minneapolis area reported they were unable to operate during the display.

Soviet Satellite Stron.

[illegible] UFO reports received from Feb 9 [illegible]
[illegible] were determined to have been the result
of the aurora. Normally not seen [illegible]

[illegible]

IRIS WORKSHEET

INDEXER A	IRIS Accession — -1
OTHER REPOSITORY	OLD ACCESSION NUMBER 7-3745-65-1

ITEM SECURITY CLASSIFICATION	DOCUMENT SECURITY CLASSIFICATION
X UNCLASSIFIED / SECRET / CONFIDENTIAL / TOP SECRET	UNCLASSIFIED / SECRET / CONFIDENTIAL / TOP SECRET

SECURITY SCHEDULE

ADS (A) (Stamp Worksheet)	GDS (G) Declassification Year	XGDS (X) 1 2 3 4 Declassification Year	XCL (Z)	Group 3 (3)

ADMINISTRATIVE MARKINGS

FOUO (1)	AFEO (2)	RD (3)	FRD (4)	NSI (5)	NOFORN (6)	AFWP (7)	SIG (8)	PV (9)	(A)

ITEM/DOCUMENT TYPE	AUTHOR (AU)
OTHER HARD COPY ITEM	[redacted]

DATE FROM	DATE TO	DATE PUBLISHED
YY/MM/DD	YY/MM/DD	58/03/31 YY/MM/DD

ORGANIZATION (OR)

SMITHSONIAN INSTITUTION ASTROPHYSICAL OBSERVATORY

ORGANIZATION UP (OU)

TITLE SECURITY CLASSIFICATION	
X UNCLASSIFIED / SECRET / CONFIDENTIAL / TOP SECRET	CALL NUMBER K243.6012-1

TITLE (TI) NO CARD

SPECIAL REPORT NO. 11

REFERENCE IRIS ACCESSION NUMBER	DUPLICATE COPY OF ACCESSION NUMBER	DOCUMENT NUMBER
VOLUME NUMBER (VO)	PART (PT)	CHAPTER (CH)
ANNEX (AN)	MICROFILM ROLL NUMBER	MICROFILM FRAME NUMBER
AUDIO REEL NUMBER	REEL NUMBER IN SERIES	NUMBER OF PAGES (PG)

HOTM Microfilm Roll Number	CATALOG CARDS OK
	DATA KEYPUNCHED
HOTM Frame Number	ENTERED INTO IRIS

3325 FORM DEC 74 0-9

HARRISON LEON CHURCH
313 W. St. Louis Street
Lebanon, Illinois
K9GCC, AAF9GCC

No Case (Information Only)

February 1958
Naples, Italy

12 FEB

February 15, 1958

Department of the Air Force
Office of the Secretary
Washington, D. C.

Dear Sirs:

A few days ago I learned in a round-about way that an unidentified object had landed and exploded in Naples, Italy. What was this object.

Sincerely yours,

Harrison Leon Church

Harrison Leon Church

MEMO ROUTING SLIP	NEVER USE FOR APPROVALS, DISAPPROVALS, CONCURRENCES, OR SIMILAR ACTIONS		
1 NAME OR TITLE MAJOR L. J. TACKER	INITIALS		CIRCULATE
ORGANIZATION AND LOCATION SAFIS-3 - OSAF	DATE		COORDINATION
2			FILE
			INFORMATION
3			NECESSARY ACTION
			NOTE AND RETURN
4	H. L. Church		SEE ME
	Lebanon, Ill.		SIGNATURE

REMARKS

Larry- The Air Force has never received a report on this incident.

However, several days ago there was a dispatch or news item on the United Press ticker to the effect that a military-type rocket had been thrown into an incinerator (or something similar) in Naples and it exploded. The story caused some excitement in Italy until the Italian military authorities were able to explain it.

FROM NAME OR TITLE Ted Hieatt	DATE 26 Feb 58
ORGANIZATION AND LOCATION AFCIN-4X3	TELEPHONE 55266

DD FORM 1 FEB 50 95 Replaces DA AGO Form 895, 1 Apr 48, and AFHQ Form 12, 10 Nov 47, which may be used.

☆ GPO : 1955—O—403461

HEADQUARTERS UNITED STATES AIR FORCE
OFFICE OF THE VICE CHIEF OF STAFF
REFERRAL SLIP

DATE

TO:

AFCSS	AFCAD	AFPDC	AFODC	AFXDC	AFMDC	AFDDC
AFCAG	SAFIS	AFPMP	AFOOP	AFXSC	AFMPP	AFDRD
AFCIG	SAFLL	AFPTR	AFOMO	AFXWX	AFMMP	AFDDS
AFCIN	AFAAC	AFPCP	AFOIE	AFXLR	AFMMS	AFDDP
AFCJA	AFABF	AFPDP	AFOAC	AFXPD	AFMSS	AFDAP
AFCRF	AFASC	AFPGS	AFOAT	AFXPR	AFMTP	AFDRQ
AFCSG	AFAMA	AFPDW	AFOOA		AFMLP	
AFCSA	AFAAF	AFPCH			AFMME	
AFCGM	AFAUD					

ATTENTION:

FOR:

✓	APPROPRIATE ACTION
	DIRECT REPLY
	COMMENT AND/OR RECOMMENDATION
	COORDINATION
	CVC AND CAV HAVE/HAS NOT SEEN
	PREPARATION OF REPLY TO SAF
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	PREPARATION OF REPLY FOR SIGNATURE AFCVC
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	PREPARATION OF REPLY FOR SIGNATURE
	COPY OF REPLY FOR
	NOTE AND RETURN
	INFORMATION AND/OR FILE
	INFORMATION COPIES HAVE GONE TO
	ACTION HAS GONE TO
	SUSPENSE DATE

COMMENTS:

FOR THE VICE CHIEF OF STAFF

X5322

JAMES M. [illegible], Jr Lt Col, USAF
Chief, Executive Services Division
Vice Chief of Staff

AFHQ FORM 0-160 AUG 57 PREVIOUS EDITIONS OF THIS FORM ARE OBSOLETE GPO 928214

OFFICE OF THE SECRETARY OF THE AIR FORCE

ROUTING SLIP

DATE FEB 20 1958

TO	OFFICE	COPIES TO	TO	OFFICE	COPIES TO
	SECRETARY AIR FORCE			SPECIAL ASSISTANT FOR	
✓	CHIEF OF STAFF			ADMINISTRATIVE ASSISTANT	
	UNDER SECRETARY			GENERAL COUNSEL	
	ASSISTANT SECRETARY FINANCIAL MANAGEMENT			OFFICE OF LEGISLATIVE LIAISON	
	ASSISTANT SECRETARY MATERIEL			OFFICE OF INFORMATION SERVICES	
	ASST SECTY MANPOWER, PERSONNEL & RESERVE FORCES				
	ASSISTANT SECRETARY RESEARCH & DEVELOPMENT				

TYPE OF ACTION

✓	APPROPRIATE ACTION	ACTION ASSIGNED TO
	REMARKS AND RECOMMENDATIONS	
	DIRECT REPLY	ATTENTION
	INFO ON WHICH TO BASE REPLY	
	INFORMATION	
	COORDINATION	COORDINATE WITH
	NOTE AND RETURN	
	NOTE AND FORWARD	
	FILE	
	PREPARE REPLY FOR SIGNATURE OF	**SUSPENSE DATE**

REMARKS

BY DIRECTION OF:

✓	THE SECRETARY	Charles R. Grandy
	THE UNDER SECRETARY	Chief, Mail Branch
	THE ASSISTANT SECRETARY	Corres. Con. Div., SAFS

AFHQ FORM 0-96 8 DEC 55

U. S. GOVERNMENT PRINTING OFFICE: 1956 O—370354

SAFIS-3/Maj Tacker/jmd/74966

5 March 1958

Dear Mr. [redacted]

This is to acknowledge your letter of 15 February concerning an unidentified flying object in Naples, Italy.

The U. S. Air Force has received no report on this sighting or incident.

The United Press carried a news item on or about 12 February 1958 stating a military type rocket inadvertently placed in an incinerator had caused a mysterious explosion in Naples, and it caused much excitement until military authorities explained the mishap.

Sincerely,

LAWRENCE J. TACKER
Major, USAF
Executive Officer
Public Information Division
Office of Information Services

Mr. [redacted], Illinois

COMEBACK-SAFIS-3
READER-SAFIS-1
STAYBACK-SAFIS-3

12-16 FEB 58

JAP-CAL-

MEX-S. TEX-

FLA — E. OF AFRICA

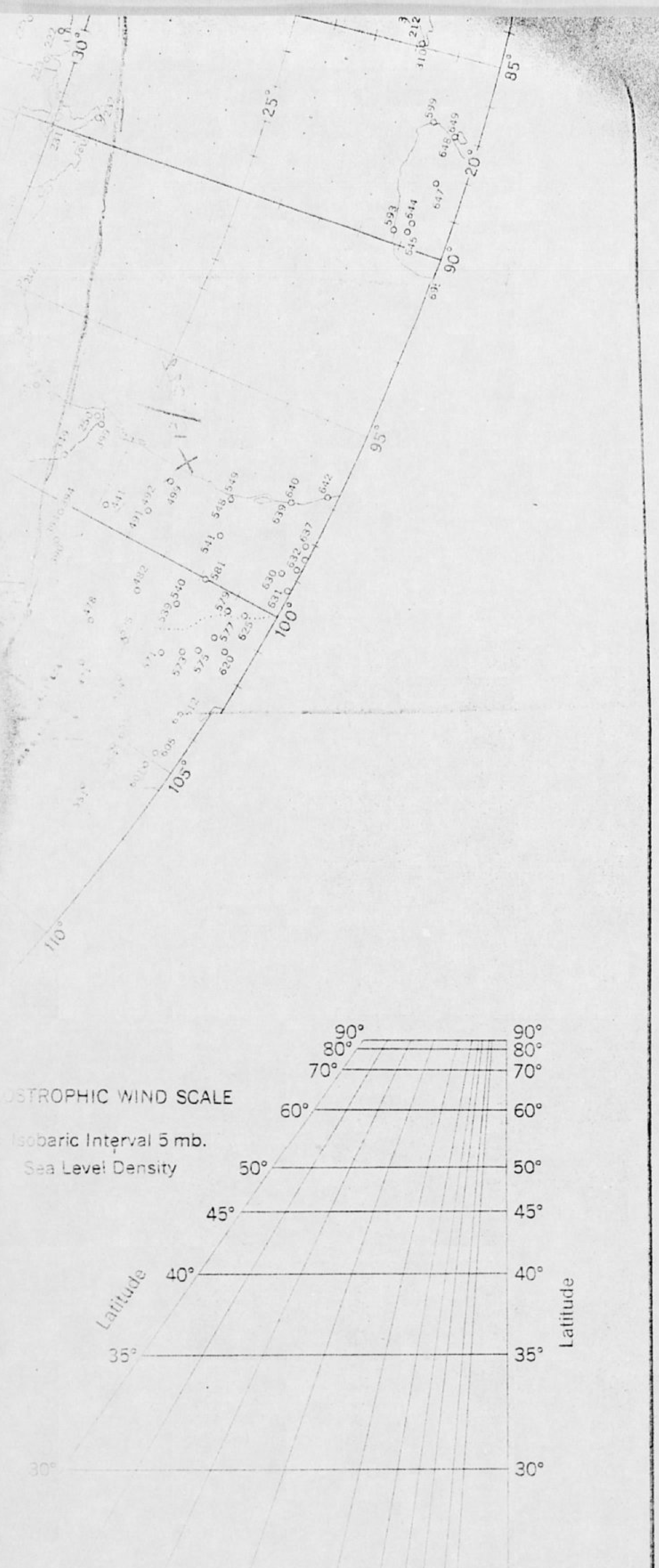
May 19

~~12-16 Feb 58~~

~~JAP-ACROSS US -~~

~~TO EAST AF~~

~~AFRICA~~



NORTHERN HEMISPHERE AWS-WPC 6-3-1
(NORTH OF LATITUDE 20°)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95°
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80°
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65°
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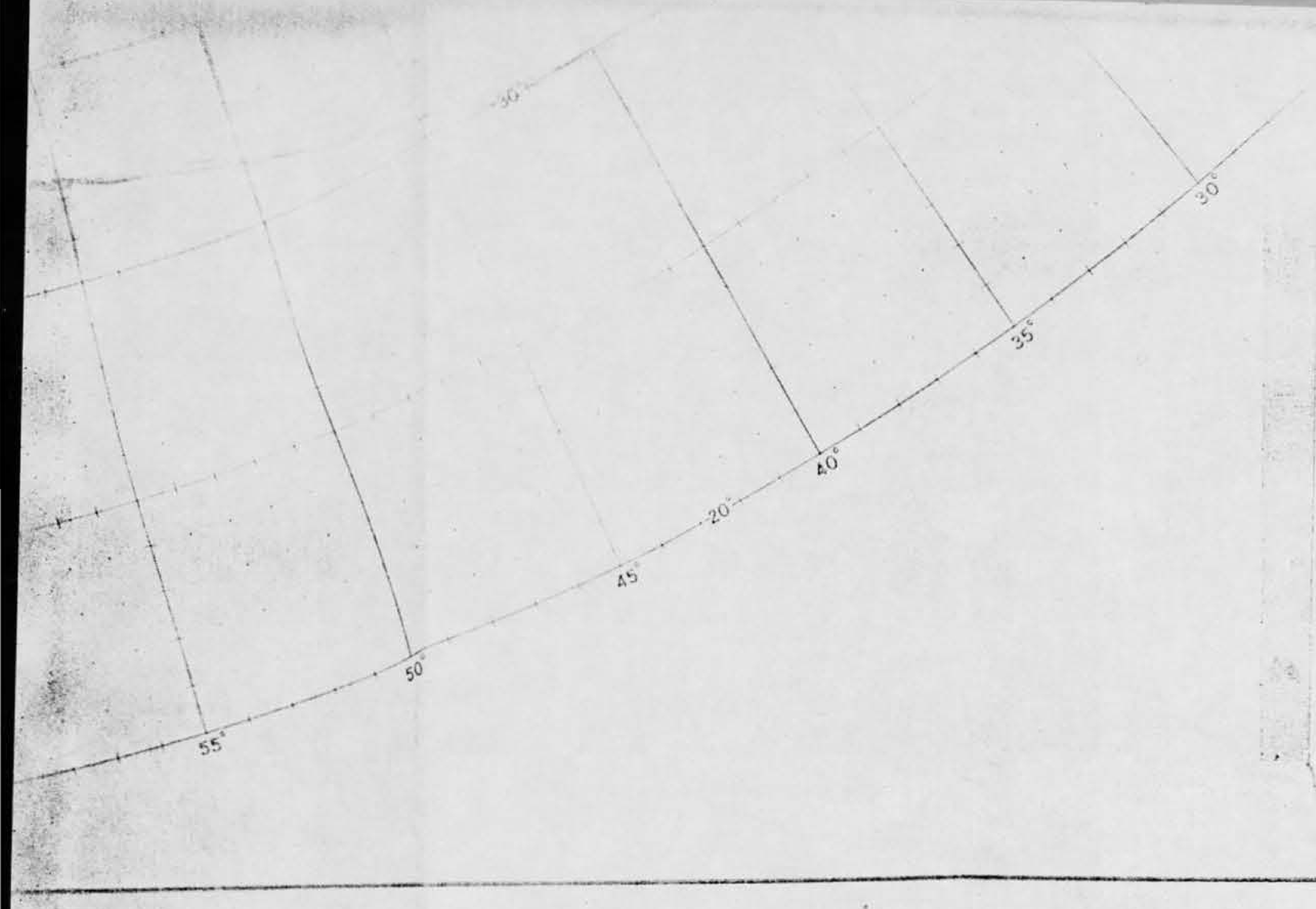
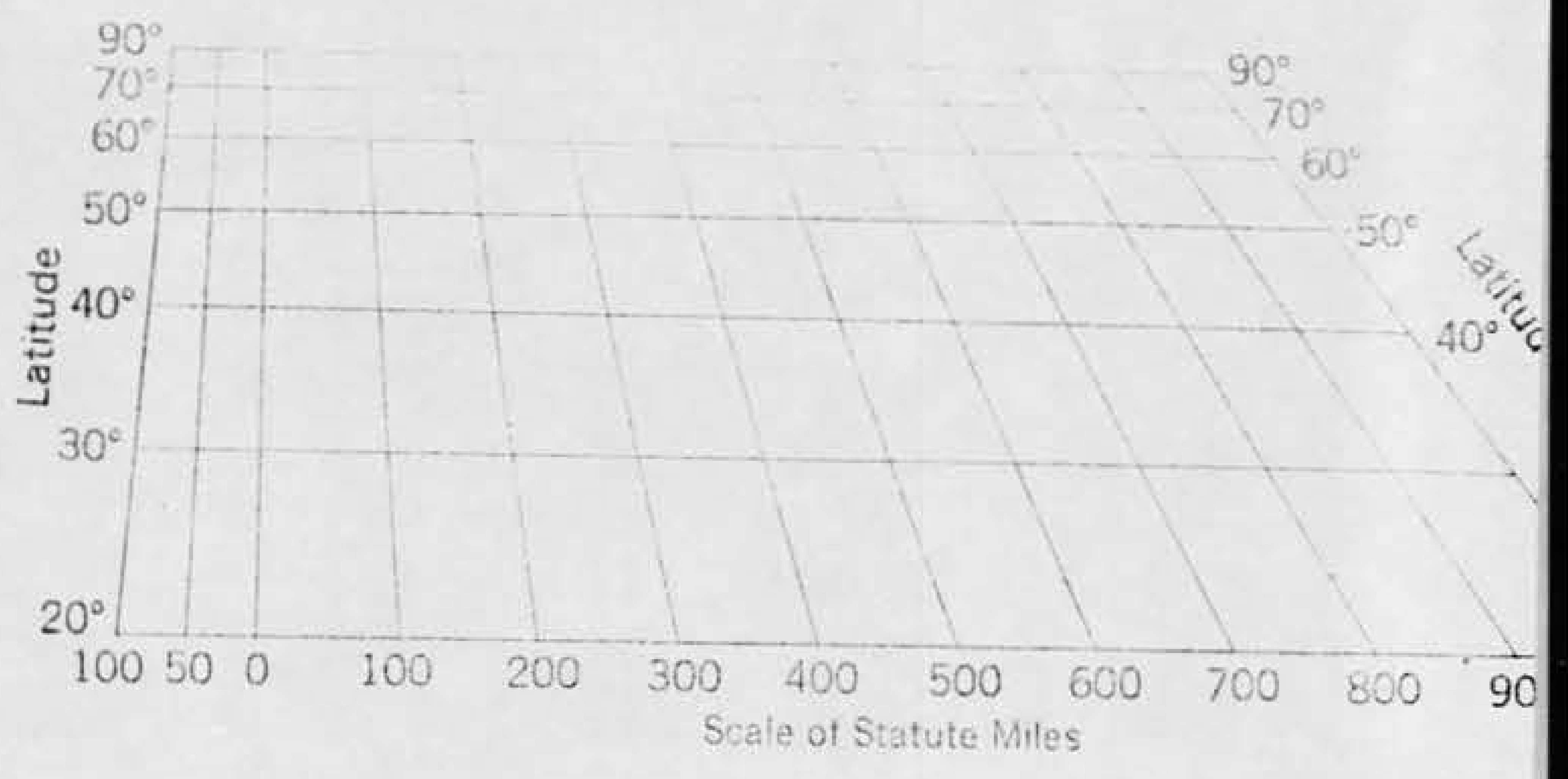
25°
20°





POLAR STEREOGRAPHIC PROJECTION
Scale 1:20,000,000 at Latitude 60°

·········· APPROXIMATE LOCATION OF MAJOR DIVIDES

12-16 FEB JAP, MEX, U.S, ATLA

PUBLISHED BY THE USAF AERONAUTICAL CHART AND INFORMATION CENTER, ST. LOUIS 18, MO.
JANUARY 1950 (ACIC-WP)
BASE NO. 1

STATION ....
ANALYST ....

SMITHSONIAN INSTITUTION
ASTROPHYSICAL OBSERVATORY

Special Report No. 11
IGY Project No. 30.10
NSF Grant No. Y/30.10/167

STATUS REPORTS ON OPTICAL OBSERVATIONS OF SATELLITES 1958 ALPHA AND 1958 BETA

Project Director: Fred L. Whipple
Associate Director: J. Allen Hynek
Edited by: G. F. Schilling

March 31, 1958
Cambridge, Massachusetts


GEOSTROPHIC WIND SCALE
Sea Level Density
Latitude
50°
45°
40°
35°
30°
25°
3
4
5
10
12
15
20
30
Velocity: (m.p.h.)
(Italics indicate Beaufort S
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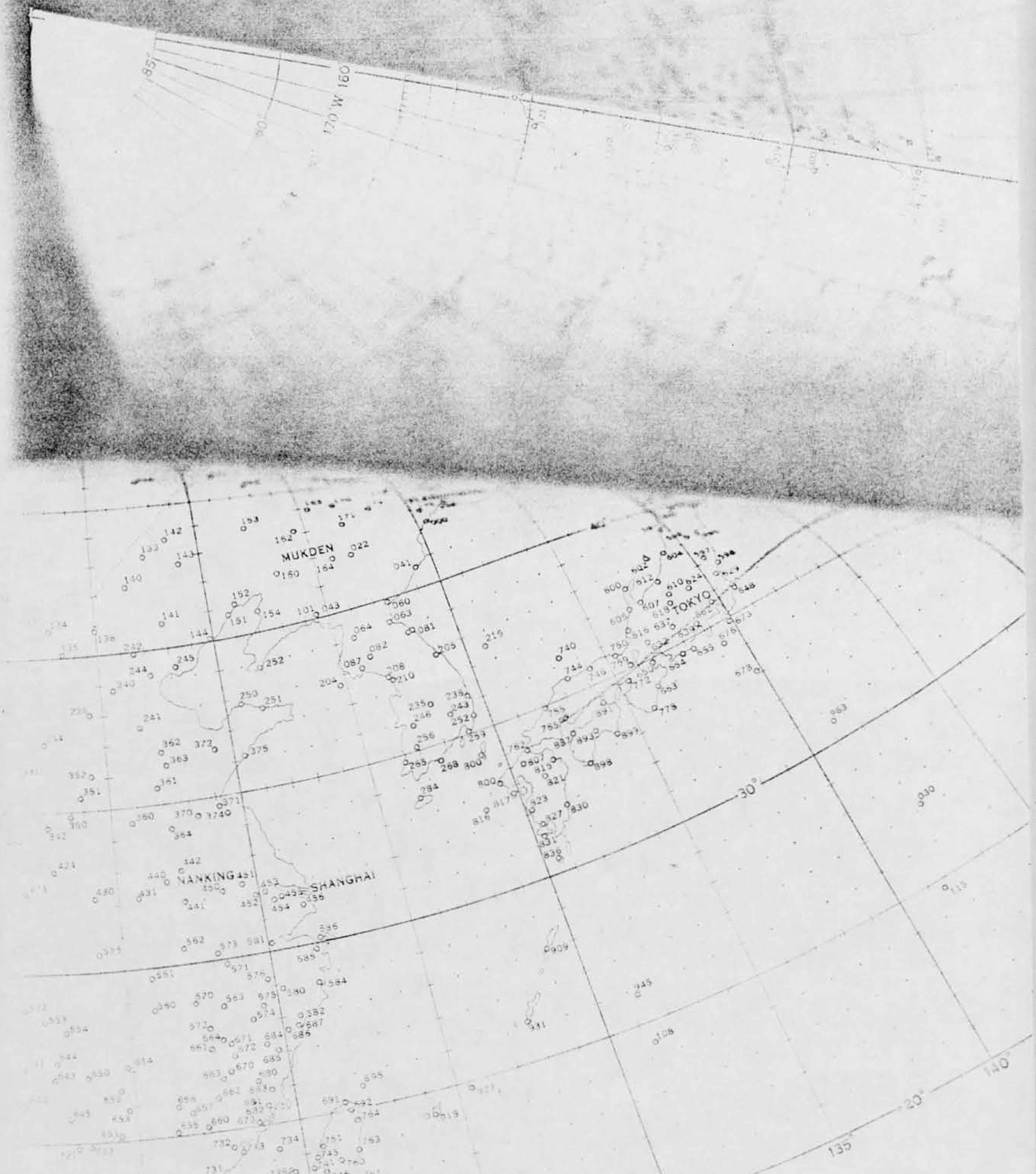
115°
120°
125°
130°
135°
140°
145°
150°
20°
Lithographed by ACIC 11-53
NORTHERN HEMIS
(NORTH OF LATITUD


170 W 160
MUKDEN
TOKYO
NANKING
SHANGHAI
HONG KONG
30°
20°
115°
120°
125°
130°
135°
140°


YAKUTSK
ANADIR
HARBIN
VLADIVOSTOK
MUKDEN
HAKODATE

NO CASE (INFORMATION ONLY)

Mid- Feb 58
New Mexico

SOURCE: FLYING SAUCERS – MAY 58

FLASHING LIGHT IN SKY BURNS TWO WOMEN

Two New Mexico housewives returning from a short pleasure trip in mid-February, 1958 reported they saw an unidentified object in the skies which gave off two brilliant flashes of light. They suffered slight burns, the women said.

They are Mrs. Leroy Evans, of Albuquerque, and Mrs. Fred McIntosh of nearby Los Lunas. After a preliminary geiger counter check disclosed the possibility of radioactive burns, the women decided to have a thorough laboratory test.

They said that after seeing the flashes their skin started burning. "I have a lovely suntan I didn't have before," Mrs. Evans reported.

The Civil Aeronautics Authority at Albuquerque reported sightings of the flash from a six-state area. Dr. Lincoln Lapaz of the University of Meteoritics said the flash probably came from a meteor. He neglected to say what caused the burns on the two women.

New Mexico

1958

Two women received mild burns from a UFO on Feb. 21st, while driving their car on a New Mexico highway. The saucer gave off two brilliant flashes of light, which caused the burns. After a preliminary Geiger counter check disclosed the possibility of radioactivity, the women decided to have a thorough laboratory test. - The flash was seen in a six-state area....

No. Case (Information Only)

22 February 1958
Columbus, Ohio

1958

...Also in Columbus, seven persons watched a 40-foot-long orange-colored saucer for a period of several minutes, on the night of Feb. 22nd. The object had "a sort of tail in the opposite direction from which it moved." It was flying at an altitude of about 2,000 feet.

****

EB. 24, 1958 BETWEEN NAZARE AND SALVADOR (LORENZEN P 143) 3 WITNESSES

DR. [redacted], A LAWYER IN SENAI-S NATIONAL DEPARTMENT, MANOEL MENDES AND A FRIEND, ANTONIO DE ARAUJO, WERE DRIVING BETWEEN NAZARE AND SALVADOR, IN BAHIA. (ABOUT 1200 MILES FROM PONTA PORAN, BRAZIL.) BETWEEN THESE TWO TOWNS LIE TWO SMALL VILLAGES, SANTO ANTONIO DE JESUS AND CONCEICAO ALMEIDA. AT 3.05 A.M. SOMEWHERE BETWEEN THE TWO VILLAGES, THEIR CAR BEGAN COUGHING AND MISSING AND THEN ABRUPTLY THE MOTOR STOPPED DEAD. THE MEN ATTEMPTED TO LOCATE THE TROUBLE, BUT TO NO AVAIL. THE NEXT INHABITED SPOT WAS SOME DISTANCE AWAY, AND THEY DECIDED TO SLEEP AT THE EDGE OF THE ROAD AND IN THE MORNING, DO SOMETHING ABOUT THE CAR.

IT WAS THEN THAT THEY SPOTTED A HUGE LUMINOUS OBJECT HOVERING OVERHEAD. ACCORDING TO DR. [redacted] REPORT, *IT GLOWED WITH A STRANGE LIGHT WHICH SEEMED FLUID, BETWEEN SILVER AND BLUE. AT FIRST IT WAS ONLY A LIGHT, BUT AS IT APPROACHED WE WERE ABLE TO DETECT WHAT APPEARED TO BE A SOLID BODY BEHIND THE GLOW. THE OBJECT SEEMED TO BE TWO HEMISPHERES ON TOP OF EACH OTHER -- BETWEEN THEM A LUMINOUS DISK OR RING SPINNING AT HIGH SPEED. IT WAS THE SOURCE OF THE BRILLIANT GLOW SURROUNDING THE WHOLE OBJECT.* THE OBJECT CAME SILENTLY TOWARD THE CAR UNTIL IT WAS ABOUT TWO HUNDRED AND FORTY FEET FROM THE OBSERVERS AND ABOUT NINETY FEET ABOVE THE GROUND. THEN IT DESCENDED IN A CURIOUS MANNER AS THOUGH IT WERE A FALLING LEAF. IT STEADIED ITSELF AT ABOUT NINE OR TWELVE FEET ABOVE GROUND, AND THE THREE MEN WERE ABLE TO DISCERN ITS CONTOURS VERY CLEARLY. THE BOTTOM WAS SMALLER THAN THE TOP HEMISPHERE AND IT WAS SLIGHTLY FLATTENED UNDERNEATH. ITS LUMINOSITY SPREAD IN A CURTAIN OF LIGHT SUSPENDED BETWEEN THE UFO AND THE GROUND BELOW.

THE FRIGHTENED DRIVER, MENDES, GOT BACK INTO THE CAR. THE OTHER TWO, HOWEVER, DECIDED TO INVESTIGATE, AND WALKED TOWARD THE STRANGE OBJECT. AS THEY APPROACHED THE ILLUMINATED AREA (ABOUT TWICE THE SIZE OF THE UFO, WHICH APPEARED TO BE ABOUT 60 TO 75 FEET IN DIAMETER) THE OBJECT SUDDENLY TOOK OFF IN A VERTICAL CLIMB. IT STOPPED AT ABOUT 600 FEET, AND MADE A TIGHT CIRCLE IN THE SKY, ITS LUMINOUS FOCUS ON THE GROUND ROTATING AROUND ITSELF. THEN THE UFO STOPPED AGAIN AND TILTED FORTY-FIVE DEGREES. IN THIS POSITION THE ROTATING RING WAS MORE EASILY VIEWED AND DR. PEREIRA GOT THE IMPRESSION THAT IT WAS NOTCHED LIKE A COGWHEEL WHOSE INDENTATIONS APPEARED TO BE OBLIQUE RELATIVE TO THE EDGE OF THE RING. MINUTES LATER THE OBJECT BEGAN TO MOVE AGAIN, IN A SERIES OF HIGH-SPEED MANEUVERS ACROSS THE SKY, SOMETIMES MOVING VERTICALLY, SOMETIMES IN TIGHT CIRCLES AROUND THE CAR AND SOMETIMES IN STRAIGHT LINES IN DIFFERENT DIRECTIONS. IN THE STRAIGHT-LINE MANEUVERS IT MOVED *MORE RAPIDLY THAN LIGHTNING,* BECOMING AT TIMES A SMALL DOT OF LIGHT IN THE SKY IN A SPLIT-SECOND. THEN FOR A SECOND TIME THE OBJECT EXECUTED THE *DEAD-LEAF* DESCENT, STOPPING ABOUT 9 TO 12 FEET FROM THE GROUND. WHEN THE OBSERVERS TRIED TO APPROACH IT, THE OBJECT TOOK OFF VERTICALLY AT HIGH SPEED AND WAS GONE. THE TIME WAS 4.35 A.M.

AT 6.30 A.M., THE OBJECT APPEARED FOR THE LAST TIME, AT A LOW ALTITUDE, SILVERY IN COLOR AND WITH NO GLOW. IT WAS MOTIONLESS, TILTED TO ONE SIDE. THEN IT SUDDENLY SHOT UP AT TREMENDOUS SPEED AND VANISHED IN A SPLIT-SECOND.

EN ATTEMPTED TO START THEIR CAR. TO THEIR SURPRISE THE MOTOR FUNCTIONED THLY, WITH NO FURTHER STALLING, AND THE CAR MADE THE REST OF THE TRIP TO ADOR WITHOUT TROUBLE.

TDETR/Maj H Quintanilla, Jr/70916/76678/mhs/27 Oct 66

UFO Sighting, 27 February 1958

OCT 31 1966

Hq USAF (SAFOICC)

Reference the attached letter from [redacted] reporting his observation which occurred on 27 February 1958. The following is a suggested reply.

a. Dear Mr. [redacted]

There have been many accusations made against the Air Force concerning our alleged official stand that "there just ain't no such thing." We have never made such a statement. Our official stand is that there has been no evidence submitted to or discovered by the Air Force that sightings categorized as unidentified are extraterrestrial vehicles.

If you had reported your observation to the Air Force, our analysts and evaluators would have attempted to determine what you had observed. If we had been unable to find a logical answer, then your case would have been categorized as unidentified. The Air Force would not have made your name available to the press without your permission.

It would be extremely difficult at this late date to perform a comprehensive investigation on your observation. It will be filed with our 1958 cases for information purposes, however, it will not be considered a case. There were no UFO reports submitted to the Air Force for 27 February 1958.

FOR THE COMMANDER

L. De Goes

LOUIS DE GOES, Colonel, USAF
Deputy for Technology and Subsystems

1 Atch
Ltr, R. Hartinger

COORDINATION

H. Quintanilla Jr DATE 27 Oct 66
TDETR/MAJ H QUINTANILLA, JR

Fred P. Van Dam DATE 27 Oct 66
TDET

No Case (Information Only)

28 February 1958
Miami, Florida

Space Animals: New evidence for the animal theory: falls of rapidly-evaporating "sky jelly" (compare evaporation of angel hair) in Miami, Florida, February 28, 1958 (policeman as witness) and Australia in 1950.

MARCH 1958 SIGHTINGS

DATE	LOCATION	OBSERVER	EVALUATION
1	Kunashiri Island, Japan	Civilian	Insufficient Data
2	Tampa, Florida	[redacted]	Other (INCONSISTENT
4	Dugway, Utah	[redacted]	Other (LENTICULAR CL
5	Akron, Ohio	[redacted] (PHYSICAL S)	Other (CHAFF)
5	NE of Louisville, Kentucky	[redacted]	Astro (METEOR)
5	Harrisburg, Pennsylvania	[redacted]	Aircraft
5	George AFB, California	Military	Astro (METEOR)
5	Holloman AFB, New Mexico	Military	Balloon
5-6	Ft Monmouth, New Jersey	[redacted] [redacted]	Insufficient Data
6	Denver, Colorado	[redacted]	Astro (METEOR)
6	Dayton, Ohio	Multi	Balloon
7	Wantagh, Long Island, New York	[redacted]	Insufficient Data
7	Lawton, Oklahoma	Multi	Astro (METEOR)
9	Uruguay	CIOVI	Insufficient Data
9-11	Panama Canal Zone	Multi RADAR	[redacted]
10	E of Sakhalin Island, USSR	Military	Other (PARACHUTE FLA
10	Alsea, Oregon	[redacted]	Other (REFLECTION GR LIGHT)
10	Roslyn Harbor, Long Island, New York	[redacted]	Aircraft
11	Off Coast of Taichung, Taiwan	Fishing Vessel(PHYS S)	Other (FLOAT VALVE)
11	Springfield, Ohio	[redacted]	Aircraft
11	Bar Harbor, Maine	[redacted]	Insufficient Data
11	Greenwood, Louisiana	[redacted]	Balloon
12	Adana, Turkey	Military	Aircraft
12	Kalamazoo, Michigan	[redacted]	Other (UNRELIABLE RE
13	Sitka, Alaska	[redacted]	Astro (METEOR)
14	New Orleans, Louisiana	LSU Professor	Balloon
14	Healdsburg, California	Multi	UNIDENTIFIED
14	San Antonio, Three Rivers, ESE Corpus Christi, Texas	Multi	Astro (METEOR)
16	Tampa, McDill AFB, Florida	Multi	Balloon
17	Northern Norway	Civilians	Insufficient Data
17	Modoc Point, Oregon	[redacted]	Astro (METEOR)
18	Ogallala, Nebraska	[redacted]	Aircraft
19	Moscow, USSR	Radio Moscow	Aircraft
19	Laurium, Michigan	[redacted]	Insufficient Data
21	Dayton, Ohio	Multi	Balloon
21-22	Seaside Park, New Jersey	Civilian Police	Insufficient Data
22	Enola, Pennsylvania	[redacted]	Insufficient Data
23	Alexandria, Virginia	[redacted]	Astro (METEOR)
24	Great Bend, Kansas	[redacted]	Astro (METEOR)
24	Carrolton, Missouri	Military	Astro (METEOR)
26	Vero Beach, Florida	[redacted]	Insufficient Data
27	Saranac Lake, New York	[redacted]	Astro (METEOR)
28	Hartford, Connecticut	Military	Balloon
28	Buffalo, New York	[redacted]	Astro (ARCTURUS)
29	Yukon, Alaska	Multi	Astro (METEOR)
31	Walnut Ridge AFS, Arkansas	Military RADAR	Insufficient Data

Preface

The original intent of this collection of short reports was the presentation of preliminary data, to the U. S. National Committee for the International Geophysical Year, obtained by the Optical Satellite Tracking Program of the Smithsonian Astrophysical Observatory with regard to the first artificial earth satellite launched by the United States on January 31, 1958.

At the present time, however, three more objects have been successfully launched into satellite orbits from Cape Canaveral, Florida. The collection has therefore been expanded to include such additional orbital information and results of data analyses as could be put into usable form, as well as descriptions of the principal machine computation programs in use.

Since we are endeavoring to make these satellite data available as rapidly as possible to all scientists participating in the International Geophysical Year, we have of necessity included information of an extremely preliminary nature.

Gerhard F. Schilling

Cambridge, Massachusetts

March 31, 1958