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U.S. Weather Bureau.

Tiros I picture documentation.

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UNITED STATES DEPARTMENT OF COMMERCE
U.S. WEATHER BUREAU

TIROS I PICTURE DOCUMENTATION

This preliminary draft documents picture sequences from orbit passes 1 through 109 (April 1 to 8, 1960). It will be superseded by a complete catalogue of all TIROS I photography to be issued as a number in the U. S. Weather Bureau series Key to Meteorological Records Documentation.

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Meteorological Satellite Laboratory

Washington, D. C.
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National Oceanic and Atmospheric Administration
TIROS Satellites and Satellite Meteorology

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January 26, 2009

TIROS I PICTURE DOCUMENTATION

Orbit Passes 1 to 109, April 1 to 8, 1960

TIROS I, the first experimental meteorological satellite, was launched by the National Aeronautics and Space Administration on April 1, 1960, and before the equipment ceased functioning in mid-June its two television cameras had taken and transmitted to earth more than 20,000 pictures of the underlying cloud cover. It traveled in a nearly circular orbit averaging 390 nautical miles above the earth's surface with a difference of about 25 nautical miles between perigee and apogee. The orbit was inclined at an angle of 48.4 degrees to the earth's equatorial plane so that picture coverage is confined to the zone bounded roughly by 55 degrees north and south latitude. The orbital period was 99.24 minutes.

The satellite was spinning at a rate that varied between 8 and 12 rpm. Being spin-stabilized, the spin axis orientation in space changed only gradually during the lifetime of the satellite and never deviated more than 20 degrees from the orbital plane. The two cameras were mounted with their optical axes parallel to the spin axis, so that the earth was within their fields of view during about one-third of each orbit pass. Useable picture coverage was thus restricted to the portion of each orbit pass where the underlying earth was 1) sunlighted and 2) within view of the cameras.

Camera 2, the wide-angle camera, had a 104 degree field of view and covered an area about 800 miles square when its optical axis was normal to the earth's surface; at other times a larger area was included in oblique perspective. Camera 1, with a 13 degree field of view, provided a magnified picture of a much smaller area.

The pictures were either transmitted directly to one of the two readout stations, or were stored on tape for transmission at a later time. The tape pictures were made at 30-second time intervals in sequences of up to 32 frames each. Each time the satellite came within radio range of a readout station one tape sequence from each camera could be read out and, if it was daytime and the optical axes were appropriately oriented, a series of direct pictures could also be obtained. The direct pictures from any one pass are grouped into one or two sequences depending on whether or not the series was interrupted to permit readout of a tape sequence. Time interval between frames was 30 seconds for most direct sequences but was 10 seconds for some of them. Direct sequences sometimes contain alternating frames from the two cameras, but each tape sequence always consists solely of pictures from one camera or the other. Tape sequences from both

cameras on the same orbit pass are normally concurrent. Because of camera positions on the satellite, an earth image in a camera 1 picture will appear to be rotated 120 degrees clockwise with respect to its orientation in a simultaneous camera 2 picture.

The pictures are virtually square with a slight distortion caused by varying settings of the electronic readout equipment. "Fiducial marks" etched on the face of the vidicon tube appear in the picture image as a central cross and four L-shaped corners, although they may show poorly or not at all against a dark background.

Since the satellite is spinning, the earth's image rotates from frame to frame by an amount that depends on how much the satellite's spin rate departs from being an integral number of rotations during the picture taking interval. The rotation rate may be considered constant during any one sequence. The center of rotation, which is the point where the optical and spin axes intercept the image plane, is not quite at the central fiducial cross mark. It is displaced to the lower left on taped pictures and to the upper right on directs by an amount about equal to the length of a half cross-arm.

Cloud picture transmissions received at readout stations were displayed on a television screen and simultaneously recorded on magnetic tape. A 35 mm camera photographed the television screen, including also a lighted panel board mounted underneath. The panel board information provides a legend for each picture including station, orbit number, camera number, and mode (tape or direct). There also appears a series of numerals whose sum indicates frame number. A similar series gives information on sun angle. The indicated frame numbers increase in the order that the pictures were received at the readout station. For direct mode this is also the time order in which the pictures were taken, but in tape sequences the last picture taken is the first one read out. Frame numbers in all sequences increase in the same direction on the film reel and it is important to note that this is correct time order for directs but reversed time order for tape sequences. Malfunctioning frequently caused the frame numbering system to behave erratically resulting in repetition and discontinuity in frame count.

The orderly time sequence of pictures is sometimes interrupted by spurious noise frames or complicated by skipped frames. In such cases the erratic frame numbers are not a dependable indicator of real picture counts. However, the regular rotation of image orientation is often a helpful clue in determining the actual time interval between particular frames.

The original TIROS I negative film will be deposited at the National Weather Records Center of the U. S. Weather Bureau in Asheville, North Carolina. Persons or institutions desiring copies will be able to order them from NWRC in the form of 35 mm positive transparencies for projection or 35 mm duplication negatives from which opaque prints can be made. The pictures are stored chronologically on 100 foot reels amounting to about 55 reels in all. Orders must be placed for one or more complete reels, at a cost of $4.00 each, as it will not be possible to furnish copies of individual frames or to provide enlargements or other picture formats. Reel number should be given when ordering.

The attached pages of maps and tabulated listings give descriptive information about the pictures obtained on the first 109 orbit passes of TIROS I. Of the 14 passes made each day only 8 or 9 came within range of one or both readout stations. Picture coverage on the remaining passes was limited to one tape sequence by each camera.

In the listings each sequence is described by one line, and for each station they are listed in the order in which they appear on the film reel. The section headed READOUT DATA gives the information appearing in the panel board legend on the film. The correct data for ground station readout are entered under ACTUAL. In a few instances when the panel board information was incorrect the legend as it appears in the picture is entered under INDICATED as an aid in identifying the sequence on the film reel.

The column headings have the following meanings:

S: Readout station. K = Kaena Point, Hawaii
M = Fort Monmouth, New Jersey

ORB: Orbit pass number at time of readout

M: Mode of transmission. D = Direct
T = Tape playback

C: Camera. 01 = narrow-angle camera
02 = wide angle camera
12 = both cameras alternating

The section headed PICTURE SEQUENCE DATA documents actual picture content.

STARTING TIME: Orbit pass number, month, day and time to the nearest minute (GMT) when camera action began. For direct sequences this orbit number and the actual readout orbit

number are the same, but in tape sequences camera action frequently began on an earlier pass.

FRAME: US = number of useable frames in the sequence
+ = number of frames in which the central fiducial cross mark appears on the earth, indicating that the earth's image occupies a substantial portion of the picture.

GEOGRAPHICAL AREA COVERED: Column headings refer to numbered areas outlined on the first map. Column entries indicate the areas included in the picture sequence.

L: Presence of a landmark is indicated by the following code:

1. Possible ground image somewhere in the sequence.
2. Ground image present but not identified.
3. Identified ground image.

VBS: The presence of a vortex, cloud bands or cloud streets in the sequence is indicated by a 2 in the appropriate column. Since all sequences were not routinely examined using uniform criteria for the presence of these features, the absence of a 2 does not necessarily mean that none are present.

REEL: Number of the film reel which contains the sequence.

The maps provide a rough indication of the area covered by each sequence having useable frames. The coverage swaths are grouped by date and are identified by the picture-taking orbit number and mode. Readout station initial is added when necessary to definitely identify the sequence in the listings. Two direct sequences acquired at the same station on the same orbit pass are normally combined in one swath, since the short interruption for tape readout does not cause a significant gap in the coverage. Similarly, when camera 1 and 2 tape sequences are concurrent they are represented on the maps by one swath showing camera 2 coverage.

Since the orientation of each frame with respect to compass directions on the earth has not been calculated, the swaths show the maximum coverage obtained when the diagonals of the square picture are oriented parallel and perpendicular to the orbital track. Therefore, the outer edge of the swath, equal to about 15% of its width, is actually not covered except in the corners of a few pictures which have the proper orientation.

A forthcoming report of the Meteorological Satellite Laboratory describes the problems and uncertainties in specifying the satellite's attitude as a function of time, and presents graphs and tables needed to accurately locate TIROS I pictures.

R. L. Pyle
Meteorological Satellite Laboratory
3/3/61

READOUT DATA INDICATED ORB M C S	ACTUAL ORB M C	PICTURE SEQUENCE DATA STARTING TIME ORB	DATE	TIME	FRAME US	+	GEOGRAPHICAL AREA COVERED 1234567891011121314151617	LVBS	REE
	M0001 D02	0001	0401	1331	29	01	45	1	101
	M0001 D02				00				101
	M0002 D02	0002	0401	1513	10	10	34	3	101
	M0002 D02				00				101
	M0002 D01				00				101
	M0003 D02	0003	0401	1706	22	22	45	1	101
	M0004 D12	0004	0401	1839	51	51	4	1	101
	K0004 T02		0401		15	15		1	151
	M0005 D02	0005	0401	2025	38	38	34	1 2	101
	K0007 D02	0007	0401	2340	07	07	2	1	151
	K0007 T02	0006	0401	2157	30	28	23	32	151
	K0007 T01	0006	0401	2157	09	07	23		151
	K0007 D02	0007	0401	2345	26	26	23	1	151
	K0008 D02	0008	0402	0123	08	08	2	1	151
	K0008 T02	0008	0402	0104	25	08	12 7	1	151
	K0008 T01	0008	0402	0104	04	04	12 7		151
	K0008 D12	0008	0402	0127	15	15	2 9	1	151
	K0009 D02	0009	0402	0310	04	04	2 8	1 2	151
	K0009 T02	0009	0402	0250	31	26	12 7	3 2	151
	K0009 T01	0009	0402	0250	21	21	12 7		151
	K0009 D12	0009	0402	0314	05	05	9 14	1	151
	M0014 D02				00				101
	M0014 T02				00				101
	M0014 T01				00				101
	M0015 D02				00				101
	M0015 T02	0014	0402	1105	32	30	567	3	101
	M0015 T01	0014	0402	1105	03	01	567	3	101
	M0015 D01				00				101
	M0016 D02	0016	0402	1418	05	00	3	122	101
	M0016 T02	0015	0402	1249	31	31	567	3 2	101
	M0016 T01	0015	0402	1249	15	13	567	2	101
	M0016 D01	0016	0402	1424	10	03	45	122	101
	M0017 D02	0017	0402	1603	06	00	34	1	101
	M0017 T02	0016	0402	1446	32	32	1112 17	3 2	101
	M0017 T01				00				101
	M0017 D12	0017	0402	1608	22	22	45	1	101
	K0017 D12				00				151
	K0017 D12				00				151
	M0018 D02	0018	0402	1747	06	06	34	1 2	101
	M0018 T02	0017	0402	1623	16	16	11 1617	1 2	101
	M0018 T01	0017	0402	1623	20	20	11 1617	2	101
	M0018 D12	0018	0402	1753	09	09	45	1 2	101
	K0018 D12				00				151
	K0018 D12				00				151
	M0019 D12	0019	0402	1931	06	06	34	122	101
	M0019 T01				00				101
	M0019 T02	0019	0402	1912	16	03	123	1 2	101
	M0019 D12	0019	0402	1937	11	11	34 10	122	101
	K0019 D02	0019	0402	1917	05	00	2	1	151
	K0021 D02				00				151
	K0021 T02	0020	0402	2101	31	26	123	3	151
	K0021 T01	0020	0402	2101	23	23	123		151
	K0021 D12	0021	0402	2252	05	05	23	1 2	151
	K0022 D01	0022	0403	0029	25	25	12	1 2	151
	K0022 T01				00				151
	K0022 D12	0022	0403	0035	09	09	2 9	1	151
	K0023 D01	0023	0403	0213	12	12	12	1	151
	K0023 T01				00				151

| READOUT DATA | | | | | | PICTURE SEQUENCE DATA | | | | | |

READOUT DATA INDICATED ORB M C	ACTUAL S ORB M C	STARTING TIME ORB	DATE	TIME	PICTURE SEQUENCE DATA FRAME US	+	GEOGRAPHICAL AREA COVERED 1234567891011121314151617	LVBS	REEL
	M0057 D02				00				102
	M0058 T02	0057	0405	1013	32	24	56 1112	32	102
	M0058 D02	0058	0405	1146	05	00	45		102
	M0059 D02	0059	0405	1321	08	00	345	1	103
	M0059 D12				00				103
	K0059 T01				00				152
	K0059 D02				00				152
	M0060 D12	0060	0405	1505	18	08	234	3	103
	M0060 D12				00				103
	K0060 D12				00				152
	K0060 T01				00				152
	K0060 T02	0058	0405	1154	31	28	56 1112 17	32	152
	K0060 D12				00				152
	M0061 D12	0061	0405	1650	19	12	34	122	103
	M0061 D12				00				103
	K0061 D12				00				152
	K0061 T01				00				152
	K0061 T02	0060	0405	1519	30	30	5 1011	1 22	152
	K0061 D12				00				152
	M0062 D12	0062	0405	1834	04	04	3	1	103
D01	M0062 T02	0061	0405	1704	32	32	45 1011 16	0	103
	M0062 D12	0062	0405	1839	10	10	34	1	103
	K0062 D12				00				152
	K0064 D02	0064	0405	2153	05	05	2	122	152
	K0064 T02				00				152
	K0064 D02	0064	0405	2157	07	07	23	122	152
	K0065 D02	0065	0405	2335	09	09	2	1	152
	K0065 T02	0065	0405	2316	18	01	12 7	12	152
	K0065 D02	0065	0405	2341	10	10	2 9	1	152
	K0066 D02	0066	0406	0120	07	07	2 8	1	152
	K0066 T02	0066	0406	0100	30	09	12 7	1	152
	K0066 D02	0066	0406	0126	04	04	89	1	152
	M0071 D02				00				103
	M0071 T02	0068	0406	0426	30	04	1 78	1	103
	M0072 D01				00				103
	M0072 T02	0071	0406	0923	30	30	567 1112	3	103
	M0072 D02				00				103
	M0073 D02				00				103
	M0073 T02	0072	0406	1103	31	31	56 11	3	103
	M0073 D02	0073	0406	1233	07	00	34	1	103
	M0074 D02	0074	0406	1413	13	00	34	1 2	103
	M0074 D12	0074	0406	1421	06	00	345	1 2	103
	K0074 D02				00				152
	K0074 T02	0073	0406	1246	32	30	56 11	32	152
	M0075 D02	0075	0406	1559	23	13	45	1	103
	M0075 D02				00				103
	K0075 D01				00				152
	K0075 T02	0074	0406	1431	32	32	56 1011 16	3 2	152
	M0076 D02	0076	0406	1741	07	07	34	1	103
	M0076 T02	0075	0406	1614	31	31	45 1011 16	3	103
	M0076 D02	0076	0406	1747	10	10	4 10	3	103
	K0078 D01				00				153
	K0078 D02	0078	0406	2102	02	00	23	1	153
	K0079 D02	0079	0406	2240	09	07	12	1 2	153
	K0079 T02	0077	0406	1916	30	18	234 9	12	153
	K0079 D02				00				153
	M0085 D02				00				103
	M0085 T02	0080	0407	0008	31	04	12 7	0 2	103

READOUT DATA INDICATED ORB M C S	ACTUAL ORB M C	PICTURE SEQUENCE DATA STARTING TIME ORB	DATE	TIME	FRAME US	+	GEOGRAPHICAL AREA COVERED 1234567891011121314151617	LVBS	REEL
	M0086 D02				00				103
	M0086 T02	0085	0407	0830	31	20	567 12	3 2	103
	M0086 T01				00				103
	M0087 D02				00				103
	M0087 T02	0086	0407	1009	31	20	56 11	3 2	103
	M0087 D12	0087	0407	1139	02	00	4	1	103
	M0088 D02	0088	0407	1319	05	00	4	1	103
	M0088 D12				00				103
	K0088 D02				00				153
	K0088 T02	0087	0407	1152	31	20	56 11	322	153
	M0089 D02	0089	0407	1503	11	00	234	1	103
	M0089 D12	0089	0407	1509	10	06	345	1	103
	K0089 D02				00				153
	K0089 T02	0088	0407	1335	31	29	56 11	3 2	153
	M0090 D12	0090	0407	1647	02	00	23	1	103
	M0090 T02	0089	0407	1518	32	32	45 1011	3 2	103
	M0090 D12	0090	0407	1650	13	10	34	1	103
	M0091 D02	0091	0407	1833	14	14	34 9	3 2	104
	K0093 D12	0093	0407	2148	07	05	2 9	1 2	153
	K0093 T02	0092	0407	2015	31	31	23 910	1	153
	K0093 D12	0092	0407	2155	07	07	23 9	1	153
	K0094 T02	0094	0407	2314	20	03	12 7	1	153
	K0094 D12	0094	0407	2335	08	08	12	1	153
	K0094 D12	0094	0407	2330	04	04	2 89	12	153
	M0100 T02	0097	0407	0427	31	31	1 78	1 2	104
	M0101 T01				00				104
	M0101 T02	0100	0408	0918	31	11	567 11	322	104
	M0102 D02				00				104
	M0102 T02	0101	0408	1059	28	12	56 11	1	104
	M0102 D02	0102	0408	1230	11	00	4	1	104
	M0103 D02				00				104
	M0103 D12	0103	0408	1418	10	00	345	1	104
	K0103 D02				00				153
	K0103 T02	0102	0408	1242	03	03	56 11	1	153
	M0104 D02	0104	0408	1554	13	00	234	1	104
	M0104 D12	0104	0408	1600	08	08	345 10	1	104
	K0104 D02				00				153
	K0104 T02	0103	0408	1427	31	31	5 1011 16	1	153
	M0105 D02				00				104
	M0105 T02	0104	0408	1610	30	30	5 1011 16	0	104
	M0105 D12	0105	0408	1742	10	10	34 910	1	104
	K0107 D02	0107	0408	2054	02	00	12	1	153
	K0107 T02	0106	0408	1910	15	02	23 9	1	153
	K0107 D12				00				153
	K0108 D12	0108	0408	2238	05	05	12	1	153
	K0108 T02	0108	0408	2219	14	00	1	1	153
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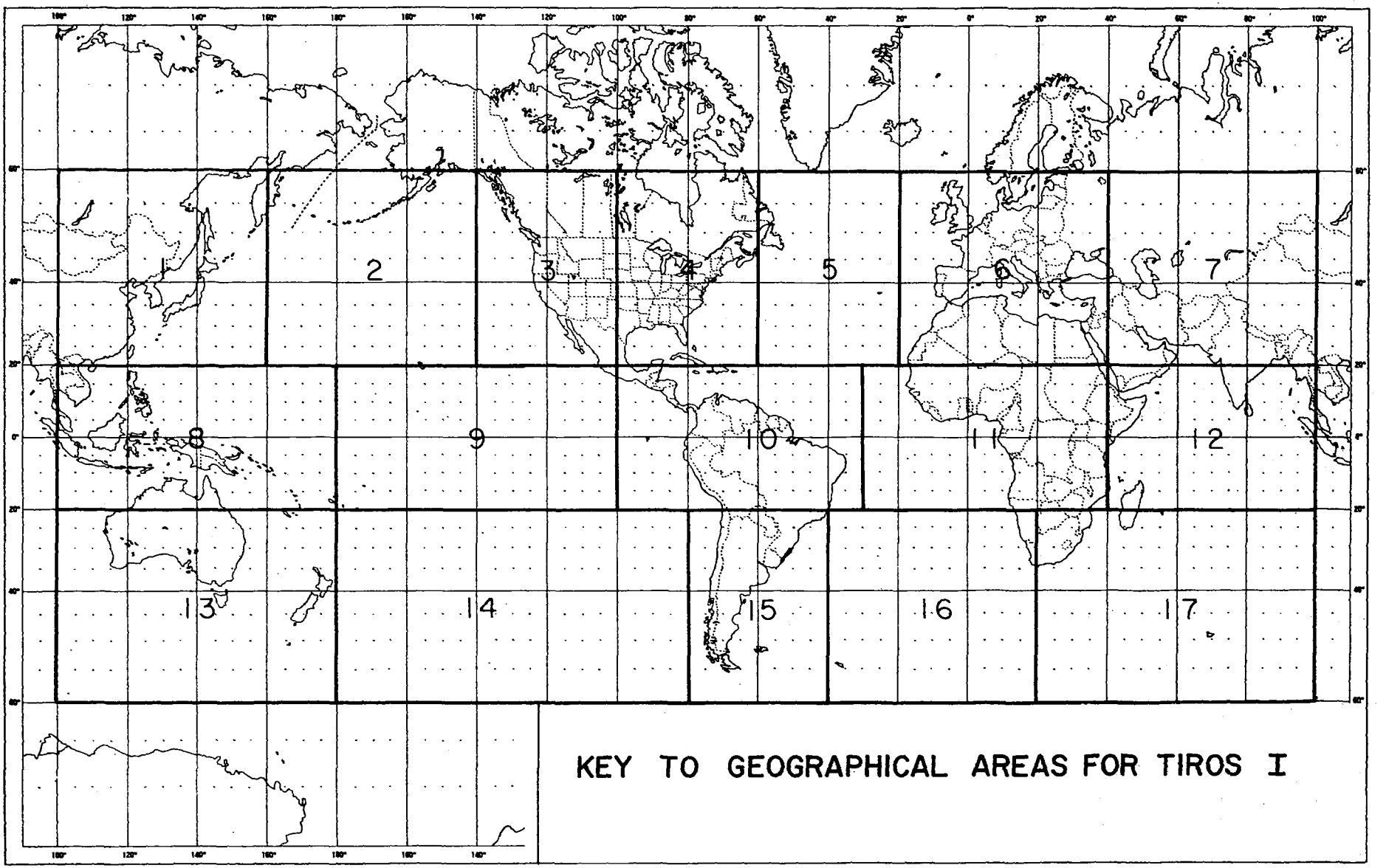
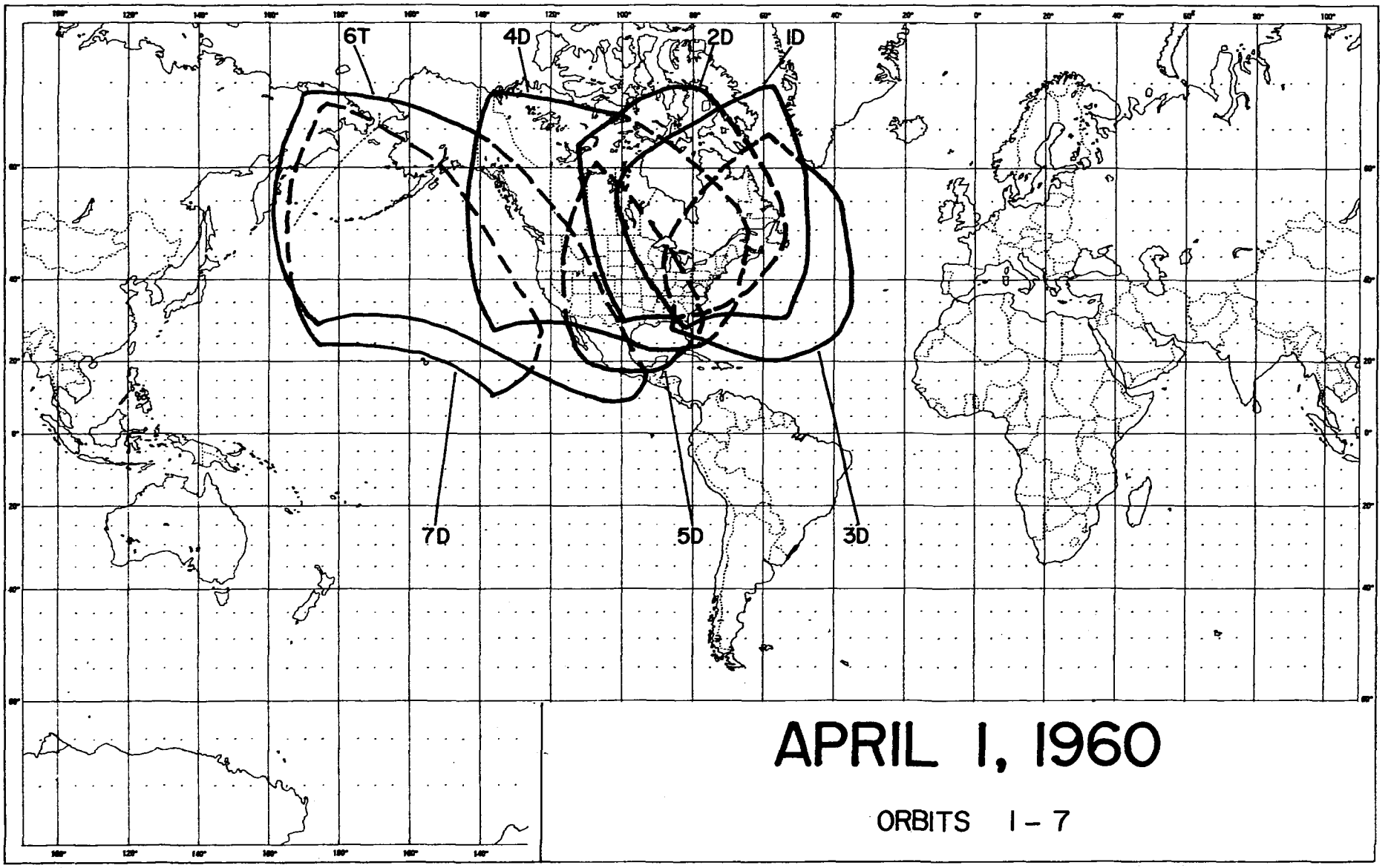
	K0109 D02	0109	0409	0022	06	06	12 8	1	153

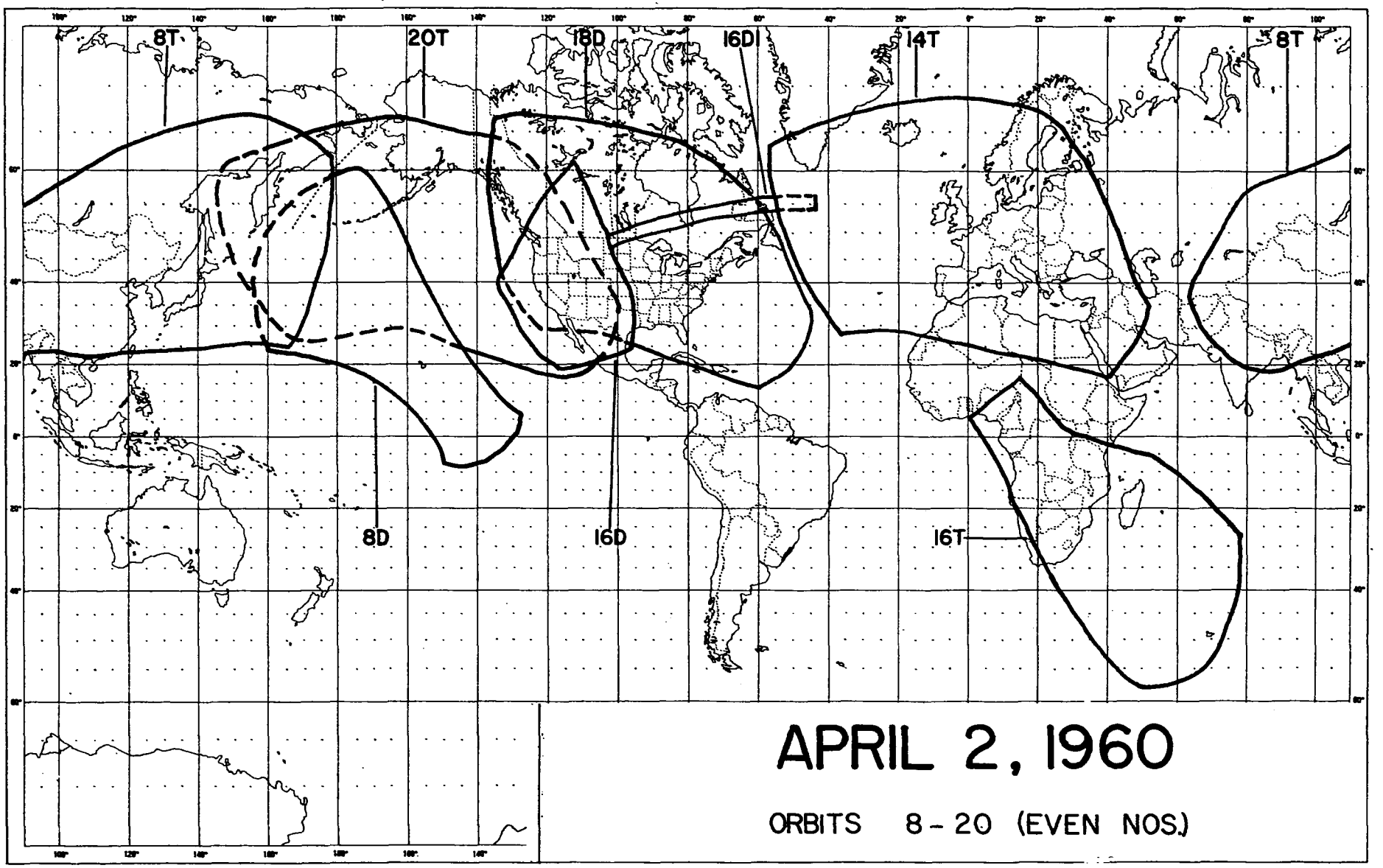


KEY TO GEOGRAPHICAL AREAS FOR TIROS I



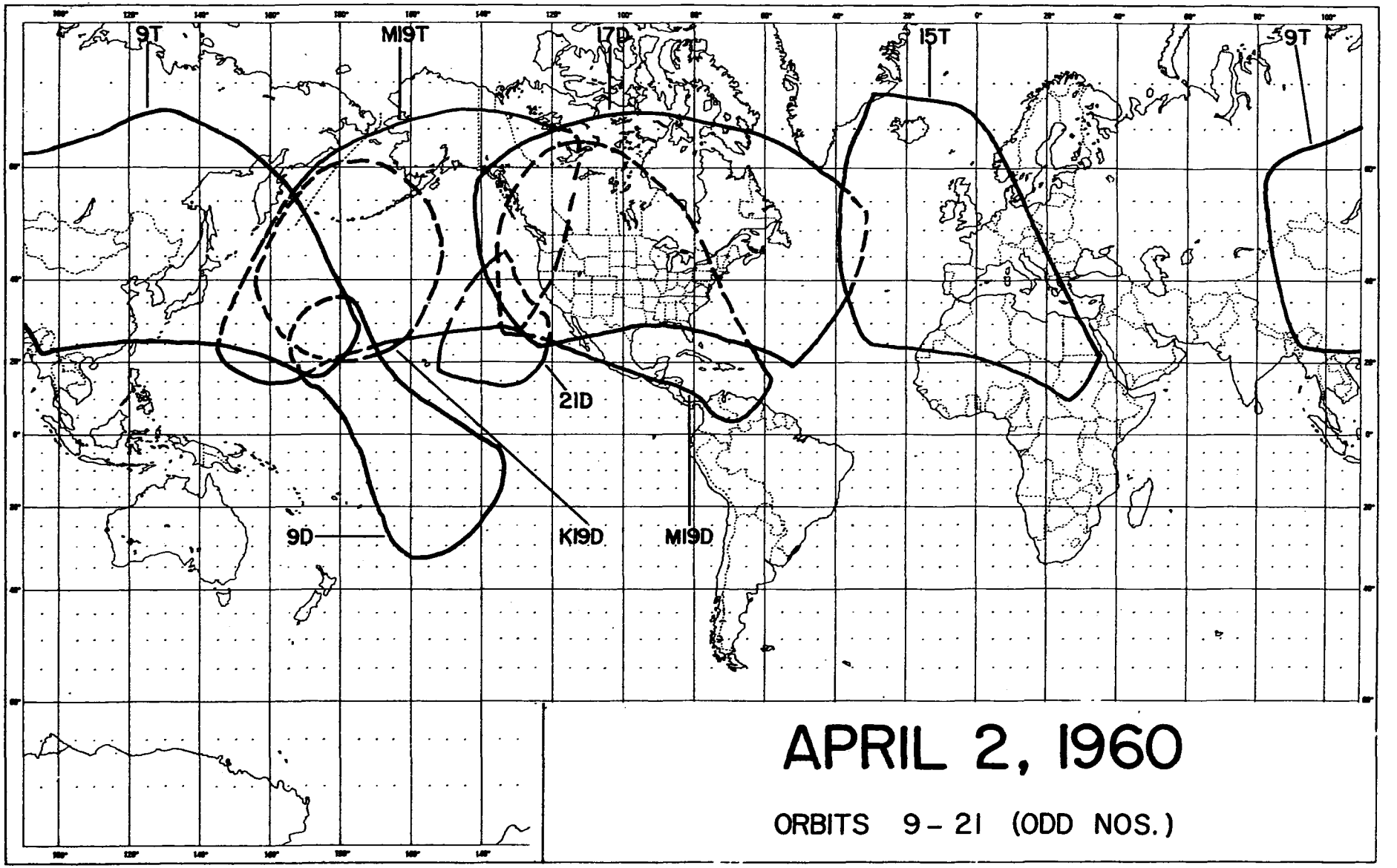
APRIL 1, 1960

ORBITS 1 - 7



APRIL 2, 1960

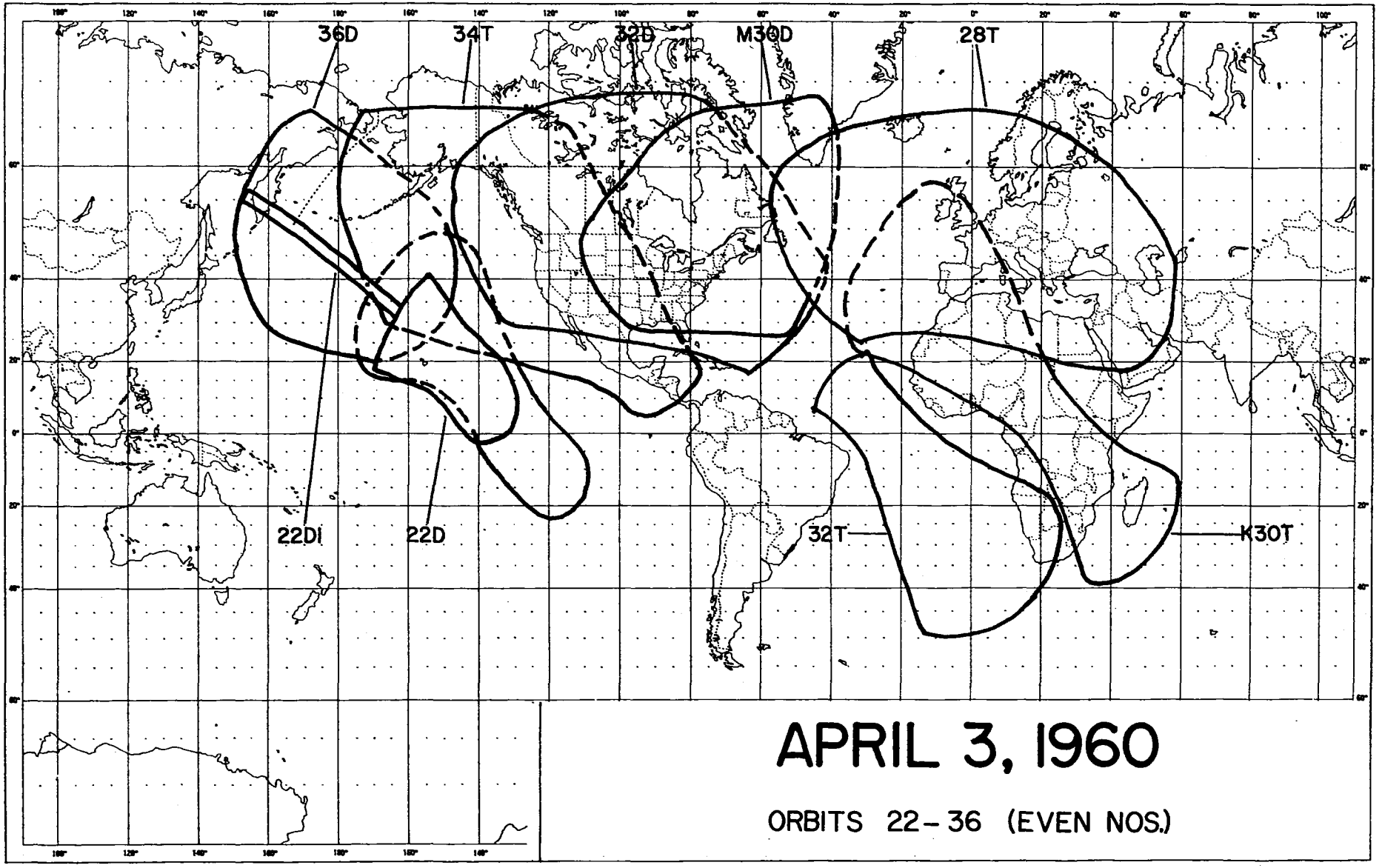
ORBITS 8 - 20 (EVEN NOS.)



APRIL 2, 1960

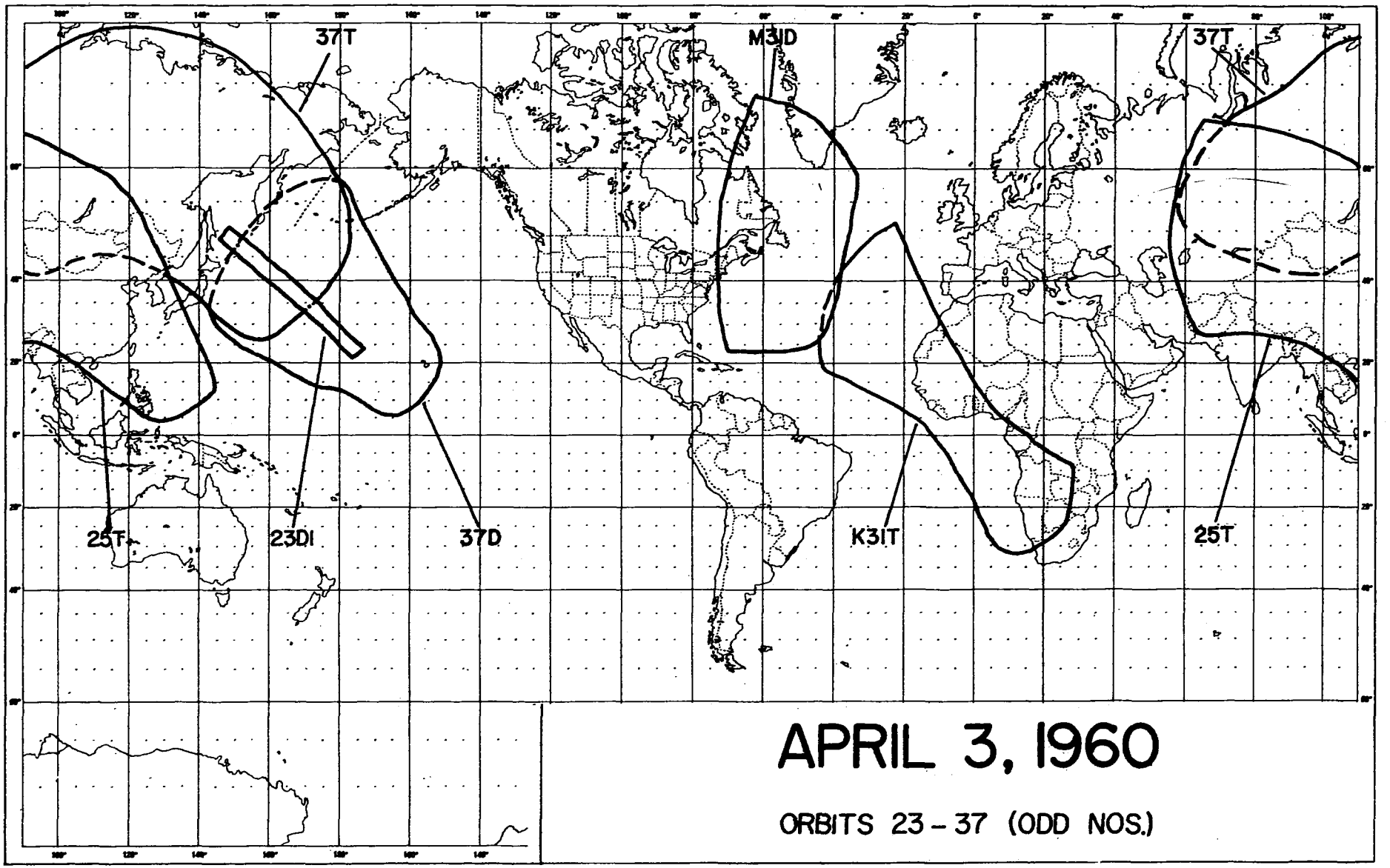
ORBITS 9 - 21 (ODD NOS.)

113 358



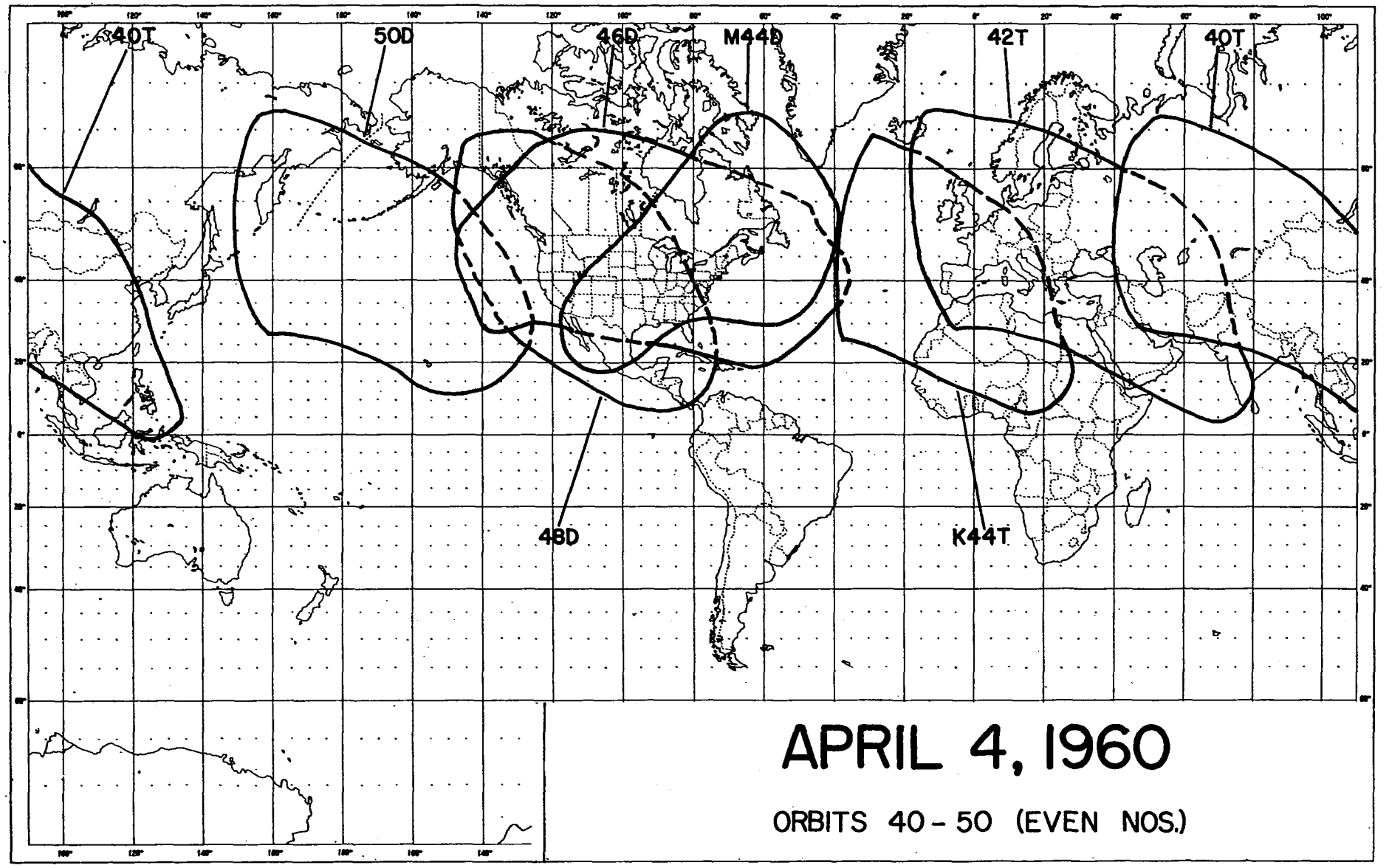
APRIL 3, 1960

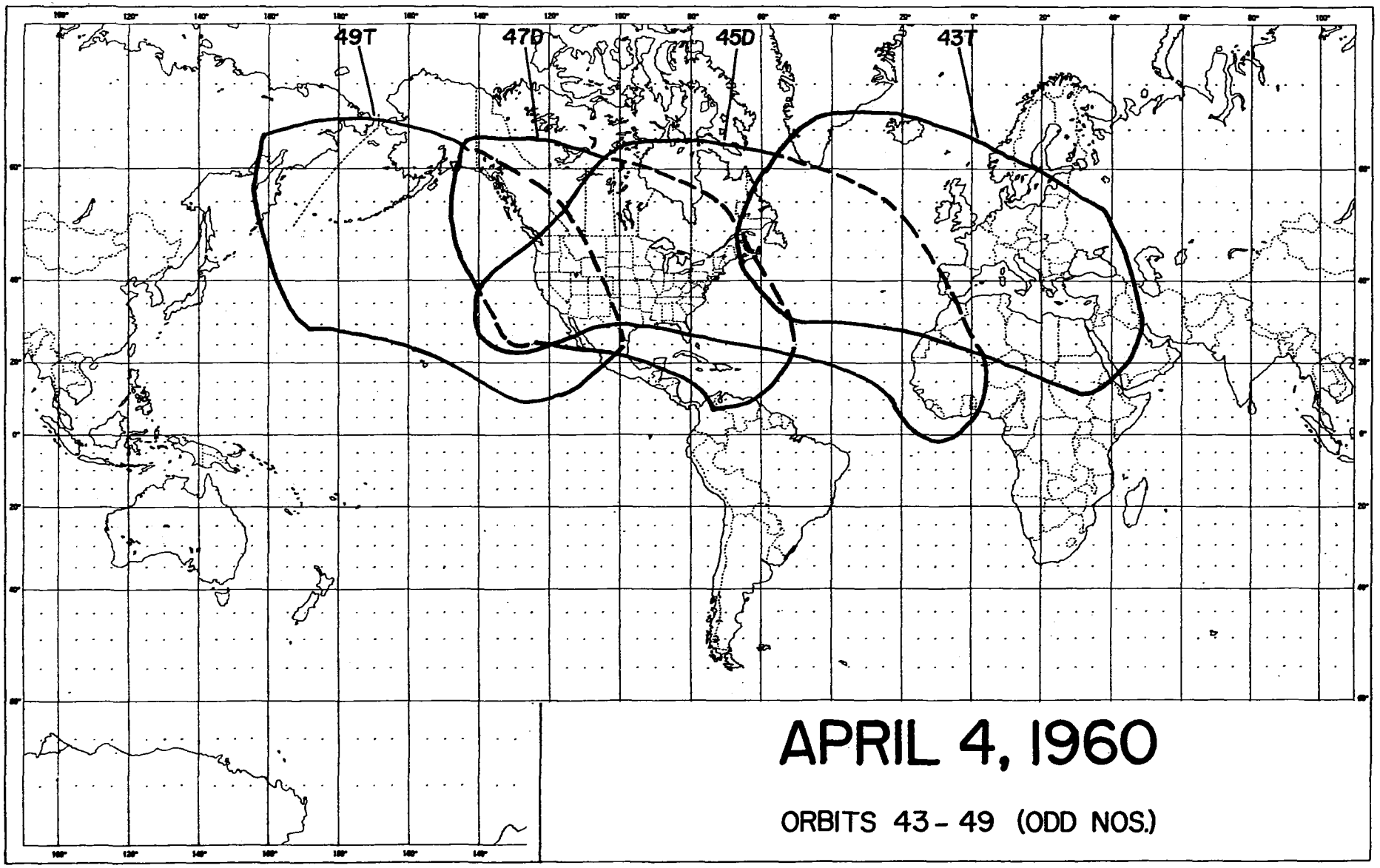
ORBITS 22 – 36 (EVEN NOS.)



APRIL 3, 1960

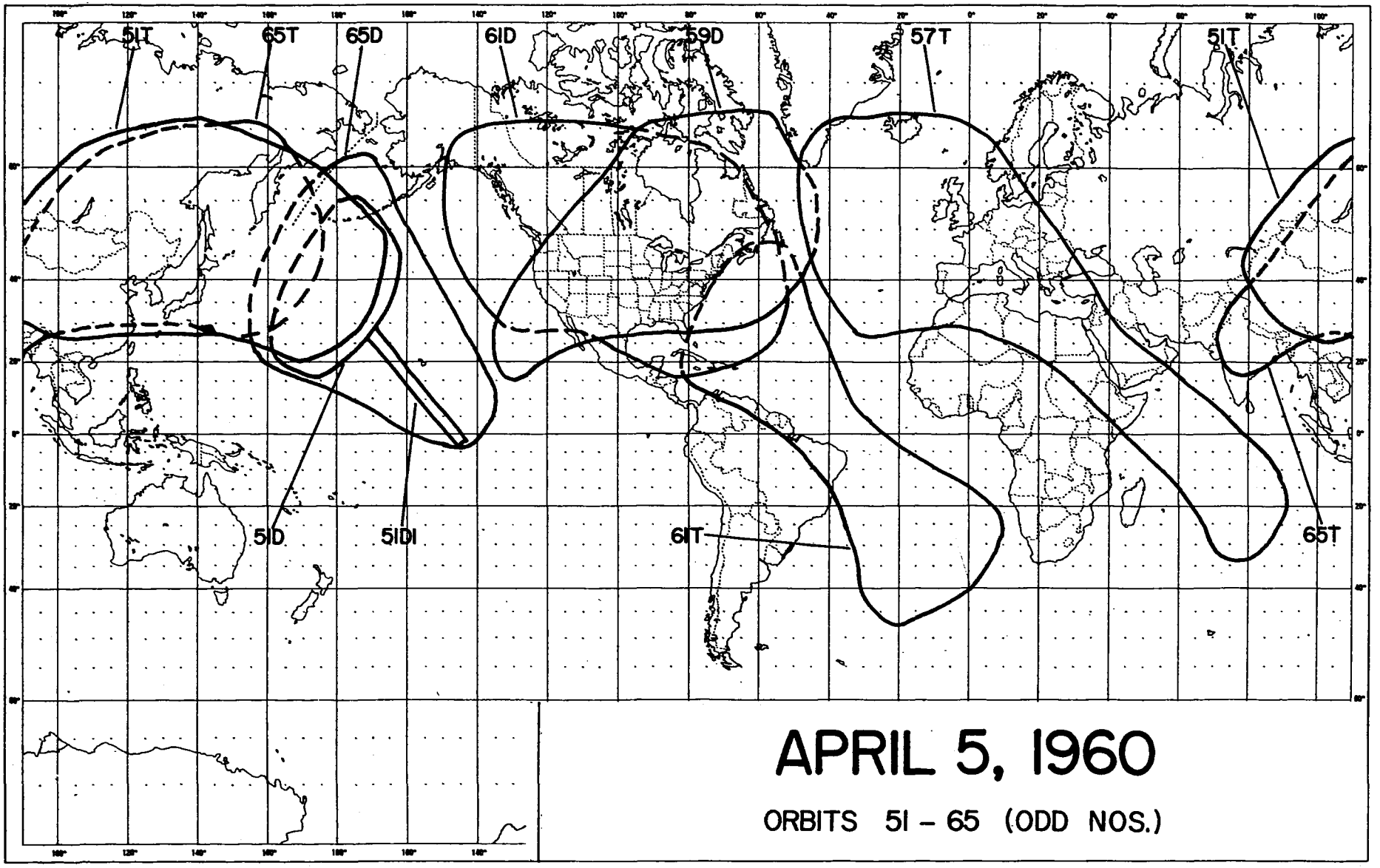
ORBITS 23 - 37 (ODD NOS.)


40T
50D
46D
M44D
42T
40T
48D
K44T
APRIL 4, 1960
ORBITS 40 - 50 (EVEN NOS.)



APRIL 4, 1960

ORBITS 43 - 49 (ODD NOS.)


51T
65T
65D
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59D
57T
51T
51D
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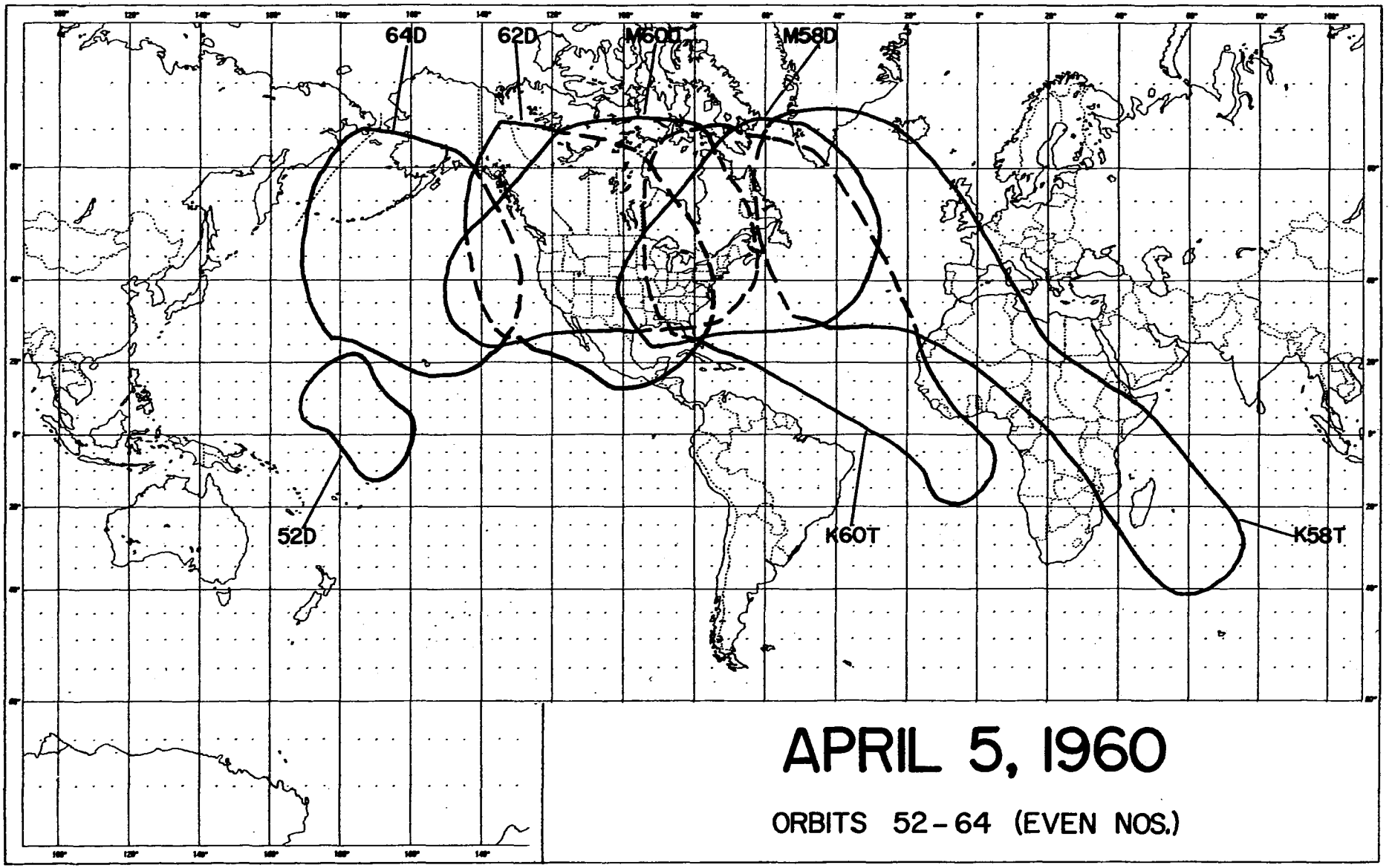
61T
65T
APRIL 5, 1960
ORBITS 51 - 65 (ODD NOS.)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62D
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52D
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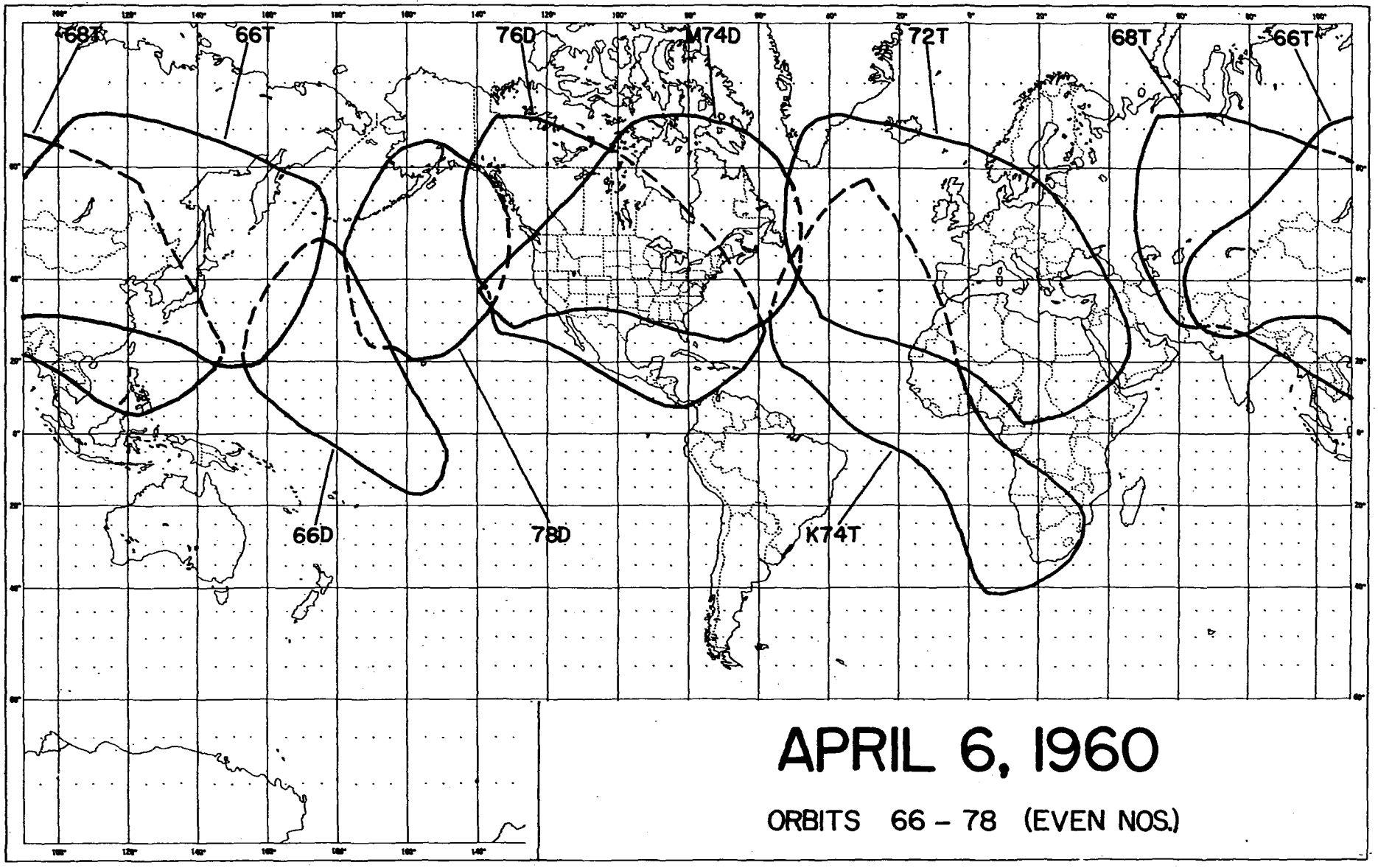
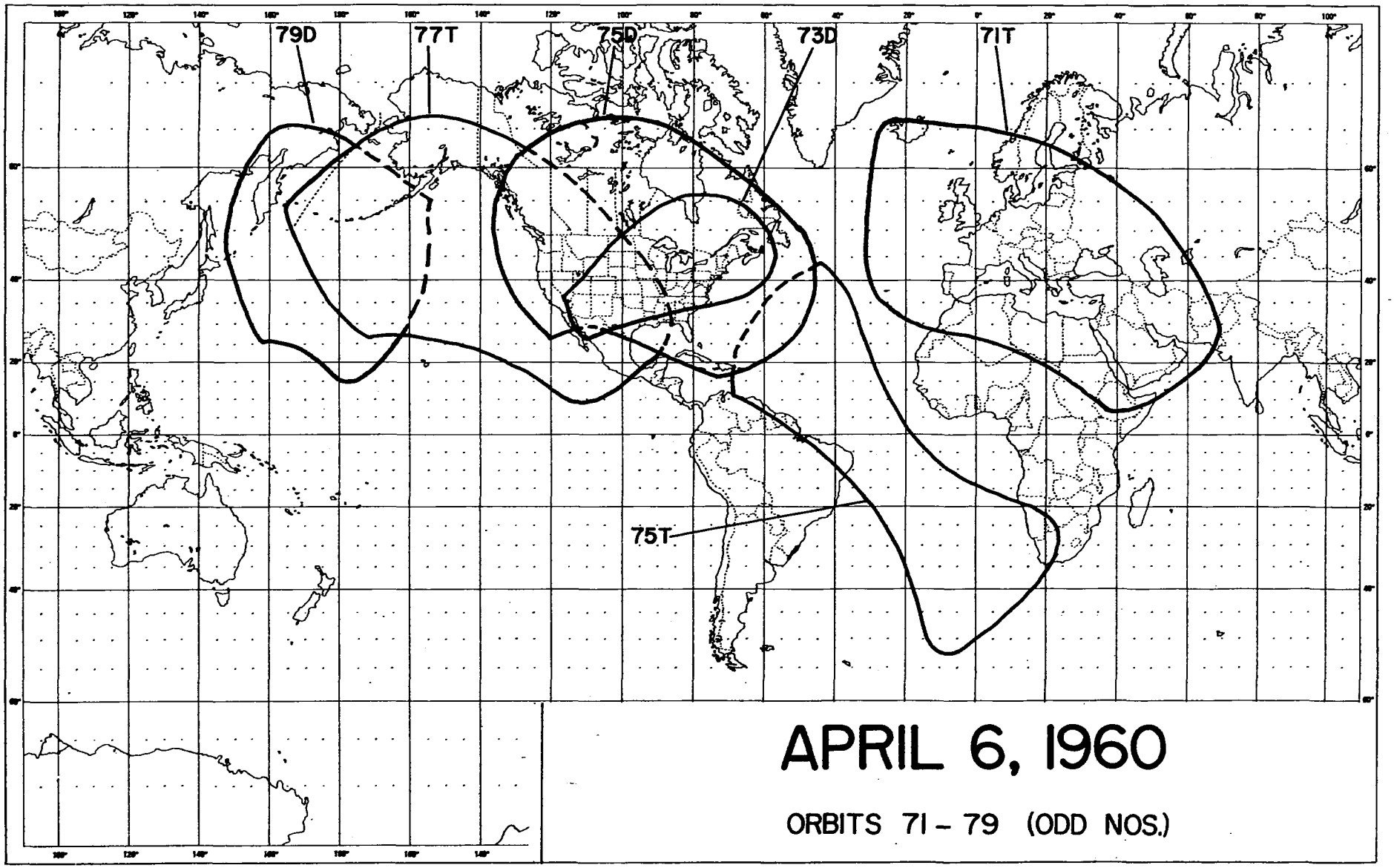
K58T
APRIL 5, 1960
ORBITS 52-64 (EVEN NOS.)



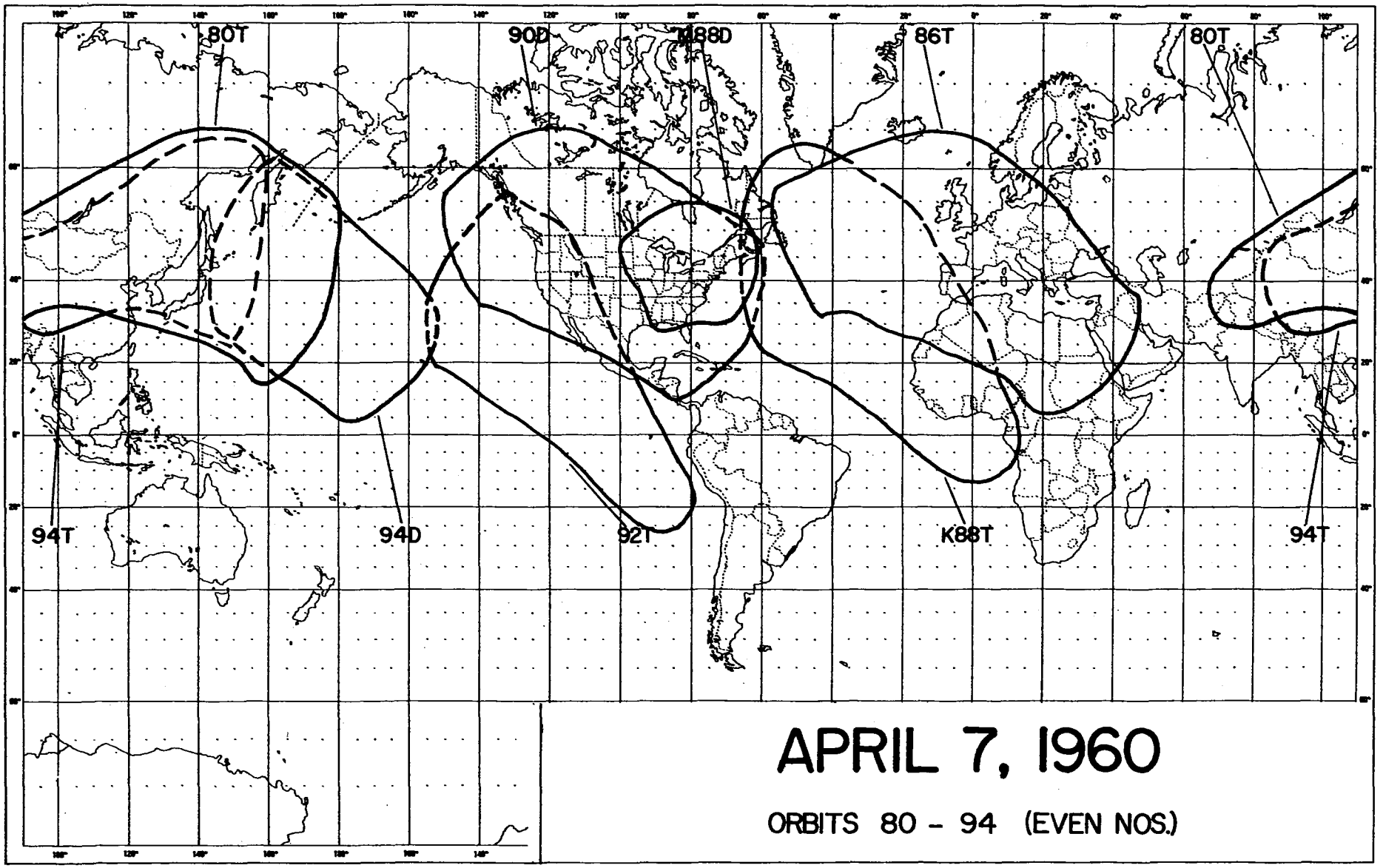
APRIL 6, 1960

ORBITS 66 – 78 (EVEN NOS.)



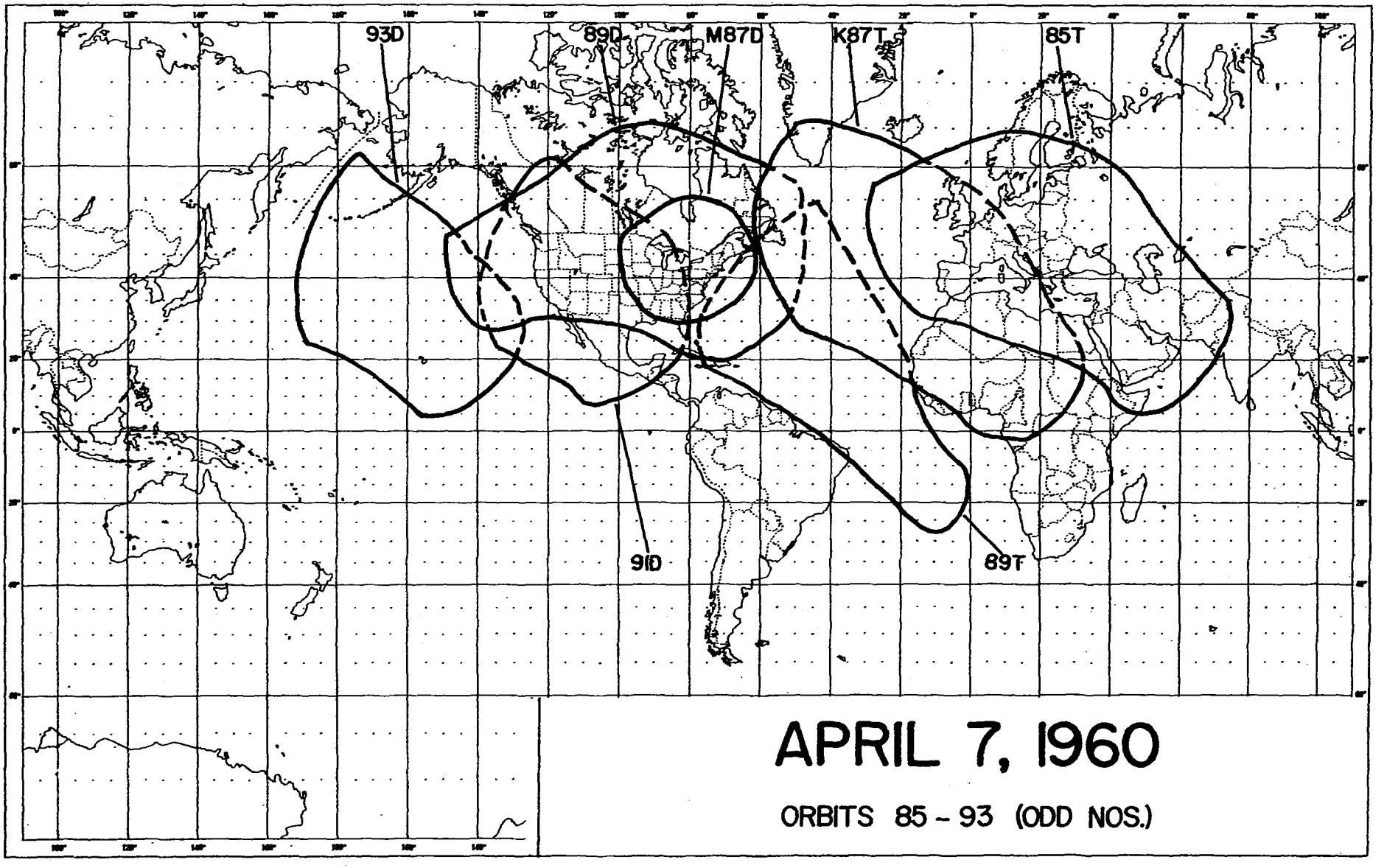
APRIL 6, 1960

ORBITS 71 - 79 (ODD NOS.)



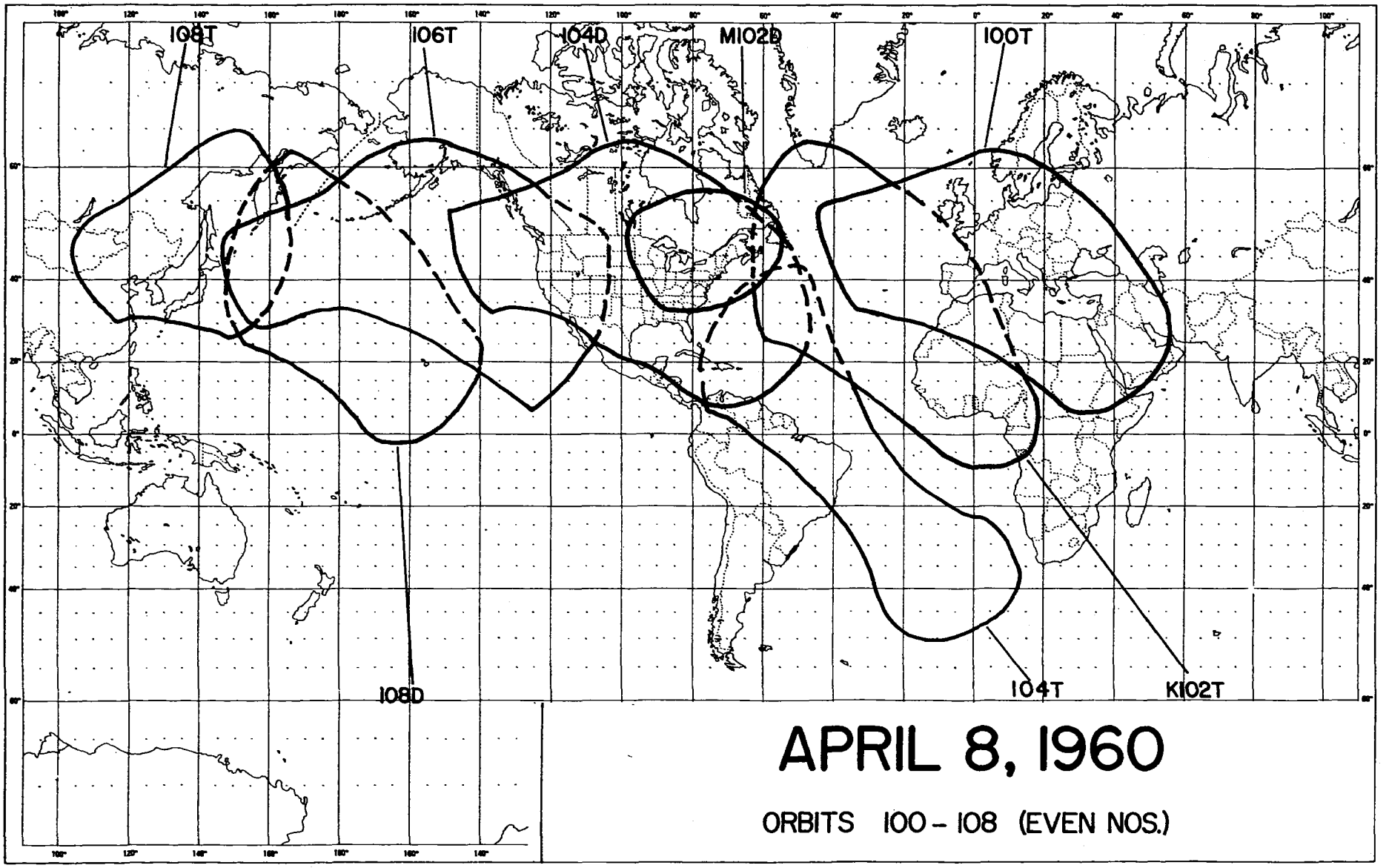
APRIL 7, 1960

ORBITS 80 - 94 (EVEN NOS.)



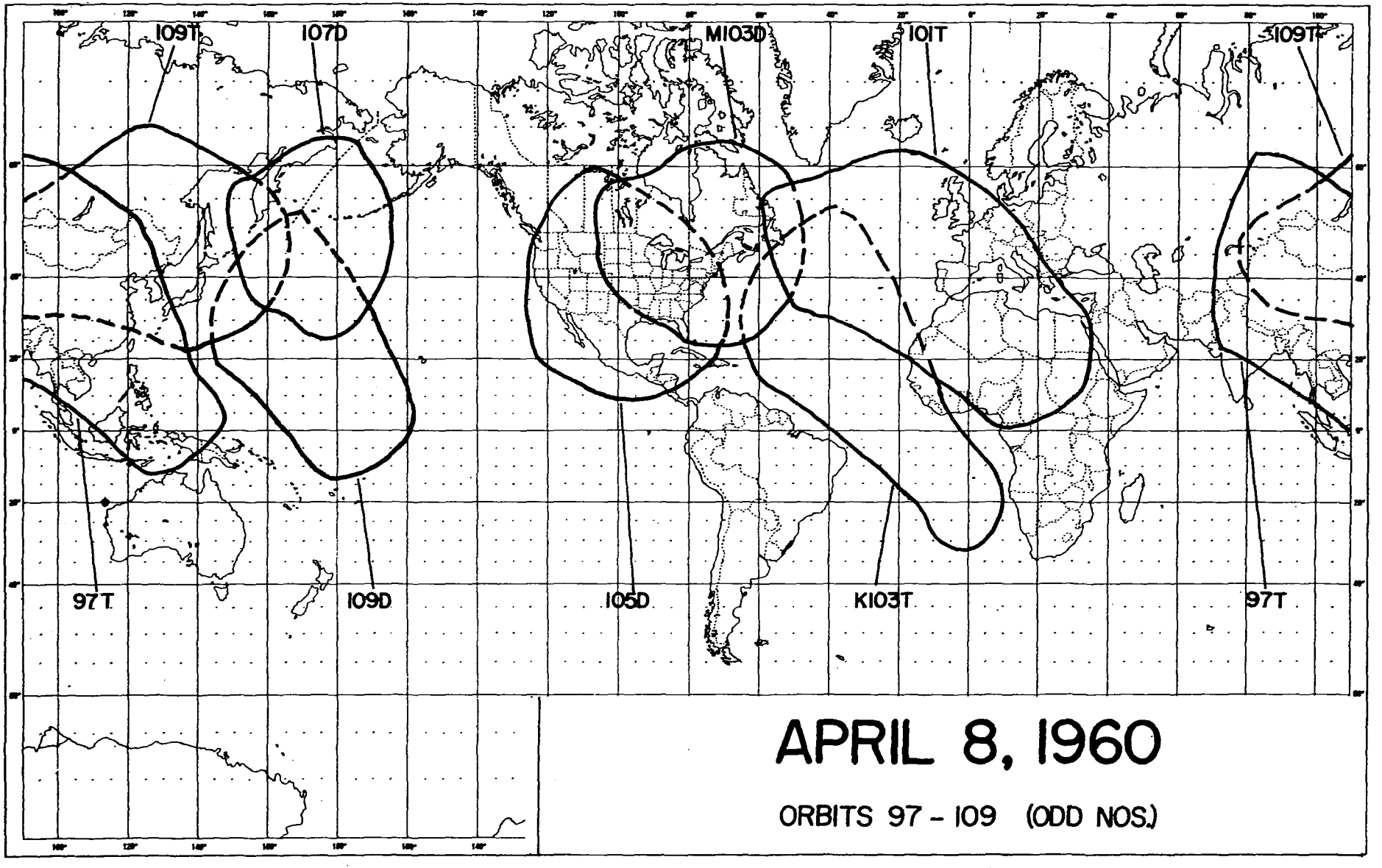
APRIL 7, 1960

ORBITS 85 - 93 (ODD NOS.)



APRIL 8, 1960

ORBITS 100 - 108 (EVEN NOS.)



APRIL 8, 1960

ORBITS 97 - 109 (ODD NOS.)