



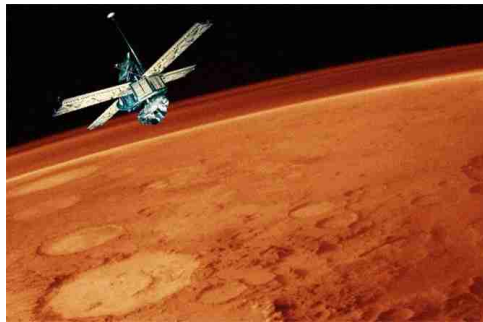
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**Mariner Mars 1969 Spacecraft Trajectories:
the basis for NAIF SPICE S Kernels**

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1 Introduction

The Mariner Mars 1969 Mission (NASA, 1969) had two spacecraft, Mariner 6 and Mariner 7. Each spacecraft had a narrow and a wide angle camera (Danielson and Montgomery, 1971, Reindfleisch, *et. al.*, 1971) that were mounted on two degree-of-freedom scan platforms to point the cameras at Mars during Mars approach and flyby. About 200 approach and flyby images of Mars were taken by the narrow and wide angle cameras (Leighton, *et. al.*, 1969, Leighton, *et. al.*, 1971, Collins, 1971). The NASA Science Missions Directorate Planetary Science Division, under its Planetary Data Archive, Restoration and Technology Program (PDART), is restoring these images in Planetary Data System PDS4 data formats and creating their associated ancillary engineering data as NAIF SPICE Kernels (Acton, 1996, Acton, *et. al.*, 2017). The complete set of SPICE kernels were created that are listed in the SPICE meta-kernel *mariner69_v02.tm*, making the use of the Mariner 69 kernels collection much easier.

The Mariner Mars 1969 NAIF SPICE Kernel collection includes Instrument I Kernels (Duxbury, 2017)

mr6_na_tcd_v10.ti and

mr7_na_tcd_v10.ti,

Narrow Angle Camera Pointing and Spacecraft Attitude C Kernels (Duxbury and Semenov, 2017)

mr6_na_690729_690730_tcd_v10.bc,

mr7_na_690802_690804_tcd_v10.bc,

mr6_sc_690729_690730_tcd_v10.bc and

mr7_sc_690802_690804_tcd_v10.bc,

Spacecraft Frames *fk* and *ck* Kernels (Duxbury and Semenov, 2017)

mr6_v10.tf and

mr7_v10.tf

and Spacecraft Clock Correlations Kernels (Duxbury and Semenov, 2017b)

m6_fict.tsc and

m7_fict.tsc

The NAIF SPICE spacecraft and camera ID numbers for Mariner Mars 1969 are listed in Table 1.

This report describes how published spacecraft position data at image times in Mars-centered and Earth Mean Equator and Ecliptic of Bessilian 1950 frame were transformed to Mars-center and Earth Mean Equator and Equinox of J2000.0 frame to create NAIF SPICE S Kernels. The NAIF SPICE spacecraft and camera ID numbers within the kernels are listed in Table 1.

2 Trajectory Data

The Regional Planetary Image Facility at JPL has some archival Mariner Mars 1969 mission, spacecraft and image publications, including JPL Document 605-237, Mariner Mars 1969 Simulated TV Pictures by Campbell, 1970. This document has tables listing the Areocentric spacecraft positions in Earth Mean Ecliptic and Vernal Equinox of B1950 coordinates, the time tags in Julian Ephemeris Date and UTC and the camera pointing relative to the Sun-Canopus celestial spacecraft attitude of clock, cone and twist angles for all far and near encounter image. This is an excellent reference for ancillary information except the document is over 45 years old and some of the numbers were illegible and were erroneously misinterpreted by the lead author. Most of the problems were related to distinguishing between a 5 from a 6 and a 3 from an 8 that were only partially printed or copied in the publication process. This report describes how these Mariner 6 and 7 Far Encounter misinterpreted data were identified, corrected and then used to make SPICE S Kernels.

The 1970 Campbell document contained the UTC, Julian Ephemeris Dates (JED), camera pointing data and the Areocentric position and velocity of the spacecraft in a variety of reference frames for each Far and Near Encounter image. To verify the time tags, the JEDs were converted to Barycentric Dynamical Times (TDB) and then to UTC using NAIF SPICE Toolkit software and kernels. The UTC's derived from the JED's were then compared directly with the printed UTC's, allowing four (4) misinterpreted JEDs / UTC's to be corrected.

Then ranges to Mars were computed from the 3 Areocentric spacecraft position components at each image time and plotted against the time from Mars closest approach (Figure 1). A simple second order polynomial approximation was fit to these ranges. The differences between the ranges and polynomial approximation, multiplied by 100 and shown by the +'s, were also plotted to identify which position components may have been misinterpreted. It is seen that 5 ranges differed significantly from the polynomial. These were cases where 5's were interpreted to be 6's somewhere in the 8 significant figures of the position components. Figure 2 shows the results after the five misinterpreted position components were corrected. The second order model fits better across all range points after the 5 misinterpreted points were corrected.

With the five misinterpreted position components corrected, the residuals were replotted and magnified by 100 in Figure 3 and an additional seven (7) ranges were suspect. Again illegible numbers that were interpreted as 5's and 3's were corrected to 6's and 8's, respectively, leaving only one questionable range (Figure 4). Image 6F40 has an apparent error of over 10 km in its Y position component and smaller errors in the X and Y components that did not have any illegible characters in the Campbell document. Figure 5 shows the same information as in Figure 4 but for the Mariner 7 Far Encounter images with the same data corrections applied. The image 6F40 is unique in that there was only a 2-minute time gap before 6F41 was taken while there was at least 35 minutes between all other far encounter images (Figure 6). Therefore, image 6F40 is flagged for further study, possibly with a time tag error, possibly not. Figure 7 shows the times between the Mariner 7 Far Encounter images. No anomalies are seen as with 6F40. The Mariner 7 tape recorder could only hold 33 full images and partial images were not reconstructed. Therefore images 7F34 and 7F68 were taken but only partially recorded and were not reconstructed on earth. Image 7F0 does exist in the digital archive but the Campbell document has no data for this image.

3 S (.bsp) Kernels

The corrected Mariner 6 and 7 spacecraft position data in Earth Mean Ecliptic and Vernal Equinox of B1950 (Tables 2 and 4, 5) were then transformed to Areocentric Earth Mean Equator and Vernal Equinox of J2000 frame (Tables 3 and 6, 7), today's standard reference system, also using the NAIF SPICE Toolkit and kernels. The Mariner 6 and 7 position and velocities at encounter were also transformed and were used as initial conditions, together with the latest IAU Mars orientation frame, gravity field and the planetary ephemerides, to numerically integrate the N-body equations of motion and variational equations. The initial encounter positions and velocities were adjusted to minimize the difference between the positions derived from Campbell, 1970 and the position extracted from the integrated trajectories. After convergence, these integrated trajectories were converted to NAIF SPICE S kernels *mr6_690721_690810_ssd_v10.bsp* and *mr7_690726_690815_ssd_v10.bsp*. The differences in spacecraft to Mars ranges between the Campbell document and the S kernels for Mariner 6 and 7 are shown in Figures 8 and 9, respectively. These range differences map to the pixel level for all images. The anomaly for 6F40 is seen as it still has not been resolved. The time tag was varied for 6F40 without resolving the spacecraft position / range discrepancy.

From Campbell, 1970, the Mariner 6 closest flyby / encounter occurred at 1969 July 31 05:19:07 UTC with Navigation **B**-plane coordinates (Bezrouk, 2015) of **B.T**, parallel to the ecliptic plane (Mars-centered), = 7595.2350 km and **B.R**, normal to the ecliptic plane (Mars-centered), = -336.26822 km. The S kernel m6.bsp has a computed encounter time of 1969 July 31 05:19:44. The Mariner 7 closest flyby / encounter occurred at 1969 August 05 05:00:50 with **B.T** = 6730.9359 km and **B.R** = 3623.4907 km. The S kernel m7.bsp has a computed encounter time of 1969 August 05 05:01:26.

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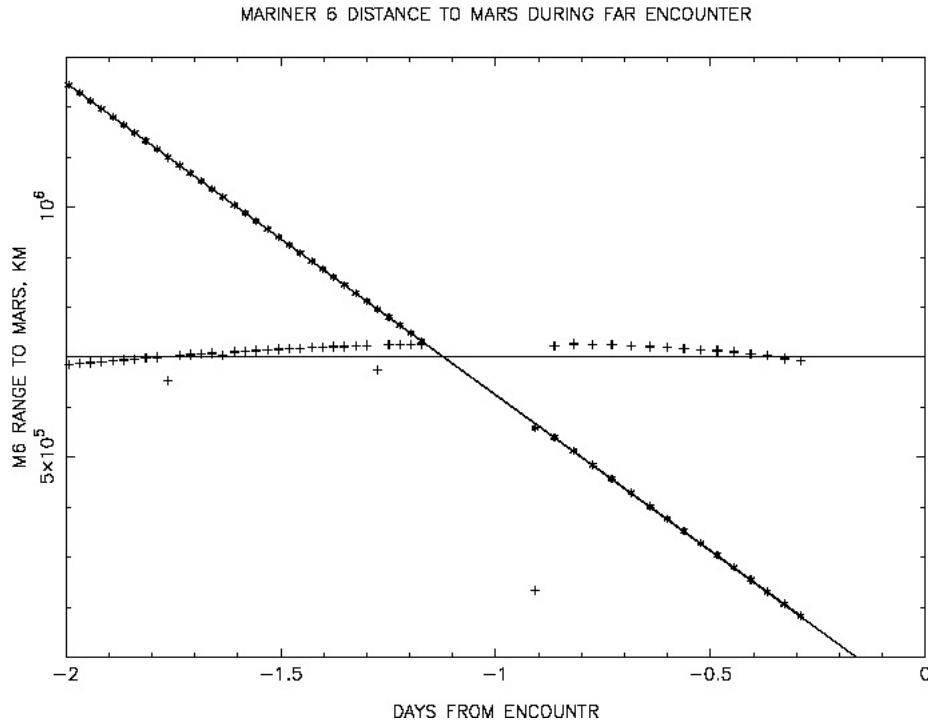


Figure 1: M6 S/C position data (*'s) that includes errors, and residuals (+'s) x100

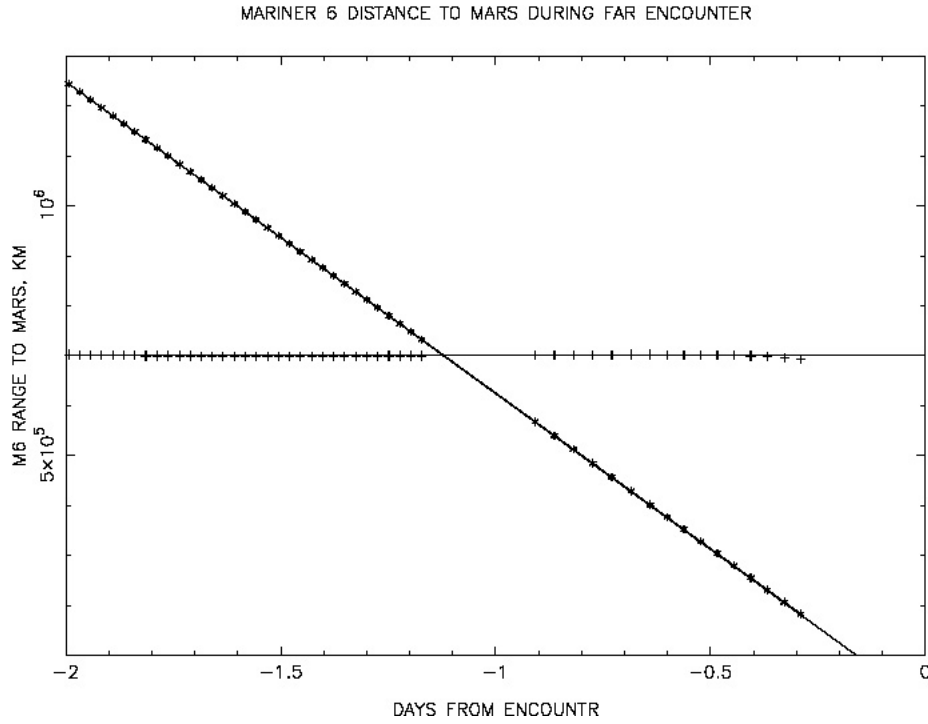


Figure 2: Corrected M6 S/C position data, on straight line, with errors corrected, and residuals, wavy curve, x100

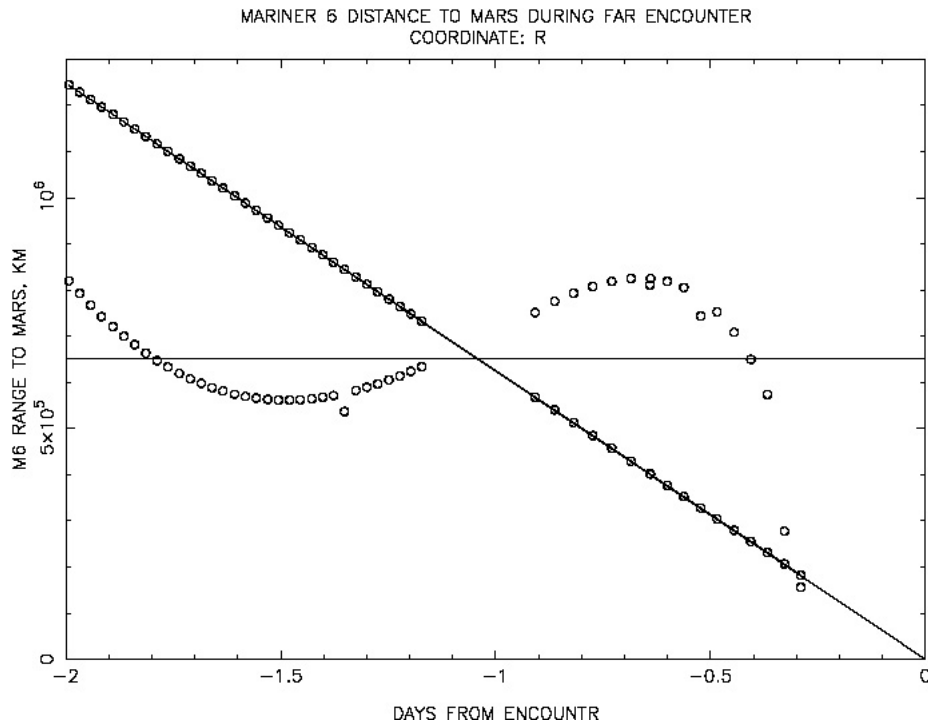


Figure 3: Corrected M6 S/C position data, on straight line, with errors corrected, and residuals, wavy curve, x100

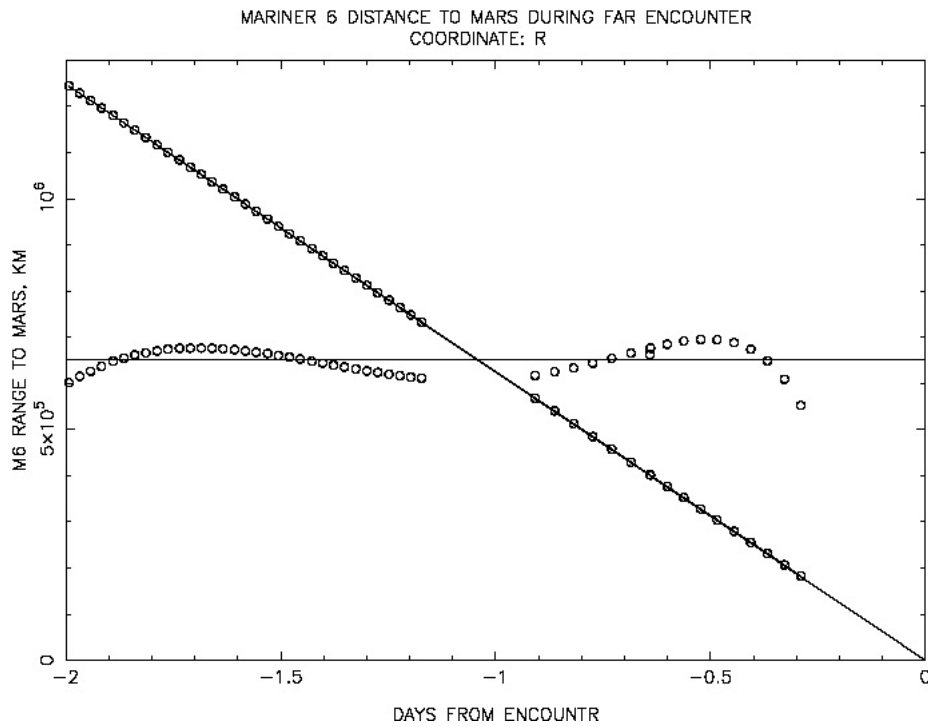


Figure 4: Expanded view of M6 S/C position data with errors magnified by 4000

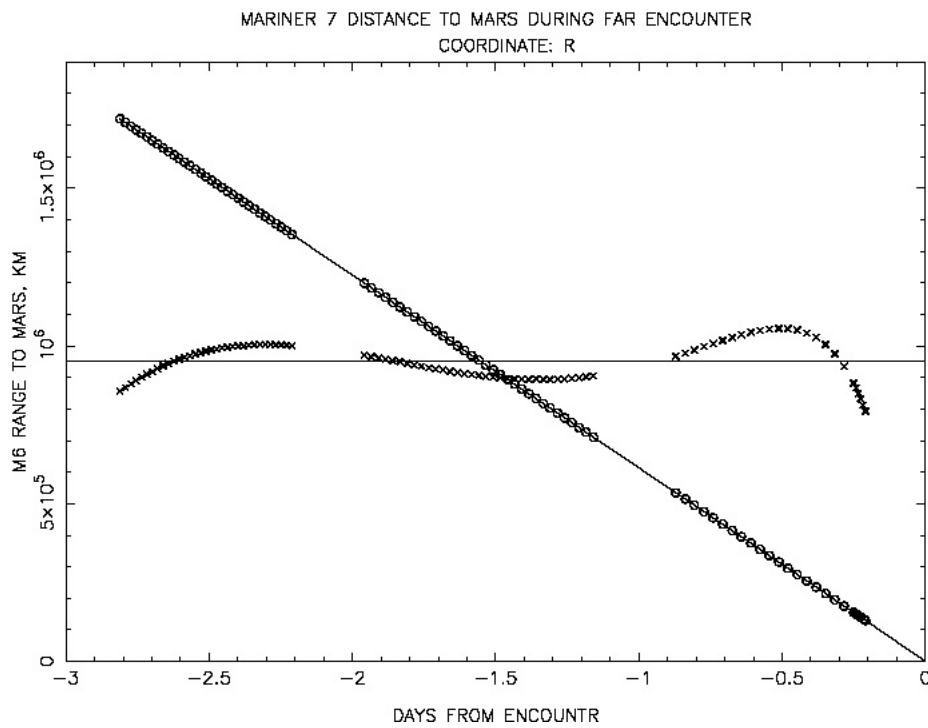


Figure 5: Same as Figure 4 but for Mariner 7 with data corrections

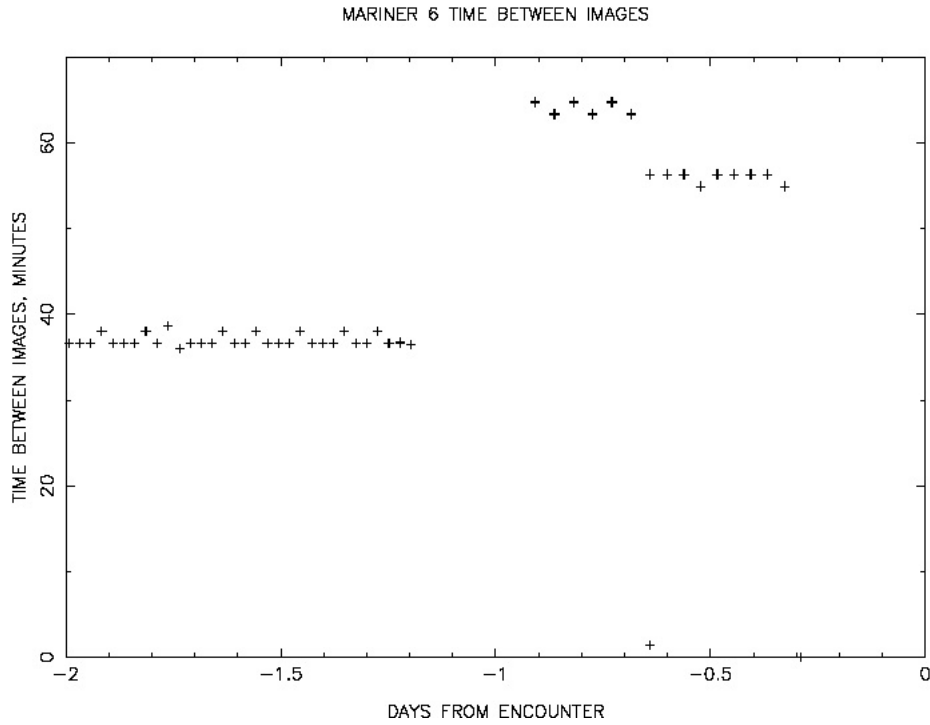


Figure 6: The amount of time in minutes is shown before the next M6 far encounter image. There is an apparent anomaly for image 6F40 at -0.64 days from encounter that has not been resolved.

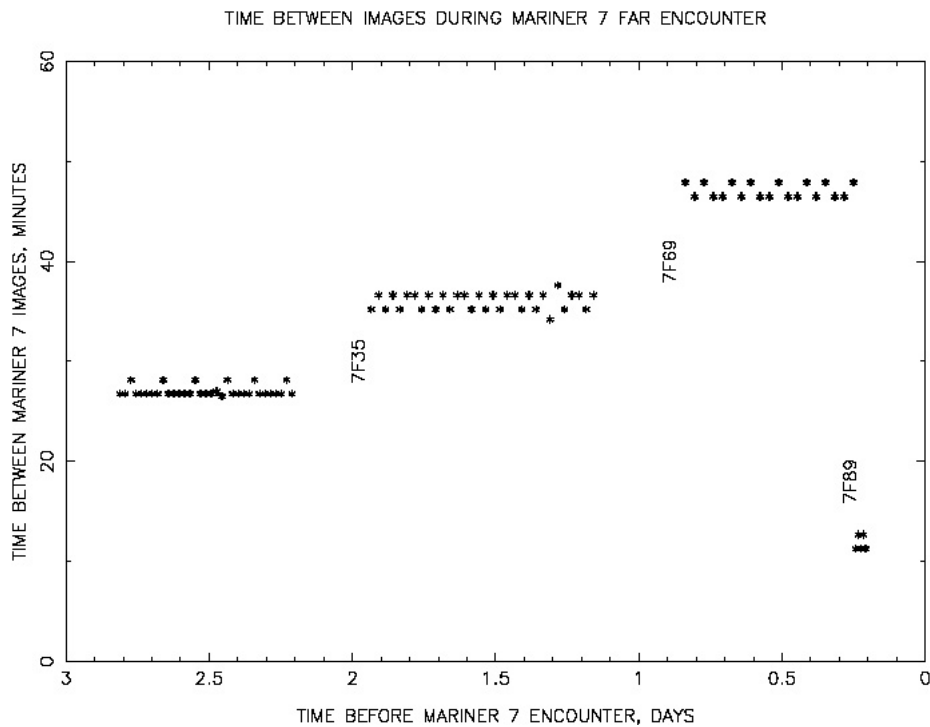


Figure 7: The time between Mariner 7 Far Encounter images.

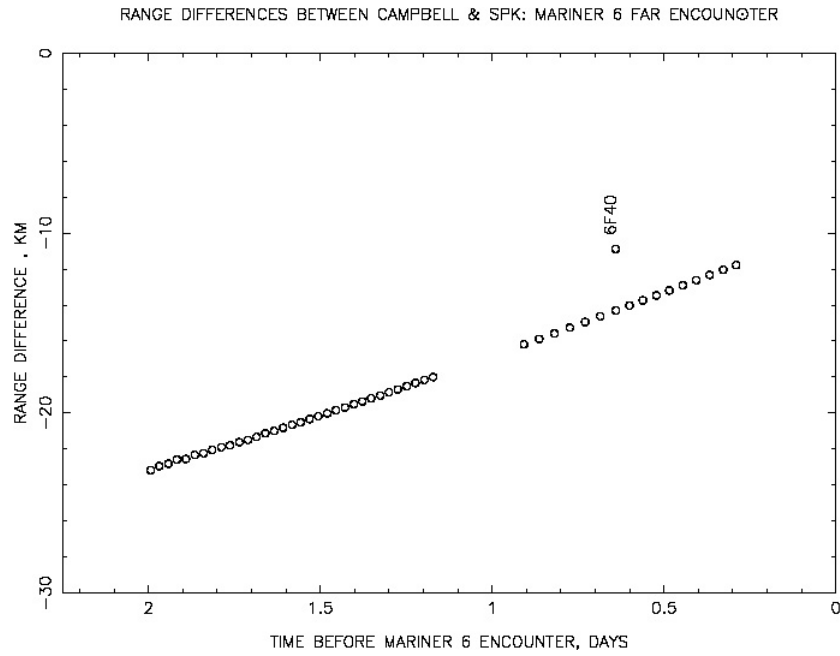


Figure 8: A comparison between the Mars - Mariner 6 ranges after all data corrections from Campbell and m6.bsp

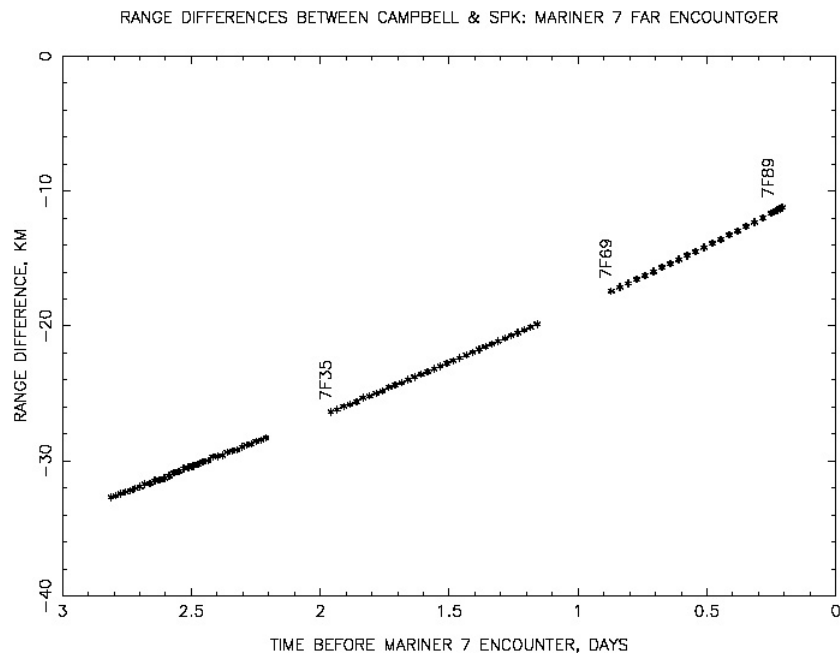


Figure 9: A comparison between the Mars - Mariner 7 ranges from Campbell converted to J2000 and m7.bsp

Table 1: Mariner Mars 1969 SPICE Spacecraft and Camera Identification Numbers

S/C	S/C (S & SCLK) Kernels	S/C (C, F & I) Kernels	Narrow Angle Camera	Wide Angle Camera
Mariner 6	-530	-530000	-530101	-530102
Mariner 7	-531	-531000	-531101	-531102

Table 2: M6 Areocentric positions in Earth Mean Ecliptic and Vernal Equinox of B1950

PICNO	JED	X - km	Y - km	Z - km
6F50	2440433.43174189	15262.841	181185.800	-19509.654
6F49	2440433.39360590	18231.018	204685.090	-22097.203
6F48	2440433.35449208	21274.278	228775.730	-24749.878
6F47	2440433.31537825	24316.666	252857.320	-27401.562
6F46	2440433.27626443	27358.307	276931.530	-30052.431
6F45	2440433.23715061	30399.303	300999.610	-32702.618
6F44	2440433.19901463	33363.730	324461.020	-35285.995
6F43	2440433.15990081	36403.672	348519.640	-37935.118
6F42	2440433.12078697	39443.165	372574.460	-40583.810
6F41	2440433.08167315	42482.252	396625.970	-43232.116
6F40	2440433.08069531	42539.699	397231.710	-43243.498
6F39	2440433.03669225	45976.746	424281.630	-46277.253
6F38	2440432.99171136	49470.796	451933.970	-49321.993
6F37	2440432.94770831	52888.494	478982.370	-52300.206
6F36	2440432.90272740	56381.768	506629.330	-55344.287
6F35	2440432.85872436	59798.759	533673.060	-58321.918
6F34	2440432.81374346	63291.358	561315.800	-61365.458
6F33	2440432.54972515	83785.503	723536.390	-79225.476
6F32	2440432.52438030	85752.387	739106.930	-80939.650
6F31	2440432.49887718	87731.473	754774.440	-82664.486
6F30	2440432.47345319	89704.341	770393.070	-84383.920
6F29	2440432.44705136	91753.004	786612.150	-86169.441
6F28	2440432.42162737	93725.713	802230.280	-87888.782
6F27	2440432.39620338	95698.343	817848.210	-89608.080
6F26	2440432.36980156	97746.766	834066.590	-91393.459
6F25	2440432.34437756	99719.242	849684.120	-93112.675
6F24	2440432.31895358	101691.540	865301.460	-94831.844
6F23	2440432.29352960	103663.970	880918.640	-96550.980
6F22	2440432.26712776	105712.080	897136.310	-98336.197
6F21	2440432.24170378	107684.250	912753.180	-100055.240
6F20	2440432.21627980	109656.350	928369.920	-101774.260
6F19	2440432.19085581	111628.380	943986.540	-103493.240
6F18	2440432.16445398	113676.170	960203.680	-105278.300
6F17	2440432.13902999	115648.040	975820.060	-106997.210
6F16	2440432.11360601	117619.850	991436.350	-108716.080
6F15	2440432.08720417	119667.410	1007653.200	-110501.030
6F14	2440432.06178019	121639.060	1023269.300	-112219.840
6F13	2440432.03635620	123610.640	1038885.400	-113938.600
6F12	2440432.01093222	125582.140	1054501.400	-115657.340
6F11	2440431.98595075	127519.250	1069845.500	-117346.130
6F10	2440431.95910641	129600.740	1086333.800	-119160.820
6F09	2440431.93368241	131572.020	1101949.600	-120879.460
6F08	2440431.90728059	133619.030	1118166.000	-122664.170
6F07	2440431.88185661	135590.150	1133781.800	-124382.740
6F06	2440431.85643261	137561.200	1149397.500	-126101.290
6F05	2440431.83100863	139532.180	1165013.300	-127819.810
6F04	2440431.80460680	141578.880	1181229.500	-129604.390
6F03	2440431.77918281	143549.690	1196845.300	-131322.840
6F02	2440431.75375883	145520.440	1212461.000	-133041.260
6F01	2440431.72833484	147491.100	1228076.800	-134759.660

Table 3: M6 Areocentric positions in Earth Mean Equator and Vernal Equinox of J2000.0

PICNO	JED	X - km	Y - km	Z - km
6F50	2440433.43174189	13053.377	174147.351	54260.341
6F49	2440433.39360590	15734.920	196767.585	61250.079
6F48	2440433.35449208	18484.333	219957.057	68415.704
6F47	2440433.31537825	21232.984	243137.823	75578.632
6F46	2440433.27626443	23980.978	266311.486	82739.369
6F45	2440433.23715061	26728.402	289479.247	89898.289
6F44	2440433.19901463	29406.657	312063.029	96876.767
6F43	2440433.15990081	32153.142	335221.676	104032.894
6F42	2440433.12078697	34899.225	358376.661	111187.903
6F41	2440433.08167315	37644.942	381528.452	118341.947
6F40	2440433.08069531	37695.001	382089.310	118572.779
6F39	2440433.03669225	40802.104	408149.559	126568.054
6F38	2440432.99171136	43958.863	434767.459	134793.202
6F37	2440432.94770831	47046.636	460803.999	142838.734
6F36	2440432.90272740	50202.684	487416.692	151062.342
6F35	2440432.85872436	53289.807	513448.708	159106.547
6F34	2440432.81374346	56445.232	540057.307	167328.969
6F33	2440432.54972515	74960.680	696208.687	215582.827
6F32	2440432.52438030	76737.642	711196.640	220214.501
6F31	2440432.49887718	78525.622	726277.929	224875.033
6F30	2440432.47345319	80307.981	741312.158	229521.044
6F29	2440432.44705136	82158.811	756924.364	234345.682
6F28	2440432.42162737	83941.016	771958.095	238991.578
6F27	2440432.39620338	85723.146	786991.626	243637.433
6F26	2440432.36980156	87573.744	802603.130	248461.922
6F25	2440432.34437756	89355.724	817636.259	253107.693
6F24	2440432.31895358	91137.528	832669.193	257753.430
6F23	2440432.29352960	92919.467	847701.968	262399.135
6F22	2440432.26712776	94769.761	863312.753	267223.488
6F21	2440432.24170378	96551.443	878345.205	271869.154
6F20	2440432.21627980	98333.057	893377.527	276514.788
6F19	2440432.19085581	100114.602	908409.722	281160.412
6F18	2440432.16445398	101964.583	924019.955	285984.697
6F17	2440432.13902999	103745.971	939051.900	290630.288
6F16	2440432.11360601	105527.300	954083.746	295275.879
6F15	2440432.08720417	107377.054	969693.667	300100.149
6F14	2440432.06178019	109158.226	984725.313	304745.719
6F13	2440432.03635620	110939.327	999756.939	309391.335
6F12	2440432.01093222	112720.350	1014788.464	314036.929
6F11	2440431.98595075	114470.300	1029558.255	318601.658
6F10	2440431.95910641	116350.672	1045429.408	323506.804
6F09	2440431.93368241	118131.478	1060460.707	328152.409
6F08	2440431.90728059	119980.687	1076070.113	332976.717
6F07	2440431.88185661	121761.333	1091101.383	337622.386
6F06	2440431.85643261	123541.909	1106132.552	342268.033
6F05	2440431.83100863	125322.414	1121163.800	346913.747
6F04	2440431.80460680	127171.316	1136772.967	351738.093
6F03	2440431.77918281	128951.652	1151804.186	356383.870
6F02	2440431.75375883	130731.928	1166835.300	361029.635
6F01	2440431.72833484	132512.114	1181866.497	365675.457

Table 4: M7 Areocentric positions in Earth Mean Ecliptic and Vernal Equinox of B1950

PICNO	JED	X - km	Y - km	Z - km
7F01	2440435.89771092	182535.550	1707875.800	-97554.827
7F02	2440435.91628922	181290.020	1696610.500	-96935.719
7F03	2440435.93584533	179978.890	1684752.300	-96284.007
7F04	2440435.95442364	178733.250	1673487.100	-95664.874
7F05	2440435.97300194	177487.560	1662222.000	-95045.726
7F06	2440435.99158024	176241.820	1650956.900	-94426.566
7F07	2440436.01015855	174996.020	1639691.900	-93807.406
7F08	2440436.02873684	173750.180	1628426.900	-93188.218
7F09	2440436.04829296	172438.700	1616569.200	-92536.449
7F10	2440436.06687127	171192.740	1605304.300	-91917.259
7F11	2440436.08544957	169946.730	1594039.600	-91298.039
7F12	2440436.10402787	168700.660	1582774.900	-90678.816
7F13	2440436.12260617	167454.550	1571510.200	-90059.586
7F14	2440436.14118448	166208.380	1560245.500	-89440.351
7F15	2440436.16074058	164896.570	1548388.100	-88788.512
7F16	2440436.17931890	163650.300	1537123.500	-88169.250
7F17	2440436.19789720	162403.970	1525859.100	-87549.976
7F18	2440436.21647551	161157.600	1514594.700	-86930.695
7F19	2440436.23522741	159899.530	1503225.100	-86305.613
7F20	2440436.25363211	158664.700	1492066.000	-85692.097
7F21	2440436.27318821	157352.560	1480208.900	-85040.195
7F22	2440436.29176652	156105.990	1468944.500	-84420.875
7F23	2440436.31034482	154859.360	1457680.400	-83801.538
7F24	2440436.32892314	153612.680	1446416.300	-83182.195
7F25	2440436.34750143	152365.960	1435152.100	-82562.847
7F26	2440436.36705754	151053.560	1423295.200	-81910.894
7F27	2440436.38563584	149806.740	1412031.200	-81291.519
7F28	2440436.40421415	148559.860	1400767.100	-80672.137
7F29	2440436.42279245	147312.940	1389503.100	-80052.738
7F30	2440436.44137076	146065.970	1378239.200	-79433.340
7F31	2440436.45994906	144818.950	1366975.200	-78813.922
7F32	2440436.47950517	143506.250	1355118.500	-78161.902
7F33	2440436.49808346	142259.140	1343854.600	-77542.468
7F35	2440436.75035728	125320.090	1190904.300	-69130.211
7F36	2440436.77480242	123678.270	1176083.600	-68314.973
7F37	2440436.80022535	121970.700	1160670.000	-67467.097
7F38	2440436.82467049	120328.730	1145849.300	-66651.820
7F39	2440436.85009343	118620.990	1130435.700	-65803.914
7F40	2440436.87453857	116978.870	1115614.800	-64988.593
7F41	2440436.89996151	115270.980	1100201.200	-64140.648
7F42	2440436.92538445	113563.010	1084787.500	-63292.683
7F43	2440436.94982959	111920.650	1069966.600	-62477.309
7F44	2440436.97525253	110212.520	1054552.700	-61629.304
7F45	2440436.99969767	108570.020	1039731.700	-60813.890
7F46	2440437.02512061	106861.740	1024317.800	-59965.844
7F47	2440437.04956575	105219.090	1009496.600	-59150.394

Table 5: - cont. M7 Areocentric positions in Earth Mean Ecliptic and Vernal Equinox of B1950

PICNO	JED	X - km	Y - km	Z - km
7F48	2440437.07498869	103510.660	994082.510	-58302.304
7F49	2440437.10041164	101802.140	978668.320	-57454.195
7F50	2440437.12485677	100159.270	963846.890	-56638.680
7F51	2440437.15027972	98450.607	948432.500	-55790.527
7F52	2440437.17472485	96807.589	933610.860	-54974.976
7F53	2440437.20014780	95098.774	918196.230	-54126.781
7F54	2440437.22459292	93455.611	903374.350	-53311.187
7F55	2440437.25001588	91746.645	887959.440	-52462.945
7F56	2440437.27543882	90037.602	872544.380	-51614.679
7F57	2440437.29988395	88394.219	857722.040	-50799.019
7F58	2440437.32530689	86685.026	842306.640	-49950.703
7F59	2440437.34975203	85041.498	827483.970	-49134.996
7F60	2440437.37517497	83332.153	812068.190	-48286.632
7F61	2440437.39892565	81735.174	797666.220	-47494.049
7F62	2440437.42504305	79978.981	781828.900	-46622.459
7F63	2440437.44948818	78335.160	767005.390	-45806.652
7F64	2440437.47491113	76625.508	751588.690	-44958.184
7F65	2440437.50033407	74915.778	736171.710	-44109.683
7F66	2440437.52477921	73271.731	721347.420	-43293.797
7F67	2440437.55020215	71561.843	705929.850	-42445.240
7F69	2440437.83767695	52221.034	531564.480	-32847.568
7F70	2440437.87092234	49983.576	511395.330	-31737.279
7F71	2440437.90318993	47811.755	491818.220	-30659.560
7F72	2440437.93643531	45573.938	471646.540	-29549.086
7F73	2440437.96870289	43401.752	452066.750	-28471.170
7F74	2440438.00097047	41229.372	432485.440	-27393.146
7F75	2440438.03421585	38990.948	412309.010	-26282.333
7F76	2440438.06648343	36818.137	392724.140	-25204.059
7F77	2440438.09972882	34579.241	372543.640	-24092.960
7F78	2440438.13199639	32405.939	352954.360	-23014.380
7F79	2440438.16426398	30232.365	333362.520	-21935.622
7F80	2440438.19750936	27992.615	313173.970	-20823.967
7F81	2440438.22977694	25818.410	293575.870	-19744.774
7F82	2440438.26204452	23643.845	273974.030	-18665.323
7F83	2440438.29528992	21402.963	253773.660	-17552.842
7F84	2440438.32755750	19227.537	234162.320	-16472.720
7F85	2440438.36080288	16985.653	213950.460	-15359.419
7F86	2440438.39307046	14809.111	194325.820	-14278.336
7F87	2440438.42533804	12631.890	174692.510	-13196.608
7F88	2440438.45858342	10387.864	154452.950	-12081.240
7F89	2440438.46640586	9859.719	149688.720	-11818.646
7F90	2440438.47520612	9265.488	144327.920	-11523.145
7F91	2440438.48302856	8737.219	139561.790	-11260.399
7F92	2440438.49182881	8142.841	134198.720	-10964.714
7F93	2440438.49965126	7614.435	129430.400	-10701.789

Table 6: M7 Areocentric positions in Earth Mean Equator and Vernal Equinox of J2000.0

PICNO	JED	X - km	Y - km	Z - km
7F01	2440435.89771092	161705.187	1607607.793	590867.612
7F02	2440435.91628922	160597.060	1597013.103	586947.636
7F03	2440435.93584533	159430.563	1585860.799	582821.366
7F04	2440435.95442364	158322.324	1575266.190	578901.451
7F05	2440435.97300194	157214.034	1564671.665	574981.590
7F06	2440435.99158024	156105.694	1554077.136	571061.739
7F07	2440436.01015855	154997.293	1543482.697	567141.928
7F08	2440436.02873684	153888.851	1532888.247	563222.143
7F09	2440436.04829296	152721.999	1521736.375	559096.123
7F10	2440436.06687127	151613.436	1511142.014	555176.378
7F11	2440436.08544957	150504.821	1500547.825	551256.740
7F12	2440436.10402787	149396.146	1489953.633	547337.105
7F13	2440436.12260617	148287.431	1479359.439	543417.476
7F14	2440436.14118448	147178.656	1468765.241	539497.852
7F15	2440436.16074058	146011.470	1457613.613	535372.013
7F16	2440436.17931890	144902.594	1447019.495	531452.453
7F17	2440436.19789720	143793.656	1436425.556	527532.982
7F18	2440436.21647551	142684.677	1425831.613	523613.518
7F19	2440436.23522741	141565.281	1415138.725	519657.465
7F20	2440436.25363211	140466.558	1404643.804	515774.662
7F21	2440436.27318821	139299.039	1393492.422	511649.000
7F22	2440436.29176652	138189.860	1382898.461	507729.570
7F23	2440436.31034482	137080.618	1372304.769	503810.276
7F24	2440436.32892314	135971.326	1361711.073	499890.986
7F25	2440436.34750143	134861.994	1351117.283	495971.661
7F26	2440436.36705754	133694.213	1339966.062	491846.124
7F27	2440436.38563584	132584.779	1329372.444	487926.903
7F28	2440436.40421415	131475.287	1318778.730	484007.648
7F29	2440436.42279245	130365.753	1308185.101	480088.449
7F30	2440436.44137076	129256.168	1297591.564	476169.288
7F31	2440436.45994906	128146.535	1286997.927	472250.106
7F32	2440436.47950517	126978.451	1275846.859	468124.708
7F33	2440436.49808346	125868.726	1265253.305	464205.580
7F35	2440436.75035728	110795.204	1121405.030	410989.470
7F36	2440436.77480242	109334.152	1107466.260	405832.984
7F37	2440436.80022535	107814.581	1092969.861	400470.234
7F38	2440436.82467049	106353.378	1079031.074	395313.782
7F39	2440436.85009343	104833.637	1064534.662	389951.060
7F40	2440436.87453857	103372.287	1050595.672	384794.568
7F41	2440436.89996151	101852.397	1036099.242	379431.880
7F42	2440436.92538445	100332.427	1021602.712	374069.171
7F43	2440436.94982959	98870.837	1007663.698	368912.726
7F44	2440436.97525253	97350.710	993166.967	363549.973
7F45	2440436.99969767	95888.981	979227.844	358393.525
7F46	2440437.02512061	94368.704	964731.095	353030.809
7F47	2440437.04956575	92906.827	950791.773	347874.314

Table 7: - cont. Mariner 7 Areocentric positions in Earth Mean Equator and Vernal Equinox of J2000.0

PICNO	JED	X - km	Y - km	Z - km
7F48	2440437.07498869	91386.402	936294.830	342511.562
7F49	2440437.10041164	89865.889	921797.786	337148.787
7F50	2440437.12485677	88403.795	907858.225	331992.258
7F51	2440437.15027972	86883.141	893360.979	326629.443
7F52	2440437.17472485	85420.902	879421.209	321472.864
7F53	2440437.20014780	83900.099	864923.724	316109.991
7F54	2440437.22459292	82437.718	850983.715	310953.355
7F55	2440437.25001588	80916.767	836485.954	305590.413
7F56	2440437.27543882	79395.741	821988.044	300227.434
7F57	2440437.29988395	77933.145	808047.584	295070.674
7F58	2440437.32530689	76411.973	793549.341	289707.604
7F59	2440437.34975203	74949.237	779608.558	284550.756
7F60	2440437.37517497	73427.918	765109.946	279187.578
7F61	2440437.39892565	72006.599	751564.821	274177.117
7F62	2440437.42504305	70443.574	736669.736	268667.310
7F63	2440437.44948818	68980.554	722728.139	263510.217
7F64	2440437.47491113	67458.939	708228.638	258146.767
7F65	2440437.50033407	65937.250	693728.866	252783.236
7F66	2440437.52477921	64474.014	679786.520	247625.905
7F67	2440437.55020215	62952.174	665286.182	242262.189
7F69	2440437.83767695	45738.094	501293.886	181601.934
7F70	2440437.87092234	43746.639	482324.561	174585.355
7F71	2440437.90318993	41813.599	463912.048	167774.757
7F72	2440437.93643531	39821.816	444940.324	160757.339
7F73	2440437.96870289	37888.444	426525.270	153945.854
7F74	2440438.00097047	35954.896	408108.776	147133.862
7F75	2440438.03421585	33962.564	389132.554	140114.862
7F76	2440438.06648343	32028.629	370712.690	133301.682
7F77	2440438.09972882	30035.874	351732.615	126281.322
7F78	2440438.13199639	28101.502	333308.578	119466.666
7F79	2440438.16426398	26166.889	314882.119	112651.152
7F80	2440438.19750936	24173.378	295894.428	105628.096
7F81	2440438.22977694	22238.211	277462.046	98810.488
7F82	2440438.26204452	20302.729	259026.127	91991.628
7F83	2440438.29528992	18308.230	240027.251	84964.621
7F84	2440438.32755750	16372.003	221582.340	78142.592
7F85	2440438.36080288	14376.642	202572.587	71111.762
7F86	2440438.39307046	12439.461	184115.080	64285.318
7F87	2440438.42533804	10501.707	165649.355	57456.013
7F88	2440438.45858342	8504.543	146613.344	50416.048
7F89	2440438.46640586	8034.507	142132.403	48758.939
7F90	2440438.47520612	7505.661	137090.355	46894.352
7F91	2440438.48302856	7035.524	132607.609	45236.626
7F92	2440438.49182881	6506.560	127563.403	43371.304
7F93	2440438.49965126	6036.313	123078.575	41712.870