SSM/I

TA *(ANTENNA TEMPS)*

COMPARISON

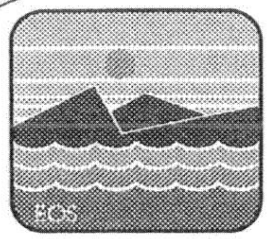
STUDY

Dr. Adrian Ritchie, Hughes STX/Sverdrup

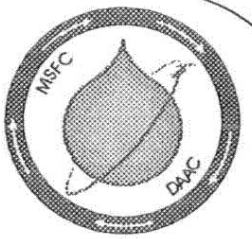
STUDY PURPOSE

CHARACTERIZE EACH DATA SET

COMPARE AGAINST A BASELINE



OUTLINE



BACKGROUND

CHARACTERIZATION

ANTENNA TEMPERATURES COMPARISONS

GEOLOCATION COMPARISONS

SUMMARY

STACT MEMBERS

MICHAEL GOODMAN--MSFC

ADRIAN RITCHIE--HSTX

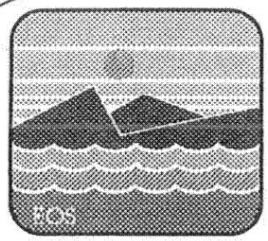
DAWN CONWAY--HSTX

RON SCHUDALLA--HSTX

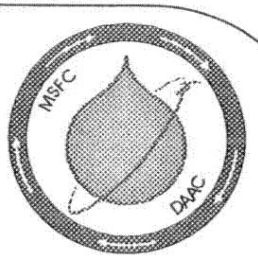
MATT SMITH--HSTX

FRANK LAFONTAINE--HSTX

DON MOSS--UAH



Glossary



AFGWC- ***Air Force Global Weather Central***

FNMOC- ***Fleet Numerical Meteorology and Oceanography Center***

NESDIS- ***National Environmental Satellite, Data and Information Service***

NGDC- ***National Geophysical Data Center***

BST- ***B-Scan Start Time***

DEF- ***Data Exchange Format***

HDF- ***Hierarchial Data Format***

TDR- ***Temperature Data Record***

SPN- ***Shared Processing Network (FNMOC, AFGWC, NESDIS)***

DATA SOURCES 1-7 APRIL 94

Orbits 12071-12169

FNMOC	**AFGWC**
FNMOC DEF	**NGDC**
WENTZ	**NESDIS (LEVEL 1b)**
NESDIS TDR (SPN)	

STACT DATA

ANTENNA TEMPERATURES *

- **7 CHANNELS**

LATITUDES/LONGITUDES *

B-SCAN START TIMES *

SPACECRAFT POSITION VECTORS

SURFACE TYPE (where available)

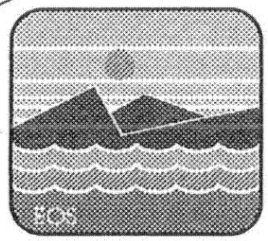
* Data Used in Study

DATA ORGANIZATION

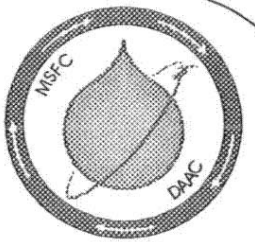
ALL DATA STORED IN HDF FORMAT

EACH FILE CONTAINS ONE ORBIT OF SSM/I

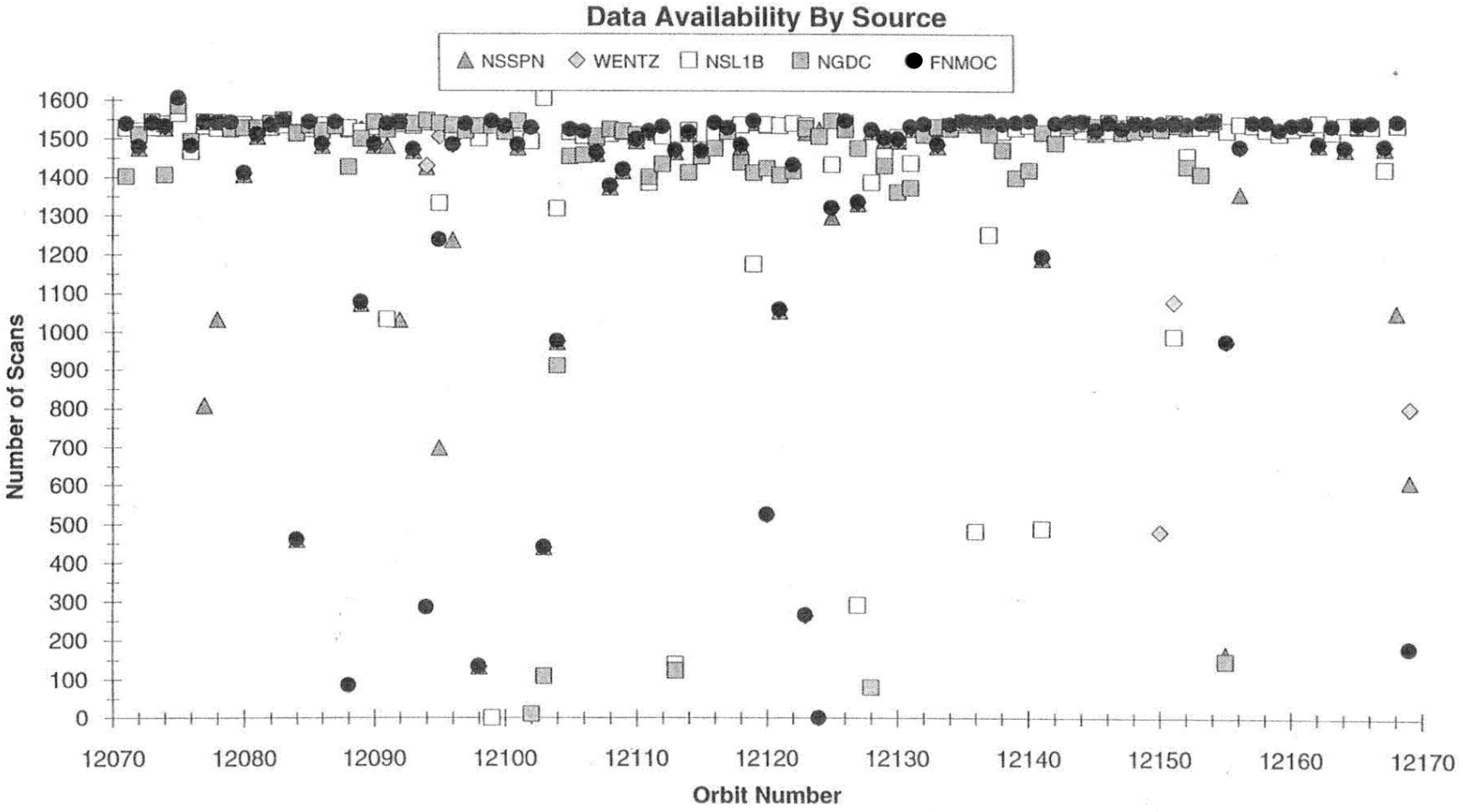
DATA REGISTERED USING FNMOC SCAN START TIMES AND NOMINAL B-SCAN START TIME (BST) DELTAS

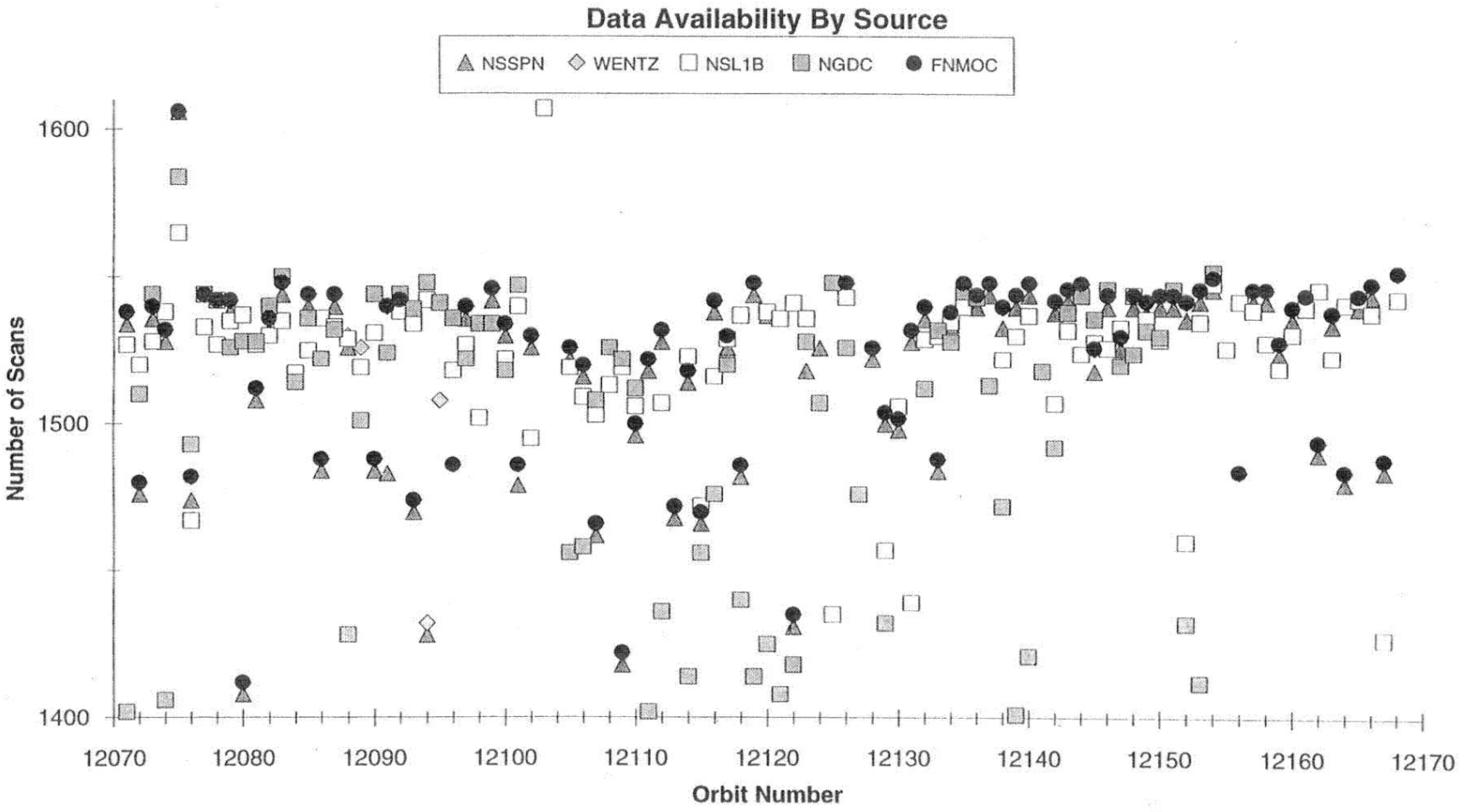


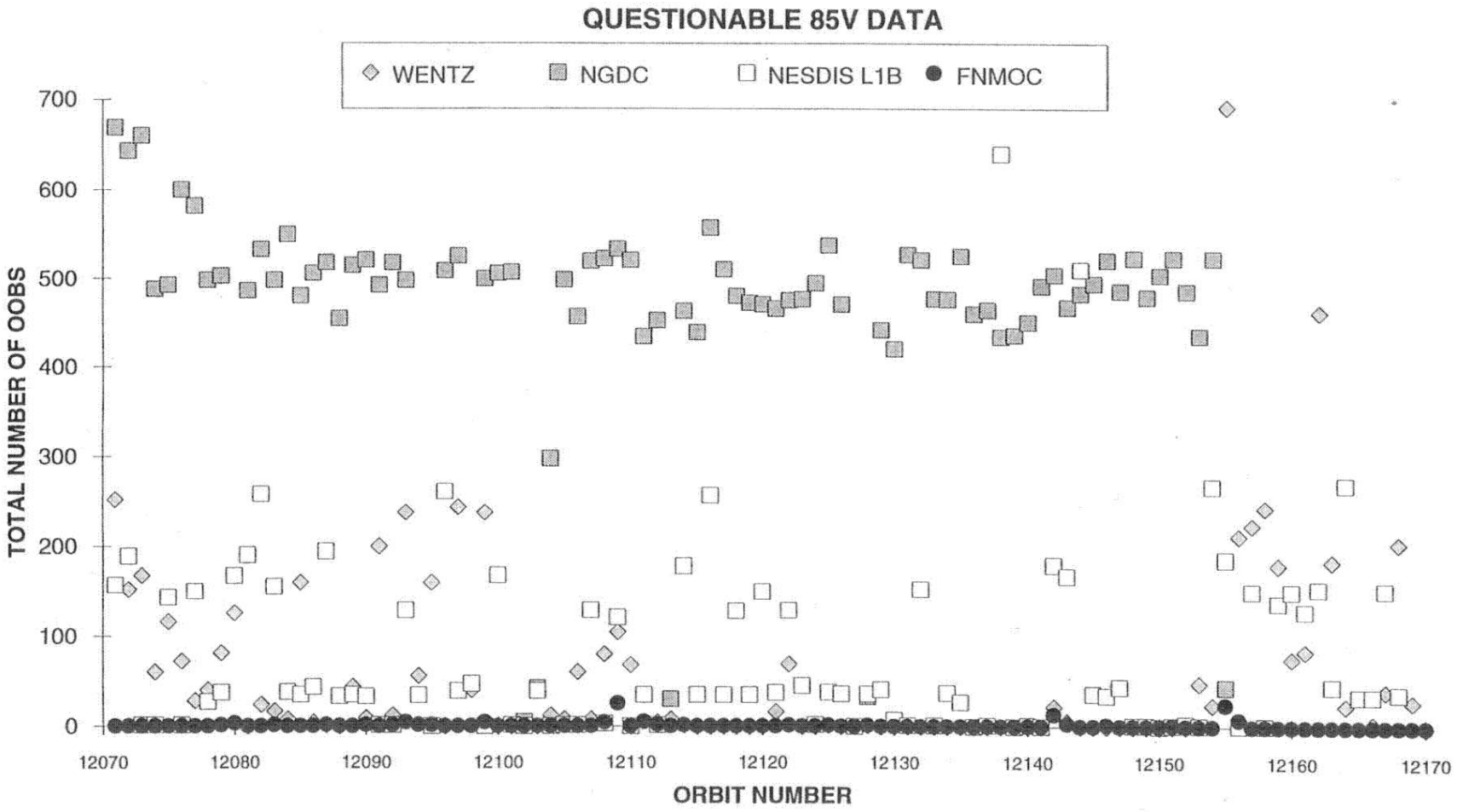
STACT

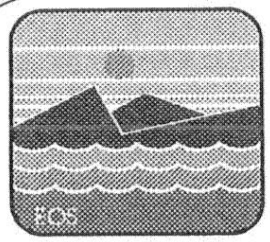


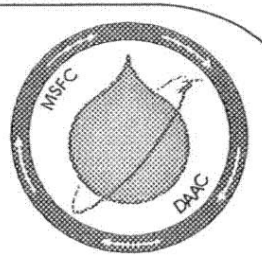
SOURCE CHARACTERIZATION


Data Availability By Source
NSSPN
WENTZ
NSL1B
NGDC
FNMOC
Number of Scans
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
12070
12080
12090
12100
12110
12120
12130
12140
12150
12160
12170
Orbit Number


Data Availability By Source
NSSPN
WENTZ
NSL1B
NGDC
FNMOC
1600
1500
1400
Number of Scans
12070
12080
12090
12100
12110
12120
12130
12140
12150
12160
12170
Orbit Number

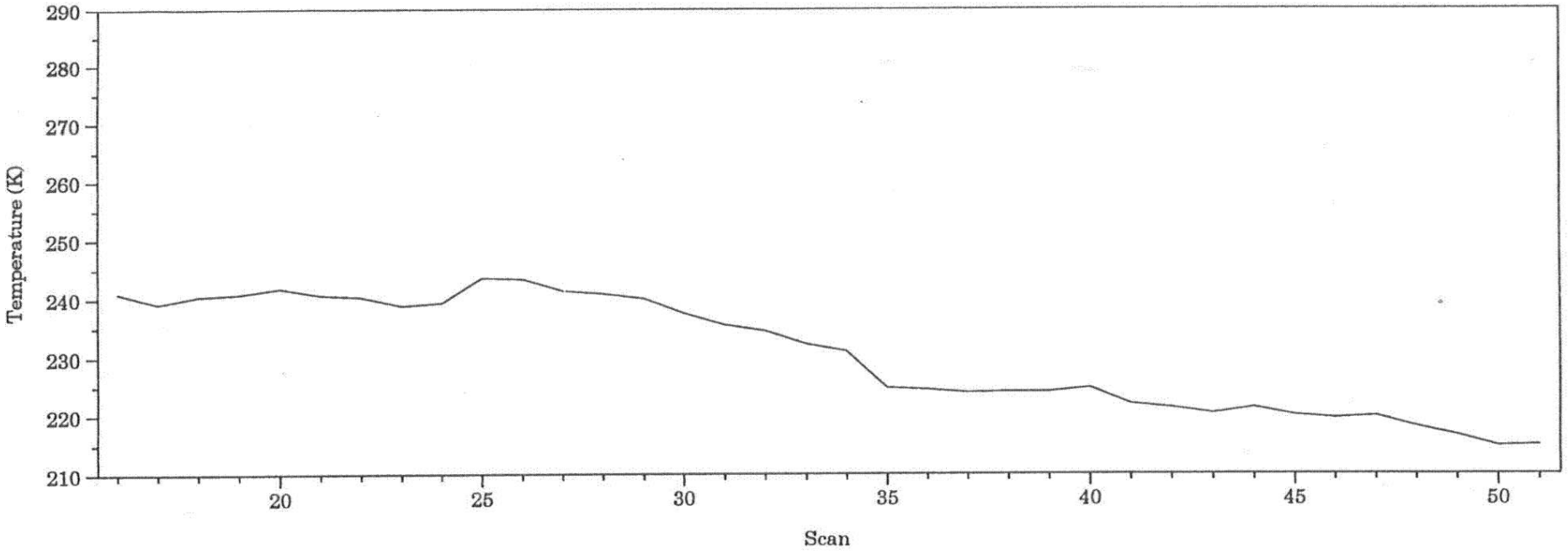

QUESTIONABLE 85V DATA
WENTZ
NGDC
NESDIS L1B
FNMOC
TOTAL NUMBER OF OOBS
700
600
500
400
300
200
100
0
12070
12080
12090
12100
12110
12120
12130
12140
12150
12160
12170
ORBIT NUMBER

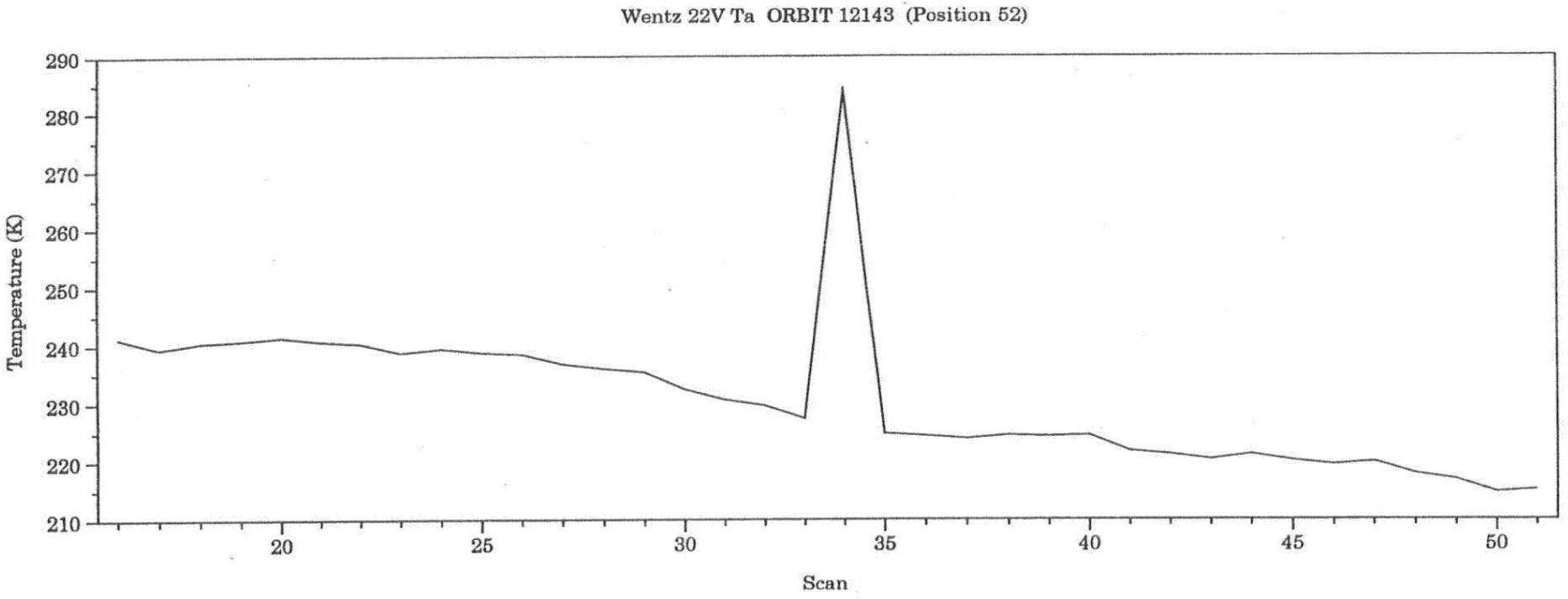




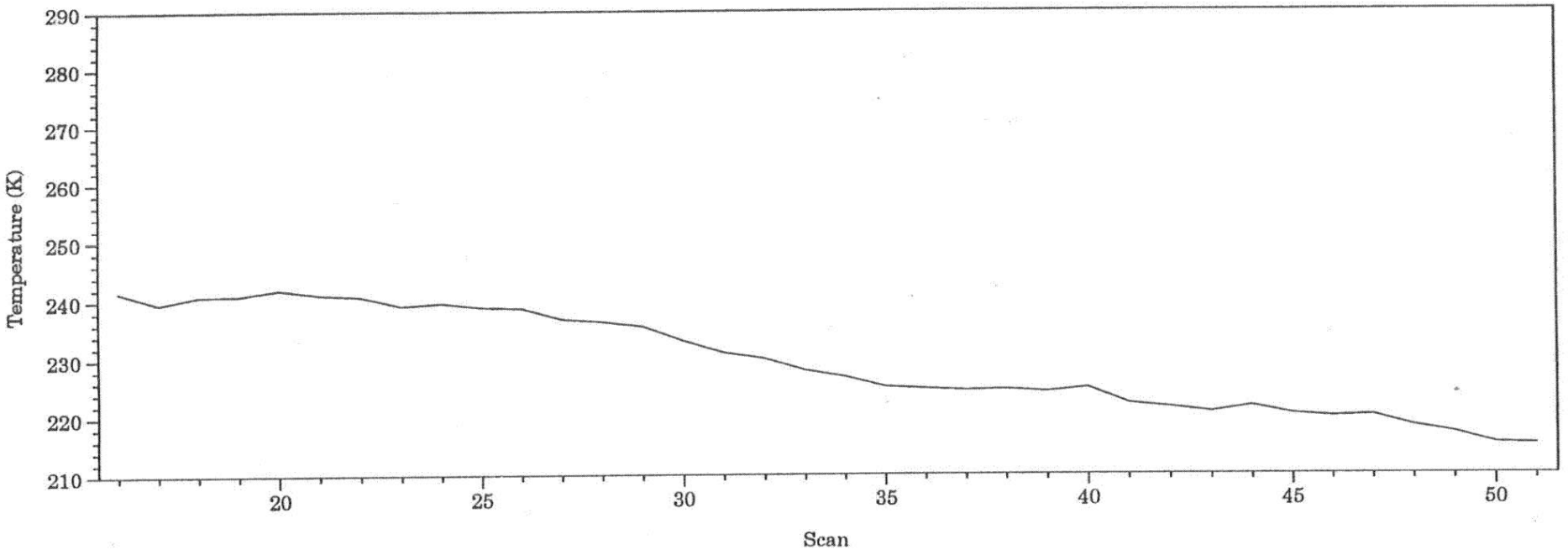
ANTENNA TEMPERATURE CALCULATIONS

FNMOC 22V TA ORBIT 12143 (Position 52)

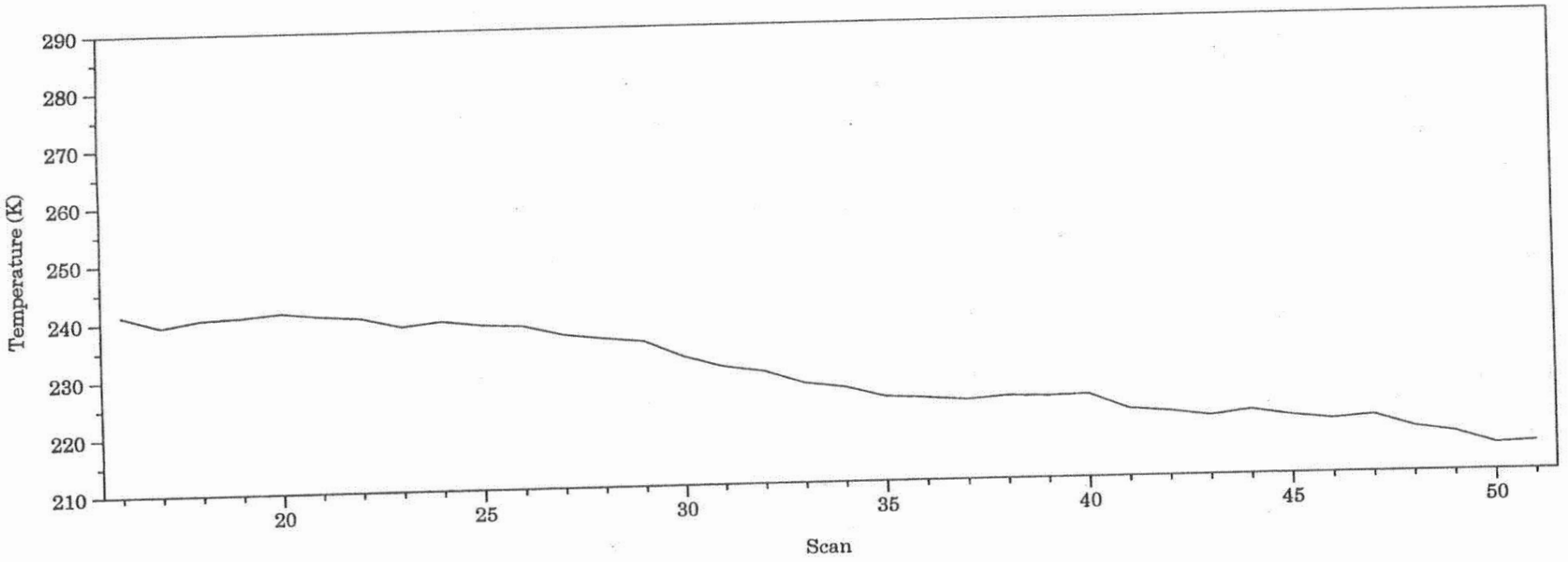



Wentz 22V Ta ORBIT 12143 (Position 52)
Temperature (K)
290
280
270
260
250
240
230
220
210
20
25
30
35
40
45
50
Scan

NGDC 22V TA ORBIT 12143 (position 52)



NSL1B 22V TA ORBIT 12143 (Position 52)



B-SCAN START TIME DELTAS

INSTRUMENT SPIN RATE-31.6 RPM

- 3.798 sec between B-Scan Start Times (BST)

FNMOC, NESDIS TDRs, & WENTZ IDENTICAL

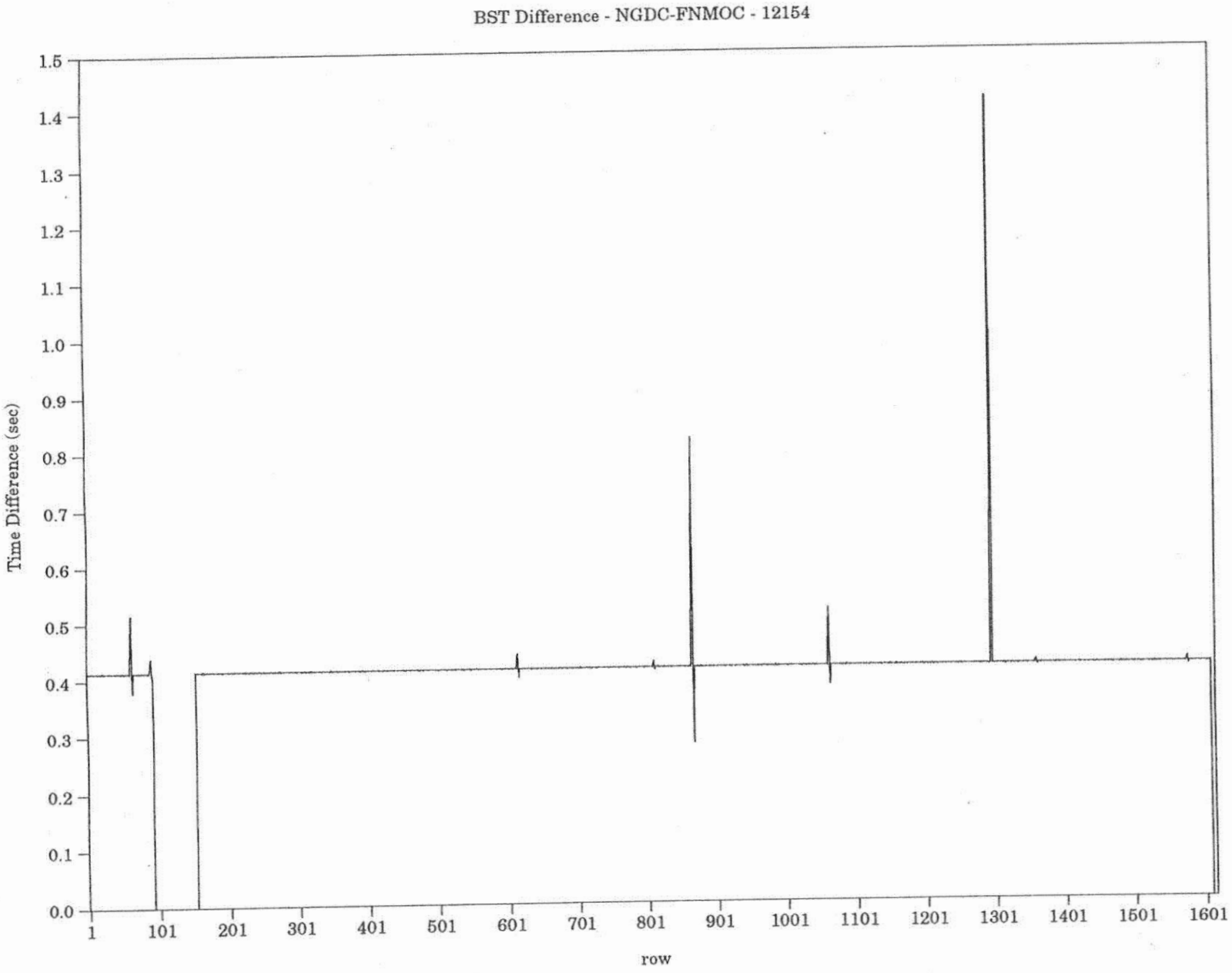
- Standard Deviation- 10^{-4}

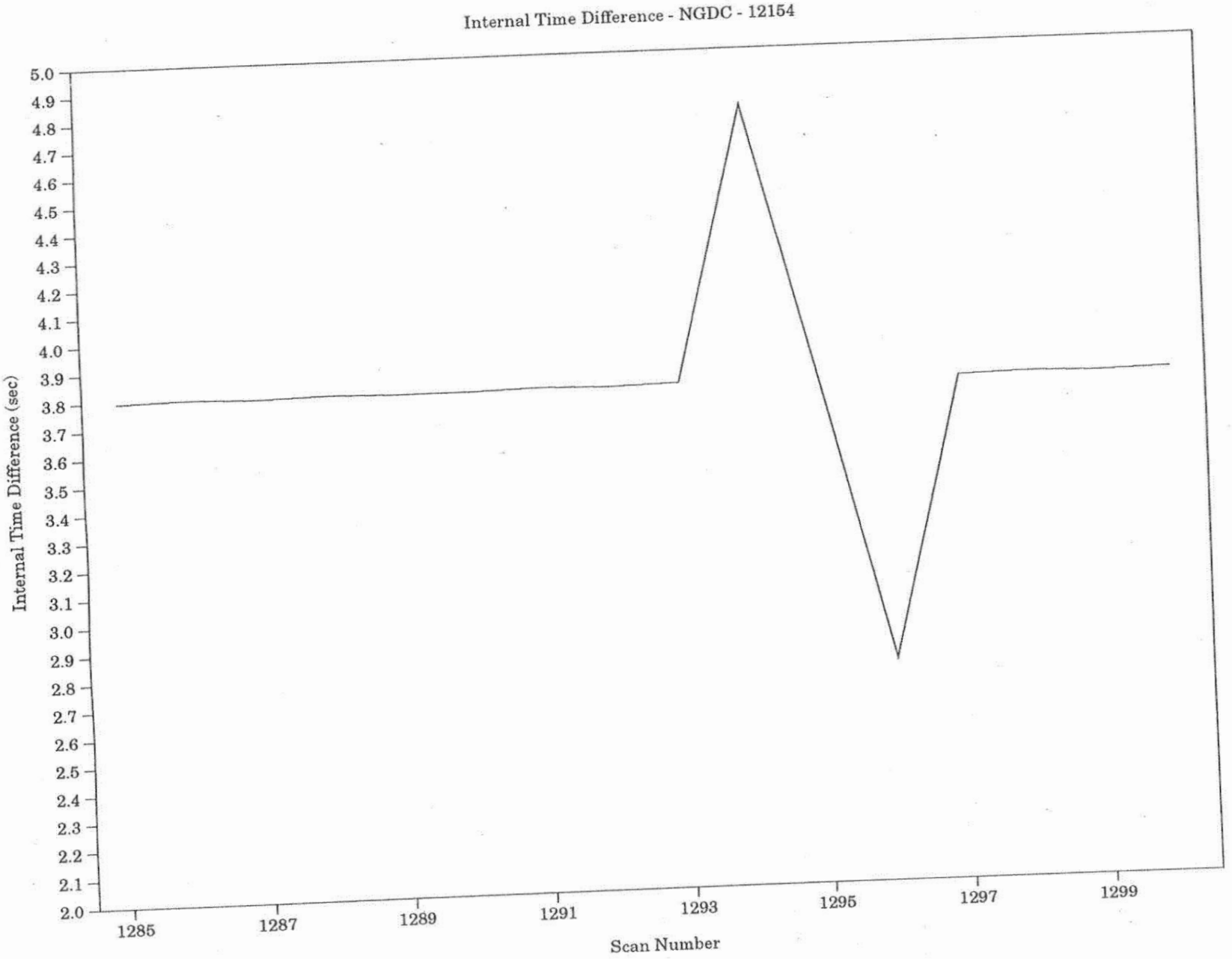
NGDC

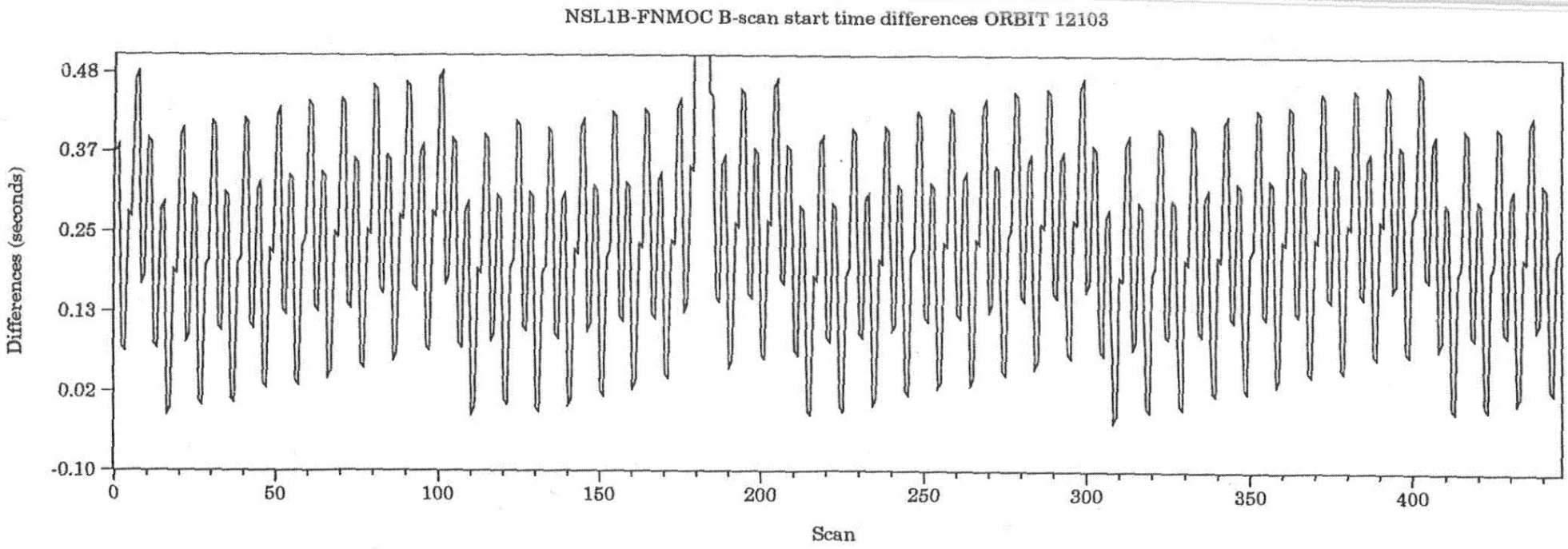
- .42 sec offset
- Mean 3.79 sec; Standard Deviation -varies from 10^{-1}-10^{-4}
- Missing scans at beginning of orbit not included

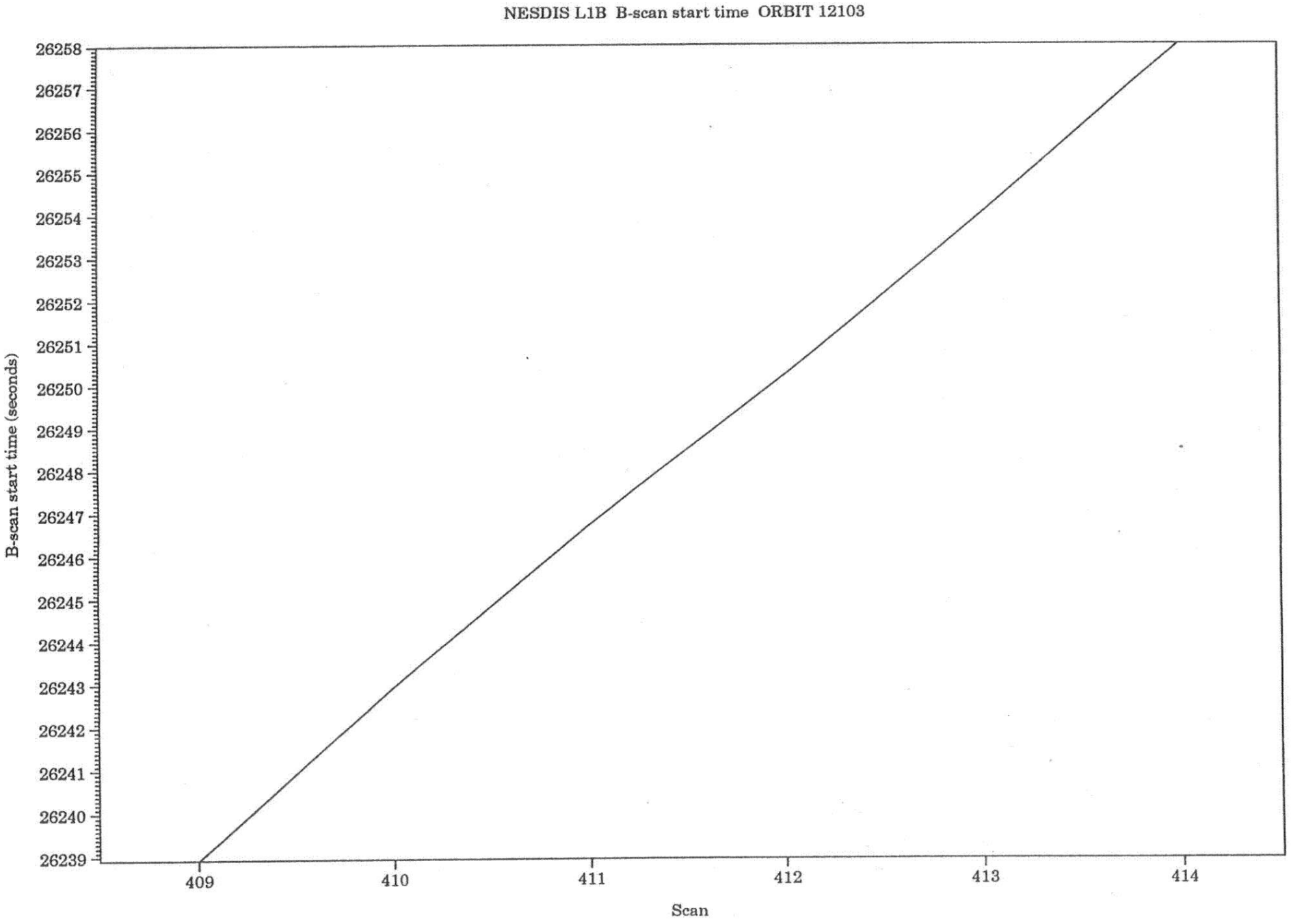
NESDIS LEVEL 1b

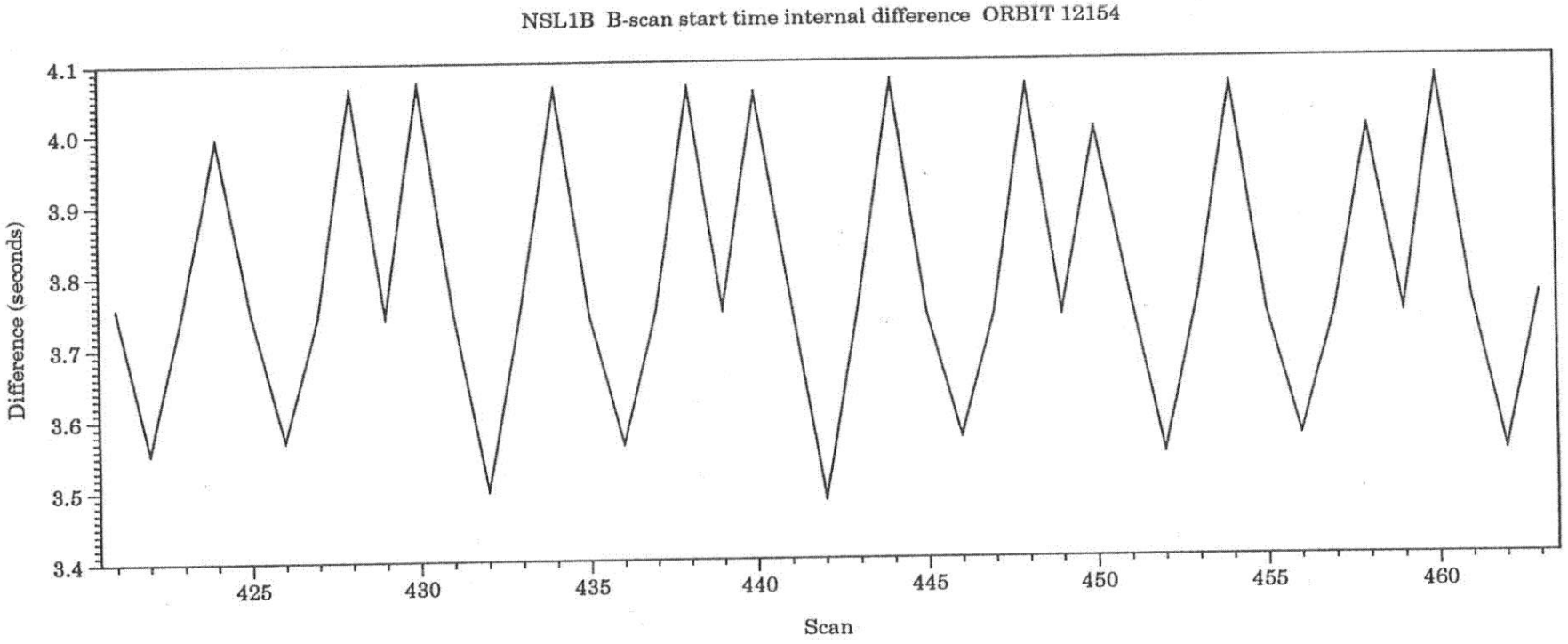
- Mean 3.79; Standard Deviation-varies from 10^{-1}-10^{-3}
- Oscillations are repetitive

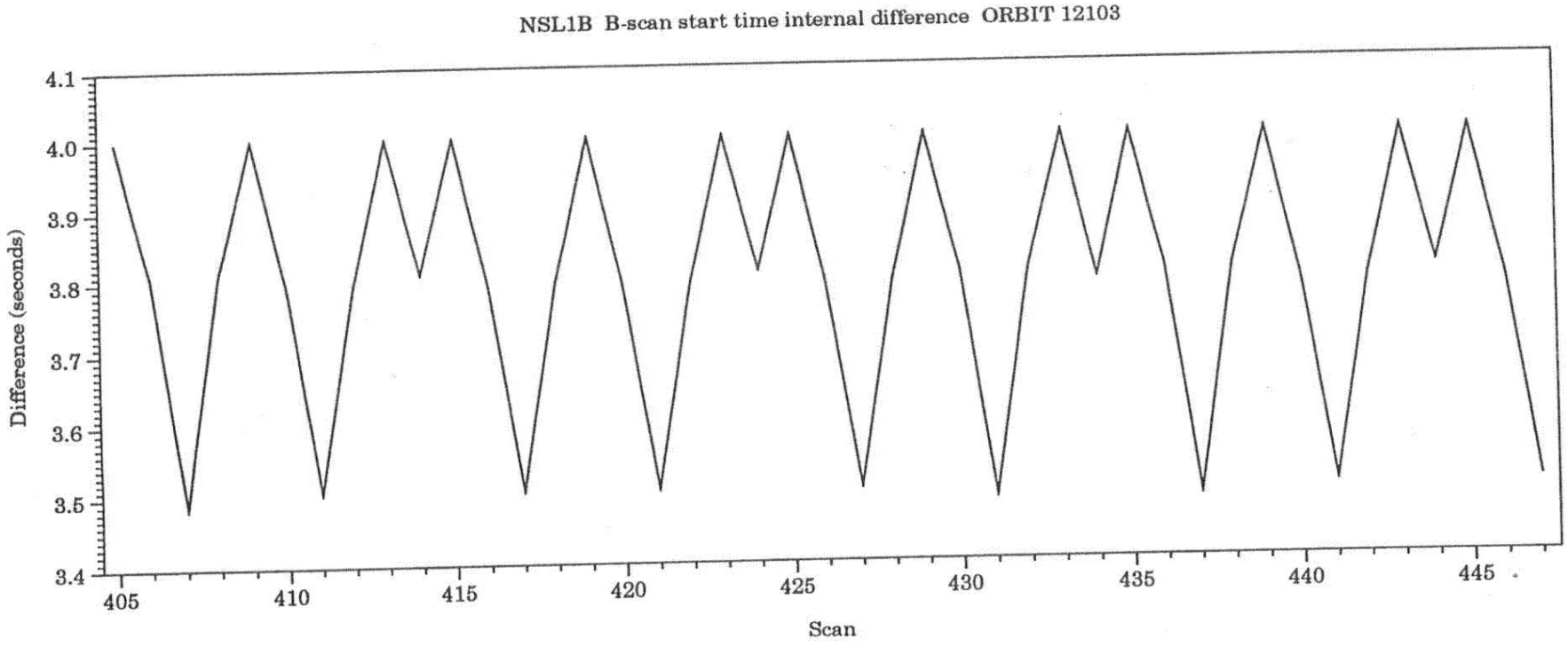

BST Difference - NGDC-FNMOC - 12154
Time Difference (sec)
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
1
101
201
301
401
501
601
701
801
901
1001
1101
1201
1301
1401
1501
1601
row

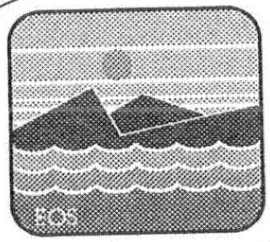

Internal Time Difference - NGDC - 12154
Internal Time Difference (sec)
5.0
4.9
4.8
4.7
4.6
4.5
4.4
4.3
4.2
4.1
4.0
3.9
3.8
3.7
3.6
3.5
3.4
3.3
3.2
3.1
3.0
2.9
2.8
2.7
2.6
2.5
2.4
2.3
2.2
2.1
2.0
1285
1287
1289
1291
1293
1295
1297
1299
Scan Number


NSL1B-FNMOC B-scan start time differences ORBIT 12103
Differences (seconds)
0.48
0.37
0.25
0.13
0.02
-0.10
0
50
100
150
200
250
300
350
400
Scan

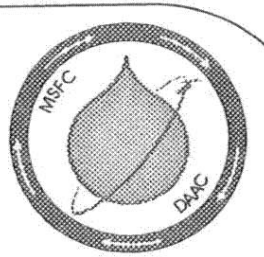

NESDIS L1B B-scan start time ORBIT 12103
B-scan start time (seconds)
26258
26257
26256
26255
26254
26253
26252
26251
26250
26249
26248
26247
26246
26245
26244
26243
26242
26241
26240
26239
409
410
411
412
413
414
Scan


NSL1B B-scan start time internal difference ORBIT 12154
Difference (seconds)
4.1
4.0
3.9
3.8
3.7
3.6
3.5
3.4
425
430
435
440
445
450
455
460
Scan

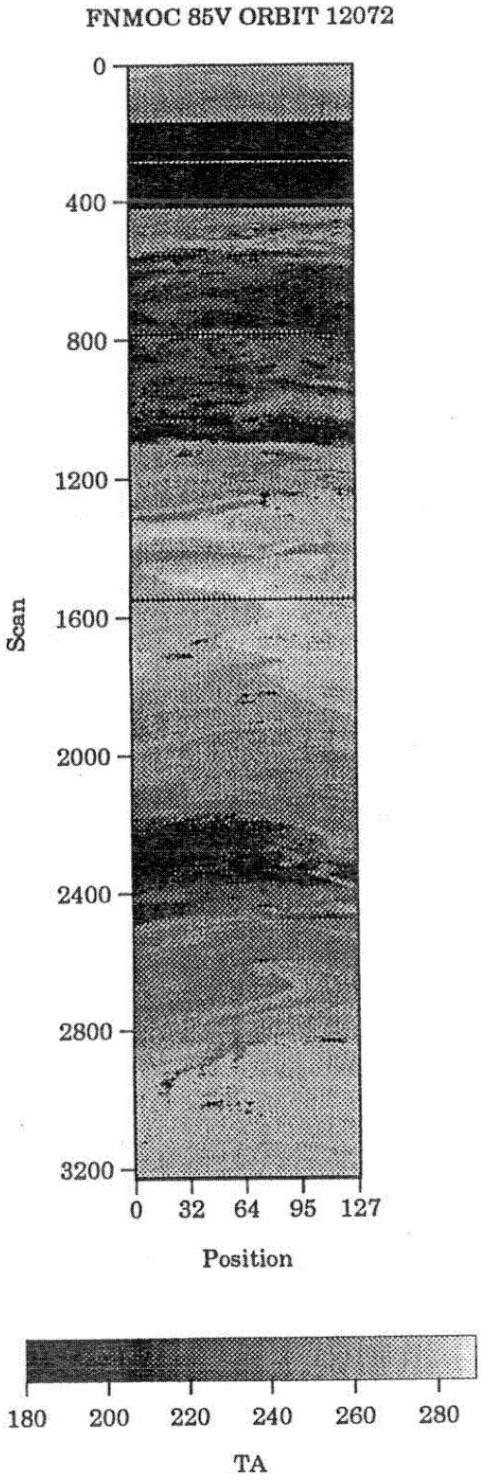

NSL1B B-scan start time internal difference ORBIT 12103
Difference (seconds)
4.1
4.0
3.9
3.8
3.7
3.6
3.5
3.4
405
410
415
420
425
430
435
440
445
Scan

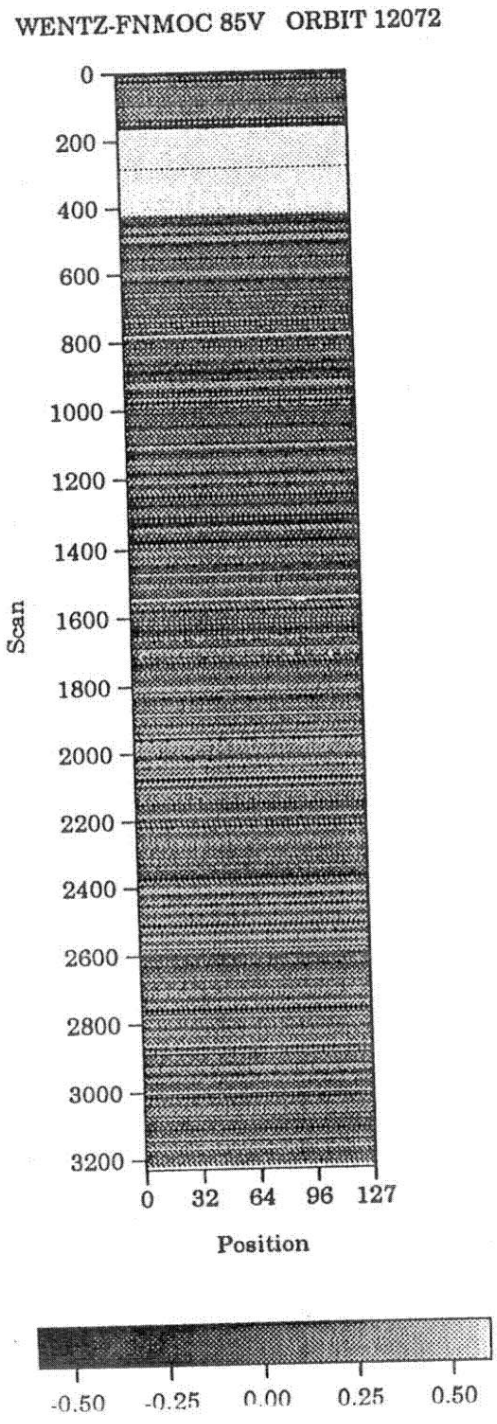


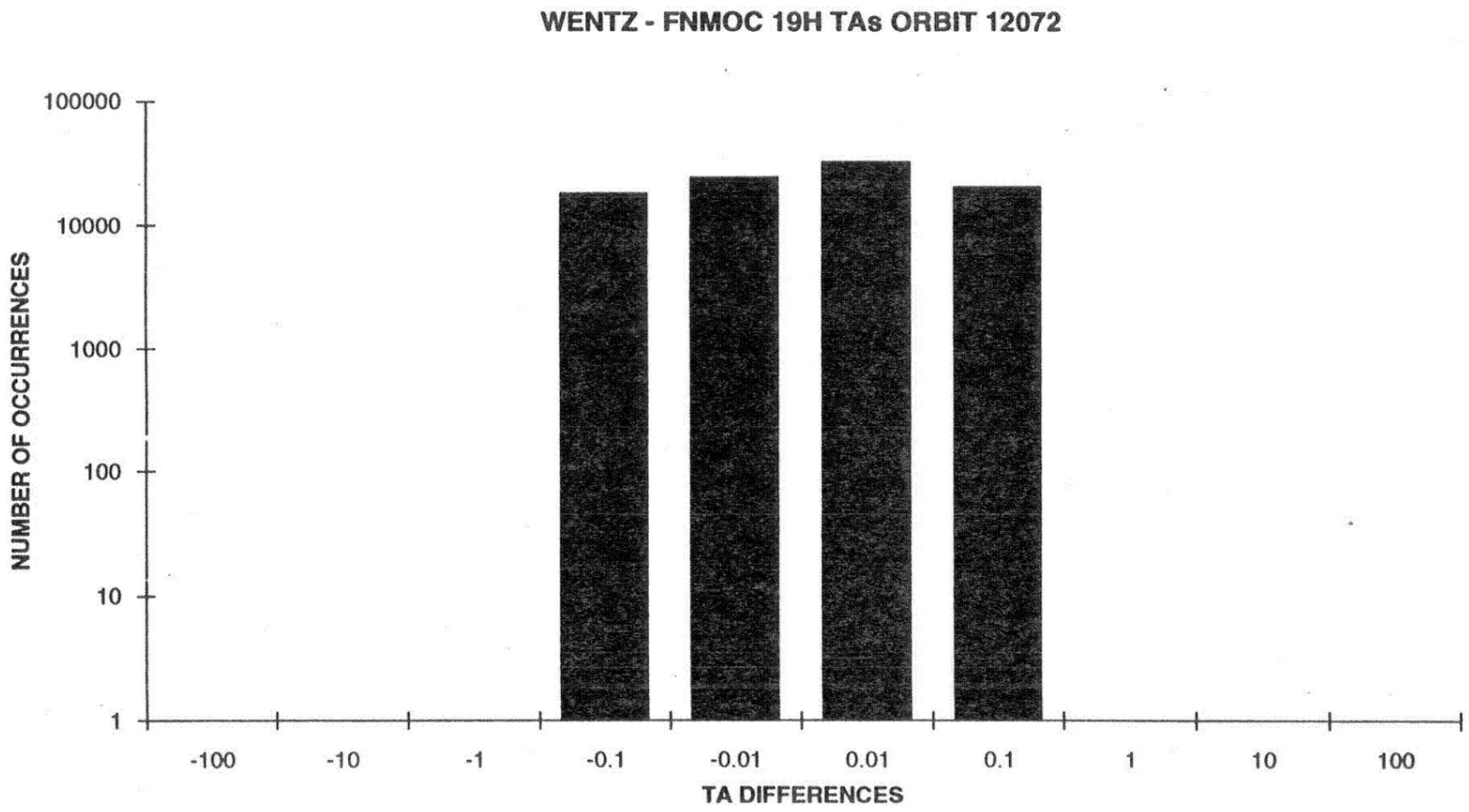
STACT

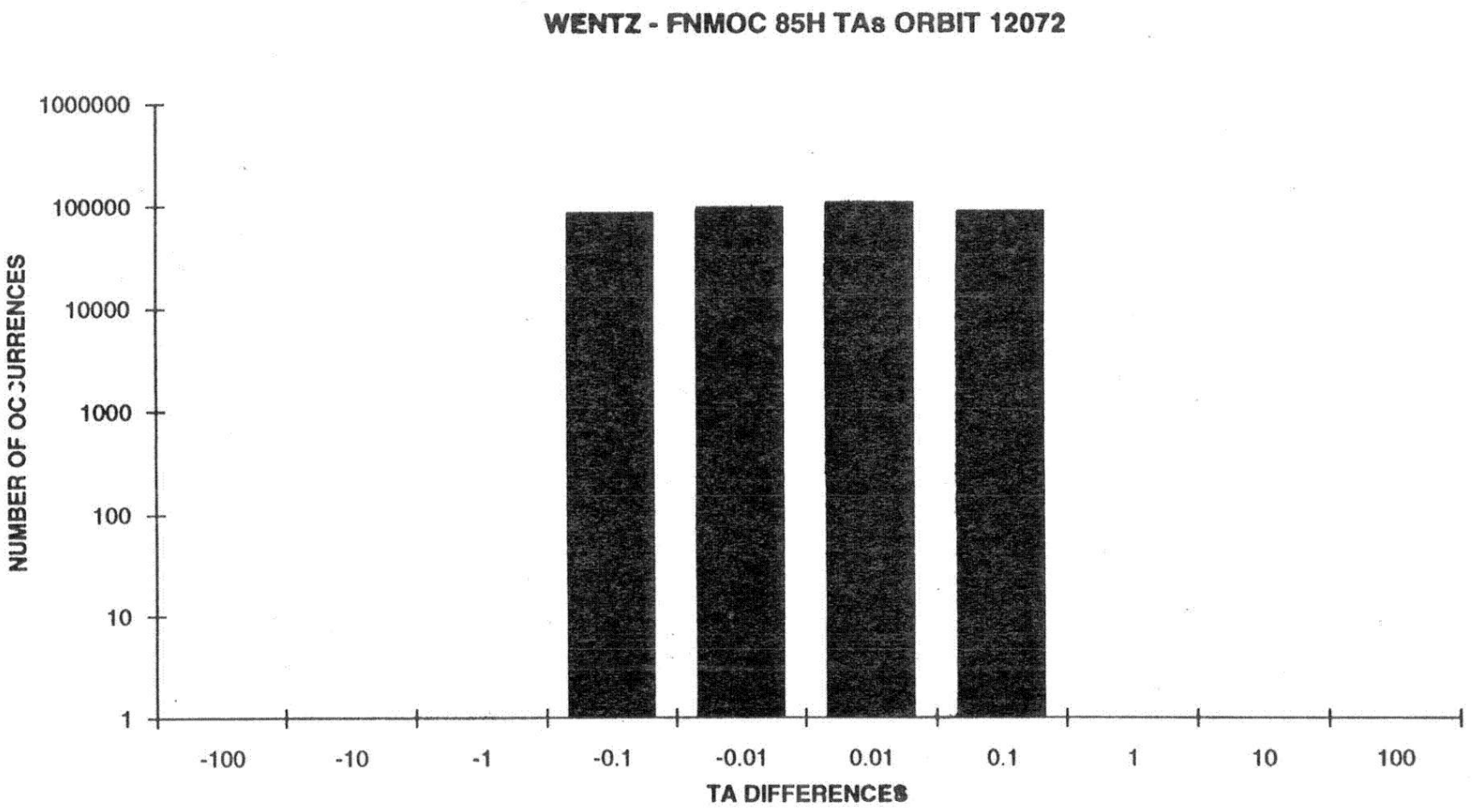


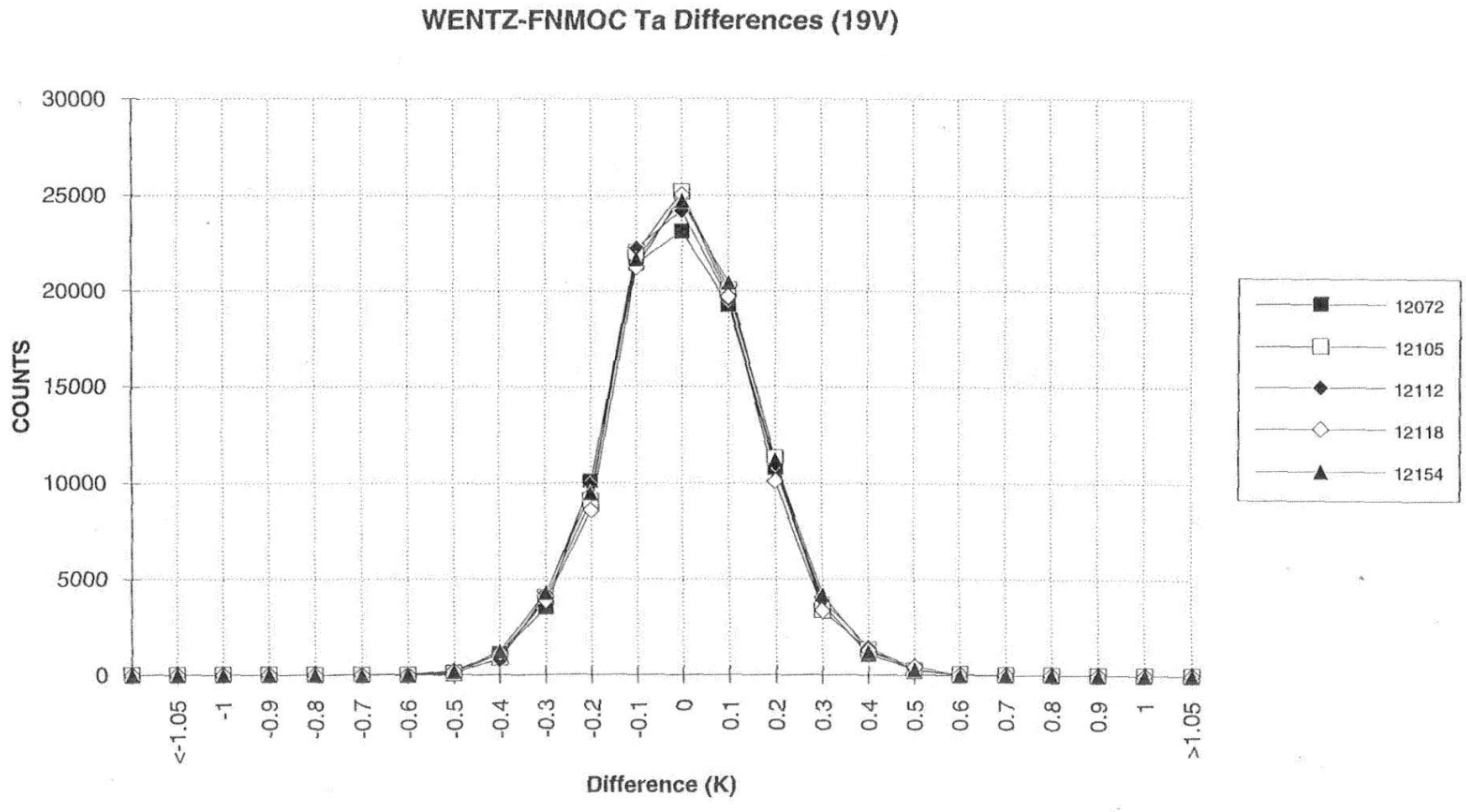
ANTENNA TEMPERATURE COMPARISONS

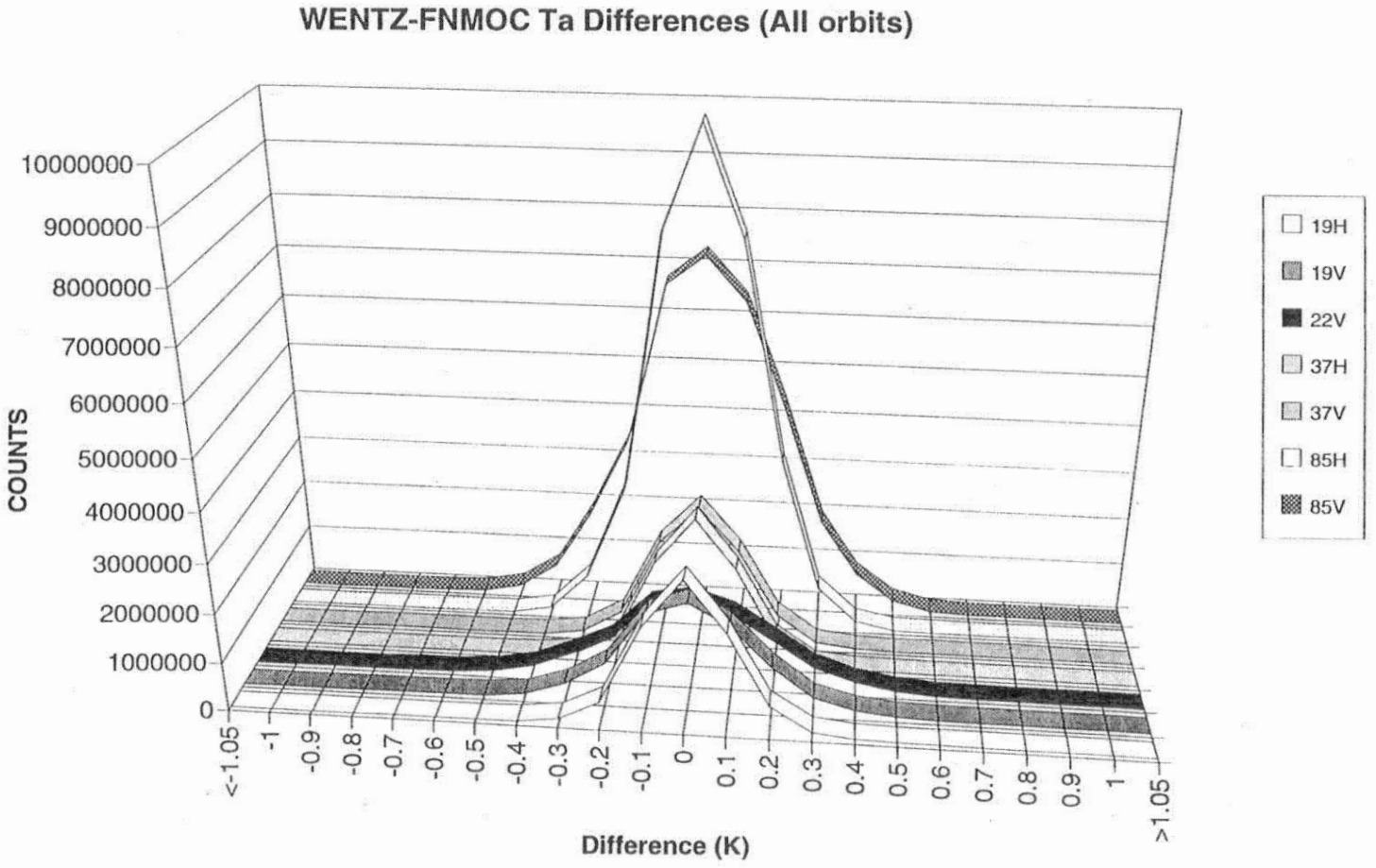

FNMOC 85V ORBIT 12072
0
400
800
1200
1600
2000
2400
2800
3200
Scan
0
32
64
95
127
Position
180
200
220
240
260
280
TA

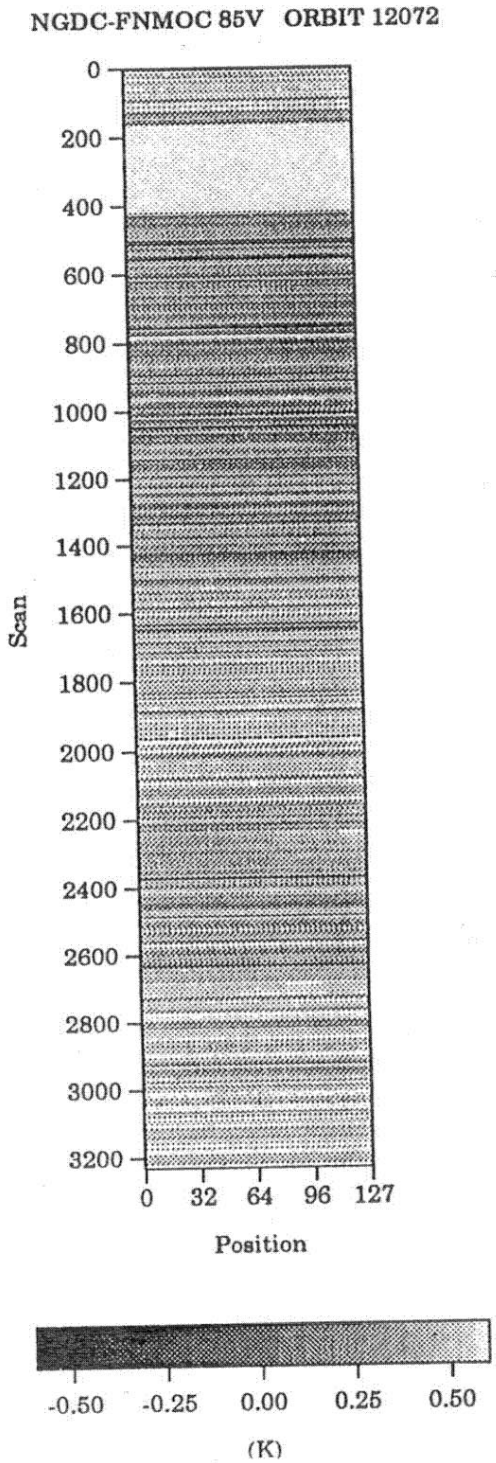

WENTZ-FNMOC 85V ORBIT 12072
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
3000
3200
Scan
0
32
64
96
127
Position
-0.50
-0.25
0.00
0.25
0.50

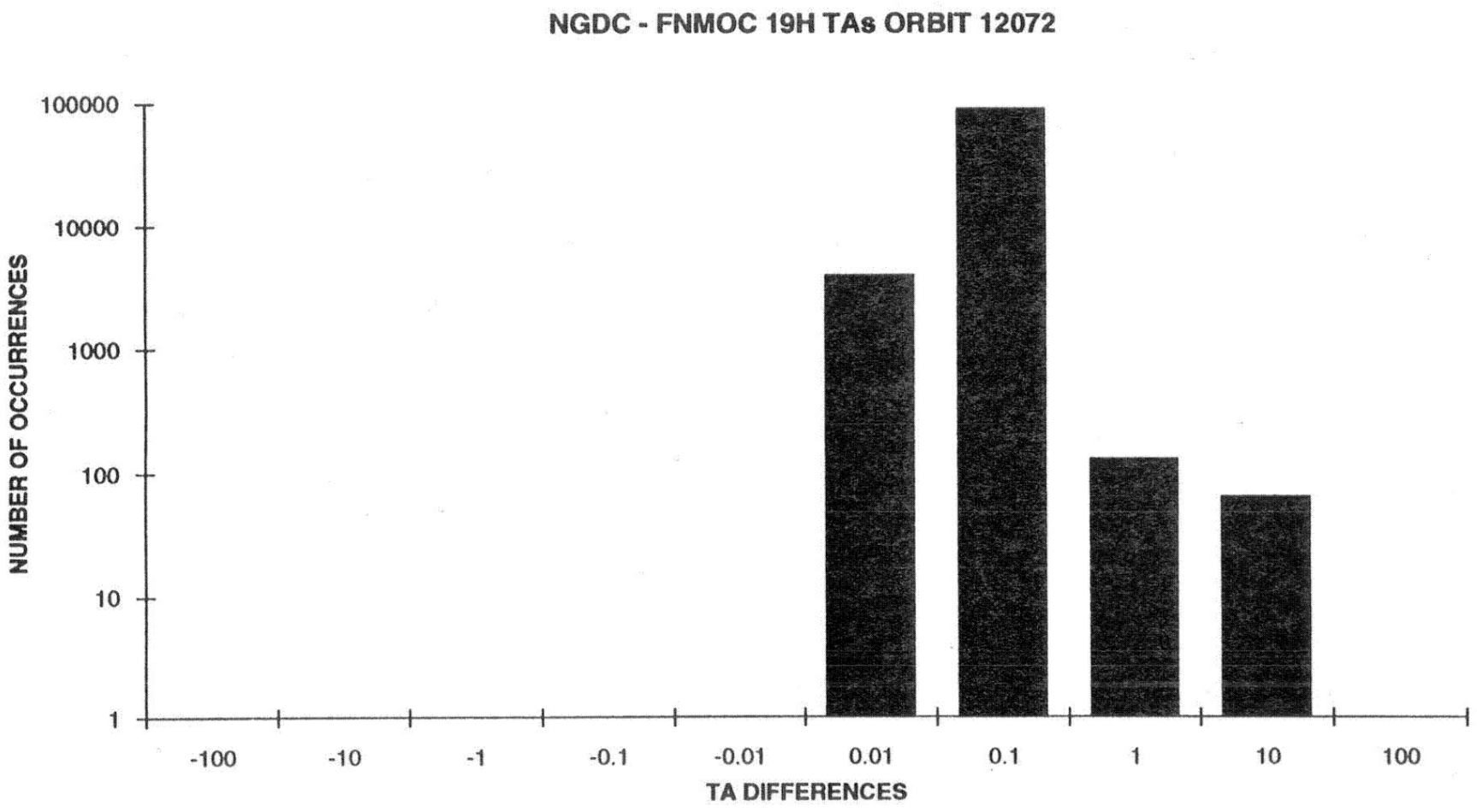

WENTZ - FNMOC 19H TAs ORBIT 12072
NUMBER OF OCCURRENCES
100000
10000
1000
100
10
1
-100
-10
-1
-0.1
-0.01
0.01
0.1
1
10
100
TA DIFFERENCES

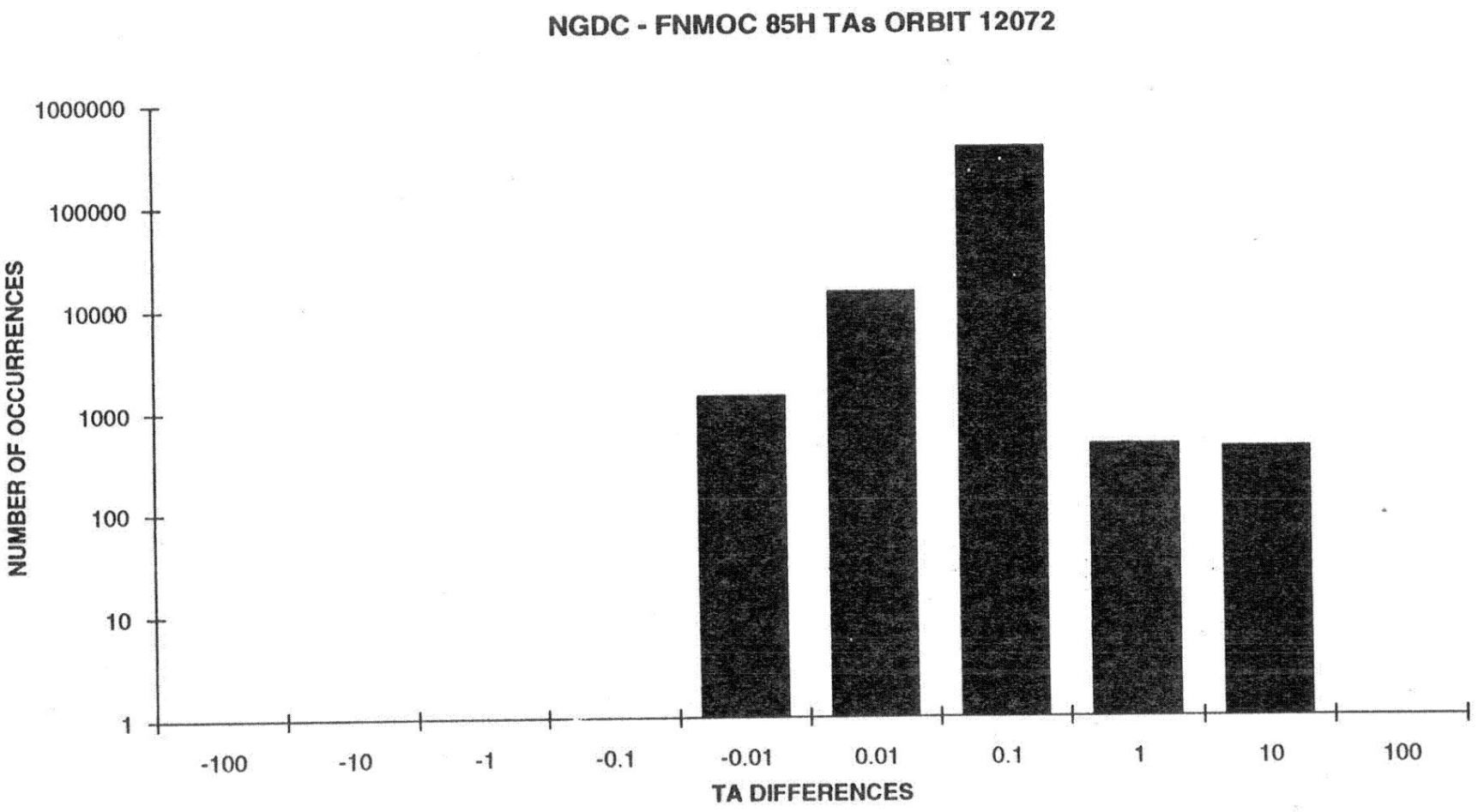

WENTZ - FNMOC 85H TAs ORBIT 12072
NUMBER OF OCCURRENCES
1000000
100000
10000
1000
100
10
1
-100
-10
-1
-0.1
-0.01
0.01
0.1
1
10
100
TA DIFFERENCES

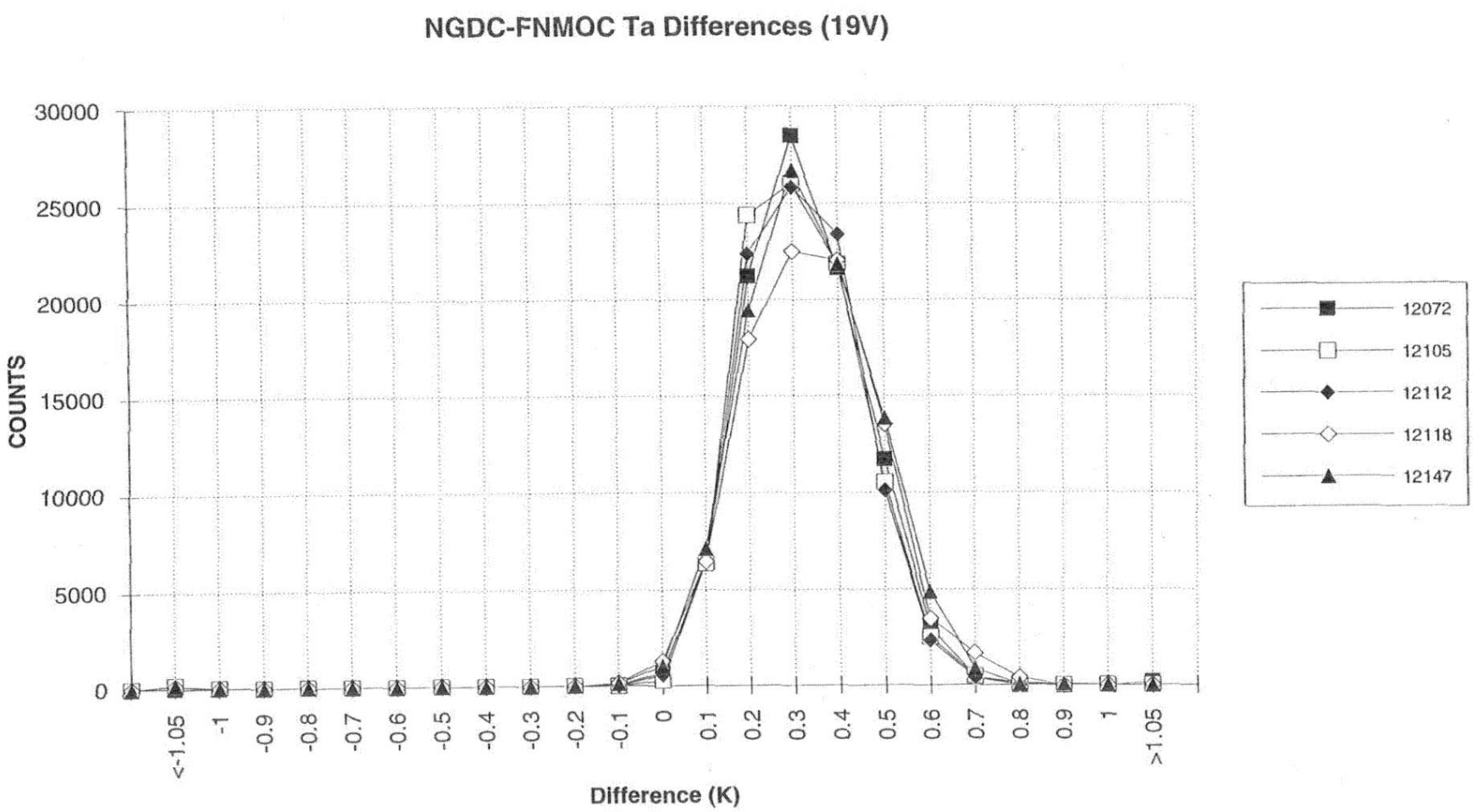

WENTZ-FNMOC Ta Differences (19V)
COUNTS
30000
25000
20000
15000
10000
5000
0
<-1.05
-1
-0.9
-0.8
-0.7
-0.6
-0.5
-0.4
-0.3
-0.2
-0.1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
>1.05
Difference (K)
12072
12105
12112
12118
12154

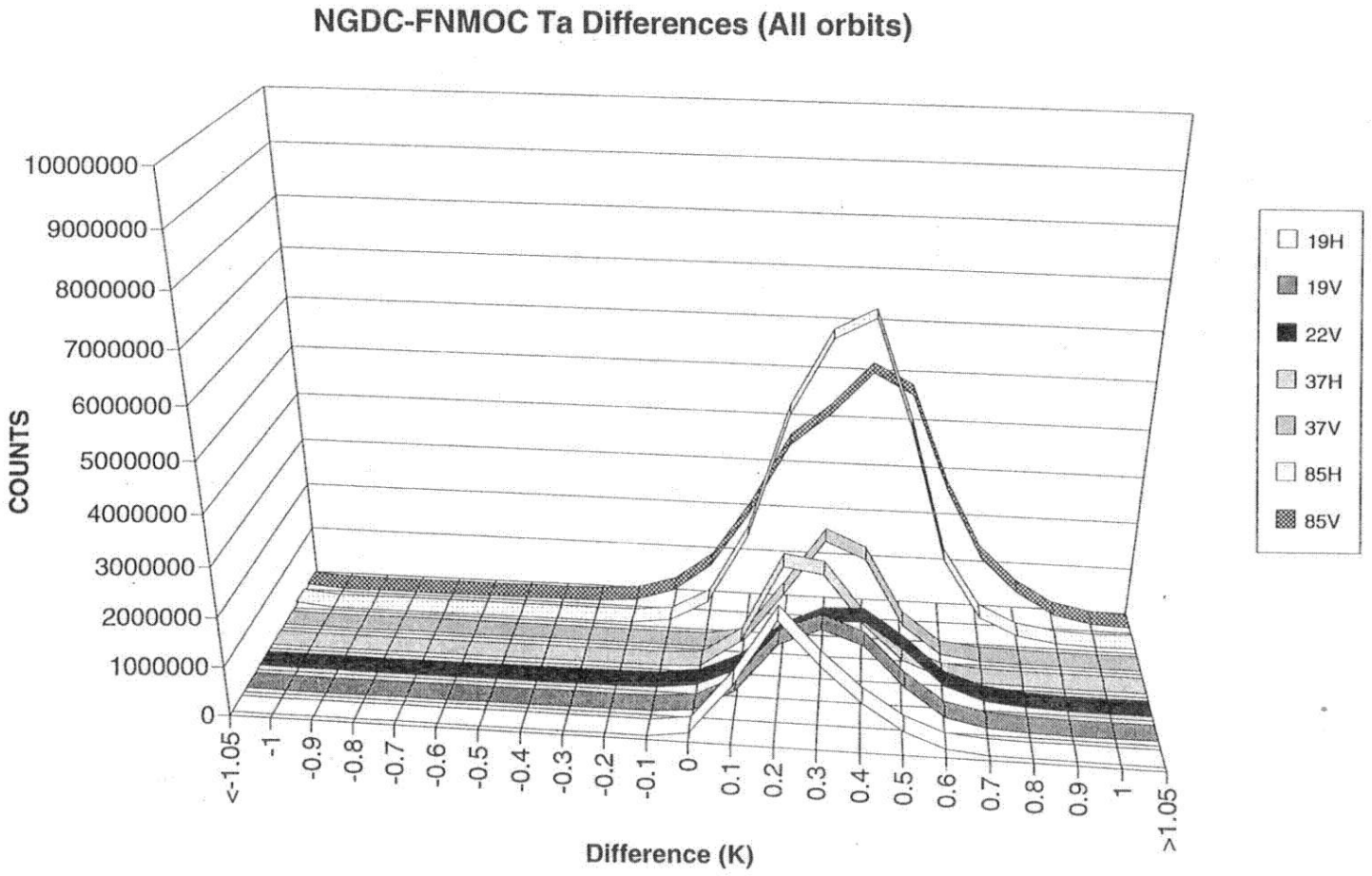

WENTZ-FNMOC Ta Differences (All orbits)
COUNTS
10000000
9000000
8000000
7000000
6000000
5000000
4000000
3000000
2000000
1000000
0
<-1.05
-1
-0.9
-0.8
-0.7
-0.6
-0.5
-0.4
-0.3
-0.2
-0.1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
>1.05
Difference (K)
19H
19V
22V
37H
37V
85H
85V

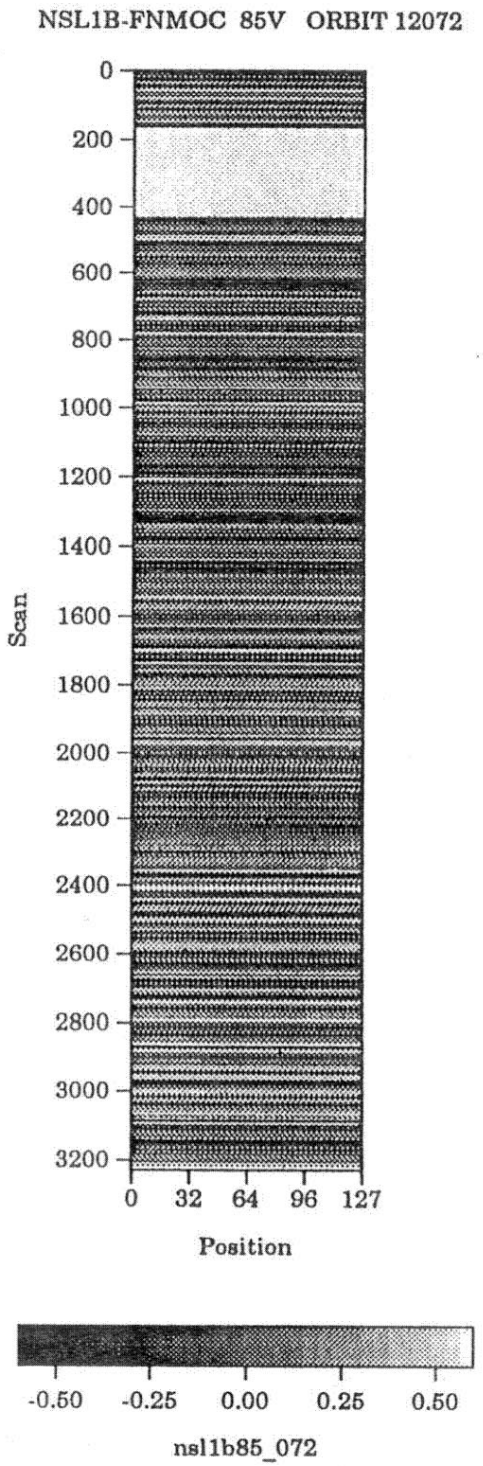

NGDC-FNMOC 85V ORBIT 12072
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
3000
3200
Scan
0
32
64
96
127
Position
-0.50
-0.25
0.00
0.25
0.50
(K)

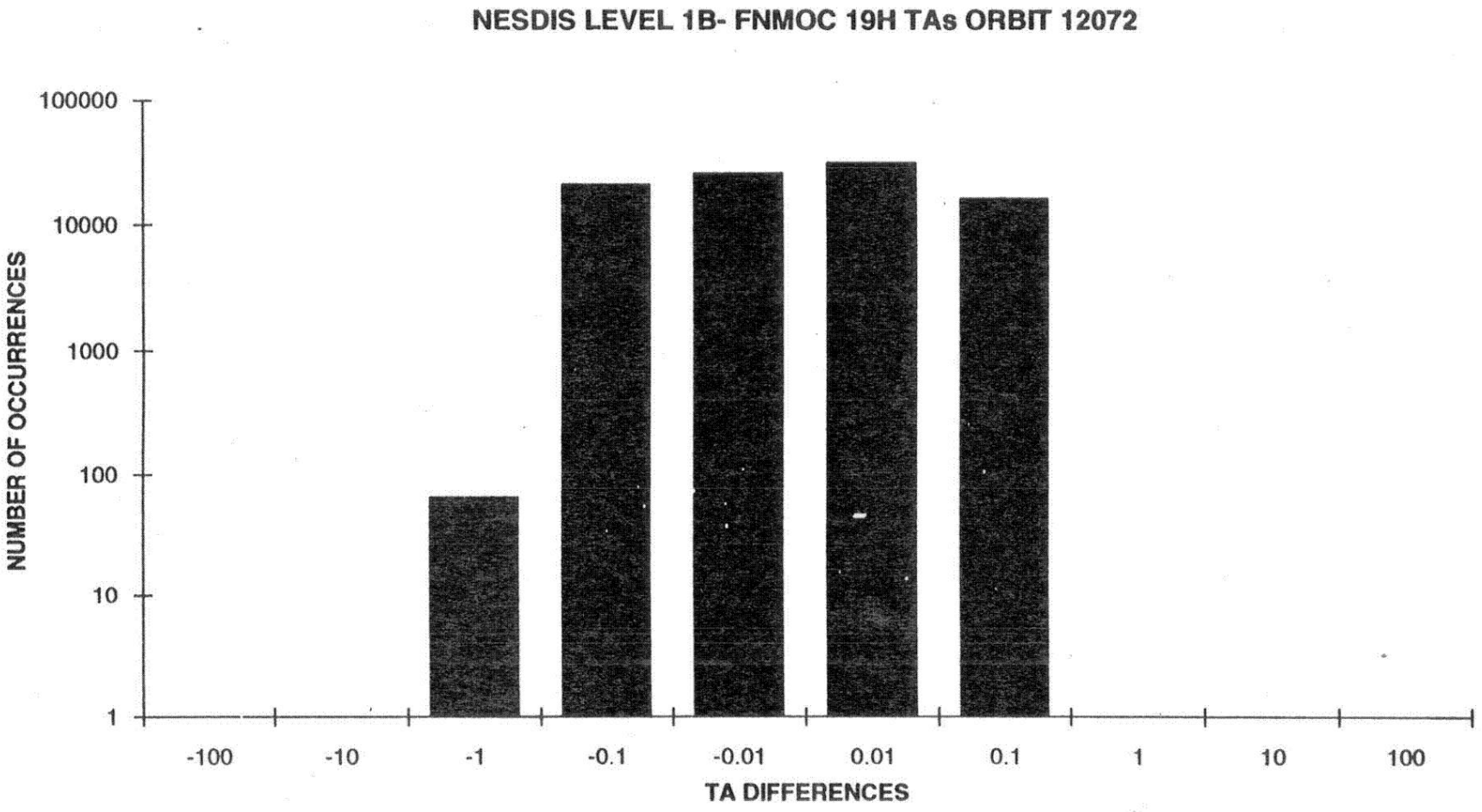

NGDC - FNMOC 19H TAs ORBIT 12072
NUMBER OF OCCURRENCES
100000
10000
1000
100
10
1
-100
-10
-1
-0.1
-0.01
0.01
0.1
1
10
100
TA DIFFERENCES

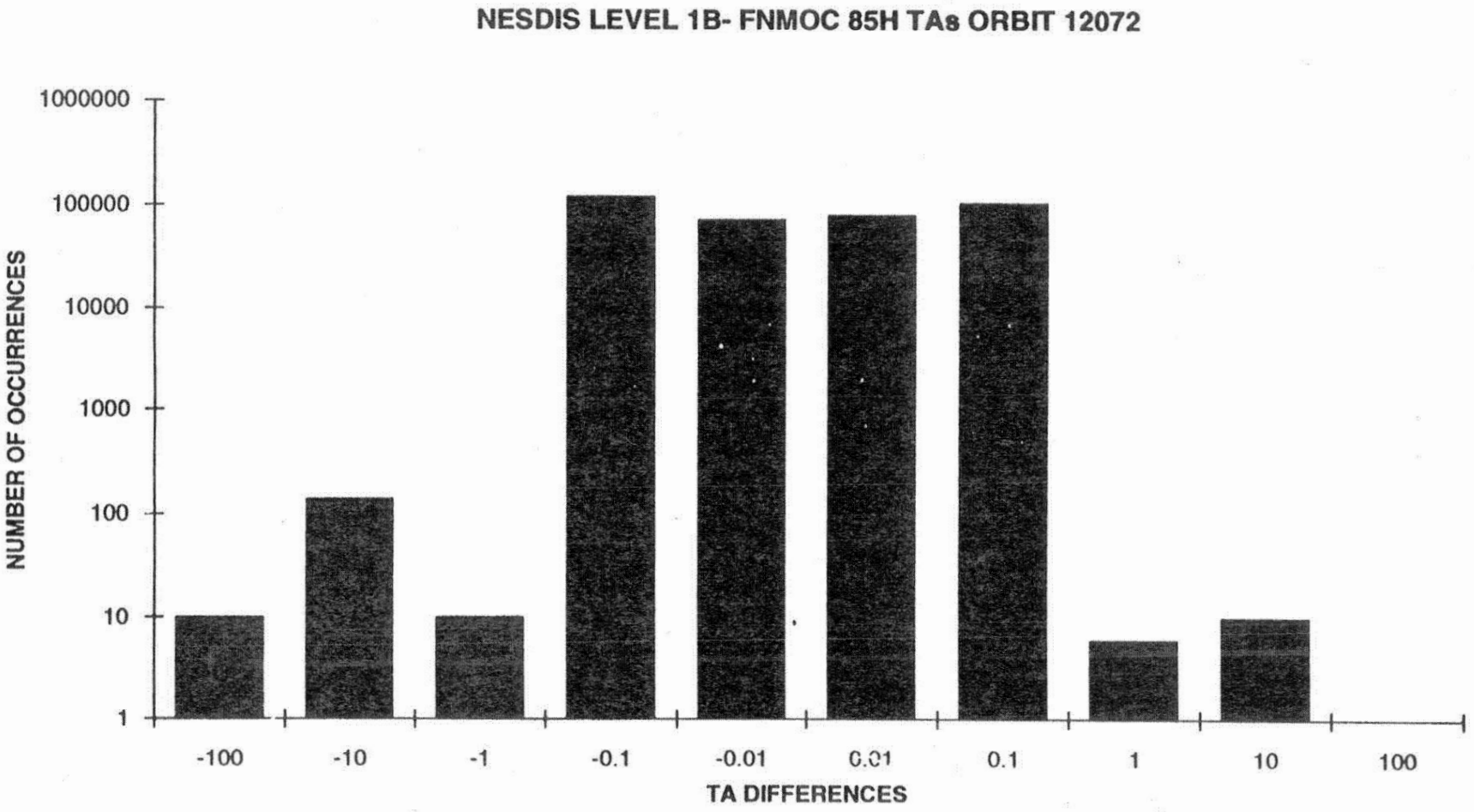

NGDC - FNMOC 85H TAs ORBIT 12072
NUMBER OF OCCURRENCES
1000000
100000
10000
1000
100
10
1
-100
-10
-1
-0.1
-0.01
0.01
0.1
1
10
100
TA DIFFERENCES

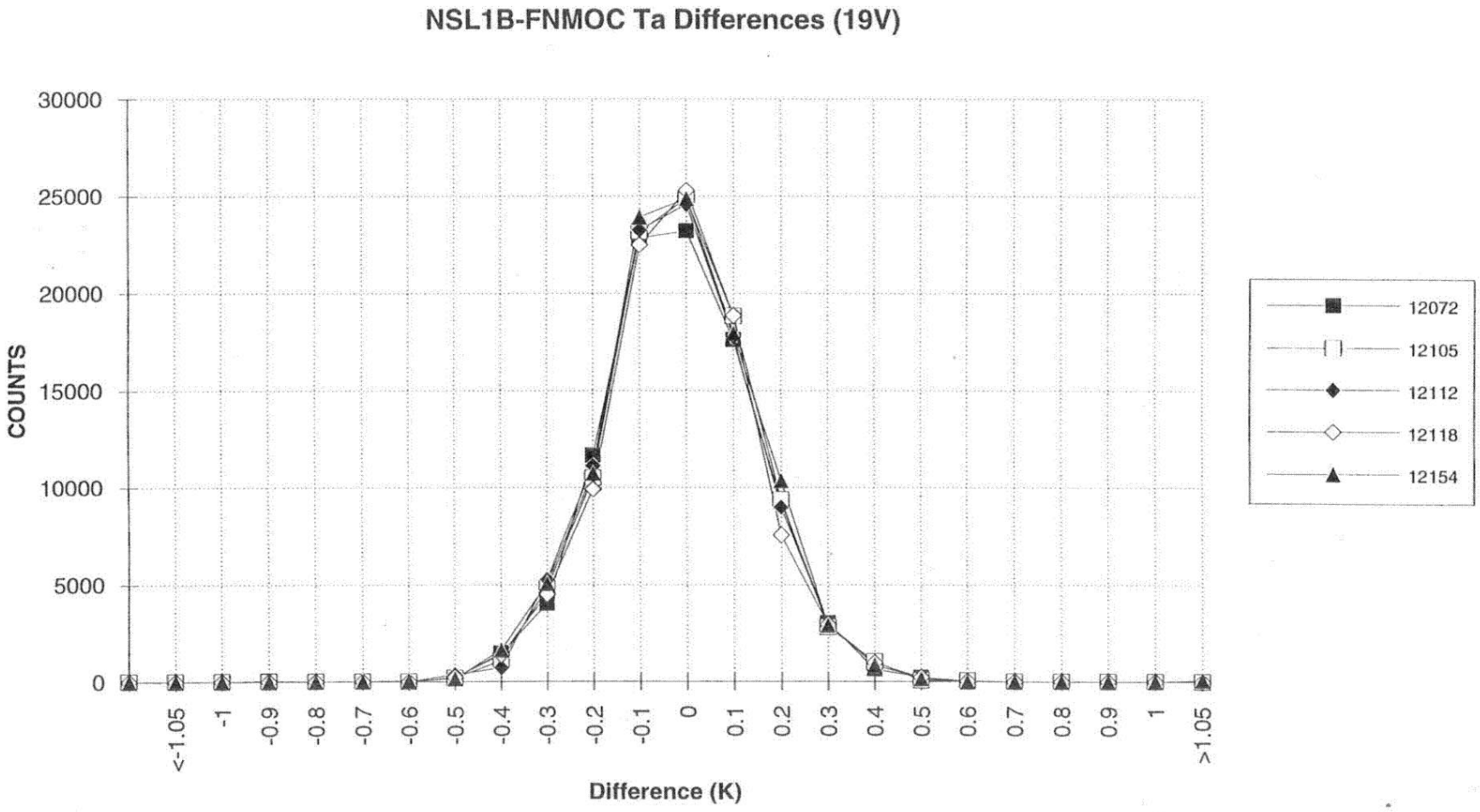

NGDC-FNMOC Ta Differences (19V)
COUNTS
30000
25000
20000
15000
10000
5000
0
<-1.05
-1
-0.9
-0.8
-0.7
-0.6
-0.5
-0.4
-0.3
-0.2
-0.1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
>1.05
Difference (K)
12072
12105
12112
12118
12147

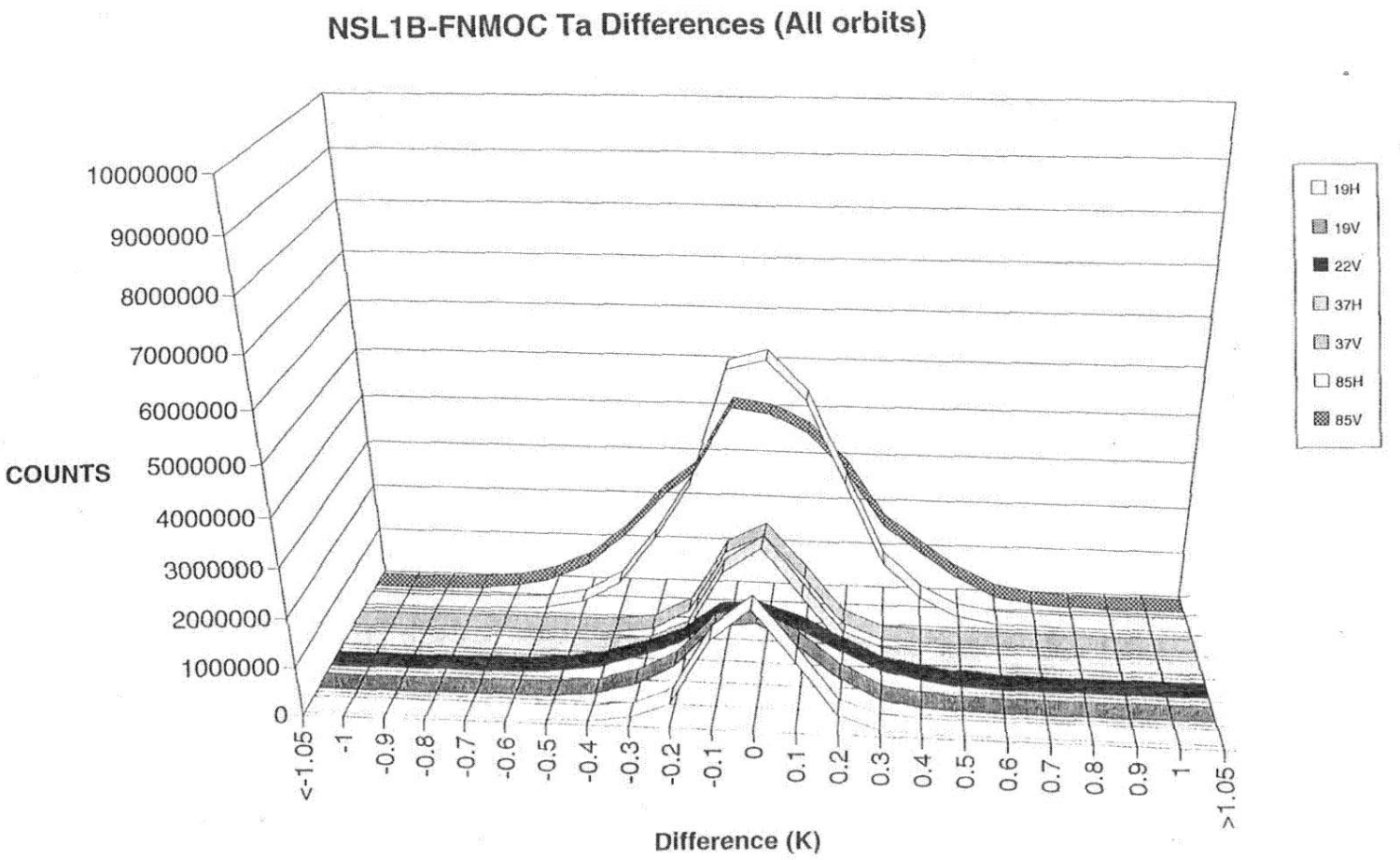

NGDC-FNMOC Ta Differences (All orbits)
COUNTS
10000000
9000000
8000000
7000000
6000000
5000000
4000000
3000000
2000000
1000000
0
<-1.05
-1
-0.9
-0.8
-0.7
-0.6
-0.5
-0.4
-0.3
-0.2
-0.1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
>1.05
Difference (K)
19H
19V
22V
37H
37V
85H
85V


NSL1B-FNMOC 85V ORBIT 12072
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
3000
3200
Scan
0
32
64
96
127
Position
-0.50
-0.25
0.00
0.25
0.50
nsl1b85_072


NESDIS LEVEL 1B- FNMOC 19H TAs ORBIT 12072
NUMBER OF OCCURRENCES
100000
10000
1000
100
10
1
-100
-10
-1
-0.1
-0.01
0.01
0.1
1
10
100
TA DIFFERENCES


NESDIS LEVEL 1B- FNMOC 85H TAs ORBIT 12072
NUMBER OF OCCURRENCES
1000000
100000
10000
1000
100
10
1
-100
-10
-1
-0.1
-0.01
0.01
0.1
1
10
100
TA DIFFERENCES


NSL1B-FNMOC Ta Differences (19V)
COUNTS
30000
25000
20000
15000
10000
5000
0
<-1.05
-1
-0.9
-0.8
-0.7
-0.6
-0.5
-0.4
-0.3
-0.2
-0.1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
>1.05
Difference (K)
12072
12105
12112
12118
12154


NSL1B-FNMOC Ta Differences (All orbits)
COUNTS
10000000
9000000
8000000
7000000
6000000
5000000
4000000
3000000
2000000
1000000
0
<-1.05
-1
-0.9
-0.8
-0.7
-0.6
-0.5
-0.4
-0.3
-0.2
-0.1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
>1.05
Difference (K)
19H
19V
22V
37H
37V
85H
85V

Orbit 12072

19V

	Min	Max	OOB	Min Diff.	Max Diff.	Mean Diff.	Diff SD
FNMOC	156.75	285.83	0				
NSSPN	156.75	285.83	0				
WENTZ	156.70	286.10	0	-0.54	0.71	0.00	0.1574
NGDC	156.98	327.67	70	-0.36	42.34	0.36	1.0531
NSL1B	156.67	286.04	0	-1.02	0.61	-0.01	0.1582

19H

	Min	Max	OOB	Min Diff.	Max Diff.	Mean	Sigma
FNMOC	97.74	277.63	0				
NSSPN	97.74	277.63	0				
WENTZ	97.80	277.80	0	-0.47	0.51	0.01	0.1156
NGDC	97.78	327.67	42	0.02	36.89	0.30	0.9759
NSL1B	97.77	277.77	0	-3.63	0.43	-0.01	0.1448

22V

	Min	Max	OOB	Min Diff.	Max Diff.	Mean	Sigma
FNMOC	156.16	284.84	0				
NSSPN	156.16	284.84	0				
WENTZ	156.10	284.80	0	-0.78	0.78	0.01	0.1994
NGDC	156.41	327.67	84	-0.13	42.88	0.38	1.1415
NSL1B	0.00	284.77	64	-2.45	1.96	-0.01	0.1991

OOB-Out of Bounds
NSSPN-NESDIS TDR Data
NSL1B-NESDIS Level 1b Data

Orbit 12072

37V

	Min	Max	OOB	Min Diff.	Max Diff.	Mean	Sigma
FNMOC	157.44	286.47	0				
NSSPN	157.44	286.47	0				
WENTZ	157.40	286.40	0	-0.50	0.51	0.00	0.1189
NGDC	157.65	327.67	40	0.04	45.58	0.36	1.0228
NSL1B	0.00	286.44	64	-0.47	0.45	-0.01	0.1160

37H

	Min	Max	OOB	Min Diff.	Max Diff.	Mean	Sigma
FNMOC	130.50	280.52	0				
NSSPN	130.50	280.52	0				
WENTZ	130.70	280.60	0	-0.48	0.50	0.00	0.1139
NGDC	-138.41	327.67	38	-0.53	47.20	0.32	1.1956
NSL1B	0.00	280.57	64	-1.80	2.25	-0.01	0.1130

OOB-Out of Bounds
NSSPN-NESDIS TDR Data
NSL1B-NESDIS Level 1b Data

Orbit 12072

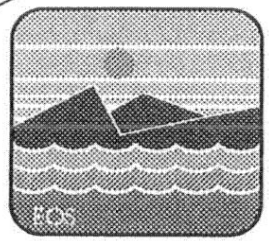
85V

	Min	Max	OOB/Flags	Min Diff.	Max Diff.	Mean	Sigma
FNMOC	144.29	288.94	0				
NSSPN	144.29	288.94	0				
WENTZ	-285.10	289.00	152/152	-0.66	0.65	0.00	0.1797
NGDC	144.58	327.67	643	-0.29	64.29	0.40	0.8265
NSL1B	-327.67	327.67	189	-121.60	83.21	-0.02	0.5554

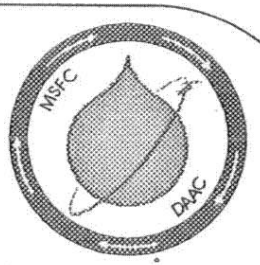
85H

	Min	Max	OOB	Min Diff.	Max Diff.	Mean	Sigma
FNMOC	134.53	287.46	0				
NSSPN	134.53	287.46	0				
WENTZ	134.6	287.5	0	-0.53	0.52	0.00	0.1297
NGDC	134.83	327.67	215	-0.06	51.62	0.38	1.1892
NSL1B	-127.52	327.67	49	-127.39	84.88	-0.04	1.4961

OOB-Out of Bounds
NSSPN-NESDIS TDR Data
NSL1B-NESDIS Level 1b Data

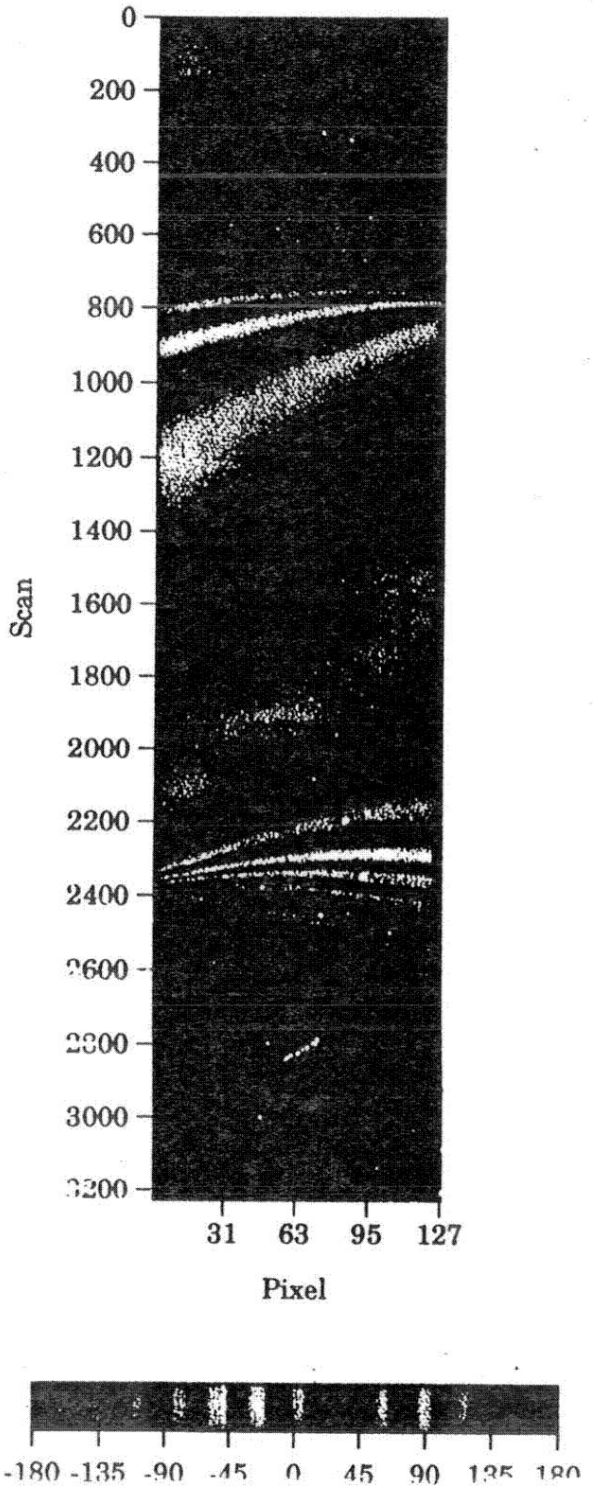


STACT

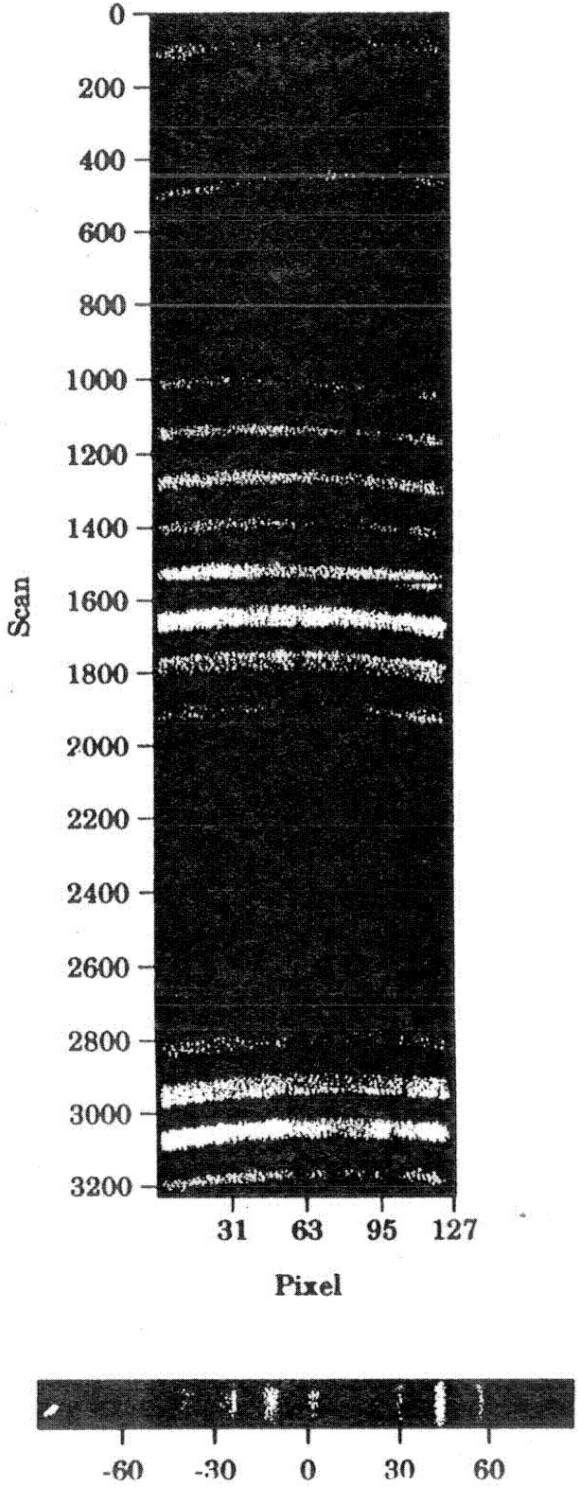


GEOLOCATION COMPARISONS

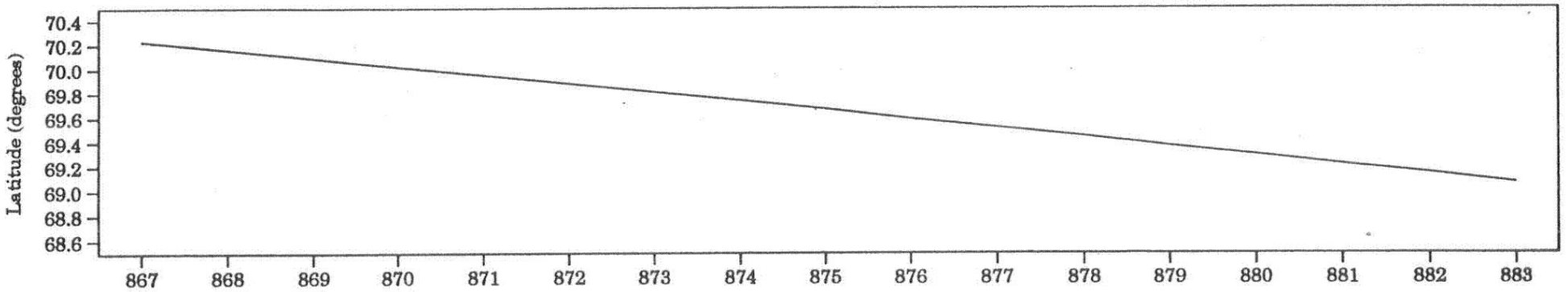
FNMOC LONGITUDES ORBIT 12072



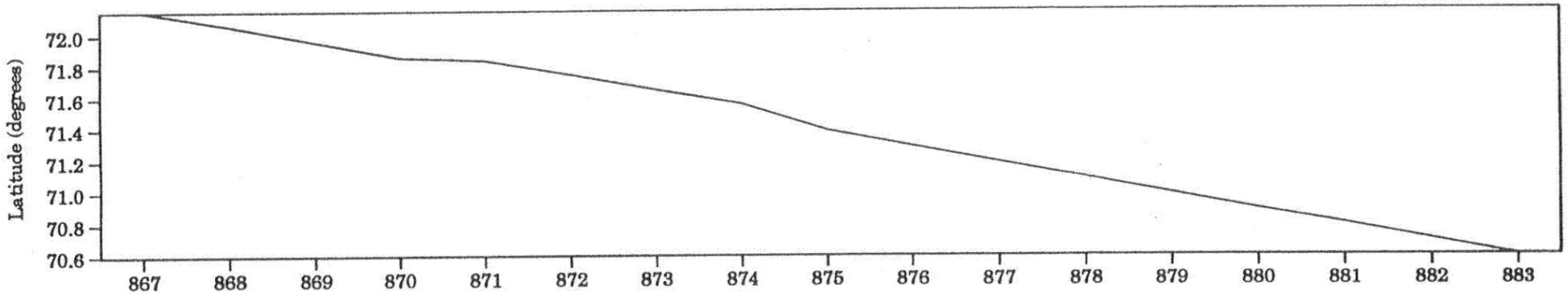
FNMOC LATITUDES ORBIT 12072



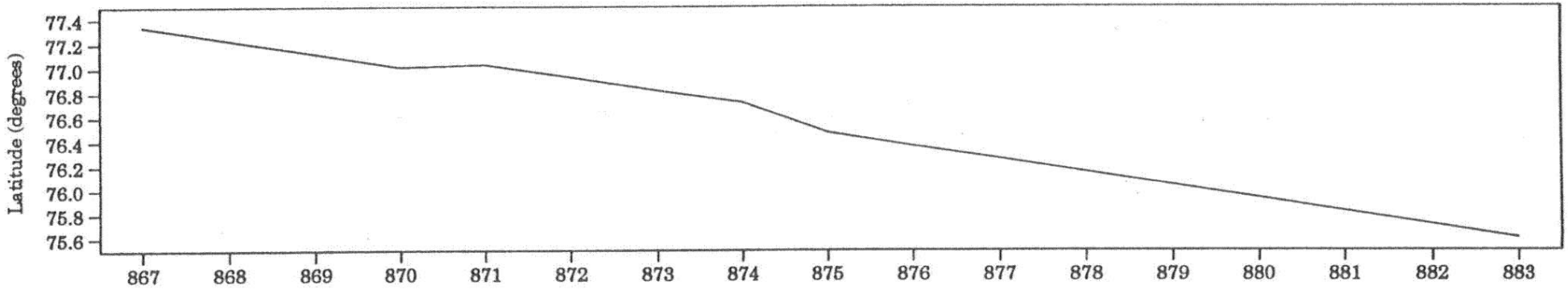
FNMOC Latitude ORBIT 12091 (Position 1)



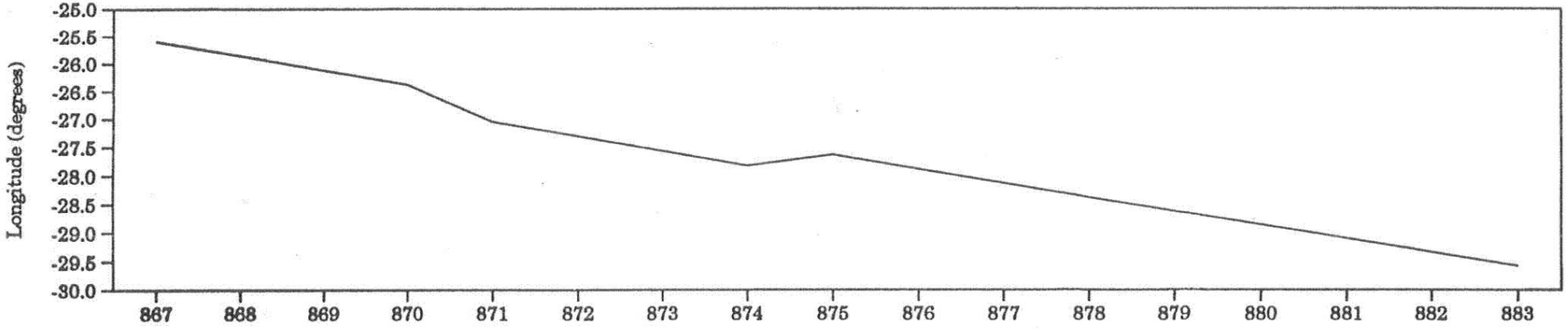
FNMOC Latitude ORBIT 12091 (Position 65)



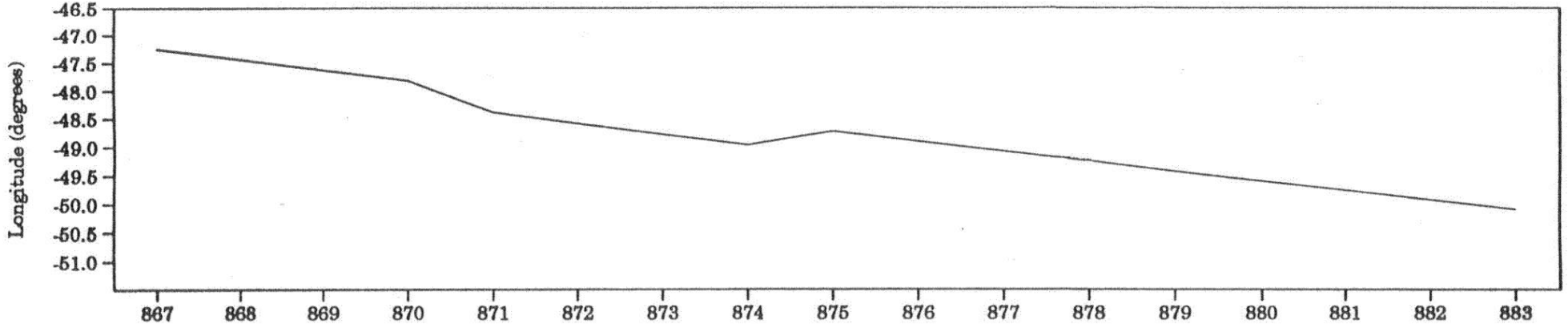
FNMOC Latitude ORBIT 12091 (Position 128)



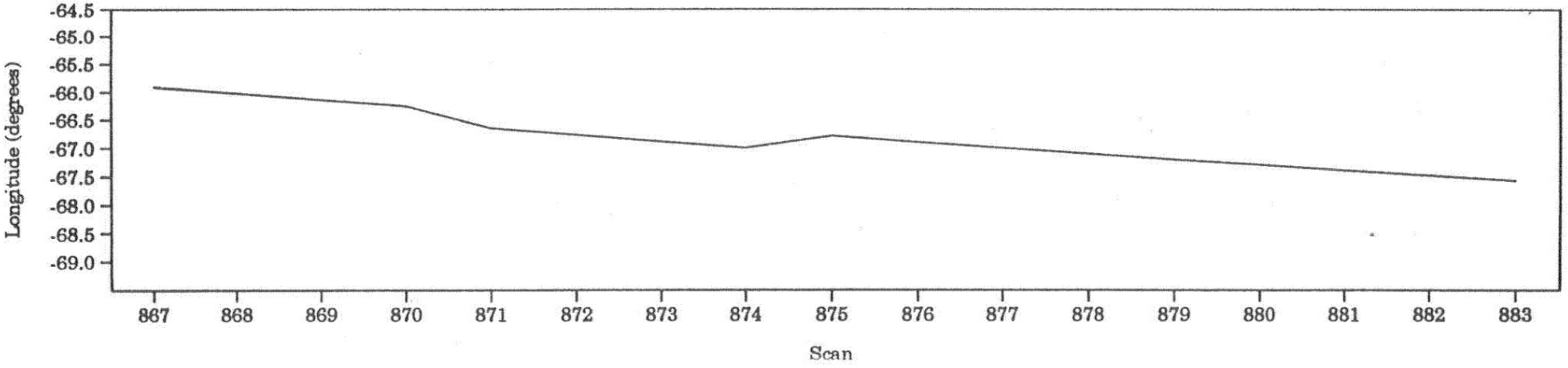
FNMOC Longitude ORBIT 12091 (Position 1)

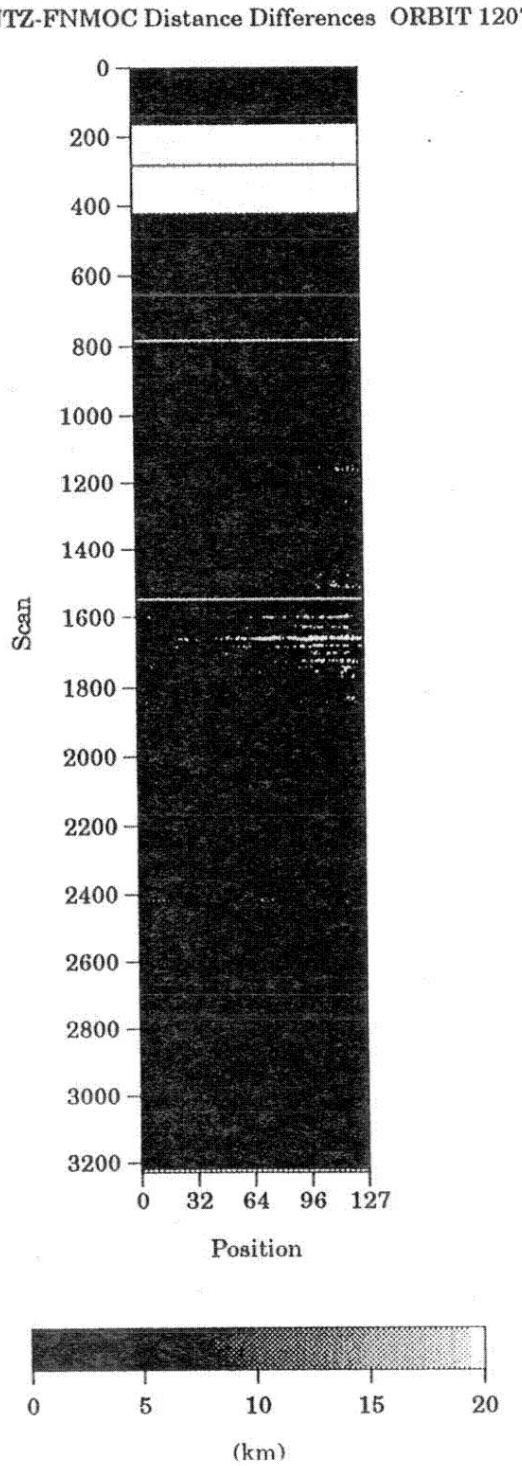


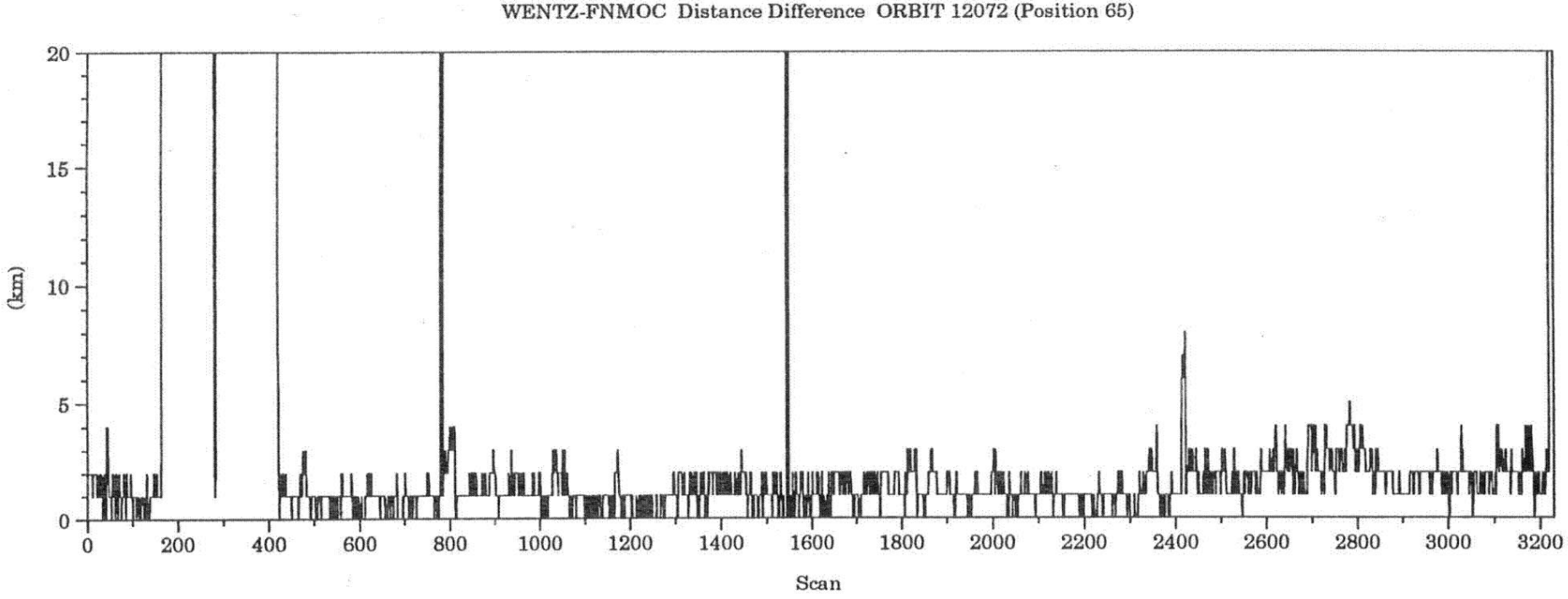
FNMOC Longitude ORBIT 12091 (Position 65)

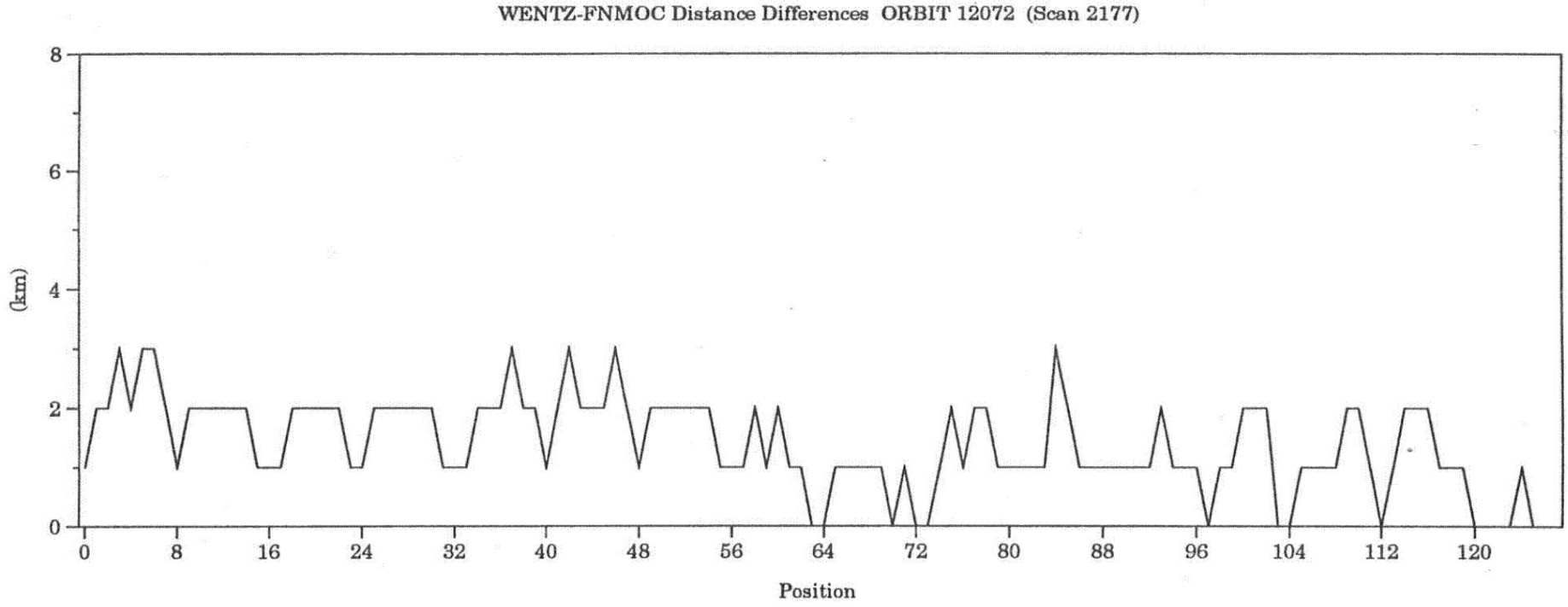


FNMOC Longitude ORBIT 12091 (Position 128)

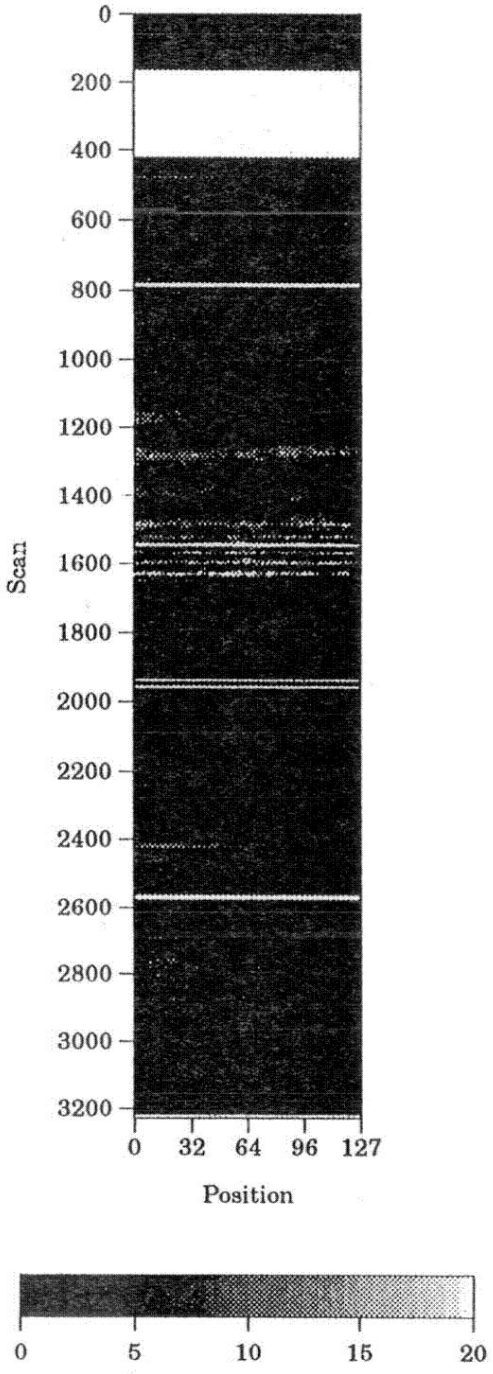


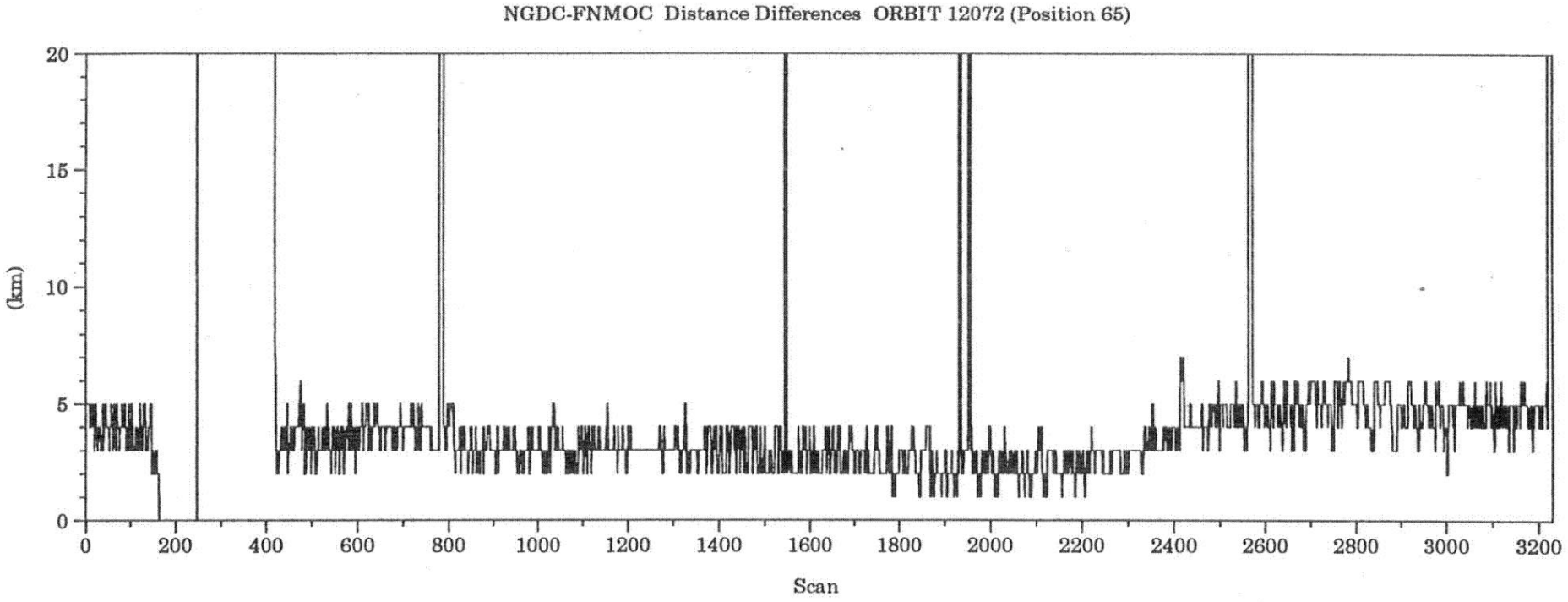

WENTZ-FNMOC Distance Differences ORBIT 12072
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
3000
3200
Scan
0
32
64
96
127
Position
0
5
10
15
20
(km)

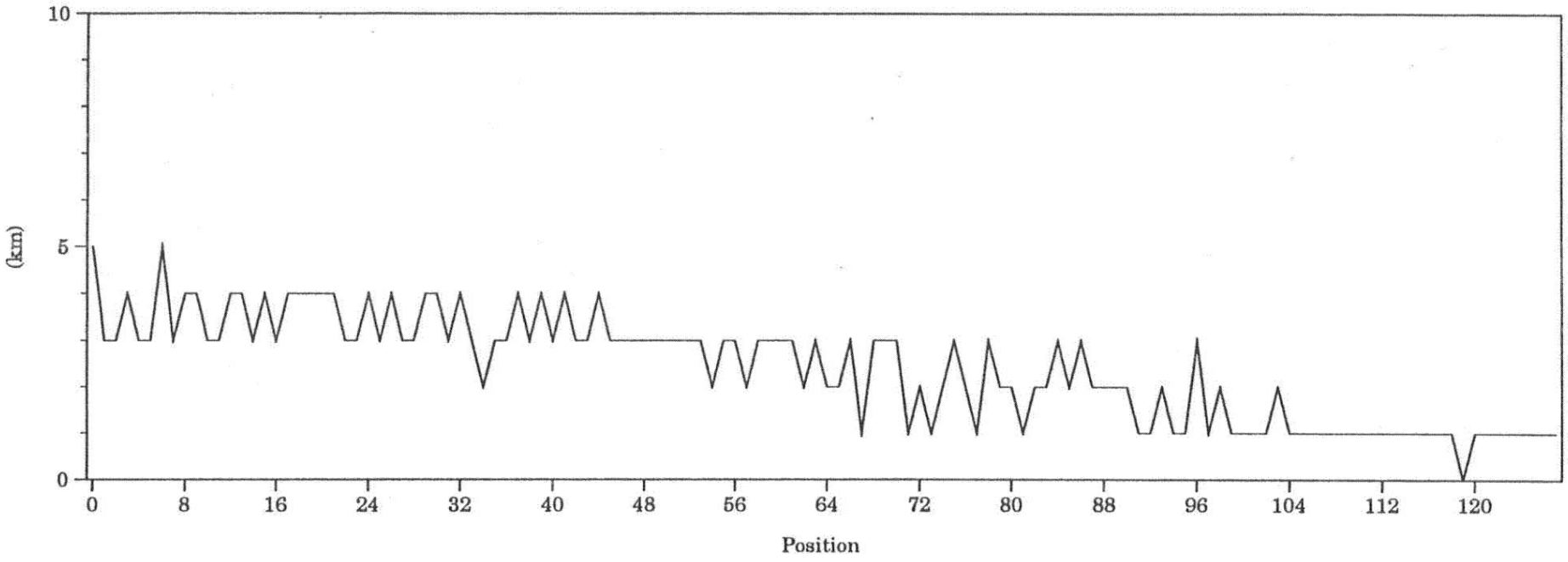

WENTZ-FNMOC Distance Difference ORBIT 12072 (Position 65)
20
15
10
5
0
(km)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
3000
3200
Scan

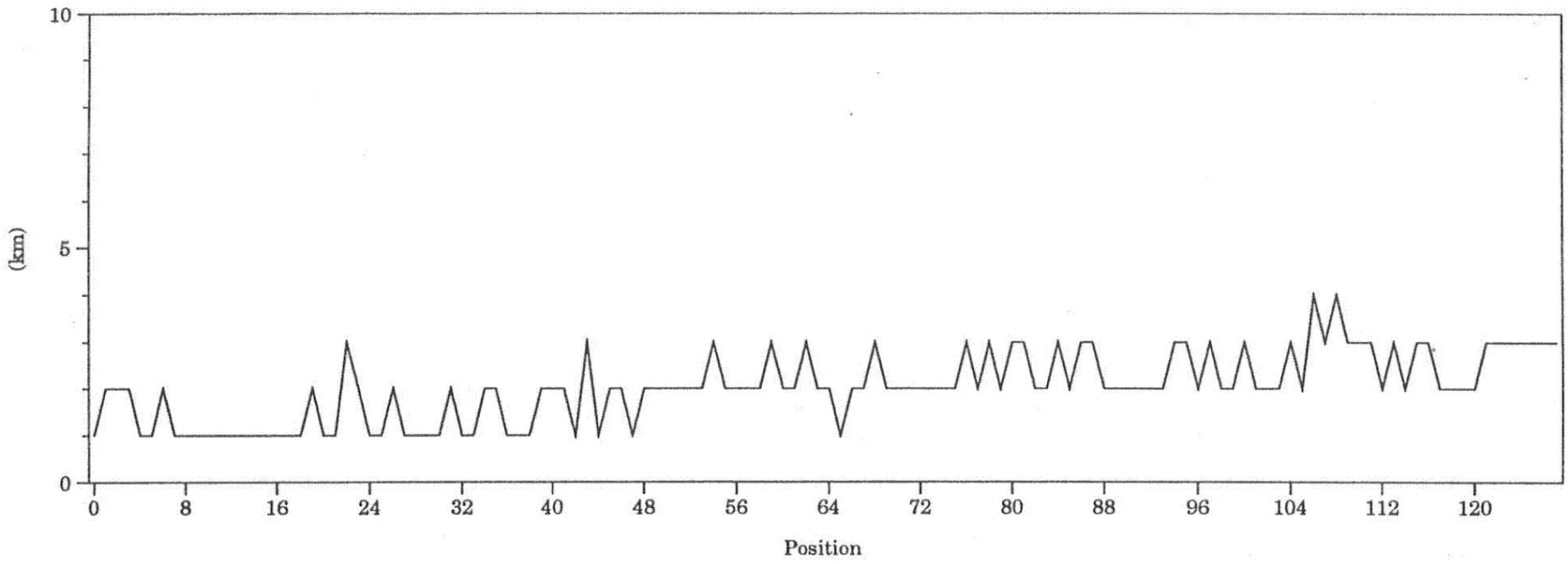

WENTZ-FNMOC Distance Differences ORBIT 12072 (Scan 2177)
(km)
0
2
4
6
8
0
8
16
24
32
40
48
56
64
72
80
88
96
104
112
120
Position

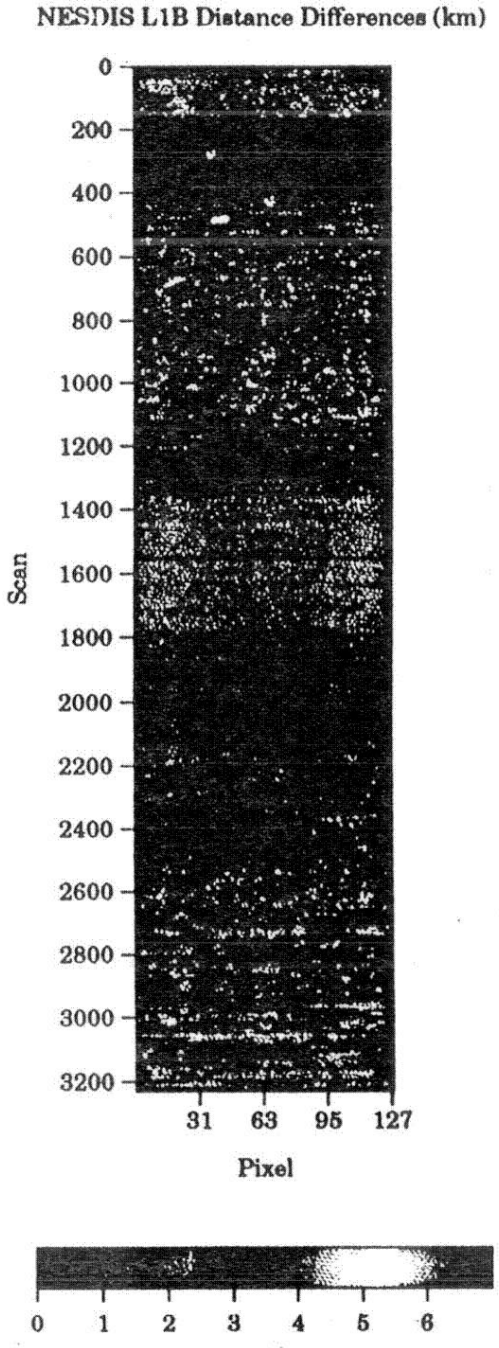
NGDC-FNMOC Distance Differences ORBIT 12072

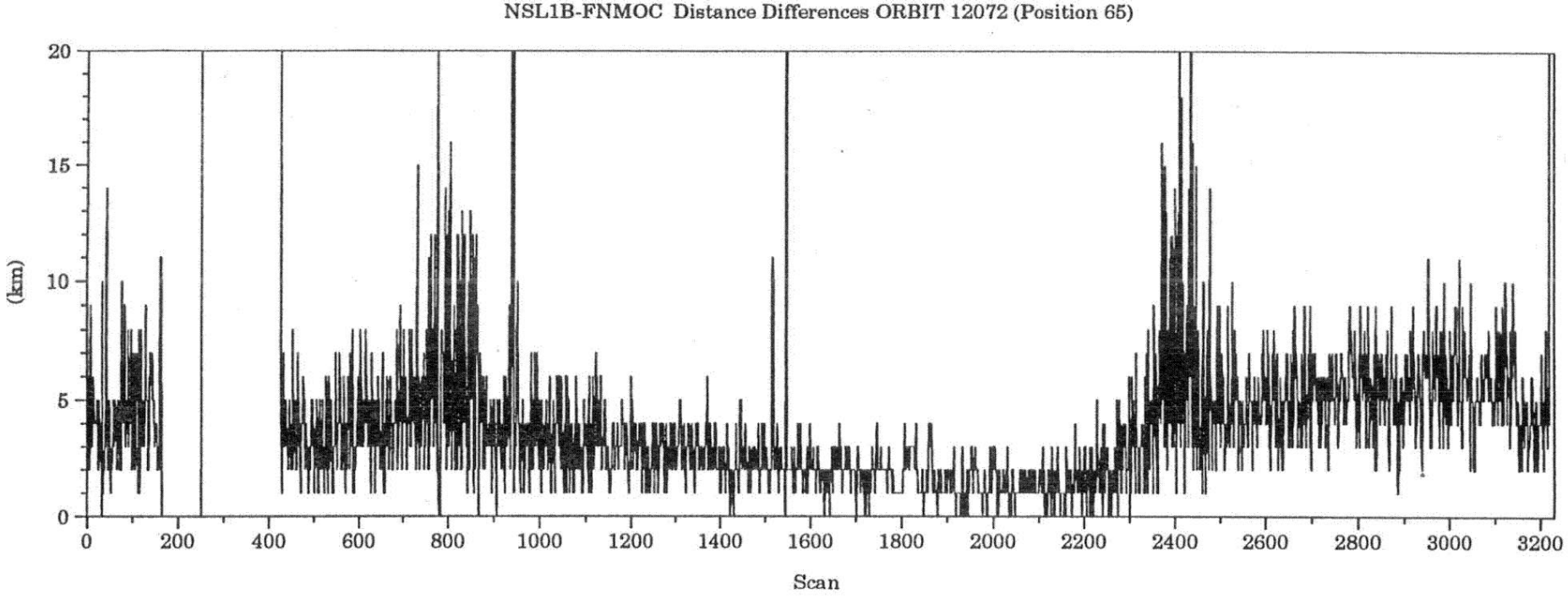


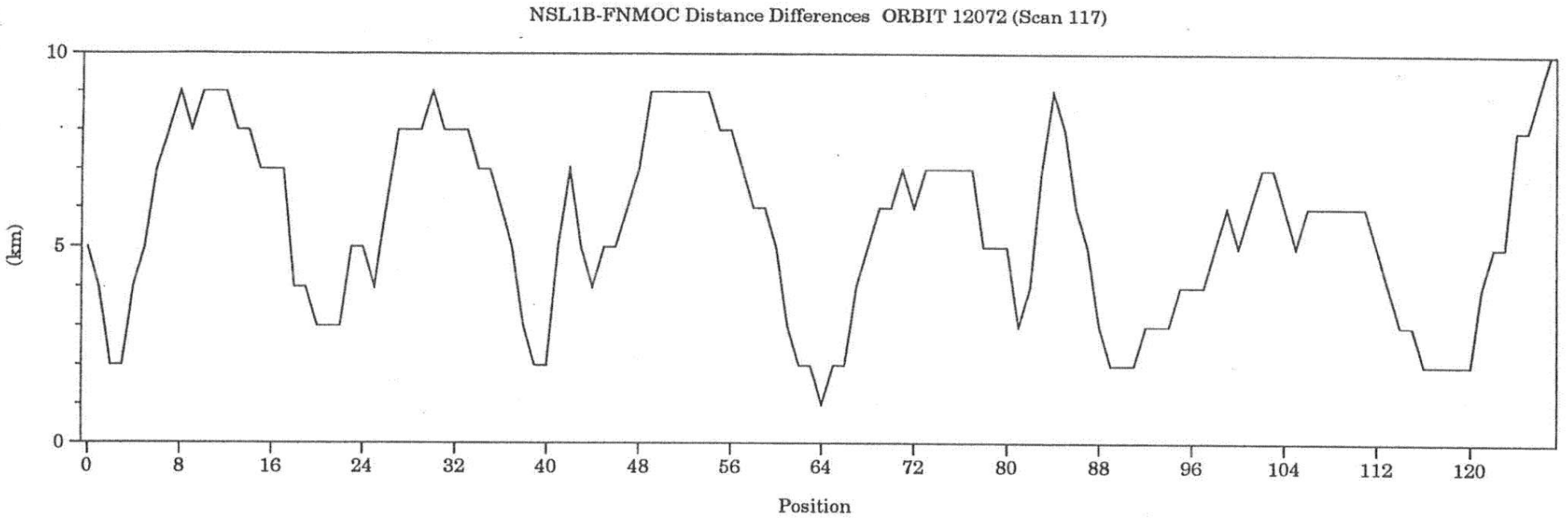

NGDC-FNMOC Distance Differences ORBIT 12072 (Position 65)
(km)
20
15
10
5
0
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
3000
3200
Scan

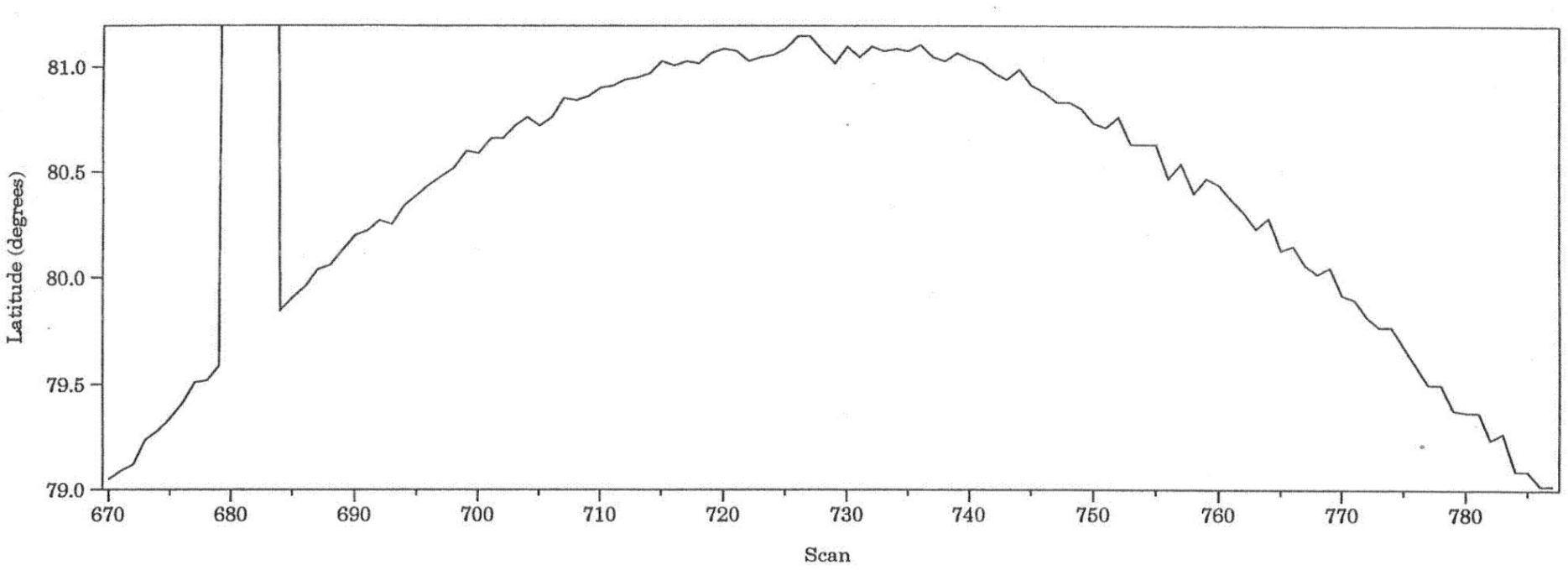

NGDC-FNMOC Distance Differences ORBIT 12072 (Scan 1816)
10
5
0
(km)
0
8
16
24
32
40
48
56
64
72
80
88
96
104
112
120
Position

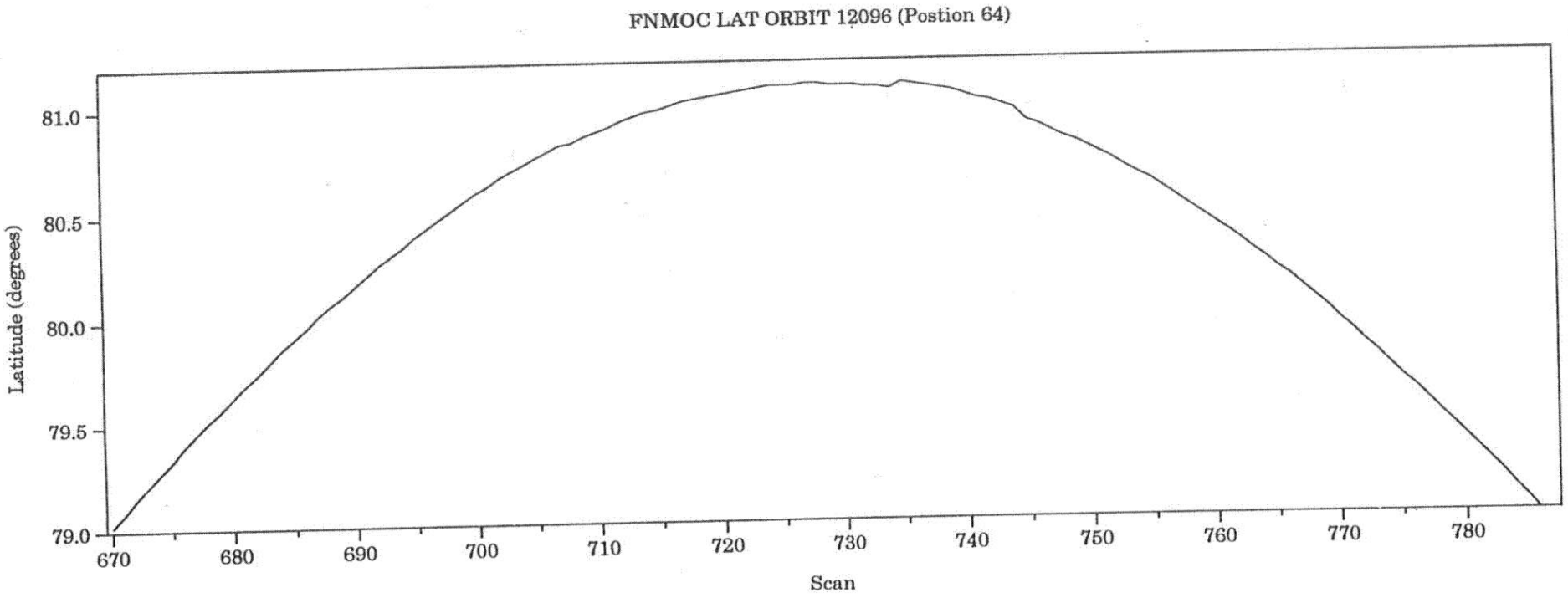

NGDC-FNMOC Distance Differences ORBIT 12072 (Scan 1875)
10
5
0
(km)
0
8
16
24
32
40
48
56
64
72
80
88
96
104
112
120
Position

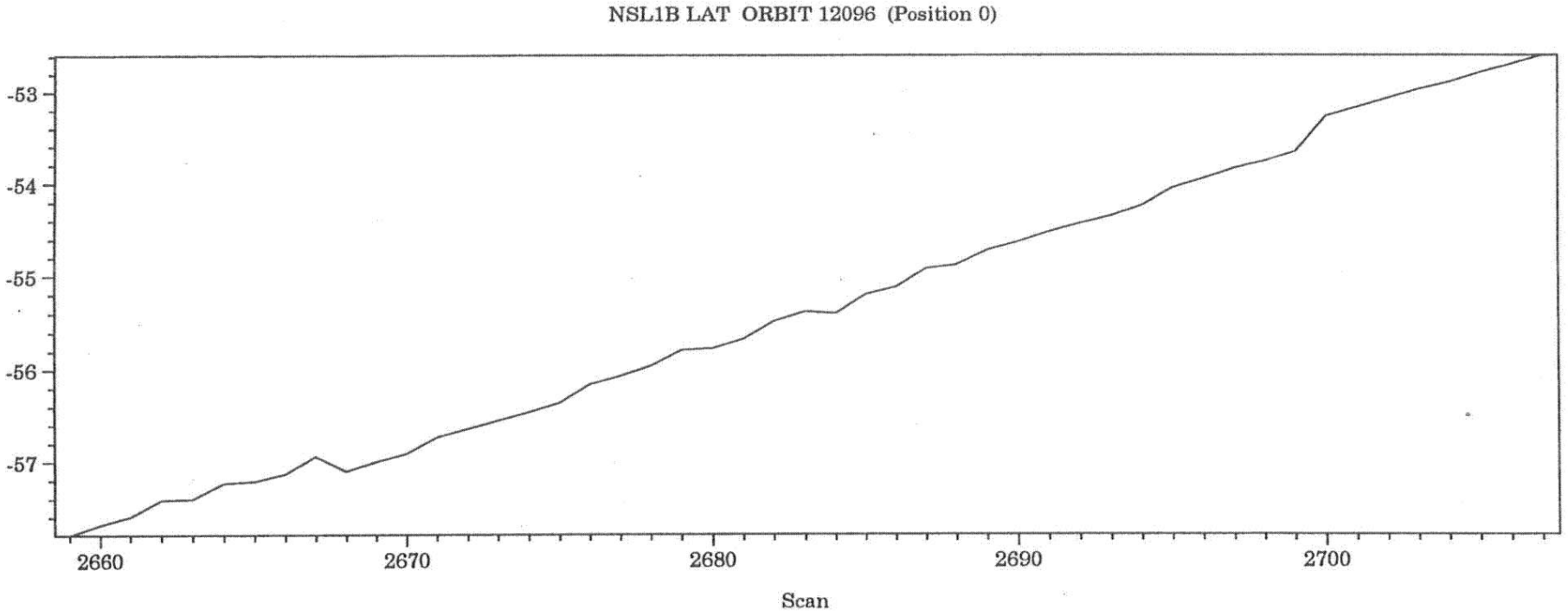

NESDIS L1B Distance Differences (km)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
3000
3200
Scan
31
63
95
127
Pixel
0
1
2
3
4
5
6


NSL1B-FNMOC Distance Differences ORBIT 12072 (Position 65)
(km)
20
15
10
5
0
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
3000
3200
Scan


NSL1B-FNMOC Distance Differences ORBIT 12072 (Scan 117)
10
5
0
(km)
0
8
16
24
32
40
48
56
64
72
80
88
96
104
112
120
Position


NSL1B LAT ORBIT 12096 (Position 64)
Latitude (degrees)
81.0
80.5
80.0
79.5
79.0
670
680
690
700
710
720
730
740
750
760
770
780
Scan


FNMOC LAT ORBIT 12096 (Postion 64)
Latitude (degrees)
81.0
80.5
80.0
79.5
79.0
670
680
690
700
710
720
730
740
750
760
770
780
Scan


NSL1B LAT ORBIT 12096 (Position 0)
-53
-54
-55
-56
-57
2660
2670
2680
2690
2700
Scan

Orbit 12072

BST

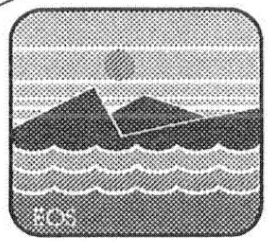
	Min	Max	AVG Delta	Std. Dev.	Min Diff.	Max Diff.	Mean	Sigma
FNMOC	3.7974	3.7985	3.7979	0.0002				
NSSPN	3.7974	3.7985	3.7979	0.0002				
WENTZ	3.7974	3.7985	3.7979	0.0002	0.00	0.00	0.00	0.0000
NGDC	3.2577	4.6075	3.7979	0.0271	-0.40	0.48	0.41	0.0263
NSL1B	2.0500	5.4490	3.7982	0.1935	-1.51	0.49	0.24	0.1701

Distance

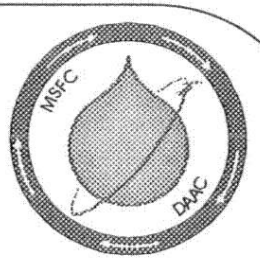
	Min Diff.	Max Diff.	Mean	Sigma
WENTZ	0	9	1.49	0.8910
NGDC	0	10	3.43	1.2654
NSL1B	0	52	4.12	3.1780

OOB-Out of Bounds
NSSPN-NESDIS TDR Data
NSL1B-NESDIS Level 1b Data

SUMMARY



Fleet Numerical Meteorology and Oceanography Center



NOT MANY OUT OF BOUNDS (50-320 K)

B-SCAN START TIME DELTA CONSISTENT 3.7979 sec

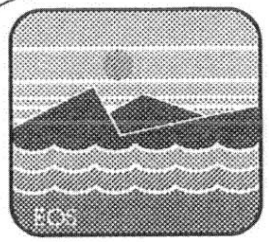
UP TO .1 degree OFFSET IN SOME LATITUDES & LONGITUDES

- **Not constant across the scan**

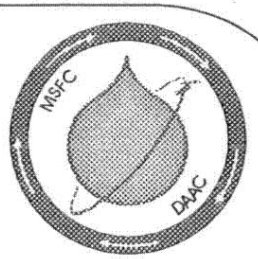
SOME "DUMP FILES" NOT RECEIVED

NONE of 100 ORBITS HAD COMPLETE NUMBER OF SCANS

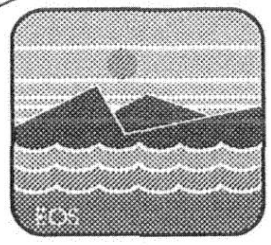
- **max - orbit 12075; 1606 scans**



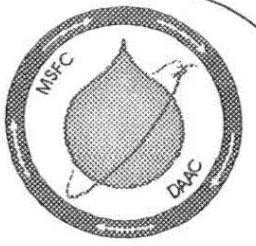
National Environmental Satellite, Data and Information Service
TDR



IDENTICAL TO FNMOC EXCEPT FOR AT LEAST 1 OCCURRENCE IN EACH ORBIT OF INCORRECTLY ENCODED DATA



WENTZ

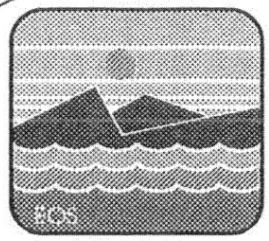


B-SCAN START TIMES IDENTICAL TO FNMOC

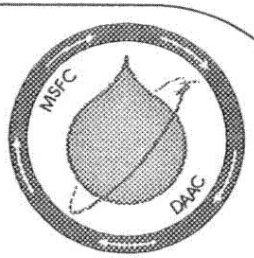
ANTENNA TEMPS WITHIN EXPECTATIONS

- **Differences due to rounding & desmoothing**
- ❖ **85V out of bounds (OOB) much larger than FNMOC**
  - ⇨ **Flagged by his Decode routine**

LAT/LON WITHIN EXPECTATIONS



National Geophysical Data Center



B-SCAN START TIMES (BST) AVERAGE .4+ SEC LATER THAN FNMOC

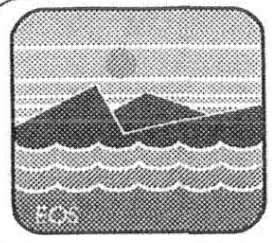
BST DELTAS VARY ORBIT TO ORBIT

- A few scan pairs with non nominal deltas
- 10 sec gaps between orbits (12087,12104,12114, 12124, 12130, 2131, 2144)

ANTENNA TEMPS AVERAGE .1-.5 K WARMER AND MUCH NOISIER

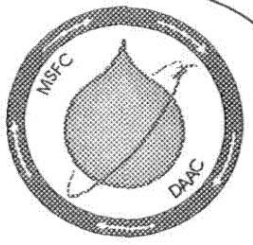
- 90+% of orbits had Out Of Bounds

85V OUT OF BOUNDS SIGNIFICANTLY LARGER THAN FNMOC'S



National Environmental Satellite, Data and Information Service

Level 1b



B-SCAN START TIMES DELTAS VARY SIGNIFICANTLY

- **Some neg deltas between successive scans**

ANTENNA TEMPS ARE NOISIER

NOISY GEOLOCATION

- **Distances differences increase rapidly at poles**
- **Many orbits had sections with large distance differences**