This report contains a detailed description of the IERS products related to the Terrestrial Reference System for the period of the IERS Annual Report for 1992. It gives a detailed analysis about the ITRF92 and its associated combined velocity field.

This description intends to be the continuation of the previous reports: the IERS Technical Note 4 , 6, 9 and 12. In particular, methodological presentation will be followed here.

1) INPUT DATA

1.1) Sites included

The list of sites considered in the 1992 solution is included in Table T1 of the appendix.

A more detailed list of points and marks for these sites is also provided by the Table T2 of the appendix.

Table T3 also gives a summary of the occupancies of these sites by VLBI, LLR, GPS or SLR instruments. We have distinguished the IERS sites into the following data sets:

1) colocation (at least two techniques)

2) multiple SLR (simultaneous or successive)

3) single SLR

4) multiple VLBI (simultaneous or successive)

5) single VLBI

6) multiple GPS (simultaneous or successive)

7) single GPS

1.2) Input data sets

The data sets received for the 1992 solution and included in the global combination performed by the IERS Terrestrial Frame Section (ITFS), under the label ITRF92 are summarized in Table 1.

1.3) Description of individual data sets

For all solutions, no permanent tidal correction has been performed, and the adopted velocity of light is $c = 299792458\ m\ s^{-1}$.

As the formal errors σ_f provided by the analysis centers are in most cases too optimistic, the

input errors σ are adopted according to the following formula:

$$\sigma = \sqrt{A^2 + B^2 \cdot \sigma_f^2} \qquad (1)$$

where A is an additive variance and B is a factor. The values of A and B are determined by an empirical estimation. Figures 1 to 20 show for all the solutions, the histograms of the formal errors and those after applying the previous formula.

1.3.1) GIUB VLBI solution

Identifer : SSC(GIUB) 93 R 01

Model : CALC-7 software, with local earth relativistic scale (Hellings model).

Adjusted parameters : X,Y,Z at epoch 1988.0

Constraints for the CTS :

- Westford X,Y,Z fixed at ITRF91 values,
- the orientation is fixed on one IRIS-S measurement day (1989 Dec 21) to the IERS Rapid Service value.

- fixed NNR-NUVEL1 motion

Raw data :

Positions at 1988.0.

Input data (RF) :

The 1988 values, with formal errors unmodified.

1.3.2) GSFC VLBI solution

Identifer : SSC(GSFC) 93 R 04, also named GLB886a

Model : CALC-7 software, with local earth relativistic scale (Hellings model).

Adjusted parameters :

X,Y,Z and VX, VY, VZ of stations with sufficient data

Constraints for the CTS :

- Westford X,Y,Z fixed at a nominal value on Oct 17 1980,
- ERP fixed on Nov 6 1986 at BIH Circular D values,
- Westford velocities fixed at NNR-NUVEL1 values,
- Westford-Richmond azimut moving with NNR-NUVEL1 value.

Raw data :

Positions at 1988.0 and velocities (except for stations with short time span),

Input data (RG) :

The 1988 values, with formal errors modified using the formula (1) with A = 0.5 cm and B = 1.5.

1.3.3) JPL VLBI solution

Identifer : SSC(JPL) 93 R 01, also named 1993-1.

Model : Modest software.

Adjusted parameters : X, Y, Z at 1988.0 and velocities

Constraints for the CTS :

- six constraints (with 5 mm uncertainty) : 3 translations and 3 rotations between 1993-1 and ITRF91.

Raw data : X, Y, Z and velocities with formal errors.

Input data (RJ)

X, Y, Z, with formal errors modified with A = 0.5 cm and B = 2.0

1.3.4) NOAA VLBI solution

Identifer : SSC(NOAA) 93 R 02

Model : CALC software, with Hellings relativistic model

Adjusted parameters :

Positions at 1988.0 and velocities (except for stations with short time span),

Constraints for the CTS :

- the orientation is that of the ITRF91 through a constraint on the coordinates of 16 selected VLBI sites,

- the time evolution matches NNR-NUVEL1 through a constraint on the velocities of 9 selected VLBI sites

Raw data :

1988 positions and velocity for sites with sufficient data, with formal errors

Input data (RN) :

The 1988 values, with formal errors modified using the formula (1) with A = 0.0 cm and B = 1.5.

1.3.5) USNO VLBI solution

Identifer : SSC(USNO) 93 R 09, also named 1993-9

Model : CALC-7 software with LE relativistic scale. Motion with NNR-NUVEL1 model

Adjusted parameters: X, Y, Z at Oct 17 1980

Constraints for the CTS :

- NRAO85 3 position fixed at its value in ITRF90 at 1988.0
- fixed NNR-NUVEL1 motion

Raw data : X, Y, Z and formal errors

Input data (RO) :

X, Y, Z transformed at 1988.0 with NNR-NUVEL1 . Formal errors modified with A = 0.5 cm and B = 1.5.

1.3.6) JPL LLR solution

Identifer : SSC(JPL) 93 M 01

Model : Motion with NNR-NUVEL1 model

Adjusted parameters : X, Y, Z at 1991.0

Constraints for the CTS :

- DE210/LE210 planetary ephemeris
- fixed NNR-NUVEL1 motion model

Raw data : X, Y, Z without error estimate

Input data (MJ) :

X, Y, Z with 3 cm as error.

1.3.7) SHA LLR solution

Identifer : SSC(SHA) 93 M 01

Model : Motion with NNR-NUVEL1 model

Adjusted parameters : X, Y, Z at 1988.0

Constraints for the CTS :

- DE303/LE303 planetary ephemeris

Raw data : X, Y, Z without error estimate

Input data (MS) :

X, Y, Z with 3.5 cm as error.

1.3.8) UT/McD LLR solution

Identifer : SSC(UTXMO)93 M 01

Model : Motion with AM0-2 model, GM = 398600.444 km^3/s^2

Adjusted parameters : lambda, phi, h at 1984.0

Constraints for the CTS :

- fixed AM0-2
- ERP fixed at 1985 Jan. 11 to CSR LGN7692 series

Raw data : X, Y, Z

Input data (MX) :

X, Y, Z transformed at 1988.0 with AM0-2 with 3 cm as apriori error.

1.3.9) CODE GPS solution

Identifer : SSC(CODE) 92 P 01

Model : Bernese software

Adjusted parameters : X, Y, Z at 1992.62 for european stations

Constraints for the CTS :

Orientation and time evolution constrained to those of ITRF91.

Raw data : X, Y, Z without formal error.

Input data (PB) :

X, Y, Z transformed to 1988.0 with ITRF91 velocity field with 8 mm as error.

1.3.10) CSR GPS solution

Identifer : SSC(CSR) 92 P 03

Model : UTOPIA software,

Adjusted parameters : X, Y, Z at 1992.79

Constraints for the CTS :

The a priori EOP and the tie to the geocenter are taken from EOP/SSC(CSR) 92 L 01.

Raw data : X, Y, Z with formal error.

Input data (PC) :

X, Y, Z transformed to 1988.0 with ITRF91 velocity field with formal errors modified with A = 0.0 cm and B = 8.0.

1.3.11) EMR GPS solution

Identifer : SSC(EMR) 93 P 01

Model : GIPSY/OISIS II software, GM = 398600.4414 km^3/s^2

Adjusted parameters : X, Y, Z at 1992.79

Constraints for the CTS :

Origin and orientation constrained to those of ITRF91.

Raw data : X, Y, Z with formal error.

Input data (PE) :

X, Y, Z transformed to 1988.0 with ITRF91 velocity field with formal errors modified with A = 0.0 cm and B = 4.0.

1.3.12) ESOC GPS solution

Identifer : SSC(ESOC) 93 P 01

Model : GPSOBS/BAHN-V5 software, GM = 398600.4415 km^3/s^2

Adjusted parameters : X, Y, Z at 1992.5

Constraints for the CTS :

- EOP from IERS Bulletin A,
- 12 stations are constrained in longitude and latitude with a priori uncertainty of 5 cm to ITRF91 values.
- time evolution according to NNR-NUVEL1

Raw data : X, Y, Z with formal errors.

Input data (PA) :

X, Y, Z transformed to 1988.0 with ITRF91 velocity field with formal errors unmodified.

1.3.13) JPL GPS solution

Identifer : SSC(JPL) 93 P 01

Model : GIPSY software, free network

Adjusted parameters : X, Y, Z at 1992.5

Constraints for the CTS :

Orientation and time evolution constrained to those of ITRF91.

Raw data : X, Y, Z with error estimate

Input data (PJ) :

X, Y, Z transformed to 1988.0 with ITRF91 velocity field. Formal errors modified with a=0.0cm and B = 0.8.

1.3.14) SIO GPS solution

Identifer : SSC(SIO) 93 P 01

Model : GAMIT software.

Adjusted parameters : X, Y, Z at 1992.836

Constraints for the CTS :

- tied to ITRF91 through the average of coordinates of 18 fundamental sites,
- time evolution constrained to that of ITRF91.

Raw data : X, Y, Z without formal errors

Input data (PP) :

X, Y, Z transformed to 1988.0 with ITRF91 velocity field with 1.5 cm as a priori error.

1.3.15) CLG SLR solution

Identifer : SSC(CLG) 93 L 01

Model : Sites velocities fixed to AM0-2. GM = 398600.436 km^3/s^2

Adjusted parameters: X, Y, Z at 1988.0.

Constraints for the CTS :

- latitude of 7210 and 7907 and longitude of 7907 fixed to ITRF89 values,

Raw data : X, Y, Z

Input data (LL) :

X, Y, Z at 1988.0 with formal errors modified with A = 3 cm and B = 3.0.

1.3.16) CSR SLR solution

Identifer : SSC(CSR) 93 L 01

Model : Horizontal velocities adjusted for 47 sites. For all other sites velocities fixed to NNR-NUVEL1. GM = 398600.4415 km^3/s^2.

Adjusted parameters: X, Y, Z at 1988.0 and horizontal velocities for 42 sites

Constraints for the CTS :

- system oriented to agree with EOP(JPL) 93 C 01 in a mean sense over period 1981 - 1992,
- latitude and longitude of 7210 and latitude of 7105 fixed,
- rate of latitude and longitude of 7210 and latitude of 7105 fixed to NUVEL-1 NNR velocities.

Raw data : X, Y, Z, and 2D velocities for 47 sites and formal errors

Input data (LC) :

X, Y, Z at 1988.0 with formal errors modified with A = 1.0 cm and B = 1.0.

1.3.17) DUT SLR solution

Identifer : SSC(DUT) 93 L 02

Model : GEODYN-II/SOLVE-2 software, estimation of station motions, GM = 398600.4415 km^3/s^2

Adjusted parameters : X, Y, Z, and velocities

Constraints for the CTS :

- the orientation is defined by initial coordinates at reference epoch
- NNR-NUVEL1 values for 12 stations

Raw data : X, Y, Z at 1988.0 and VX, VY, VZ

Input data (LU) :

X, Y, Z at 1988.0 with formal errors modified with A = 1.0 cm and B = 1.0

1.3.18) GAOUA SLR solution

Identifer : SSC(GAOUA)93 L 01

Model : KIEV-GEODYNAMICS - 4 software. Adjusted velocities. GM = 398600.4418 $km3/s^2$

Adjusted parameters : X, Y, Z for 73 stations and velocities for 43 stations.

Constraints for the CTS :

- ERP values from IERS Bulletin B
- latitude and longitude of 7105 and latitude of 7210 fixed
- fixed NNR-NUVEL1 motion for selected stations, longitude rate of 7105 and latitude rate of 7210 fixed to NNR-NUVEL1.

Raw data : X, Y, Z and velocities with formal errors

Input data (LK) :

X, Y, Z and formal errors modified with A = 2.5 cm and B = 2.0

1.3.19) GFZ SLR solution

Identifer : SSC(GFZ) 93 L 01

Model : EPOS.P.V1 software. Adjusted velocities. GM = 398600.442 km^3/s^2

Adjusted parameters : r, lambda, phi at 1988.0 and 3-D velocities

Constraints for the CTS :

- latitude and velocity in latitude fixed for stations 7105,7840
- longitude and velocity in longitude fixed for station 7840

Raw data : X, Y, Z and velocity with formal errors

Input data (LZ) :

X, Y, Z with formal errors modified with A = 1.5 cm and B = 1.5.

1.3.20) GSFC SLR solution

Identifer : SSC(GSFC) 93 L 01 (SL8.2)

Model : GEODYN II software, GM = 398600.4415 km^3/s^2

Adjusted parameters : X, Y, Z and velocities

Constraints for the CTS :

- latitude and longitude of 7105, the latitude of 7210 were fixed

- apriori values of ERP from IERS 90 C 04

Raw data : X, Y, Z and velocities with formal errors

Input data (LG) :

X, Y, Z with formal errors modified with A = 1.0 cm and B = 3.0.

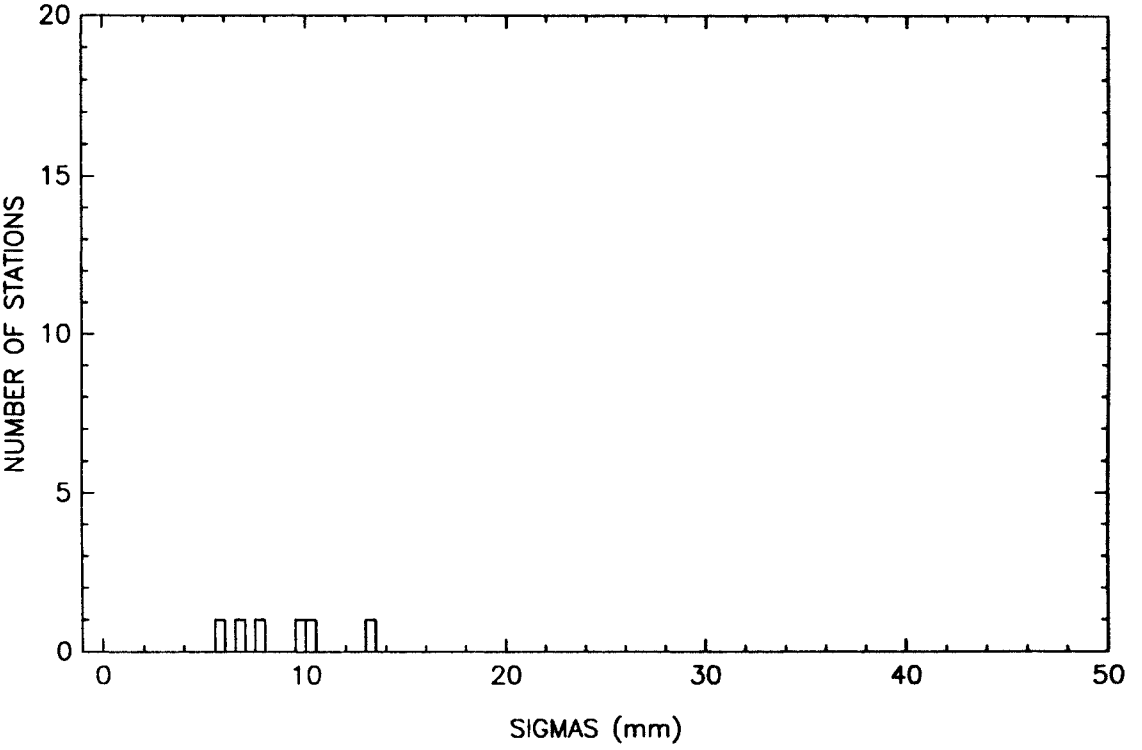
Table 1 : ITRF92 input data

Tech.	Label	Designation	Motion Model	Ref. Epoch	Num. of Station	Other name
	RF92	SSC(GIUB) 93 R 01	NNR-NUVEL1	1988.0	6	
	RG92	SSC(GSFC) 93 R 04	Etim./NNR-NUVEL1	1988.0	115	GLB886a
VLBI	RJ92	SSC(JPL) 93 R 01	Etim./ITRF91	1988.0	12	1993-1
	RN92	SSC(NOAA) 93 R 02	Estim./NNR-NUVEL1	1988.0	54	
	RO92	SSC(USNO) 93 R09	NNR-NUVEL1	1980.8	15	1993-9
	MJ92	SSC(JPL) 93 M 01	NNR-NUVEL1	1991.0	5	
LLR	MS92	SSC(SHA) 93 M 01	NNR-NUVEL1	1988.0	4	
	MX92	SSC(UTXMO)93 M01	AM0-2	1984.0	5	
	PB92	SSC(CODE) 92 P 01		1992.62	13	
	PC92	SSC(CSR) 92 P 03		1992.79	24	
GPS	PE92	SSC(EMR) 93 P 01		1992.5	20	
	PA92	SSC(ESOC) 93 P 01	NNR-NUVEL1	1992.5	33	
	PJ92	SSC(JPL) 93 P 01	ITRF91	1992.5	42	
	PP92	SSC(SIO) 93 P 01	ITRF91	1992.836	48	
	LL92	SSC(CLG) 93 L 01	AM0-2	1988.0	45	
	LC92	SSC(CSR) 93 L 01	Estim/NNR-NUVEL1	1988.0	111	
SLR	LU92	SSC(DUT) 93 L 01	Estim./NNR-NUVEL1	1988.0	68	
	LK92	SSC(GAOUA)93 L 01	Estim./NNR-NUVEL1	1988.0	73	
	LZ92	SSC(GFZ) 93 L 01	Estim/NNR-NUVEL1	1988.0	101	
	LG92	SSC(GSFC) 93 L 01	Estim./NNR-NUVEL1	1988.0	35	SL8.2

1.4) Excentricites

The excentricities used for ITRF92 are given in Table T4 of the appendix.

FIGURE 1 : SSC(GIUB) 93 R 01



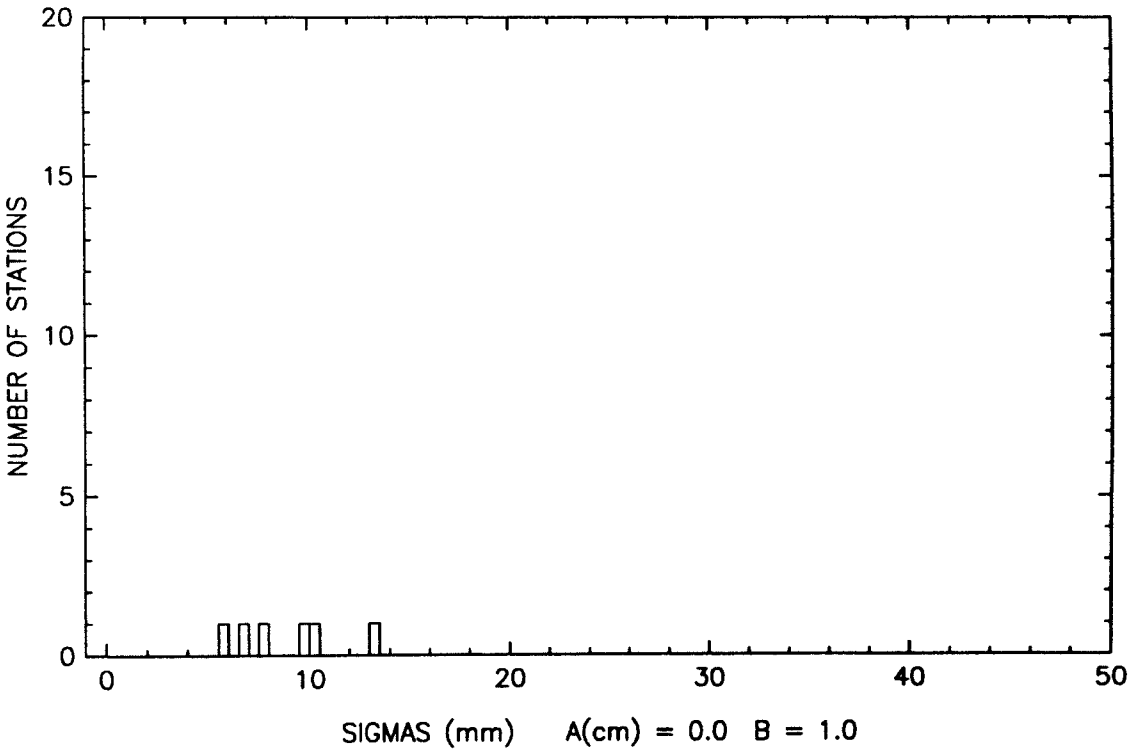
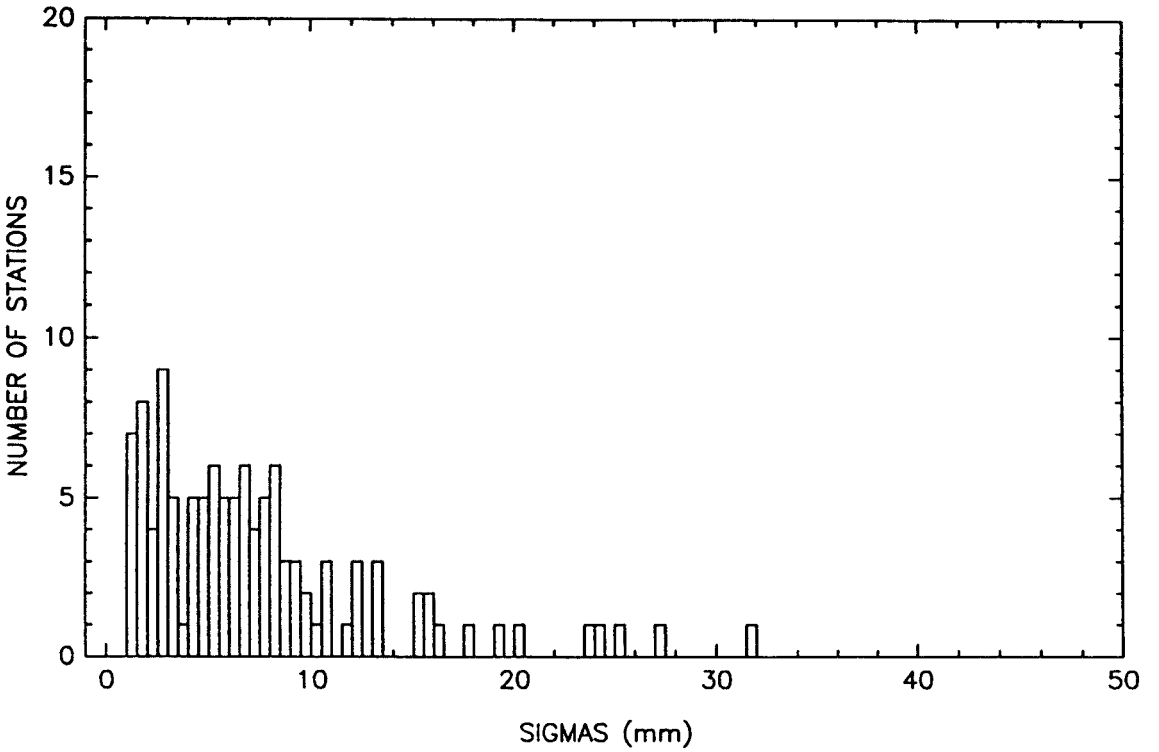


FIGURE 2 : SSC(GSFC) 93 R 04 / GLB886a



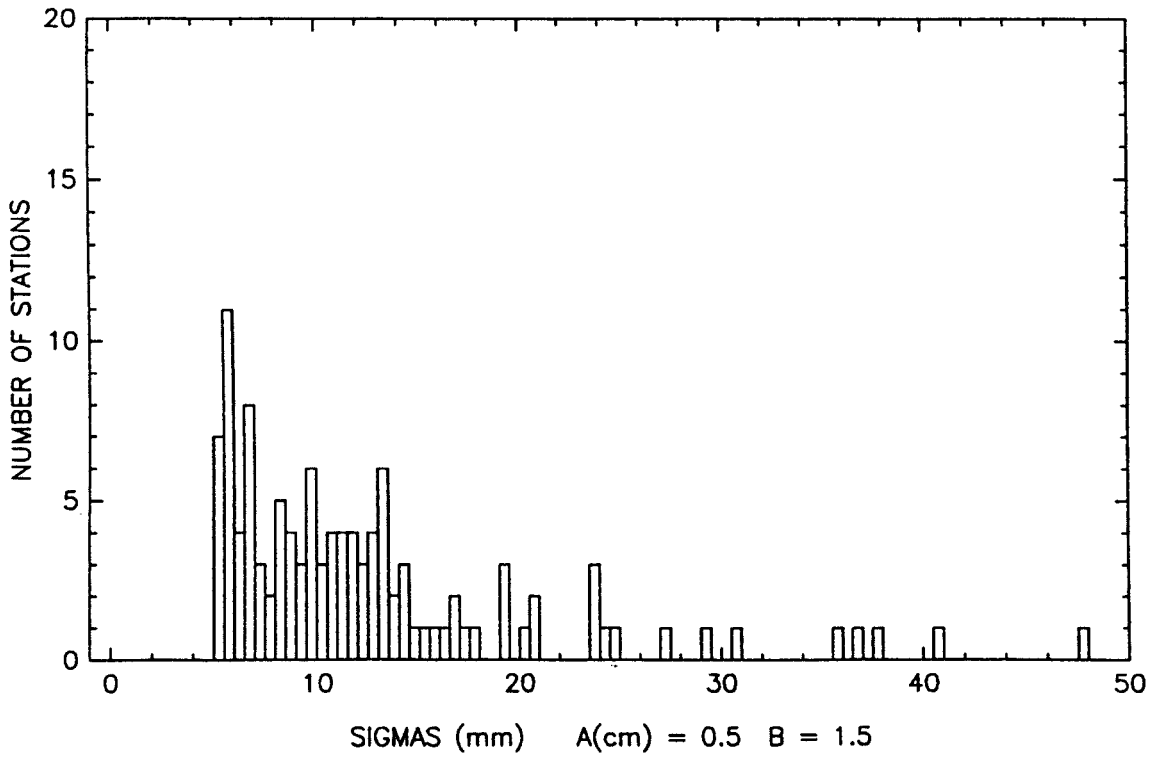
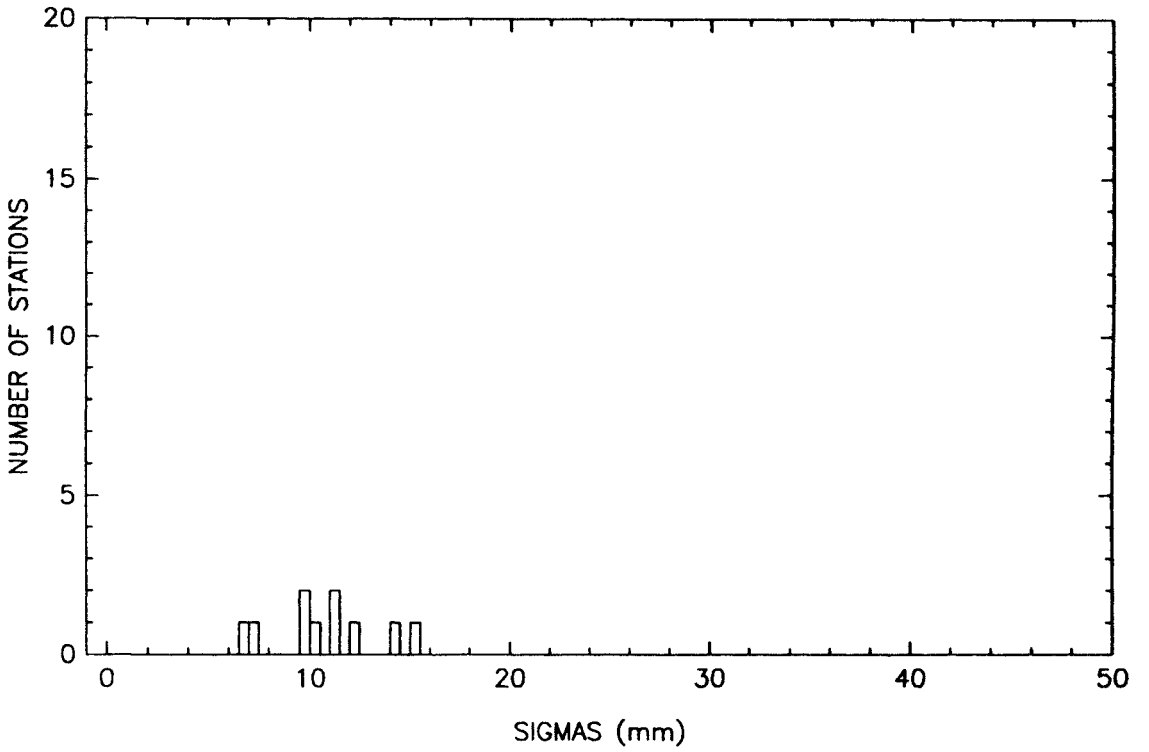


FIGURE 3 : SSC(JPL) 93 R 01



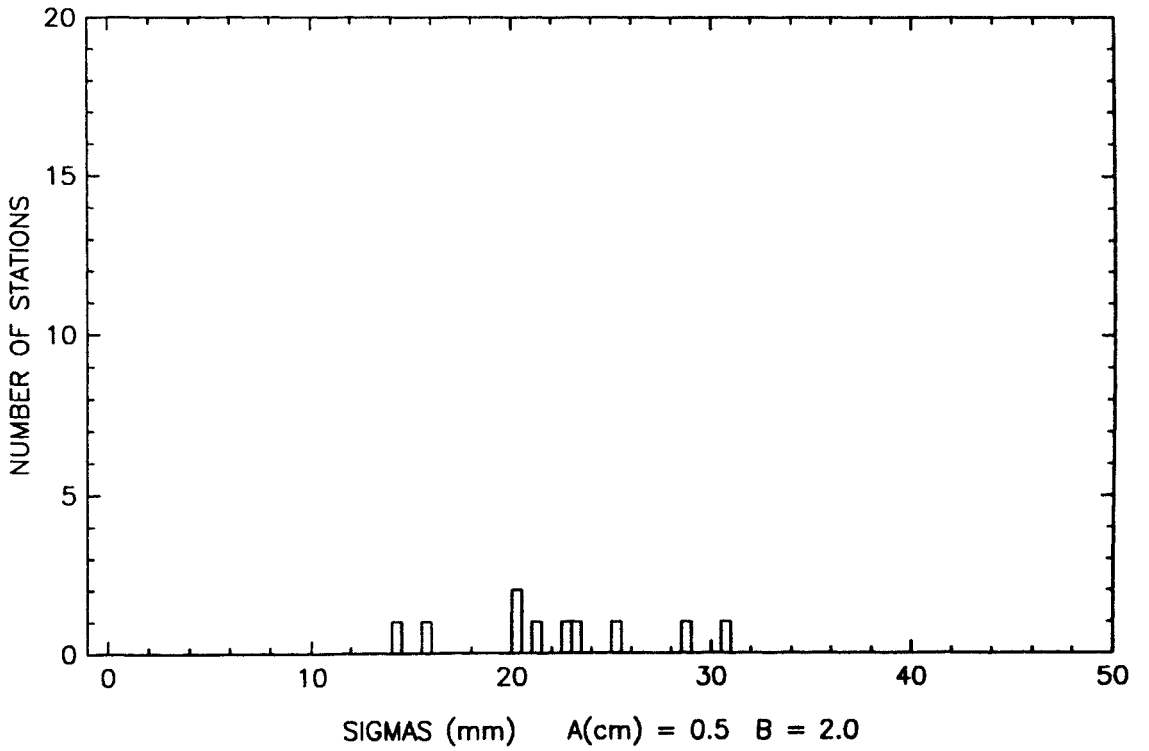
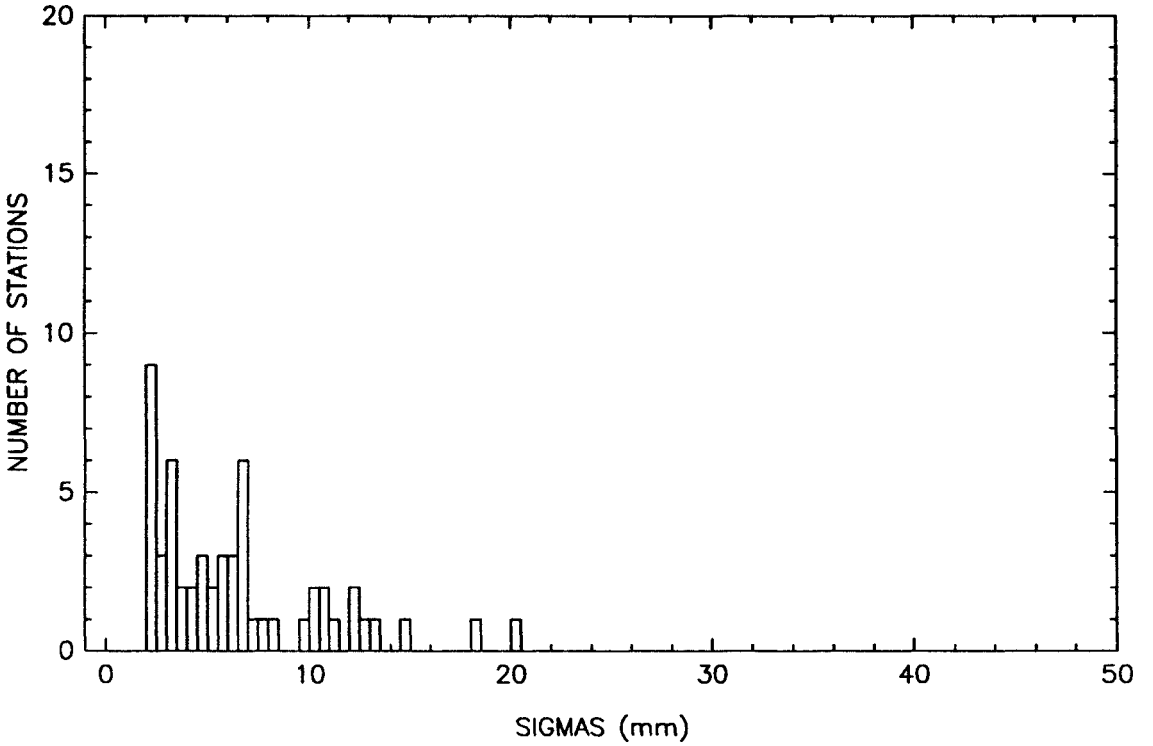


FIGURE 4 : SSC(NOAA) 93 R 02



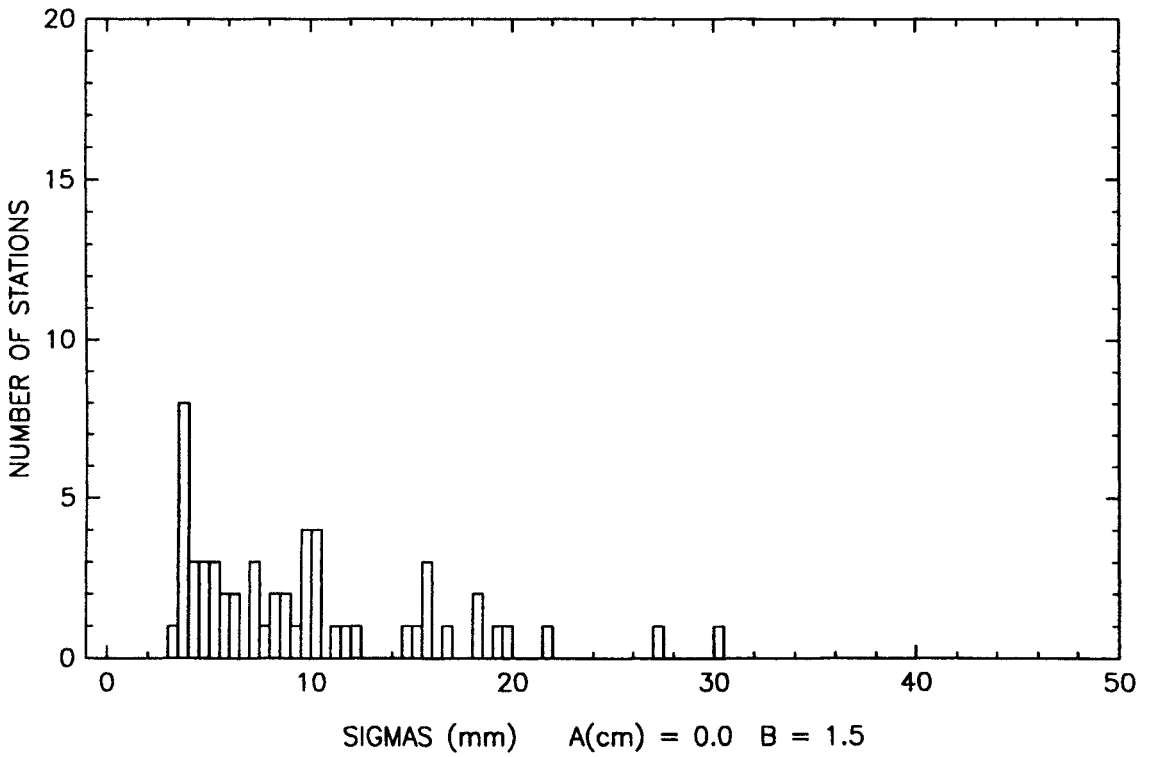
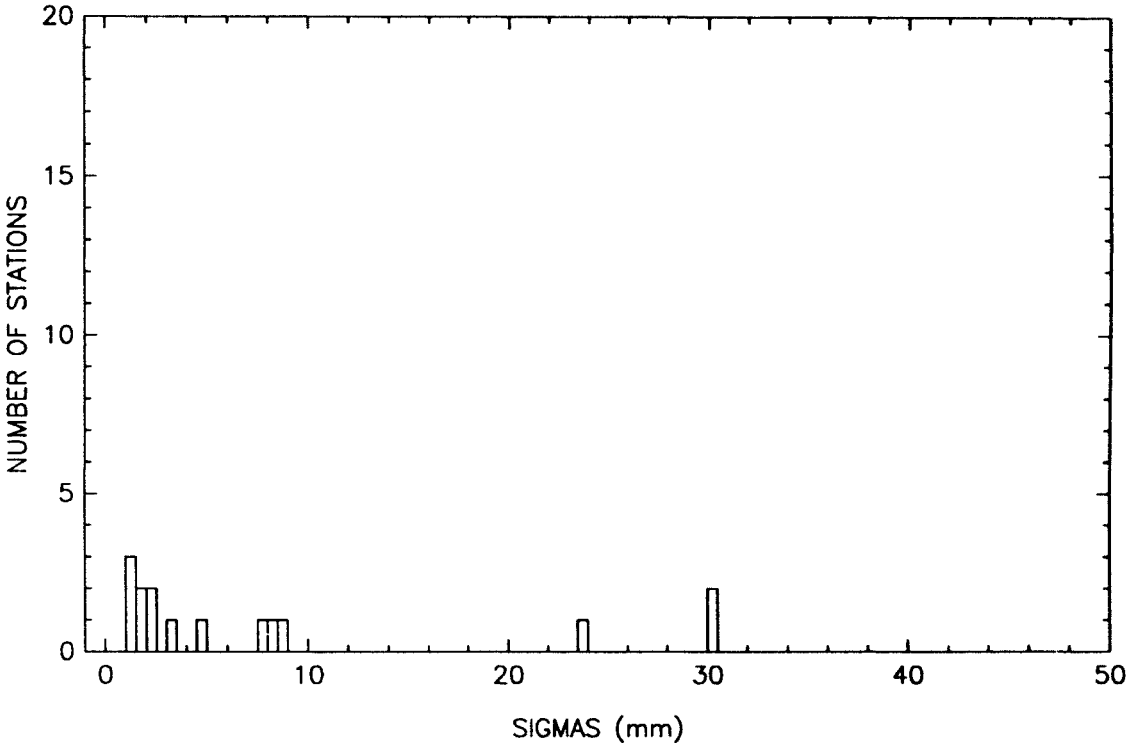


FIGURE 5 : SSC(USNO) 93 R 09 / 1993-9



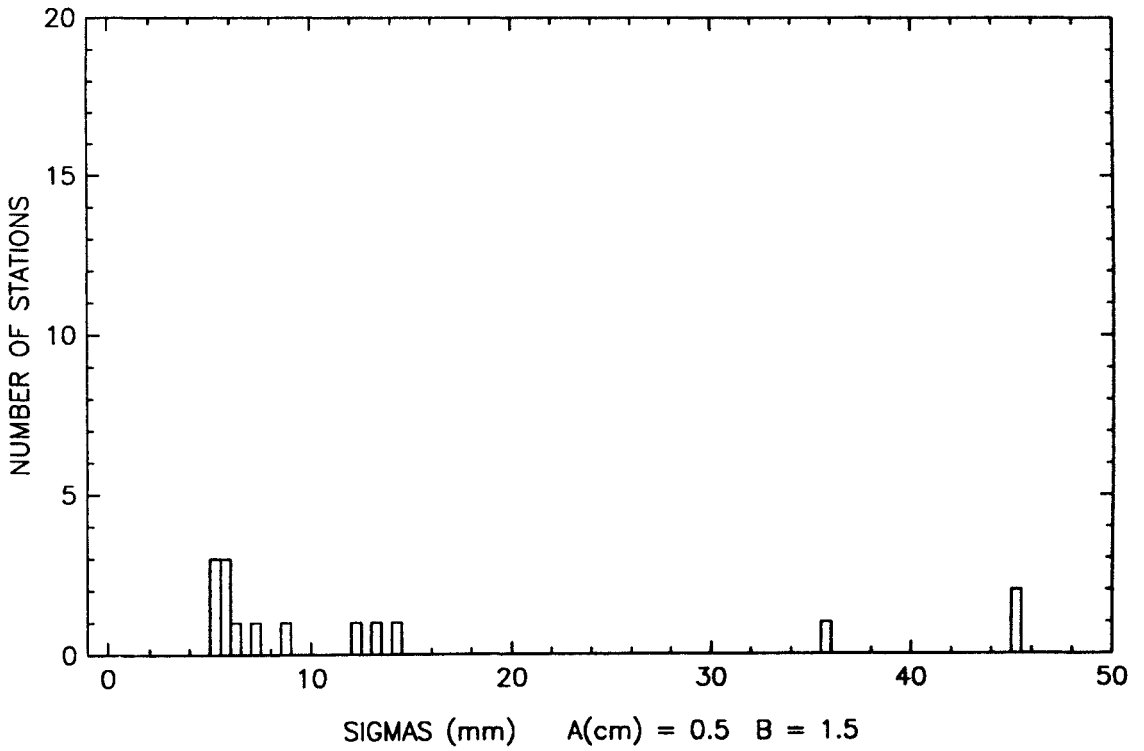
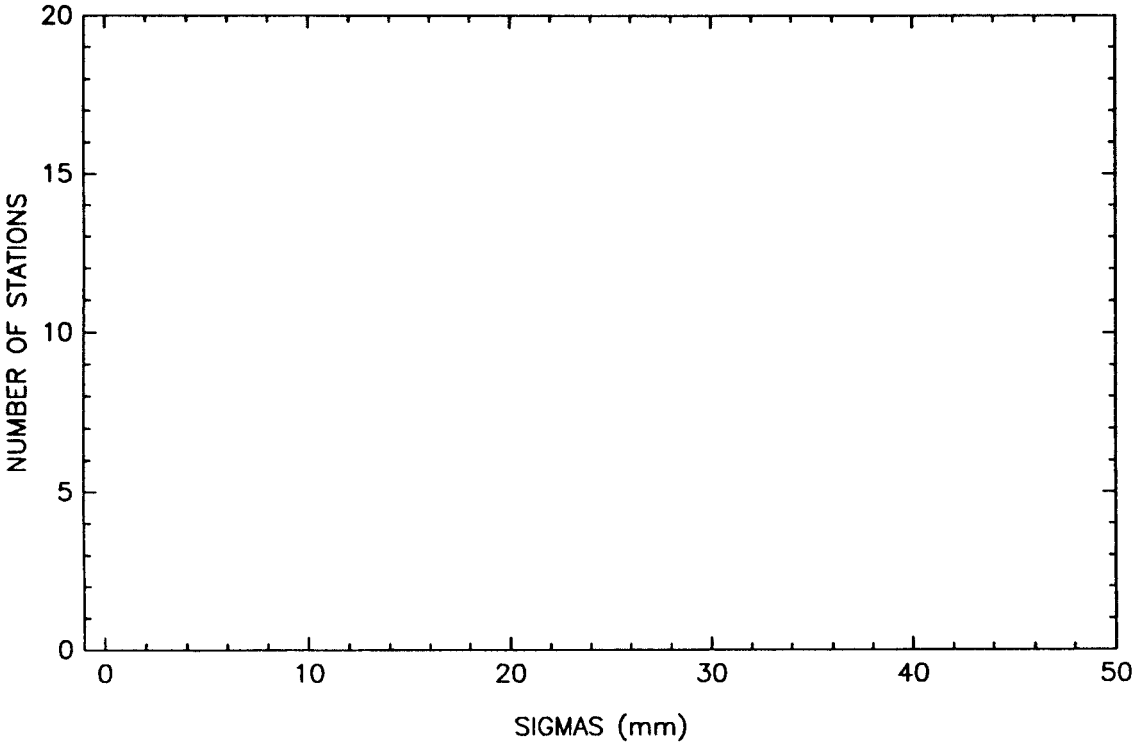


FIGURE 6 : SSC(JPL) 93 M 01



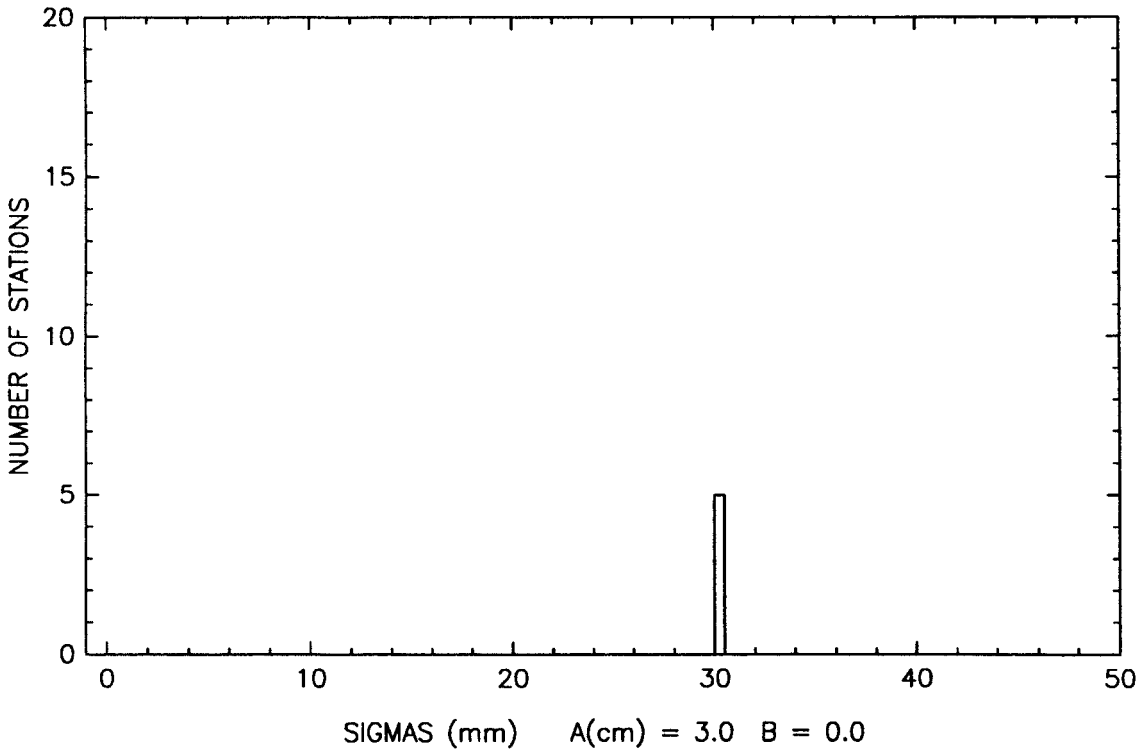
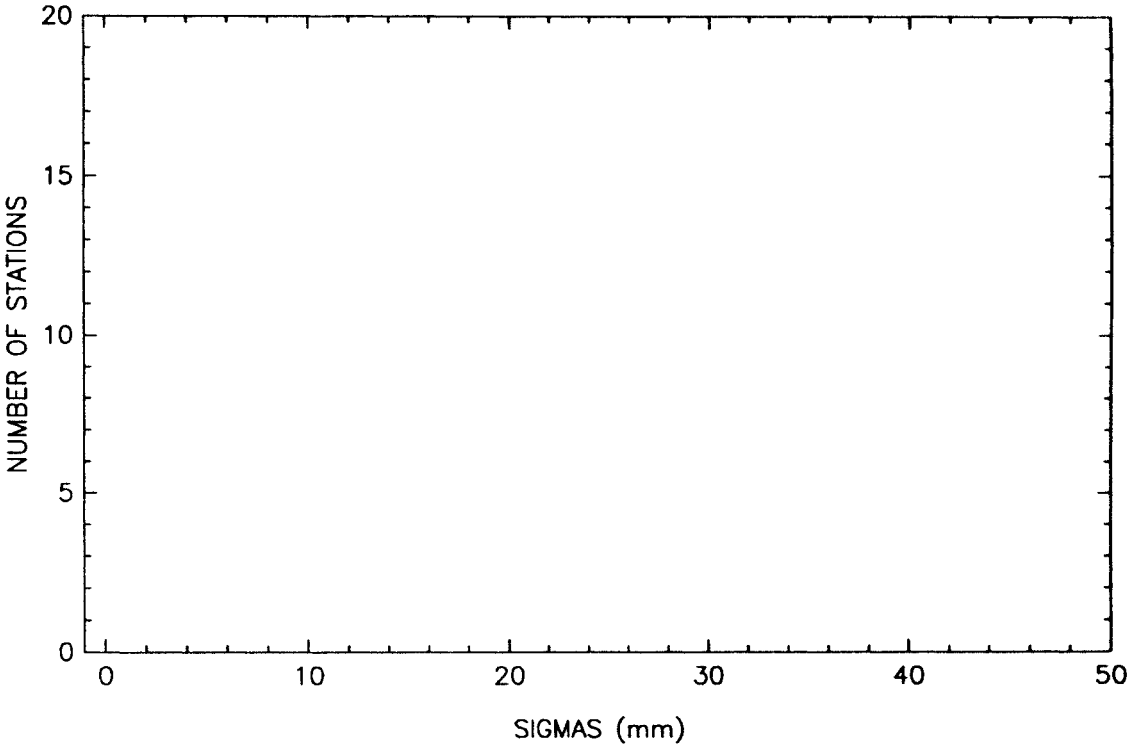


FIGURE 7 : SSC(SHA) 93 M 01



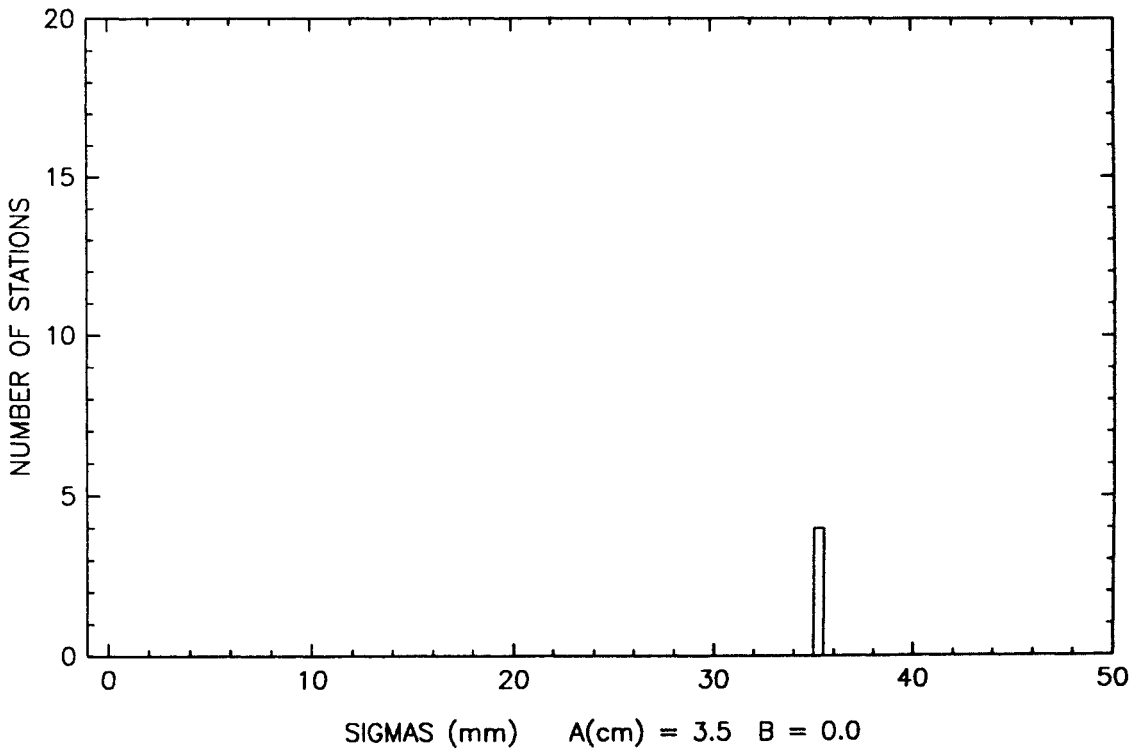
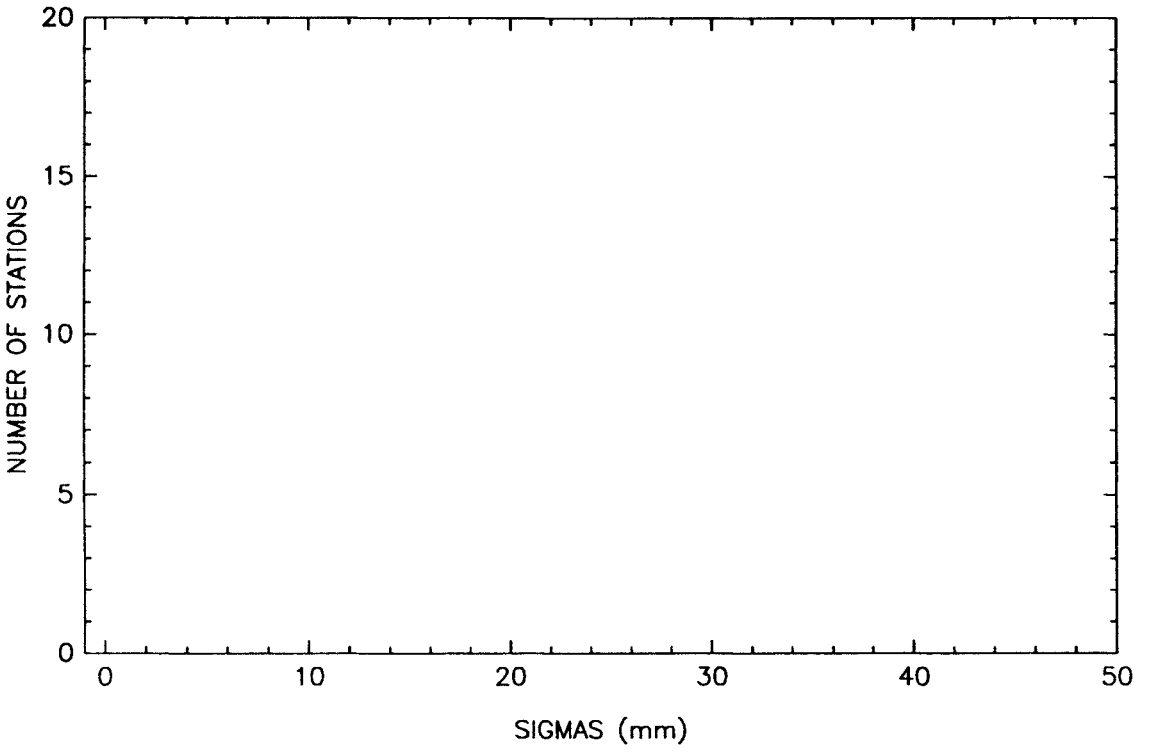


FIGURE 8 : SSC(UTXMO)93 M 01



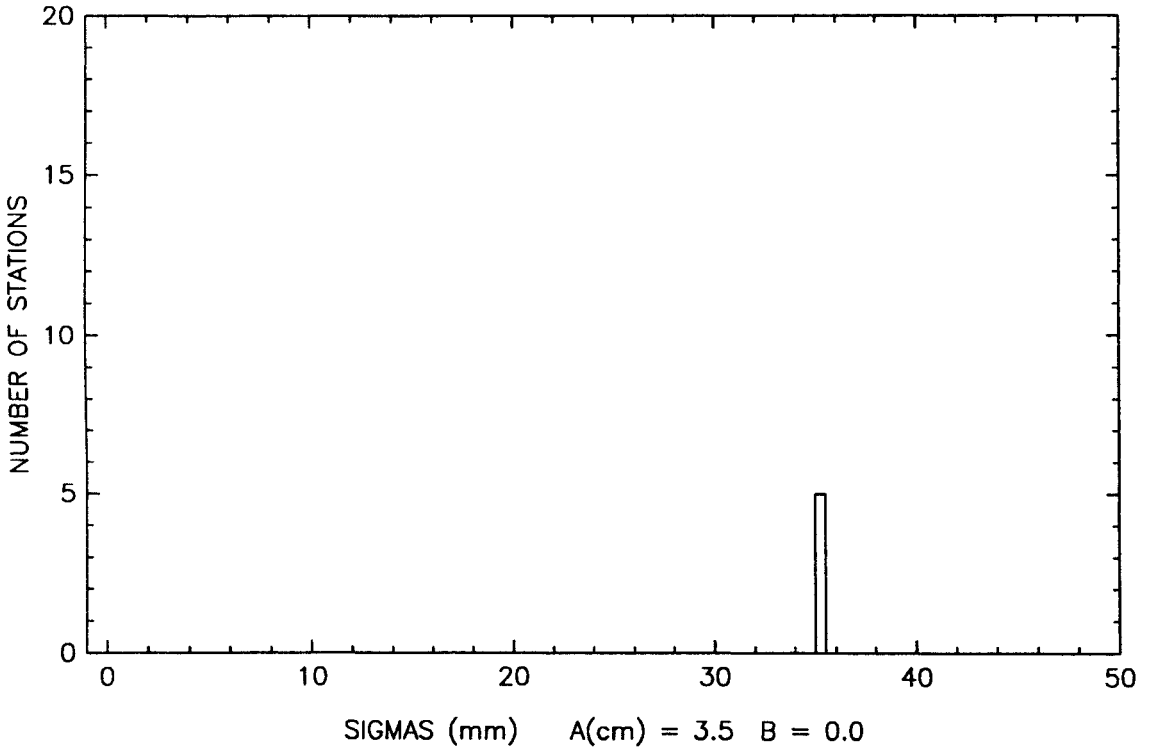
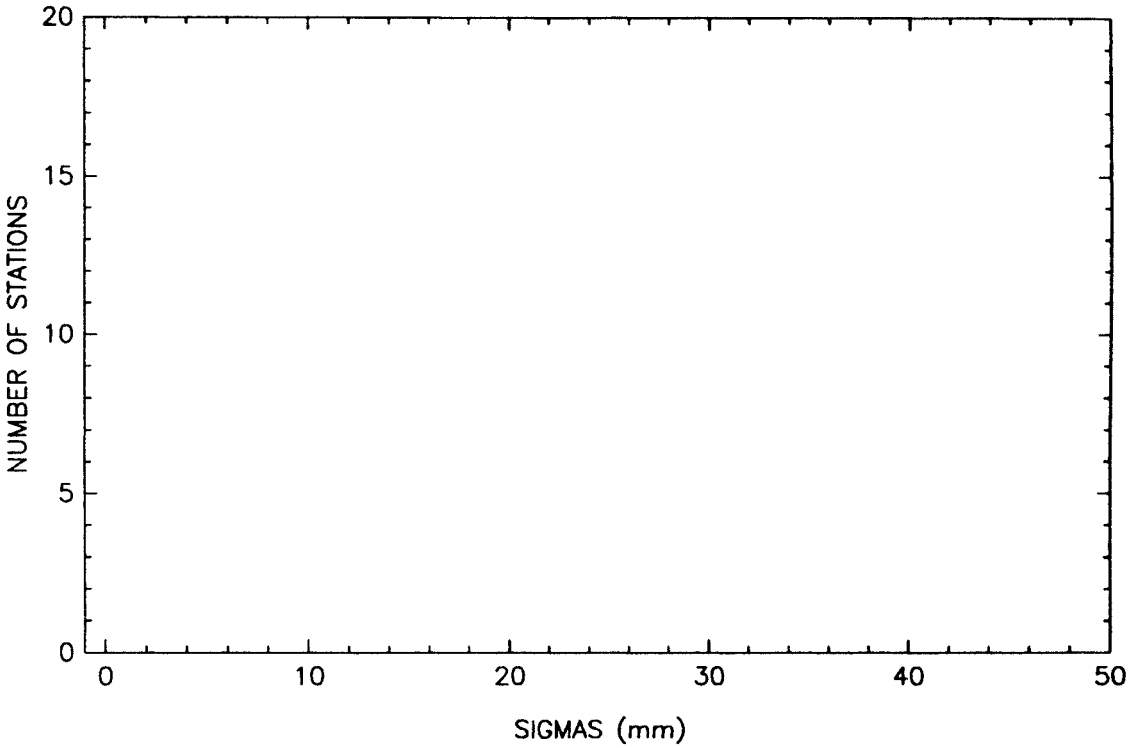


FIGURE 9 : SSC(CODE) 92 P 01



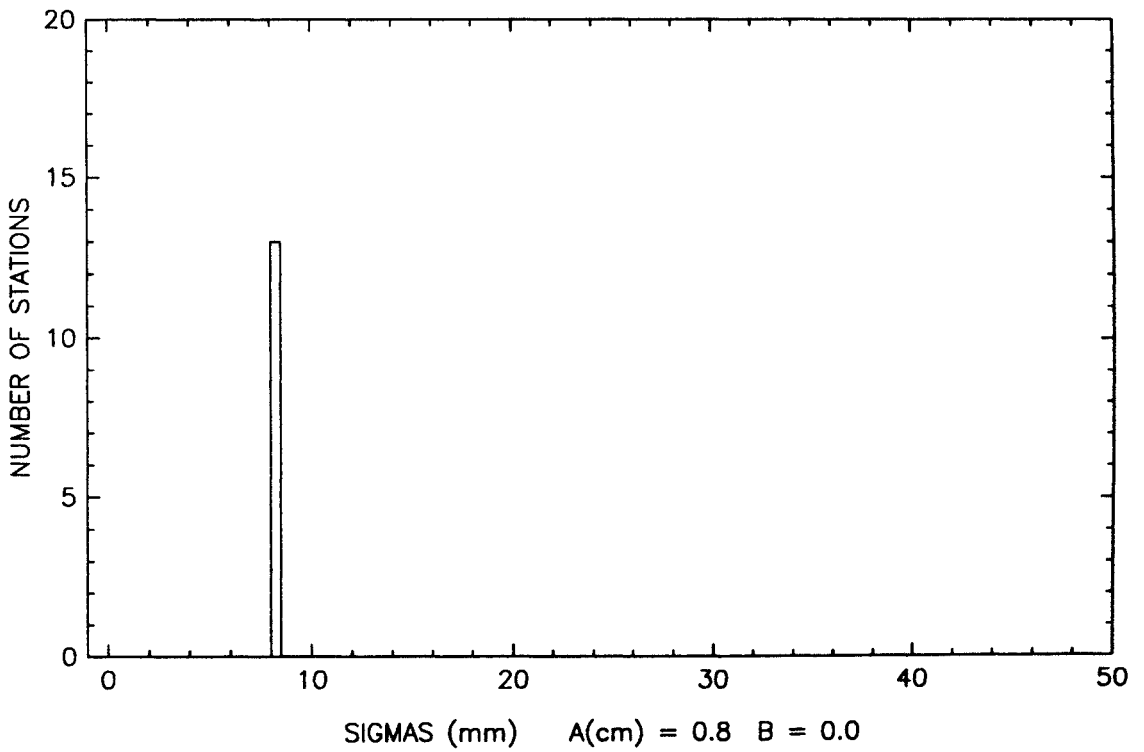
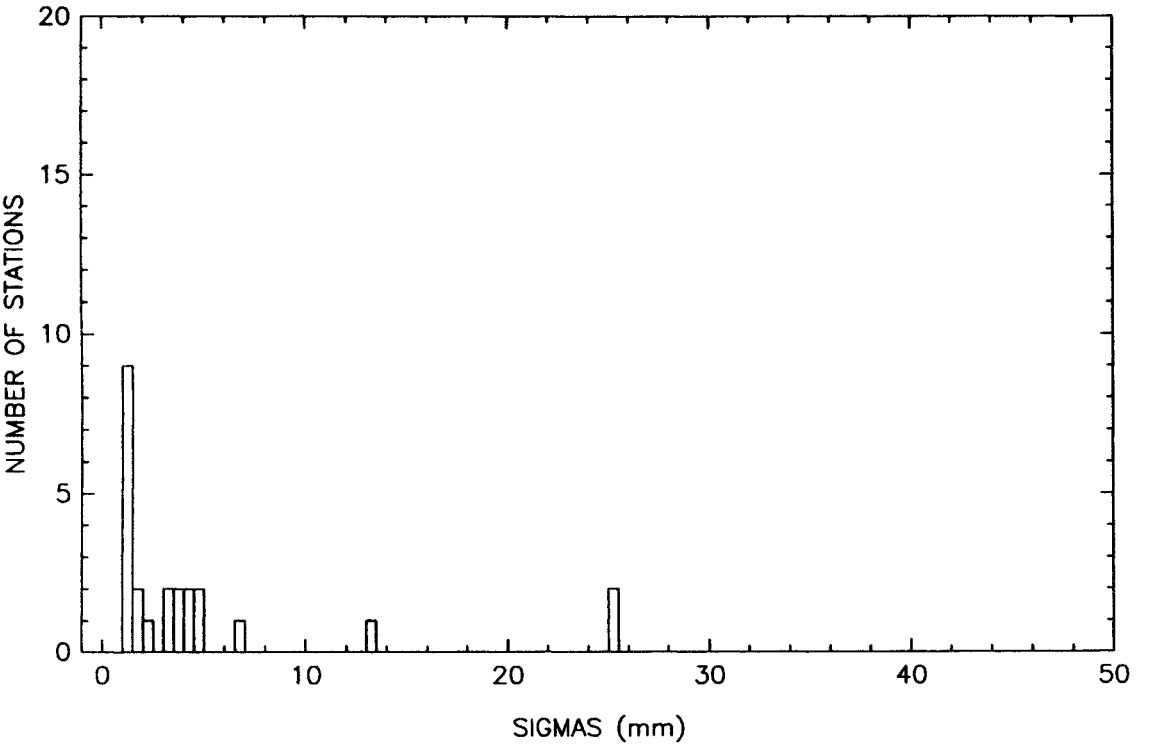


FIGURE 10 : SSC(CSR) 92 P 03



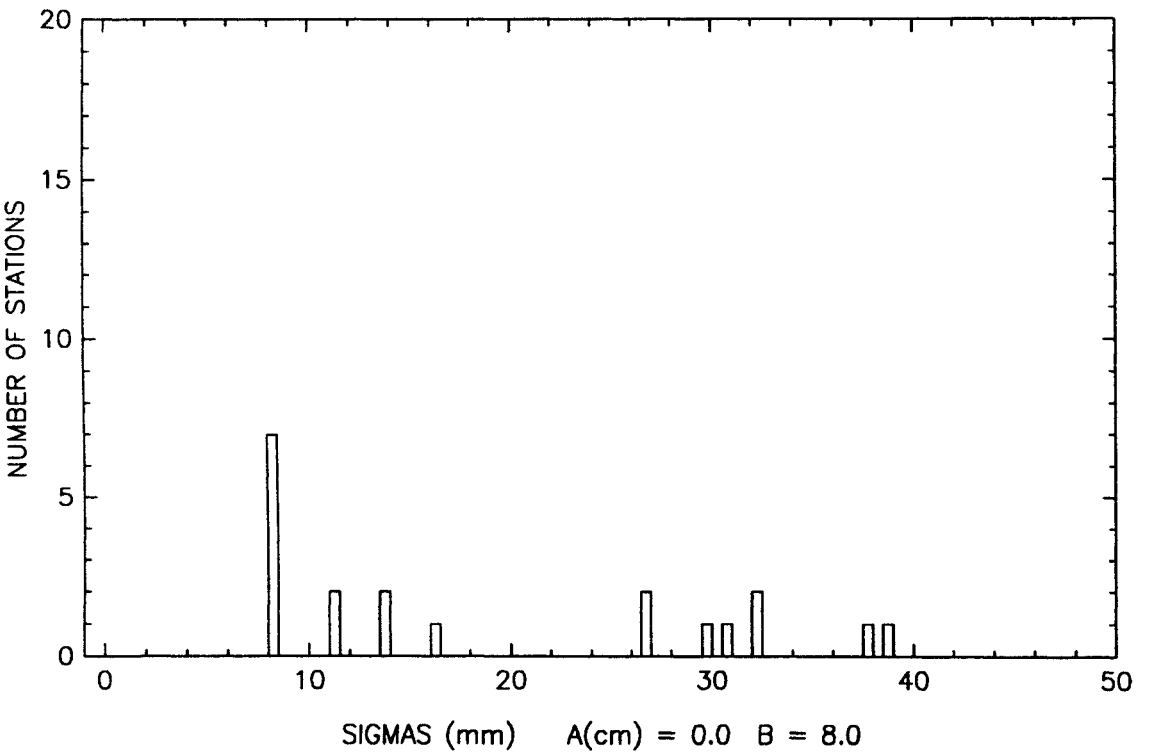
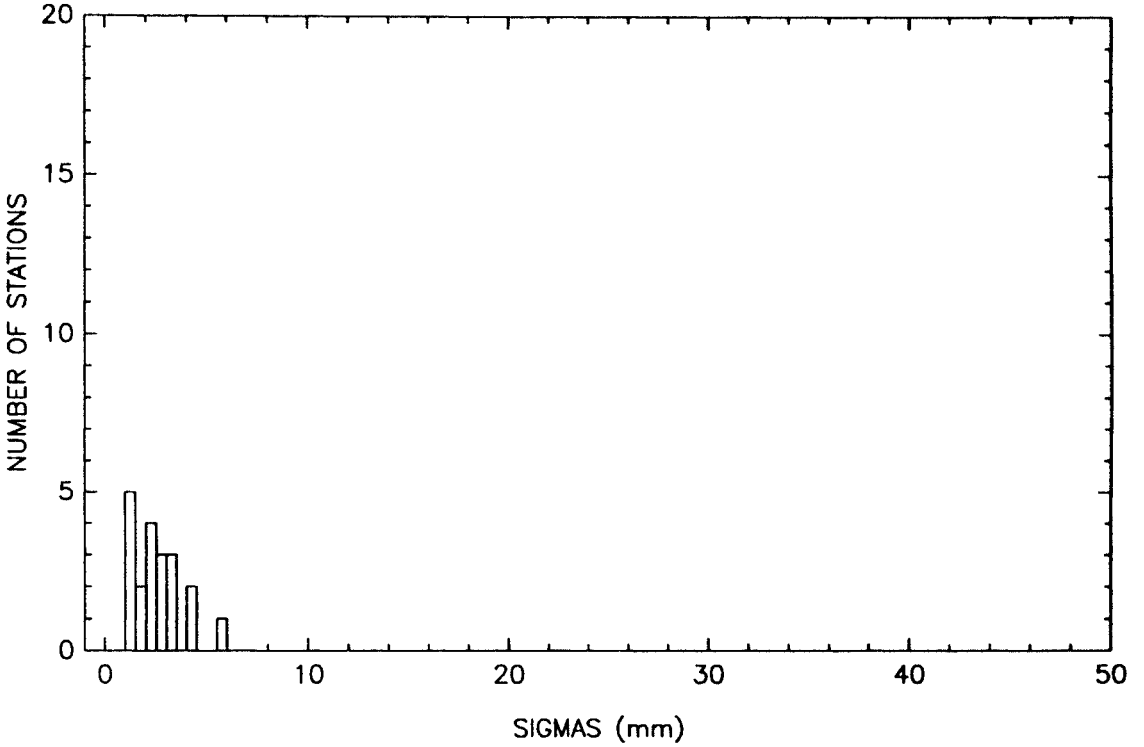


FIGURE 11 : SSC(EMR) 93 P 01



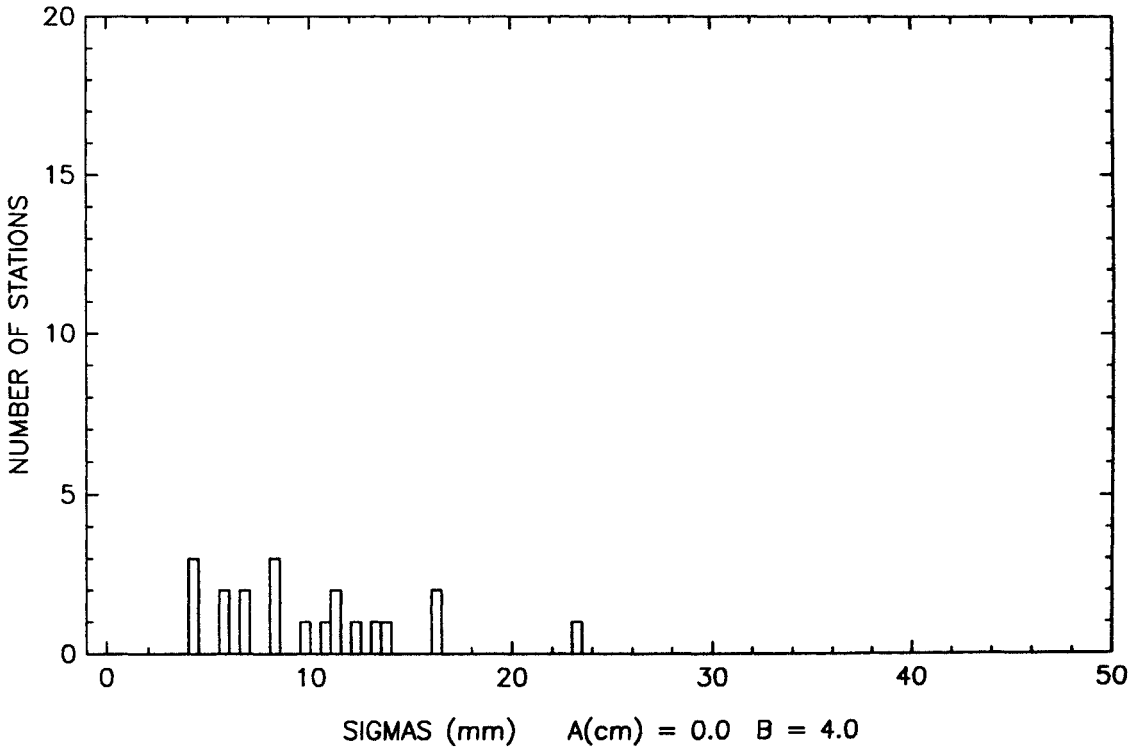
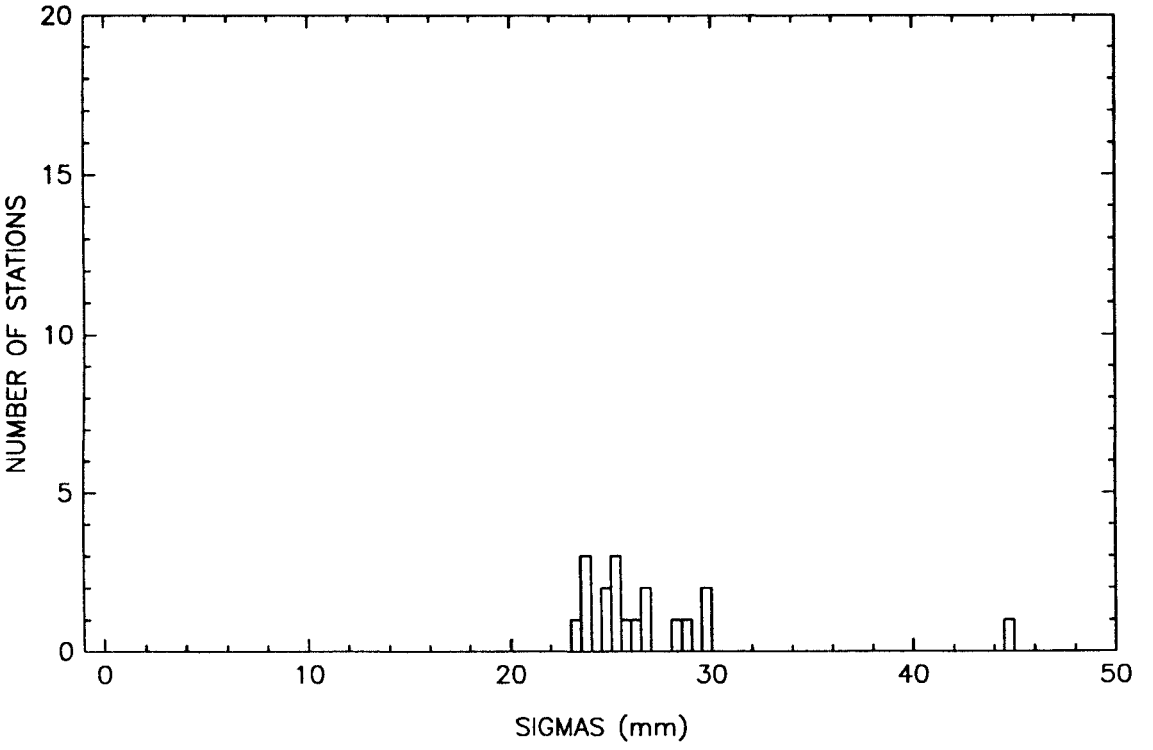


FIGURE 12 : SSC(ESOC) 93 P 01



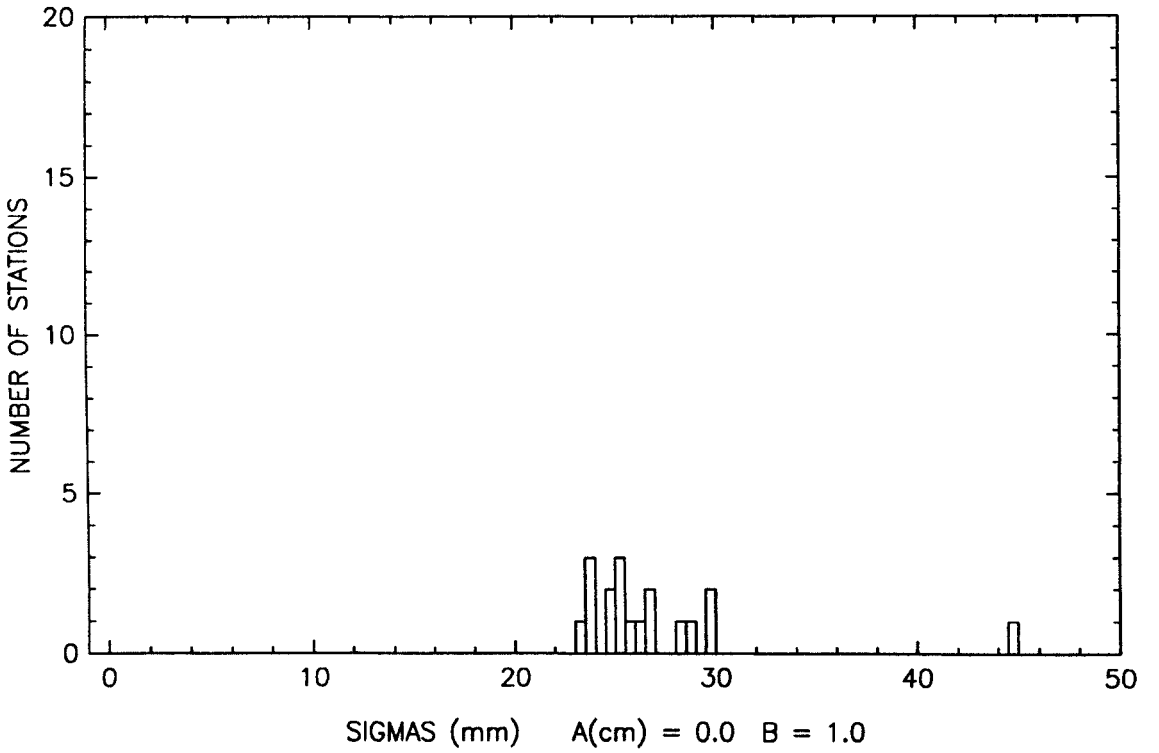
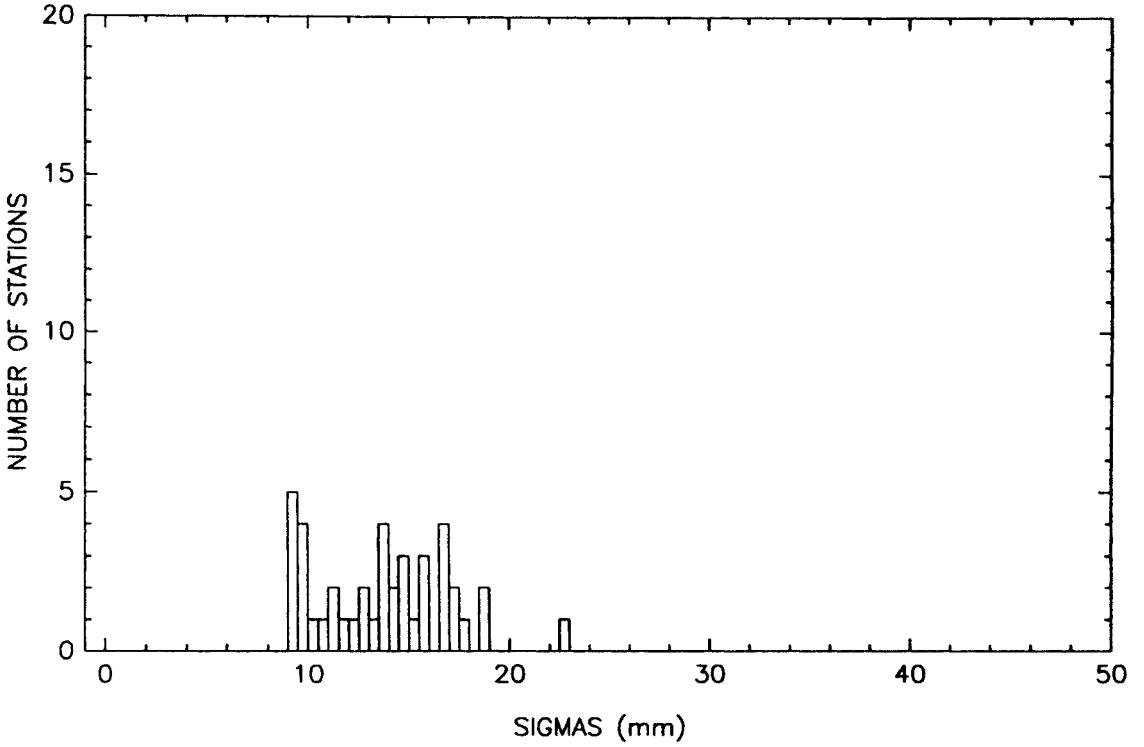


FIGURE 13 : SSC(JPL) 93 P 01



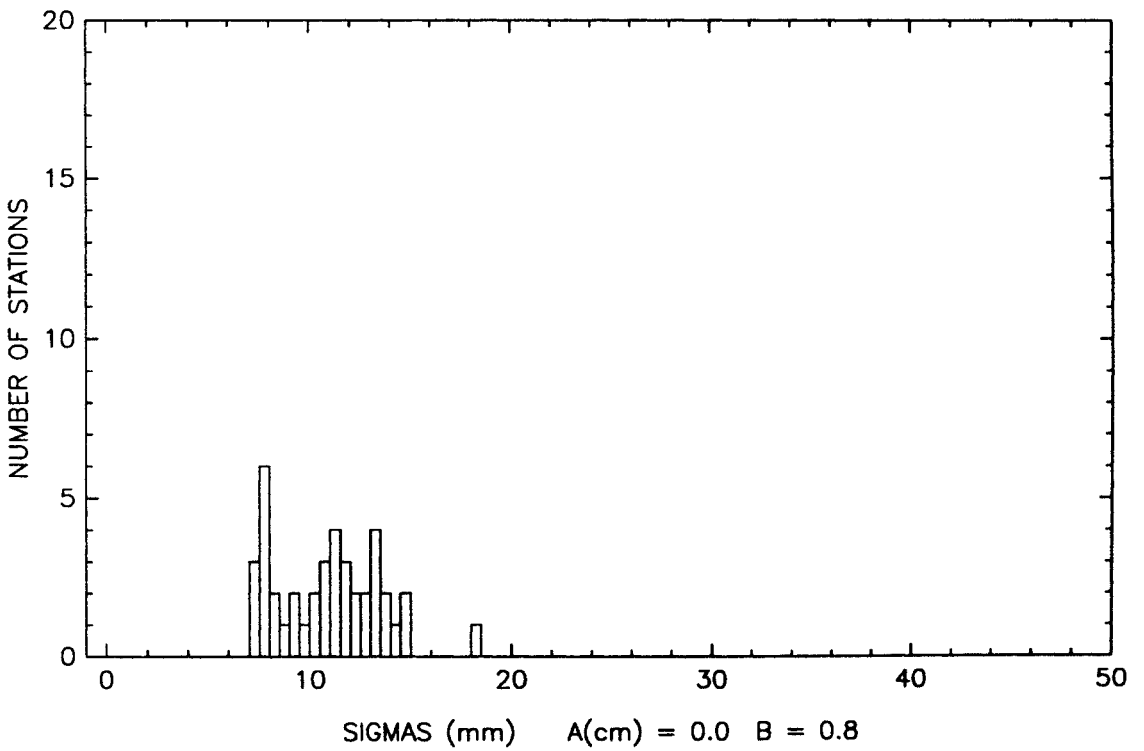
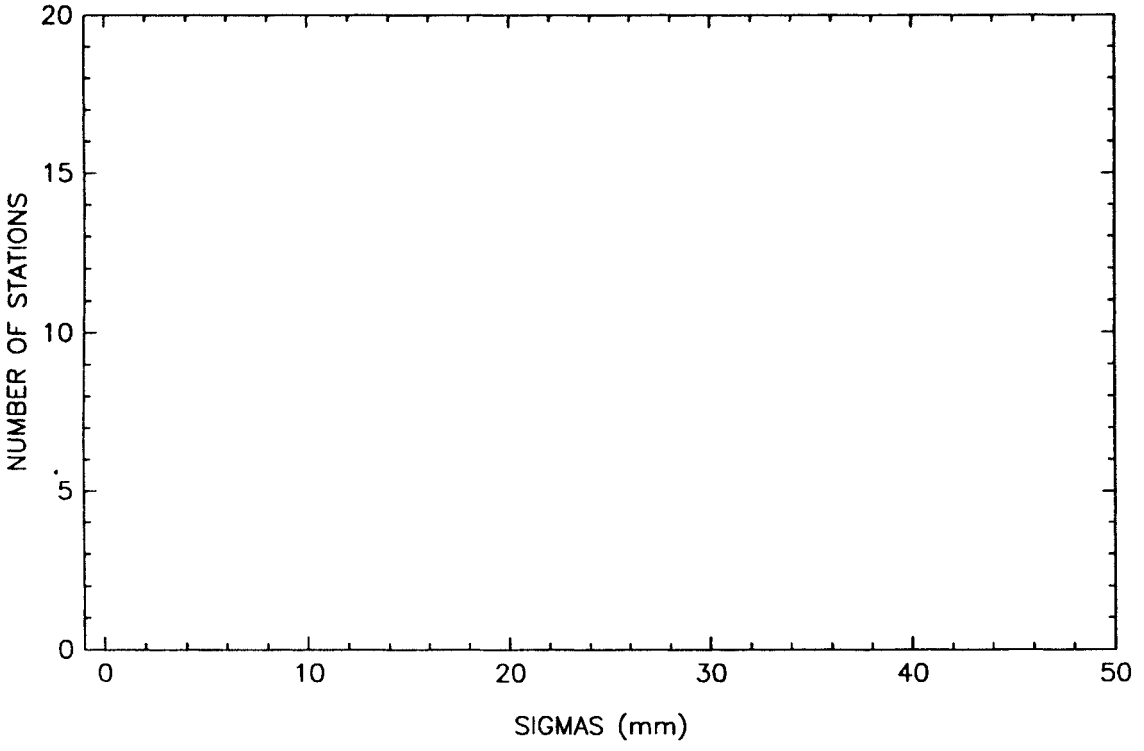


FIGURE 14 : SSC(SIO) 93 P 01



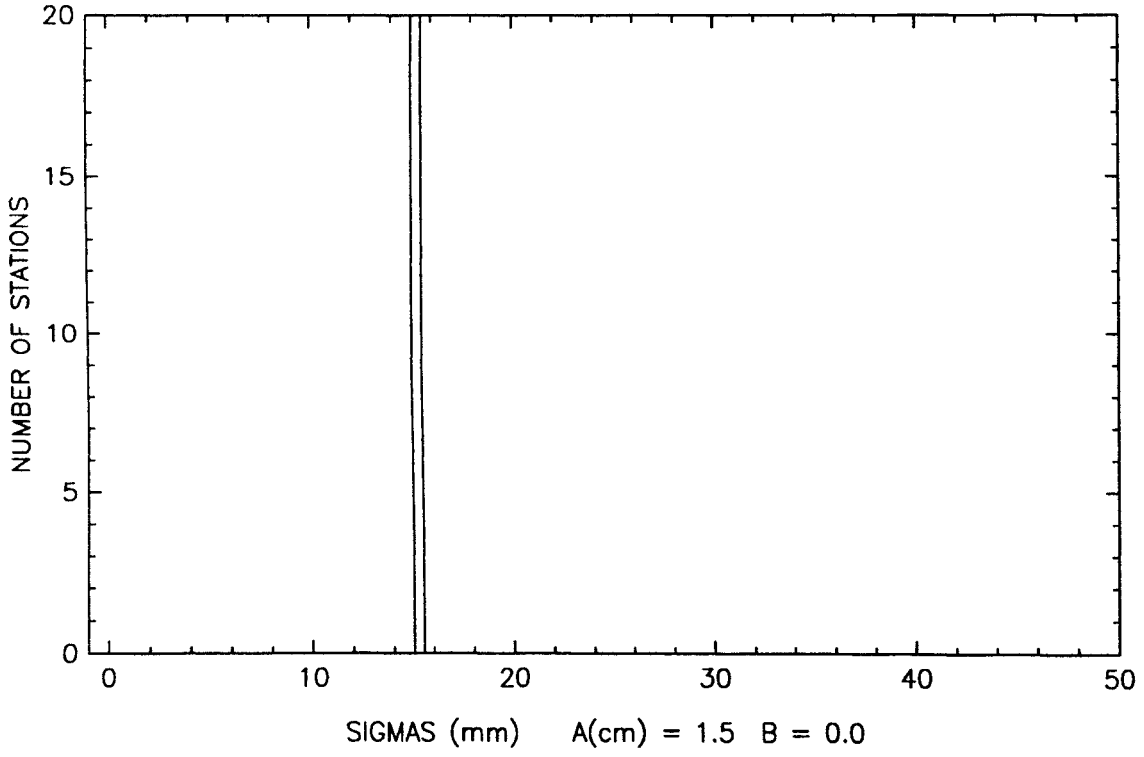
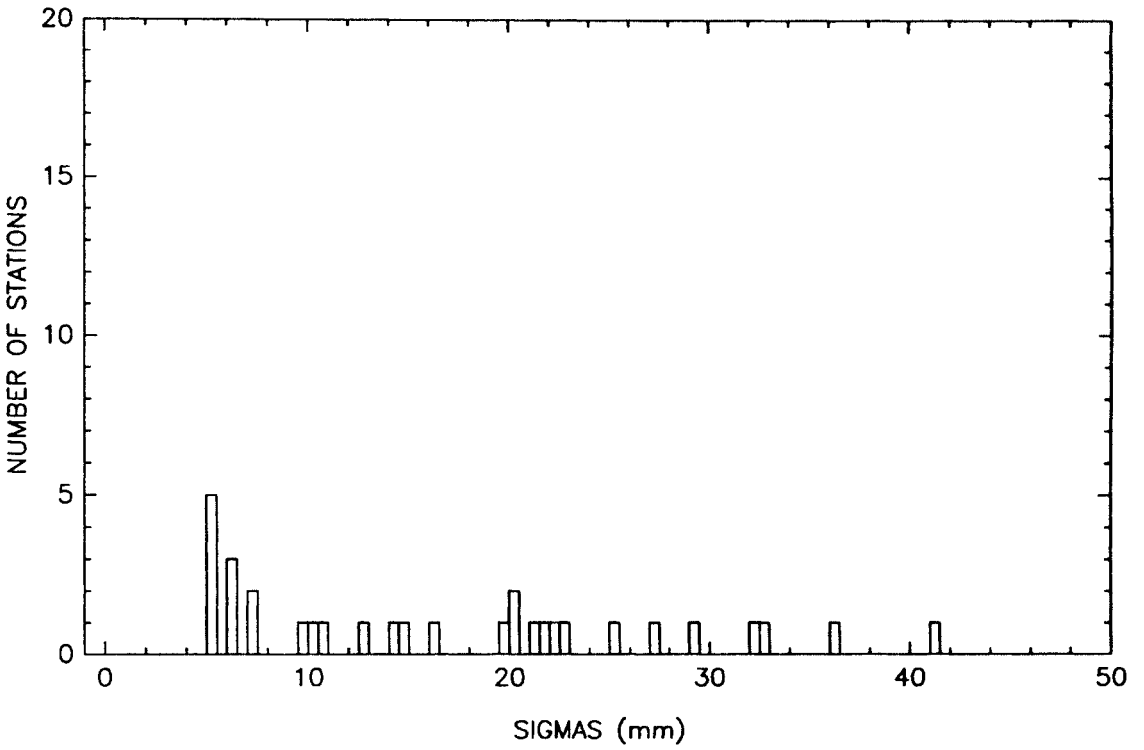


FIGURE 15 : SSC(CLG) 93 L 01



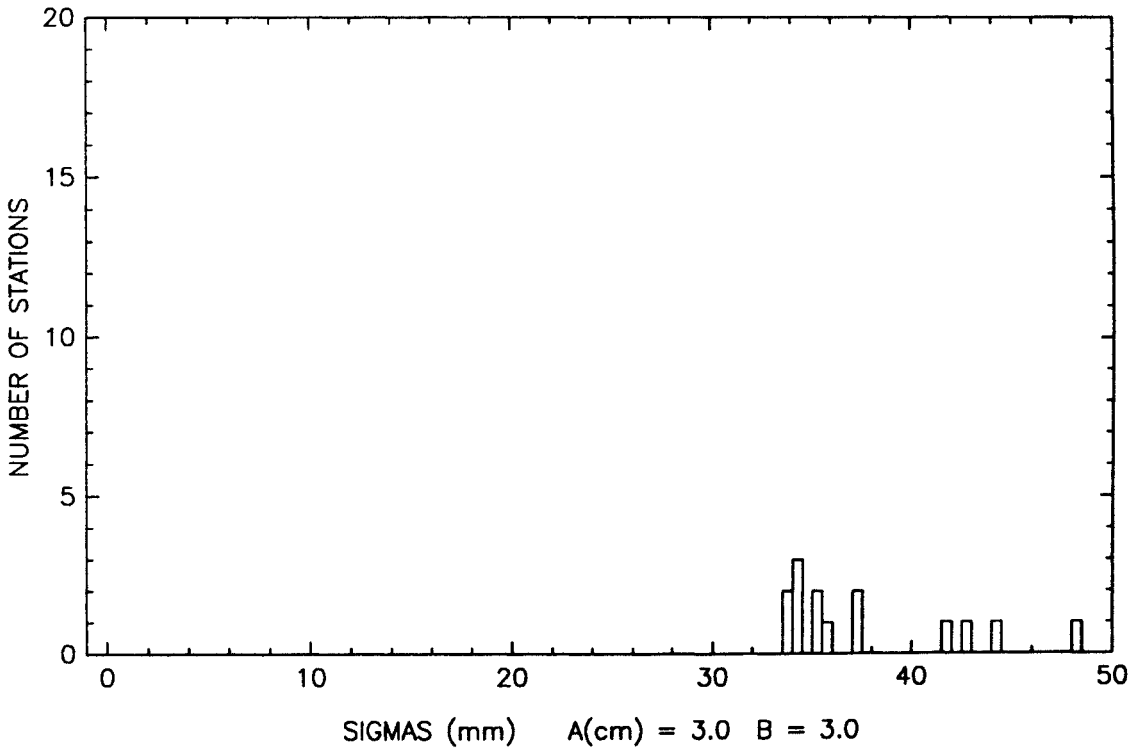
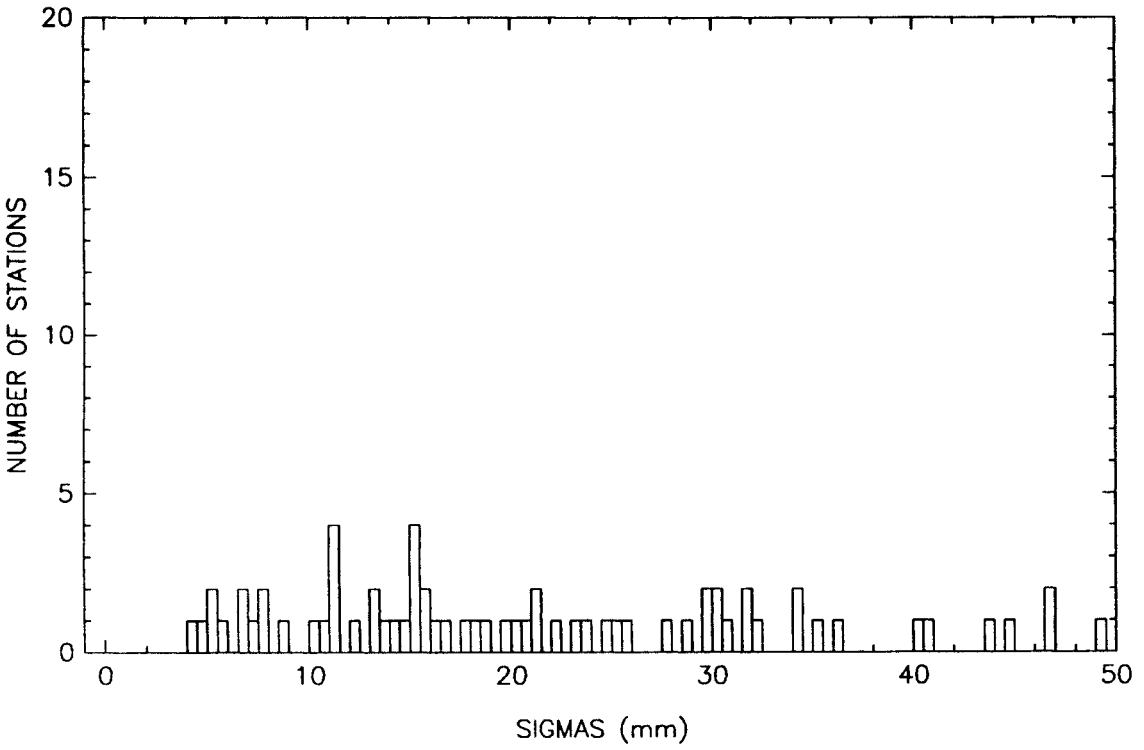


FIGURE 16 : SSC(CSR) 93 L 01



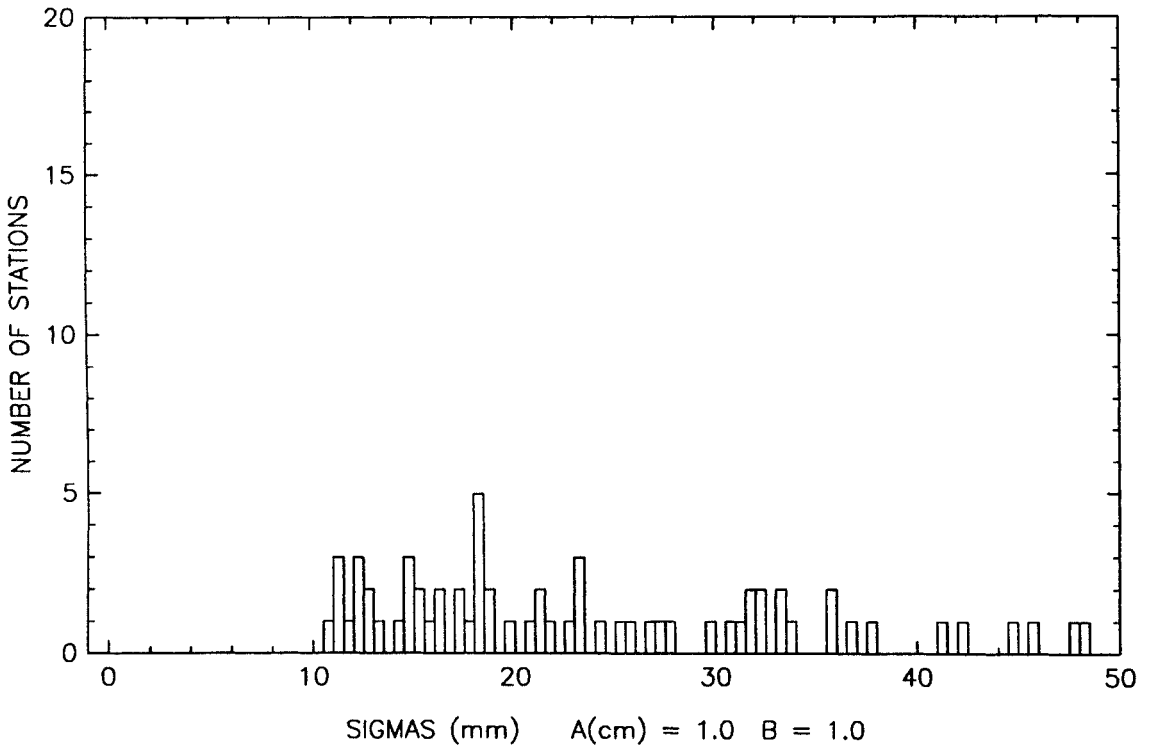
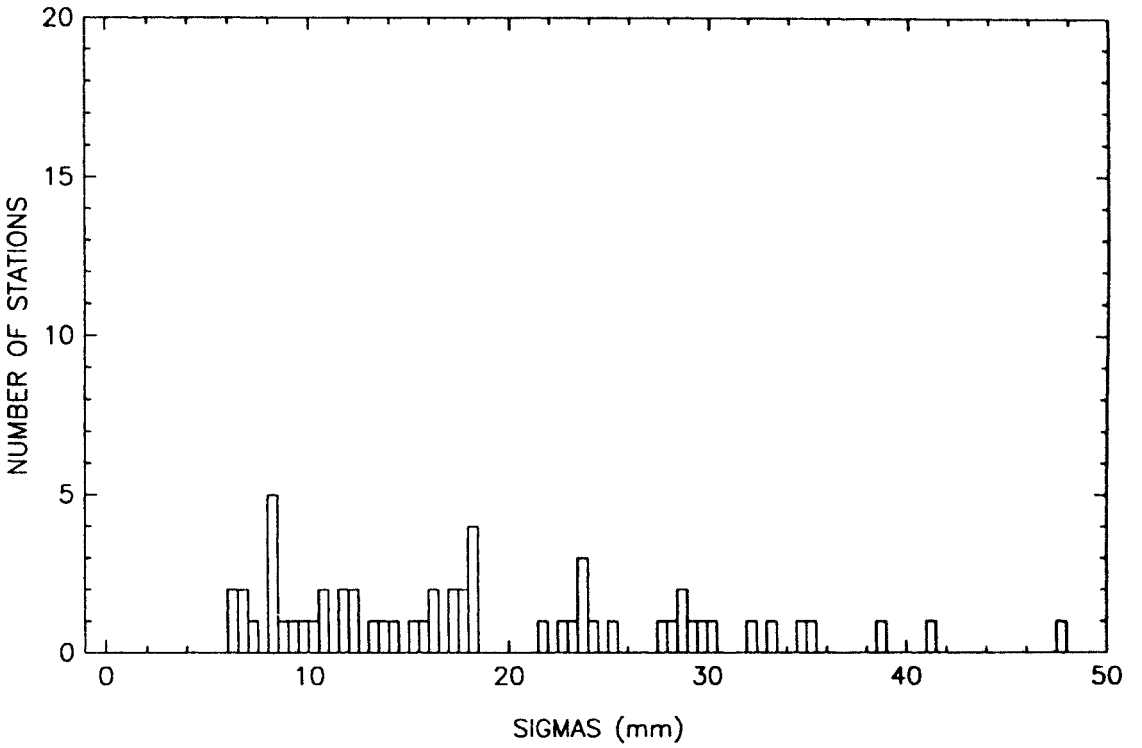


FIGURE 17 : SSC(DUT) 93 L 02



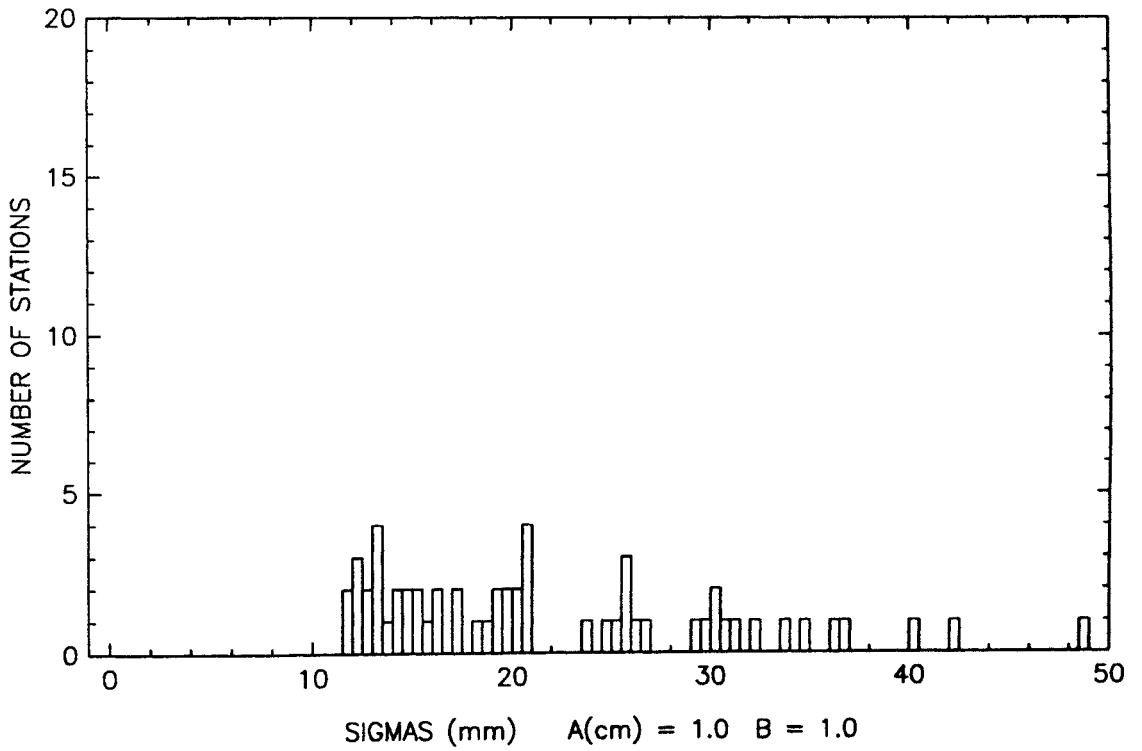
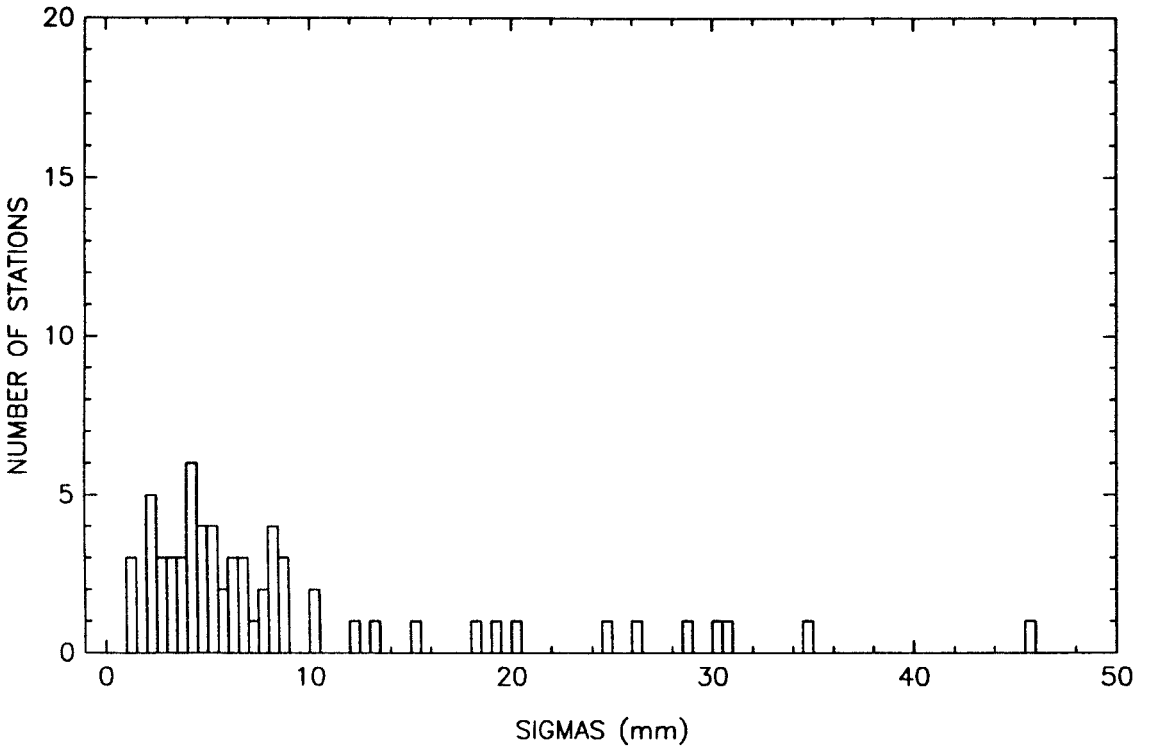


FIGURE 18 : SSC(GAOUA)93 L 01



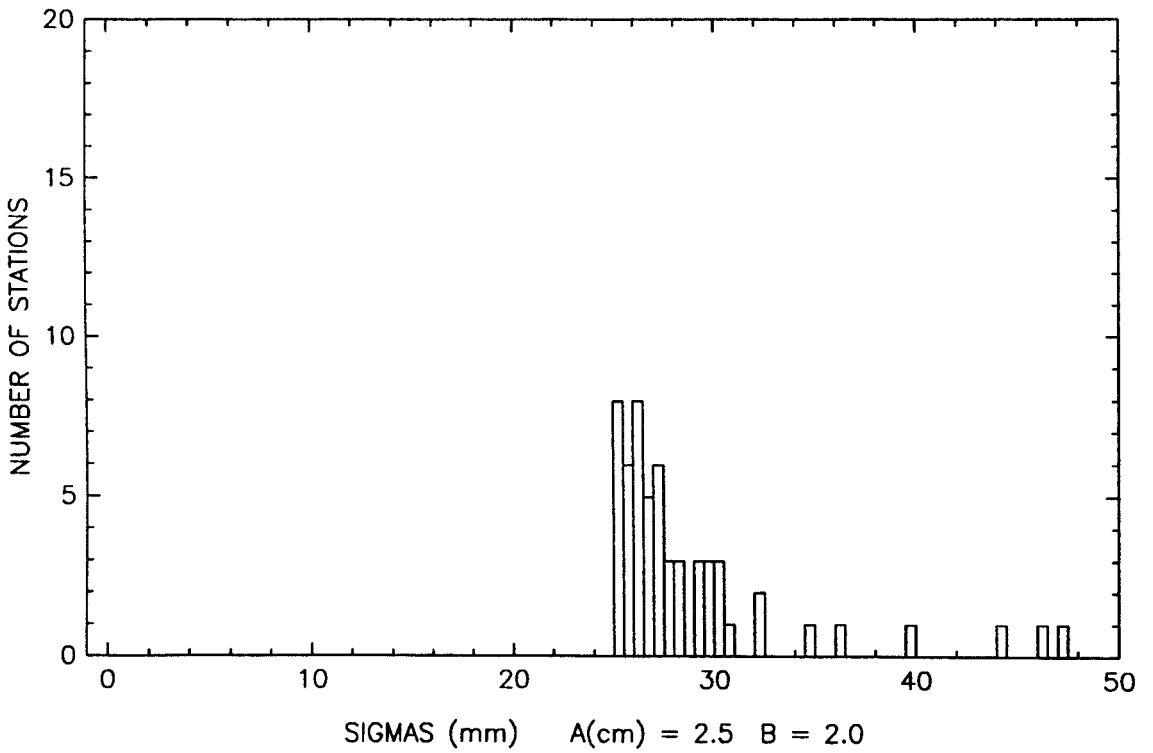
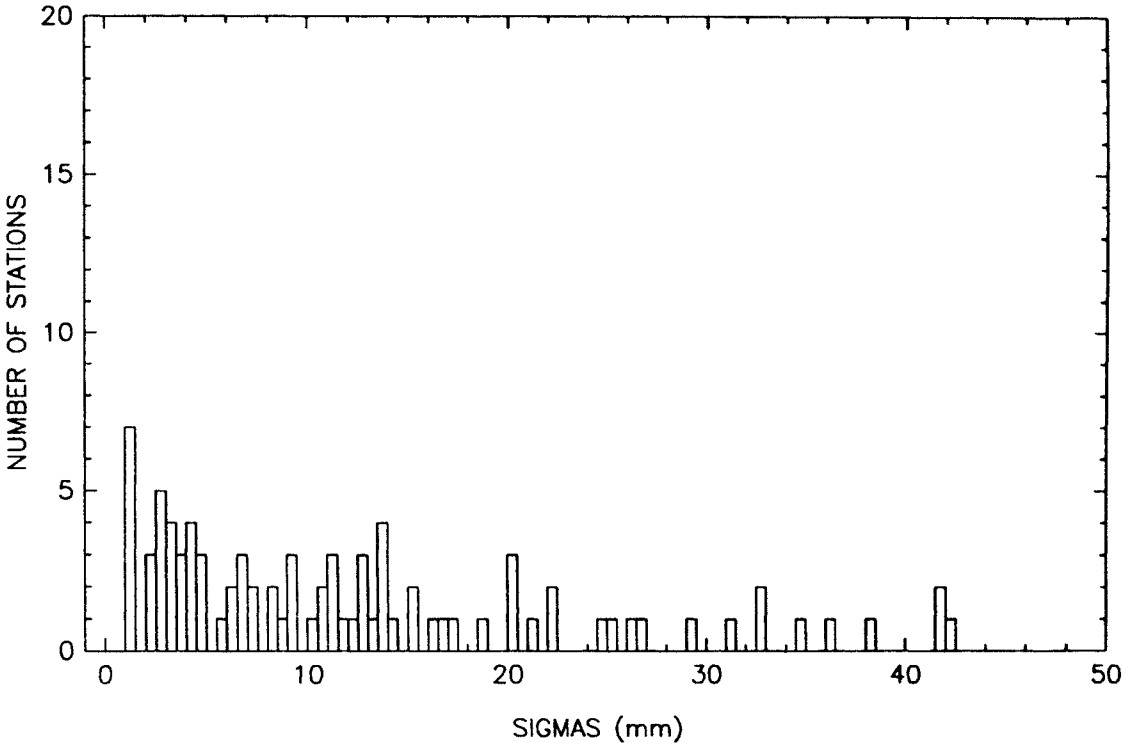


FIGURE 19 : SSC(GFZ) 93 L 01



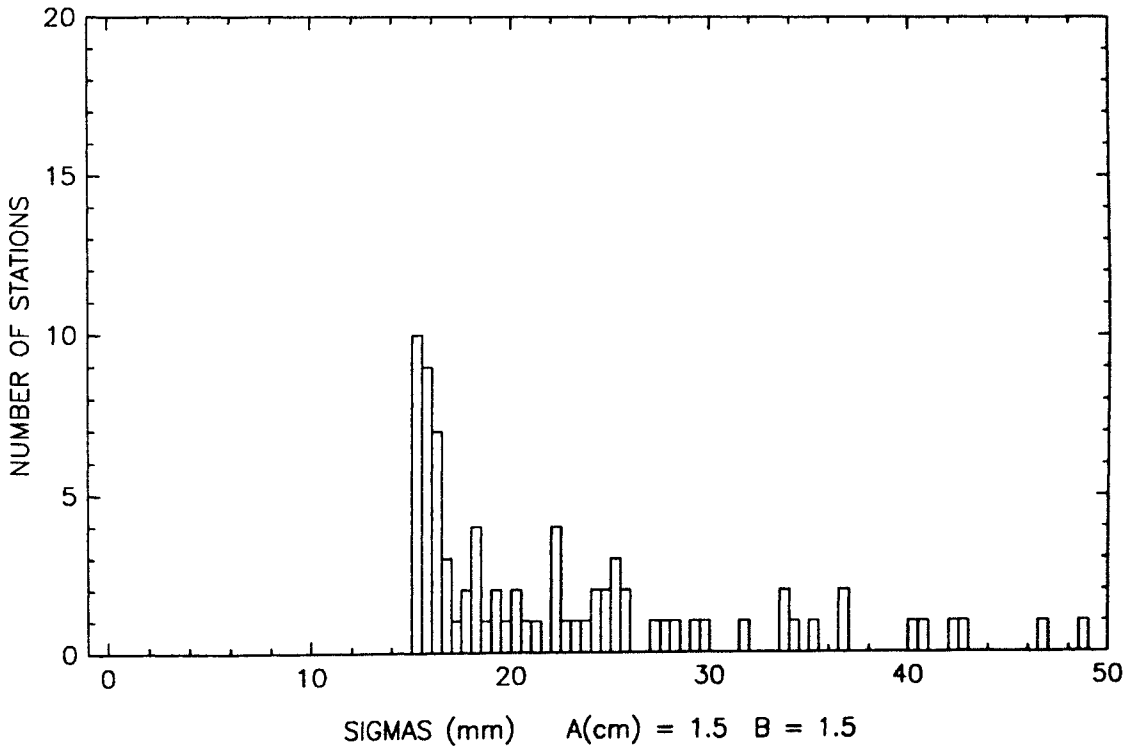


FIGURE 20 : SSC(GSFC) 93 L 01