DORIS

COORDINATES AND VELOCITIES FROM DORIS TRACKING OF TOPEX/POSEIDON

SSC(CSR) 95 D 01

M. M. Watkins
Jet Propulsion Laboratory, California Institute of Technology, Pasadena, USA
G. W. Davis and J. C. Ries
Center for Space Research, The University of Texas at Austin, Austin, USA

Positions and velocities have been computed for 47 separate DORIS beacons. The data set used consisted of 85 cycles (~2.3 years) of tracking data to the Topex/Poseidon satellite. Although a total of over 60 beacons have tracked the Topex/Poseidon and SPOT-n spacecraft, only 47 have sufficient data to estimate a reasonable velocity. The solution was performed without fiducial constraints on any site. Rotational constraints were applied to the network as a whole to remove the rotational singularity, and the network was aligned in rotation and rotation rate to the JCOD7 solution following the method of Heflin *et al.* (1992). Translation (geocenter) and scale are left as estimated from the DORIS data. The force and measurement models generally adhered to the IERS standards and additional references can be found in Watkins *et al.* (1993) and Tapley *et al.* (1994). Specific departures from the IERS standards were:

1) The apriori gravity field was JGM-3, a state of the art gravity field derived as a joint effort by the Goddard Space Flight Center and the Center for Space Research.

2) The ocean tide model was an enhanced version of the Schwiderski model extrapolated to include 80 consituents complete through degree and order 20, assuming admittances which vary linearly with frequency. Some ocean tide coefficients were adjusted using satellite tracking data.

3) The solid tide model (dynamic effect) has been expanded to include third degree and fourth degree terms.

Earth rotation parameters were held fixed to the operational series from the University of Texas Center for Space Research CSR94L02 series, a general description of which is found in Eanes and Watkins [1994].

References

Eanes, R. J., Watkins, M. M., 1994: Earth Orientation and Site Coordinates from the Center for Space Research Solution CSR 94 L 01, *IERS Technical Note 17*, P. Charlot (ed.), Observatoire de Paris, Paris, p. L-7.

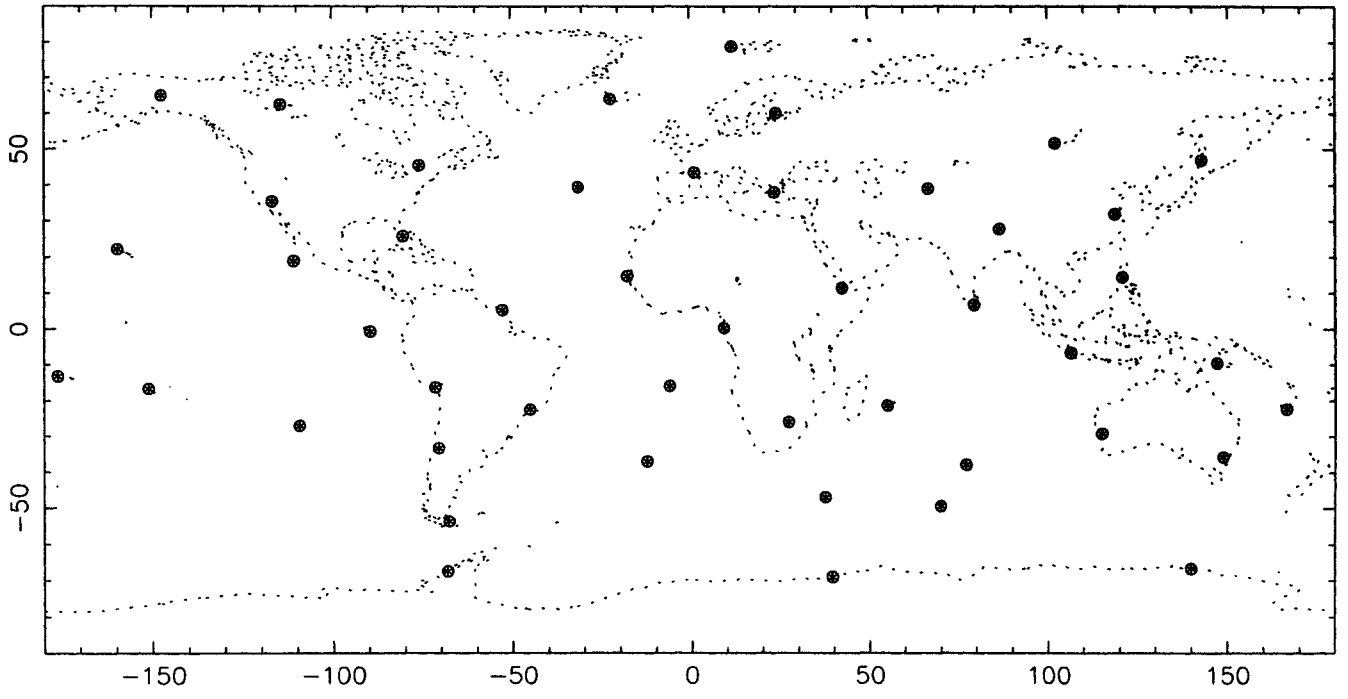
Heflin, M., Bertiger, W., Blewitt, G., Freedman, A., Hurst, K., Lichten, S., Lindqwister, U., Vigue, Y., Webb, F., Yunck, T., Zumberge, J., 1992: Global Geodesy Using GPS Without Fiducial Sites, *Geophys. Res. Lett.*, **19**, No. 2, 131-134.

Tapley, B. D., Ries, J. C., Davis, G. W., Eanes, R. J., Schutz, B. E., Shum, C. K., Watkins, M. M., Marshall, J. A., Nerem, R. S., Putney, B. H., Klosko, S. M., Luthke, S. B., Pavlis, D., Williamson, R. G., Zelensky, N. P., 1994: Precise Orbit Determination for TOPEX/Poseidon, *J. Geophys. Res.*, **99** (C12), 24 383-24 404.

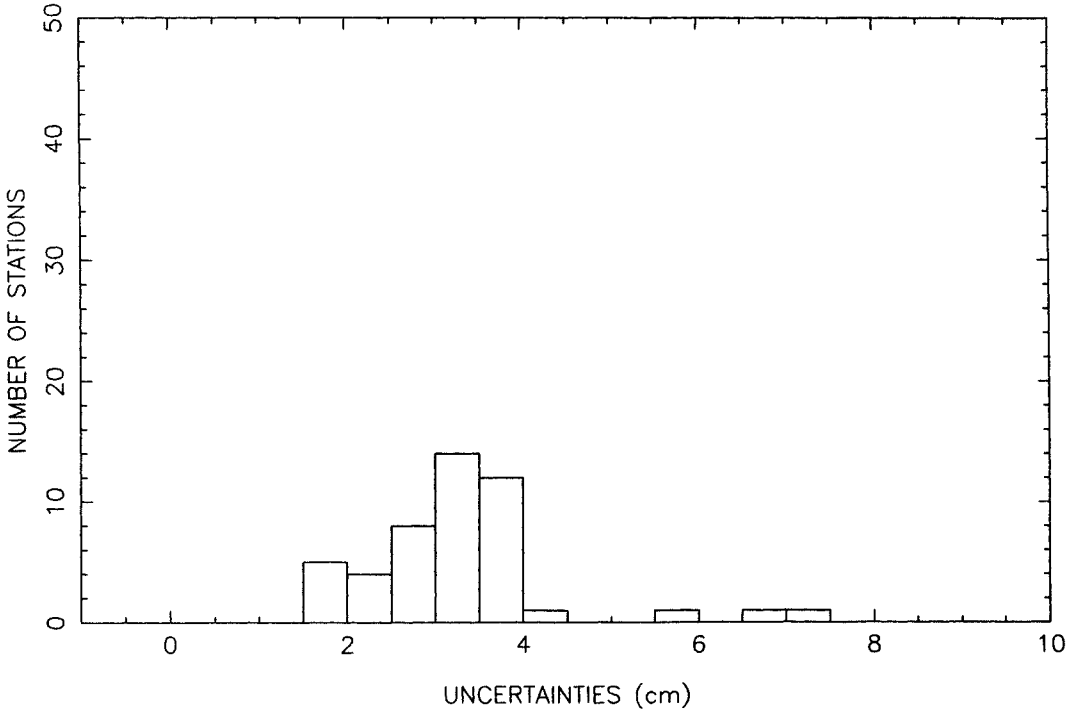
Watkins, M. M., Davis, G. W., Ries, J. C., 1993: Precise Station Coordinate Determination from DORIS tracking of the TOPEX/POSEIDON spacecraft, *Proc. of AAS/AIAA Astrodynamics Specialist Conference,* Paper AAS-93-575, Victoria, Canada.

Technical description of solution CSR 95 D 01

1 - Technique:	DORIS
2 - Analysis Center:	Center for Space Research, The University of Texas/ Jet Propulsion Laboratory, California Institute of Technology
3 - Software used:	UTOPIA GIPSY/OASIS-II routines used for reference frame definition
4 - Data span:	September, 1992 - January, 1995
5 - Celestial Reference Frame:	Not applicable
a - Nature:	Dynamical, Topex/Poseidon
b - Definition of the orientation:	nutation corrections, UT1 tie to VLBI
6 - Terrestrial Reference Frame:	SSC(CSR) 95 D 01
a - Relativity scale:	Local Earth
b - Velocity of light:	299792458 m/sec
c - Geogravitational constant:	GM0 = 3.986004415 10^{14} m^3 s^{-2}
d - Permanent tidal correction:	No
e - Definition of origin:	Defined by satellite dynamics through C10=0, C11= 0,S11=0
f - Definition of orientation:	No net rotation with respect to ITRF93
g - Reference epoch:	1993.0
h - Tectonic plate model:	Estimated/NUVEL1 background
i - Constraint for time evolution:	No net rotation rate with respect to ITRF93
7 - Earth orientation:	Fixed to CSR 94 L 02
a - A priori nutation model:	IAU(1980) + 6 frequency correction formula
b - Short-period tidal variations in x, y, UT1:	Not estimated
8 - Estimated Parameters:	
a - Celestial Frame:	Orbit initial conditions, empirical accelerations per arc.
b - Terrestrial Frame:	X0, Y0, Z0, Xdot, Ydot, Zdot
c - Earth Orientation:	
d - Others:	troposphere correction and frequency offset per pass.



Distribution of the 47 sites of the terrestrial frame SSC(CSR) 95 D 01.



Distribution of the uncertainties (quadratic mean of σ_x, σ_y, σ_z) for the 47 stations of the terrestrial frame SSC(CSR) 95 D 01.

SITE COORDINATES AND VELOCITIES FROM THE GRGS USING DORIS

SSC(GRGS) 95 D 01

L. Soudarin, J.F. Cretaux and A. Cazenave

Coordinates and velocities for 49 globally distributed sites have been computed using a no-fiducial approach. The DORIS data of 4 years of SPOT2 (September 1990 to December 1994), 2 years of TOPEX/POSEIDON (january 1993 to December 1994) and 14 months of SPOT3 (November 1993 to December 1994) were used for this solution.

Data analysis

The DORIS data are analysed through a dynamical orbit computation in which the satellite orbit, station positions and velocities, and EOP are determined in a single inversion, together with selected parameters required to improve the force model and the measurement corrections. Orbits are computed on a daily basis from which normal equations for station coordinates, velocity vectors and EOP are derived. Individual normal equations of daily orbit computations for each satellite have been accumulated to form a 4-year combined matrix involving data of the three satellites. The inversion of this matrix yields the solution for the geodetic parameters.

The gravity field model used in the orbit computation is GRIM4-C4 with a GM0 different from the IERS Standards.

Estimated parameters

The EOP parameters are being fixed to the EOP (IERS) 90 C 04 before 21/02/1992 and to the IERS bulletin B values after this date.

The stations parameters (positions and velocities) were all estimated, to make the frame entirely free and connected to the IERS only by the EOP.

The sites of Arlit (Niger), Richmond (USA) and Kourou (France) were respectively occupied by two stations which observed over distinct time spans. Because of the short observing periods, velocities were estimated by using the data of the two stations. The stations being close enough, we constrain each couple of stations to have the same velocities. However, for Kourou, the data are unsufficient. The horizontal velocities were so constrained to the NNR-NUVEL1 values and the vertical velocities to 0 mm/yr. Coordinates of the six stations were estimated (with a weak constrain (1 m) on the tie between the pairs of station).

For the sites of Socorro (Mexico), Cibinong (Indonesy), Cachoeira (Brasil), Santiago (Chili) and Dionysos (Greece) with unsufficient data or short observing history, the velocities were constrained to the NNR-NUVEL1 values in horizontal and to 0 mm/yr in vertical.

References

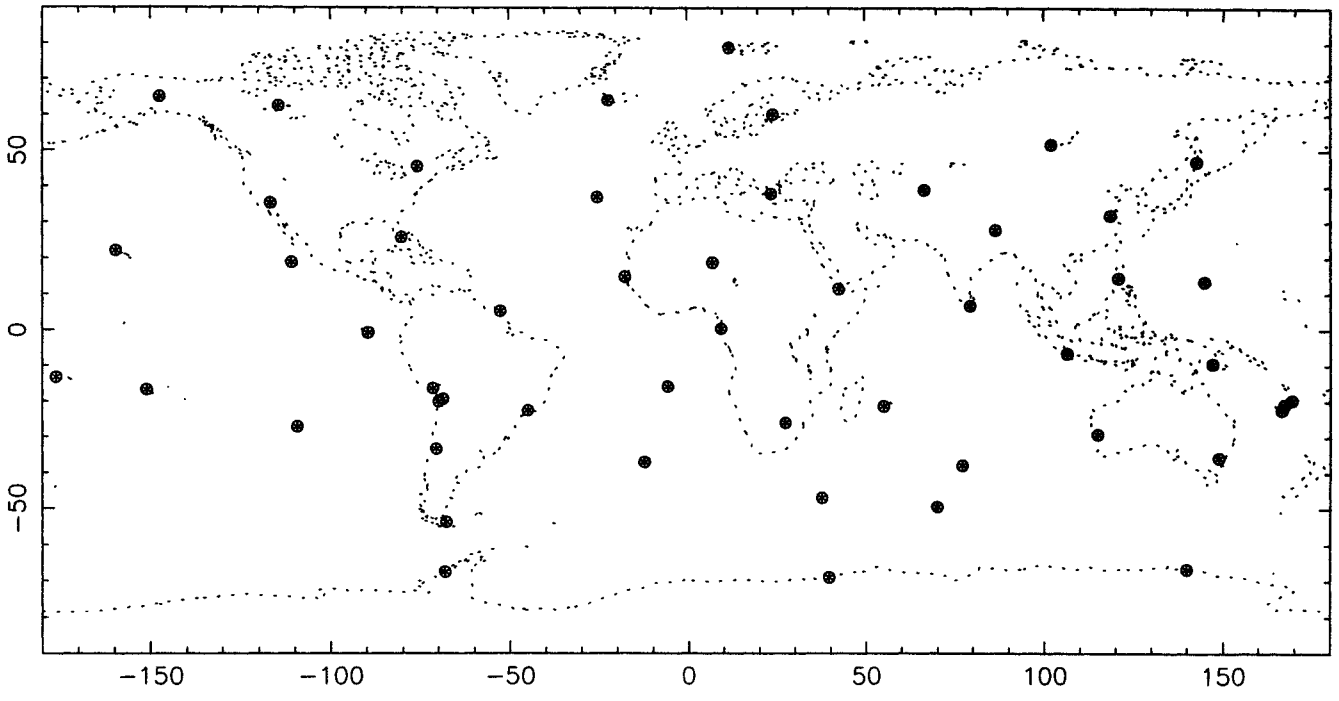
Schwintzer *et al.*, 1995: Long-wavelength global gravity field models: GRIM4-S4, GRIM4-C4, (in preparation).

Soudarin L. and Cazenave C., 1993: Global geodesy using DORIS data on SPOT-2, *Geophys. Res. Lett.*, **20**, No 4, 289-292.

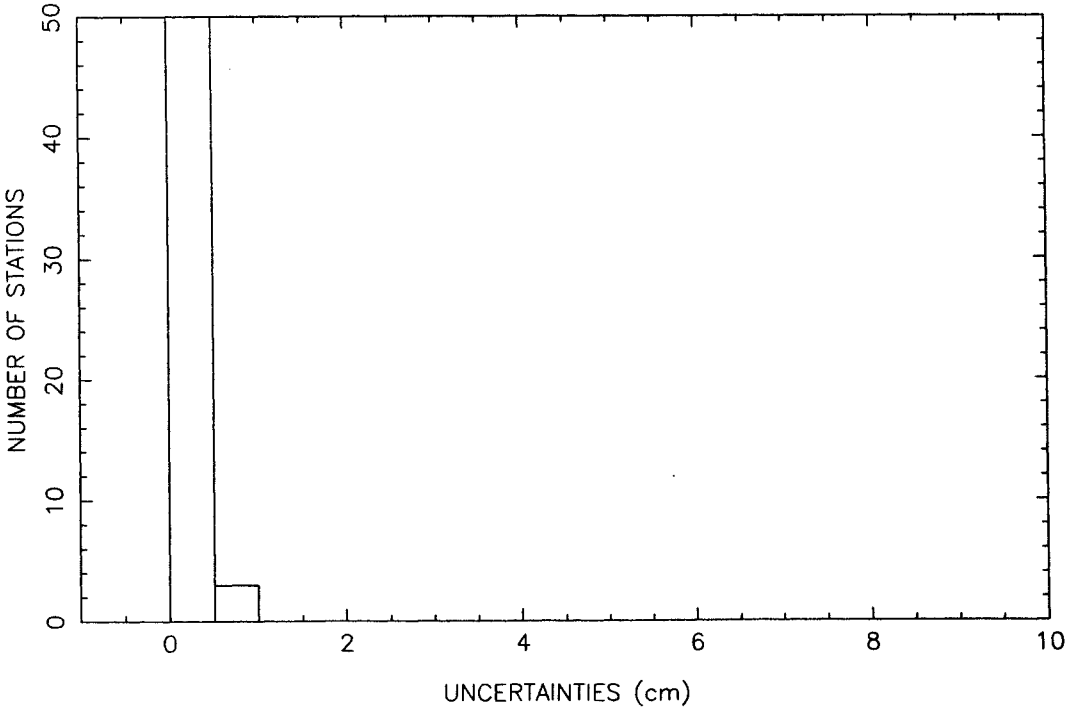
Soudarin L. and Cazenave C., 1995: Large scale tectonic plate motions measured with the DORIS space geodesy system, *Geophys. Res. Lett.*, **22**, No 4, 469-472.

Technical description of solution GRGS 95 D 01

1 - Technique:	DORIS
2 - Analysis Center:	GRGS
3 - Software used:	GINS/DYNAMO
4 - Data span:	Sep 90 - Dec 94
5 - Celestial Reference Frame:	none
a - Nature:	
b - Definition of the orientation:	
6 - Terrestrial Reference Frame:	GRGS 95 D 01
a - Relativity scale:	Local Earth
b - Velocity of light:	299 792 458 m/s
c - Geogravitational constant:	GM0 = 3.98600437 10^{14} m^3/s^2
d - Permanent tidal correction:	Yes
e - Definition of the origin:	Geocentric, C10=C11=S11=0.0
f - Definition of the orientation:	daily EOP fixed to EOP(IERS) 90 C 04 series and IERS bulletin B
g - Reference epoch:	1993.0
h - Tectonic plate model:	NNR-NUVEL1
i - Constraint for time evolution:	For 7 sites with unsufficient data or short observing history, velocities were estimated but strongly constrained to the NNR-NUVEL1 values for the horizontal velocities and to 0 mm/yr for the vertical velocities.
7 - Earth Orientation:	none
a - A priori nutation model:	
b - Short-period tidal variations in x, y, UT1:	
8 - Estimated parameters:	
a - Celestial Frame:	
b - Terrestrial Frame:	X0, Y0, Z0, Xdot, Ydot, Zdot, of 49 DORIS sites
c - Earth Orientation:	
d - Others:	All satellite epoch states, wet zenith tropospheric delays per station and per pass, frequency bias per station and per pass, radiation pressure and drag coefficients once per revolution coefficients.



Distribution of the 52 sites of the terrestrial frame SSC(GRGS) 95 D 01.



Distribution of the uncertainties (quadratic mean of σ_x, σ_y, σ_z) for the 54 stations of the terrestrial frame SSC(GRGS) 95 D 01.

COORDINATES AND VELOCITIES FROM DORIS TRACKING OF TOPEX/POSEIDON

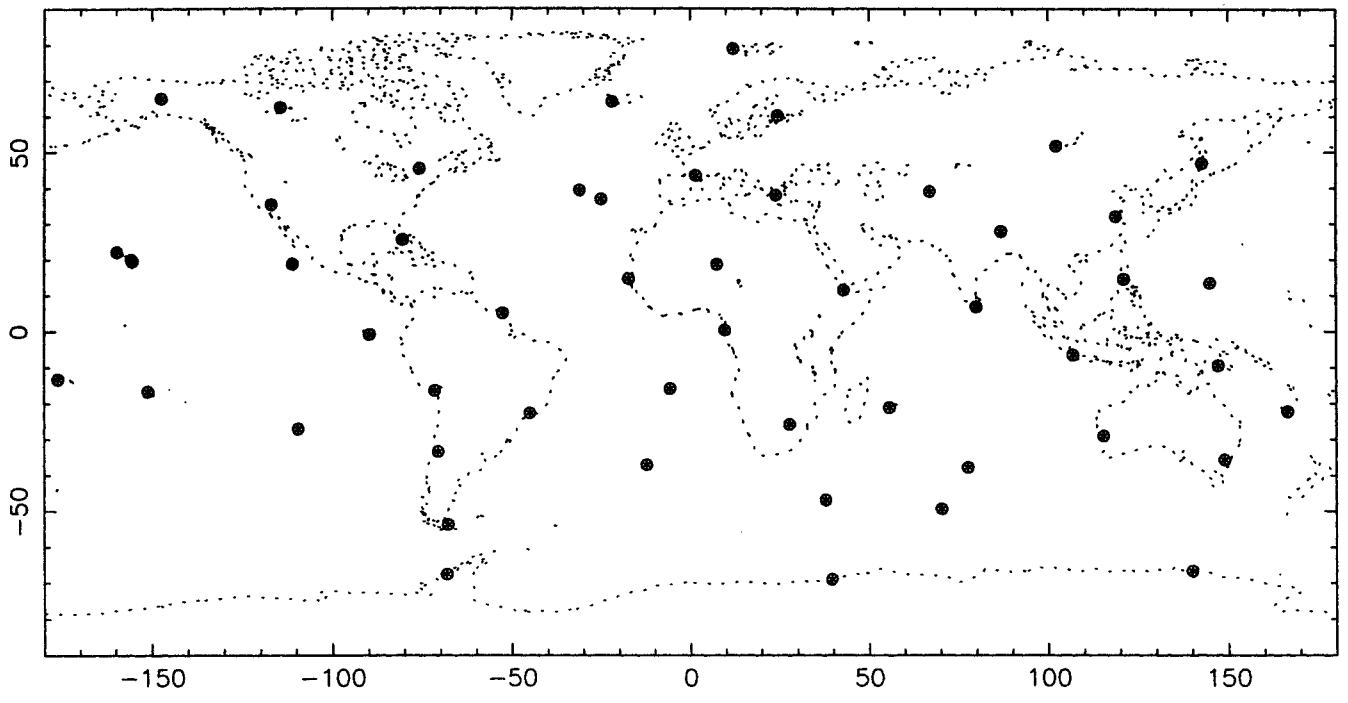
SSC(IGN) 95 D 02

Pascal Willis - Institut Géographique National, Saint-Mandé, France

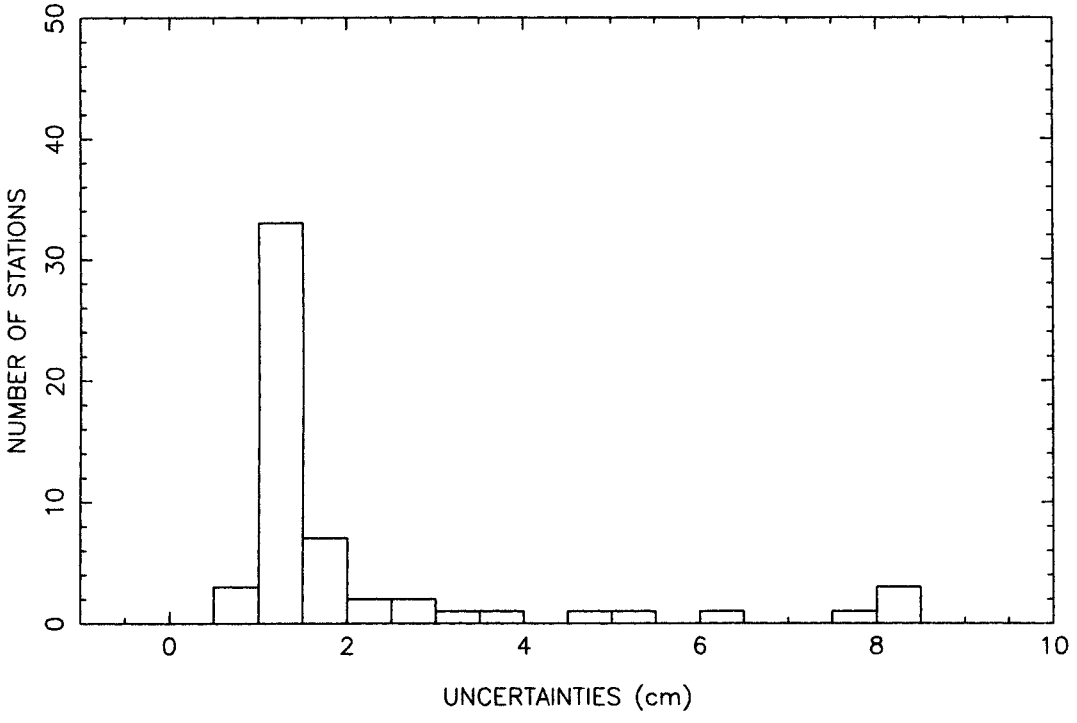
The DORIS data from the Topex/Poseidon were used (october 1992-february 1995). The data were computed on a daily basis using the free network approach (estimating simultaneously the stations positions and velocities and earth rotation parameters (pole+UT1-UTC rate)). These daily files were combined in a global adjustment. The initial constrains are very loose (1 km for the stations positions and the pole). After this adjustment, rotational constraints were applied to the JCOD7 solution using the Heflin method. For the pole solution, the constraints were applied for translation, rotation and scale. For the terrestrial solution, only constraints in rotation were applied (the geocenter and the scale then come from the DORIS data adjustment only). The main difference with the IERS standard is the use of the JGM3 70*70 gravity field.

Technical description of solution IGN 95 D 02

1 - Technique:	DORIS
2 - Analysis Center:	IGN, Saint-Mandé, France
3 - Software used:	GIPSY/OASIS-II
4 - Data span:	October, 1992 - February, 1995
5 - Celestial Reference Frame:	Not applicable
a - Nature:	Dynamical, Topex/Poseidon
b - Definition of the orientation:	
6 - Terrestrial Reference Frame:	SSC(IGN) 95 D 02
a - Relativity scale:	Local Earth
b - Velocity of light:	299792458 m/sec
c - Geogravitational constant:	GM0 = 3.986004415 10^{14} m^3 s^{-2}
d - Permanent tidal correction:	No
e - Definition of origin:	Defined by satellite dynamics through C10=0, C11=0, S11=0
f - Definition of orientation:	No net rotation with respect to JCOD7
g - Reference epoch:	1993.0
h - Tectonic plate model:	Estimated
i - Constraint for time evolution:	No net rotation rate with respect to JCOD7
7 - Earth orientation:	
a - A priori nutation model:	
b - Short-period tidal variations in x, y, UT1:	Not estimated
8 - Estimated Parameters:	
a - Celestial Frame:	Orbit initial conditions, empirical accelerations per arc.
b - Terrestrial Frame:	X0, Y0, Z0, Xdot, Ydot, Zdot
c - Earth Orientation:	XPOLE, YPOLE, UT1-UTCRATE
d - Others:	troposphere correction and frequency offset per pass.



Distribution of the 52 sites of the terrestrial frame SSC(IGN) 95 D 02.



Distribution of the uncertainties (quadratic mean of σ_x, σ_y, σ_z) for the 56 stations of the terrestrial frame SSC(IGN) 95 D 02.