VERY LONG BASELINE INTERFEROMETRY

EARTH ROTATION AND TERRESTRIAL REFERENCE FRAME FROM VLBI DATA ANALYSIS

GAOUA 95 R 01

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Estimated values for time series of EOP and station coordinates have been determined from analysis of VLBI observations. These group delay data have been acquired by IRIS-A and NEOS-A networks since January 02, 1990 till December 27, 1994. In total 177707 dual frequency Mark III group delays with zero flag quality from 215 sessions have been processed.

The software SteelBreeze 1.01 has been used for processing VLBI observations.

This software is based on the IERS Standards (McCarthy, 1992) (models, constants) and SRIF (square root information filter) technique (Bierman, 1977) (estimation of parameters).

The initial values of station coordinates and velocities have been taken from solution SSC(IERS) 94 C 01. The obtained terrestrial reference frame has been linked to ITRF94 by requiring that the vector sum of the adjusted station coordinates be equal to the corresponding sum for the ITRF94 for a set of 8 stations (ALGOPARK, GILCREEK, KAUAI, NRAO85 3, ONSALA60, RICHMOND, WESTFORD, WETTZELL).

The initial values of radio source coordinates have been taken from solution RSC(IERS) 94 C 01.

The IAU 1980 Nutation model and initial values of EOP(IERS) 90 C 04 have been applied. The transformation between CRS and TRS has been calculated using the non-rotating origin concept (Capitaine, 1986). The tabulated daily values of EOP have been interpolated by cubic splines using 8 points. The tidal variations in UT1 have been removed from tabulated values before the splining procedure and added to interpolated ones (except for diurnal and semi-diurnal variations because they are not present in the solution EOP(IERS) 90 C 04). Then polar motion and UT1 have been corrected for diurnal and semi-diurnal tidal variations (Herring, 1993).

The orientation of the terrestrial and celestial reference frames has been defined by EOP from EOP(IERS) 90 C 04 (with linear transformations to be consistent with ITRF94 and ICRF94) for the EOP reference date August 12, 1991.

Tropospheric refraction in the local zenith direction caused by hydrostatic and water vapour components of the neutral atmosphere have been modelled according to Saastamoinen (1972). The zenith delays have been mapped to line of sight elevations with the MTT mapping function of Herring (1992) for both hydrostatic and wet components.

The ionospheric component has been eliminated by using simultaneous dual frequency observations.

Calibration data collected at each observing site have been applied to correct for variations in the electrical length of the cables between the radio receivers and the data acquision systems.

The wet zenith delay and clock offset have been estimated as stochastic processes and modelled as random walk with following magnitudes of power spectral density of ruled white noise: for clock offset 20^2 ps^2/hour, for wet component of tropospheric delay 1.0 cm^2/hour.

The weighted rms post-fit residuals of this solution is 29.04 ps in delay.

Acknowledgments

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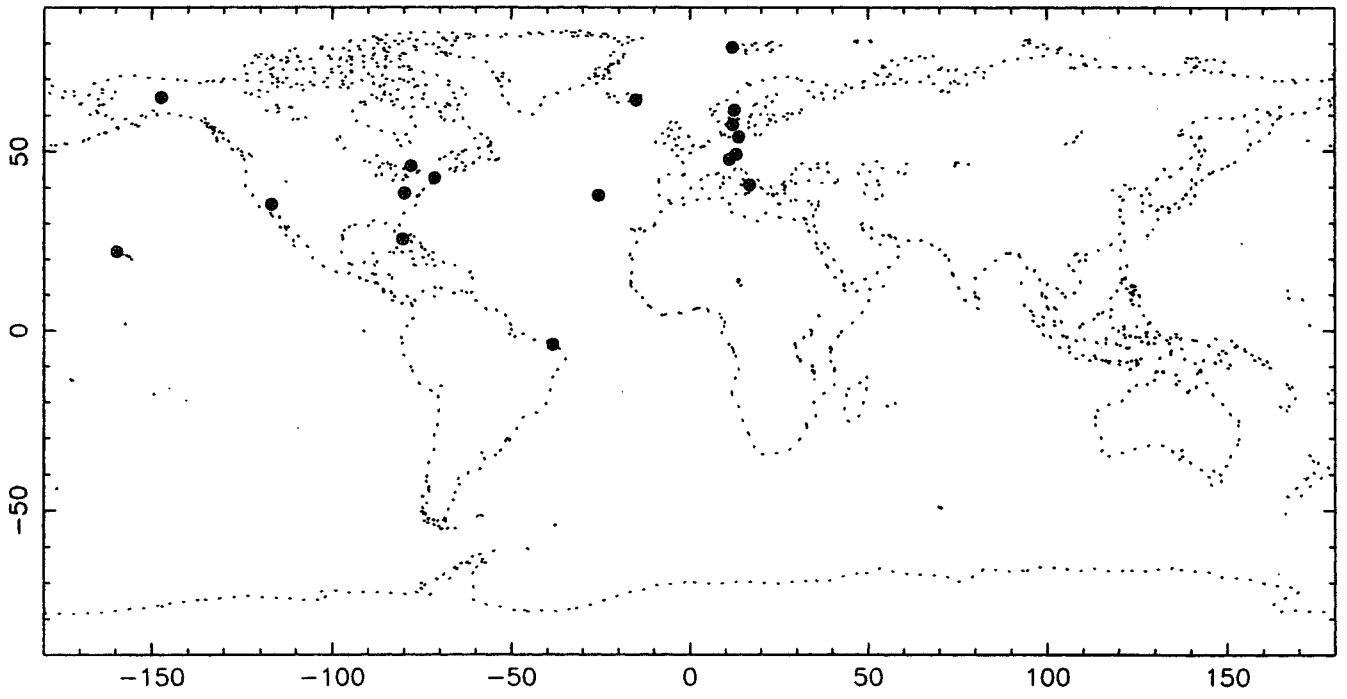
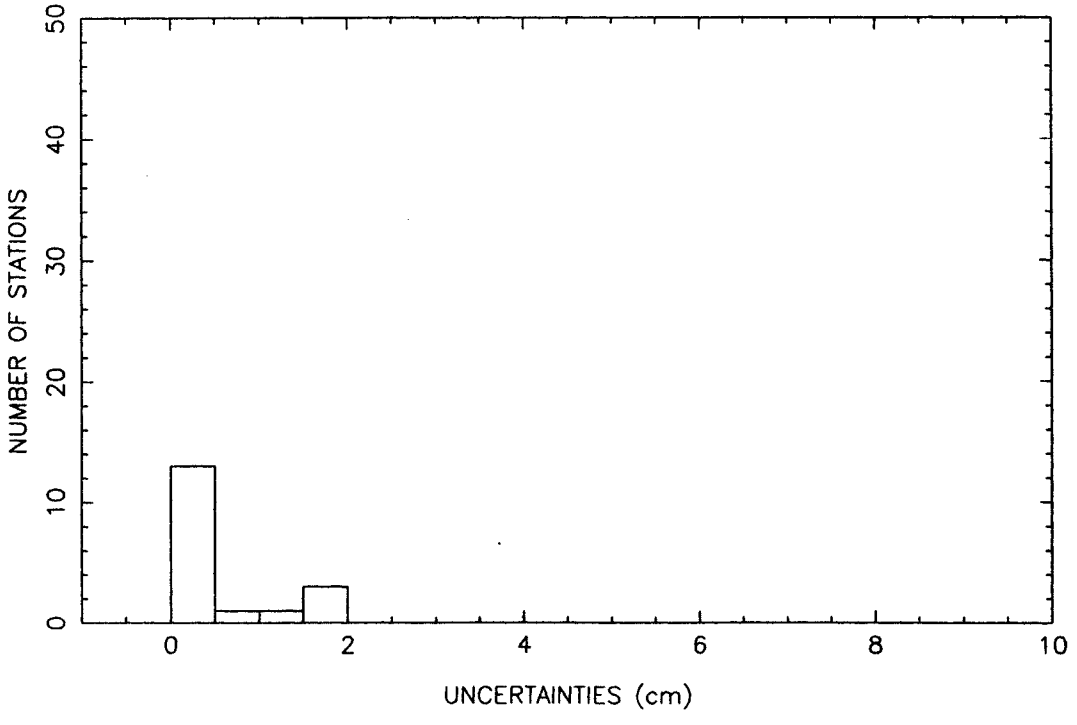
Technical description of solution GAOUA 95 R 01

1 - Technique:	VLBI
2 - Analysis Center:	GAOUA
3 - Software used:	SteelBreeze 1.01
4 - Data span:	Jan 1990 - Dec 1994
5 - Celestial Reference Frame:	RSC(IERS) 94 C 01
a - Nature:	
b - Definition of the orientation:	
6 - Terrestrial Reference Frame:	SSC(GAOUA) 95 R 01
a - Relativity scale:	SSB
b - Velocity of light:	299792458 m/s
c - Geogravitational constant:	not applicable
d - Permanent tidal correction:	no
e - Definition of origin:	by using no-translation constraint for 8 VLBI stations
f - Definition of orientation:	by fixing EOP values at Aug 12, 1991 equal to EOP(IERS) 90 C 04
g - Reference epoch:	1993.0 (MJD 48988)
h - Tectonic plate model:	set of velocities from SSC(IERS) 94 C 01
i - Constraint for time evolution:	no
7 - Earth orientation:	EOP(GAOUA) 95 R 01
a - A priori nutation model:	IAU 1980 + corrections EOP(IERS) 90 C 04
b - Short-period tidal variations in x, y, UT1:	according to Herring (1993). Corrections added to EOP(IERS) 90 C 04. EOP(GAOUA) 95 R 01 does not contain diurnal and semidiurnal tidal variations
8 - Estimated Parameters:	
a - Celestial Frame:	no
b - Terrestrial Frame:	X0, Y0, Z0
c - Earth Orientation:	Xp, Yp, UT1-UTC, $\delta\psi$, $\delta\varepsilon$
d - Others:	wet zenith tropospheric delays and station clock offset at each site of observation as stochastic parameters



Distribution of the 17 sites of the terrestrial frame SSC(GAOUA) 95 R 01.



Distribution of the uncertainties (quadratic mean of σ_x, σ_y, σ_z) for the 18 stations of the terrestrial frame SSC(GAOUA) 95 R 01.

EOP(GAOUA) 95 R 01 From Jan 1991 to Dec 1994

Number of measurements per year and median uncertainties
Units : 0.001" for X,Y,δψ,δε; 0.0001s for UT1

YEAR	X		Y		UT1		δψ		δε	
	Nb	Sigma	Nb	Sigma	Nb	Sigma	Nb	Sigma	Nb	Sigma
1991	58	0.14	58	0.15	58	0.07	58	0.21	58	0.08
1992	52	0.20	52	0.20	52	0.08	52	0.30	52	0.13
1993	52	0.13	52	0.12	52	0.05	52	0.22	52	0.09
1994	52	0.11	52	0.09	52	0.05	52	0.18	52	0.08

EARTH ORIENTATION PARAMETER DETERMINATIONS AT THE GEODETIC INSTITUTE OF THE UNIVERSITY OF BONN

GIUB 95 R 01

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The VLBI group at the Geodetic Institute of the University of Bonn (GIUB) has analysed VLBI experiments which are organized within project IRIS-S (International Radio Interferometric Surveying - South), with the German Antarctic station O'Higgins and within the European geodetic VLBI project. The IRIS-S observations form the backbone of the analyses for Earth orientation and terrestrial reference frame determinations. Until the end of 1994, 83 experiments were observed with a network of stations which is grouped around the Wettzell (Germany) - Westford (US East Coast) - HartRAO (Hartebeesthoek Radio Astronomy Observatory, South Africa) baseline triangle. Today the network is formed by the stations of Wettzell, HartRAO, Westford and Fortaleza (Brazil).

The IRIS-S as well as all other sessions included in the final solution are analyzed using the CALC 8.1/SOLVE/GLOBL software system (Gordon 1994). The theoretical delays in the adjustment are calculated according to the Consensus model (Eubanks, 1991).

The apriori EOP values for each observation are calculated by linearly interpolating the USNO Rapid Service Series and subsequently applying corrections for diurnal and semidiurnal tidal variations of polar motion and UT1. The corrections are modelled using the Wünsch and Busshoff (1992) amplitudes for UT1 scaled by 1.13 to subtract the equatorial moment of inertia of the core and the Seiler and Wünsch (in preparation) amplitudes for polar motion (see Technical Description). The Seiler and Wünsch model of ocean tidal variations in polar motion is an extension of the Brosche and Wünsch (1994) model that takes into account the resulting polar motion of the angular momentum balance of the oceans for a hydrodynamical numerical ocean model. The extension includes 20 additional tides in the diurnal and semidiurnal tidal band.

Additional VLBI data is acquired within the European geodetic VLBI project and within activities closely related to the German ERS/VLBI station O'Higgins in Antarctica. The station of O'Higgins has successfully observed three bursts of four experiments each with southern hemisphere networks consisting of the stations of Santiago (Chile), Hobart (Tasmania, Australia), DSS45 (NASA Complex Tidbinbilla, Australia) and HartRAO. These experiments contribute a number of precise source positions in the deep south.

Since 1990 the European VLBI stations of Wettzell, Onsala (Sweden), Madrid (Spain), Medicina, Matera and Noto (all Italy) have been performing geodetic VLBI experiments for the determination of European tectonic motions on a regular basis. More recently the telescopes at Effelsberg (Germany), Ny Alesund (Spitsbergen, Norway) and Simeiz on the Crimea peninsula (Ukraine) have been participating in several experiments extending the number of stations with highly accurate positions on the European continent.

In a combined solution (GIUB 95 R 01) all IRIS-S measurements, 21 European sessions and 11 experiments of the O'Higgins bursts are adjusted in a single least squares adjustment solving for station coordinates and radio source positions as global parameters as well as EOP and celestial pole offsets. In order to stabilize the European subnet within the global frame of the IRIS-S network we also added the data of two 1994 South Atlantic sessions of the NASA Goddard Space Geodesy Program to the solution which includes observations between Madrid and the South American stations.

The origin of the terrestrial reference frame is fixed through the Wettzell station coordinates which are kept at the ITRF 1992 (IERS, 1993b) values applying drift effect corrections according to the NNR-NUVEL1A model (DeMets *et al.* , 1994).

For the estimation of station displacement parameters the global kinematics of the network has to be defined by fixing an additional set of six degrees of freedom. This is achieved by modelling the tectonic station displacement of Wettzell according to the NNR-NUVEL1A model, constraining the change of the direction of the Westford to Wettzell baseline vector to the same model, and fixing the height changes of HartRAO to zero. Using the direction of the Westford to Wettzell baseline as a definition for the long term displacement of the terrestrial reference frame bears two advantages. The first is that this long baseline reduces the effects of inaccuracies in the individual sessions. The second is that possible inaccuracies in the model of a single tectonic plate do not so strongly affect the long term orientation of the network with respect to the axis of rotation. The origin of right ascension is fixed by the ICRF 1992 position of OJ287 (IERS, 1993a).

The European sessions are treated slightly differently since the comparably small extension of the network reduces the sensitivity for Earth orientation parameter determinations. Thus the inclusion of the European sessions mainly aims at the determination of station coordinates and displacement vectors for the terrestrial reference frame. In order to stabilize the solution weak constraints of 15 mas are introduced for the pole components and UT1-UTC estimated with data of these sessions.

Since the data gathered at some of the stations are limited or the time span is not long enough for a reliable estimation of station displacement parameters, drift components are modelled according to NNR-NUVEL1A for some of the stations while vertical drift rates are constrained to zero for most of the others. Since the data of Mojave cover only 2.5 years in our analysis no provision is made for any episodic movements detected in longer data sets.

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Technical description of solution GIUB 95 R 01

1 - Technique:	Mark III VLBI, Group delay observables
2 - Analysis Center:	Geodetic Institute of the University of Bonn (GIUB), Nussallee 17, D-53115 Bonn, Germany
3 - Software used:	CALC 8.1, SOLVE/GLOBL
4 - Data span:	Jan 86 - Dec 94 (irregular intervals)
5 - Celestial Reference Frame:	RSC(GIUB) 95 R 01
a- Nature:	extragalactic
b- Definition of the orientation:	RA of OJ287 fixed to ICRF 1992 and nutation at Dec 22, 1989 fixed to IAU 1980
6 - Terrestrial Reference Frame:	SSC(GIUB) 95 R 01
a- Relativity scale:	SSB
b- Velocity of light:	299 792 458 m/s
c- Geogravitational constant:	Not applicable
d- Permanent tidal correction:	No
e- Definition of origin:	Wettzell fixed at ITRF 1992
f- Definition of orientation:	EOP at Dec 22, 1989 fixed to IERS RS
g- Reference epoch:	1988.0
h- Tectonic plate model:	NNR-NUVEL1A
i- Constraint for time evolution:	Reference station Wettzell moves according to NNR-NUVEL1A, baseline direction Wettzell to Westford moves according to NNR-NUVEL1A, HartRAO height changes are constrained to zero
7 - Earth Orientation:	EOP(GIUB) 95 R 01
a- A priori nutation model:	IAU(1980)

b- Short period tidal variations in x, y, UT1:

UT1 tidal terms

l	l'	F	D	Om	GST +π	Tide	A1-Amplitude [microtimesec]	A2-Amplitude [microtimesec]
0	0	0	0	0	-1	K1	14.64	11.48
0	0	2	-2	2	-1	P1	-6.09	-3.65
0	0	2	0	2	-1	O1	-12.90	-32.10
0	0	2	-2	2	-2	S2	-3.58	18.25
0	0	2	0	2	-2	M2	-23.34	27.14
1	0	2	0	2	-2	N2	-4.75	5.93

Polar motion tidal terms

l	l'	F	D	Om	GST +π	Tide	A1-Amplitude [microarcsec]	A2-Amplitude [microarcsec]
0	0	2	0	1	1	to 001 p	5.28	-2.64
0	0	2	0	2	1	001 p	8.22	-4.13
1	0	0	0	0	1	J1 p	9.31	-2.32
0	0	0	0	-1	1	to K1 p	20.10	-8.95
0	0	0	0	0	1	K1 p	160.18	-65.37
0	0	-2	2	-2	1	P1 p	-50.44	21.93
0	-1	-2	2	-2	1	Pi1 p	-2.86	1.43
-1	0	0	0	0	1	M1 p	10.53	-5.09

Polar motion tidal terms (continued)

l	l'	F	D	Om	GST +π	Tide	A1-Amplitude [microarcsec]	A2-Amplitude [microarcsec]
1	0	-2	0	-2	1	to O1 p	3.77	-1.85
0	0	-2	0	-2	1	O1 p	-177.50	38.38
0	0	-2	0	-1	1	to O1 p	-31.75	5.94
1	0	-2	-2	-2	1	Rho1 p	-6.29	0.40
-1	0	-2	0	-2	1	Q1 p	-33.38	1.22
-1	0	-2	0	-1	1	to Q1 p	-6.39	0.30
0	0	-2	-2	-2	1	Sigma1 p	-5.79	-0.32
0	0	0	0	1	-2	to K2 r	0.63	18.89
0	0	0	0	0	-2	K2 r	-0.78	63.70
0	0	2	-2	2	-2	S2 r	-64.02	227.65
0	1	2	-2	2	-2	T2 r	2.38	12.58
-1	0	2	0	2	-2	L2 r	-3.11	9.29
0	0	2	0	2	-2	M2 r	164.97	258.94
0	0	2	0	1	-2	to M2 r	3.13	6.04
1	0	2	2	2	-2	Ny2 r	0.41	8.79
1	0	2	0	2	-2	N2 r	15.66	35.95
0	0	2	2	2	-2	My2 r	2.27	5.56
2	0	2	0	2	-2	2N2 r	1.56	4.54
0	0	0	0	-1	2	to K2 p	0.10	-3.30
0	0	0	0	0	2	K2 p	-0.50	-10.69
0	0	-2	2	-2	2	S2 p	-11.65	-29.45
0	-1	-2	2	-2	2	T2 p	0.39	-2.47
1	0	-2	0	-2	2	L2 p	-0.79	2.37
0	0	-2	0	-2	2	M2 p	26.88	-103.40
0	0	-2	0	-1	2	to M2 p	1.82	-3.22
-1	0	-2	-2	-2	2	Ny2 p	2.25	-3.19
-1	0	-2	0	-2	2	N2 p	12.32	-18.26
0	0	-2	-2	-2	2	My2 p	3.99	-0.29
-2	0	-2	0	-2	2	2N2 p	2.89	0.24

p = prograde, r = retrograde
Terms are included in the EOP reported to IERS

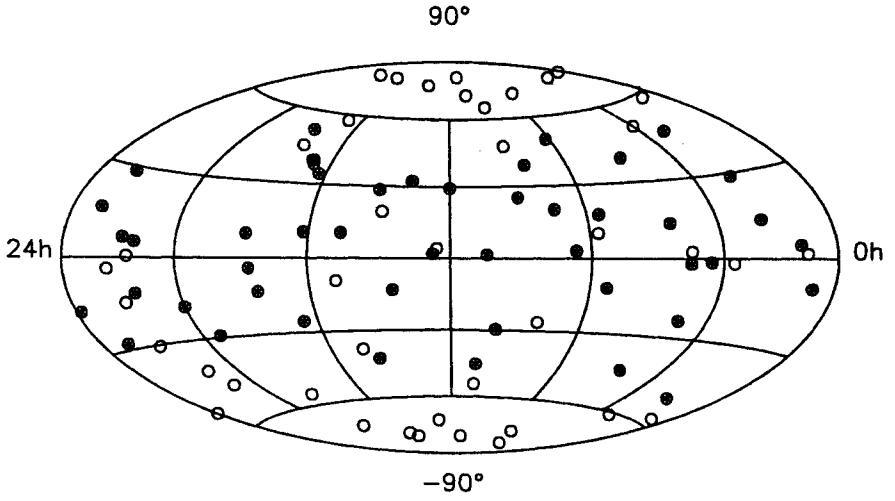
8 - Estimated Parameters:

a- Celestial frame: right ascensions (except OJ287) and declinations

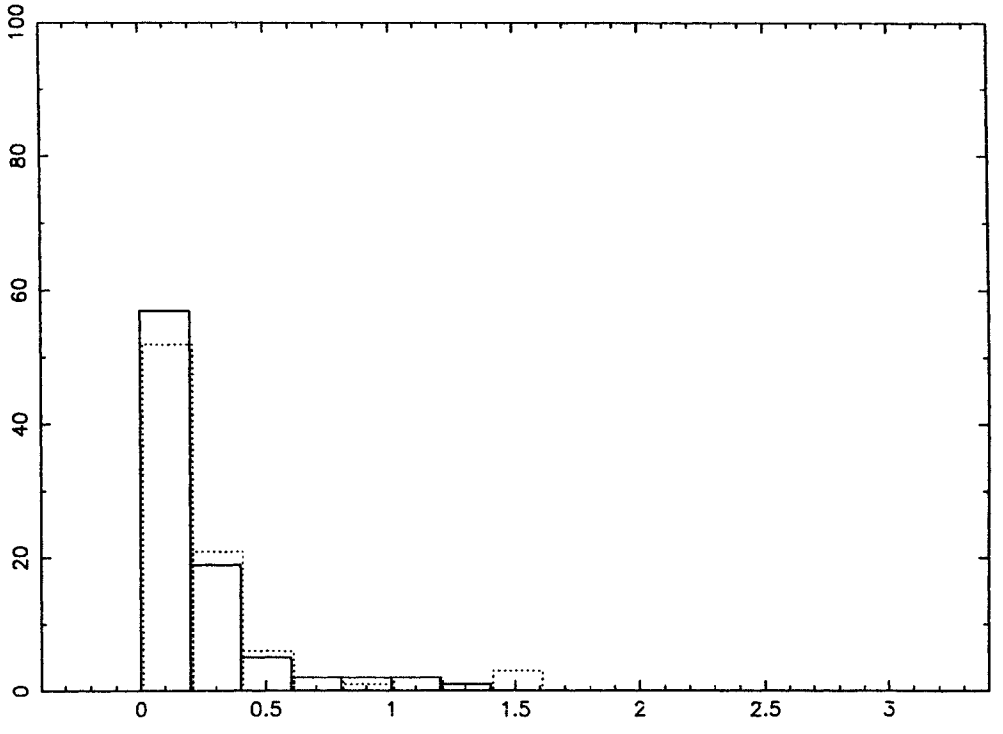
b- Terrestrial frame: station coordinates (x,y,z) of all stations except Wettzell; linear horizontal velocities (Ldot, Pdot expressed as xdot, ydot, zdot) of HartRAO, DSS65, Noto, Effelsberg, Richmond and Mojave; linear velocities (xdot, ydot, zdot) of Onsala, Matera and Medicina;

c- Earth Orientation: xp, yp, UT1-UTC, $\delta\psi$, $\delta\varepsilon$, (xp, yp and UT1-UTC of European sessions are constrainted by 15 mas)

d- Others: clock polynomials, wet zenith tropospheric delays



Distribution over the sky of the 89 extragalactic radio sources of the celestial frame RSC(GIUB) 95 R 01. Filled circles indicate radio sources with uncertainties in right ascension ($\alpha \cos \delta$) and declination smaller than 0.0003".



Distribution of the uncertainties in right ascension (full line) and declination (dashed line) of the celestial frame RSC(GIUB) 95 R 01. 1 radio source with uncertainty larger than 0.003" is not shown.

EOP(GIUB) 95 R 01 From Jan 1986 to Dec 1994

Number of measurements per year and median uncertainties
Units : 0.001" for X,Y,δψ,δε; 0.0001s for UT1

YEAR	X		Y		UT1		δψ		δε	
	Nb	Sigma	Nb	Sigma	Nb	Sigma	Nb	Sigma	Nb	Sigma
1986	6	0.50	6	0.36	6	0.39	6	0.65	6	0.27
1987	8	0.42	8	0.31	8	0.39	8	0.51	8	0.22
1988	5	0.42	5	0.31	5	0.53	5	0.52	5	0.24
1989	6	0.45	6	0.30	6	0.26	6	0.59	6	0.29
1990	14	0.36	14	0.27	14	0.19	14	0.51	14	0.23
1991	15	0.35	15	0.27	15	0.18	15	0.46	15	0.21
1992	18	0.38	18	0.28	18	0.22	18	0.47	18	0.21
1993	23	0.46	23	0.31	23	0.21	23	0.48	23	0.21
1994	22	0.55	22	0.38	22	0.24	22	0.51	22	0.22

SITE POSITIONS AND VELOCITIES, SOURCE POSITIONS, AND EARTH ORIENTATION PARAMETERS FROM THE NASA SPACE GEODESY PROGRAM-GSFC: SOLUTION GLB979F

GSFC 95 R 01

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Mark III VLBI delay data acquired between Aug. 1979 and Dec. 1994 have been analyzed for the terrestrial and celestial reference frames. The sessions used for GLB979f (GSFC 95 R 01) include all geodetic and astrometric VLBI sessions available to the NASA Space Geodesy Program-GSFC except for the data acquired by the NASA Deep Space Network (DSN) for spacecraft navigation. An alternate celestial frame solution which includes also the DSN data (RSC(GSFC) 95 R 02) has been calculated as well.

The major differences from previous submissions include the use of CALC 8.1, changes in some axis offsets, and three new permanent stations: Urumqi (China), Crimea (Ukraine), and Ny Alesund (Spitzbergen). The solid Earth tide model in CALC 8.1 and the ocean loading coefficients have been made fully consistent with the 1992 IERS standards. The axis offset model has been improved. The axis offset values at GILCREEK and HARTRAO were updated using new surveys that are consistent with estimates from VLBI. The axis offset of USSURISK was updated from a VLBI estimate. Only delay observations were used in this work. The number of sites used to constrain the time evolution of the TRF was reduced from eight to five. The sites eliminated (KAUAI, GILCREEK, and ONSALA60) show small but formally significant departures from the underlying NNR NUVEL-1 plate motion model. UT1 values are reported for IRIS and NAVNET intensive sessions.

The basic models used to calculate the VLBI delays are consistent with the 1992 IERS standards and are contained in the Goddard CALC 8.1 program. These include IAU 1980 nutation with daily offsets in longitude and obliquity estimated, solid Earth tides correcting the K1 term but not the zero frequency displacement, pole tide, vertical and horizontal ocean loading, DE200 solar system ephemeris, and a modified Hellings (1986) VLBI time delay that agrees with the IERS standard model within 5 ps rms. The pole position for each observation was interpolated linearly from a one-day input series. The UT1 value for each observation was derived from the one-day series by first removing the IERS standard UT1R tidal model, interpolating linearly to the epoch of observation, then restoring the standard tidal model. In addition, diurnal and semidiurnal EOP variations (derived from a subset of the Mark III geodetic data) were added to the interpolated pole and UT1 values.

The GLB979f solution was constructed in several steps using an incremental solution and arc-parameter elimination (Ma *et al.*, 1990). First the sessions comprising large networks and strong data as well as the single baseline POLARIS days (2106 sessions, 1354582 delays) were combined to form a preliminary TRF using the modified one-day EOP(IERS) 90 C 04 values as a priori input. The adjusted parameters included site positions and velocities, source positions, EOP values, UT1 rates, nutation offsets, and clock and troposphere parameters. Weak EOP constraints (45 mas and 3 ms for X/Y pole and UT1, respectively) were applied so that all three EOP components could be estimated for single baseline sessions with reliable indication of uncertainty and correlation. The EOP values, UT1 rates, and their covariances from each day were then input to a simple Kalman filter to generate a one-day VLBI EOP series. The covariances and interpolated EOP values from this series were used as a priori information when the solution was incremented with the remaining full-day data (308 sessions, 108190 delays), largely mobile and small network sessions. Finally the reported EOP and nutation offset values were generated from a back

solution using weak EOP constraints for all the sessions. While EOP values are given for all sessions, a flag indicates which values are useful. UT1 values from the 1-hr, single baseline, daily IRIS intensive measurements were generated from a back solution using pole position values, nutation offsets, and their respective covariances from the GLB979f solution. Similarly, the EOP values from the 2 and 3-hr, three-baseline NAVNET intensive measurements came from a back solution using nutation offset and covariance information from the GL979f solution.

About 220 sources used largely in the geodetic programs form the core of the celestial reference frame. These have ~100 to ~100000 observations each. About 450 sources have 1-sigma formal errors under 1 mas while ~300 have formal errors under 0.3 mas. The remaining sources include a number with weak data. Sources with uncertainties >10 mas are not reported. While the terrestrial reference frame has more than 120 points, the distribution of data temporally and spatially is very uneven. The southern hemisphere has only five stations. Some of the best stations, notably the VLBA, only began observing in recent years, and their positions at the reference epoch 1988.0 is not representative. The median 1-sigma formal errors in the horizontal and vertical position components at the best epoch for each site are 2 mm and 7 mm, respectively. More than half the sites have useful velocity estimates, and the median horizontal and vertical rate errors are 0.5 mm/yr and 2 mm/yr, respectively.

In total 1466561 dual-frequency Mark III delays from 2415 full-day sessions are included in solution GLB979f. The solution has 1997 global parameters and 495627 arc parameters with 1135300.8 degrees of freedom. The weighted rms post-fit delay residual of the solution is 35.4 ps. The reduced chi-square is 1.019 including the constraints for the wet troposphere, clocks, and EOP in the computation of the degrees of freedom (Theil, 1963). The statistics for the IRIS and NAVNET intensives are 2356 sessions and 22267 delays with 23.5 ps wrms residual and 119 sessions and 4146 delays with 30.8 ps wrms residual, respectively.

The site coordinates and velocities at 1988.0 are designated SSC(GSFC)95 R 01. Other results are three Earth orientation time series designated EOP(GSFC)95 R 01 for the full-day data, EOP(GSFC)95 R 02 for the IRIS intensive data, and EOP(GSFC)95 R 03 for the NAVNET intensive data. The source positions are designated RSC(GSFC)95 R 01.

References

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Technical description of solution GSFC 95 R 01

1 - Technique:	VLBI
2 - Analysis Center:	Goddard Space Flight Center
3 - Software used:	CALC 8.1, SOLVE/GLOBL
4 - Data span:	Aug 79 - Dec 94
5 - Celestial Reference Frame:	RSC(GSFC) 95 R 01
a - Nature:	extragalactic
b - Definition of the orientation:	The celestial reference frame orientation is defined by the CEP pole position computed from the IAU 1980 nutation model and the J2000.0 precession model for the 1993 Sep 30 reference day corrected by the nutation offset

from the modified EOP(IERS) 90 C 04 series and by the ICRF92 right ascension of 2145+067.

6 - Terrestrial Reference Frame: SSC(GSFC) 95 R 01

a - Relativity scale: SSB from modified Hellings VLBI delay model

b - Velocity of light: 299 792 458 m/s

c - Geogravitational constant: not applicable

d - Permanent tidal correction: No permanent tide applied

e - Definition of origin: The origin of the terrestrial reference frame is set by minimizing the Cartesian adjustments of nine stations (WESTFORD, RICHMOND, GILCREEK, KAUAI, HOBART26, DSS45, HARTRAO, WETTZELL, ONSALA60) with respect to ITRF92 at 1988.0.

f - Definition of orientation: The orientation of the terrestrial reference frame is defined by the a priori EOP values on the reference day (1993 Sep 30) from the modified EOP(IERS) 90 C 04 series that is consistent with ITRF92 (M. Feissel, private communication).

g - Reference epoch: 1988.0

h - Tectonic plate model: NNR-NUVEL1

i - Constraint for time evolution:

The horizontal rate residuals of five stations (WESTFORD, RICHMOND, HOBART26, DSS45, WETTZELL) with respect to No-Net-Rotation NUVEL1 are minimized. The adjusted vertical rates of the same stations are also minimized. The stations with insufficient data or time interval are constrained to move with NNR-NUVEL1 with uncertainties in vertical, east and north rates of 0, 3, and 3 mm/yr, respectively. These stations are:

OCOTILLO, GOLDMARS, PARKES, TIDBIN64, MADRID64, SEST, VLA,VICTORIA, MIZNAO10, CHLBOLTN, USSURISK, TITIJIMA, MIYAZAKI, DAITO, URUMQI, CRIMEA, NYALES20, MIZUSGSI, SAGARA, AUSTINTX, CARROLGA, BERMUDA, SINTOTU, USUDA64, MILESMON, BLOOMIND, LEONRDOK, BREST, CARNUSTY, METSHOVI, HOHENFRG, GRASSE, HOFN, KARLBURG, TOULOUSE, AZORES, HOHNBERG, KIRSBERG.

The vertical rates for stations that had uncertainties in their vertical rates in excess of 3mm/yr in an unconstrained solution are also constrained to zero. These stations are:

MON_PEAK, HN-VLBA, MK-VLBA, PLATTVIL, GORF7102, GGAO7108, SANTIA12, QUINCY, DSS15, TSUKUBA, PT_REYES, SC-VLBA, KWAJAL26, PINFLATS, PRESIDIO JPL_MV1, NOME, MARCUS, TROMSONO, YUMA, FORT_ORD, FORTORDS, ELY, FLAGSTAF, KODIAK, VERNAL, PBLOSSOM, SNDPOINT, PENTICTN, SANPAULA, PVERDES, BLKBUTTE, TRYSILNO, SOURDOGH, YAKATAGA, SEATTLE1, MAMMOTHL OHIGGINS WHTHORSE DEADMANL, NOBEY_6M.

The velocities of the following groups of sites are constrained to be identical:

DSS65-ROBLED32, SESHAN25 - SHANGHAI, FORT ORD - FORTORDS, MOJAVE12-MOJ 7288, OVRO 130 - OVR 7853, ONSALA60 - MV2ONSLA - ONSALA85, NRAO 140-NRAO85 1, KAUAI - KOKEE - HALEAKAL, YELLOWKN - YLOW7296, GORF7102 - GGAO7108, HRAS 085 - FTD 7900 - MCD 7850.

The positions of the following sites were allowed to change discontinuously once:

YAKATAGA (871201), SOURDOGH (871201), WHTHORSE (871201), FORTORDS (891001), PRESIDIO (891001), NRAO85 3 (901201), MOJAVE12 (920627), DSS15 (920627).

7 - Earth orientation: EOP(GSFC) 95 R 01
a - A priori nutation model: IAU(1980)
b - Short-period tidal variations in x, y, UT1: Diurnal and semidiurnal tidal variations in polar motion and UT1 were estimated using geodetic VLBI data (10 tidal components in UT1 and 12 in polar motion). The model below is applied in this solution. The variations are included in the reported EOP series.

UT1 tidal terms (microseconds)

l	l'	F	D	Om	GST +pi	term	Cos	Sin
0	0	0	0	0	-1	K1	6.252927	15.600300
0	0	2	-2	2	-1	P1	-2.649379	-5.246193
0	0	2	0	2	-1	O1	-15.381776	-15.592820
1	0	2	0	2	-1	Q1	-3.534252	-4.015490
0	1	0	0	0	-1	S1	-.369238	1.106177
1	0	0	0	0	-1	M1	1.220679	1.882189
0	0	0	0	0	-2	K2	-.071600	3.800587
0	0	2	-2	2	-2	S2	-1.043297	8.605459
0	0	2	0	2	-2	M2	-10.846194	14.708632
1	0	2	0	2	-2	N2	-2.514309	3.199383

Polar motion tidal terms (microarcseconds)

l	l'	F	D	Om	GST +pi	term	Cos	Sin
0	0	0	0	0	1	P K1	128.996879	-47.392242
0	0	-2	2	-2	1	P P1	-48.638393	28.332852
0	0	-2	0	-2	1	P O1	-132.971705	68.974209
-1	0	-2	0	-2	1	P Q1	-33.869221	11.177365
0	0	0	0	0	-2	R K2	-15.297337	15.916971
0	0	2	-2	2	-2	R S2	-74.696652	108.377915
0	0	2	0	2	-2	R M2	-3.221247	273.078222
1	0	2	0	2	-2	R N2	-4.989908	41.822294
0	0	0	0	0	2	P K2	11.645893	-10.680081
0	0	-2	2	-2	2	P S2	-10.393208	-15.655399
0	0	-2	0	-2	2	P M2	16.337510	-57.620809
-1	0	-2	0	-2	2	P N2	2.330556	-15.138890

P = Prograde, R = Retrograde

Earth orientation: EOP(GSFC) 95 R 02 - IRIS intensive sessions
a - A priori nutation model: EOP(GSFC) 95 R 01
b - Short-period tidal variations in x, y, UT1: same as above

Earth orientation: EOP(GSFC) 95 R 03-USNO intensive sessions
a - A priori nutation model: EOP(GSFC) 95 R 01
b - Short-period tidal variations in x, y, UT1: same as above

8 - Estimated Parameters:
a - Celestial Frame: right ascension except 2145+067, declination

b - Terrestrial Frame:	X0, Y0, Z0, Xdot, Ydot, Zdot
c.- Earth Orientation:	x, y, UT1-TAI, UT1dot, $d\psi$, $d\varepsilon$
d - Others:	Piece-wise linear, continuous wet zenith troposphere delays using MTT wet mapping function
	Station clock offsets, rates and quadratics as well as piece-wise linear, continuous terms
	Clock breaks as required
	Baseline clock offsets

9 - Miscellaneous notes:

Only group delay observations are used.

Only observations above 7 degrees elevation are used.

EOP values are estimated at the chronological midpoint of each session rounded to the nearest minute.

The axis offsets of the following sites are modified from previous values using information from local surveys (GILCREEK, HARTRAO) and VLBI estimates:

ALGOPARK, BR-VLBA, DSS65, FORTLEZA, GILCREEK, HARTRAO, HATCREEK, HOBART26, KASHIM34, KAUAI, KOKEE, MATERA, MEDICINA, MOJAVE12, NRAO 140, NRAO85 3, ONSALA60, OV-VLBA, OVRO 130, RICHMOND USSURISK, VNDNBERG, WETTZELL.

The primary effect is a change in the station vertical position for az-el and x-y mount antennas and in the station north component for equatorial mount antennas.

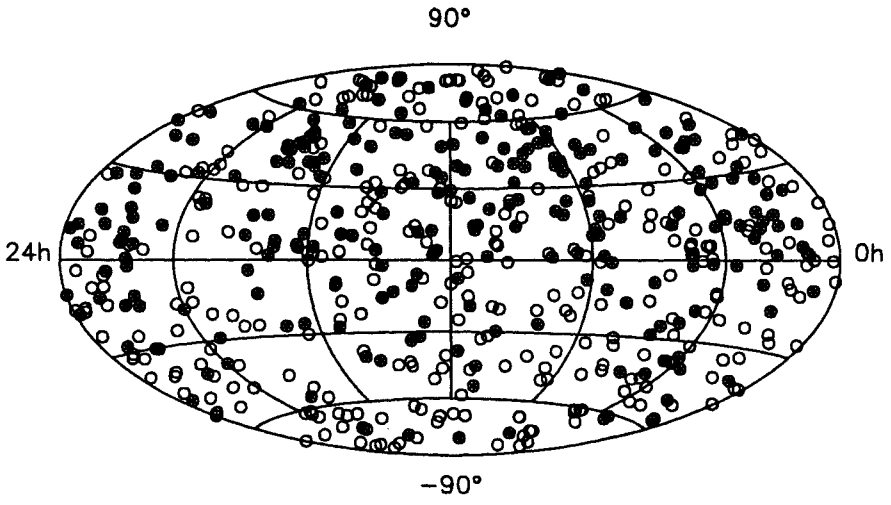
Observation weights are adjusted by session-dependent constants derived so that the chi-square per degree of freedom is unity in individual session solutions.

Data to SHANGHAI (7226), VLA (7619), USSURISK (7247) and DAITO (7326) lack ionosphere calibration.

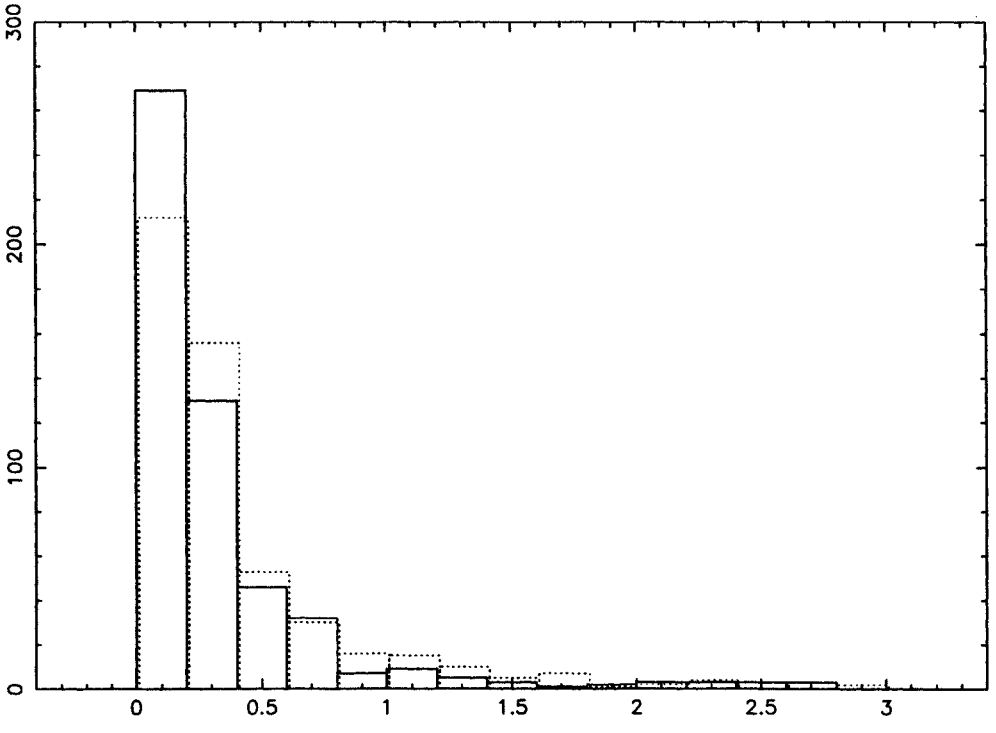
The solution in done is several steps to apply VLBI EOP information to some sessions.

Mean epochs are computed using the date of the session weighted by the number of good observations in the session for each source or site. The time span of observations is the difference between the date of the earliest session in which the given site or source appears and the date of the most recent session in which the same site or source appears. The central epoch and span for the sites (PRESIDIO, FORTORDS, SOURDOGH, YAKATAGA, WHTHORSE, MOJAVE12, DSS15, NRAO85 3) that appear more than once due to the application of a discontinuous motion model are calculated from the observations which were made in the sessions within the appropriate time interval.

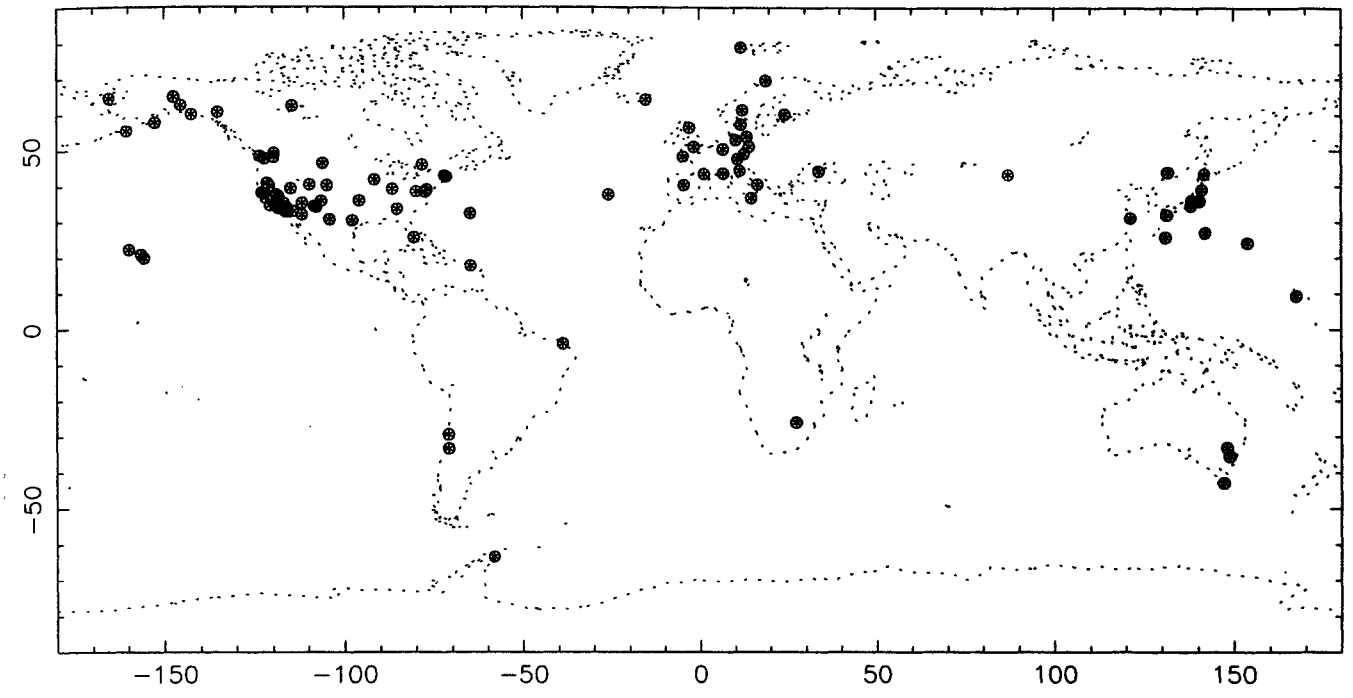
An entry for the EOP reference day 1993 September 30 is included in each EOP table although the values were, strictly speaking, not estimated. The purpose is to indicate the quality of the EOP determination for the reference day that sets the overall lower limit of the precision of the EOP series.



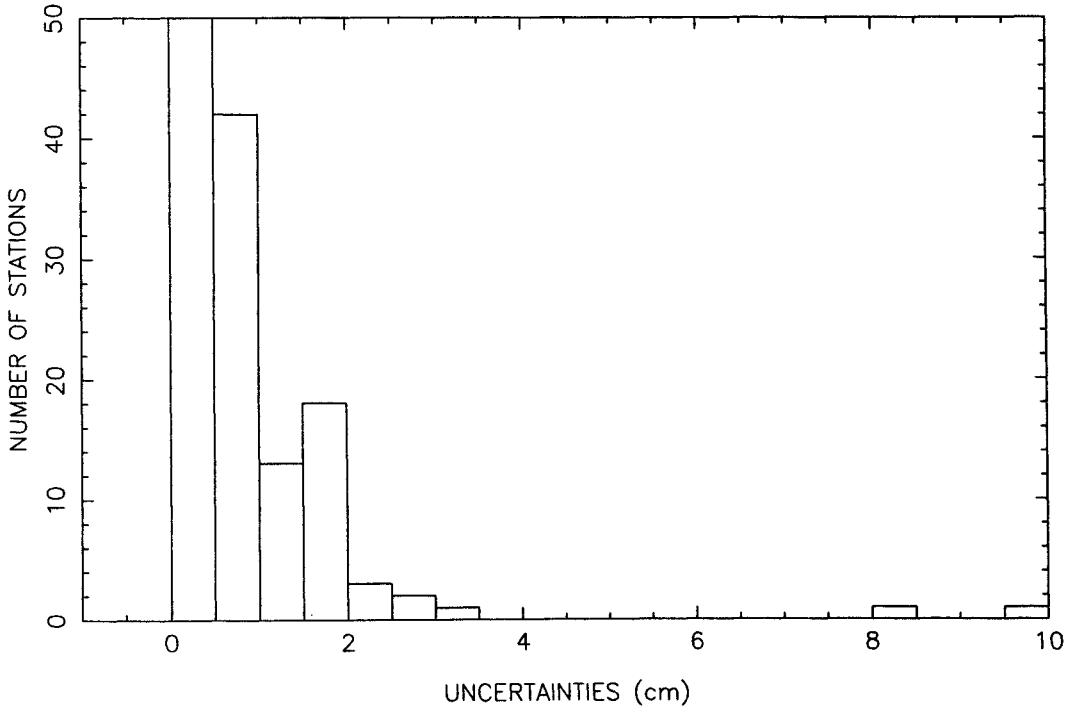
Distribution over the sky of the 550 extragalactic radio sources of the celestial frame RSC(GSFC) 95 R 01. Filled circles indicate radio sources with uncertainties in right ascension ($\alpha \cos \delta$) and declination smaller than 0.0003".



Distribution of the uncertainties in right ascension (full line) and declination (dashed line) of the celestial frame RSC(GSFC) 95 R 01. 34 radio sources with uncertainties larger than 0.003" are not shown.



Distribution of the 104 sites of the terrestrial frame SSC(GSFC) 95 R 01.



Distribution of the uncertainties (quadratic mean of σ_x, σ_y, σ_z) for the 134 stations of the terrestrial frame SSC(GSFC) 95 R 01. 2 stations with uncertainties larger than 10 cm are not shown.

EOP(GSFC) 95 R 01 From Aug 1979 to Dec 1994

Number of measurements per year and median uncertainties
Units : 0.001" for X,Y,$\delta\psi$, $\delta\varepsilon$; 0.0001s for UT1

YEAR	X		Y		UT1		$\delta\psi$		$\delta\varepsilon$	
	Nb	Sigma	Nb	Sigma	Nb	Sigma	Nb	Sigma	Nb	Sigma
1979	2	1.17	2	2.28	2	0.85	2	1.86	2	0.66
1980	20	0.60	20	0.60	20	0.30	20	0.98	20	0.43
1981	34	13.06	34	41.06	34	10.57	34	3.21	34	1.14
1982	62	12.87	62	40.62	62	10.44	62	2.91	62	1.11
1983	85	12.66	85	33.25	85	10.22	85	2.27	85	0.93
1984	119	0.76	119	0.68	119	0.37	119	1.10	119	0.43
1985	131	0.47	131	0.45	131	0.24	131	0.73	131	0.28
1986	152	0.47	152	0.41	152	0.24	152	0.72	152	0.26
1987	185	0.46	185	0.43	185	0.24	185	0.71	185	0.26
1988	210	0.46	210	0.46	210	0.26	210	0.64	210	0.25
1989	247	0.34	247	0.35	247	0.19	247	0.55	247	0.22
1990	271	0.26	271	0.27	271	0.14	269	0.43	269	0.18
1991	248	0.21	248	0.22	248	0.12	244	0.38	247	0.16
1992	259	0.20	259	0.20	259	0.09	258	0.35	258	0.15
1993	194	0.16	194	0.14	194	0.07	193	0.26	193	0.11
1994	196	0.13	196	0.10	196	0.06	196	0.21	196	0.09

EOP(GSFC) 95 R 02
From Apr 1984 to Dec 1994

Number of measurements per year and median uncertainties
Units : 0.0001" for UT1

YEAR	UT1	
	Nb	Sigma
1984	64	1.16
1985	159	0.90
1986	234	0.84
1987	248	0.81
1988	255	0.63
1989	234	0.75
1990	261	0.64
1991	247	0.69
1992	191	0.39
1993	260	0.36
1994	203	0.34

EOP(GSFC) 95 R 03
From Apr 1989 to Apr 1993

Number of measurements per year and median uncertainties
Units : 0.0001" for UT1

YEAR	UT1	
	Nb	Sigma
1989	9	0.48
1990	54	0.90
1991	29	0.89
1992	20	0.50
1993	7	0.53

EARTH ROTATION PARAMETERS FROM DSN VLBI: 1995 JPL 95 R 01

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California Institute of Technology; Pasadena, California 91109, USA

A description of the DSN VLBI data set and of last year's analysis can be found in last year's report (see IERS Technical Note 17, pp. R-19 to R-32). Other than including another year's data, the main changes in this year's analysis from last year's are in the use of meteorological data for determining tropospheric parameters and in the weighting of the data to account for the uncertainty in the observables caused by tropospheric effects and source structure. A priori dry zenith tropospheric delays were determined from barometric pressure measurements at the DSN sites, corrected for height differences between the pressure sensor and the antennas. A priori wet zenith tropospheric delays were derived from tables of monthly average wet zenith delays for each station, which are based on historical radiosonde data. The Lanyi function was used for mapping zenith tropospheric delays to observed elevations. The temperature at the top of the boundary layer, a parameter in the Lanyi function, was taken to be the 24-hour average of the surface temperature at the station. Adjustments to the wet troposphere zenith delays were estimated every two to three hours.

The raw observable uncertainties have been modified by adding quadratically four additional uncertainty components. The first component is a source-specific constant determined from source-specific residual scatter. It varies from 0 to 150 ps for delays (0 to 100 fs/s for delay rates), and tends to be associated with sources having known structure. The second and third components - one for each of the two stations - are proportional to the a priori wet tropospheric delay (which grows as elevation angle decreases) with a proportionality constant of 0.042 for delays and 7.5 10^{-5} sec^{-1} for delay rates. The fourth component is an "additive noise" constant selected to make the Chi Square of the postfit residuals approximately equal to the number of degrees of freedom in the solution. The delay and delay rate additive noise constants were adjusted separately for each CAT M&E observing session. For the TEMPO data, the additive noises were adjusted for each of several blocks of observing sessions. The change in the tropospheric error model compared to last year has dramatically reduced the size of the "additive noise" constants needed for the delay rate data.

During calendar year 1994, the TEMPO project produced earth rotation measurements from 91 dual frequency observing sessions, with a median standard error along the minor axis of the error ellipse of 0.3 milliarcseconds (mas), and along the major axis of 1.4 mas. During 1994 the median turnaround time for TEMPO measurements, from observation to availability of earth orientation parameters, was 48 hours.

In the Tidal ERP table below, the argument conventions are those of Sovers *et al.* (1993). The formal errors range from 11 to 46 microarcseconds but realistic uncertainties are probably about 70 microarcseconds (one standard deviation).

Acknowledgements. We would like to thank each and every one of the many people who contributed to the acquisition and analysis of the DSN VLBI data. The work described in this paper was carried out by the Jet Propulsion Laboratory, California Institute of Technology, under contract with the National Aeronautics and Space Administration.

Short Period Tidal ERP Variations

Term	Period (hours)	UT1 (microseconds) Cosine	UT1 (microseconds) Sine	Polar Motion Amplitude (microarcseconds) prograde	Polar Motion Amplitude (microarcseconds) retrograde	Polar Motion Phase (degrees) prograde	Polar Motion Phase (degrees) retrograde
K2	11.96724	1.6	2.7	46	58	45	229
S2	12.00000	0.1	9.3	5	130	53	310
M2	12.42060	-10.8	17.0	72	248	117	275
N2	12.65835	- 1.0	2.8	16	34	88	221
K1	23.93447	11.8	24.4	176	0	154	*
P1	24.06589	- 1.3	- 3.1	91	0	309	*
O1	25.81934	-10.6	-13.2	155	0	301	*
Q1	26.86836	3.2	- 2.0	42	0	326	*

Celestial Ephemeris Pole Motion Model (nutations relative to ZMOA-1990-2)

IAU-Index	Period days	Phase	Component	Adjustment mas	Formal Error mas	Generalized Error mas
precession			Longitude	-3.05/yr	0.05/yr	0.07/yr
obliquity rate			Obliquity	-0.26/yr	0.03/yr	0.03/yr
Y-offset			L sin eps	-17.59	0.23	0.36
X-offset			Obliquity	+ 5.61	0.36	0.37
1	-6798.38	In	Longitude	- 0.27	0.25	0.41
			Obliquity	- 0.06	0.08	0.08
		Out	Longitude	+ 0.30	0.16	0.21
			Obliquity	- 0.04	0.15	0.16
2	-3399.19	In	Obliquity	- 0.23	0.04	0.04
		Out	Longitude	- 0.29	0.10	0.11
			Obliquity	+ 0.09	0.08	0.08
10	365.26	In	Longitude	- 0.35	0.06	0.06
			Obliquity	+ 0.06	0.02	0.03
		Out	Longitude	+ 0.33	0.06	0.07
			Obliquity	- 0.01	0.02	0.03
9	182.62	In	Longitude	- 0.07	0.05	0.05
			Obliquity	- 0.02	0.02	0.03
		Out	Longitude	+ 0.17	0.06	0.06
			Obliquity	+ 0.03	0.02	0.02
31	13.66	In	Longitude	- 0.24	0.04	0.11
			Obliquity	+ 0.14	0.02	0.04
		Out	Longitude	+ 0.31	0.06	0.10
			Obliquity	+ 0.10	0.02	0.04
	-429.8	In	Longitude	- 0.24	0.06	0.07
			Obliquity	+ 0.03	0.02	0.03
		Out	Longitude	- 0.45	0.06	0.06
			Obliquity	- 0.15	0.03	0.03

Technical description of solution JPL 95 R 01

1 - Technique:	VLBI
2 - Analysis Center:	JPL
3 - Software used:	MODEST
4 - Data span:	Oct 78 - Jan 95
5 - Celestial Reference Frame:	RSC(JPL) 95 R 01
a - Nature:	extragalactic
b - Definition of the orientation:	The Right Ascension and Declination of OJ 287 (0851+202) and the Declination of CTD 20 (0234+285) were held fixed at the values specified in RSC(IERS) 94 C 01.
6 - Terrestrial Reference Frame:	SSC(JPL) 95 R 01
a - Relativity scale:	LE (TDT = geocentric with IAT) The relativity model used is essentially equivalent to the "consensus model" described by Eubanks.
b - Velocity of light:	299 792 458 m/s
c - Geogravitational constant:	$3.9860\,0448\,10^{14}$ m^3 s^{-2}
d - Permanent tidal correction:	Yes
e - Definition of the origin, and f - Definition of the orientation:	Six constraints were applied to the nine coordinates (at epoch 1993.0) of DSS 15, DSS 45, and DSS 65, such that if a seven parameter transformation (3 translations, 3 rotations, 1 scale) between the JPL 1995-1 and ITRF-93 systems was estimated by unweighted least squares applied to the coordinates of DSS 15, 45, and 65, then the resulting 3 translation and 3 rotation parts of the transformation would be zero while the scale could be nonzero and unknown in advance of computing the catalog. (When expressed as the dot product of a nine dimensional unit vector with the nine station coordinates, each constraint is assigned an a priori standard deviation of 5 mm; this does not affect the resulting coordinates but does affect the calculated formal errors, giving them a more spherical distribution than would result if either very large or very small a priori standard deviations were used.)
g - Reference epoch:	1993.0
h - Tectonic plate model:	ITRF-93 plus adjustments
i - Constraint for time evolution:	Three-dimensional site velocities were estimated for each of the three DSN complexes. All stations in each DSN complex were assumed to have the same site velocity. The velocities were constrained so as to produce no net translation rate and no net rotation rate, for the network composed of the three DSN complexes, relative to the

net motion of this network of three sites as expressed in the ITRF-93 velocity field. (When expressed as the dot product of a nine dimensional unit vector with the nine site velocity components, each constraint is assigned an a priori standard deviation of 1.0 mm/yr; this does not affect the resulting velocity components but does affect the calculated formal errors, giving them a more spherical distribution than would result if either very large or very small a priori standard deviations were used.)

7 - Earth Orientation: EOP(JPL) 95 R 01

a - A priori nutation model: ZMOA-1990-2 plus adjustments

b - Short-period tidal variations in x, y, UT1:

As part of the JPL 1995-1 catalog solution we estimated coefficients of a model of ERP variations at nearly-diurnal and nearly-semidiurnal tidal frequencies. (Nearly-diurnal polar motion variations were constrained to have no retrograde part, thus allowing simultaneous estimation of nutations.) The reported earth rotation parameters have had these tidal frequency variations removed according to the parametric model estimated in the catalog solution. (In other words, these effects have NOT been added back in producing EOP(JPL) 95 R 01.)

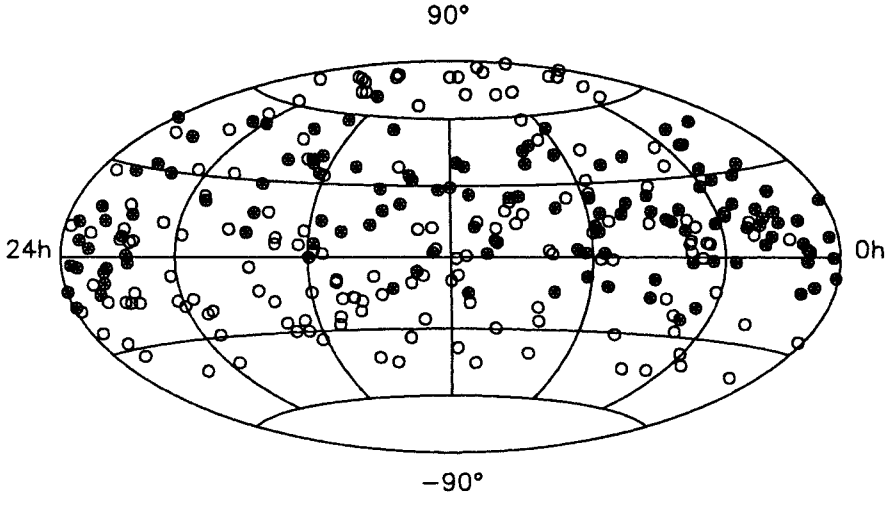
8 - Estimated Parameters:

a - Celestial Frame: right ascension, declination (all sources, but see 5b)

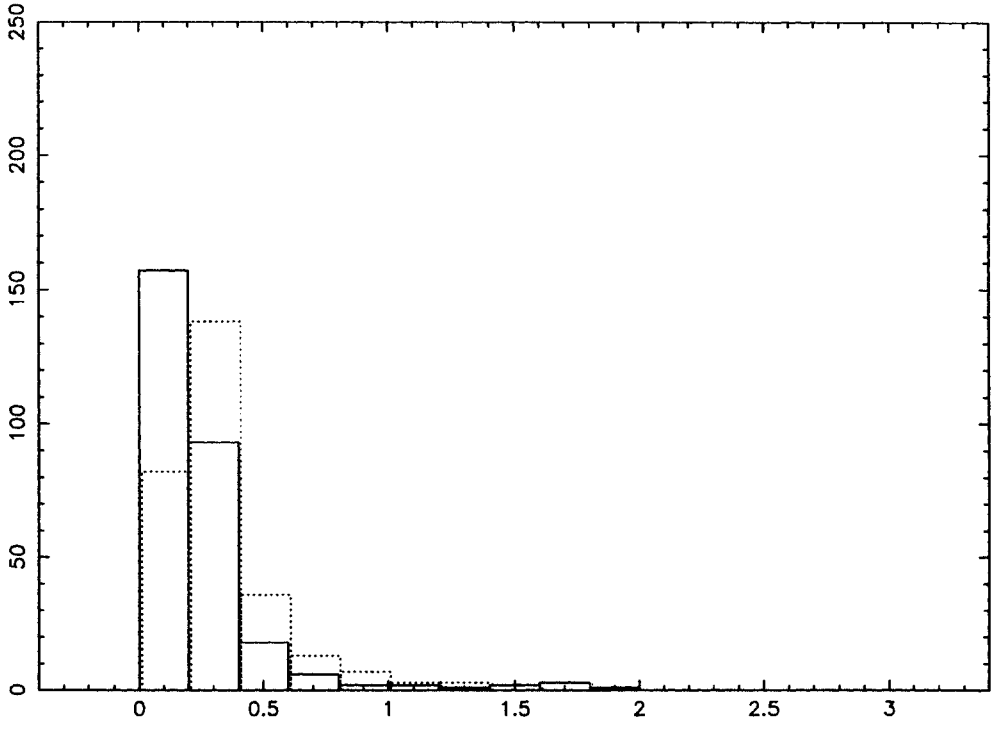
b - Terrestrial Frame: X0, Y0, Z0 (by station), $\dot{X}$, $\dot{Y}$, $\dot{Z}$ (by site)

c - Earth Orientation: UT0-UTC and Variation of Latitude of the baseline vector
precession constant, obliquity rate, celestial pole offsets at J2000
coefficients of 23 nutation terms
coefficients of 40 diurnal and semidiurnal tidal terms in ERP

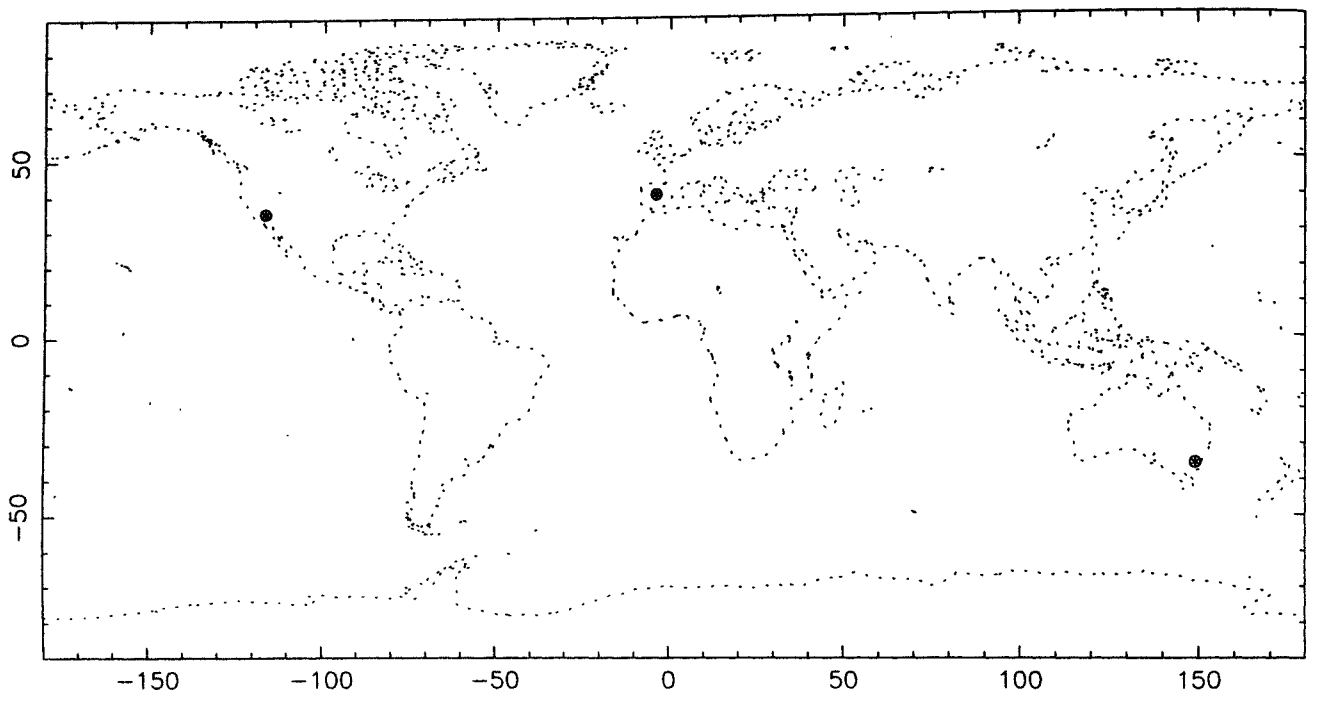
d - Others: wet zenith tropospheric delays
station clock offsets, rates, and frequency offsets



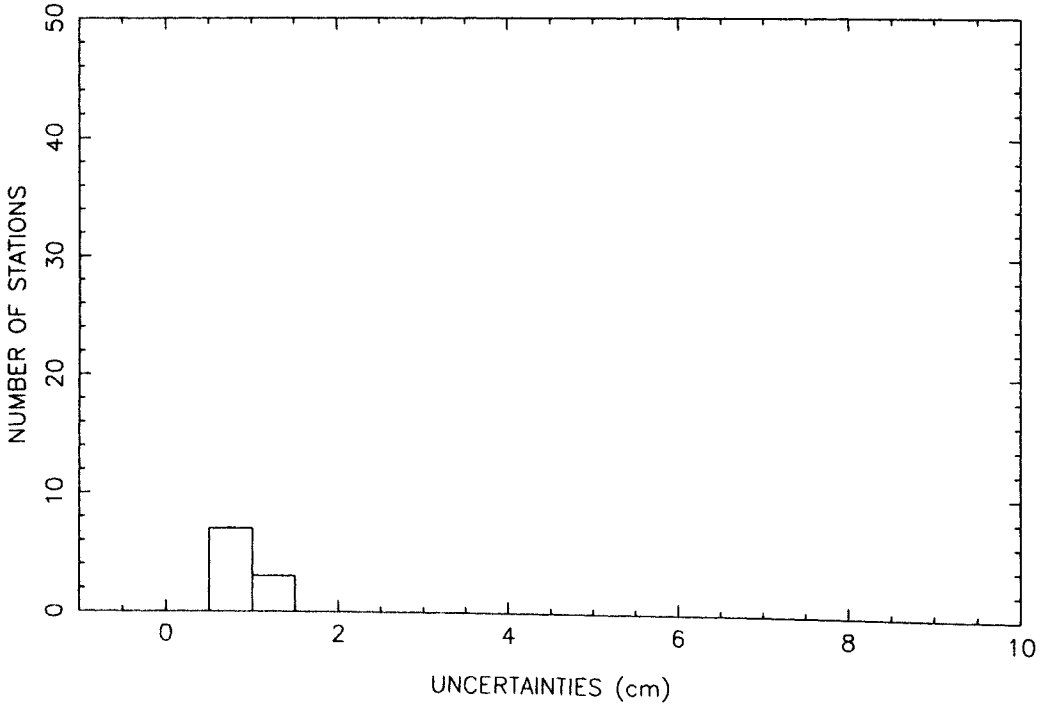
Distribution over the sky of the 287 extragalactic radio sources of the celestial frame RSC(JPL) 95 R 01. Filled circles indicate radio sources with uncertainties in right ascension ($\alpha \cos \delta$) and declination smaller than 0.0003".



Distribution of the uncertainties in right ascension (full line) and declination (dashed line) of the celestial frame RSC(JPL) 95 R 01. 2 radio sources with uncertainties larger than 0.003" are not shown.



Distribution of the 3 sites of the terrestrial frame SSC(JPL) 95 R 01.



Distribution of the uncertainties (quadratic mean of σ_x, σ_y, σ_z) for the 10 stations of the terrestrial frame SSC(JPL) 95 R 01.

EOP(JPL) 95 R 01 From Oct 1978 to Jul 1995

Number of measurements per year and median uncertainties
Units : 0.001" for φ ; 0.0001s for UT0

YEAR	φ		UT0	
	Nb	Sigma	Nb	Sigma
1978	3	0.42	3	1.15
1979	6	1.84	6	1.83
1980	21	4.11	21	6.47
1981	17	2.81	17	5.75
1982	43	3.44	43	4.08
1983	74	3.03	74	4.91
1984	71	3.62	71	5.47
1985	19	2.18	19	3.78
1986	71	2.50	71	3.48
1987	77	2.08	77	3.43
1988	93	1.61	93	2.27
1989	89	0.78	89	1.70
1990	108	0.88	108	1.98
1991	111	0.45	111	1.06
1992	115	0.41	115	0.80
1993	101	0.59	101	0.89
1994	99	0.72	99	0.88
1995	42	0.90	42	0.85

RADIO SOURCE COORDINATES FROM DSN VLBI JPL 95 R 02

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California Institute of Technology; Pasadena, California 91109, USA

VLBI data collected from radio telescopes at the three NASA Deep Space Network sites (Australia, Spain, and the USA) by JPL between 1978 and 1994 were analyzed to yield a celestial reference frame. This celestial frame differs from RSC(JPL) 95 R 01 in three important respects: 1) no TEMPO data are included, 2) daily nutation corrections are estimated, rather than ZMOA-2 amplitudes, and 3) short-period UTPM corrections are modeled, not estimated. It contains coordinates of 290 radio sources and is tied to RSC(IERS) 94 C 01 through the right ascension of a single source, 0235+164. Daily nutation angle offsets were estimated from those given by the ZMOA-2 series, with 1992 March 22 serving as the reference day. The terrestrial frame is tied to ITRF-93 through the locations of the stations at the Goldstone site. A new set of coordinates is estimated for each experiment for stations at the other two sites. The time series SPACE94 [EOP(JPL) 95 C 01] is used to fix the UTPM part of Earth orientation. Nearly-diurnal and nearly-semidiurnal tidal frequency variations of UTPM were modeled with the parameters derived by Sovers, Jacobs and Gross (1993). Other aspects of modeling that departed from convention were the inclusion of the octupole components and frequency dependent Love numbers for the solid Earth tides, and a simple model for antenna thermal expansion.

The data base contains approximately 9000 Mark II (1978-89) and 14000 Mark III (1988-94) observations. Different tropospheric modeling was performed for these two classes. In both cases, a priori dry zenith tropospheric delays were determined from barometric pressure measurements at the DSN sites, corrected for height differences between the pressure sensors and the antennas. A priori wet zenith tropospheric delays were derived from tables of monthly average wet zenith delays for each station, which are based on historical radiosonde data. The Lanyi function was used for mapping zenith tropospheric delays to observed elevations. Three parameters in the Lanyi function were assigned values that differ from the defaults. The temperature at the top of the boundary layer was taken to be the 24-hour average of the surface temperature at the station. Both the tropopause height and temperature lapse rate were taken to be the monthly average values derived from radiosonde data at Australia and Spain, while global averages were used for Goldstone. Adjustments to the wet troposphere zenith delays were estimated every two to three hours for the Mark II experiments, and every 12 hours for Mark III. An a priori covariance matrix was introduced for each Mark III experiment. It is based on the turbulent troposphere model of Treuhaft and Lanyi (1987), with two empirically adjusted parameters at each station: wind direction and fluctuation scale. No external elevation cuts were applied: the elevation limits were imposed by the antenna and horizon geometry (6 degrees).

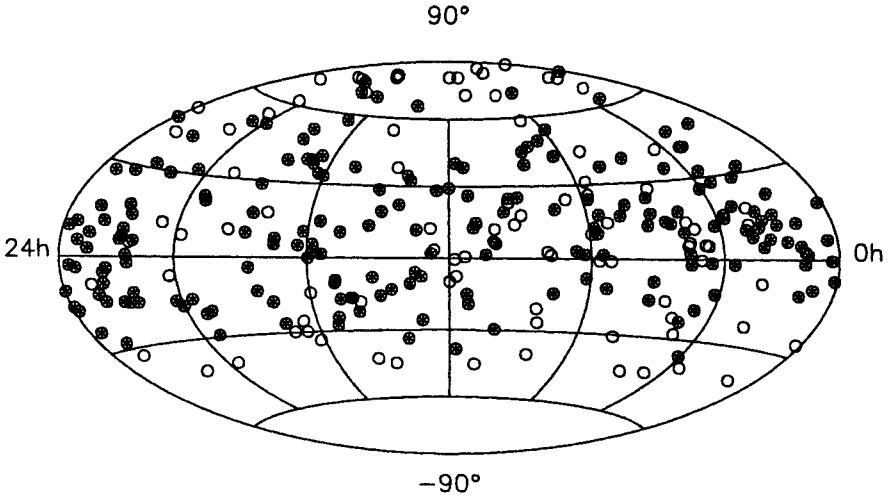
The raw observable uncertainties were further modified by quadratic addition of four additional uncertainty components. Only the first of these was used for Mark III data: a source-specific constant determined from source-specific residual scatter, which varies from 0 to 150 ps for delays (0 to 100 fs/s for delay rates), and which tends to be associated with sources having known structure. Such downweighting was applied to a total of 39 sources. Mark II data weights also included troposphere errors modeled as components proportional to the a priori wet troposphere contribution to each observable (which grow as the elevation angle decreases) at each of the two stations, with proportionality constants of

0.042 for delays and 0.24 for delay rates. The fourth component is an "additive noise" constant selected to make the normalized chi square of the postfit residuals approximately 1. These delay and delay rate additive noise constants were adjusted separately for each observing session.

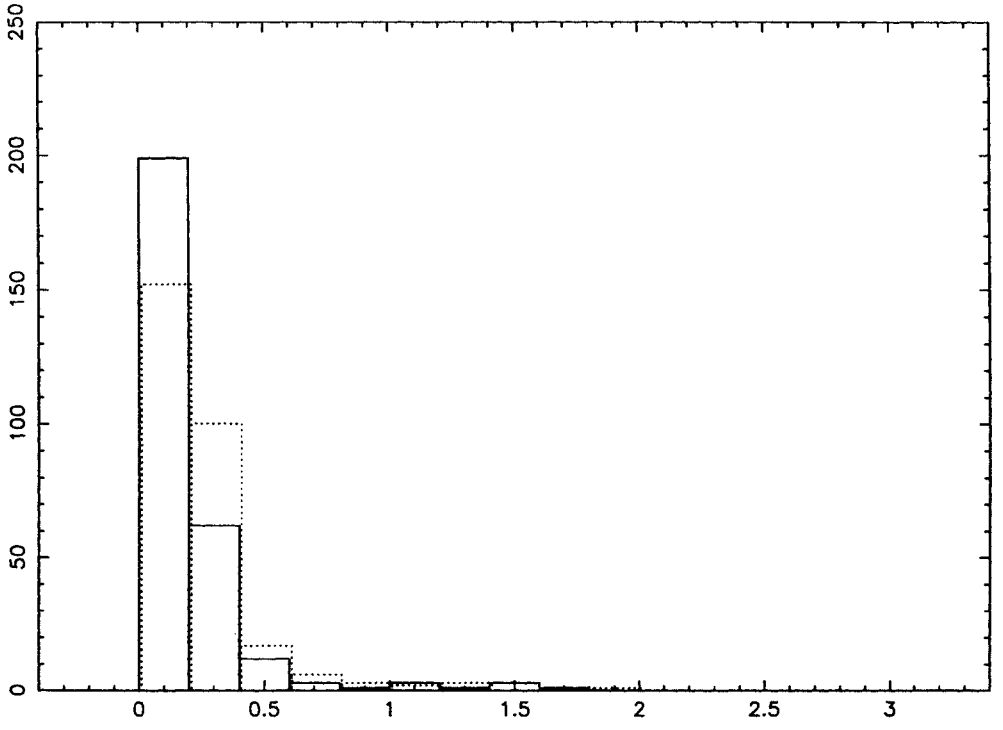
There is a minimum of 10 observations for all but 9 of the 290 sources, ranging up to a maximum of 403 for 1641+399. All but 12 sources have declination uncertainties below 1 mas, with the median being 0.21 mas. In spite of the special care employed to ensure realistic error assignment based on source structure and troposphere considerations, the declination uncertainties are as small as 80 microarcseconds for a number of sources at high declinations. Based on external catalog comparisons, we consider these formal uncertainties to be overly optimistic.

Technical description of solution JPL 95 R 02

1 - Technique:	VLBI
2 - Analysis Center:	JPL
3 - Software used:	MODEST
4 - Data span:	Oct 78 - Nov 94
5 - Celestial Reference Frame:	RSC(JPL) 95 R 02
a - Nature:	Extragalactic
b - Definition of the orientation:	The right ascension and declination of 0235+164 was held fixed at the value specified in RSC(IERS) 94 C 01.
6 - Terrestrial Reference Frame:	SSC(JPL) 95 R 02
a - Relativity scale:	LE (TDT = geocentric with IAT)
b - Velocity of light:	299 792 458 m/s
c - Geogravitational constant:	$3.9860\,0448\ 10^{14}\ m^3s^{-2}$
d - Permanent tidal correction:	Yes
e - Definition of the origin:	Goldstone stations fixed
f - Definition of the orientation:	UTPM values fixed at EOP(JPL) 95 C 01
g - Reference epoch:	None (daily adjustments)
h - Tectonic plate model:	None (daily adjustments)
i - Constraint for time evolution:	None
7 - Earth Orientation:	EOP(JPL) 95 C 01
a - A priori nutation model:	ZMOA-1990-2
b - Short-period tidal variations in x, y, UT1:	Model and coefficients of Sovers, Jacobs, Gross, JGR 98, 19959 (1993)
8 - Estimated Parameters	
a - Celestial Frame:	Right ascension, declination (all sources, but see 5b)
b - Terrestrial Frame:	Daily X, Y, Z for Spain and Australia stations
c - Earth Orientation:	Daily celestial pole offsets, with 92/3/22 reference day
d - Others:	Dry zenith tropospheric delays Wet zenith tropospheric delays Station clock offsets, rates, and frequency offsets



Distribution over the sky of the 290 extragalactic radio sources of the celestial frame RSC(JPL) 95 R 02. Filled circles indicate radio sources with uncertainties in right ascension ($\alpha \cos \delta$) and declination smaller than 0.0003".



Distribution of the uncertainties in right ascension (full line) and declination (dashed line) of the celestial frame RSC(JPL) 95 R 02. 5 radio sources with uncertainties larger than 0.003" are not shown.

NOAA EARTH ORIENTATION AND REFERENCE FRAME RESULTS DERIVED FROM VLBI OBSERVATIONS: FINAL REPORT

NOAA 95 R 01, 02

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Results from two VLBI solutions are submitted using nearly 207000 more observations this year, an increase of more than 20% over last year. Most of the available Mark III VLBI data from 1980 September through 1994 have been included. NOAA 95 R 01 reports estimated values for the coordinates of 249 radio sources (73 more than last year), terrestrial site coordinates and velocities for 111 points (5 more than last year), and a time series of 1773 Earth orientation values. A separate series of quasi-daily UT1 values is reported in NOAA 95 R 02 for 2397 epochs, referenced to the NOAA 94 R 01 system. All tidal effects are included in the reported EOP values, including diurnal and semi-diurnal variations.

The most significant changes since our submission last year [Ray *et al.*, 1994] are summarized below:

• First data are included from the following VLBI facilities: 25-m OV-VLBA antenna (Owens Valley, CA, USA), 22-m CRIMEA antenna (Simeiz, Crimea), 25-m URUMQI antenna (China), and 20-m NYALES20 antenna (Ny Alesund, Spitzbergen). The time series of data from DSS15 (Goldstone, CA, USA) was broken into two segments, before (DSS15) and after (DSS15pq) the Landers earthquake of 1992 June 28; the velocity of each segment was constrained to agree with that of MOJAVE12.

• During 1994, several significant changes were made in the VLBI observing procedures for the quasi-daily UT1 observing sessions. At the start of the year, the frequency sequences were changed to the same set of wideband sequences used in the NEOS-A sessions. On 1994 Feb. 24, WESTFORD was replaced by NRAO85_3 as the western end of the VLBI baseline. Beginning 1994 Jul. 01, the data acquisition mode was changed from 14 channels using upper sideband only with 4-MHz bandwidth sampled in each channel to 28 channels using upper and lower sidebands with 2-MHz bandwidth sampled in each channel. Both modes record the same number of data samples and therefore yield the same sensitivity.

Our data analysis procedures are otherwise the same as those described last year [Ray *et al.*, 1994].

References

Ray, J.R., Abell, M.D., Carter, W.E., Dillinger, W.H., Morrison, M.L., and Robertson, D.S., 1994: NOAA Earth Orientation and Reference Frame Results Derived from VLBI Observations: 1994 Analysis Procedures, in *IERS Technical Note 17* (P. Charlot, ed.), Observatoire de Paris, Paris, p. R-37 - R-62.

Technical description of solutions NOAA 95 R 01 and 95 R 02

1 - Technique: VLBI

2 - Analysis Center: NOAA VLBI Analysis Center, Geosciences Laboratory, N/OES13, SSMC-4, 1305 East-West Highway, Silver Spring, MD, USA 20910-3281

3 - Software used: COREL and FRNGE for the Mark III data correlation and fringe-fitting; DE200 ephemerides; CALC-7.6 for theoreticals and partials; SOLVE-3 for parameter estimation.

4 - Data span: Sep. 1980 - Jan. 1995 for NOAA 95 R 01
Apr. 1984 - Dec. 1994 for NOAA 95 R 02

5 - Celestial Reference Frame: RSC(NOAA) 95 R 01
a - Nature: Extragalactic radio sources
b - Definition of the orientation: The RA origin at epoch J2000.0 is specified by constraining the sum of the adjusted RA values for 71 "primary" sources (each weighted by the cosine of its declination) to equal the corresponding sum obtained from RSC(IERS) 93 C 01.
The orientation is specified by fixing the EOP values for the reference epoch 1991 August 12 19:49:50 at values interpolated from the EOP(IERS) 90 C 04 series.

6 - Terrestrial Reference Frame: SSC(NOAA) 95 R 01
a - Relativity scale: Radio source coordinates are in SSB system; terrestrial site coordinates are geocentric (ignoring the local gravitational potential of the Earth)
b - Velocity of light: 299 792 458. m/s
c - Geogravitational constant: not applicable
d - Permanent tidal correction: No correction is applied to remove the zero-frequency displacement introduced by the solid Earth tide model.

e - Definition of origin:
The coordinate origin of the terrestrial reference frame is specified by setting the vector sum of the adjusted coordinates for 20 VLBI sites equal to the corresponding vector sum for ITRF-92 at epoch 1988.0. The sites used in the origin constraint are:

WESTFORD, RICHMOND, ALGOPARK, GILCREEK, NRAO85_3, PLATTVIL, MOJAVE12, OVRO_130, VNDNBERG, ONSALA60, EFLSBERG, WETTZELL, KASHIMA, SESHAN25, DSS65, KAUAI, KWAJAL26, HOBART26, DSS45, and HARTRAO.

f - Definition of orientation: The orientation is specified by fixing the EOP values for the reference epoch 1991 August 12 19:49:50 at values interpolated from the EOP(IERS) 90 C 04 series.
g - Reference epoch: 1993.0
h - Tectonic plate model: NNR-NUVEL1A
i - Constraint for time evolution:
The secular translational velocity and rotational velocity of the terrestrial reference frame are specified through a set of constraints to match the net motion of the NNR-NUVEL1A model for 10 VLBI sites. The sites used in the velocity constraints are:

WESTFORD, RICHMOND, ALGOPARK, GILCREEK, NRAO85_3, PLATTVIL, ONSALA60, EFLSBERG, WETTZELL, and KAUAI.

7 - Earth orientation: EOP(NOAA) 95 R 01, R 02

a - A priori nutation model: The IAU(1980) nutation model is applied a priori and the reported nutation offset values are with respect to this model. However, the ZMAO-1990.2 model is also used to model the time variation between tabular points in the NOAA EOP a priori file.

b - Short-period tidal variations in x, y, UT1: The model of Herring [1993] has been used to model tidal variations in x, y, and UT1 near diurnal and semi-diurnal frequencies. These tidal effects are included in the reported EOP values.

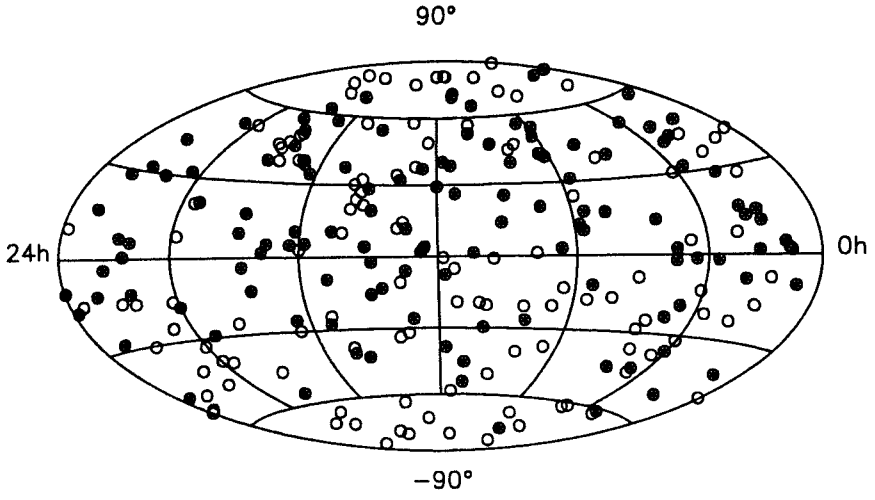
8 - Estimated Parameters:

a - Celestial Frame: Right ascension, declination.
A constraint is applied such that the sum of the adjusted RA values for 71 "primary" radio sources (each weighted by the cosine of its declination) equals the corresponding sum from RSC(IERS) 93 C 01.
No celestial frame parameters are adjusted for EOP(NOAA) 95 R 02.

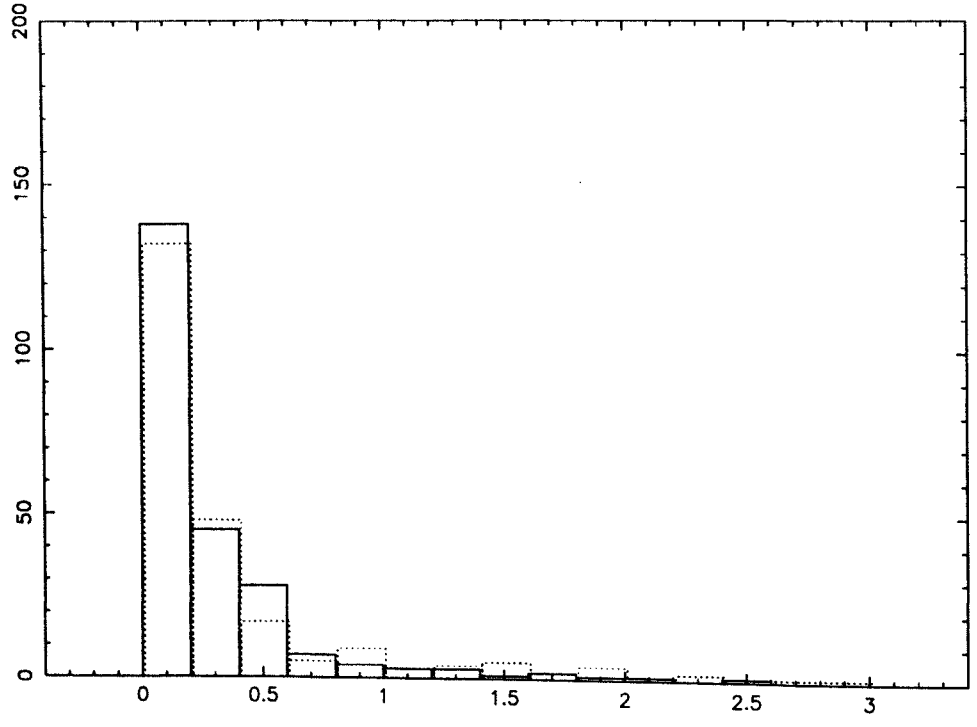
b - Terrestrial Frame: X0, Y0, Z0, Xdot, Ydot, Zdot.
Constraints are applied, as described above, to fix the coordinate origin and to fix the net translational and rotational velocities; note that the coordinates are estimated at the mean epoch for each site and subsequently projected to a common epoch.
No terrestrial frame parameters are adjusted for EOP(NOAA) 95 R 02.

c - Earth Orientation: x, y, UT1-UTC, $\delta\psi$ $\delta\epsilon$.
EOP values for the reference epoch 1991 August 12 19:49:50 are held fixed at values interpolated from the EOP(IERS) 90 C 04 series.
Only UT1-UTC parameters are adjusted for EOP(NOAA) 95 R 02.

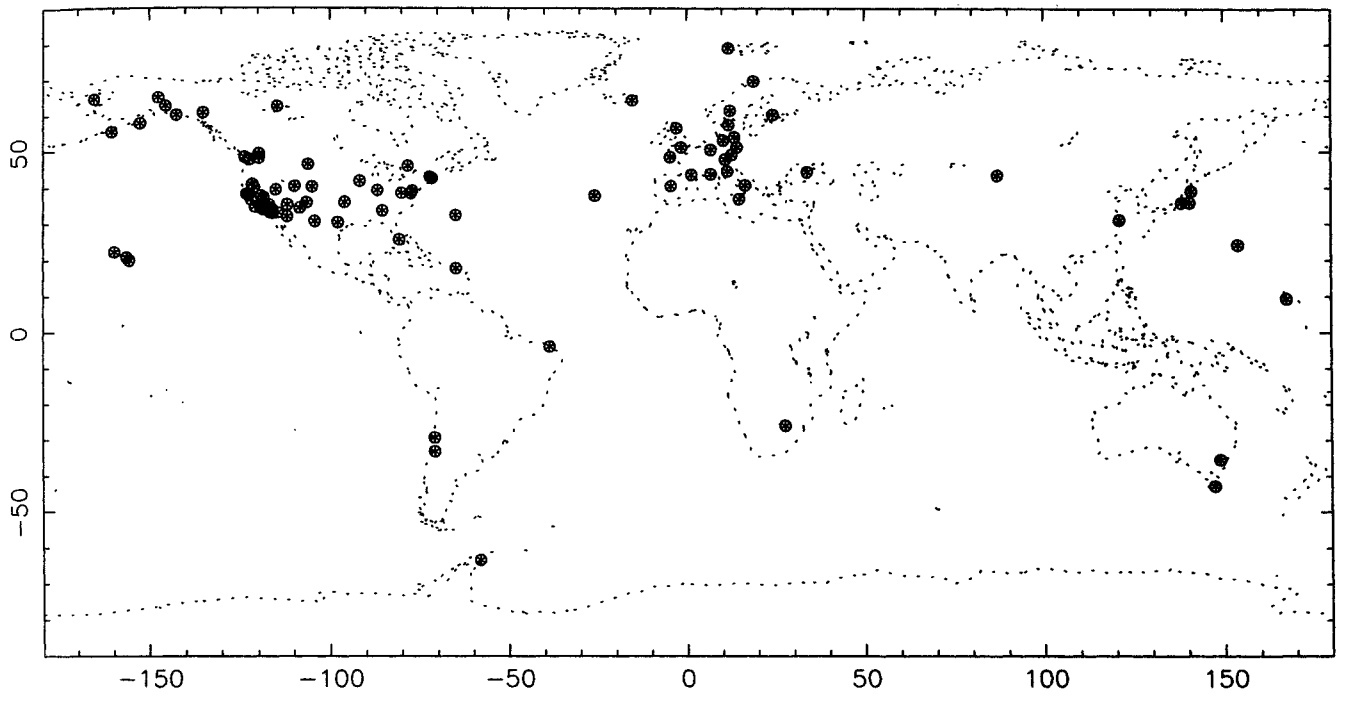
d - Others: - residual zenith tropospheric delay at each VLBI site using constrained offset parameters at each 1-hour interval and the NMF "dry" and "wet" mapping models; no tropospheric parameters are adjusted for EOP(NOAA) 95 R 02.
- station clock offsets relative to one reference clock in each observing session using segmented polynomial models; only one clock offset and one clock rate parameter are adjusted for EOP(NOAA) 95 R 02.
- no observations with an elevation angle below 5 degrees are included in the analysis.



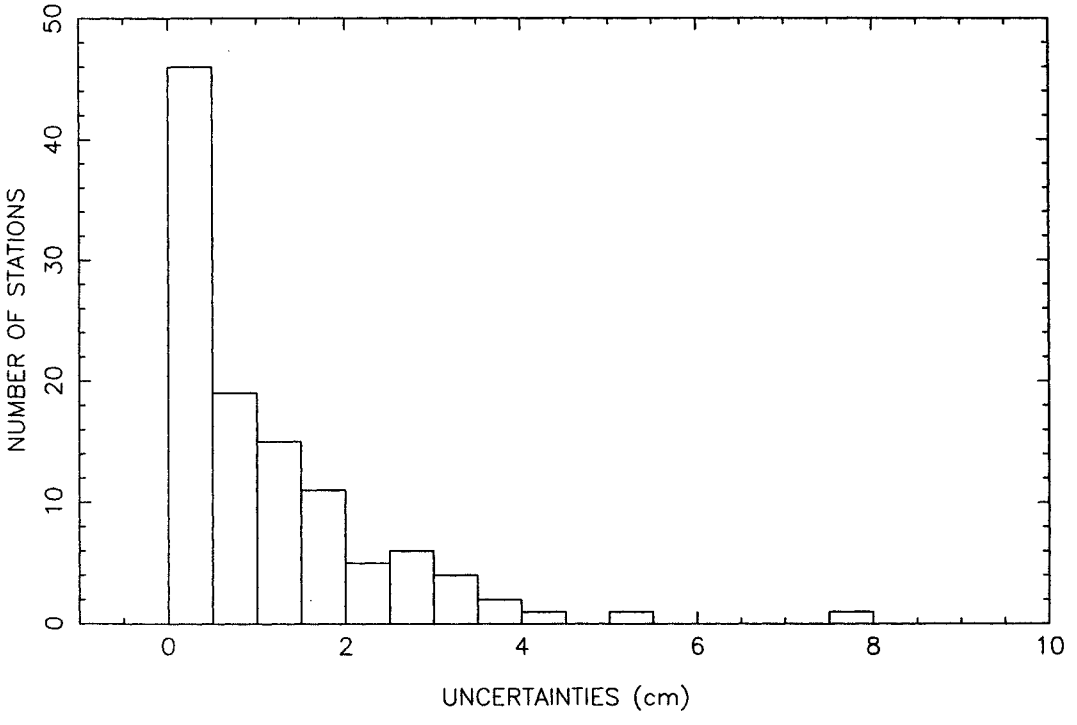
Distribution over the sky of the 249 extragalactic radio sources of the celestial frame RSC(NOAA) 95 R 01. Filled circles indicate radio sources with uncertainties in right ascension ($\alpha \cos \delta$) and declination smaller than 0.0003".



Distribution of the uncertainties in right ascension (full line) and declination (dashed line) of the celestial frame RSC(NOAA) 95 R 01. 15 radio sources with uncertainties larger than 0.003" are not shown.



Distribution of the 94 sites of the terrestrial frame SSC(NOAA) 95 R 01.



Distribution of the uncertainties (quadratic mean of σ_x, σ_y, σ_z) for the 111 stations of the terrestrial frame SSC(NOAA) 95 R 01.

EOP(NOAA) 95 R 01 From Sep 1980 to Jan 1995

Number of measurements per year and median uncertainties
Units : 0.001" for X , Y, δψ, δε; 0.0001s for UT1

YEAR	X		Y		UT1		δψ		δε	
	Nb	Sigma	Nb	Sigma	Nb	Sigma	Nb	Sigma	Nb	Sigma
1980	16	0.62	16	0.66	16	0.31	16	0.98	16	0.33
1981	6	0.99	6	1.14	6	0.57	6	1.33	6	0.46
1982	10	1.09	10	0.97	10	0.45	10	1.76	10	0.51
1983	17	0.96	17	1.74	17	0.72	17	1.58	17	0.49
1984	82	0.66	82	0.69	82	0.36	82	0.99	82	0.35
1985	108	0.43	108	0.44	108	0.22	108	0.62	108	0.23
1986	120	0.41	120	0.39	120	0.20	120	0.59	120	0.22
1987	141	0.43	141	0.42	141	0.20	141	0.61	141	0.23
1988	159	0.39	159	0.37	159	0.20	159	0.53	159	0.21
1989	186	0.33	186	0.32	186	0.16	186	0.46	186	0.19
1990	194	0.24	194	0.24	194	0.12	194	0.37	194	0.15
1991	173	0.20	173	0.21	173	0.09	173	0.33	173	0.13
1992	218	0.21	218	0.22	218	0.09	218	0.34	218	0.14
1993	169	0.16	169	0.15	169	0.07	169	0.28	169	0.12
1994	172	0.14	172	0.14	172	0.06	172	0.26	172	0.11
1995	1	0.12	1	0.13	1	0.05	1	0.23	1	0.09

EOP(NOAA) 95 R 02 From Apr 1984 to Dec 1994

Number of measurements per year and median uncertainties
Units : 0.0001s for UT1

YEAR	UT1	
	Nb	Sigma
1984	64	1.00
1985	159	0.57
1986	237	0.58
1987	245	0.56
1988	255	0.56
1989	234	0.58
1990	261	0.58
1991	247	0.55
1992	223	0.40
1993	260	0.39
1994	212	0.40

ANALYSIS OF THE IRIS VLBI INTENSIVE SESSIONS

EOP(OPA) 95 R 01

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The series is based on the analysis of VLBI observations obtained in the frame work of the IRIS program on the Wettzell-Westford baseline over 1988-1994 and on the Wettzell-NRAO85-3 baseline since March 1994. The latitude of the stations are respectively 49°, 43° and 38° N. The observations consist of two scans of each of the four radio sources in the program (four scans since October 1991), repeated on all days when no 24h routine IRIS-A is scheduled. The observation list includes two high declination sources (0212+735, 1803+784), and two lower declination sources which are changed about every three months. This scheduling results in three-month batches with constant geometry and sidereal time of observation. It is optimised for the determination of universal time. The analysis is similar to that described by Gontier *et al.* (1993).

The data analysis includes the adoption of fixed values for the coordinates of stations and sources, for the pole coordinates (x, y) and the celestial pole offsets ($d\psi$, $d\varepsilon$). All values were adopted from homogeneous IERS results: SSC(IERS) 94 C 01 and the NNR-NUVEL1 model for the terrestrial frame, RSC(IERS) 94 C 01 for the celestial frame, and EOP(IERS) 90 C 04 for the terrestrial and celestial coordinates of the pole (corrected for the bias recommended in the 1993 IERS Annual Report, p. II-19).

Modelling of observations is made with the French-developped software GLORIA (Global Radio-Interferometry Analysis, see Gontier 1992), which follows generally the IERS Standards (McCarthy, 1992), with the following peculiarities:

- the transformation between the terrestrial frame and the celestial frame makes use of Guinot's (1979) non-rotating origin (or departure point) concept (Gontier 1991, Capitaine and Gontier 1993),

- the tropospheric correction is based on Saastamoinen (1972) zenith delay using the CFA 2.2 mapping function (Davis *et al*, 1985) for the dry component and the Chao (1974) mapping function for the wet component (see the references in the IERS Standards, McCarthy, 1992).

- the BDL2000 ephemeris (Chapront-Touzé and Chapront 1983, Bretagnon 1982).

Editing of observations is performed by using an L_1 norm analysis of each session to detect outliers. This estimation technique (minimizing the sum of absolute values of residuals) is known to be less sensitive to outliers than the least-squares (L_2 norm) technique when the degree of freedom of an estimation is low (Bougeard 1992).

Acknowledgements. We are thankful to J. Morrison (NOAA) for providing the past and current observation data sets, and to J. Souchay (Paris Observatory) for the L_1 norm estimation software.

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EOP(OPA) 95 R 01 From Jan 1988 to Dec 1994

Number of measurements per year
and median uncertainties
Units : 0.0001s for UT1

YEAR	UT1	
	Nb	Sigma
1985	157	0.34
1986	236	0.32
1987	245	0.30
1988	255	0.27
1989	233	0.29
1990	261	0.26
1991	239	0.22
1992	211	0.23
1993	255	0.17
1994	211	0.15

EARTH ROTATION AND REFERENCE FRAMES FROM VLBI ANALYSIS

SHA 95 R 01

Yang Zhigeng - Shanghai Observatory

The SHA Earth orientation reduction depends on the reference frames, which were derived from all available VLBI data of IRIS-A network in 1993 and NEOS-A network in 1994, instead of using both the celestial and terrestrial reference frames of a global VLBI solution of the VLBI group at NASA Goddard Space Flight Center. This is a considerable difference from previous solutions, which were only SOLVK EOP solution.

The SHA VLBI celestial and terrestrial reference frame were obtained from the available VLBI data mentioned above in a two solution process. In the first solution, the calculation was made by using SOLVK software, in which, the polar motion of EOP(NEOS) 94 R 01 series was treated as a priori pole position for each session and the priori UT1 measurement value for each session was also taken from the same series by first removing the IERS standard tidal model, interpolating with a spline to the epoch of session, and then restoring the standard tidal model. The nutation in longitude and obliquity was estimated at the same time in this first solution. The positions of radio sources and stations were fixed, in which the right ascensions and declinations of all observed sources and the coordinates of stations in IRIS-A and NEOS-A networks were respectively taken from the values of IERS combined celestial reference frame RSC(IERS) 94 C 01 and the terrestrial reference frame SSC(IERS) 94 C 01.

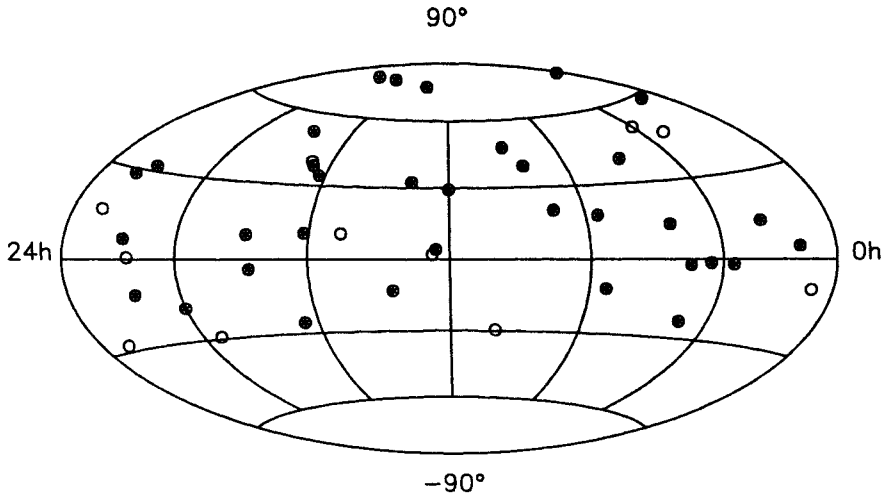
In the second solution, the right ascension of the source 0229+131 and the declination of two sources 0229 + 131 and 0851 + 202 were held fixed at the values given in RSC(IERS) 94 C 01. The position of Wettzell was fixed to define the origin of the terrestrial frame while its orientation was defined by fixing the direction from Westford to Wettzell. The updated ERP parameters in the first solution were treated as a priori measurements in this solution. Then, all parameters, including ERP and nutation offsets of each session,and the positions of the observed sources and involved stations, except for the reference radio sources and stations mentioned above, were globally adjusted. The second solution, as final results, was submitted to IERS.

The estimations of station positions were only calculated in the second solution, because it is difficult to estimate the station velocities by using only these two years data of VLBI experiments with the adequate accuracies. Therefore, the station velocities of NNR-NUVEL1 tectonic plate motion model were adopted for this solution.

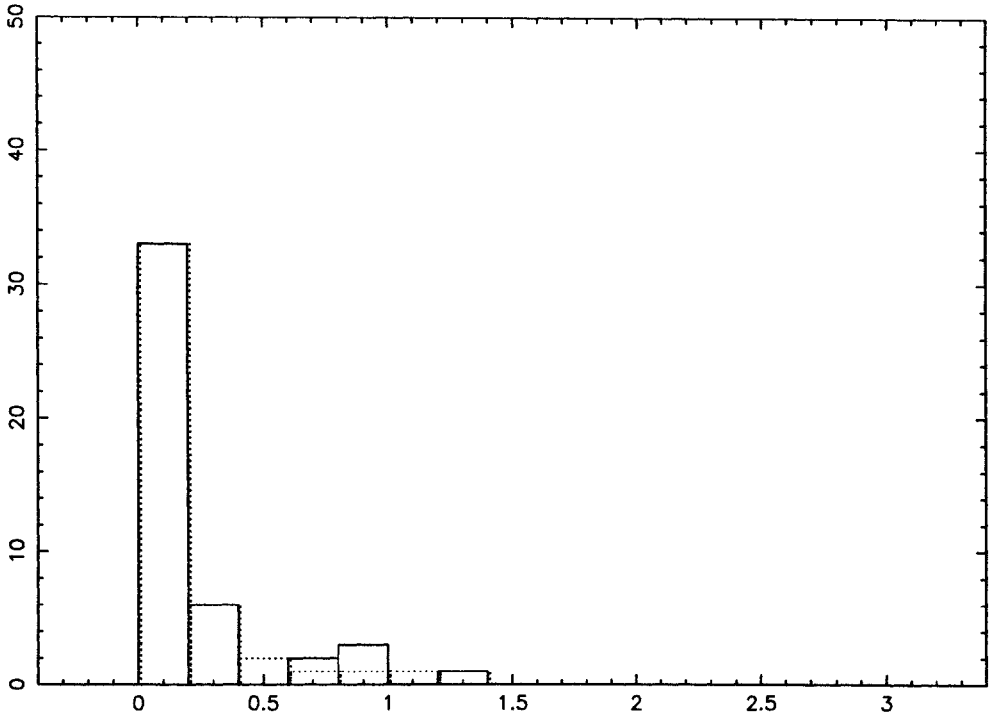
The data analysis in this report used the standard models which were adopted in CALC 7.6 software.

Technical description of solutions SHA 95 R 01

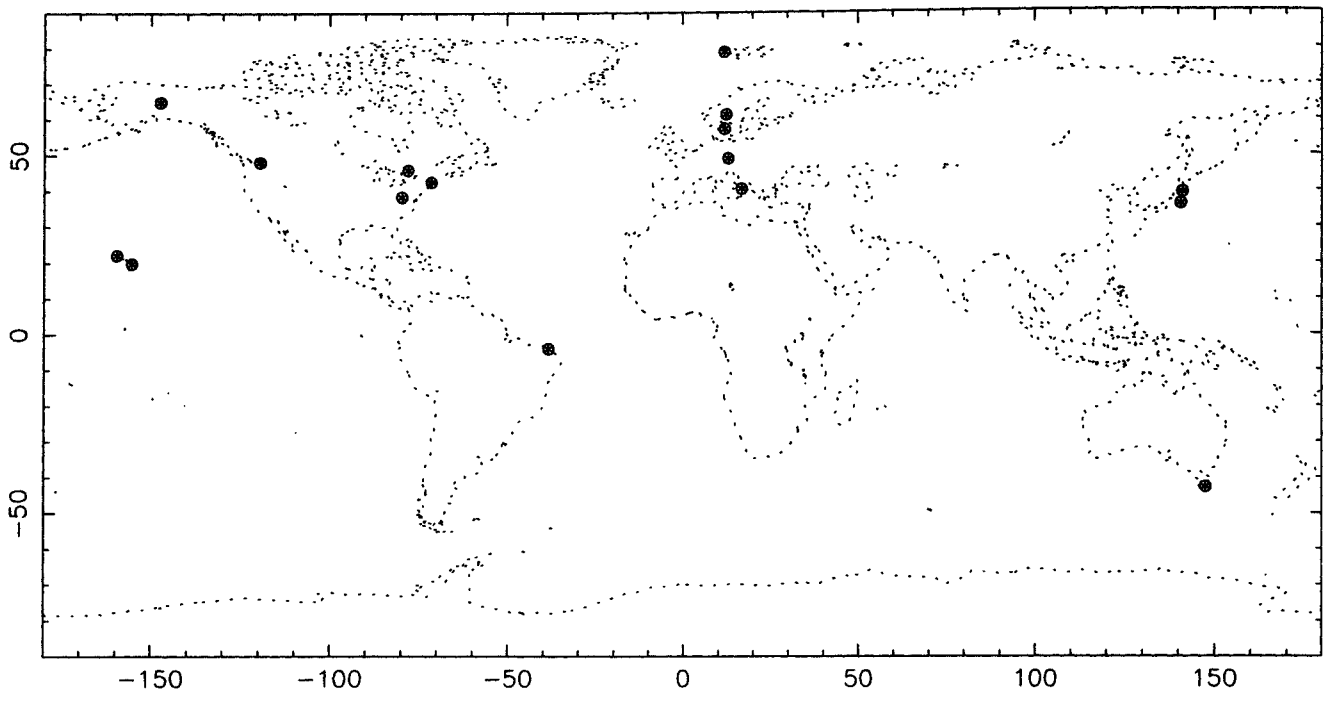
1 - Technique:	VLBI
2 - Analysis Center:	SHA
3 - Software used:	CALC7.6, SOLVK/GLOBK
4 - Data span:	Jan.1993 - Dec.1994
5 - Celestial Reference Frame:	RSC(SHA) 95 R 01
a - Nature:	Extragalactic radio sources
b - Definition of the orientation:	The orientation of the frame is defined by fixing the right ascension of 0229+131 and the declinations of 0229+131 and 0851+202
6 - Terrestrial Reference Frame:	SSC(SHA) 95 R 01
a - Relativity scale:	solar system barycentric (SSB)
b - Velocity of light:	299792458 m/s
c - Geogravitational constant:	$3.986004415\ 10^{14}\ m^3\ s^{-2}$
d - Permanent tidal correction:	No
e - Definition of origin:	By fixing Wettzell coordinates (m) at 1993.0 (4075539.946, 931735.204, 4801629.319)
f - Definition of orientation:	By fixing the direction from Wettzell to Westford at the reference epoch
g - Reference epoch:	1993.0
h - Tectonic plate model:	NNR-NUVEL1
i - Constraint for time evolution:	Linear in time by fixing NNR-NUVEL1 plate motion model
7 - Earth orientation:	EOP(SHA) 95 R 01
a - A priori nutation model:	IAU(1980) nutation series
b - Short-period tidal variations in x,y,UT1:	No
8 - Estimated Parameters:	
a - Celestial frame:	right ascension, declination
b - Terrestrial frame:	X0, Y0, Z0
c - Earth orientation:	x, y, UT1-UTC, $\delta\psi$, $\delta\varepsilon$
d - Others:	atmospheric zenith time delays, station clock offsets



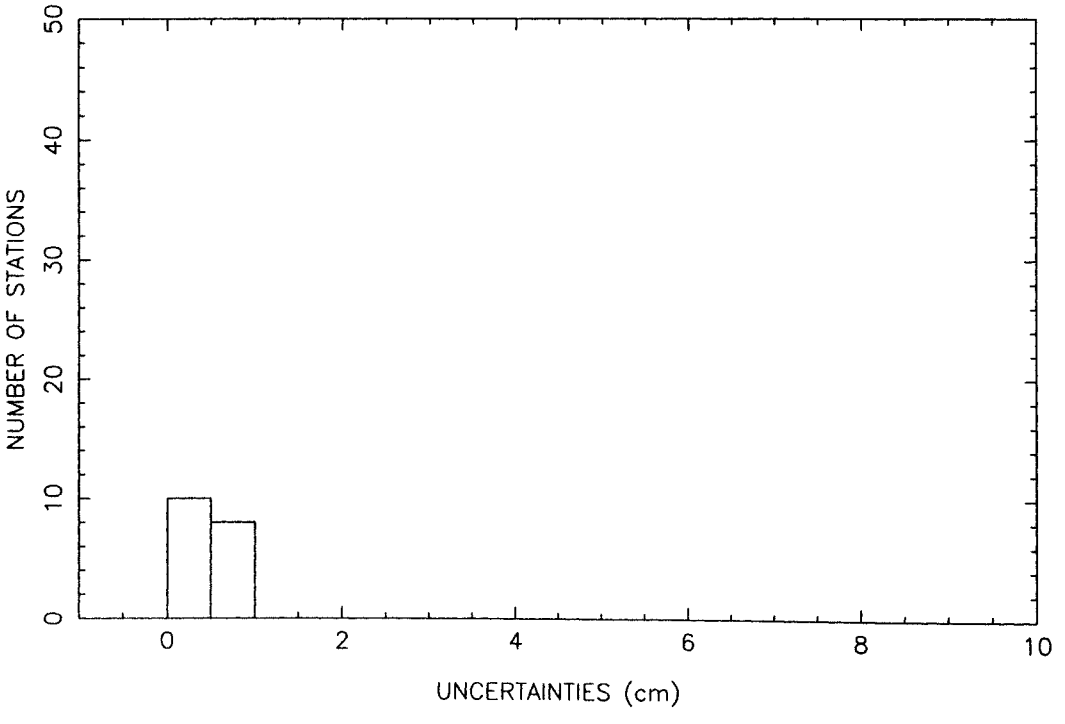
Distribution over the sky of the 45 extragalactic radio sources of the celestial frame RSC(SHA) 95 R 01. Filled circles indicate radio sources with uncertainties in right ascension ($\alpha \cos \delta$) and declination smaller than 0.0003".



Distribution of the uncertainties in right ascension (full line) and declination (dashed line) of the celestial frame RSC(SHA) 95 R 01.



Distribution of the 16 sites of the terrestrial frame SSC(SHA) 95 R 01.



Distribution of the uncertainties (quadratic mean of σ_x, σ_y, σ_z) for the 18 stations of the terrestrial frame SSC(SHA) 95 R 01.

EOP(SHA) 95 R 01 From Jan 1993 to Dec 1994

Number of measurements per year and median uncertainties
Units : 0.001" for X, Y, $\delta\psi$,$\delta\varepsilon$; 0.0001s for UT1

YEAR	X		Y		UT1		$\delta\psi$		$\delta\varepsilon$	
	Nb	Sigma	Nb	Sigma	Nb	Sigma	Nb	Sigma	Nb	Sigma
1993	65	0.16	65	0.12	65	0.07	65	0.30	65	0.12
1994	51	0.10	51	0.07	51	0.05	51	0.18	51	0.08

CELESTIAL FRAME: RORF94 RSC(USNO) 95 R 00

Reference: Johnston *et al.* (1995), submitted to AJ (copies available upon request)

A catalog is presented based on the radio positions of 436 extragalactic sources distributed over the entire sky. The positional accuracy of the sources is better than 3 mas in both coordinates, with the majority of the sources having errors better than 1 mas. This catalog is based upon a baseline solution (using CALC 7.6 and SOLVE 4.x) of all applicable dual frequency 2.3 GHz and 8.4 GHz Mark--III VLBI data available through the end of 1993 consisting of 1,015,292 pairs of group delay and phase delay rate observations. This includes the majority of the data collected between late 1979 and the end of 1993 by NASA, NOAA, JPL, USNO, and NRL. The final orientation of the catalog has been obtained by a rotation of the positions into the system of the International Earth Rotation Service (IERS) and is consistent with the FK5~J2000.0 optical system, within the limits of the link accuracy.

The positions of the sources were solved for as global parameters. All other parameters were arc parameters in the solution. The coordinates of each station were estimated as arc parameters with the exception that the position of one station in each experiment was fixed to its a priori value and served as the local zero point of the terrestrial frame. Thus no terrestrial frame or model assumptions for long term station motions were used.

The IAU definitions of precession, sidereal time, and nutation were adopted as the underlying models. Because of insufficient knowledge of nutation, offset parameters with respect to the IAU standards for nutation in obliquity and longitude were solved for in each experiment. The degeneracy of the adjustment process with respect to these offset parameters was fixed by selecting 1993 February 12 as the reference day, adopting the standards on that day without modification. All determined nutation offset parameters are thus with respect to the pole of that reference day. Data from different epochs were therefore not combined using the standard models but rather through the sources observed in common.

The zero point of right ascension was fixed by arbitrarily adopting the J2000.0 right ascension of 0420-014 to define the equinox of the solution. This source was chosen primarily because of its good observing history (~ 21,000 observations) and its proximity to the celestial equator.

Finally, the source coordinates were rotated into the system of the IERS using the USNO n9409 celestial reference frame. The relative orientation of the frames (three rotation angles for the three axes) defined by these solutions was obtained by a least-squares adjustment between common sources. The resulting three rotation parameters were then used to transform all positions from our solution into the system of the IERS. Consequently, the RORF94 positions are consistent with the IERS celestial reference system. However, there remains an ~0.3 mas rotation in right ascension between the RORF94 positions and the current 1994 IERS frame. This rotation is presumably a consequence of the different method used here to construct the celestial frame but is well within the year to year variations in the IERS frame.

Parametrization of the RORF94 solution.

MODELS:

	Solar System: PEP planetary ephemeris
	Precession/sidereal time: IAU 1984
	Solar relativistic deflection of light: IERS Standards
	Solid Earth tides: IERS Standards
	Ocean loading: IERS Standards
	Sub-diurnal Earth orientation

CALIBRATIONS:

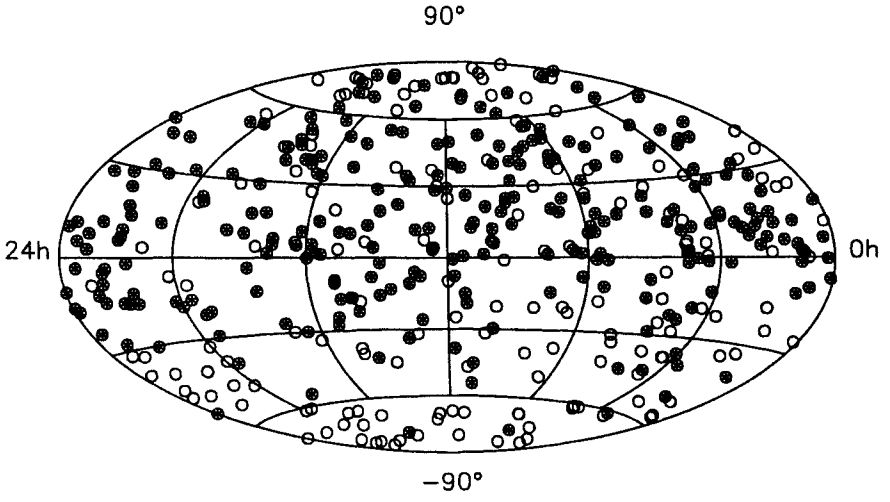
Troposphere	MTTDRFLY using meteorological data
Ionosphere	Simultaneous S/X observations
Instrumental	Length of timing signal/phase cal cable

ADJUSTED PARAMETERS:

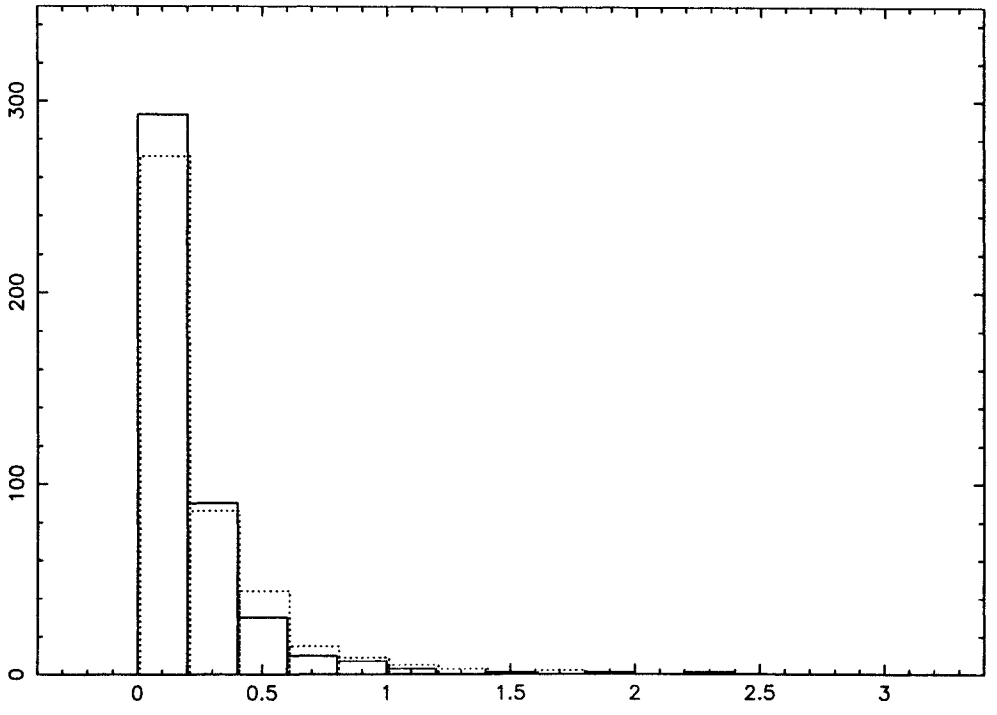
Global	Source positions
Arc	Station positions
	Nutation offsets in longitude and obliquity
	Polynomial clocks
	Zenith atmosphere delays
	Constrained atmosphere rates

MISCELLANEOUS:

Elevation cutoff	7.0 degrees
Reference day	1993 February 12
Data type	Group delays and phase delay rates
Observations	1,015,292



Distribution over the sky of the 436 extragalactic radio sources of the celestial frame RSC(USNO) 95 R 00. Filled circles indicate radio sources with uncertainties in right ascension ($\alpha \cos \delta$) and declination smaller than 0.0003".



Distribution of the uncertainties in right ascension (full line) and declination (dashed line) of the celestial frame RSC(USNO) 95 R 00.

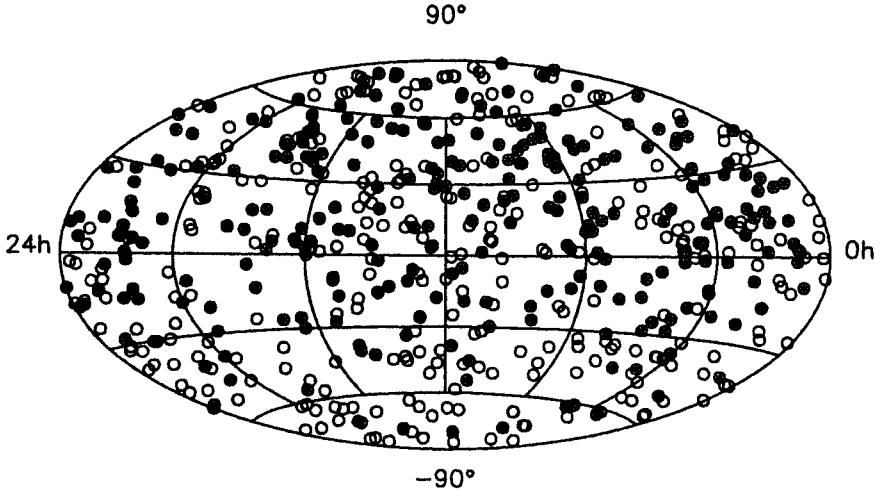
EARTH ORIENTATION RESULTS FROM THE U.S. NAVAL OBSERVATORY VLBI PROGRAM

USNO 95 R 04, 05

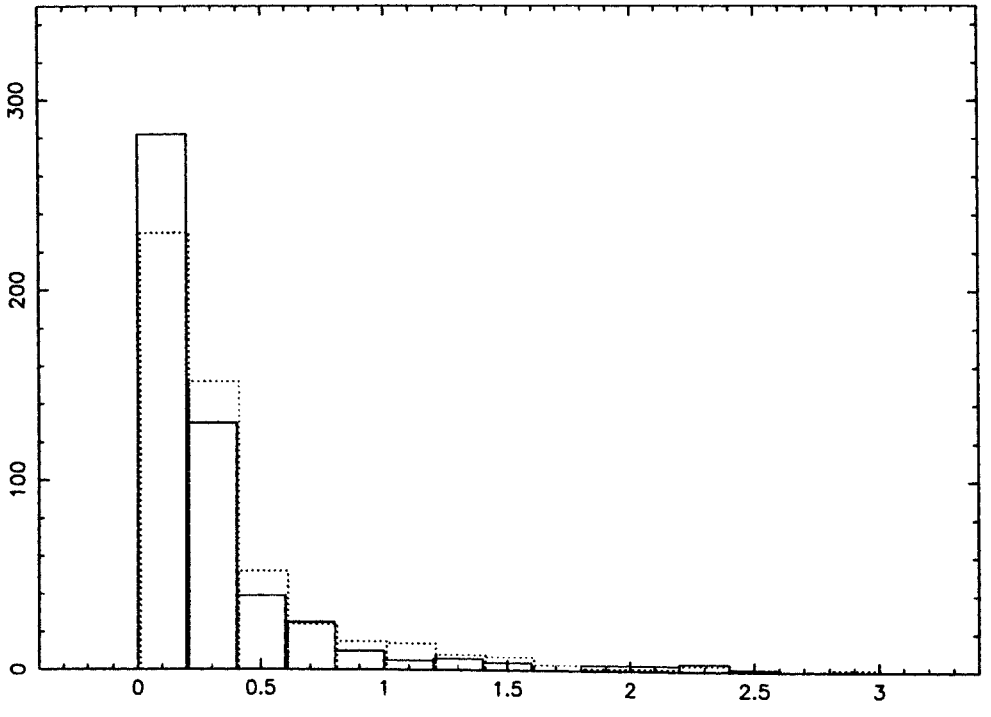
T.M. Eubanks, B.A. Archinal, M.S. Carter, F.J. Josties, D.N. Matsakis, and D.D. McCarthy, U.S. Naval Observatory, Washington, D.C., 20392-5100

Technical description of solution USNO 95 R 04

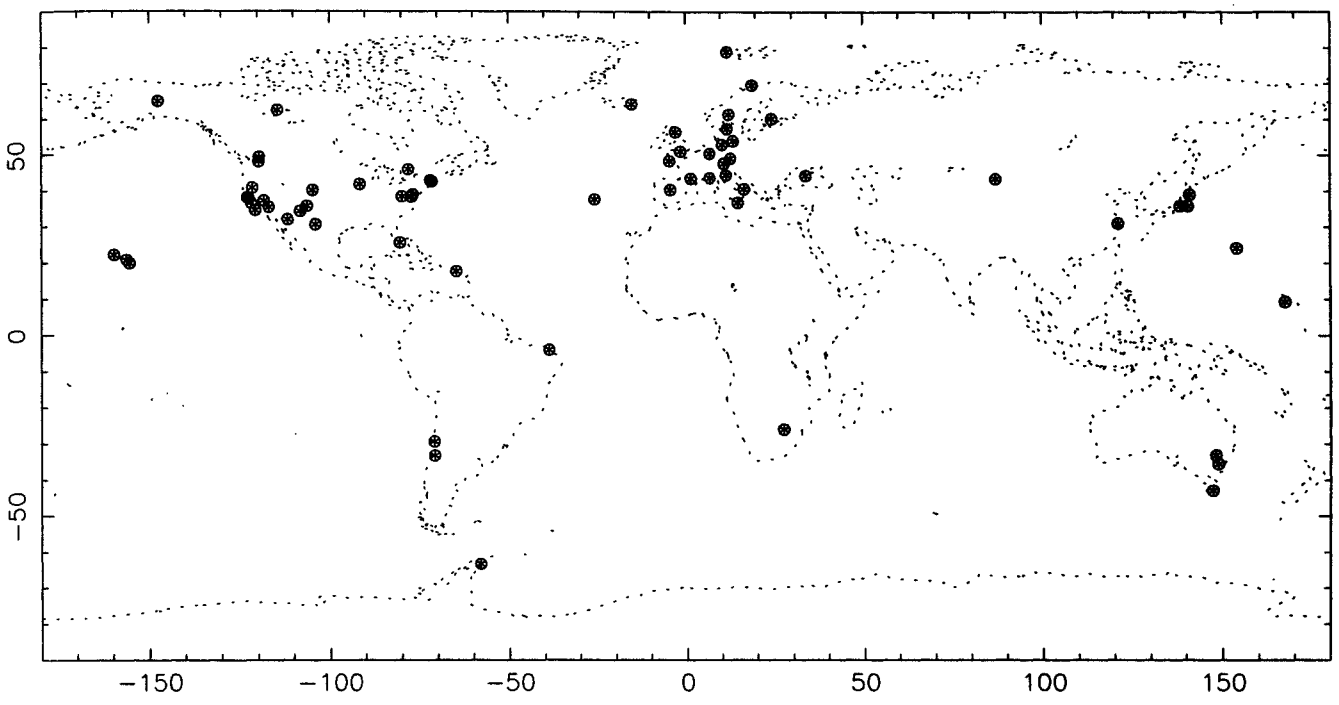
1 - Technique:	VLBI
2 - Analysis Center:	USNO
3 - Software used:	Calc. 7 - 6
4 - Data span:	
5 - Celestial Reference Frame:	RSC(USNO) 95 R 04
a - Nature:	extragalactic
b - Definition of the orientation:	Mean 50 sources in Right Ascension. Indirectly through mean IERS Bull. A values for nutation.
6 - Terrestrial Reference Frame:	SSC(USNO) 95 R 04
a - Relativity scale:	geocentric
b - Velocity of light:	299 792 458 m/s
c - Geogravitational constant:	
d - Permanent tidal correction:	No
e - Definition of the origin:	Mean of 12 stations positions in ITRF-93
f - Definition of the orientation:	Mean IERS Bull. A values for UT1 and polar motion
g - Reference epoch:	1 January 1993
h - Tectonic plate model:	1995 - 4 empirical model
i - Constraint for time evolution:	Mean of 12 station velocities with the Nuvel model as a priori
7 - Earth Orientation:	
a - A priori nutation model:	
b - Short-period tidal variations in x, y, UT1:	
8 - Estimated Parameters	
a - Celestial Frame:	
b - Terrestrial Frame:	
c - Earth Orientation:	
d - Others:	



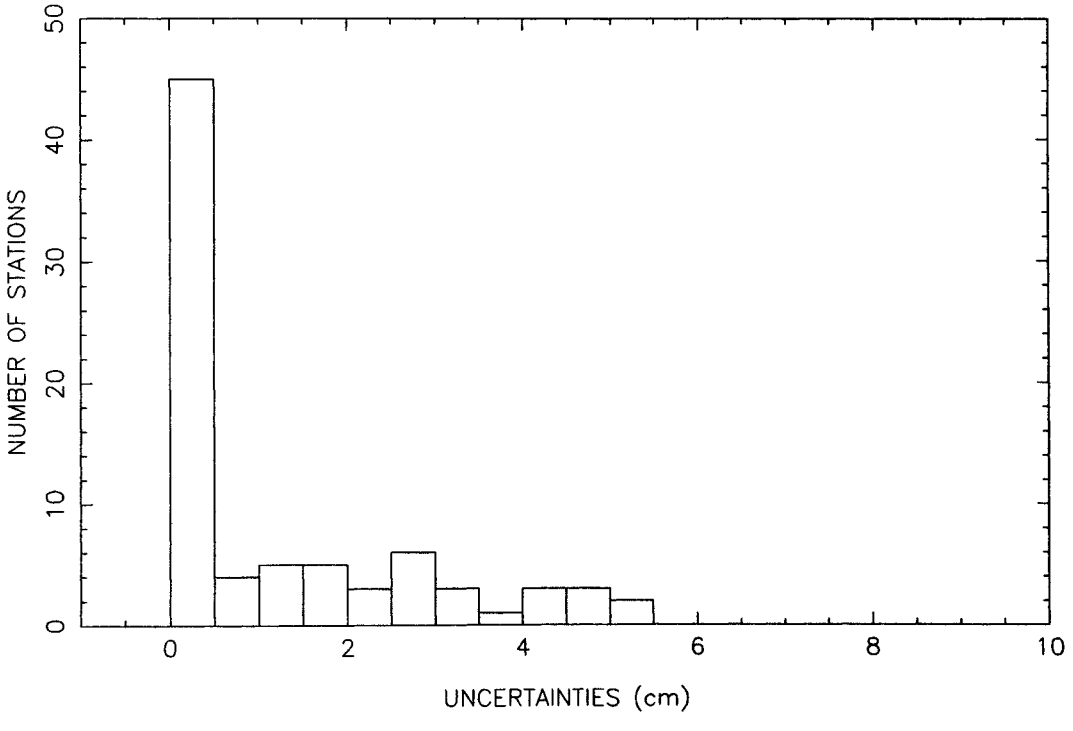
Distribution over the sky of the 536 extragalactic radio sources of the celestial frame RSC(USNO) 95 R 04. Filled circles indicate radio sources with uncertainties in right ascension ($\alpha \cos \delta$) and declination smaller than 0.0003".



Distribution of the uncertainties in right ascension (full line) and declination (dashed line) of the celestial frame RSC(USNO) 95 R 04. 44 radio sources with uncertainties larger than 0.003" are not shown.



Distribution of the 65 sites of the terrestrial frame SSC(USNO) 95 R 04.



Distribution of the uncertainties (quadratic mean of σ_x, σ_y, σ_z) for the 81 stations of the terrestrial frame SSC(USNO) 95 R 04. 1 station with uncertainty larger than 10 cm is not shown.

EOP(USNO) 95 R 04 From Nov 1979 to Jul 1995

Number of measurements per year and median uncertainties
Units : 0.001" for X, Y, $\delta\psi$, $\delta\epsilon$; 0.0001s for UT1

YEAR	X		Y		UT1		$\delta\psi$		$\delta\epsilon$	
	Nb	Sigma	Nb	Sigma	Nb	Sigma	Nb	Sigma	Nb	Sigma
1979	1	1.00	1	0.97	1	0.52	1	2.09	1	1.05
1980	19	0.53	19	0.55	19	0.26	19	0.89	19	0.43
1981	7	0.76	7	1.64	7	0.53	7	0.97	7	0.54
1982	16	0.80	16	0.79	16	0.37	16	1.43	16	0.60
1983	17	1.11	17	2.04	17	0.77	17	2.13	17	0.74
1984	87	0.57	87	0.56	87	0.30	87	0.93	87	0.40
1985	92	0.36	92	0.36	92	0.20	92	0.59	92	0.26
1986	107	0.35	107	0.32	107	0.19	107	0.55	107	0.24
1987	136	0.34	136	0.31	136	0.18	136	0.50	136	0.23
1988	133	0.27	133	0.27	133	0.15	133	0.44	133	0.18
1989	167	0.23	167	0.22	167	0.11	167	0.39	167	0.16
1990	203	0.21	203	0.21	203	0.10	203	0.35	203	0.14
1991	211	0.19	211	0.18	211	0.09	211	0.33	211	0.13
1992	236	0.16	236	0.16	236	0.08	236	0.29	236	0.12
1993	171	0.13	171	0.12	171	0.06	171	0.23	171	0.10
1994	164	0.10	164	0.08	164	0.05	164	0.19	164	0.08
1995	58	0.09	58	0.07	58	0.05	58	0.16	58	0.07

EOP(USNO) 95 R 05 From Dec 1993 to Jul 1995

Number of measurements per year and median uncertainties
Units : 0.0001" for UT1

YEAR	UT1	
	Nb	Sigma
1993	3	0.12
1994	213	0.18
1995	139	0.13