APPENDIX 1

Appendix 1

A COMBINED TERRESTRIAL REFERENCE FRAME BASED ON SPACE GEODESY

C. Boucher and Z. Altamimi
International Earth Rotation Service
Institut Géographique National

H Feissel
International Earth Rotation Service
Observatoire de Paris

INTRODUCTION

A terrestrial reference frame of 64 sites has been compiled on the basis of several space geodesy analyses, leading to the last realisation of the Terrestrial System of the Bureau International de l'Heure (BIH), BTS 1987 (BIH 1988), before the BIH activities on Earth rotation be transfered to the new International Earth Rotation Service (IERS). This realisation provides the initial definition of the IERS Terrestrial System.

The method described herenfter is based on a proposal of Guinot (1981). Its implementation has been studied by Boucher and Feissel (1984), following models described by Zhu and Mueller (1983).

The definition is as follows. A direct geocentric system of tri-rectangular axes is selected. The axis Gz is in the direction of the BIH pole origin in its previous realization ; the axis Gx is in the direction of the origin of longitudes, as previously realized by the BIH ; the length unit is the metre (SI).

DATA ANALYSIS

The analysis takes into account homogeneous Sets of Stations Coordinates (SSC) derived from programs of observations using space techniques in several networks, from which series of Earth Rotation Parameters (ERP : coordinates of the pole and universal time) are derived. The networks and series of ERP participating to the adjustment are listed in Table 1.

The fiducial points selected for the realization of the terrestrial system are one point per colocation site, i.e., sites for which station coordinates are available in at least two of the networks of Table 1. A site is defined as an area of dimension up to 50 km for which precise geodetic ties between space geodesy stations and geodetic marks are available. The selected sites are listed in Table 2. Some of the ground stations on these sites do not belong to the permanent tracking networks used in the determination of the Earth's rotation. Nevertheless their coordinates are assumed to be consistent with those of the permanent stations of the same network. This is the case for the VLBI networks, and the Doppler network for which a number of points obtained with portable receivers are included. Some other sites could not be included due to lack of information either on the local geodetic ties or on the station coordinates in one of the networks.

The epoch of the BTS (1987) is 1984.0. The plate motion model AM0-2 (no net rotation) of J.B. Minster and T.H. Jordan (1978) is adopted. This model is the one recommended in the MERIT Standards (Melbourne et al., 1985).

The terrestrial system is realized through the cartesian coordinates adopted for the selected sites. For linking the system to the geocentre, the adopted origin is derived from the determinations of the dynamical solutions SSC(JPL) 88 M 01, SSC(CERGA) 88 M 01, SSC(SHA) 86 M 01, SSC(CSR) 88 L 01, and SSC(GSFC)87 L 14. The adopted scale is based on SSC(CSR) 88 L 01 and SSC(GSFC)87 L 14. The orientation is obtained by insuring the continuity of the derived series of ERP with the preceding BIH series.

A least square estimation is performed among the observed coordinates of the colocation sites in the different networks, and the determinations of the ERP of the different series. The station coordinates are brought to the fiducial point of their site by means of the known geodetic ties ; the series of ERP are under the form of normal values at 0.05 year interval. In the case of VLBI, the rotation angles of the associated frames of Radio Source Coordinates around the polar axis (A3) are constrained to values obtained from the comparison of coordinates of common radio sources (Arias et al., 1988). The following unknowns are adjusted:

- a set of cartesian coordinates for each site in the BTS (Table 2),
- a set of 7 transformation parameters which relate the individual SSC to the BTS (Table 3), for 1984.0,
- a series of ERP at 0.05 year interval, referred to the BTS, from 1987.00 to 1987.95.

RESULTS

Table 1 lists the Sets of Stations Coordinates (SSC) and the corresponding series of Earth Rotation Parameters (ERP) contributing to the realisation of the BTS, with the following information.

SSC : label of the SSC, plate motion model used, number of colocated sites, status of the transformation parameters in the global adjustment.

ERP : name and label of the series, time span and a priori standard deviations used in the constraints for the orientation of the axes of the BTS. The later are proportional to the formal uncertainties of normal values of the coordinates of the pole (x, y) and universal time (UT) at 0.05 year interval. The multiplying factors are derived from the analysis of the stability of each time series. The original series which were originally referred to the AM1-2 plate motion model are brought to the AM0-2 model by linear drifts derived from the relative rotation of the two models.

Table 2 lists the cartesian coordinates for 1984.0 (MJD=45700) of the reference points of the colocated sites. Each site is designated by its name, the DOMES number of the reference point, the mention of the networks to which it is related, and the plate to which it belongs. DOMES is the Directory of MERIT sites, a part of the space geodesy coordinates data base of the Institut Géographique National.

The complete description of the points of each site and the local ties used in the adjustment is given in Note Interne du BIH nr 5, available on request. In addition to the site reference marks, the table contains for each site the coordinates of the VLBI, LLR and SLR reference points, using local excentricities published in the Note Interne. Because doubts can exist on some local surveys, the coordinates of these reference points are in some cases more reliable that those of the reference marks. For colocation sites between two different observing techniques, this reliability is tested by the combined adjustment.

The site coordinates can be brought to date by use of the velocity vectors given in Table 2A (AM0-2 model).

Table 3 lists the numerical values of the parameters which transform the coordinates in the SSC's of Table 1 into the BTS at epoch 1984.0. In the case of VLBI, the associated values of A3 are listed. The transformation parameters for the terrestrial systems are in the sense combined towards individual system.

The transformation parameters for the World Geodetic System 1984 (WGS 84) of the U.S. Defense Mapping Agency are also listed. They are obtained as explained by Boucher et al. (1988).

ACCESS TO THE TERRESTRIAL SYSTEM, LINK TO CELESTIAL SYSTEM

The access to the terrestrial system can be obtained through comparison of an individual series of ERP with the series ERP(BIH) 87 C 02 (Feissel and Guinot, 1988). This series is identical to the BIH combined solution for the years 1984-1987. Starting with 1988, the IERS series can be used. Prior to this date, it is based on a calibration of the earlier BIH series of ERP. The part of the uncertainty which is due to the instability of this series in this type of access is given hereafter for averaging times of one day and one year, in units of 0.001".

Period:	1962-1966		1967-1971		1972-1977		1978-1983		1984-1987	
averaging time	1d	1y	1d	1y	1d	1y	1d	1y	1d	1y
direction										
pole	24	10	17	6	11	5	6	4	3	2
longitudes	30	15	23	10	20	8	17	4	10	2

When using the transformation parameters of the terrestrial systems, the uncertainty due to the realization of the BTS is estimated to a few cm in the origin, 0.002 ppm in the scale and up to 0.004" in the orientation.

The tie of the BTS polar origin with the Conventional International Origin as realized by the International Latitude Service (ILS) is estimated from the differences between the ILS and BIH series of the coordinates of the pole over 1964-1966. The coordinates of the ILS CIO with respect to the BTS pole are $x = -0.034" \pm 0.018"$, $y = \pm 0.010" \pm 0.014"$.

This terrestrial frame, the combined celestial frame of Arias et al. (1988), the series ERP(BIH)87 C 02, and the corresponding time series of celestial pole offsets with respect to the IAU 1976 precession and IAU 1980 Nutation models (available on request) form a consistent ensemble, with uncertainties given in the present report and by Arias et al. (1988).

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Table 1 - CONTRIBUTIONS TO THE COMBINED TERRESTRIAL FRAME

SETS OF STATION COORDINATES

Set	Station Coordinates	Plate motion model	Nb of coloc. sites	Status of the transformation parameters: centre	scale	orient.
1	SSC(NGS) 88 R 01	AM0-2	13	free	free	free
2	SSC(GSFC) 88 R 01	AM0-2	18	free	free	free
3	SSC(JPL) 83 R 05	(1)	3	free	free	free
4	SSC(SHA) 88 R 01	(1)	5	free	free	free
5	SSC(JPL) 88 M 01	(1)	3	Fixed	free	free
6	SSC(CERGA)88 M 01	(1)	3	Fixed	free	free
7	SSC(SHA) 86 M 01	(1)	2	Fixed	free	free
8	SSC(CSR) 88 L 01	AM1-2	53	Fixed	Fixed	free
9	SSC(GSFC) 87 L 14	AM0-2	51	Fixed	Fixed	free
10	SSC(DGFI)87 L 03	(2)	46	free	free	free
11	SSC(SHA) 87 L 01	AM1-2	22	free	free	free
12	SSC(DUT) 87 L 04	(1)	25	free	free	free
13	SSC(DMA) 77 D 01(3)	(1)	39	free	free	free

SERIES OF EARTH ROTATION PARAMETERS

Label	Time span	A priori standard deviation (averaging time : 0.05 y) x 0.001"	y 0.001"	UT1 0.0001s
ERP(NGS) 88 R 01	1986.0-1988.0	1.0	1.0	0.5
ERP(GSFC) 88 R 01	1986.0-1988.0	1.0	1.0	0.5
ERP(JPL) 83 R 01	1986.0-1988.0			4.7(4)
ERP(SHA) 88 R 01	1986.0-1987.2	2.1	2.4	3.0
ERP(JPL) 88 M 01	1986.0-1988.0			5.0(4)
ERP(CERGA)88 M 01	1986.0-1988.0			5.0(4)
ERP(SHA) 86 M 01	1986.0-1987.9			9.0
ERP(CSR) 88 L 01(5)	1986.0-1988.0	1.0	1.0	
ERP(GSFC) 87 L 14	1986.0-1987.5	1.0	1.0	
ERP(DGFI)87 L 02	1986.0-1986.9	3.3	3.0	
ERP(SHA) 87 L 01(5)	1986.0-1988.0	2.2	2.1	
ERP(DUT) 87 L 04	1986.0-1987.0	2.3	2.0	

Notes
(1) No plate motion assumed.
(2) Motion of the sites adjusted.
(3) NSWC 9Z-2.
(4) UT0 - UTC
(5) Series referred to AM0-2 by the following linear corrections.

$$\dot{x} = -0.00052"/y,$$
$$\dot{y} = -0.00024"/y,$$
$$\dot{UT1} = -0.000047s/y.$$

Complete reference to the data listed can be found in the BIH Annual Report for 1987, p. D-2 to D-8.

TABLE 2 - SITE COORDINATES FOR EPOCH 1984.0

SITE, SITE REFERENCE MARKS	DOMES NUMBER	NETWORKS (1) 0000000001111 1234567890123	X m	Y m	Z m	PLATE
ALGONQUIN	40104M001	* *	918127.795	-4346061.976	4561984.210	NOAM
VLBI 7282	40104S001		918035.035	-4346132.256	4561971.144	
AMERICAN SAMOA	50503M001	*** *	-6100045.746	-996203.486	-1568976.542	PCFC
SLR 7096M001	50503M001		-6100045.746	-996203.486	-1568976.542	
AREQUIPA	42202M002	******	1942784.899	-5804081.705	-1796911.286	SOAM
SLR 7907S001	42202S001		1942791.969	-5804077.735	-1796919.376	
ASKITES	12612M001	* * *	4353445.043	2082666.212	4156506.621	EURA
SLR 7510M001	12612M001		4353445.043	2082666.212	4156506.621	
BAR GIYYORA	20702M001	*** *	4443967.518	3121945.281	3334694.354	AFRC
SLR 7530M001	20702M001		4443967.518	3121945.281	3334694.354	
BEAR LAKE	40438M001	*** *	-1735997.063	-4425048.200	4241430.462	NOAM
SLR 7082M001	40438M001		-1735997.063	-4425048.200	4241430.462	
BERMUDA	42501M001	** *	2308538.609	-4874079.933	3393628.512	NOAM
SLR 7067M001	42501M001		2308538.609	-4874079.933	3393628.512	
BOLOGNE	12711M001	** *	4461385.752	919555.797	4449529.710	EURA
VLBI 7230	12711S001		4461370.265	919596.680	4449558.993	
CABO SAN LUCAS	40505M001	**	-1997241.481	-5528041.166	2468355.083	PCFC
SLR 7882M001	40505M001		-1997241.481	-5528041.166	2468355.083	
CAGLIARI	12725M202	*** *	4885453.227	783999.779	4011509.915	EURA
SLR 7545M001	12725M002		4893398.179	772673.204	4004140.913	
CERRO TOLOLO	41706M001	***	1815517.137	-5213464.857	-3187999.424	SOAM
SLR 7401M001	41706M001		1815517.137	-5213464.857	-3187999.424	
CHILBOLTON	13201M001	** *	4008269.778	-100699.680	4943807.047	EURA
VLBI 7215	13201S002		4008310.294	-100650.914	4943794.600	
DIONYSOS	12602M001	* *	4595211.886	2039440.665	3912635.283	EURA
SLR 7940S001	12602S001		4595217.739	2039464.564	3912613.341	
EFFELSBERG	14209S001	** *	4033947.687	486990.358	4900430.577	EURA
VLBI 7203	14209S001		4033947.687	486990.358	4900430.577	
FLAGSTAFF	40491M003	***	-1923998.797	-4850850.819	3658590.927	NOAM
SLR 7891M001	40491M002		-1923976.564	-4850871.640	3658574.751	
FORT DAVIS	40442M004	** **********	-1330832.406	-5328746.596	3235663.743	NOAM
VLBI 7216	40442S003		-1324210.814	-5332023.194	3232118.407	
LLR MCD 2.7	40442S002		-1330781.205	-5328755.591	3235697.690	
LLR MLRS	40442S007		-1330120.876	-5328532.292	3236146.710	
SLR 7086M001	40442M001		-1330125.228	-5328526.644	3236150.265	
SLR 7885M001	40442M005		-1330125.228	-5328526.644	3236150.265	
GOLDSTONE	40405M001	*** *** *	-2353394.040	-4641529.700	3676899.298	NOAM
VLBI 7222	40405S009		-2356170.853	-4646755.960	3668470.651	
VLBI DSS14	40405S001		-2353621.046	-4641341.699	3677052.447	
VLBI DSS15	40405S019		-2353538.612	-4641649.676	3676670.150	
VLBI DSS13	40405S014		-2351128.987	-4655477.144	3660956.949	
SLR 7085M001	40405M001		-2353394.040	-4641529.700	3676899.298	
SLR 7115M001	40405M002		-2350861.485	-4655546.323	3660997.892	
SLR 7265M001	40405M006		-2356475.599	-4646618.370	3668424.780	
GRAND TURK	43602M001	** *	1919494.539	-5620965.118	2316112.861	NOAM
SLR 7068M001	43602M002		1920482.719	-5619478.288	2318914.351	

TABLE 2 - (CONT.) SITE COORDINATES FOR EPOCH 1984.0

SITE, SITE REFERENCE MARKS	DOMES NUMBER	NETWORKS (1) 0000000001111 1234567890123	X m	Y m	Z m	PLATE
GRASSE	10002M001	*********	4581933.461	556384.065	4389077.201	EURA
LLR CERGA	10002S002		4581692.478	556195.765	4389354.889	
SLR 7835S001	10002S001		4581691.900	556159.292	4389359.327	
GRAZ	11001M001	******	4194424.308	1162702.297	4647245.175	EURA
SLR 7839S001	11001S002		4194426.838	1162693.790	4647246.469	
GREENBANK	40441M001	** *	883223.826	-4924442.820	3944067.031	NOAM
VLBI 7204	40441S001		882880.146	-4924482.320	3944130.611	
HAYSTACK	40440M001	** * *** *	1492453.875	-4457278.775	4296815.869	NOAM
VLBI 7205	40440S002		1492405.010	-4457266.511	4296881.675	
VLBI 7209	40440S003		1492206.874	-4458130.495	4296015.440	
SLR 7091M001	40440M001		1492453.875	-4457278.775	4296815.869	
HELWAN	30101S001	****	4728283.419	2879669.884	3156894.162	AFRC
SLR 7831S001	30101S001		4728283.419	2879669.884	3156894.162	
HERSTMONCEUX	13212M002	******	4033586.098	24250.831	4924205.776	EURA
SLR 7840S001	13212S001		4033463.932	23662.241	4924304.980	
JOHANNESBURG	30302M001	**	5084867.344	2670346.577	-2768064.652	AFRC
VLBI 7231	30302S001		5085442.840	2668263.384	-2768697.439	
KARITSA	12614M001	*** *	4596042.734	1733476.733	4055720.797	EURA
SLR 7520M001	12614M001		4596042.734	1733476.733	4055720.797	
KATAVIA	12615M001	* * *	4573400.112	2409322.220	3723881.784	EURA
SLR 7512M001	12615M001		4573400.112	2409322.220	3723881.784	
KOOTWIJK	13504M001	**** *	3899217.579	396767.860	5015070.066	EURA
SLR 7833S001	13504S001		3899224.225	396742.771	5015073.684	
KWAJALEIN ATOLL	50505M001	* *** *	-6143447.463	1364699.748	1034162.876	PCFC
VLBI 4968	50505S003		-6143536.697	1363996.771	1034707.116	
SLR 7092M001	50505M001		-6143447.463	1364699.748	1034162.876	
MADRID	13407S003	** *	4849245.503	-360278.377	4114884.354	EURA
VLBI DSS61	13407S003		4849245.503	-360278.377	4114884.354	
VLBI DSS63	13407S001		4849092.956	-360180.764	4115109.040	
VLBI DSS62	13407S005		4846700.403	-370196.097	4116905.644	
MARYLAND POINT	40490M001	** *	1106560.128	-4882972.913	3938004.944	NOAM
VLBI 7217	40490S001		1106629.567	-4882907.175	3938086.890	
MATERA	12734S001	*****	4641965.199	1393069.834	4133262.152	EURA
SLR 7540M001	12734M005		4641984.723	1393057.633	4133233.387	
SLR 7541M001	12734M004		4641990.456	1393042.210	4133231.788	
SLR 7939S001	12734S001		4641965.199	1393069.834	4133262.152	
MAUI	40445M001	** ******	-5466006.395	-2404428.159	2242187.329	PCFC
LLR HAL.TMTR	40445S005		-5466006.878	-2404428.371	2242188.332	
SLR 7120M001	40445M002		-5465998.381	-2404408.750	2242228.256	
SLR 7210M001	40445M001		-5466006.395	-2404428.159	2242187.329	
MAZATLAN	40504M001	*****	-1660089.260	-5619100.387	2511637.853	NOAM
SLR 7122M001	40504M001		-1660089.260	-5619100.387	2511637.853	
METSAHOVI	10503M001	**** *	2892580.841	1311797.673	5512614.168	EURA
SLR 7805S001	10503S001		2892595.545	1311808.220	5512610.017	

TABLE 2 - (CONT.) SITE COORDINATES FOR EPOCH 1984.0

SITE, SITE REFERENCE MARKS	DOMES NUMBER	NETWORKS (1) 0000000001111 1234567890123	X m	Y m	Z m	PLATE
MONTE GENEROSO	14005M002	**	4390309.978	696751.949	4560835.845	EURA
SLR 7590M001	14005M002		4390309.978	696751.949	4560835.845	
MONUMENT PEAK	40497M001	*****	-2386277.797	-4802354.450	3444881.362	PCFC
SLR 7110M001	40497M001		-2386277.797	-4802354.450	3444881.362	
SLR 7220M001	40497M002		-2386292.066	-4802347.578	3444880.766	
SLR 7274M001	40497M003		-2386289.174	-4802346.655	3444883.884	
MOTU HIUMOO	92202M001	*****	-5345882.518	-2958272.496	-1824430.598	PCFC
SLR 7121M001	92202M002		-5345865.107	-2958246.834	-1824623.971	
MOUNT HOPKINS	40434M001	** *	-1936760.353	-5077703.320	3331925.385	NOAM
SLR 7921S001	40434S001		-1936760.073	-5077707.130	3331922.515	
NATAL	41604M002	*** *	5186779.180	-3653499.313	-653908.448	SOAM
SLR 7929S001	41604S001		5186467.956	-3653856.205	-654322.072	
ONSALA	10402M003	** * *	3370764.171	711471.646	5349802.684	EURA
VLBI 7213	10402S001		3370966.369	711465.900	5349663.813	
ORRORAL	50103M103	* *** **	-4466609.699	2683169.494	-3667428.677	INDI
VLBI DSS44	50103S006		-4451073.943	2676824.106	-3691347.918	
VLBI DSS42	50103S005		-4460980.981	2682413.771	-3674582.792	
VLBI DSS43	50103S001		-4460894.352	2682361.681	-3674749.094	
SLR 7843M001	50103M106		-4446469.615	2678122.900	-3696248.962	
SLR 7943S001	50103S003		-4447548.581	2677134.104	-3694996.794	
OWENS VALLEY	40439M001	** *** *	-2410422.293	-4477802.758	3838686.719	NOAM
VLBI 7207	40439S002		-2409600.587	-4478349.634	3838603.226	
SLR 7084M001	40439M003		-2410590.178	-4477745.262	3838648.877	
SLR 7114M001	40439M001		-2410422.293	-4477802.758	3838686.719	
PASADENA	40400M001	*** *	-2493211.773	-4655229.681	3565574.482	PCFC
SLR 7896M001	40400M001		-2493211.773	-4655229.681	3565574.482	
PATRICK AFB	40417M001	** *	917901.094	-5548374.189	2998777.166	NOAM
SLR 7069M001	40417M002		917959.154	-5548370.269	2998776.606	
PLATTEVILLE	40496M002	* ****	-1240707.975	-4720454.350	4094481.666	NOAM
VLBI 7258	40496M002		-1240707.975	-4720454.350	4094481.666	
SLR 7112M001	40496M001		-1240678.078	-4720463.387	4094480.651	
POTSDAM	14106M001	*****	3800621.523	882005.307	5028859.509	EURA
SLR 1181S001	14106S001		3800621.450	882005.286	5028859.459	
QUINCY	40433M001	******	-2516893.058	-4198845.075	4076411.496	NOAM
SLR 7051M001	40433M001		-2516893.058	-4198845.075	4076411.496	
SLR 7109M001	40433M002		-2517234.632	-4198556.255	4076569.651	
SLR 7886M001	40433M005		-2517242.243	-4198550.947	4076570.266	
RICHMOND	40499M001	** * *	961317.965	-5674054.862	2740563.635	NOAM
VLBI 7219	40499S001		961258.243	-5674090.075	2740533.716	
ROUMELLI	12613M001	*** *	4728694.813	2174373.268	3674572.941	EURA
SLR 7517M001	12613M001		4728694.813	2174373.268	3674572.941	
SAN DIEGO	40436M001	**** *	-2428809.139	-4799757.042	3417274.825	PCFC
SLR 7062M001	40436M002		-2428825.688	-4799750.642	3417272.632	
SANTIAGO	41705M001	***	1769699.753	-5044612.882	-3468260.046	SOAM
SLR 7400M001	41705M001		1769699.753	-5044612.882	-3468260.046	

TABLE 2 - (CONT.) SITE COORDINATES FOR EPOCH 1984.0

SITE, SITE REFERENCE MARKS	DOMES NUMBER	NETWORKS (1) 0000000001111 1234567890123	X m	Y m	Z m	PLATE
SHANGHAI	21605M001	**** *	-2831089.696	4676203.044	3275170.120	EURA
SLR 7837S001	21605S001		-2831087.447	4676203.448	3275172.798	
SIMOSATO	21726M001	*****	-3822373.283	3699359.794	3507585.808	EURA
SLR 7838M001	21726M002		-3822386.991	3699362.259	3507571.965	
TRIESTE	12718M002	*** *	4336738.715	1071271.377	4537910.975	EURA
SLR 7550M001	12718M002		4336738.715	1071271.377	4537910.975	
VANDENBERG AFB	40420M001	* **	-2668815.814	-4530761.553	3598687.322	NOAM
VLBI 7223	40420M002		-2678094.512	-4525451.169	3597409.959	
SLR 7887M001	40420M004		-2668867.961	-4530743.141	3598684.806	
VERNAL	40492M001	***	-1631484.576	-4589133.818	4106749.549	NOAM
SLR 7892M001	40492M001		-1631484.576	-4589133.818	4106749.549	
WASHINGTON	40451M110	******	1130731.532	-4831322.625	3994136.411	NOAM
SLR 7063M001	40451M112		1130714.889	-4831367.755	3994087.334	
SLR 7064M001	40451M107		1130689.377	-4831341.941	3994123.411	
SLR 7065M001	40451M108		1130691.428	-4831351.085	3994111.906	
SLR 7100M001	40451M106		1131355.642	-4831168.354	3994131.615	
SLR 7101M001	40451M101		1131240.403	-4831179.761	3994148.412	
SLR 7102M001	40451M102		1130686.723	-4831353.050	3994110.859	
SLR 7103M001	40451M103		1130685.765	-4831348.730	3994116.300	
SLR 7104M001	40451M104		1131095.942	-4831196.975	3994170.691	
SLR 7105M001	40451M105		1130719.836	-4831350.594	3994106.460	
SLR 7899M001	40451M111		1131364.872	-4831168.815	3994128.871	
WETTZELL	14201M001	** * ******	4075575.172	931832.026	4801568.796	EURA
VLBI 7224	14201S004		4075540.172	931735.126	4801629.196	
SLR 7834S001	14201S002		4075530.045	931781.242	4801618.088	
XRISOKALARIA	12616M001	*** *	4745949.696	1905705.836	3799169.046	EURA
SLR 7525M001	12616M001		4745949.696	1905705.836	3799169.046	
YARRAGADEE	50107M001	******	-2389006.268	5043329.273	-3078525.568	INDI
SLR 7090M001	50107M001		-2389006.268	5043329.273	-3078525.568	
YIGILCA	20804M001	**	4117362.146	2517076.743	4157678.983	EURA
SLR 7587M001	20804M001		4117362.146	2517076.743	4157678.983	
YUMA	40493M001	***	-2196777.736	-4887337.107	3448425.286	NOAM
VLBI 7894	40493M001		-2196777.736	-4887337.107	3448425.286	
SLR 7894M001	40493M001		-2196777.736	-4887337.107	3448425.286	
ZIMMERWALD	14001M001	*** **	4331274.089	567584.205	4633139.107	EURA
SLR 7810S001	14001S001		4331283.695	567549.396	4633139.911	

Note.

(1) Reference of the networks: a site has positions in the networks marked with *.

01 : SSC(NGS) 88 R 01	02 : SSC(GSFC) 88 R 01	03 : SSC(JPL) 83 R 05
04 : SSC(SHA) 88 R 01	05 : SSC(JPL) 88 M 01	06 : SSC(CERGA)88 M 01
07 : SSC(SHA) 88 M 01	08 : SSC(CSR) 88 L 01	09 : SSC(GSFC) 87 L 14
10 : SSC(DGFI) 87 L 03	11 : SSC(SHA) 87 L 01	12 : SSC(DUT) 87 L 04
13 : SSC(DMA) 77 D 01		

TABLE 2A - VELOCITIES OF SITES (AMO-2 MODEL)

SITE	DOMES NUMBER	VX m	VY m	VZ m	PLATE
ALGONQUIN	40104M001	-.0193	-.0029	.0012	NOAM
AMERICAN SAMOA	50503M001	-.0199	.0664	.0353	PCFC
AREQUIPA	42202M002	-.0054	-.0047	.0093	SOAM
ASKITES	12612M001	-.0186	.0171	.0109	EURA
BAR GIYYORA	20702M001	-.0243	.0153	.0180	AFRC
BEAR LAKE	40438M001	-.0180	-.0020	-.0095	NOAM
BERMUDA	42501M001	-.0147	-.0025	.0064	NOAM
BOLOGNE	12711M001	-.0155	.0177	.0119	EURA
CABO SAN LUCAS	40505M001	-.0498	.0281	.0227	PCFC
CAGLIARI	12725M202	-.0138	.0189	.0131	EURA
CERRO TOLOLO	41706M001	-.0019	-.0059	.0085	SOAM
CHILBOLTON	13201M001	-.0133	.0164	.0112	EURA
DIONYSOS	12602M001	-.0178	.0178	.0116	EURA
EFFELSBERG	14209S001	-.0152	.0164	.0109	EURA
FLAGSTAFF	40491M003	-.0158	-.0016	-.0105	NOAM
FORT DAVIS	40442M004	-.0142	-.0015	-.0084	NOAM
GOLDSTONE	40405M001	-.0158	-.0015	-.0120	NOAM
GRAND TURK	43602M001	-.0106	-.0018	.0044	NOAM
GRASSE	10002M001	-.0141	.0180	.0124	EURA
GRAZ	11001M001	-.0168	.0168	.0110	EURA
GREENBANK	40441M001	-.0169	-.0025	.0007	NOAM
HAYSTACK	40440M001	-.0182	-.0028	.0034	NOAM
HELWAN	30101S001	-.0227	.0167	.0187	AFRC
HERSTMONCEUX	13212M002	-.0137	.0164	.0112	EURA
JOHANNESBURG	30302M001	-.0019	.0240	.0197	AFRC
KARITSA	12614M001	-.0172	.0179	.0118	EURA
KATAVIA	12615M001	-.0186	.0176	.0114	EURA
KOOTWIJK	13504M001	-.0152	.0160	.0106	EURA
KWAJALEIN ATOLL	50505M001	.0212	.0725	.0305	PCFC
MADRID	13407S003	-.0102	.0188	.0136	EURA
MARYLAND POINT	40490M001	-.0169	-.0025	.0016	NOAM
MATERA	12734S001	-.0162	.0181	.0121	EURA
MAUI	40445M001	-.0153	.0673	.0349	PCFC
MAZATLAN	40504M001	-.0114	-.0010	-.0098	NOAM
METSAHOVI	10503M001	-.0198	.0129	.0073	EURA
MONTE GENEROSO	14005M002	-.0150	.0175	.0118	EURA
MONUMENT PEAK	40497M001	-.0362	.0347	.0233	PCFC
MOTU HIUMOO	92202M001	-.0438	.0572	.0354	PCFC
MOUNT HOPKINS	40434M001	-.0145	-.0014	-.0106	NOAM
NATAL	41604M002	-.0043	-.0085	.0132	SOAM
ONSALA	10402M003	-.0172	.0144	.0090	EURA
ORRORAL	50103M103	-.0362	-.0027	.0422	INDI
OWENS VALLEY	40439M001	-.0164	-.0016	-.0122	NOAM
PASADENA	40400M001	-.0339	.0362	.0235	PCFC
PATRICK AFB	40417M001	-.0133	-.0020	.0005	NOAM
PLATTEVILLE	40496M002	-.0175	-.0020	-.0077	NOAM
POTSDAM	14106M001	-.0169	.0157	.0101	EURA
QUINCY	40433M001	-.0173	-.0017	-.0124	NOAM
RICHMOND	40499M001	-.0123	-.0018	.0006	NOAM

TABLE 2A - (CONT.) VELOCITIES OF SITES (AMO-2 MODEL)

SITE	DOMES NUMBER	VX m	VY m	VZ m	PLATE
ROUMELLI	12613M001	-.0176	.0181	.0119	EURA
SAN DIEGO	40436M001	-.0363	.0351	.0235	PCFC
SANTIAGO	41705M001	-.0011	-.0061	.0082	SOAM
SHANGHAI	21605M001	-.0251	-.0079	-.0103	EURA
SIMOSATO	21726M001	-.0224	-.0112	-.0126	EURA
TRIESTE	12718M002	-.0162	.0173	.0114	EURA
VANDENBERG AFB	40420M001	-.0155	-.0014	-.0132	NOAM
VERNAL	40492M001	-.0175	-.0020	-.0091	NOAM
WASHINGTON	40451M110	-.0171	-.0026	.0017	NOAM
WETTZELL	14201M001	-.0165	.0165	.0108	EURA
XRISOKALARIA	12616M001	-.0170	.0183	.0121	EURA
YARRAGADEE	50107M001	-.0514	.0080	.0530	INDI
YIGILCA	20804M001	-.0201	.0163	.0101	EURA
YUMA	40493M001	-.0150	-.0014	-.0116	NOAM
ZIMMERWALD	14001M001	-.0148	.0173	.0117	EURA

TABLE 3 - TRANSFORMATION BETWEEN THE INDIVIDUAL AND THE COMBINED TERRESTRIAL SYSTEMS

NETWORK	SSC	T1	T2	T3	D	R1	R2	R3	A3
					10^{-8}				
		cm	cm	cm		0.001"	0.001"	0.001"	0.001"
SSC(NGS)	88 R 01	-8.9	14.3	-1.6	0.9	-4.3	9.3	-3.3	-0.5
SSC(GSFC)	88 R 01	167.1	-105.4	40.0	-2.3	-7.2	5.0	-3.6	-0.2
SSC(JPL)	83 R 05	24.2	-12.1	-18.3	-3.9	-1.4	-4.8	-5.7	-0.3
SSC(SHA)	88 R 01	163.8	-97.5	41.7	-0.9	-4.7	5.8	-3.4	-8.0
SSC(JPL)	88 M 01	0.0	0.0	0.0	-1.7	4.0	-0.4	-8.6	
SSC(CERGA)	88 M 01	0.0	0.0	0.0	-2.4	-5.6	-0.8	-3.8	
SSC(SHA)	86 M 01	0.0	0.0	0.0	-3.8	1.4	7.5	-15.5	
SSC(CSR)	88 L 01	0.0	0.0	0.0	0.0	-4.7	2.3	-10.5	
SSC(GSFC)	87 L 14	0.0	0.0	0.0	0.0	-1.8	6.2	-7.5	
SSC(DGFI)	87 L 03	-4.0	0.9	11.9	1.3	-284.2	-44.9	6.8	
SSC(SHA)	87 L 01	-4.3	-4.5	7.2	0.5	-4.3	-2.7	-1.9	
SSC(DUT)	87 L 04	-7.5	4.7	11.9	1.0	0.2	-1.0	-0.0	
SSC(DMA)	77 D 01 (1)	7.1	-50.9	-466.6	58.3	17.9	-0.5	-807.3	
WGS84		7.1	-50.9	-16.6	-1.7	17.9	-0.5	6.7	

Notes

1 - NSWC 9Z-2

Remark.

The table lists the values of the parameters which transform the coordinates in the SSC's into the combined system at epoch 1984.0, according to the relationship

$$\begin{pmatrix} X \\ Y \\ Z \end{pmatrix} = \begin{pmatrix} XS \\ YS \\ ZS \end{pmatrix} - \begin{pmatrix} T1 \\ T2 \\ T3 \end{pmatrix} - \begin{pmatrix} D & -R3 & R2 \\ R3 & D & -R1 \\ -R2 & R1 & D \end{pmatrix} \begin{pmatrix} XS \\ YS \\ ZS \end{pmatrix}$$

where X, Y, Z are the coordinates in the combined system, and XS, YS, ZS are the cartesian coordinates in the individual system. T1, T2, T3 are the components of the translation vector, R1, R2, R3 are the rotation angles and D is the excess to 1 of the scale factor.