SUMMARY

This report contains a detailed description of the IERS products related to the Terrestrial Reference System for the period of the 1993 IERS Annual Report. It gives a detailed analysis about the ITRF93 and its associated combined velocity field.

In this analysis, we have constrained the orientation of the ITRF93 and its rate of change with time to be consistent with the IERS series of Earth Orientation Parameters (EOP). The corresponding ITRF93 velocity field estimated in this way appears to have a small rotation rate in comparison to the geophysical motion model NNR-NUVEL1A (see page 17). A second velocity field (labeled ITRF93N) is estimated and allowed to follow the time evolution of NNR-NUVEL1A.

This description intends to be the continuation of the previous reports: the IERS Technical Notes 4, 6, 9, 12 and 15. In particular, methodological presentation will be followed here.

1) INPUT DATA

1.1) Sites included

The list of sites considered in the 1993 solution is included in Table T1 of the appendix. A more detailed list of points and marks for these sites is also provided by the Table T2 of the appendix.

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

1) colocation (at least two techniques)
2) multiple SLR (simultaneous or successive)
3) single SLR
4) multiple VLBI (simultaneous or successive)
5) single VLBI
6) multiple GPS (simultaneous or successive)
7) single GPS

1.2) Input data sets

The data sets received by the IERS Central Bureau for 1993 analysis are summarized in Table 1. Table 2 summarizes the contribution of these data to the ITRF93 combinations.

1.3) Description of individual data sets

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

As the formal errors \( \sigma_f \) provided by the analysis centers are in most cases too optimistic, the input errors \( \sigma \) are adopted according to the following formula:
\[ \sigma = \sqrt{A^2 + B^2 \cdot \sigma_f^2} \]

where \( A \) is an additive variance and \( B \) is a factor. The values of \( A \) and \( B \) are determined by an empirical estimation.

### 1.3.1) GIUB VLBI solution

**Identifier** : SSC(GIUB) 94 R 01

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

**Adjusted parameters** : \( X,Y,Z \) at epoch 1988.0 and horizontal velocities of HartRAO and Mojave,

**Constraints for the CTS** :

- Wettzell coordinates fixed to ITRF92 values,
- Horizontal drift components are estimated for HartRAO and Mojave,
- fixed NNR-NUVEL1 motion for the other stations
- Fixing USNO concrete EOP series and IAU 1980 Nutation for 1989 Dec. 21

**Raw data** : Positions at 1988.0 and 1993.0

**Input data (RF)** : The 1988.0 and 1993.0 values, with \( A = 0.5 \) cm and \( B = 1.5 \) for 88.0 and with \( A = 0 \) cm and \( B = 1.0 \) for 93.0

### 1.3.2) GSFC VLBI solution

**Identifier** : SSC(GSFC) 94 R 01, also named GLB932

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

**Adjusted parameters** :

\( X,Y,Z \) at 88.0 and \( VX, VY, VZ \) of stations with sufficient data

**Constraints for the CTS** :

- The orientation of the terrestrial reference frame is defined by the a priori EOP values on the reference day (1993 Sep 30) from the modifiedEOP(IERS) 90 C 04 series that is consistent with ITRF92,
- The horizontal rate residuals of eight stations (WESTFORD, RICHMOND, GILCREE KAUA1, HOBART26, DSS45, WETTZELL, ONSALA60) with respect to NNR-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.
- The vertical rates for stations that had uncertainties in their vertical rates in excess of 3 mm/yr in an unconstrained solution are also constrained to zero with the exception of YELLOWKN/YLOW7296.

Raw data: Positions at 1988.0 and 1993.0 and velocities with formal errors

Input data (RG): The 1988.0 and 1993.0 positions, with formal errors modified using the formula (1) with $A = 0.5$ cm and $B = 1.5$. Velocities with formal errors modified with $A = 0.5$ mm/yr and $B = 1.5$.

1.3.3) JPL VLBI solution

Identifier: SSC(JPL) 94 R 01, also named 1994-1.

Model: Modest software.

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

Constraints for the CTS:
- Six constraints with 5 mm uncertainty for station coordinates at epoch 1988.0: 3 translations and 3 rotations between 1994-1 and ITRF92,
- Six constraints were applied (with 1.0 mm/yr uncertainty) to the nine site-velocity parameters of the DSN network so as to yield no-net-translation-rate and no-net-rotation-rate with respect to the net motion of the three sites Madrid, Goldstone, and Canberra as specified by the ITRF-92 velocity field.

Raw data: X, Y, Z at 88.0 and velocities with formal errors.

Input data (RJ): X, Y, Z at 88.0 with formal errors modified with $A = 0.5$ cm and $B = 2.0$. Velocities with formal errors unmodified.

1.3.4) NAOMZ VLBI solution

Identifier: SSC(NAOMZ) 94 R 02

Model: CALC3, MSLV3 and GLK developed at Mizusawa

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

Constraints for the CTS:
- Westford’s coordinates (m) 1492206.755 -4458130.499 4296015.503
- Mean orientation of GILCREEK, ONSALA60, NRAO85 3, WETTZELL, RICHMOND, WESTFORD, KAUAI and mean of KASHIMA and KASHIM34 are adjusted to that of ITRF92.
Raw data: 1988 positions and velocity for sites with formal errors.

Input data (RM): Velocities with formal errors modified with $A = 0.5 \text{ mm/y}$ and $B = 1.5$. The SSC is compared to the ITRF93 a posteriori.

1.3.5) **NOAA VLBI solution**

Identifier: SSC(NOAA) 94 R 01

Model: COREL and FRNGE for the Mark III data correlation; DE200 ephemerides, CALC-7.6, and SOLVE-3 for data analysis.

Adjusted parameters: Positions at 1988.0 and velocities (except for stations with short time span).

Constraints for the CTS:

- The vector sum of the adjusted coordinates for 20 VLBI sites are equal to the corresponding vector sum for ITRF-92.
- The relative orientation of the terrestrial and celestial reference frames is specified by fixing the EOP values to those interpolated from the EOP(IERS)90C04 series (corrected for the offsets and drift rates reported by the IERS to give consistency with the ITRF-92 and ICRF-92 frames).
- NNR-NUVEL-1A is used to specify the large-scale motion of the entire terrestrial reference frame in both translational and rotational senses for 10 VLBI sites.

Raw data: Positions at 88.0 and 93.0 and velocities with formal errors.

Input data (RN): The 88.0 and 93.0 positions, with formal errors modified using the formula (1) with $A = 0.5 \text{ cm}$ and $B = 1.5$. Velocities with formal errors modified with $A = 0.5 \text{ mm/y}$ and $B = 1.5$.

1.3.6) **USNO VLBI solution**

Identifier: SSC(USNO) 94 R 03, also named 1994-3 and SSC(USNO) 94 R 06, also named 1994-6

Model: CALC-7.6 software with LE relativistic scale.

Adjusted parameters: $X, Y, Z$ at 88.0 and 93.0 and velocities.

Constraints for the CTS:

- Mean of 15 station positions in ITRF92
- Mean IERS Bull. A values for UT1, Polar Motion and (indirectly) Nutation
- Mean of 15 station velocities with the NNR-NUVEL1 model as a priori
Raw data: X, Y, Z at 88.0 for SSC(USNO) 94 R 03, X, Y, Z at 93.0 for SSC(USNO) 94 R 06 and velocities

Input data (RO): Velocities with formal errors modified with A = 0.5 mm/y and B = 1.5. The two SSC have been compared a posteriori.

1.3.7) FSG LLR solution

Identifier: SSC(FSG) 94 M 01

Model: FSG LLR software. Motion with NNR-NUVEL1 model

Adjusted parameters: X, Y, Z at December 10, 1991 (MJD 48600)

Constraints for the CTS:

- EOP from 1970 to 1994 taken from a file of R. Gross consisting of SPACE93 (aligned with IERS system)

Raw data: X, Y, Z at 1991.9

Input data (MV): The SSC is compared to the ITRF93 a posteriori

1.3.8) JPL LLR solution

Identifier: SSC(JPL) 94 M 01

Model: JPL LLR software. Motion with NNR-NUVEL1 model

Adjusted parameters: X, Y, Z at 1991.0

Constraints for the CTS:

- Input Earth rotation values from 1970 to early 1994 taken from a file from R. Gross (a version of COMB-93 generated without LLR data) aligned with IERS system.
- Fixed NNR-NUVEL1 motion model

Raw data: X, Y, Z at 1991.0

Input data (MJ): The SSC is compared to the ITRF93 a posteriori

1.3.9) SHA LLR solution

Identifier: SSC(SHA) 94 M 01
Model: SHA LLR software. Motion with NNR-NUVEL1 model

Adjusted parameters: X, Y, Z at 1988.0

Constraints for the CTS:
- EOP from 1988 to 1993 taken from IERS circular B

Raw data: X, Y, Z at 1988.0

Input data (MS): The SSC is compared to the ITRF93 a posteriori

1.3.10) UT/McD LLR solution

Identifier: SSC(UTXMO)94 M 01

Model: PEP software. Motion with AM0-2 model, $\text{GM} = 398600.443$ km$^3$/s$^2$

Adjusted parameters: lambda, phi, h at 1984.0

Constraints for the CTS:
- Fixed AM0-2
- Fixed to CSR EOP(CSR)93L02 series at 11 Jan 1985

Raw data: X, Y, Z at 1984.0

Input data (MX): The SSC is compared to the ITRF93 a posteriori

1.3.11) CODE GPS solution

Identifier: SSC(CODE) 94 P 01 and SSC(CODE) 94 P 02

Model: Bernese software, Version 3.5+

Adjusted parameters: X, Y, Z at 1993.62 and, for SSC(CODE) 94 P 02, velocity for each site

Constraints for the CTS:
Orientation and time evolution constrained to those of ITRF92 through the official 13 IGS ITRF 92 stations

Raw data: X, Y, Z at 1993.62 and, for SSC(CODE) 94 P 02, velocity for each site

Input data (PB): X, Y, Z from SSC(CODE) 94 P 01, mapped at 1993.0 using the ITRF92 velocity
field, with formal errors modified using the formula (1) with \( A = 0.0 \) cm and \( B = 4.0 \). The SSC(CODE) 94 P 02 is compared to the ITRF93 a posteriori.

1.3.12) **EMR GPS solution**

**Identifier** : SSC(EMR) 94 P 02, SSC(EMR) 94 P 03, SSC(EMR) 94 P 04  

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

**Adjusted parameters** :  
- \( X, Y, Z \) at 1993.21 for SSC(EMR) 94 P 02  
- \( X, Y, Z \) at 1993.50 for SSC(EMR) 94 P 03  
- \( X, Y, Z \) at 1993.83 for SSC(EMR) 94 P 04

**Constraints for the CTS** :  
- Origin and orientation constrained to those of ITRF91.
- Raw data : \( X, Y, Z \) at the three epochs with formal errors.

**Input data (PE)** : \( X, Y, Z \) from SSC(EMR) 94 P 02 mapped at 1993.0 with ITRF92 velocity field with formal errors modified with \( A = 0.0 \) cm and \( B = 4.0 \). The SSC(EMR) 94 P 03 and SSC(EMR) 94 P 04 are compared to the ITRF93 a posteriori.

1.3.13) **ESOC GPS solution**

**Identifier** : SSC(ESOC) 94 P 01  

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

**Adjusted parameters** : \( X, Y, Z \) at 1994.0

**Constraints for the CTS** :  
- EOP from IERS Bulletin B,  
- Origin of a set of 13 fiducial stations constrained to be the same as that of the ITRF92.  
- Time evolution according to ITRF92 and NNR-NUVEL1

**Raw data** : \( X, Y, Z \) at 1994.0 with formal errors.

**Input data (PA)** : \( X, Y, Z \) mapped at 1993.0 with ITRF92 velocity field with formal errors modified using the formula (1) with \( A = 0.0 \) cm and \( B = 8.0 \).

1.3.14) **GFZ GPS solution**

**Identifier** : SSC(GFZ) 94 P 01
Model : EPOS.P.V2 software, GM= 398600.4400 km$^3$/s$^2$

Adjusted parameters : X, Y, Z at 1993.5

Constraints for the CTS :
- Alignment to ITRF92
- fixed NNR-NUVEL1 motion model

Raw data : X, Y, Z at 93.5 with formal errors.

Input data (PZ) : X, Y, Z mapped at 1993.0 using NNR-NUVEL1 with formal errors modified with A=0.0 cm and B = 4.0.

1.3.15) JPL GPS solution

Identifier : SSC(JPL) 94 P 01 (JPL Identifier JGC9401)

Model : GIPSY software, free network

Adjusted parameters : X, Y, Z at 1992.5 and velocities

Constraints for the CTS :
Orientation, translation and time evolution constrained to those of ITRF92.

Raw data : X, Y, Z at 88.0 and 93.0 and velocities with error estimate

Input data (PJ) : X, Y, Z at 88.0 and 93.0. Formal errors modified with A = 0.0cm and B = 1.5 for 88.0 and A = 0.0 cm and B = 4.0 for 93.0. Velocities with formal errors modified with A = 0.0 mm/y and B = 1.5.

1.3.16) CSR SLR solution

Identifier : SSC(CSR) 94 L 01

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

Adjusted parameters: X, Y, Z at 1988.0 and horizontal velocities for 47 sites

Constraints for the CTS :
- System oriented to agree with EOP(CSR)93L02 maintained through fixing the latitude and longitude of site 7210 (HOLLAS) and the latitude of site 7105 (GRF105)
- rate of latitude and longitude of 7210 and latitude of 7105 fixed to NUVEL-1 NNR velocities.

**Raw data**: X, Y, Z, at 88.0 and 93.0 and 2D velocities for 47 sites with formal errors

**Input data** (LC): X, Y, Z at 1988.0 and 1993.0 with formal errors modified with A = 1.0 cm and B = 1.0 for 88.0 and A = 1.5 cm and B = 1.5 for 93.0. Velocities with formal errors modified with A = 0.5 mm/y and B = 1.0.

### 1.3.17) GAOUA SLR solution

**Identifier**: SSC(GAOUA)94 L 02

**Model**: KIEV-GEODYNAMICS - 4 software. GM = 398600.4415 km^3/s^2

**Adjusted parameters**: X, Y, Z at 88.0 for 87 stations and velocities for 45 stations.

**Constraints for the CTS**:

- ERP values from EOP(IERS) 90 C 04,
- Latitude and longitude of 7105 and latitude of 7210 fixed
- Fixed NNR-NUVEL1 motion for selected stations, longitude rate of 7105 and latitude rate of 7210 fixed to NNR-NUVEL1.

**Raw data**: X, Y, Z at 88.0 and velocities with formal errors

**Input data** (LK): The SSC is compared to the ITRF93 a posteriori.

### 1.3.18) GFZ SLR solution

**Identifier**: SSC(GFZ) 94 L 01

**Model**: EPOS.P.V1 software. Adjusted velocities. GM = 398600.451 km^3/s^2

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

**Constraints for the CTS**:

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

**Raw data**: X, Y, Z at 1988.0 and velocity with formal errors

**Input data** (LZ): X, Y, Z at 88.0 with formal errors modified with A = 2.0 cm and B = 3.0. Velocities with formal errors modified with A = 1.0 mm/y and B = 1.5.
1.3.19) **GSFC SLR solution**

**Identifier**: SSC(GSFC) 94 L 01 (SL8.5)

**Model**: GEODYN II software, \( GM = 398600.4415 \) km\(^3\)/s\(^2\)

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

**Constraints for the CTS**:

- latitude and longitude of 7105, the latitude of 7210 were fixed
- a priori values of ERP from IERS 90 C 04

**Raw data**: X, Y, Z at 88.0 and velocities with formal errors

**Input data (LG)**: X, Y, Z at 88.0 with formal errors modified with \( A = 1.0 \) cm and \( B = 3.5 \). Velocities with formal errors modified with \( A = 1.0 \) mm/y and \( B = 2.0 \).

1.3.20) **DUT Combined (SLR and GPS) solution**

**Identifier**: SSC(DUT) 94 C 01

**Model**: GEODYN-II/SOLVE-2 software. \( GM = 398600.4415 \) km\(^3\)/s\(^2\)

**Adjusted parameters**: X, Y, Z, at 88.0 and velocities

**Constraints for the CTS**:

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

**Raw data**: X, Y, Z at 1988.0 and 1993.0 and VX, VY, VZ

**Input data (CU)**: X, Y, Z at 1988.0 and 1993.0 with formal errors modified with \( A = 1.0 \) cm and \( B = 1.0 \). Velocities with formal errors unmodified.
<table>
<thead>
<tr>
<th>Tech.</th>
<th>Label</th>
<th>Designation</th>
<th>Motion Model</th>
<th>Ref. Epoch</th>
<th>Nb. of Sta.</th>
<th>Other name</th>
</tr>
</thead>
<tbody>
<tr>
<td>VLBI</td>
<td>RF</td>
<td>SSC(GIUB) 94 R 01</td>
<td>NNR-NUVEL1</td>
<td>1988.0, 1993.0</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td></td>
<td>RG</td>
<td>SSC(GSFC) 94 R 01</td>
<td>Estim./NNR-NUVEL1</td>
<td>1988.0, 1993.0</td>
<td>118</td>
<td>GLB932</td>
</tr>
<tr>
<td></td>
<td>RJ</td>
<td>SSC(JPL) 94 R 01</td>
<td>Estim./ITRF92</td>
<td>1988.0</td>
<td>12</td>
<td>1994-1</td>
</tr>
<tr>
<td></td>
<td>RM</td>
<td>SSC(NAOMZ)94 R 02</td>
<td>Estim./NNR-NUVEL1</td>
<td>1988.0</td>
<td>56</td>
<td></td>
</tr>
<tr>
<td></td>
<td>RN</td>
<td>SSC(NOAA) 94 R 01</td>
<td>Estim./NNR-NUVEL1A</td>
<td>1988.0, 1993.0</td>
<td>103</td>
<td></td>
</tr>
<tr>
<td></td>
<td>RO</td>
<td>SSC(USNO) 94 R 03</td>
<td>Estim./NNR-NUVEL1</td>
<td>1988.0</td>
<td>76</td>
<td>1994-3</td>
</tr>
<tr>
<td></td>
<td>RO1</td>
<td>SSC(USNO) 94 R 06</td>
<td>Estim./NNR-NUVEL1</td>
<td>1993.0</td>
<td>76</td>
<td>1994-6</td>
</tr>
<tr>
<td>LLR</td>
<td>MV</td>
<td>SSC(FSG) 94 M 01</td>
<td>NNR-NUVEL1</td>
<td>1991.9</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>MJ</td>
<td>SSC(JPL) 94 M 01</td>
<td>NNR-NUVEL1</td>
<td>1991.0</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>MS</td>
<td>SSC(SHA) 94 M 01</td>
<td>NNR-NUVEL1</td>
<td>1988.0</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>MX</td>
<td>SSC(UTXMO)94 M01</td>
<td>AM0-2</td>
<td>1984.0</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>PJ</td>
<td>SSC(JPL) 94 P 01</td>
<td>Estim./ITRF92</td>
<td>1988.0, 1993.0</td>
<td>44</td>
<td>JGC9401</td>
</tr>
<tr>
<td></td>
<td>(CU)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GPS</td>
<td>PB</td>
<td>SSC(CODE) 94 P 01</td>
<td>ITRF92</td>
<td>1993.62</td>
<td>41</td>
<td></td>
</tr>
<tr>
<td></td>
<td>PB1</td>
<td>SSC(CODE) 94 P 02</td>
<td>Estim./ITRF92</td>
<td>1993.62</td>
<td>41</td>
<td></td>
</tr>
<tr>
<td></td>
<td>PE</td>
<td>SSC(EMR) 94 P 02</td>
<td></td>
<td>1993.21</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td></td>
<td>PE1</td>
<td>SSC(EMR) 94 P 03</td>
<td></td>
<td>1993.50</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td></td>
<td>PE2</td>
<td>SSC(EMR) 94 P 04</td>
<td></td>
<td>1993.83</td>
<td>19</td>
<td></td>
</tr>
<tr>
<td></td>
<td>PA</td>
<td>SSC(ESOC) 94 P 01</td>
<td>ITRF92</td>
<td>1994.0</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td></td>
<td>PZ</td>
<td>SSC(GFZ) 94 P 01</td>
<td>NNR-NUVEL1</td>
<td>1993.5</td>
<td>31</td>
<td></td>
</tr>
<tr>
<td></td>
<td>PJ</td>
<td>SSC(JPL) 94 P 01</td>
<td>Estim./ITRF92</td>
<td>1988.0, 1993.0</td>
<td>44</td>
<td>JGC9401</td>
</tr>
<tr>
<td></td>
<td>(CU)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SLR</td>
<td>LC</td>
<td>SSC(CSR) 94 L 01</td>
<td>Estim/NNR-NUVEL1</td>
<td>1988.0, 1993.0</td>
<td>116</td>
<td></td>
</tr>
<tr>
<td></td>
<td>LK</td>
<td>SSC(GAOUA)94 L 02</td>
<td>Estim./NNR-NUVEL1</td>
<td>1988.0</td>
<td>87</td>
<td></td>
</tr>
<tr>
<td></td>
<td>LZ</td>
<td>SSC(GFZ) 94 L 01</td>
<td>Estim./NNR-NUVEL1</td>
<td>1988.0</td>
<td>103</td>
<td></td>
</tr>
<tr>
<td></td>
<td>LG</td>
<td>SSC(GSFC) 94 L 01</td>
<td>Estim./NNR-NUVEL1</td>
<td>1988.0</td>
<td>38</td>
<td>SL8.5</td>
</tr>
<tr>
<td></td>
<td>(CU)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comb.</td>
<td>CU</td>
<td>SSC(DUT) 94 C 01</td>
<td>Estim./NNR-NUVEL1</td>
<td>1988.0, 1993.0</td>
<td>59</td>
<td></td>
</tr>
<tr>
<td>SLR +</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GPS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 2: Contribution to the ITRF93 combinations

<table>
<thead>
<tr>
<th>Tech.</th>
<th>Label</th>
<th>88.0 N1</th>
<th>93.0 N2</th>
<th>V N3</th>
<th>A posteriori analyzed N4 (epoch)</th>
</tr>
</thead>
<tbody>
<tr>
<td>VLBI</td>
<td>RF</td>
<td>7</td>
<td>7</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>RG</td>
<td>118</td>
<td>118</td>
<td>70</td>
<td></td>
</tr>
<tr>
<td></td>
<td>RJ</td>
<td>12</td>
<td>-</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>RM</td>
<td>-</td>
<td>-</td>
<td>26</td>
<td>56 (88.0)</td>
</tr>
<tr>
<td></td>
<td>RN</td>
<td>103</td>
<td>103</td>
<td>72</td>
<td></td>
</tr>
<tr>
<td></td>
<td>RO</td>
<td>-</td>
<td>-</td>
<td>48</td>
<td>76 (88.0)</td>
</tr>
<tr>
<td></td>
<td>RO1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>76 (93.0)</td>
</tr>
<tr>
<td>LLR</td>
<td>MV</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>5 (88.0)</td>
</tr>
<tr>
<td></td>
<td>MJ</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>5 (88.0)</td>
</tr>
<tr>
<td></td>
<td>MS</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>4 (88.0)</td>
</tr>
<tr>
<td></td>
<td>MX</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>5 (88.0)</td>
</tr>
<tr>
<td>GPS</td>
<td>PB</td>
<td>-</td>
<td>41</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>PB1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>41 (93.0)</td>
</tr>
<tr>
<td></td>
<td>PE</td>
<td>-</td>
<td>18</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>PE1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>17 (93.0)</td>
</tr>
<tr>
<td></td>
<td>PE2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>18 (93.0)</td>
</tr>
<tr>
<td></td>
<td>PA</td>
<td>-</td>
<td>25</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>PZ</td>
<td>-</td>
<td>31</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>PJ</td>
<td>44</td>
<td>44</td>
<td>44</td>
<td></td>
</tr>
<tr>
<td>(CU)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SLR</td>
<td>LC</td>
<td>116</td>
<td>116</td>
<td>47</td>
<td>87 (88.0)</td>
</tr>
<tr>
<td></td>
<td>LK</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>LZ</td>
<td>103</td>
<td>-</td>
<td>56</td>
<td></td>
</tr>
<tr>
<td></td>
<td>LG</td>
<td>38</td>
<td>-</td>
<td>38</td>
<td></td>
</tr>
<tr>
<td>(CU)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comb.</td>
<td>SLR + GPS</td>
<td>CU</td>
<td>59</td>
<td>59</td>
<td>50</td>
</tr>
</tbody>
</table>

N1, N2, N3, N4: number of stations included in each computation
1.4) Excentricites

The excentricities used for ITRF93 are given in Table T4 of the appendix.

2) DATA ANALYSIS

The ITRF93 global combined solution is divided into three parts:

- a set of station coordinates at epoch 1988.0
- a set of station coordinates at epoch 1993.0
- a velocity field consistent with the above two sets.

All of these three parts are estimated, using least square adjustment, by combination of individual terrestrial reference frames provided by the analysis centers participating in the IERS activities. These individual terrestrial reference frames are derived from VLBI, GPS and SLR observations.

We have only used solutions which should bring a significant contribution to the combination. Solutions of weaker quality or with unsufficient information were only compared a posteriori.

In this analysis, we have constrained the orientation of the ITRF93 and its rate of change with time to be consistent with the IERS series of Earth Orientation Parameters (EOP). This is different from what was done in the past, where a no-net-rotation condition at 1988.0 with respect to the previous ITRF was applied and where a no-net-rotation condition was applied to the velocity field through NNR-NUVEL1.

2.1) ITRF93 station coordinates combined solutions

2.1.1) ITRF93 station coordinates at epoch 1988.0

The ITRF93 station coordinates at epoch 1988.0 are estimated by combination of selected individual terrestrial reference frames among those submitted by the IERS analysis centers. The combination at 1988.0 is performed in two steps:

- in the first step, a global adjustment is done, holding to zero the seven transformation parameters of the SLR solution SSC(CSR) 94 L 01 (labeled hereafter LC). The three rotations R1, R2 and R3 obtained from this combination for two VLBI solutions (SSC(GSFC) 94 R 01 and SSC(NOAA) 94 R 01, labeled hereafter RG and RN respectively) have been compared to their corresponding EOP bias relative to the EOP of CSR solution: EOP(CSR) 94 L 01. Table 3 lists these values as the following:

*) the rotation angles of RG and RN wrt LC,
*) the corresponding EOP bias,
*) the differences between the rotation angles and the corresponding EOP bias,
*) the average of the above differences
*) the EOP bias of LC wrt to the IERS series (EOP(IERS) 94 C 01)