



INTERNATIONAL EARTH ROTATION SERVICE (IERS)
SERVICE INTERNATIONAL DE LA ROTATION TERRESTRE

DIRECTING BOARD

REPORT OF MEETING No. 12

PARIS, 1993 May 10 and 14

IERS 1993 WORKSHOP

The 1993 IERS Workshop was held on May 10-13. The program is given in Annex 1 and the list of attendance in Annex 2. The updated list of Corresponding Members of IERS is in Annex 3.

DIRECTING BOARD MEETING

1- ATTENDANCE

The Directing Board met on May 10, 14:30-17:30 and May 14, 9:00-13:00 at Paris Observatory.

Attendance : W.E. Carter, M. Feissel (secretary), W.G. Melbourne, B.E. Schutz, C. Veillet
(May 14), Ya. S. Yatskiv (Chairman).

Invitees : May 10: Z. Altamimi, E.F. Arias, D.D. McCarthy, D. Salstein
May 14: E.F. Arias, C. Boucher, B. Kolaczek, I.I. Mueller, D. Salstein .

PAST ACHIEVEMENTS AND FUTURE PROSPECTS

VLBI (W. Carter)

The extension of a worldwide network is pursued, with the equipment of sites in Ny Alesund, Russia, Brazil and Antarctica. The last two stations (Fortaleza and O'Higgins) have started operation. Newly built antennas will be installed by USNO at Richmond, Hawaii and Green Bank. The core IRIS-A network (Wettzell, Alaska, Hawaii, Green Bank, Fortaleza) is operated once a week in 24 h sessions; it offers for the first time the necessary redundancy. The two participants in the VLBI Technical Centre (Communication Research Laboratory, Japan, and Haystack Observatory, USA) have initiated discussions on possible common technical developments.

SLR (B. Schutz)

Lageos 2 was launched in October 1992. It is observed in parallel with Lageos 1; Earth orientation solutions based on the two satellites are currently being prepared. Etalon is observed by too few stations to allow estimation of Earth orientation. There are plans to put a laser station at Hartebeesthoek. Some new stations started operation in Russia; they concentrate mainly on ranging ERS-1. The increase in the number of targets (Lageos 2; Topex/Poseidon, launched in August 1992), and the priority given to the oceanography satellites does not presently result in lessening the number of observations of the Lageos satellites. Recent tests in two-colour SLR have been performed; they confirm the validity of the Murray-Marini model.

GPS (W. Melbourne)

The IGS'92 Campaign took place from June through September 1992. It was fully successful in establishing permanent observations by several tens of stations, rapid transmission to the data centres and high quality operational analysis by a number of space geodesy groups. The operation was continued after the end of the campaign, under the name IGS Pilot Service, to prepare the setting up of the International GPS Geodynamics Service (IGS), which is expected to start in 1994. The IERS Central Bureau and the sub-bureau for Rapid Service and Predictions participated in the campaign and its continuation by providing GPS station positions in the IERS system, Earth orientation predictions, and analyses of the Earth orientation and terrestrial reference frame results.

The IGS core network has presently about 40 stations equipped with high quality receivers; some gaps still exist in the network, in the southern hemisphere, Asia, Siberia. GPS operations are well supported by NASA. The quality of the analyses is continuously progressing. The multitechnique orbital analysis of Topex/Poseidon (GPS, SLR, Doris) shows the excellent accuracy of all techniques. They are expected to reach soon the level of consistency of ± 1 cm (radial). Antispoofing (AS) was activated repeatedly since August 1992 and will be in the future too. When on, it creates problems at the analysis level for the reconstruction of the signal, with special difficulties for low elevation observations.

Sub-bureau for Rapid Service and Predictions (D. McCarthy)

The weekly service was continued. The GPS polar motion results were introduced in the current computation. A new prediction scheme for UT1, based on chaotic prediction, will be investigated.

Sub-bureau for Atmospheric Angular Momentum (D. Salstein)

The arrangements for inclusion of data from the four meteorological centres by rapid transfer were achieved (Global Telecommunications System). The missing periods existing in the data sets were filled. The friction and mountain torques linking the solid Earth and atmosphere are currently computed. During the SEARCH'92 Campaign (June-September 1992), four-times daily AAM data were provided by all centres, and torques from NMC. An article describing the sub-bureau was published in the Bulletin of the American Meteorological Society. Data are distributed to an international group of scientists.

Future prospects are the inclusion of higher stratospheric levels at NMC (already in place at other centres), and inclusion of new data sources into the meteorological analysis/forecast systems, such as scatterometry (e.g. ERS-1) and microwave data (e.g. SSM/I). A reanalysis of data since 1958 will be started at NMC, using a Climate data assimilation system. The angular momentum of oceans will be calculated. More optimal weather analysis systems are tested; the availability of even faster computers will yield a new generation of forecast/analysis systems.

IERS Terrestrial Reference Frame (Z. Altamimi)

The Terrestrial Frame Section of the Central Bureau contributed to the IGS'92 Campaign by providing coordinates, local ties and a site information catalogue for the IGS stations.

The 1992 realizations of the ITRF will provide coordinates for 152 sites and velocities for 95 sites, based on 19 global solutions (5 VLBI, 3 LLR, 6 GPS, 5 SLR) including 7 observed velocity fields (3 VLBI, 4 SLR). The ITRF velocity field is constrained to follow Nuvel NNR-1 by a no-rotation, no-translation condition based on 61 sites away from the deformation zones.

IERS Celestial Reference Frame (F. Arias)

The 1992 realization of the ICRF will include 504 sources. Thanks to the general improvement in the data available, about 150 sources north of -71° can be selected as primary in the maintenance of the axes of the frame. The IERS VLBI Analysis Centres and the Central Bureau participate in the discussions of the IAU Working Group "Reference Frame" (chairman: C. de Vegt).

The IERS has been asked to provide coordinates of extragalactic reference sources for the tie of the Hipparcos galactic frame. In the coming year, efforts will be made to enhance the quality of the few tens of source positions to be used as references for the tie.

Earth orientation and general activity of the Central Bureau (M. Feissel)

The introduction of GPS results opens the possibility of constructing combined series of one day normal points.

Some Analysis Centres started to consider explicitly the daily and semi-daily variations in polar motion and universal time. This raises the need for conventions about the way to proceed.

Proposals are made about the way to perform a reset of the IERS results which would bring the EOP in agreement with the ITRF and the ICRF within better than $\pm 0.0005''$ (the current discrepancy is $0.001-2''$).

It is proposed to prepare an IERS Technical Note based on the SEARCH'92 Campaign, which was coordinated by IERS.

After the first five years of existence, the influence of IERS, as measured by the number of participating Analysis Centres and by the distribution of IERS publications, has increased by a factor of two.

On the invitation of CCDS (Comité Consultatif pour la Définition de la Seconde) which met at BIPM in March 1993, the Central Bureau reported on the implementation of the UTC system by IERS. The IERS responsibility consists in deciding and announcing the UTC one second time steps and in announcing the value of DUT1 (UT1-UTC with a precision of ± 0.1 s) to be transmitted with the time signals. The report suggested that time was ripe to re-examine the UTC-TAI system, which was set up more than 20 years ago.

GPS PARTICIPATION IN IERS

Following the Call for Proposals for GPS participation in IERS, a number of answers were received: two for analysis and coordinating centre, three for analysis centre, one for data centre, and four for station. The proposers were:

- coordinating and/or analysis centres: Centre for Orbit Determination in Europe (CODE, Bern); Energy, Mines and Resources Canada (EMR, Ottawa); Jet Propulsion Laboratory (JPL, Pasadena); National Oceanic and Atmospheric Administration (NOAA, Silver Springs), Scripps Institution of Oceanography (SIO, San Diego);
- data centre: NASA Crustal Dynamics Data Information System (CDDIS, Greenbelt);
- stations: Observatoire Royal de Belgique, Observatory of the Slovak Technical University; Czech Research Institute of Geodesy, Topography and Cartography; Kitab Observatory, Uzbekistan.

In parallel, the future cooperation of IERS with the International GPS Geodynamics Service (IGS) was discussed in detail by the two services. After the IERS/DB had expressed in March 1993 their view of the cooperation (see Report on IERS/DB meeting No 11), they were invited to comment on the draft IGS Terms of Reference. The latter were subsequently amended to take into account their remarks. The final agreement is that the IERS will rely on IGS for the GPS observations and their organisation, and that in turn the IGS rules will make provision for the interfacing of its participants with IERS, including direct interaction of the GPS Analysis Centres with the IERS Central Bureau and Sub-bureau for Rapid Service and Predictions. Through the existing reciprocity agreement between the services, the IERS Directing Board will have a representative on the IGS Governing Board, and the IGS Central Bureau will serve as the GPS Coordinating Centre in IERS.

The Directing Board decided to welcome all proposed participations, and to invite the proposers to establish or confirm their link to IGS.

The effective participation of GPS Analysis Centres in the IERS work started in June 1992 with the IGS'92 Campaign. It has been uninterrupted since, both for the operational services and the yearly global analysis. The Directing Board is satisfied with this situation.

IERS STANDARDS

Summary of the May 12 Workshop session (D. McCarthy)

The current IERS Standards appear in IERS Technical Note 13. It is likely that a new set will be required in 1995. It is important that careful consideration of the future standards begin now and participants were asked to provide input. Options for the introduction of the periodic terms in the definition of Universal Time were discussed in the introduction. The actual date on which they will be introduced will depend on this year's re-reduction of all past Earth orientation data by the IERS Central Bureau. The preliminary date is still in 1997. The requirement for a standard method of treating diurnal and sub-diurnal variations was also discussed. It is essential that analysts document the model that they use to process the observations. Failure to do so can lead to the introduction of systematic errors in the interpolation. The possibility of an IERS Technical Note on standard interpolation procedures was mentioned.

A. Brzezinski presented some possibilities for the definition of nutation in view of diurnal and sub-diurnal Earth orientation variations. Adoption of a new nutation model was also discussed following the presentation of P. Charlot on nutation theories. Adoption of a new model still seems to be premature without the adoption of a new precession constant, but discussion continues on the topic.

R. Gross and M. Watkins reviewed the diurnal and sub-diurnal variations in the Earth's orientation. Various models were presented for consideration as possible standards. JPL had already reported that they are using an in-house model for diurnal and sub-diurnal Earth orientation variations in the treatment of their VLBI data.

B. Schutz reported that the current GEM-T3 gravity field adopted in the Standards will be replaced in the next issue of the standards. The new model will take into account the Lageos 2 and Topex/Poseidon observations. A report was presented by M. Rothacher on the requirements for the definition of standards to be used in the treatment of GPS data and the need for GPS analysts to consider the effect of nutation in their data processing. Radiation pressure models also need to be standardized. Finally, O. Sovers reviewed the effects of ocean loading on observations pointing out that additions to the existing tables will be required in the new standards.

DISCUSSION ON QUESTIONS RAISED IN THE WORKSHOP

IERS Celestial Reference Frame

The next deadlines for the Hipparcos link and the IAU Working Group are October 1993 (provision of ICRF coordinates for the extragalactic reference objects) and December 1993 (proposals for the IAU list of sources). Final coordinates will be due in 1995 for Hipparcos and in 1997 for IAU.

The concepts related to the classification and ranking of extragalactic sources in view of celestial frame maintenance and accessibility need to be further clarified.

It will be necessary in the future that the Celestial Frame Section of the Central Bureau maintain a data base of radio source maps.

Precession, Nutation

There is in IERS a need for adopting an interim model for precession and nutation, in particular for satellite geodesy analyses. The IERS Standards specialist, D.D. McCarthy, is requested to circulate the corresponding part of the recent issue of the Explanatory Supplement of the American Ephemeris.

The IAU Commission on Earth rotation (19) organizes a Joint Commission Meeting on Nutation at the next IAU General Assembly (August 1994). IERS should participate in the preparation of the discussion on the problem.

Reset of the IERS reference frames and EOP

In principle, the IERS Earth Orientation Parameters (EOP) are those angles which transform the IERS terrestrial reference frame (ITRF) into the IERS celestial reference frame (ICRF) as a function of time. The initialization of the IERS System performed in 1988 realized this concept with the observations available at this time. In practice, maintaining this consistency in the subsequent realizations of frames and series of EOP would have made it necessary to constrain some of the IERS products on the basis of information from the other ones.

At its April 1990 meeting (cf Report on meeting No 6, p. 18), the Directing Board recommended that in the future the global analyses insure the continuity of the series of EOP independently from the maintenance process of the celestial and terrestrial reference frames. The estimated inconsistency introduced by this procedure in the set of IERS results (reference frames and time series) is published in the IERS Annual Report. The offsets that exist between the IERS EOP and the ITRF have a linear time variation (about 0.2 mas/year) due to the evolution of Analysis Centres and Central Bureau practices in constraining the terrestrial velocity field. The offsets amount to 1-2 mas in 1993.

Considering that the current practice is now to estimate the station velocities from the same observations that determine the Earth's orientation (as opposed to adopting a geophysical model for all station motions), and that the progressive divergence of the IERS results should be lessened, the Directing Board decides that

- the ICRF be rotated in the near future to match the IERS EOP at some epoch,
- the IERS EOP linear time evolution be changed to match the ITRF velocity field.

It is expected that this reset will insure an initial consistency better than 0.2 mas, with a rate of divergence smaller than 0.1 mas/year.

The Directing Board also decided that the correct expression of Greenwich Sidereal Time be adopted in 1997, when the 18.6-year and 9.3-year periodic terms in this expression are zero. The Presidents of the IAU Commissions concerned will be informed of this plan.

To accompany the two above mentioned changes in IERS Earth orientation, the past series of EOP will be recomputed by the Central Bureau.

Results of the SEARCH'92 Campaign

A campaign, SEARCH'92 (Study of Earth-Atmosphere Rapid CHanges), for high time resolution (sub-daily) measurements of Earth rotation by all of the space geodetic techniques, was coordinated by the International Earth Rotation Service (IERS) and was held in conjunction with the IGS Campaign (June 21-September 22, 1992). A special intensive period (Epoch'92) extended from July 25 through August 8, 1992. The SEARCH campaign involved all space geodetic techniques and the best available complementary geophysical, atmospheric and oceanographic data were collected. A joint International Association of Geodesy/International Astronomical Union (IAG/IAU Special Study Group, Rapid Earth Orientation Variations, has been formed to interface with the IERS in the determination of rapid variations in Earth rotation by the space geodetic techniques, especially during SEARCH'92, advocate for the best possible auxiliary data from geophysical, atmospheric and oceanographic sources; and encourage improvements in measurement techniques and cooperative multidisciplinary studies.

The Directing Board decided that an IERS Technical Note be prepared to present the campaign and its major results, as well as theoretical consideration on diurnal and semi-diurnal oscillations in Earth orientation, under the responsibility of J. Dickey, President of the IAG Special Study Group of Rapid Earth Orientation variations, with the help of M. Feissel.

GENERAL

Next IERS Workshop

It was decided that the next meeting of the Directing Board will be held in conjunction with the 1994 IERS Workshop, to take place in Paris, 21-24 March 1994. In agreement with the IGS oversight Committee, 24 March sessions will be common with an IGS Workshop, to take place also in Paris, 24-25 March 1994.

The Directing Board decided to make efforts aiming at having more thorough discussion on the hot subjects in IERS, as opposed to formal presentations.

Corresponding members

It was decided to invite representatives from the Analysis Centres to become corresponding members. The list of added names is as follows.

B. Ambrosius, G. Blewitt, Y. Bock, J. Dow, M. Eubanks, I. Georgiev, J. Kouba, C. Ma, E. Pavlis, V. Salyamov, O. Sovers, A. Steppe, M. Watkins, J.F. Zumberge.

Conclusion

I. Mueller thanks the Directing Board for their spirit of cooperation in the discussions which took place in the last year for establishing the mutual contributions of IERS and IGS.

Y. Yatskiv thanks the Central Bureau, Sub-bureau and Technique Coordinators for their excellent work for IERS.

ANNEX 3

IERS CORRESPONDING MEMBERS (May 1993)

B. Ambrosius	J. Kouba	C. Schalinski
M. Baltuck	J. Kovalevsky	H.G. Scherneck
P. Bender	R.B. Langley	H. Seeger
G. Beutler	J.L. Le Mouel	A. Sengoku
J. Bosworth	J.-F. Lestrade	P. Shelus
G. Blewitt	D.D. McCarthy	O. Sovers
C.D. Boucher	P. McCulloch	A. Sprent
Y. Bock	C. Ma	A. Steppe
A. Brzezinski	G.L. Mader	A. Stolz
P. Brosche	S. Manabe	F. Takahashi
J. Campbell	A.J. Miller	V. Taradij
J. Degnan	J.B. Minster	S. Tatevian
J.O. Dickey	H. Montag	C. de Veigt
J. Dow	L.V. Morrison	R.O. Vicente
R. Eanes	I.I. Mueller	J. Vondrak
M. Eubanks	J. Müller	K.F. Wakker
A.M. Finkelstein	M. Murata	M. Watkins
D.M. Fubara	A. Nothnagel	A.L. Whipple
T. Fukushima	R. Neilan	A. Whitney
I. Georgiev	P. Pâquet	J. Williams
C. Goad	E. Pavlis	G.A. Wilkins
R. Gross	W.R. Peltier	C.R. Wilson
E. Groten	G. Petit	P. Wilson
B. Guinot	D. Pugh	W.H. Wooden
T. Herring	J. Ray	P. Woodworth
R. Hide	C. Reigber	T. Yoshino
Jin W.J.	D.S. Robertson	T. Yunck
K. Kaminuma	R. Rosen	Zhu S.Y.
T. Kato	D. Salstein	J.F. Zumberge
R.W. King	V. Salyamov	
B. Kolaczek	T. Sasao	

President of FAGS	: E. Tandberg-Hanssen
General Secretary of IAU	: J. Bergeron
President of IAU Commission 19	: B. Kolaczek
President of IAU Commission 31	: E. Proverbio

General Secretary of IUGG	: G. Balmino
General Secretary of IAG	: C. Boucher
President of IAG Section II	: C. Reigber
President of IAG Section V	: J. Dickey
President of IAG Commission 8 (CSTG)	: B. Schutz

ANNEX 1

IERS WORKSHOP, 1993 PROGRAM

Tuesday, May 11

9:00 - 9:15 *Opening of the Workshop*

9:15 - 10:30 *Central Bureau, Sub-Bureaux, Standards*

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| N. Essaïfi (Central Bureau): | Access to the IERS/CB data bank.
A first look at the 1992 Annual Report EOP data. |
| M. Feissel (Central Bureau): | Possible reset of the IERS results. |
| D. McCarthy (Sub-Bureau for Rapid Service and Predictions): | Current results. |
| D. Salstein (Sub-Bureau for Atmospheric Angular Momentum): | Recent activities of the sub-Bureau, including SEARCH'92. |
| D. McCarthy (Standards): | Current issues. |

11:00 - 12:30 *SLR*

Convenor: B. Schutz

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| B. Schutz: | Coordinator's report. |
| H. Montag, G. Gendt, G. Dick: | Earth rotation parameters based on SLR data (GFZ). |
| B. Ambrosius: | SLR analysis at Delft University. |
| B. Schutz, M. Watkins: | SLR analysis at CSR. |
| V. Salyamov and V. Tarady: | ERP as derived from SLR analysis in Kiev. |
| I. Georgiev: | Four dynamic solutions from laser ranging to LAGEOS (CLG). |
| E. Pavlis: | SLR analysis at GSFC (SL8.2). |
| H. Drewes: | SLR analysis at DGFI. |

ANNEX 1 (cont.)

14:00 - 15:30 **GPS**

Convenor: B. Melbourne

B. Melbourne:	Coordinator's report.
M. Rothacher, G. Beutler, W. Gurtner:	Earth rotation parameters estimated from GPS during the IGS 1992 Campaign and the IGS Pilot Service.
W.H. Wooden:	NAVSTAR Global Positioning System activities at the Defense Mapping Agency.
J. Zumberge and G. Blewitt:	JPL Earth Orientation Measurements with GPS: Results from 1992.
B. Schutz:	GPS analysis at CSR.
D. Gambis, E. Eisop, N. Essaïfi, M. Feissel:	Analyses of EOP series derived from GPS

16:00 - 17:30 **VLBI**

Convenor: B. Carter

B. Carter	Coordinator's report.
W. Jin:	VLBI observations of extragalactic sources in Southern hemisphere and the contributions of Shanghai VLBI Station.
J.A. Steppe, S. Oliveau , O.J. Sovers:	JPL TEMPO Analysis Report .
A.-M. Gontier, E. Eisop:	Analysis of the IRIS Intensive sessions at Paris Observatory .

17:30 - 18:00 **LLR**

Convenor: C. Veillet

C. Veillet:	Coordinator's report.
XX Newhall and J.O. Dickey:	JPL LLR Analysis Report.
J. Müller, M. Schneider, M. Soffel, H. Ruder:	Analysis report of Forschungsgruppe Satellitengeodesie (FGS).

ANNEX 1 (cont.)

Wednesday, May 12

9:00 - 10:30

Observation and estimation of Earth orientation

Convenor: M. Feissel

V.E. Zharov, V.A. Kraïnov, S.N. Marcova, E.N. Fedoseev: Present State of the laser gyroscope of the Sternberg Astronomical Institute.

R.S. Gross: A Combination of Earth Orientation Data: Space 92.

E. Eisop, N. Essaïfi, M. Feissel, D. Gambis: Comparison of daily combined EOP series.

Terrestrial system *Convenor: C. Boucher*

C. Boucher, Z. Altamimi, L. Duhem Status report on the IERS Terrestrial Reference Frame

11:00 - 12:30

H. Drewes: Remark on the realization of the terrestrial kinematic datum.

G. Blewitt, F. Zumberge: The geocentre and scale determination of the TRF by GPS at JPL.

O. Sovers: Recent results on ocean loading estimates.

Z. Altamimi, C. Boucher, L. Duhem: Analysis of the 1993 Terrestrial Reference Frames.

J.-P. Dufour, C. Boucher, P. Willis: Comparisons between ITRF-91 and recent DORIS solutions.

14:00 - 15:00 ***Poster viewing*** *Contact: N. Essaïfi*

15:30 - 17:30 ***Standards***

Convenor: D. McCarthy

D. McCarthy: Introduction and current concerns.

A. Brzezinski : Remarks concerning the definition of nutation in view of observed diurnal and sub-diurnal polar motion.

P. Charlot : Nutation models.

M. Watkins: Observations of diurnal and sub-diurnal variations in earth orientation.

R. Gross: Sub-daily tide models.

B. Schutz: Gravity fields.

M. Rothacher: Standards used in the treatment of GPS data.

O. Sovers: Ocean loading.

ANNEX 1 (cont.)

Thursday, May 13

9:00 - 10:30 **High frequency Earth orientation** *Convenor: J. Dickey*

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| M. Watkins: | Estimation of high frequency polar motion based on SLR and GPS. |
| A.P. Freedman, R. Ibanez-Meier, J.O. Dickey, S.M. Lichten: | Sub-daily Variations in UT1 from GPS during the Epoch'92 Campaign. |
| B. Kolaczek: | Variability of short periodic oscillations of polar motion. |
| A. Brzezinski: | On the application of 2-dimensional maximum entropy spectral analysis for the interpretation of the observed earth orientation parameters. |

11:00 - 12:30 **Long term Earth orientation** *Convenor: D. Gambis*

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| P. Brosche: | Remarks on the angular momentum balance of the Earth. |
| J. Vondrak: | Nutations before 1980 from the new solution of ILS observations. |
| R. Abarca and S. Houry: | Atmospheric excitation of polar motion: comparative time-frequency descriptions using the wavelet transform. |
| E. Eissop, M. Feissel: | A 150 years long polar motion series. |
| Y. Ricard: | True polar wander and mantle convection. |

14:00 - 15:30 **Celestial system: realization and connection with other systems**

Convenor: E. F. Arias

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| A. Nothnagel: | Analysis of VLBI observations at the Geodetic Institute of the University of Bonn. |
| C. Schalinski: | Mapping of IRIS sources with milliarcsecond resolution: progress report. |
| Y. Yatskiv: | Attempts for combination of radio source catalog. |
| E.F. Arias: | The ICRF and the IAU. |
| J. Kovalevsky: | Hipparcos link to the extragalactic reference frame. |
| J.-F. Lestrade: | VLBI observations of radio stars and the Hipparcos link. |

16:00 - 17:30 **General discussion**

Participants of the 1993 IERS Workshop

R. Abarca	(France)	W.G. Melbourne	(USA)
Z. Altamimi	(France)	C. Mulhauser	(France)
B. Ambrosius	(Netherlands)	D.D. McCarthy	(USA)
E.F. Arias	(Argentina)	H. Montag	(Germany)
C. Boucher	(France)	I.I. Mueller	(USA)
S. Botton	(France)	J. Mueller	(Germany)
M.L. Bougeard	(France)	A. Nothnagel	(Germany)
D. Bourquard	(France)	P. Pâquet	(Belgium)
P. Brosche	(Germany)	P. Pavlis	(USA)
A. Brzezinski	(Poland)	B. Richter	(Germany)
N. Capitaine	(France)	M. Rothacher	(Switzerland)
B. Carter	(USA)	D. Salstein	(USA)
L. Castrique	(France)	V. Salyamov	(Ukraine)
P. Charlot	(France)	C. Schalinski	(Germany)
L. Daniel	(France)	B. Schutz	(USA)
G. Dick	(Germany)	J. Souchay	(France)
J.O. Dickey	(USA)	O. Sovers	(USA)
H. Drewes	(Germany)	A. Steppe	(USA)
L. Duhem	(France)	V. Tarady	(Ukraine)
E. Eisop	(France)	P. Tomasi	(Italy)
N. Essaïfi	(France)	Ch. Veillet	(France)
M. Feissel	(France)	R. Vicente	(Portugal)
D. Gambis	(France)	J. Vondrak	(Czech R.)
I. Georgiev	(Bulgaria)	M. Watkins	(USA)
A.-M. Gontier	(France)	P. Willis	(France)
R. Gross	(USA)	W. Wooden	(USA)
E. Groten	(Germany)	G. Wöppelmann	(France)
B. Guinot	(France)	Ya. Yatskiv	(Ukraine)
R. Haas	(Germany)	K. Yokoyama	(Japan)
W. Jin	(China)	J. Zumberge	(USA)
B. Kolaczek	(Poland)	V. Zharov	(Russia)
J. Kovalevsky	(France)		
J.-F. Lestrade	(France)		