19. ROTATION OF THE EARTH (ROTATION DE LA TERRE).

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Introduction

During the period the activities of the Commission were expanded by several major events which have had beneficient effects on the determination of the Earth's rotation parameters (ERP):

- the People's Republic of China becoming member of IAU the astronomical observations were available for the international services or special experiments as MERIT. This contribution is more specially noticed in the reports of BIH and IPMS.
- by the organization of the MERIT campaign the scientific communauty succeeded to set up a first world campaign with a simultaneous operation of all the techniques currently available : classical astronomy, Doppler, Laser and radio-astronomy.
  The analysis of such a set of data confirms the necessity to refine the relations between the reference systems associated intrinsically with each approach.
- the increased accuracy obtained in the determination of the ERP and in geodynamics as well require a better definition of a conventional Reference System and its maintenance. To fulfill these objectives a new Working Group has been established by the IAU Colloquium 56.
- the 1979 IAU Theory of Nutation has been revised in order to be in agreement with the resolution taken by IUGG in December 1979. A large majority (80%) of Commission 19 was in favour of that modification and adopted the 1980 IAU theory of Nutation.

On the other hand the difficulties to maintain in operation the classical instrumentation in some of the ILS stations seem to be in an irreversible status (refer to IPMS report); but let us hope that, in a near future, periodic measurements will be possible with new techniques in all of the ILS stations.

Changes in the instrumentation

Lists of the instruments collaborating in international programmes are published in the Annual Reports of the BIH and IPMS.

Borowiec: observations with a Danjon astrolabe started in 1981 while those conducted since 23 years with a transit instrument were terminated.

Cagliari: three instruments are now in operation, a WANSCHAFF zenith telescope, a PZT in loan from Mizusawa, a Danjon astrolabe respectively since 1979,1980, 1981. The WANSCHAFF is working in parallel with the similar instrument of Carloforte.

Natal: the Universidade Federale do Rio Grande do Norte is installing a Danjon astrolabe transfered from Herstmonceux.

Brussels, Mizusawa, Ottawa, San Fernando: new Doppler equipments TRANET II are installed or tests are in progress.

Simeiz: has been equipped with a Doppler receiver MX-1502 in addition to the laser ranging technique and astrolabe.

Potsdam: a new PZT, made by ZEISS (Jena) was brought into service in july 1980. The programme of observations is the same than for the old PZT.

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Research in instrumentation

Borowiec: a Doppler station which is expected to be in service in 1982 is in progress of installation.
Cagliari: a laser system is in construction while a Doppler equipment is in test.
Canada:-development of a geophysical Long Base Interferometry (LBI) system has been under way since 1978. Experimental results demonstrated viability of a commercial satellite communication link for operation of LBI with relative phase stability of about 2×10^{-15} for a period of one day. It is planned to complete the LBI with near real time data processing by 1986.
-Surveys and Mapping Branch reports, by Dr. A. VAMOSI, that a prototype of a microprocessor controlled portable Transit recorder is experienced for geodetic purposes and development of a PZT. Transit are measured with a precision of 5 ms on a star of magnitude 6.
CERGA - Grasse: - a photoelectric astrolabe has been developped and operated. The first results show that the epoch at which a star cross the primary vertical is determined with an error of the order of 5 or 8 ms. The instrument will be used for UTO and also to continue the catalogue of absolute declination.
Dresden: a system of electronic levels has been applied as a Horrebow level system at the transit instrument by Potthoff and Wächter (25.032.058; 27.031.530). Development of a photoelectric Circumzenithal is continued (27.031.531).
Herstmonceux:- the control system of the PZT has been rebuilt. Some mechanical work has been done to counteract the effects of age and wear in the plateholder location and traverse systems.
-a satellite laser ranging system is being built by RGO and the University of Hull. It is expected to be in regular operation, not only for ER, by late 1982.
Mizusawa: a full automatic photoelectric astrolabe of Tsubokawa type is now in provisional observation.
Potsdam: Major (1979) has experienced a photoelectric transit, investigations of a photoelectric recording of epochs of transit of stars are conducted with the aim to develop a PZT with a photoelectric detecting device (Meining et al, 1979), (Nguyen Tri Long 1979 a, b, c), a new approach for the compensation of the axis of inclination of the transit instrument is proposed by Dittrich et al (1980).
US Naval Observatory: - a visual 20 cm instrument (PZT6) is tested in Richmond and compared to the PZT2 the improvement is expected to be of the order of 10 to 20%.
-a visual 65cm instrument (PZT7) has been in operation; the improvement in the internal precision over that of PZT3 is about 25%.
-construction of a 20 cm instrument (PZT8) is nearly completed.
USSR: research of instrumental·errors of classical astronomical techniques is being continued. Different methods of determination of the scale of ZT have been discussed in Pulkovo (27.032.004) and in Blagoveshchensk (27.032.024). Z.M. Malkin (27.032.023) considered the method of calculation of the scale of the PZT. The instrumental errors of PTI is studied by K.A. Steinset et al. (27.041.046,27.041.050) and by M.I. Il'kiv et al (27.041.021). V.A. Naumov and Z.M. Malkin (27.044.004) modernized the system of time registration of the Pulkovo PZT_2.

Revision of observing catalogues and of earlier observations

G.M. Blank (25.044.013) considered the errors of the Catalogues of stars used by the USSR Time Service. A.A. Tochilina (27.044.015) discussed the determination of time with the Moscow PZT; V.A. Naumov et al. (27.041.018) and E. Ya. Prudnikova (27.045.011) undertake the second readjustment of observations with ZTL-180 for the years 1967-1974 and an analysis of latitude variations of Pulkovo respectively.

In collaboration with the observatory of Mizusawa, D. Mc Carthy (1980) investigate a possible observing program for the PZT at 39° latitude Nord.

J. Vondrak (1980a) determined the mean positions and proper motions of 304 stars observed during 1973-1978 with the PZT of Ondrejov. The new positions were used to re-reduce all the PZT plates (Vondrak, 1980b).

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Due to influence of precession, the programme of observations with the astrolabe of Potsdam has been modified (Höpfner, 1980b)while correction to the FK4 stars were deduced from the past observations (Höpfner, 1981a).

On the basis of the 22 years of operation performed with the PZT of Hamburg an improved PZT catalogue is in preparation and could be ready for mid-1982.

Earth's rotation from the new techniques

The impact of the new techniques on the ER studies has been more sensitive during this period, mainly by the organization of the first MERIT campaign (see reports of BIH, IPMS, MERIT WG).

Doppler

The observatories of Belgium, Calgary, Mizusawa and Ottawa, by their continuous observations are contributing to the determination of the DMAHTC polar motion. In Ottawa special Doppler data reduction package has been developped to evaluate residual variation in station positions, polar motion and UT1 (Kouba, 1981). At the Observatoire Royal de Belgique the software has been improved (Pâquet et al, 1979) and compared to other methods of analysis (Boucher et al, 1979). The time evolution of the station coordinates is given in Pâquet (1980). The Groupe de Recherches de Géodésie Spatiale (France) managed the MEDOC project of Doppler determinations of the polar motion, using Transit satellites, with the participation of the DMAHTC of several foreign organizations and of four french stations. In october 1980 the current operation was interrupted in order to prepare an improved MEDOC by the use of better receivers, model of forces and data transmission means.

Laser

The observatories of Cagliari and Herstmonceux are installing Satellite Laser Ranging (SLR) equipment while the station of Wettzell is in progress to run a Lunar Laser Ranging (LLR) station. Potsdam has managed a SLR station during the MERIT campaign (Montag et al, 1981).

The SLR station of CERGA is operational since 1979 and participates to LAGEOS and STARLETTE ranging. A cooperation between CNES, GRGS and the San Fernando Observatory (Spain) is established for the operation of the San Fernando laser station. Pole determinations from SLR data were performed by CNES and GRGS; researches continue on this topic, in cooperation with BIH.

The first identified lunar laser returns from the CERGA LLR station were obtained in June 1981. The theoretical work and the interpretation of observed data from Mc Donald and Orroral stations are pursued in CERGA, in the framework of EROLD. In cooperation with the University of Texas, a new lunar ephemeris has been established, which was used for the evaluations of UT1 published by the BIH and for the MERIT short campaign.

Radio-astronomy

The Jet Propulsion Laboratory conducts two single baseline VLBI experiments per week using the 64 meters radio telescopes of the Deep Space Network. The results from these experiments are used for earth orientation estimates and to monitor station clock behavior and have made available to the BIH starting in July 1980. (Fanselow et al, 1979; Fanselow, 1980, 1981).

At the USNO, routine observations have been made continuously with the 35-km connected element radio interferometer (CERI) at Green Bank, West Virginia. Since only one baseline is available, two parameters analogous to the variation of astronomical latitude and UT0-UTC are routinely determined. Three days of observations are used to form one normal point which is transmitted to the Bureau International de l'Heure and the International Polar Motion Service. Preliminary analysis of the observational results shows that the connected-element interferometer may be expected to contribute an important part of future observational efforts.

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Reference systems for study of the Earth's rotation

Taking into account the development of geodynamics and the relations existing between space geodesy and ER studies an IAU Colloquium (N°56) on Reference Coordinate Systems for Earth Dynamics has been held in Warsaw in 1980. As a consequence the International Association of Geodesy and IAU Commissions 4, 19, 31 decided to create a joint Working Group having the task to prepare a proposal for the establishment and maintenance of a conventional terrestrial reference system.
The WG is chaired by Prof. I. Mueller and the members are MM. E. Gaposchkin, B. Guinot, B. Kolaczek , J. Kovalevsky, D.D. MC Carthy, N.G. Melbourne, P. Melchior, K. Yokoyama. A first meeting has been held in May 1981 (Grasse).

E.P. Fedorov (1980), Ya.S. Yatskiv and al. (1980) discussed the definition and establishment of the basic coordinate systems in astronomy and geodynamics.
Ya. S. Yatskiv (1980) reviewed the establishment of the terrestrial coordinate system by classical astronomical methods.
M.M. Dagaev (25.044.004) considered the terminology in reference systems of time.

P.L. Bender (1981) reviewed the use of new observational techniques to determine terrestrial reference frames which are suitable for investigating both worldwide tectonic plate motions and variations in the earth's rotation. The particular case of using laser range measurements to the Lageos satellite for this purpose was discussed earlier by Bender et al (1979).

Research in problems concerned with the rotation of the earth

Theoretical studies

A.I. Rybakov and E.P. Kalinina (27.044.010) integrated numerically the differential equations of motion for the Earth-Moon-Sun system for the time span of 100 years. The value of the angular acceleration of the Earth was estimated to be 0.66×10^{-11} day^{-2}. T.V. Ruzmaikina (27.081.063) considered the nonhydrostatic quadrupole excess moment of the Earth. V.N. Zharkov and S.M. Molodensky (27.081.073) derived the Love numbers of the anelastic Earth. S.M. Molodensky (1981) considered the effect of ocean tide and anelasticity on the nutation.

Theoretical calculations of the tidally induced variations of UT1 have been presented in Yoder et al (1981 a, b). These calculations, which include contributions from the oceans and fluid core, have been compared with solutions for the coefficients of the monthly and semi-monthly terms using lunar laser ranging data. The observational and theoretical results agree within the errors. They also estimates other small periodic terms in ER and nutations due to geophysical effects.

J. Wahr et al (1981a) analysed the effect of a fluid core on changes in the length of day due to long period tides. They conclude that the poorly understood decade fluctuations in the ER rate will prohibit observation of this effect (10ms at 18.6yr).

Williams and Melbourne (1981) have examined the influence of the precession constant in the present system of definitions and coordinate systems and have concluded that a consistent, but imperfect, value of the precession constant will cause a linear drift between UT1 values derived by classical optical techniques and the inertial techniques of lunar laser ranging and VLBI. It is recommended that the equation for Greenwich Mean Sidereal Time allows for future improvements in the precession constant.

J. Vondrak et al (1982) derived the direct influence of Venus, Mars and Jupiter on the precession and nutation of the Earth's axis of rotation.

T. Sasao et al (1981a) shown that diurnal atmospheric and oceanic loading of the Earth's surface provide an efficient mechanism for the free core nutation.

Okamoto and Kikuchi (1981) clarified statistical properties of the Chandler wobble in the theoretical and finite discrete cases. The method of analysis of the Chandler wobble was shown with the statistical features of the excitation process taken into account.

J. Wahr et al (1981b) show that tides in the open ocean and the Earth's response to those tides are resonant at (1+1/460) cycle day^{-1}; the effect on the Earth's nutational motion could be as large as 0.002 arcsec at 18.6 yr.

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Sato (1979) estimated the effect of annual parallax on the latitude variation using spectroscopic parallaxes of the ILS stars. The work for determining spectroscopic parallaxes of all time and latitude stars is still under way.

The investigations of tidal friction in the present oceans and those of the geological past are presented in Brosche et al (1979, 1980) and Brosche (1979).

Decade fluctuations

The "decade" fluctuations in the Earth's rotation were re-determined in the period 1861-1978 from an analysis of timings of occultations of stars by the Moon(26.044.001). This analysis was extended back to 1600 and the results were reported at IAU Colloquium N°56. Secular changes in the Earth's rotation were investigated using ancient Babylonian timings of lunar eclipses.

Relations with geophysical phenomena

An extensive review of the relations between ER and Geophysical causes is given in the book of K. Lambeck (1980).

Fluctuations in the atmospheric angular momentum were determined by the Meteorological Office, UK, and the National Center for Atmospheric Research, USA, from wind and pressure observations obtained in the Global Atmospheric Research Programme for the periods January-March and May-June 1979. These were found to correspond fairly well with equal and opposite changes in the Earth's solid mantle (28.044.035). These results have shown the desirability of calculating the atmospheric angular momentum on a regular basis.

N.S. Sidorenkov (25.044.001) investigated the role of the atmosphere in the excitation of long-term variations in UT1 using the meteorological data for the years 1956.8-1977.0. These variations are shown to be resulted from the mechanical influence of the atmosphere on the Earth's surface. He also proposed to use the information of the irregularities in UT1 as possible indices of global water exchange (27.044.034). In K. Lambeck et al (1981) the zonal angular momentum of the atmosphere has been evaluated and compared with astronomical observations for the period 1963 - 1973.

Hara (1980) discussed the relation between the UT1 variations and the atmospheric excitations. He showed that mountain torque due to Hymalaya-Tibet plateau and the Rocky mountains are three times larger than surface stress.

Daillet (1981a) analyses the excitation of the annual wobble by the atmosphere.

Jochmann (1981c) developped a model of polar motion and uses it to analyse the influences of the deterministic and stochastic parts of the meteorological excitation function on polar motion.

On the basis of Schwiderski's ocean tide models T. Sasao et al (1981b) analysed the effects of ocean tides upon 5 ILS stations. The effect may reach several milliarcseconds at near-coast station. They recommend to correct the astronomical data for ocean tides.

The relation between zonal tides and length of day are analysed in Merriam (1980).

Djurovic (1981) assumes that a correlation between some particular fluctuations of the ER and the solar activity are existing.

Barlik et al (1980) are carrying on gravimetric measurements on the meridian of stations in Jozefoslaw in order to determine variations of meridian components of the vertical and find correlations with mean latitude variations (Kolaczek et al,1980).

Melchior P.,(1979)presents the experimental results deduced from Earth Tides observations and a discussion about the nutation tables.

The influence of Earth tides on the modern techniques observing the ER is emphasized in Vicente (1979). A review paper giving an overall view of the researches concerning the structure of the Earth and the nutations is given in Vicente (1980). Also related to the Earth's structure a Working Group from IUGG, which intends to publish an international reference Earth model, has published a preliminary final report in Dziewonski et al (1981).

S.M. Nakiboglu et al (1980) present the secular motion of the Earth's rotation pole as deduced from astronomical observations as a possible consequence of the viscoelastic response of the Earth to the mean displacements caused by late Pleistocene deglaciation and concomitant sea level changes.

The Centre for Astronomy of Bucharest started studies on the relations between ER and internal structure of the Earth. Plate motions are also analysed from the latitude observations. At the Universidad Complutense of Madrid, Dr. Sevilla is establishing a group for theoretical works related to nutations, reference systems and ER.

Astronomical refraction

Sugawa and Naito (1981) showed that there exists a refraction anomaly of the order of 0.″01 in the observed time and latitude with the time scale of about several ten minutes due to density variations caused by advections and internal gravity waves.

Varia

A. Stoyko (1980) prepared a first complement to the bibliography related to the astrolabes.

Analysis of observational data

Earth's rotation parameters

Routine predictions of polar motion and UT1-UTC were initiated during this time by USNO. The predictions are currently based on BIH Circular D and Rapid Service results. These values along with estimates of their accuracy are published weekly in the USNO Time Service Publications Series 7 and are available immediately to users equipped to access the Time Service HP 1000 computer. The rms accuracy of these values is expected to be better than ± 0.″03 in polar motion and ± 0.^{s}007 in UT1-UTC forty days after predictions are made. The accuracy improves appropriately for dates less than forty days following the time of prediction. Klepczynski W. (1980), Klepczynski et al (1980), Mc Carthy et al (1979, 1980).

An algorithm has been developped to treat observations made with new observational techniques as well as the classical methods. This procedure treats data obtained with any technique in the same manner to estimate the polar motion and UT1-UTC. Preliminary efforts have made use of optical, Doppler satellite, laser ranging to satellites and radio interferometer observations to determine the orientation of the Earth. It is anticipated that these results will also be available through the weekly Series 7 Publication and immediately accessible through the Time Service HP 1000 computer.

Manabe (1981) developed a new algorithm for the reduction of PZT observations using the method of non-linear least-squares. Vondrak (1979) also prepared a new analysis of PZT observations.

G.P. Pil'nik (25.044.009, 25.081.007, 27.044.014) considered the problem of derivation of the Love number k and nutation from time observations. Different determinations of the nutational coefficients from observational data have been finished to the IAU Symposium N°78 (27.043.008, 27.043.014).

At the Observatoire de Paris the homogeneous series of latitude observations initiated in 1956 has been analysed to determine the nutation, some particular periodic terms (26.043.001, 26.044.007, 27.043.011, 27.043.012, 27.045.002, 27.045.033), the Earth tides coefficient Λ (Chollet 1980).
The latitude observations performed at Potsdam between 1957.8 and 1977.0 were also analysed (Höpfner, 1979) to determine similar parameters than in Paris. The results of Potsdam were compared with those obtained in Paris and special investigations were carried out to study the Chandler period, its variation and the half Chandler period (Höpfner, 1980a, 1981b, Jochmann (1980, 1981 a, 1981 b).

D. Djurovic (1979 a, b) identifies several periodic terms and the irregular fluctuations of the seasonal components in the series UT2-TAI covering 1967 to 1978.

At the Jet Propulsion Laboratory, Pasadena, the rotational orientation of the earth (ΔUT0 at McDonald Observatory) has been determined from lunar laser ranging (LLR) measurements for the interval 1971 to 1980. The results have been differenced from those obtained by conventional means as published by the Bureau

International de l'Heure (BIH), on its 1979 system. The difference displays a quasi-seasonal signature, which the JPL group ascribes to systematic errors in the conventional measurements. Also, a comparison of polar motion results from three sources (Bureau International de l'Heure (BIH), Defense Mapping Agency Hydrographic/Topographic Center (DMAHTC-Doppler), the International Polar Motion Service (IPMS)) was performed using lunar laser ranging (LLR)data. Results are given in H.F. Fliegel et al (1982) and J.D. Dickey et al (1982).

Latitude variations

S. Manabe et al (1979) have determined the declination corrections and the short periodic latitude variations derived from the recalculated past ILS observations. B. Kolaczek (1979), B. Kolaczek et al (1981) investigate the variation of mean latitude stations and their influence on the polodia. Large influence of mean latitude variations on polodia was found especially in the case of small number of stations like in ILS. Spectral analysis of modelled latitude variations including sudden and continuous time variations was made in A. Brzezinski et al (1980). In order to study periodical terms of latitude variations B. Kolaczek (1980), Jacks (1981), Jacks et al (1979, 1980) perform spectral analysis of different set of latitude variations of individual stations as well as polar motion. Latitude observations were also analysed in Dresden (21.045.003).Polar motion, longitude and latitude variations are also analysed by Moczko (1980) and Schillak (1980).

Annual and Chandler components

V.I. Sakharov et al (25.045.003, 25.045.004, 27.045.001) derived the variation of amplitudes and phases of the annual and Chandler terms from observations covering the period 1893-1974.

Okamoto and Kikuchi (1981) found the 30-yr periodicity of the mean pole with amplitude of 0".034 in the direction of the 142°W - 38°E which is considered to be due to the non-polar variation of Ukiah station.

Wu Shouxian et al (1979, 1981) give the results of their researches on the characteristic and the modulation of the Chandler component. An estimation of the Chandler period and the so-called 30yr period have been computed from the homogeneous ILS polar motion series in Wilson et al (1980).

W.E. Carter (1981) suggests that the Chandlerian component may be frequency modulated as a linear function of the polar motion magnitude.

Daillet (1981b) considers the correlation between the pole tide and the Chandler wobble ellipticity. Comments on the Chandler wobble Q are given in Merriam et al (1979).

REPORT OF THE BUREAU INTERNATIONAL DE L'HEURE.

This report covers the activities on the rotation of the Earth. The BIH work on atomic time is presented to Commission 31.

During the last three years, the BIH has been increasingly involved in the new techniques for evaluating the Earth's Rotation Parameters (ERP). The year 1980 was especially marked by the BIH participation to the MERIT short campaign which had two aspects: a BIH participation to some techniques of measurement, and the coordination of the campaign. We will present first the research work, then the participation to MERIT, and finally the BIH current evaluation of the ERP which was drastically improved by the inclusion of new series of data.

Researches

The members of the BIH team participated to the researches on new techniques for measuring the ERP and to their implementation. Gambis participated to the Doppler project MEDOC (Gambis and Nouel, 1980), then evaluated the ERP from LAGEOS laser ranging in the framework of MERIT. Researches on SLR continue with the aim of improving the results, and of investigating the possibility of an observatory type operation: local filtering and data-compression, central reduction by an international body. The EROLD project entered an active phase, and BIH estimates

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of UT1 have been issued in cooperation with CERGA (Calame and Guinot, 1979: Calame, 1979, 1980, 1981).

The theoretical aspects of the rotation of deformable models of the Earth are being considered by Capitaine (1980a). In particular this work clarified some problems concerning the corrections for diurnal nutation. Capitaine also participated to several studies on the effects of the Earth tides on the rotation of the Earth. Some determinations of nutation coefficients have been performed on the data of the Paris astrolabe (Capitaine, 1980b) and on the BIH results (Feissel and Guinot, 1980); further work on this topic is in progress in cooperation with a Chinese astronomer in stay at BIH for two years.

The occurrence of short term irregularities of UT1 has long been suspected by BIH: mention of such events has been made in BIH circulars in 1968 and 1971. Feissel and Gambis (1980), using independent measurements of UT1, have confirmed these irregularities, which appear as series of waves with periods of the order of 50 days and a peak to peak amplitude of several milliseconds.
These irregularities, as well as longer term variations are highly correlated with the angular momentum of the atmosphere: researches continue on this topic, in cooperation with meteorologists and geophysicists.

As long as the ERP were referred to the plumb lines, the link between the space reference system and the geodetic coordinates was rather loose. But, with the development of methods which refer the ERP to the figure of the Earth, the definition of the systems of reference becomes critical in the BIH work (Capitaine and Feissel, 1981). The experience gained at the BIH allowed to propose statistical methods for defining the conventional terrestrial system of reference for the ERP and the geodetic coordinates (Guinot, 1981). In conjunction with considerations on the space reference system, the BIH participated to the redefinition of the Universal Time, when adopting the IAU (1976) System of Astronomical Constants.

Participation to MERIT

The BIH participated to the organization of the project through their membership in the MERIT steering committee.

The BIH acted as computing centre in two of the techniques involved in the 1980 Short Campaign (optical astrometry and SLR).

The BIH was designated as coordinating centre for the short MERIT campaign. To fulfil its duties, the BIH developed with the help of P. Morgan (National Mapping, Australia) a system of access to files in the GE mark III worldwide computer network. This system remained in use after the end of the campaign. Weekly and monthly status reports were issued during the campaign. The BIH prepared the supplement to the Short Campaign Report which contains informations on the observations and the 25 different series of ERP that were computed by the Analysis Centres. Other duties were the comparison of the series of measurements and, if possible, the evaluation of the ERP from a combination of results. These tasks are, in fact, the continuation of the efforts undertaken at BIH for using currently the data of new techniques. These matters will be considered in the next section.

Current evaluation of the ERP

Fig. 1 shows the relative weights of the techniques used in the current 5-day evaluations of the coordinates of the pole and the square root of their pair variance σ(2,5 days). This latter quantity is believed to represent the measurement uncertainties. The local deterioration in 1979 is due partly to the decreasing quality of the optical astrometry prior to the availability of the chinese observations and partly to the unusual irregularities in the Doppler solution: four different satellites were used during the year.
Concerning UT1, the optical astrometry (85% in 1981) and the connected element interferometry (CERI, 15% in 1981) are the only contributors. The pair variance of UT1 is of little significance on account of the noise of UT1 itself. Fig.2 shows the mean annual value of the formal standard deviation σ. By comparison with the corresponding figures for the pole, one can estimate that σ (2,5 days) of the measu-

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rement errors for UT1 is of the order of 1.3 x σ. The improvement of UT1 observed in 1980 is mainly due to the impact of the chinese participation.

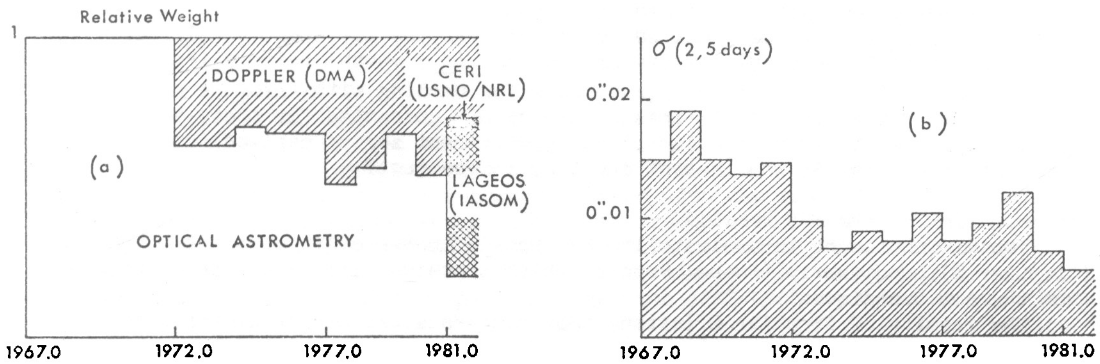

Fig.1. (a) Participation of the various techniques in the BIH evaluation of the coordinate x of the pole (5-day solution, table 6C of Annual Report).
(b) Square root of the pair variance for 5 days averaging time. The diagrams for y would be similar.

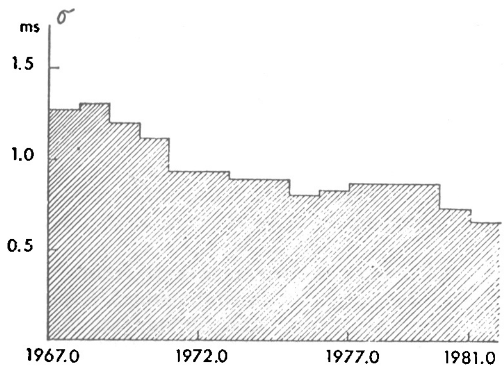

Fig.2. Formal standard deviation of the 5-day UT1 determination.

The inclusion of new series is the result of numerous studies. After the adoption of the 1979 BIH System, it has been found that the results of the optical astrometry for the pole position agree fairly well with the data of the Doppler and SLR series, except for a constant or slowly varying bias. It was thus possible to modify the weighting process concerning the annual terms. All series are used in the same way as optical measurements as explained by Feissel (1980), but the weight for the preservation of the BIH system of reference was splitted into two parts : a weight for the constant correction, and a weight for the annual correction. It was then possible, starting in January 1981, to determine the annual corrections to optical and CERI latitudes by reference to Doppler and SLR data (which receive no annual corrections), while all series contribute to the definition of the reference pole (Feissel, 1982).

Concerning UT1, it was not yet possible to use the LLR and VLBI data, which are too sparse. The inclusion of the duration of day (LOD) measures from SLR, which would require an integration, raises some unsolved problems, but it is expected that these data should improve the evaluation of the short-term irregularities of UT1. The comparison of LLR and BIH series for UT1 reveals rather large differences

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(varying in a range of several ms) which are not explained.

Among the numerous problems we have encountered we will mention a few ones on account to their general character.

- There is sometimes a bias of the order of 1 m between the pole coordinates derived by the DMA from different TRANSIT satellites. This might illustrate the danger of specialized models of the geopotential. Different constant corrections have been applied by the BIH for the different satellites.
- The tidal terms of UT1 with short periods ($\leq$ 1 month) raise difficulties on account of the lack of an agreed rule for dealing with them. We reiterate our wish that the IAU defines a form of UT1 corrected for these terms.
- We are faced to the problem of using different series derived from the same observations. To what extent are they independent?

Dissemination of the BIH results.

The BIH continues to evaluate the ERP weekly (under a JPL contract), monthly (Circular D), and yearly (Annual Report, which contains also experimental results from the new techniques).

The results of Circular D (strong smoothing) are often used as standard reference. We suggest to continue to do so, since they are not modified by subsequent improvement. However we recall that better series appear in the Annual Reports, which should be used for geophysical research.

The major changes are the increasing use of the GE Mark III, and the addition of new data in Circular D : a weak smoothing for UT1 and the corresponding LOD, the ERP from some networks.

Numerous requests for special services have been answered, for instance, transmission of data on tapes and cards, and by telex, particular smoothings ...

About 750 copies of the BIH Annual Report are sent yearly.

B. GUINOT, Director.

REPORT OF THE INTERNATIONAL POLAR MOTION SERVICE

At the end of March 1980, Dr. S. Yumi retired and Dr. K. Yokoyama succeeded him as the Director of the IPMS, in accordance with the agreement at the General Assemblies of both the IAU at Montreal in August 1979 and the IUGG at Canberra in December 1979.

The IPMS monthly raw and 1/20-year smoothed Earth rotation parameters (ERP) have been published regularly in Monthly Notes and Annual Reports. Basic data are astrometric observations, but the results of the connected element radio interferometry at Green Bank have been merged since the observation began. Inclusion of the results of other new techniques is also being considered.

Three kinds of the ERP are given in the IPMS periodicals; 1) x, y and z from latitude data, 2) x, y, z and UT1 from time and latitude data, and 3) x, y, z, τ and UT1 from time and latitude data. Periodic components in τ, as well as those in z, are explained by the nutation errors. Drifts and jumps in station coordinates were adjusted when they became perceptably large. No correction for annual and semi-annual variations is applied. Internal precision of the estimated monthly raw ERP are:

	Time				Latitude			Time and Latitude				
	x	y	τ	UT1	x	y	z	x	y	z	τ	UT1
1979	″015	″018	″016	^{s}.0010	″013	″011	″019	″010	″009	″008	″018	^{s}.0011
1980	.012	.015	.014	.0008	.012	.010	.007	.008	.008	.007	.015	.0009

Periodic and secular systematic differences of the IPMS ERP with reference to the ERP from new techniques have been monitored. In order to make more detailed comparison and to interpret the sources of the systematic differences, the IPMS is developing an algorithm to provide time-dense ERP in the system of new constants

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specified in the MERIT Standards.

During the short campaign of the project MERIT from August to October 1980, the IPMS acted as an analysis center of classical techniques, namely, optical astrometry (Principal Coordinator - K. Yokoyama). Detailed report of the IPMS activities during the short campaign was presented at the MERIT Workshop held in May 1981 at Grasse, France. 85 optical instruments of 22 countries participated in the short campaign and contributed to the work of the analysis center. The IPMS ERP were estimated on monthly basis and transmitted to the coordinating center (BIH) of the Project MERIT through GE MARK-III system.

The accuracy, as well as the precision, of the ERP derived from optical astrometry was remarkably improved due to the participation of 12 Chinese instruments of high quality. It is thus expected that the ERP derived from optical astrometry will have sufficient accuracy for comparing them with the results of new techniques. In particular, for the comparison of the fine structure in UT1 variation, for example, the short periodic variation revealed in VLBI UT1 during the short campaign, optical astrometry will still play an important role in the coming main campaign.

For the preparation of the main campaign, the IPMS has completed an algorithm to supply the ERP in the system of the MERIT Standards. This implies the adoption of the IAU 1976 System of Astronomical Constants, and the corrections for the variations of the vertical due to the Earth and oceanic tides, and for the deflection of light due to the relativistic effect. Unification of the global PZT star catalogs with a fundamental catalog is also under way. This will make it possible to exclude an uncertainty due to proper motion errors.

Under the direction of the Working Group on Pole Coordinates originated at the General Assembly of the IAU at Brighton in 1970, the IPMS had been in charge of recalculating the past ILS observations. The final results were published as "Results of the International Latitude Service in a Homogeneous System, 1899.0 - 1979.0" by S. Yumi and K. Yokoyama (1980, Mizusawa, Japan). This volume gives ILS pole coordinates and the z-term on monthly basis with reference to the CIO, based on the IAU 1964 System of Astronomical Constants. Magnetic tapes with individual latitudes of all northern ILS stations were distributed worldwidely to institutions and agencies related to investigations of the Earth rotation. General features of the newly derived pole coordinates are not very much different from those of the past reduction. However, it was confirmed that the annual z-term disappears when the nutation table of Wahr (1981) are adopted.

Present situations of the ILS chain are as follows.
The National Geodetic Survey which is in charge of observing the Earth rotation in the USA reported the closing of VZT stations of Ukiah and Gaithersburg on July 1, 1982. The NSG is concentrating its effort for monitoring the Earth rotation in the POLARIS Project. It was also reported that Carloforte in Italy and Kitab in the USSR will also suspend VZT observations in the near future due to the deterioration of the instruments.

In order to interpret the past results of the ILS in terms of the new techniques, it is absolutely necessary to monitor displacements of the ILS stations with suitable new techniques.

K. Yokoyama, Director.

REPORT OF IAU/IUGG JOINT WORKING GROUP MERIT (SEPT. 1979, OCT. 1981)

The proposal for Project MERIT, which had been endorsed at the IAU General Assembly in Montreal, was presented to the International Association of Geodesy and was endorsed by the Association and by the International Union of Geodesy and Geophysics at their meetings in Canberra in 1979 December. The IAU Working Group was reconstituted as a joint IAU/IUGG working group with added representation; Professor I.I. Mueller became vice-chairman. The group developed the plans for the MERIT short campaign in more detail and appointed a steering committee to coordinate the activities during the Project. A review of the project and of the techniques to be used to monitor the rotation of the Earth was published (Wilkins,1980).

The MERIT Short Campaign was held during the period 1980 August 1 to October

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31 to provide a realistic test of the operational arrangements that will be required during the MERIT Campaign in 1983/4. The campaign stimulated extra activity in all techniques, faster development of both laser ranging and VLBI, and a greatly increased level of interaction and cooperation between the scientists of the many disciplines and countries concerned in the project. In addition it provided a valuable set of observational data and results on both polar motion and the variations in the rate of rotation of the Earth.

A Workshop to review the short campaign and to plan the main campaign was held at Grasse on 1981 May 18-21, and some of the results obtained during the campaign were presented on the following day at IAU Colloquium N°63. Brief reports were given in CSTG Bulletin N°3 and IAU Information Bulletin N°46. A more extensive report on the short campaign is in preparation; it contains an account of the discussions at the Workshop, references to relevant papers, and a supplement giving details of the observations and results obtained during the campaign (Wilkins and Feissel, 1981). Information about the Project is published from time to time in the MERIT Newsletter which is distributed widely, on request.

G.A. Wilkins, Chairman of the Working Group.

REFERENCES

BARLIK M., GALAS R., ROGOWSKI J., 1980: Proc. 4th Int. Symp. Geodesy and Physics of the Earth, in press.
BENDER P.L., GOAD C.C., 1979: The Use of Artificial Sat. for Geodesy, Vol. II.
BENDER P.L., 1981: Proc. IAU Coll. 56.
BOUCHER C., PAQUET P., WILSON P., 1979: Proc. 2nd Int. Symp. Sat. Doppler Positionning.
BRZEZINSKI A., KOLACZECK B., 1980: 4th Int. Symp. Geodesy and Physics of the Earth, in press.
BROSCHE P., SUNDERMANN J., 1979: Proc. IAU Symp. 82.
BROSCHE P., 1979: Astr. Nach. 300, 195.
BROSCHE P., KROHN J., SUNDERMANN J., 1980: Berliner Geowiss. Abh. Reihe A/Bd 19,S117
CALAME O., GUINOT B., 1979: BIH Annual Rep. for 1978, D-27.
CALAME O., 1979: BIH Annual Rep. for 1978, D-49.
CALAME O., 1980: BIH Annual Rep. for 1979, D-35 and D-45.
CALAME O., 1981: BIH Annual Rep. for 1980, D-13.
CANNON W.H., PETROCHENKO W.T., YEN J.L., GALT J.A., WALTMAN W.B., KNOWLES S.H., POPELAER J.: 1979, Proc. Radio Int. Techn. for Geodesy.
CAPITAINE N., 1980a: Manuscripta geodetica, 5, 1.
CAPITAINE N., 1980b: Proc. IAU Symp. 78, 87.
CAPITAINE N., FEISSEL M., 1981: Proc. IAU Coll. 56, 135.
CARTER W.E., 1981 : JGR 86, B3, pp 1653-1658.
CHOLLET F., 1980: Proc. Int. Symp. Geodesy and Physics of the Earth.
DAILLET S., 1981a: Geophys. J.R. Astr. Soc. 64, pp 373-380.
DAILLET S., 1981: Geophys. J.R. Astr. Soc. 65, pp 407-421.
DICKEY J.O., FLIEGEL H.F., WILLIAMS J.G., 1982: IAU Coll. 63, p. 125.
DITTRICH J., JOCHMANN H., 1980: Astron. i. Astrofiz., Kiev 42.
DJUROVIC D., 1979a: Publ. of Dept. Astr. Beograd, 9, pp 17-30.
DJUROVIC D., 1979b: Publ. of Dept. Astr. Beograd, 9, pp 31-39.
DJUROVIC D., 1981: AA 100, pp 156-158.
DZIEWONSKI A.M., ANDERSON D.L., 1981: Phys. of the Earth and Planetary Interiors, 25.
FANSELOW J.L., THOMAS J.B., COHEN E.J., PURCELL G.H., ROGSTAD D.H., 1979: Proc. IAU Symp. 82.
FANSELOW J.L., 1980: BIH An. Report 1979, pp D75-76.
FANSELOW J.L., 1981: BIH An. Report 1980.
FEDOROV E.P., 1980: Geodynamics and astrometry, Kiev pp 74-110.
FEISSEL M., GUINOT B., 1980: Proc. IAU Symp. 78, 109.
FEISSEL M., GAMBIS D., 1980: C.R. Acad. Sci. Paris, B 291, 271.
FEISSEL M., 1980: Bull. geod., 54, 1.
FEISSEL M., 1982: Proc. IAU Coll. 63, p. 3.

https://doi.org/10.1017/S0251107X00025979 Published online by Cambridge University Press

FLIEGEL H.F., DICKEY J.O., WILLIAMS J.G., 1982: Proc. IAU Coll. 63, p. 53.
GAMBIS D., NOUEL F., 1980: Bull. geod., 54, 108.
GUINOT B., 1981: Proc. IAU Coll. 56, 125.
HARA T., 1980: Publ. Int. Lat. Obs. Mizusawa, 14, p.45.
HOPFNER J., 1979: Gerlands Beitr. Geophys. 88, 3, pp 185-192.
HOPFNER J., 1980a: Gerlands Beitr. Geophys. 89, 3/4, pp 182-186.
HOPFNER J., 1980b: Astron. Nachr. 301, 1, pp 27-32.
HOPFNER J., 1981a: Trudy XXI Astrometriceskoj konferenzii SSSR, Taschkent, pp 151-153.
HOPFNER J., 1981b: Veröff. Zentr. Phys. der Erde, Potsdam, 63.
HOPFNER J., SCHABACKER H.: Wiss. Z. Tech. Univ. Dresden 28, 3, pp 727-729.
JAKS W., LEHMANN M., 1979: Wiss. Z. Techn. Univ. Dresden 28, H3, pp 750-759.
JAKS W., LEHMANN M., 1980: Publ. Inst. Geophys. Polish Ac. of Sc., F6, 137.
JAKS W., 1981: Acta Astronomica 31, 1 (Warsaw).
JOCHMANN H., 1980: Gerlands Beitr. Geophys. 89, 3/4, pp 187-194.
JOCHMANN H., 1981a: Astr. Nachr. 302, 4, pp 141-144.
JOCHMANN H., 1981b: Veröff. Zentr. Phys. der Erde, Potsdam, 63.
JOCHMANN H., 1981c: Veröff. Zentr. Phys. der Erde, Potsdam, 67.
JOHNSTON K.J., SPENCER J.H., MAYER C.H., KLEPCZYNSKI W.J., KAPLAN G.H., McCARTHY D.D., WESTERHOUT G., 1979: Proc. IAU Symp. 82, pp 211-215.
KLEPCZYNSKI W.J., 1980: Project Merit, RGO, pp 17-20.
KLEPCZYNSKI W.J., KAPLAN G.H., McCARTHY D.D., JOSTIES F.J., BRANHAM R.L., JOHNSTON K.J., SPENCER J.H., 1980: Radio Interferometry Tech. for Geodesy, NASA Conf. Publ. 2115, pp 63-70.
KOLACZEK B., 1979: Proc. IAU Symp. 82, pp 165-173.
KOLACZEK B., 1980: Proc. 4th Symp. Geodesy and Physics of the Earth, in press.
KOLACZEK B., GALAS R., BARLIK M., DUKWICZ M., 1980: Proc. IAU Symp. 78, pp 211-222.
KOLACZEK B., TELEKI G., 1981: Proc. IAU Coll. 56.
KOUBA J., 1981: An. de Géophys. , 1.
LAMBECK K., 1980: The Earth's variable rotation, Geophysical causes and consequences , Univ. of Cambridge.
LAMBECK K., HOPGOOD P., 1981: Geophys. J.R. Astr. Soc. 64, pp 67-89.
MAJOR W., 1979: Wiss. Z. Tech. Univ. Dresden 28, 3, pp 736-737.
MANABE S., SAKAI S., SASAO T., 1979: Publ. Int. Lat. Obs. Mizusawa 18, 2.
MANABE S., 1981: Publ. Int. Lat. Obs. Mizusawa, 15, p. 1.
McCARTHY D.D., 1979: Rev. Geophys. and Space Physics, 17, pp 1397-1403.
McCARTHY D.D., 1979: Proc. IAU Symp. 82, pp 65-66.
McCARTHY D.D., PERCIVAL D., 1979: Proc. IAU Symp. 82, pp 53-54.
McCARTHY D.D., 1980: Publ. Int. Lat. Obs. Mizusawa, 14, pp 1-34.
McCARTHY D.D., KLEPCZYNSKI W.J., KAPLAN G.H., JOSTIES F.J., BRANHAM R.L., WESTERHOUT G., JOHNSTON K.J., SPENCER J.H., 1980: BIH An. Rep. 1979 , pp D67-D70.
McCARTHY D.D., 1981: Proc. IAU Coll. 56, pp 145-153.
MEINIG M., JOCHMANN H., 1979: Wiss. Z. Techn. Univ. Dresden 28, 3, pp 739-742.
MELCHIOR P., 1980: AA 875, pp 365, 368.
MERRIAM J.B., LAMBECK K., 1979: Geophys. J.R. Astr. Soc. 59, pp 281-286.
MERRIAM J.B., 1980: Geophys. J.R. Astr. Soc. 62, pp 551-561.
MOCZKO J., 1980: Int. Koll. Geod. Astr. Mitteilung Techn. Univ. Dresden.
MOLODENSKY S.M., 1981: Physics of the Earth, Moscow, n°6.
MONTAG H., GENDT G., WELMANN W., 1981: Proc. of the Merit Workshop (Grasse).
NAKIBOGLU S., LAMBECK K., 1980: Geophys. J.R. Astr. Soc. 62, pp 49-58.
NGUYEN TRI LONG, 1979a: Vermessungstechnik 27, 2, pp 49-52.
NGUYEN TRI LONG, 1979b: Wiss. Z. Techn. Univ. Dresden, 28, 3, pp 742-745.
NGUYEN TRI LONG, 1979c: Veroff. Zentr. Phys. der Erde, Potsdam 56.
OKAMOTO I., KIKUCHI N., 1981: Proc. IAU Colloq. n°63.

https://doi.org/10.1017/S0251107X00025979 Published online by Cambridge University Press

PAQUET P., DEVIS C., STANDAERT D., 1979: Proc. 2nd Int. Symp. Sat. Doppler Positioning.
PAQUET P., 1980: Phil. Tr. Roy. Soc. London, pp 237-244.
SASAO T., WAHR J., 1981a: Geophys. J. Astr. Soc. 64, pp 729-746.
SASAO T., SATO T., 1981b: Proc. of the 9th Int. Symp. on Earth Tides, NY, in press.
SATO K., 1979: Publ. Int. Lat. Obs. Mizusawa, 12, p. 55.
SCHILLAK S., 1980: Publ. Inst. Geophys. Pol. Acad. Sc. F-6/137.
SUGAWA C., NAITO I., 1981: Presented 6th European Reg. Meet., Dubrovnik.
STOYKO A., 1980: Published by Observatoire de Paris.
VICENTE R.O., 1979: Proc. of the 9th GEOP Conference, Ohio State Univ. Report 280.
VICENTE R.O., 1980: Proc. IAU Symp. 78, pp 139-151.
VONDRAK J., 1979: Wiss. Z. Univ. Dresden 28, 737.
VONDRAK J., 1980a: Bull. Astr. Inst. Czekosl. 31, 89.
VONDRAK J., 1980b: Proc. of the 4th Symp. Geodesy and Physics of the Earth.
VONDRAK J., 1982: Bull. Astr. Inst. Czechosl. 33 (in press).
WAHR J.M., 1981: Geophys. Astr. Soc. 64, p 705
WAHR J., SASAO T., SMITH M., 1981a: Geophys. J. Astr. Soc. 64, pp 635-650.
WAHR J., SASAO T., 1981b: Geophys. J. Astr. Soc. 64, pp 747-765.
WILLIAMS J.G., MELBOURNE W.G., 1981: Proc. IAU Coll. 63.
WILSON C.R., VICENTE R.J., 1980: Geophys. J.R. Astr. Soc. 62.
WU SHOUXIAN, HUA YINGMIN, WANG SHUBE, 1981: Scientia Sinica 7, pp 847-854.
WU SHOUXIAN, WANG SHUBE, HUA YINGMIN, 1979: Acta Astronomica Sinica, 20, n°12.
WILKINS G.A., 1980: Review of the techniques to be used during Project Merit.RGO Publ.
WILKINS G.A., FEISSEL M., eds, 1981: Project Merit, Report on the short campaign. RGO Publ.
YATSKIV Ye S., GUBANOV V.S., 1980: Geódynamics and astrometry, Kiev,pp 110-120.
YATSKIV Y.S., 1980: Proc. IAU Coll. 56, pp 155-165.
YODER C.F., WILLIAMS J.G., SINCLAIR W.S., PARKE M.E., 1981a: JGR 86, pp 881-891.
YODER C.F., WILLIAMS J.G., PARKE M.E., DICKEY J.O., 1981b: An.de Géophys. 37.

The following references are those of Astronomy and Astrophysics Abstracts:
25.032.058, 044.001, 044.009, 044.013, 044.088, 045.003, 045.004, 081.007
26.043.001, 044.001, 044.007
27.031.530, 031.531, 032.004, 032.023, 032.024, 041.018, 041.021, 041.046, 041.050, 043.008, 043.011, 043.012, 043.014, 044.004, 044.010, 044.014, 044.015, 044.034, 045.001, 045.011, 045.011, 045.012, 045.033, 081.063, 081.073.
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