Commission 19: Rotation of the Earth (Rotation de la Terre)

Report of Meetings: 20-27 November 1985

President: Ya. A. Yatskiv Vice-President: W. J. Klepczynski

20 November (Wednesday) 1330: Commission 19 - Organizing Committee, I

The Organizing Committee met to discuss the schedule of meetings and appointments to be made during the general assembly.

21 November (Thursday) 1100: Commission 19 - Organizing Committee, II

The organizing committee met to discuss proposed resolutions.

21 November (Thursday) 1400: Commission 19 - Business meeting, I

President: Ya. A. Yatskiv Secretary: W. J. Klepczynski

The agenda for the business session was approved by the membership. The results of the election of officers for the coming triennium were announced: Klepczynski was elected president and B. Kolaczck and M. Feissel were elected Vice-Presidents.

There were 12 appointments to the Organizing Committee: F. E. Barlier, P. Brosche, W. E. Carter, D. M. Djurovic, I. I. Mueller, M. G. Rochester, B. F. Schutz, J. Vondrak, G. S. Wilkins, Ya. Y. Yatskiv, Ye Shu-Hua, K. Yokoyama. Twenty eight new members were brought into the commission, bringing the total membership of the commission to 162. Eight consultants to the commission were approved: R. Anderle, E. A. Flinn, Kawajiri, M. Schuh, V. I. Sergienk, D. E. Smith, P. Wilson, and X.-y Zhu.

The President thanked everyone for their contribution to the triennial commission report. Professor I. Mueller then gave a short report on the Merit/Cotes project, summarizing its recommendations. Dr. Teleki gave a very short report in the work of Djurovic and Stajic concerning the possibility of solar activity as the ultimate cause of the 55 day cyclic variation noted by M. Feissel and D. Gambis.

The IPMS report was given by Dr. K. Yokoyama in two parts. The first part summarized the activities of the IPMS during the last three years. New software was developed to derive Earth Rotation Parameters (ERP's) from the new techniques on a daily basis. The R.M.S. of the differences between the data set as derived by the IMPS and that of the IRIS campaign is about 1.5 ms. Optical Astrometry still seems to be good in UT1 but not in PM. There is an agreement of about 0.2ms between the optical data set when compared with data sets corrected for the variation in the Earth's Atmospheric Angular Momentum. The second part of the report was concerned with ILOM. Presently, a review of the International Latitude Observatory at Mizusawa is being made. ILOM is planning to establish 2 VLBI stations within Japan in 5 years. ILOM plans to deal with optical data only until 1988.

Dr. Feissel's report in the activities of the BIH covered:

1.) Improved methods for reducing optical observations as developed at BIH by Li Zheng-xin of Shanghai Observatory;

2.) The introduction of Space Geodesy Techniques into the BIH Terrestrial System; and

3.) The BIH combined solutions for ERP's.

While the analysis of the improved optical observations is not complete, sufficient data exists to allow a comparison of a somewhat long series of optical observations with observations from the new techniques. Since 1962, no detectable drift of the BIH system is found. Dr. Feissel also reports that, starting with 1985, the BIH Terrestrial System is accessable through 34 points located throughout the world.

Dr. McCarthy of USNO reported on some of the details of Symposium #128, Earth Rotation and Reference Frames for Geodesy and Geodynamics to be held 20-24 October 1986 in the Washington, D.C. area.

Dr. Ye Shu-hua was confirmed as Commission 19 representative to the IPMS.

22 November (Friday) 1400: Merit/Cotes Project

CHAIRMAN: Session 1: D. D. MaCarthy SECRETARY:G. A. Wilkins
Session 2: Y. A. Yatskiv

ABSTRACT. A joint Meeting of Commissions 19 and 31 was held during the IAU General Assembly at Delhi to consider the recommendations for a new international Earth-rotation service put forward by the IAU/IUGG Joint Working Groups on the rotation of the Earth and the conventional terrestrial reference system. Wilkins gave summaries of the MERIT programme of activities to monitor Earth rotation and intercompare the techniques of observation and analysis and of the COTES programme to establish the basis of a new conventional terrestrial reference system. He reviewed the recommendations of the groups, and then introduced a draft resolution of the commissions. An amendment on the continuation of the use of the technique of optical astrometry was accepted and the resolution was then adopted without objection. Four papers on work related to the MERIT/COTES programmes were then presented. Paquet discussed the agreement in the results by different techniques for polar motion and universal time. Preuss presented a paper by Campbell and Schuh on short-period variations in Earth-rotation determined by VLBI. Dickey discussed the intercomparisons between the Earth-orientation parameters obtained by different techniques and then reviewed the close correlation between the length of the day and the angular momentum of the atmosphere. Finally, Vicente and Verbeiren presented new techniques for processing time and polar motion series.

1. REVIEW OF THE MERIT/COTES REPORT

The Chairman of the first session, D. D. McCarthy, Acting President of Commission 31 on Time, opened the first session of the Joint Meeting of Commissions 19 and 31 at 2 pm on Friday, 1985 November 22, during the XIXth General Assembly of the International Astronomical Union. The meeting was attended by about 60 persons.

G. A. Wilkins, the chairman of the IAU/IUGG Joint Working Group on the Rotation of the Earth, drew attention to the summary report that he had prepared with I. I. Mueller, the Chairman of the IAU/IUGG Joint Working Group on the Establishment and Maintenance of the Conventional Terrestrial Reference System. (This summary report has been reproduced immediately before this report on the meeting in Delhi.) He then summarised the objectives of the two working groups and the programme of activities that had been carried out during the past seven years. The MERIT programme (to Monitor Earth Rotation and Intercompare the Techniques of observation and analysis) involved six different techniques of observation, namely: Optical Astrometry, the Doppler Tracking of Satellites, Laser Ranging to Geodetic Satellites (SLR) and to the Moon (LLR), and radio interferometric observations of quasars using connected-elements and Very-Long-Baseline (VLBI) systems. The stimulus provided by the MERIT Short Campaign (in 1980) and the MERIT Main Campaign (in 1983/4) did much to foster the development of the new techniques of observation based on laser ranging and radio interferometry. The Earth-rotation parameters (universal time, length of day, and the coordinates of the pole) are now determined with much higher precision and better time-resolution. The analyses of the observational data clearly demonstrated the close correlation between the rotation of the crust of the Earth (as indicated by the observed length of the day) and the angular momentum of the atmosphere. Special observations and analyses were also made to determine the coordinates of the stations and the differences between the reference systems implicit in each technique; this work represents a major contribution to the COTES programme to establish and maintain a new conventional terrestrial reference system. It is now established that the tidal motions and relative drifts of the stations must be taken into account in the determination of Earth-rotation parameters and of geodetic coordinates of high precision.

The MERIT and COTES Working Groups met at the Third MERIT Workshop, which was held at Columbus, Ohio, on 1985 July 29-30, and on August 3; after reviewing the results of the campaigns they adopted three recommendations concerning the future international services for monitoring the rotation of the Earth and the adoption of new conventional terrestrial and celestial reference systems. The background to these recommendations on the reference systems is described in the paper by Wilkins in the report of the proceedings of the Joint Discussion on Reference Systems. It was recommended that the new service should be based initially on three techniques, namely VLBI, SLR and LLR, and that the general organization of the service should be similar to that adopted during the MERIT Campaigns. In the meantime the MERIT/COTES activities should be continued to ensure the continuing availability of high-quality data on Earth-rotation and to provide further data for use in defining the new reference systems.

2. RESOLUTION ON THE EARTH-ROTATION SERVICE

The Chairman (McCarthy) asked Wilkins to introduce the draft resolution on the implementation of the MERIT/COTES recommendations that had been previously circulated to all members of Commissions 19 and 31. The preamble to the resolution recognises the success of the MERIT/COTES activities, thanks all those concerned, and endorses the report and the recommendations. The main purpose of the resolution was to obtain the authority of the Union to proceed with the preparations for the setting up of a new service which would replace the International Polar Motion Service and the Earth-Rotation Service of the Bureau International de l'Heure. The Provisional Directing Board for the new service would be expected to put forward specific proposals for consideration at the general assembly of the International Union of Geodesy and Geophysics in Vancouver in 1987. It would also act as the steering committee for the extension of the MERIT/COTES programme until the new service is in operations.

The Chairman then drew attention to the amendments put forward by W. Markowitz and W. J. Klepczynski. B. Guinot and I. I. Mueller pointed that there was a separate resolution dealing with the responsibility for leap-seconds in UTC and that the provisional Directing Board would consider this matter in its review of the functions of the new service; Klepczynski withdrew the amendment.

Paquet then introduced an amendment to insert a new clause to the effect that an optical astrometric network should be maintained for the determination of UT1. He considered that the report gave the impression that such observations were no longer of value. His view was supported by Yatskiv and others who suggested minor changes to clarify the amendment. Yokoyama considered that the amendment was not necessary since the main resolution implied that the technique would continue to be used until 1988 by which time the new techniques should be able to meet the requirements for the rapid determination of UT1. After further discussion an amended version of the original amendment was adopted without objection. The amended resolution was then put to the meeting and was adopted without objection. The text of the resolution was edited by the IAU Resolutions Committee and was adopted without objection by the General Assembly on November 28. The full text of the resolution is given as annex 3 to the Joint Summary Report.

In adjourning the meeting for tea, McCarthy drew attention to the availability of the MERIT Standards document (US Naval Observatory Circular No. 167) and to the fact that some additions were in preparation. Mueller stated that the Proceedings of the Columbus Conference would be published shortly, and that the Proceedings of the Workshop and the Catalogue of MERIT/COTES data would be published in 1986; bibliographic details are given at the end of the Joint Summary Report.

3. REPORT ON SESSION 2: THE ROTATION OF THE EARTH

The Chairman of the second session, Y. A. Yatskiv, President of Commission 19 on the Rotation of the Earth, introduced the speakers who presented papers on various aspects of the methods of analysis, the intercomparison of the series obtained by different techniques, and the interpretation of the results on the variations in the rate of rotation of the Earth and on the motion of the pole of rotation.

3.1 P. Paquet presented his paper on the Agreement in Polar Motion and UT measurements during the MERIT Campaign. He had compared five series of values of the coordinates of the pole obtained during the MERIT Main Campaign (1983/4): two series were based on optical astrometric data provided by the BIH and IMPS analysis centres, and other series were based on Doppler observations of the NOVA satellite, satellite laser ranging and VLBI. He also compared two series of UT1 obtained by optical astrometry with that obtained by VLBI.

For the polar-motion data he determined and removed the annual and Chandler components. He then fitted the residuals by a smooth curve corresponding to a Vondrak filter of approximately 30 days, formed residuals with respect to this curve, and then carried out various correlation tests between the data for the different techniques. He found that for periods greater than 30 days there is a high correlation between the residuals for the various techniques, but that for periods less than one month the series are not correlated except between the SLR and Doppler series for the x-component. He considered that the Doppler results could be further improved by the use of better models for the analysis of data from NOVA satellites.

For the UT1-data (optical astrometry and VLBI only) he removed a linear drift and found residuals from a smooth curve by the Vondrak method. He then found that the three series of residuals showed an irregular variation with a period of about 50 days, and he claimed that the IPMS results for periods over 30 days are of high quality. He confirmed the very good performance of the VLBI technique and concluded that the activity in optical astrometry should be continued.

https://doi.org/10.1017/S0251107X00026183 Published online by Cambridge University Press

In the ensuing discussion Feissel displayed tables of operational time series on polar motion: a considerable improvement in the SLR results as a consequence of the adoption of better models was apparent. She supported Paquet's view that the Doppler results could also be improved.

3.2 E. Preuss presented a paper by Campbell and Schuh on Short-period variations of Earth-rotation determined by VLBI. The VLBI observations had been made during the MERIT Campaigns, in sessions lasting only one hour on the 6000-km baseline between Westford (USA) and Wettzell (GFR); data were obtained each day over a 64-day period and for 18 days at an interval of 15 days. The data were analysed at the IRIS analysis centre at the National Geodetic Survey (USA) to determine UT1, and a spectral analysis was then carried out. Terms with periods 9.1, 13.6 and 29.2 days were found and were claimed to be in good agreement with the Yoder model of tidal effects. McCarthy commented that USNO had obtained different periods at different times of the year from analyses of daily data from the connected-elements interferometer at Greenbank (USA). Guinot stated that N. Capitaine had also found that the 13-day term varied over an interval of 4 years.

3.3 J. O. Dickey first presented a paper by Dickey, Eubanks, Newhall, Spieth, Steppe, Sovers and Williams on work carried out at the Jet Propulsion Laboratory on Earth-orientation: analysis, intercomparisons and implications. She drew attention to the extent of the MERIT-related work at JPL: the use of the Deep Space Network (DSN) as a VLBI system to obtain regular estimates of Earth-orientation; and the operation of an LLR analysis centre, including the regular production of UT0 data. She also highlighted the recent advances in LLR at CERGA (Grasse, France), McDonald Observatory (Texas, USA) and Haleakala (Hawaii, USA) in both the quality and the quantity of the observational data.

An intercomparison of Earth-rotation and polar-motion results from a variety of services has made it possible to evaluate the accuracy of the various measurement techniques. The period considered was from 1983.5 to 1985.0. The UT1 data from LLR and VLBI (both IRIS and DSN) agree to within their formal errors; the LLR formal errors are too large, probably reflecting an overconservative analysis. On the other hand, the formal errors given by BIH from optical astrometry are significantly too small, attributable, at least in part, to seasonal errors. Differencing the different data with respect to a smoothed IRIS multi-baseline determination, the RMS differences are 0.2, 0.4, 0.5 ms for the Westford/Wettzell VLBI, the LLR, and the DSN results, respectively. In contrast, differencing the optical data with respect to a combined space-based smoothed series gives an RMS difference of 1.2 ms. Polar motion determinations from SLR by the University of Texas and from intercontinental VLBI appear to be at least as accurate as is expected from the measurement formal errors, while the errors in the results obtained by BIH from optical astrometry and in the results obtained by the Defence Mapping Agency from the Doppler measurements of the NOVA satellite are substantially larger than can be explained by their formal errors. There are no apparent periodic systematic errors in the SLR and VLBI results, but the optical astrometric and the Doppler series show appproximately annual systematic errors. The RMS difference between SLR and IRIS is about 2 milliarcseconds (mas); while the RMS differences of SLR with respect to Doppler and optical astrometry are 13 mas and 19 mas respectively for the x-component and 11 mas and 14 mas for the y-component. These results are indicative of the greatly improved performance of the new techniques.

Nutation estimates from long-duration VLBI experiments conducted by the DSN and reduced at JPL were intercompared with similar estimates from the IRIS/POLARIS data as reduced at Harvard University. The two series have and RMS difference of 1.6 mas or less. After removal of the Wahr (or IAU 1980) theory of nutation, there exist large (2 mas) annual and smaller (1 mas) semi-annual oscillations, as well as linear trends (about 1 mas/year), in both obliquity and longitude. The period of the free core nutation is about 430 d, rather than 460 d, and the damping time is about a decade; these results are consistent with interactions between core and mantle due to bumps, on the scale of 1 to 2 km, at the boundary.

In the discussion Yatskiv said that the period of 430 d has also been derived in the USSR and Dickey confirmed that the nutation corrections are consistent with those obtained by Herring.

3.4 J. O. Dickey then presented a paper by Eubanks, Dickey and Steppe on Atmospheric Angular Momentum and Earth Rotation. She began by drawing attention to the dramatic impact of the new technologies on the study of polar motion and of the variations in the rate of rotation of the Earth. The development of space geodesy has greatly increased the accuracy and precision of Earth-orientation measurements, while the analysis of global weather data for operational weather forecasting now routinely provides high quality estimates of the atmospheric excitation of the Earth's rotation. The combination of these data types has also increased the understanding of the Earth's angular momentum balance in general and, in particular, of the atmospheric as well as the non-atmospheric excitations of Earth-orientation changes.

Particular emphasis was placed on the recent data from the MERIT Main Campaign. Geodetic estimates of changes in the length of day (LOD) were compared with the corresponding meteorological excitation estimates for the period from 1983 September 1, through 1984 October 1. The geodetic excitation estimates were obtained from a Kalman smoothing of data from VLBI and LLR, while meteorological values were provided by the U. S. National Meteorological Center (NMC) and from calculations by the U. K. Meteorological office based on the results of the European Centre for Medium Range Weather Forecasting (EC). There were significant seasonal discrepancies between the EC and the NMC wind-term estimates, but seasonal errors in the pressure terms seem to be small. Changes in the EC weather-analysis software on 1984 February 1 caused a large step function change in the EC pressure term but had no observable effect on the EC wind data. The sudden jump in the pressure term was followed by a slow rebound which restored about 10% of the change over a period of 10 to 14 days. There is in general excellent agreement between the EC and NMC data (RMS difference is 0.062 ms for the wind term; 0.022 ms for the pressure term) and the geodetic LOD estimates (RMS difference is 0.072 ms for EC pressure plus wind; 0.087 ms for the NMC pressure plus wind). Anomalously high values of atmospheric angular momentum and length of day were observed in late January 1983. This signal in the time series of these two coupled quantities appears to have been a consequence of the El-Nino equatorial-Pacific warming event of 1982-83. The atmospheric estimates from both the EC and NMC results were compared with the LOD estimates; no appreciable time delay could be detected. A combined LOD series beginning in 1962 was formed by including the modern space techniques as well as the classical optical results. Studies using the longer data sets suggest that there may have been similar LOD changes during previous El-Ninos and that some of the interannual changes in the LOD are related to the Southern Oscillation. These studies reveal a correlation of -0.5 between the interannual fluctuations in the Southern Oscillation Index and in the length of day. Studies of the relation between the length of the day and the angular momentum of the atmosphere are being coordinated by IAG Special Study 5.98 (of which Dickey is the active chairman).

The discussion turned to the contribution of the ocean to the changes in the angular momentum of the Earth. It was recognised that the short-term changes due to the ocean are much less than those due to the atmosphere and that they are more difficult to monitor, but nevertheless it was agreed that it would be worthwhile attempting to obtain data on the oceanic contribution.

3.5 The session concluded with two short papers on new techniques for processing time and polar-motion series. R. O. Vicente had treated polar motion as a complex time series and had analysed data from the BIH Annual Reports for 1981-83 and also more recent data. He showed various plots and stressed the need to "be careful" in interpreting the results of the comparisons between different techniques. R. Verbieren presented a paper on the Computation of pole coordinates from the MERIT Campaign with least-squares collocations. He pointed out that the correct computation of a final set of coordinates of the pole at prespecified equidistant epochs from all available observational series is a severe statistical problem. He considered that least-squares collocation (using a technique introduced by Moritz) offers the possibility of combining in one computational step the determinations of both the coordinates of the pole and biases in the reduction constants and reference systems. The different series are introduced with appropriate weight through the use of their covariance matrices. The application of this method to the MERIT Main Campaign shows its power by giving x, y values for every day with an accuracy of 0.004; it shows the high-level of accuracy of the SLR and VLBI results and of the determination by DMA from Doppler observation of the NOVA satellite. He considered that it also shows that the methods of classical astrometry provide good results in spite of their much higher noise level. In answer to a question be stated that he had not yet used the method for prediction purposes as the series are too short.

3.6 The Chairman (Yatskiv) closed the session at 5:40 pm by thanking all the speakers and by congratulating the coordinators and other participants on the undoubted success of the MERIT/COTES Campaigns.

November 26, 1986 (Tuesday) 0900: Commission 19 - Scientific I (Statistical Properties and Prediction of Earth Rotation Parameters)

Chairman: Y. Yatskiv Secretary: J. O. Dickey

This joint meeting of Commissions 7, 8, 19 and 31 provided a very valuable forum for the presentation and discussion of recent work on the prediction of Earth rotation. Predictions require the most accurate observational data as a basis and a mathematical model which accurately represents the Earth's motion. The three papers given here each represented a different technique for investigating the statistical properties of Earth rotation. Morgan and Xing utilized a multi-channel Wiener filter. Eubanks and co-workers used a multi-dimensional Kalman filter. McCarthy considered the amplitude spectrum as a function of frequency with additional variations at selected periods. Discussion by both the audience and speakers addressed the motivations and requirements for Earth rotation prediction.

P. Morgan (Canberra College of Advanced Education, Australia) presented the highlights of a collaborative effort with C. Xing studying the prediction of the Earth rotation vector using a multi-channel Wiener filter. This filter was developed for the enhancement (smoothing) and prediction by means of a realizable linear operator. The Wiener filter is a linear, least squares, time-invariant process that assumes equally spaced data and uses the statistical information (regularity) of the known or historical data to predict the future behavior of the time series. The formulation of the Wiener filter is best accomplished in the frequency domain; however, the implementation is best done in the time domain using the recursive algorithms of Robinson (1976). The wobble components (x and y) and the rotation component are first detrended with polynominals models up to degree 2 and then have a number of forced periods removed from them. These periods include the Chandler and annual periods for the rotational component. The detrended series are then multiplexed into the linear Wiener filter which uses the measured series, advanced by the desired prediction interval, as the desired output series. The output from the Wiener filter is then reconstituted according to the pre-processor models. Error correcting post-processing is then performed over the last few data points to take into consideration conditions prevailing at the boundary between the known data and the prediction span. The post-processing modelling includes harmonic and polynominal terms. The output of the filter yields residuals whose magnitudes vary linearly with the distance into the prediction span.

D. McCarthy of the Naval Observatory (USNO) - Washington, D. C. addressed the activities of the USNO Earth Orientation Parameters Service. The goals are to provide high accuracy Earth orientation data with the shortest possible delay between observation and dissemination and to predict Earth orientation. Earth orientation observations, parameters and predictions are routinely distributed in the USNO - Time Service Publication - Series 7. Requirements for the various data sources were evaluated and include timeliness (rapid turnaround), precision and consistency. For polar motion prediction, the power law behavior of the amplitude spectrum is considered as a function of frequency (the resultant power is -0.84 ± 0.06) with the additional variations included at periods of 180 and 98 days. For Earth rotation (UT1) predictions, the amplitude is parameterized as a function of frequency (with the resultant power of -1.10 ± 0.07). Additional variations with the periods of 180, 111, 150, 7 and 122 days as well as Earth tides and seasonal variations are included for UT1. To evaluate the "predictability", variations were treated as discrete Fourier series. He concluded that UT1 - UTC may vary by ± 0.2 miliseconds in one day from prediction while x and y may vary by ± 1 milliarcseconds in two days from prediction. High frequency sampling of Earth orientation parameters may be a requirement. Better predictions would result from improvements in data accuracy, density and processing time and from modeling advancements.

J. Dickey (Jet Propulsion Laboratory/California Institute of Technology, USA) presented the paper entitled "Predictions and Smoothing of Earth Orientation Changes Using a Kalman Filter", by T. M. Eubanks, D. D. Morabito, and J. A. Steppe (all at JPL). A Kalman filter is being developed to provide prediction and smoothing of Earth rotation and polar motion for spacecraft navigation by the Deep Space Network. This filter uses stochastic models to account for the rapid changes in the Earth orientation primarily driven by the atmosphere by using the known physics for the relation between orientation and excitation (X_1, X_2 and X_3) (Barnes et al., 1983). The derivations of these models from atmospheric angular momentum and the development of the filter were outlined. The implementation of this filter and its performance under a variety of ideal measurement strategies as well as with actual data were discussed. The UT1 excitation (X_3 or length of day) is an integrated random walk with white noise forcing; while the polar motion excitation (X_1 and X_2) is an isotropic random walk driven by equal white noise forcing on both components. The model for the X_2 component includes a second order autoregressive (AR) oscillator with a resonance at 1 year and a damping time of 3 years. The white noise component of the X's account for the high frequency spectrum of the atmospheric excitation; the AR term accounts for the seasonal X_2 oscillation, and the random walk allows the filter to follow any secular drift in the pole position. Its advantages include: 1) data from any source or multiple sources may be used; 2) data may be evenly spaced and be of varying quality; 3) one, two or three dimensional measurements of any sets of components may be utilized; and 4) excitation estimates are provided automatically.

November 26, 1985 (Tuesday) 1100: Commission 19 - Scientific Session II

Chairman: D. McCarthy Secretary: J. O. Dickey

This session included the discussion of Earth rotation observations, analysis, and implications on a broad spectrum of time scales. Morrison began the session presenting results from ancient and medieval eclipse data as well as occultations together spanning close to three millennia. For these long time periods, variations in Earth rotation (T = the difference between ephemeris time and Universal Time) amount to hours. On the other end of the spectrum, Kolaczek discussed polar motion oscillations with periods ranging from 10 to 100 days. Kakuta addressed collocations of geophysical observations at the Earth Orientation Parameter observing sites and considered the analysis of measurements using running yearly means.

L. V. Morrison (Royal Greenwich Observatory, United Kingdom) presented the highlights of a collaborative effort with F. R. Stephenson studying observations of secular, non-tidal changes in Earth rotation. Occultations of stars by the moon, and solar and lunar eclipses were analysed for variations in the Earth's rotation over the past 2700 years. Lunar and solar tidal braking is shown to be the dominant long-term mechanism reducing the Earth's rate of rotation. Adopting the value of -26"/century square for the lunar tidal acceleration, the rate of change in length of day is ±2.40 ms/century. A parabolic formulation is used to parametrize Δ T; two separate fits yield the best representation of the data. A parabolic fit for data from A.D. 948 indicates a rate of lengthening of the day by +1.4 ms/century; while data prior to this date implies a lengthening of +2.4 ms/century. There are also non-tidal changes that vary on timescales ranging from decades to millennia. The magnitude and temporal behavior of these non-tidal variations were evaluated. (F. R. Stephenson and L. V. Morrison, Phil. Trans. R. Soc. Lond. A313 47-70,1984)

B. Kolaczek (Space Research Center, Poland) discussed the results of recent studies by Kolaczek and Kosek on short periodical oscillations of polar motion determined by different techniques during the MERIT campaign. Several short period terms with periods ranging from 10-100 days have been detected by the Maximum Entropy Analysis and the Ormsby filter. The amplitudes of these terms range from 12 mas in the case of the BIH-Astrometric results as published in the MERIT circular to 2 mas for the CSR-LAGEOS(84 L 01) and IRIS-VLBI(85 FEB 01) solutions. Similiar short period terms were detected in the equatorial components of the atmospheric excitation functions X_1 and X_2 of the European Centre for Medium Range Weather Forecasting.

C. Kakuta (International Latitude Observatory, Japan) reported on an inter-comparison study of Earth rotation (UT1-UTC) and latitude as determined by optical and radio interferometric techniques and discussed their geophysical implications. Non-tidal deformations of the Earth affect the Earth rotation parameters and may also change the terrestrial reference system. Geophysical measurements of the Earth's deformations may provide information for monitoring the terrestrial reference system. Determinations of Earth orientation parameters using data from several stations will be useful for evaluting variations of the terrestrial reference system as well as for studying excitations of the Earth's rotational motion.

November 27, 1985 (Wednesday) 1400: Commission 19 - Scientific Session III

CHAIRMAN: W. J. Klepczynski SECRETARY: M. Feissel

G. Wilkins reported on the work at the Royal Greenwich Observatory on the Rotation of the Earth. Regular observations of Satellite Laser Ranging (SLR) started on 1983 October 2; the operation of the PZT ended on 1984 June 30. Analyses of SLR data from the RGO station as well as from the global world network were conducted and determination of a Set of Station Coordinates and of the Earth Rotation Parameters during MERIT Campaign (1983-84) were made. This included a study of time series of measurements of individual stations, and evaluation of the Earth rotation information from a single station, in view of Rapid Service determinations. Studies of the short-term oscillations in UT1 and determinations of UT1 from occultations of stars by the Moon have been realized. The possibility of tracking geostationary satellites by photography, for the improvement of the geopotential model has been investigated.

J. Popelar reported on Earth Rotation monitoring in Canada. The two PZT's in Calgary and Ottawa continued regular observations; a global reprocessing of the total series of observations is in project. The Doppler stations in the two sites have been upgraded (TRANET 2 stations); continuous geodetic monitoring of the sites with GPS receivers is planned starting with 1986; studies of the geopotential model have been performed. The implementation of the Canadian Geodetic Long Base Interferometry (CGLBI) is progressing; it will consist primarily of a master station (25-32m diameter antenna), a reference sub-station (antenna over 9m in diameter), and a mobile station (antenna under 7m in diameter), the permanent sites will be tied to their surroundings by the monitoring of a local network (40 - 100 km) of GPS receivers and gravity stations; the data processing facility, located in Ottawa, will operate in real time; the different parts of the equipment and software are currently under development and testing; the network should be operational by 1990.

Z. Li (Shanghai Observatory) reported on a new determination of the Earth Rotation Parameters from optical astrometry that he performed during his stay at the Bureau International de l'Heure (Observatoire de Paris). The series covers 20 years (1962-1982); it is based on a series of observations obtained at 136 stations, including some (about 50%) series revised since their use in the operational work of BIH, and several new series made available more recently. The computation involved 500 000 group results of latitude or universal time, referred to the IAU 1976-1980 system of constants; it is based on a new approach in which group unknown (function of the local sideral time of observations) and their time derivatives are adjusted simultaneously with the Earth Rotation Parameters and the classical auxiliary unknowns z and w. The five time series obtained for x, y (pole coordinates), UT1-UTC, and the auxiliary unknowns z and w have a sampling time of 5 days from 1962 through the end of 1981. The individual determinations have an uncertainly smaller than those of the operational BIH series; moreover, they provide the first high resolution series prior to 1967.

S. Debarbat reported on work made at Paris Observatory in connection with the introduction of new constants and new references. The observation program of the astrolabe for the Earth's rotation has been continued; guidelines for the computation of apparent positions of stars in the new IAU 1976 system for the case of astrolabe have been published by F. Chollet. The detectability of diurnal nutation by SLR has been studied by D. Gambis, who has also determined Earth rotation parameters and station coordinates for the MERIT campaign. N. Capitaine has clarified the concept of the Celestial Ephemeris Pole as defined by IAU in 1981 and studied its realization by the different techniques of observation, either geometrical or physical.

Resolution concerning classical astrometric observations approved at final meeting of General Assembly:

COMMISSION 19

"NOTING that the new International Earth Rotation Service, to become operational in 1988, already depends considerably on radio and laser-ranging techniques and eventually may be based on these methods; and

RECOGNIZING that classical astrometric determinations of latitude and Universal Time might be valuable for studies of long-period variations in Earth rotation, for improvement of star catalogues and for studying geophysical phenomena such as changes of the local vertical, variations in refraction and the possible prediction of earthquake activity;

RECOMMENDS that a working group be established to study the future role of classical astrometric observations and to report on this study to the IAU at its next General Assembly."

https://doi.org/10.1017/S0251107X00026183 Published online by Cambridge University Press