REVIEW OF THE ACHIEVEMENTS OF PROJECT MERIT FOR THE INTERCOMPARISON OF TECHNIQUES FOR MONITORING THE ROTATION OF THE EARTH

G.A. Wilkins
Royal Greenwich Observatory, Herstmonceux Castle
Hailsham, East Sussex, England, BN27 1RP

ABSTRACT. It is generally recognised that the Working Group on the Rotation of the Earth that was set up after IAU Symposium No. 82 has successfully achieved its principal objectives, namely: "to make recommendations on ... future international services on earth-rotation" and "to obtain and analyse data on earth-rotation by both current and new methods ...". In particular, by organising Project MERIT, it has stimulated the development and use of new techniques and it has brought together in fruitful collaboration scientists from many countries and disciplines. Other subsidiary objectives have also been achieved and the project has been extended through cooperation with the COTES Working Group on the terrestrial reference system. The possible reasons for this success are also reviewed in the expectation that the conclusions will be relevant to other future projects.

1. FOUNDATIONS

Project MERIT was the name given by the IAU Working Group on the Rotation of the Earth to its proposals for a special programme of international collaboration to monitor earth rotation and intercompare the techniques for observation and analysis. The Group was appointed in 1978 on the recommendation of the participants of IAU Symposium No. 82 on Time and the Earth's Rotation in order "to promote a comparative evaluation of the techniques for the determination of the rotation of the Earth and then make recommendations for a new international programme for observation and analysis in order to provide high-quality data for practical applications and fundamental geophysical studies". The principal objectives of the Group have already been achieved and so, although the programme has been extended until the end of 1987, it is appropriate to review both the achievements and the possible reasons for the success of the project, in the hope that the conclusions will be relevant to other future projects. No attempts will be made to assess the contributions of individual scientists even though there is no doubt that the catalytic effect of the enthusiasm and expertise of a small number of persons has been crucial to the success of the project. Their efforts would, however, have been in vain if the project had not had the active support of a large number of persons from many countries whose work contributed to gathering and analysis of the observational data.

A. K. Babcock and G. A. Wilkins (eds.), The Earth's Rotation and Reference Frames for Geodesy and Geodynamics, 227–232.

Although the primary concern of the MERIT Working Group was the rotation of the Earth it was recognised at an early stage that it would be necessary to determine a consistent set of precise positions for the stations at which observations were made. This led to close collaboration with the COTES Working Group whose concern was the development of a new conventional terrestrial system for geodetic purposes. The activities of the two groups have been described briefly in their Joint Summary Report (Wilkins and Mueller, 1986), which also contains their recommendations, references to previous reports, and lists of members of the two groups.

Since 1978 there have been changes in the composition of the Group and in the allocation of responsibility for the coordination of the various aspects of the programme. Nevertheless, the programme has largely followed the plans that were drafted at the first meeting of the Group and that were developed in further detail in the "Draft Proposal for Project MERIT". This proposal was presented at the IAU General Assembly in Montreal in 1979, and later in the same year at the IUGG General Assembly in Canberra. It contained two main parts: firstly, an introduction that described in general terms the background to the proposal, the importance of studies of earth rotation, and the objectives and programme of the project; secondly, it contained position papers for each of the possible techniques of observation (laser ranging, radio interferometry, Doppler tracking of satellites, and optical astrometry). These papers discussed the basis of each method and attempted to assess their accuracies and costs. The documents, together with the presentations at the General Assemblies, attracted a great deal of interest and served to demonstrate that the project was well conceived and worthwhile. The IUGG agreed to support the project and nominated additional members to form a Joint Working Group. The material in the Draft Proposal was subsequently included with some additional material in a report (Wilkins, 1980) that was widely circulated for information and to encourage participation in the proposed campaigns of observation and analysis. The considerable effort that was devoted to the preparation of this report provided firm foundations for the further development of the Project.

2. ORGANISATION AND PROGRAMME

Although Project MERIT, and its extension to include the COTES activities, involved the participation of over 160 observing stations and over 30 data-analysis centres there was no central organisation to direct or fund the activities. Instead the Project depended on individual scientists, who were known as "coordinators", to lead, encourage and coordinate activities for each of the techniques and for other tasks that were found to be necessary. These coordinators formed a Steering Committee within the Working Group which grew in size as the project gradually involved more persons in its development. The coordinators were responsible for developing the most appropriate organisational structure for their particular techniques or tasks. These structures developed with experience as

the new techniques matured. In general, it was found to be useful to have an "operational centre" for each network of stations; this centre coordinated the regular activities within the network and collected the observational data in order to determine "rapid-service" values of the earth-rotation parameters and to forward them to "analysis centres" for further, more detailed study. In addition, the Bureau International de l'Heure in Paris received, combined and published the results from all the techniques. Each of the Centres determined its own mode of operation within the guidelines suggested by the Steering Committee.

Other tasks included the development of a set of MERIT Standards to facilitate the intercomparison of the results and the introduction and administration of the use of a commercial, international computer network for the communication of data and other information between the stations and centres. Matters of common concern were discussed at (infrequent) meetings of the Steering Committee and by correspondence, but each coordinator had full responsibility for the organisation of the activities within his/her field. This delegation of responsibility to coordinators and centres worked well in almost all cases, and it was certainly an important factor in the success of the Project.

The funds for the operational and organisational activities have been almost entirely provided by the participating institutions, and hence by national agencies. The Project owes much to the NASA Geodynamics Program, which has supported many activities, outside as well as inside the USA, that have contributed to it. The additional support provided by the Unions for the work of the BIH and for travel by some members of the Groups has also contributed to its success.

The calendar of the activities of the MERIT and COTES Working Groups is given in table 1. The programme itself was subject to review at each of the meetings of the Working Group, but in general it followed the schedule drawn up in 1978. The decision to hold a Short Campaign as early as was practicable was justified by the results. Firstly, the Campaign provided a stimulus to the faster development of both hardware and software for the new techniques and also led to improvements in the results from the techniques then in regular use; secondly, the results obtained demonstrated clearly the high potential of the new techniques; and thirdly, the Campaign revealed the need for changes in some of the operational procedures. It also became apparent that there was a need for a wider distribution of information about the activities and results, and so a Monthly Circular was issued by BIH during the Main Campaign.

The timing of the Main Campaign was quite important. It was necessary to allow enough time for the development of the technical facilities and other preparatory work, but on the other hand it was desirable that the Group should have sufficient time to consider the implications of the results and to prepare its recommendations for distribution well in advance of the IAU General Assembly. In the event the period chosen was an appropriate compromise between these conflicting requirements. Unfortunately, the development of lunar

Table 1. Calendar of activities of Project MERIT

1978 May	IAU Symposium No. 82 on "Time and the Earth's Rotation" recommended setting up a working group on the determination of the rotation of the Earth.
1978 October	IAU Working Group held first meeting and prepared outline proposal for Project MERIT.
1979 August	IAU General Assembly endorsed Draft Proposal for Project MERIT.
1979 December	IUGG General Assembly endorsed Draft Proposal for Project MERIT. Joint IAU/IUGG Working Group met to develop plans for the MERIT Short Campaign.
1980 August to October	MERIT Short Campaign of observations by 6 techniques.
1980 September	IAU Colloquium No. 56 on "Reference Coordinate Systems for Earth Dynamics" recommended setting up a working group on the terrestrial reference system.
1981 May	First MERIT Workshop, followed by presentation of results from the Short Campaign at IAU Colloquium No. 63 on "High-Precision Earth Rotation and Earth-Moon Dynamics".
1982 August	Meeting and presentations at IAU General Assembly.
1983 May	Second MERIT Workshop.
1983 August	Meeting and presentations at IUGG General Assembly.
1983 September to 1984 October	MERIT Main Campaign, including COTES Intensive Campaign in April to June.
1985 May to July	Second Intensive Campaign, especially for lunar laser ranging.
1985 July	Third MERIT Workshop, followed by presentations of results at the International Conference on Earth Rotation and the Terrestrial Reference Frame.
1985 December	IAU General Assembly endorsed the recommendations of the MERIT/COTES Joint Working Groups to establish a new International Earth Rotation Service.

laser ranging to the stage where it could be carried out regularly at a network of stations took much longer than was expected, and so the results obtained during the Main Campaign were disappointing. On the other hand, both VLBI and SLR reached full operational status much earlier than many had expected.

The collaboration with the COTES Working Group led to the realization that special efforts would be needed to ensure that the separate reference frames implicit in each technique would be related properly to the others and hence to a standard, or conventional, terrestrial reference frame. An Intensive Campaign lasting three months was held during the Main Campaign, and in addition the appropriate agencies were requested to arrange the colocation of equipment of different techniques at selected sites. Much useful and interesting data were obtained during the Intensive Campaign, but owing to funding and other constraints the number of colocations was less than had been hoped.

The Group recognised at the beginning the need to ensure that proper arrangements were made to ensure that the observational data would be analysed quickly and that the results would be subject to critical examination. The operational centres were given the responsibility for gathering and distributing the observational data; a condition of participation was that each organisation would make its data available to all others without restriction. At least two analysis centres were designated for each technique; these centres undertook to analyse the data for the duration of the Main Campaign using the MERIT standards. In addition, data were made available to associated analysis centres that were prepared to analyse subsets of the data. Moreover, the BIH agreed to collect all the results obtained by the operational and analysis centres and most have already been published. These data, together with other data on earth-rotation constitute the "MERIT database" and provide a valuable reference source for geodetic and geophysical studies (Boucher et al., 1986). This database includes geodetic and survey data for use in developing the new terrestrial reference system and data on other relevant phenomena such as the angular momentum of the atmosphere, which has been shown to be strongly correlated with the short-period variations in the length of day.

The Working Group held meetings of various kinds for planning the programme and for publicising the activities. Some of the planning meetings were held as meetings of opportunity during conferences attended by some of the members of the Group, but in addition three Workshops were held to provide adequate time for reviews of progress and discussions on the future programme. Attendance at the Workshop was deliberately restricted and the time spent on prepared presentations was kept to the minimum so that there was ample time for discussions in subgroups or in plenary sessions. These Workshops were held in places where the participants were able to continue to meet outside the organised sessions, and they led to the development of friendly, cooperative relationships between those concerned, even in cases where a competitive attitude might have been expected. The wide spread of interests of those taking part in this interdisciplinary

project became a source of strength by broadening the outlooks of all concerned.

Open meetings were held during the General Assemblies of the Unions and scientific results were presented at appropriate conferences in an endeavour to ensure that information about the plans and achievements of the Project was widely known. A small MERIT Newsletter was distributed from time to time to all groups and individuals who were known to have an interest in the Project. The acronym MERIT attracted favourable attention, and knowledge of, and interest in, the rotation of the Earth became much more widespread during the lifetime of the Project.

3. THE FUTURE

The MERIT Campaigns of observation and analysis have led to the establishment of new operational arrangements that are now in regular use. The MERIT and COTES Working Groups have jointly put forward recommendations concerning the purposes and organisation of a new International Earth Rotation Service to come into operation on 1988 January 1. Formally their tasks are completed, but it is now necessary to ensure that these recommendations are brought to fruition and that the new Service fully justifies the efforts and funds that have been devoted to the MERIT and COTES programmes over the past eight years.

REFERENCES

Boucher, C.D., Feissel, M. and Wilkins, G.A. 1986. The MERIT/COTES database on the rotation of the Earth and terrestrial reference systems. Presented at CODATA Conference, Ottawa; to be published in CODATA Bulletin.

Wilkins, G.A., (ed.). 1980. A review of the techniques to be used during Project MERIT to monitor the rotation of the Earth. Published jointly by Royal Greenwich Observatory, Herstmonceux, U.K., and Institut für Angewandte Geodäsie, Frankfurt, G.F.R..

Wilkins, G.A., and Mueller, I.I., (eds.). 1986. Joint Summary Report of the IAU/IUGG Working Groups on the rotation of the Earth and the terrestral reference system. In J.P. Swings (ed.), Highlights of Astronomy, 7, 771-788. Also in Bull.Géod., 60, 85-100.

See also references given by Wilkins and Mueller, 1986.

DISCUSSION

Westerhout: This meeting, with its large amount of new information, is witness to the success of the MERIT undertaking. This is the time where we must recognize the man who led the project from beginning to end, who pushed the many coordinators throughout the project into closer collaboration and greater heights, and who remained on top of it until today. The participants in this meeting owe a large vote of thanks to George Wilkins.