THE MOBILE LASER-RANGING SYSTEM AS A COMPARATIVE TOOL FOR MONITORING THE TERRESTRIAL REFERENCE FRAME

Peter Wilson
Institut für Angewandte Geodäsie,
Abt. II des Deutschen Geodätischen
Forschungsinstituts
Frankfurt am Main
Fed. Rep. of Germany

ABSTRACT. The proposed earth rotation service and the related efforts to monitor the terrestrial reference frame will employ instrumental and computational techniques of widely different kinds. It has already been demonstrated that the results produced by these techniques are sensitive to systematic errors occurring at the level of a few millimeters. As a result it will be extremely important to verify the performance of the different systems by making comparative observations at the same sites. Only mobile laser-ranging systems are currently in a position to perform this kind of service. To demonstrate the status of laser ranging during co-location, this paper presents a proposal for a controlled collocation experiment involving U.S. and European stations of the IRIS network.

1. Introduction

The project MERIT was first proposed at the I.A.U. Symposium No. 82 on "Time and the Earth's Rotation" held in Cadiz, Spain, in May,1978. The Project objective was to investigate the feasibility of monitoring earth rotation by intercomparing techniques with the objective of improving resolution. In 1981 the COTES initiative was explicitly drawn up to define the task and the means of determining a conventioned terrestrial reference frame. From the very beginning it had been realised that only through the co-location of different observing techniques at a number of well distributed sites would it be possible to establish a precise connection between the various reference systems in use with the different methods (VLBI, SLR, LLR etc.).

A. K. Babcock and G. A. Wilkins (eds.), The Earth's Rotation and Reference Frames for Geodesy and Geodynamics, 147–151.

A first move to minimise such differences came with the introduction of a set of MERIT standards, which were mutually acceptable to all groups and which, since their

Site or vicinity of co-location	Systems co-located			
	VLBI	SLR	LLR	GPS ties
Grasse		X	X	
Wettzell	X	X	(X)	
(Bologna)	(X)	(?)		
(Matera)	(X)	X		
(Onsala)	X	(?)		
(Crimea/Simeiz)		(X)	(X)	
Haystack/Westford	X	X		
Haleakala		X	X	
Fort Davis/McDonald	X	X	X	X
Platteville	X	X		
Quincy	X	X		
(Richmond)	x	(X)		
GORF/	X	X		X
Orroral (Tidbinbilla)	X	X		(X)
Goldstone/Mojave	X	X		
Shanghai	(X)	X		

Table 1: Summary of co-locations performed to date or (under consideration).

introduction have achieved widespread acceptance. These standards are currently undergoing review prior to modification to bring them into line with latest results.

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The problem of co-locating different systems was however more complicated. Few stations around the world have been expanded to include multiple facilities, but these form the core of the efforts to connect the different reference systems. Extending these efforts to other stations requires the availability of mobile instrumentation capable of observing anywhere within the global network of stations. Few such systems exist, and the demands made upon them, together with the global nature of the problem and the relatively high costs involved make the scheduling of co-locations extremely difficult. The co-locations of different high-accuracy systems performed to date are listed in table 1. Some of these have been made possible by using GPS to connect systems located in the same general vicinity though not located at a common site.

2. THE PLANNED CO-LOCATION AT RICHMOND

As part of the agreement between NASA and the European groups to participate jointly in the WEGENER-MEDLAS Project a reciprocal arrangement was set up between NASA and the Institut für Angewandte Geodäsie (IfAG) to use the modular transportable laser-ranging system MTLRS-1 in alternate years in field observations in the U.S. The first visit of MTLRS-1 to the States occurred in 1985, when the system was deployed for a 3-month co-location at the Goddard Optical Ranging Facility, GORF.

USNO, NGS, NASA and the IfAG have been discussing the co-location of MTLRS-1 at Richmond for some years. The proposed timing for this co-location (1986) slipped due to delays in the availability of mobile instrumentation for completing the schedule as originally planned and is now set for early 1988. With the site selection completed construction has already been taken in Land close to the site of the radio telescope.

3. A CONTROLLED EXPERIMENT

As part of the IRIS activities frequent measurements are being made between the radio telescopes located at Westford. Fort Davis, Richmond and Wettzell, with less frequent (monthly) measurements also to Onsala. Furthermore, IRIS observations are due to commence from the new telescope at Bologna in 1987. With laser-ranging facilities permanently installed at Wettzell and McDonald and with MTLRS-1 at Richmond it would be extremely valuable to try to complete a fully controlled experiment by co-locating additional mobile systems at Haystack/Westford and at Bologna, where IRIS observations commence in 1987. The particular significance of such an experiment would lie in its ability to control both the scale and orientation of the respective reference systems as they are observed on each continent and intercontinentally.

Station	Latitude	Longitude
Bologna	44 30	11 20
Fort Davis/McDonald	30 35	256 10
Haystack/Westford	42 30	288 40
Onsala	57 25	12 00
Richmond	25 30	279 40
Wettzell	49 10	12 50

Table 2: The approximate positions of the U.S. - European IRIS-network stations.

From table 2 it can be seen that the proposed network spans approximately 117 degrees in longitude. With just over 5 degrees latitude difference in Europe and 17 degrrees in the States, the suggested net has a strong E.-W. orientation with the European N.-S. component being only slightly to the north of the corresponding U.S. component. At a later date it would be very desirable to perform a similar experiment on an inter-continental N.-S. Baseline.

The ten-baseline figure could be handled by the N.G.S. correlator and the consistency of the two systems could be checked in all three dimensions. With MTLRS-2 already located in Italy when MTLRS-1 is moved to the States, Bologna is an obvious choice for this co-location. The weather on both sides of the Atlantic is normally suitable for VLBI-SLR co-locations at this time.

DISCUSSION

C.S.Joshi: Enquired as to the availability and approximate cost of mobile Lageos tracking equipment, and also whether mobile LLR equipment is available.

Reply by Wilson: Information on such systems is available, but it should be discussed with the individual manufacturers, as costs are configuration-dependent and the desirable configration is application-dependent. Prospective manufacturers can be identified upon request.

G. Wilkins: Would it be worthwhile to include the Chilbolton antenna (which is closely tied to Herstmonceux SLR) in the network?

Reply by W. Carter: Adding Chilbolton to the intercomparison suggested by P. Wilson could, of course, benefit the network. However, it would only add slightly to the North American–German network to be used, and would be of lower priority than other VLBI stations that would add relatively more.

Reply by Robertson: To Wilkins' comment on Chilbolton: Major problems would probably be the availability of a transportable Mark III terminal (TVDS). To install a system would take about one week. a Hydrogen maser would also be needed.

A. Niell: 1) How long would MTLRS stay at Richmond? 2) Would a second mobile system be the other MTLRS or a NASA system? 3) What is the expected accuracy?

Reply by Wilson: 1) We should be able to get the required 20 passes within a month of observing. This goal was easily surpassed in the MEDLAS campaign. 2) It would be a NASA system. 3) A typical pass from 4 stations in Europe gives residuals to short arc fit of less than ±4.5 cm maximum deviation.

T. Clark: It turns out that you can illuminate Lageos with phased-array military radars and observe the specular reflection at Mark III VLBI stations. If you use 10 VLBI stations, you can determine the 3–dimensional position of Lageos to within 3 cm. Unfortunately, it requires the equivalent of the gross national product of Brazil to do the experiment.