ACCURACY OF THE IRV PREDICTIONS AT BOROWIEC SLR STATION

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ABSTRACT: The Borowiec SLR station receives IRV data automatically from several orbital centres. The paper presents estimates of the accuracy of the IRVs predictions for Borowiec SLR station. A value of the time bias between ephemeris and observations is used as a criterion of the IRV accuracy. The results for several low satellites: TOPEX/POSEIDON, AJISAI, WESTPAC and CHAMP are presented. The main purpose of this work is to estimate the accuracy of prediction to improve the ephemeris, which is necessary because of the automation of the Borowiec SLR system and the beginning of the daily passes.

1. INTRODUCTION

The quality of IRV predictions is one of the fundamental factors determining high accuracy of satellite tracking which is essential for increasing the efficiency of measurements and thus the accuracy of determination of normal points. High accuracy of predictions also allows a swift change of the satellite tracked and permits observations at a small field of view needed for daily observations. The aim of the study reported was to check the quality of predictions made by a few orbital centres in order to be able to select the best IRV data and thus improve the quality of tracking at the Borowiec SLR station. The IRV data are received automatically by e-mail or ftp from selected centres. Since April 2000 the Station at Borowiec has been using daily elements instead of the data updated every two weeks. The emphemeris for Borowiec including azimuth, elevation and range are calculated by an automated ephemeris program IRA, which is a modified version of the program IRVINT developed at the University of Texas at Austin. The observations bring values of time bias, assumed as a criterion for assessment of accuracy. The assessed quality of predictions refers to the results of the Borowiec station only and can significantly differ from the real quality determined for particular orbital centres.

2. AUTOMATIC READING OF IRV PREDICTIONS

The Borowiec SLR station currently receives the predictions from the Honeywell Technology Solutions Inc. (HTSI), Natural Environment Research Council - Space Geodesy Facility (NERC), GeoForschungsZentrum (GFZ), and Mission Control Centre (MCC). They are automatically received and according to the header line, including the name of the centre and the number of the satellite, they are introduced into the appropriate IRV files. On the basis of the currently updated files, ephemeris are automatically prepared for particular

passes. At present the station in Borowiec carries out observations on the basis of daily predictions prepared by HTSI, with the exception of the satellite CHAMP for which predictions are received from GFZ four times a day.

3. METHOD OF THE ACCURACY ASSESSMENT

The quality of predictions was estimated using the data from observations of 191 passes of the satellite TOPEX/POSEIDON, 102 AJISAI, 25 WESTPAC and 9 CHAMP, performed in Borowiec from June 1999 to August 2000. The choice of TOPEX/POSEIDON and AJISAI has been made because a large number of their observations ensured a high quality of predictions. The satellites CHAMP and WESTPAC are much more difficult for observation because of low orbits and resulting from it significant errors in time. The observations of LAGEOS-1 and LAGEOS-2 have not been analysed as the predictions for them are sufficiently accurate. Unfortunately, the number of observations of CHAMP in this period was small, because of a low number of clear night and a short time (one month) from the launch of this satellite. The main criterion of the accuracy of predictions is the value of the time bias, which is a difference between the real and the predicted time of observation. The radial errors and those transversal to the orbit are much smaller and do not have such a great influence on the position of the satellite as the along track errors (time bias). Results of each observation were compared with predictions from different orbital centres to determine the values of time bias. For TOPEX/POSEIDON and AJISAI the predictions were taken from HTSI (formerly ATSC) and NERC (formerly RGO), for WESTPAC - from HTSI, NERC and MCC, while for CHAMP from HTSI and GFZ - updated four times a day.

4. RESULTS

The values of time bias for particular satellites are presented in Figs. 1-4, while the mean values and scatter of time bias is given in Table 1. In Figs. 1 and 2 changes in the set of predictions and the beginning of the use of daily predictions from HTSI are marked.
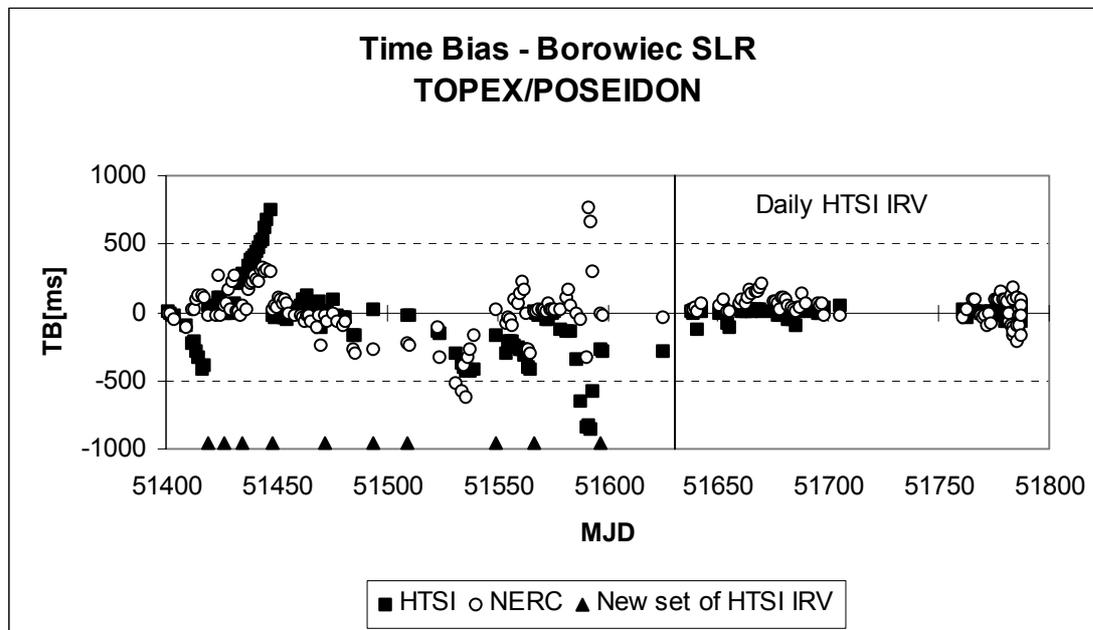

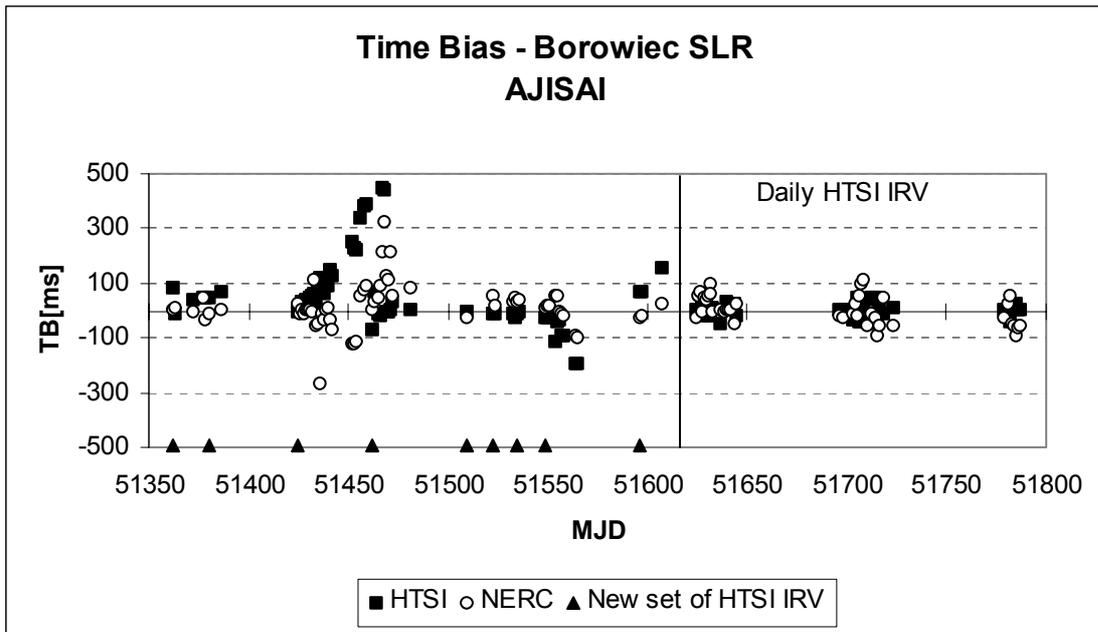Fig. 1. Time bias for the satellite TOPEX/POSEIDON.

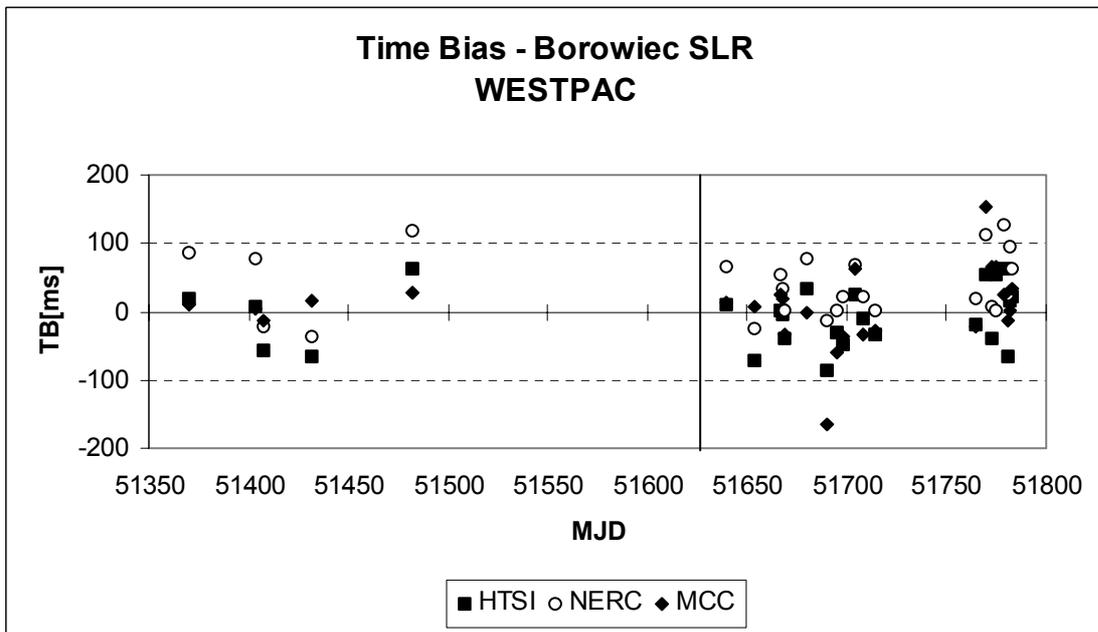Fig. 2. Time bias for the satellite AJISAI.

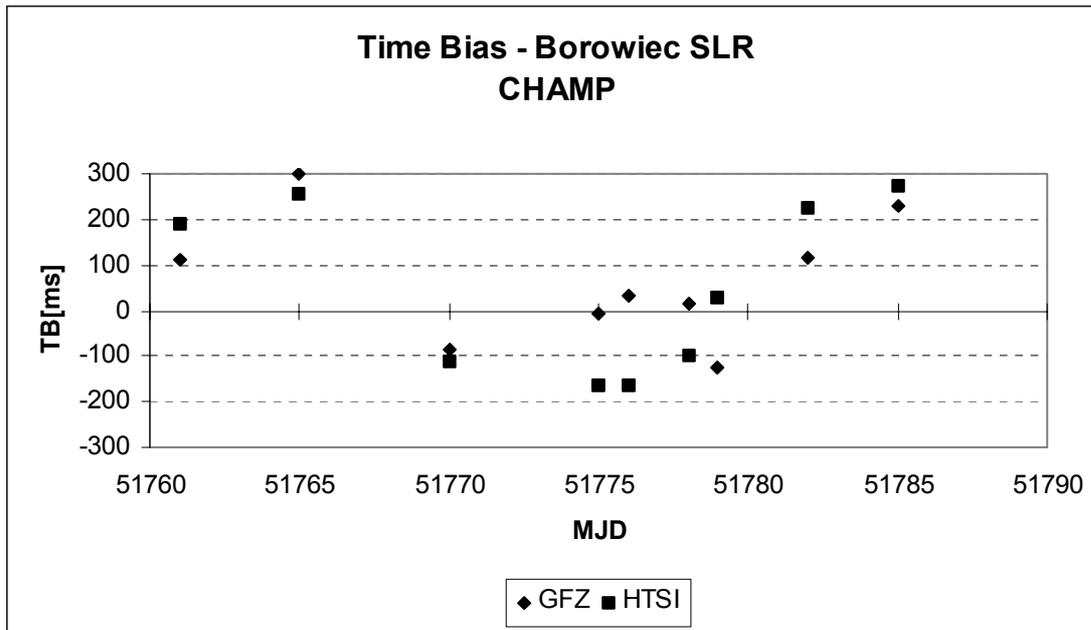Fig. 3. Time bias for the satellite WESTPAC.

Fig. 4. Time bias for the satellite CHAMP.

Table 1. Results of time bias (ms) determination for SLR Borowiec on the basis of predictions from particular orbital centres.

CENTERS	TOPEX 1999.08.08-2000.08.31	AJISAI 1999.07.03-2000.08.31	WESTPAC 1999.07.11-2000.08.27	CHAMP 2000.08.05-2000.08.29
HTSI (ATSC)	-63±287	57±137	-6± 53	-
HTSI (daily)	2± 38	-1± 25	-9± 43	48±190
NERC – to 03.2000	8±203	16± 84	45± 69	-
NERC – from 04.2000	35± 88	2± 52	38± 43	-
MCC	-	-	5± 56	-
GFZ	-	-	-	65±111

For the satellites TOPEX and AJISAI, when the predictions were provided every two weeks, time bias fast increased with time for a given set of predictions. A significant improvement of the prediction accuracy was noted after introduction of daily predictions from HTSI at the end of March 2000. Also a substantial improvement of the quality of predictions from NERC (RGO) was noted. For the satellite WESTPAC there are no significant differences between the predictions from HTSI, NERC and MCC, even after the introduction of daily predictions from HTSI, this is most probably due to a too low number of observations of this satellite. For CHAMP, the scatter of time bias is almost twice smaller for the four-times-a day predictions from GFZ than for the daily predictions from HTSI. This is a good example illustrating the benefits of having access to predictions prepared more frequently than once a day.

5. CONCLUSIONS

The estimation of the quality of IRV predictions indicates a significant improvement of their accuracy after introduction of daily predictions. It also illustrates that for low satellites it is beneficial to have predictions prepared four times a day. To improve the satellite tracking it is necessary to increase the quality of predictions, especially for low and rarely observed satellites, which requires fast transmission of the data from the station to the orbital centre. The main aim should be to reach the prediction accuracy at the level of milliseconds, which would lead to a more effective elimination of the telescope errors and improvement of the quality of the satellites tracking and accuracy of observations.