Effects of Variations in Earth Rotation on Extended Use of GPS Orbits

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SUMMARY. Time transfer data, derived from single frequency observations of GPS satellites, have shown a unique bowing characteristic in the residuals with an amplitude which sometimes amounts to about 80 ns. Investigations attempting to explain this characteristic have so far been unsuccessful. The studies have been concerned with hardware and software effects. The hardware studies have:

(a) compared data obtained with single frequency receivers with data obtained simultaneously with dual frequency receivers which eliminate the effects of the ionosphere;

(b) compared data obtained with different kinds of single frequency receivers; and

(c) compared data obtained simultaneously with different kinds of antennas, including one designed to minimize the effects of multipath.

All hardware studies have consistently verified the existence of the bowing effect.

The software studies have looked at the signature of several possible error sources. In particular, the effect of variations in the Earth's rotation rate on the Aberration Correction and the Transformation Algorithm between the Inertial Frame of Reference and the Rotating Frame of Reference attached to the Earth has been investigated. The effects of variations in the Earth's rotation rate cannot explain the observed signatures.

Finally, several of the parameters selected to represent the GPS orbits in space were studied. Again, no signature with the amplitude and shape of the observed effect could be found through variational analysis. However, it should be noted that the transmitted orbital parameters do not contain a secular term for the argument of perigee. For the current Block I GPS satellites, this is no problem since they are located at the crtical inclination of 63.5 degrees. The

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operational Block II satellites will be located at 55 degrees inclination. Therefore, after the launch at the Block II satellites,extreme caution should be taken in using the transmitted orbital parameters for extended periods of time.

None of the investigated possibilities were able to explain the signature and amplitude of the bow structure exhibited in the time transfer residuals.

DISCUSSION

Boucher: It was suggested that a wrong ionospheric model had been used in time transfer GPS receivers at some epochs. What is the present situation?

Reply by Klepczynski: A misinterpretation concerning the meaning of a variable in the model was made at the beginning. It was corrected later.

Pâquet: Among the different sources of error, have you considered the ionospheric effect?

Reply by Klepczynski: Yes. In fact, we have placed a single–channel receiver next to a dual frequency receiver. The timing residuals from both receivers showed the same "bow effect" even though the dual frquency receiver removes the effect of the ionosphere totally.

Herring: Does the "bow effect" exist at other sites?

Reply by Klepczynski: Yes, we see this "bow effect" throughout the U.S., Europe, and Asia. We also see it in receivers from different manufacturers and in single and dual frequency receivers.

G. Dedes: Did you check the way the relativity correction is applied to see if this timing error is due to this correction?

Reply by Klepczynski: Yes, we recomputed the relativity correction using the orbital elements transmitted by the satellites. The recomputed values agreed with those computed by the receiver program to within 1 ms.

Dickey: Whose orbit determination are you using?

Reply by Klepczynski: We are using the transmitted elements as specified in ICO–GPS–200.