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MULTIPATH AND DISCONTINUITIES IN CLOCK ESTIMATES AT DAY BOUNDARIES

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SUMMARY

In a previous report (http://maia.usno.navy.mil/gpst/mail/09Mar99.1), we presented evidence concerning discontinuities in GPS-based clock estimates at day boundaries, which are sometimes much larger than expected based on the standard errors (at the 1-ns level and larger). We found that these can usually be associated with a specific station rather than global causes (e.g., satellite orbits). We suggested that the cause of such station-related discontinuities is most likely due to changes in the local multipath environment. However, no specific or quantitative results were presented to support that conclusion. Using "teqc", quantitative multipath measures have now been examined for the days reported previously. These show very large multipath variations corresponding to the two day-boundary events.

RESULTS

Shown in the first line of the table below are the day-boundary clock discontinuities reported previously and attributed to the IGS station "USNO." The analysis data are available at
http://maia.usno.navy.mil/gpsclocks/finals/0987/
using USNO as the reference clock and at
http://maia.usno.navy.mil/gpsclocks/finals/0987/drao/
for the same analysis but using DRAO as the reference clock. Details are discussed in our previous report. (The USNO-DRAO clock jump at the 51156/51157 day boundary can be mostly assigned to DRAO by comparison with other stations.)

CLOCK DISCONTINUITIES (ns) & MULTIPATH VARIATIONS (m) AT USNO

	09 Dec 1998 51156	10 Dec 1998 51157	11 Dec 1998 51158	12 Dec 1998 51159
clk jump	-0.05 ns	+1.33 ns	+0.83 ns	
at USNO	(-0.015 m)	(+0.40 m)	(+0.25 m)	
	0.582245 m	0.610212 m	0.713157 m	0.629531 m
PRN05 rms	0.969301	1.205391	4.166511	1.637752
PRN08 rms	1.524197	1.084110	1.039633	0.718250
	0.852477	0.927115	1.027918	0.887785
PRN05 rms	1.698698	3.009279	6.516962	2.114808
PRN08 rms	1.533773	1.453547	1.427080	1.337911

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    PRN05 rises (>10 deg) about 03:10; sets about 07:10;
          rises again about 12:10; sets again about 15:50
    PRN08 rises (>10 deg) about 03:30; sets about 04:50;
          rises again about 10:30; sets again about 15:50
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The remainder of the table above shows multipath variations at both frequencies as determined by the UNAVCO utility "teqc." (See http://www.unavco.ucar.edu/software/ for more information.) The MPi statistics are determined from the pseudorange values in the USNO RINEX files by forming linear combinations of the pseudorange and carrier phase observables assuming that multipath and noise contributions due to the phases are negligible. In addition to determining MPi rms values for each satellite at each frequency and an overall average rms over the constellation, teqc also produces output files suitable for plotting.

The average teqc results show some increase in the overall MPi rms on 11 Dec 1999 but dramatic MPi rms changes can be seen for the specific satellite PRN05 on 10-11 Dec. PRN08 is up about the same times as PRN05 and generally has the next highest MPi rms, but its day-to-day variation is not large.

CONCLUSION

Of course, more relevant to the clock analysis results would be the mean MPi values over the constellation for the actual observations used in the clock solution. These are not readily available. However, these simple results do serve to strengthen the case for an strong association between the day-boundary discontinuities and local multipath variations.