V2C Simulations Using SOLVE

Dan MacMillan

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Simulation setup

I generated wet zenith delays and clock delays as random walk processes. For solution with SOLVE, I took the O-C to be the sum of these delays plus a white noise contribution corresponding to the observation uncertainty.

$$O - C = [wzen_2 \cdot wetmap(elev_2) + clock_2 + obserr_2] - [wzen_1 \cdot wetmap(elev_1) + clock_1 + obserr_1]$$

In the following I discuss the sensitivity of baseline length repeatabilities to the variances of the input wet delays, clock delays and observation noise.

CONT05 tests

In order to see how simulations compare with observed results, I ran 2 simulations for the CONT05 sessions and compared observed and simulated baseline length repeatabilities. In the first case, for all sites the random walk variances were 0.1 ps^2/sec for the wet zenith troposphere and 0.3 ps^2/sec for the clock, corresponding to an Allan standard deviation of 10^{-14} @ 50 min. In the second, the random walk variances were 0.3 ps^2/sec for the atmosphere and 1.2 ps^2/sec for the clock, corresponding to an Allan standard deviation of 2×10^{-14} @ 50 min. I also added 15 ps of to the observation uncertainties in each case. In our standard solve runs, this is about the level that is added (in reweighting) to the observation uncertainties to make the χ^2/dof =1 for a solution. In runs done with the SOLVK Kalman filter software years ago, I found typical atmosphere variances of 0.1-0.3 ps^2/sec using delay rates.

Figure 1 shows the baseline length repeatabilities for the two cases of CONT05 simulated data along with the observed repeatabilities. One can see that the level of repeatability is similar between observed and simulated cases. On average, the level of the observed repeatability is closer to the second simulation. There are discrepancies between observed and simulated repeatabilities, which should be expected given the simplicity of the simulations.

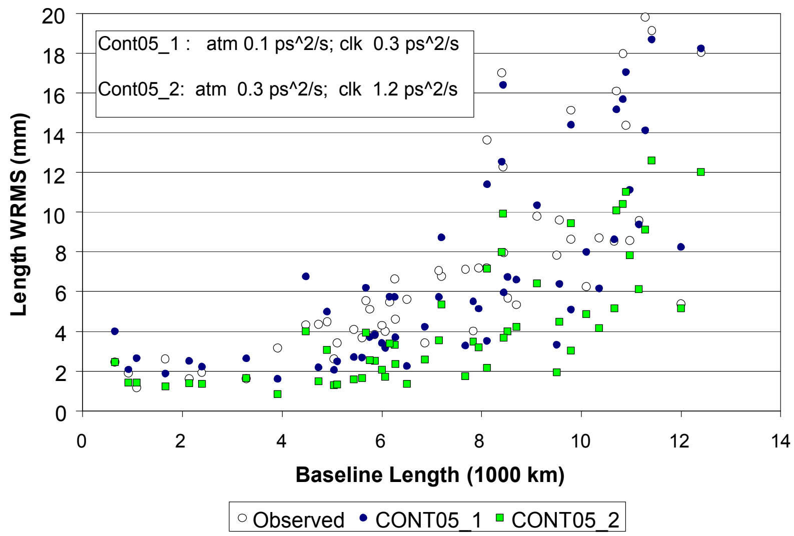

Figure. 1 Comparison of length repeatabilities observed during CONT05 and simulated.

16 station network simulations

To be consistent with the Vienna group, I ran tests using the same observing schedule they used for the results reported in their memo of September 2006. This schedule was generated by Toni Searle and Bill Petrachenko with the following properties:

a) 16 identical antennas of the size of Algonquin but with much faster slewing
b) Slew rates and accelerations of 18 deg/s and 3.6 deg/s2 in azimuth and 4.5 deg/s and 0.9 deg/s2 in elevation.
c) 45 scans/hr per station and 57595 observations

Figure 2 shows the effect of the size of the observation noise. The zenith wet tropospheres at all sites were modeled with a random walk processes of 0.1 ps^2/s. Clocks were modeled with 0.0036 ps^2/s (2×10^{-15} @ 15 minutes) respectively. Observation noise as simulated at levels of 4 ps, 8 ps, and 16 ps. The repeatabilities have some sensititivity to the choice of observation noise between 8 ps and 16 ps but it is not very significant compared to the tropospheric contribution.

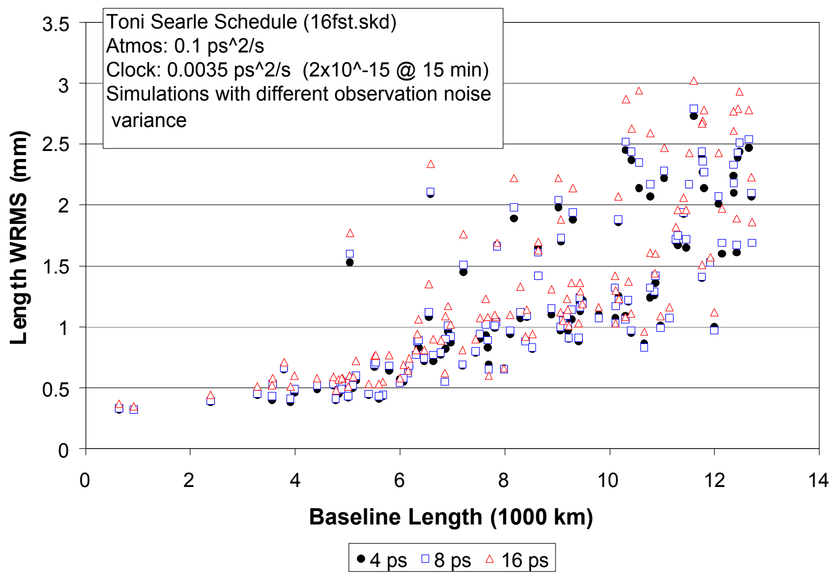

Figure 2. Sensititivity of baseline length repeatability to the observation noise ranging from 4 ps to 16 ps.

For the next set of simulations, the wet troposphere PSD was varied. Figure 3 shows the effect of varying the random walk variance from 0.1 ps^2/s to 0.7 ps^2/s. In previous work with the SOLVK Kalman filter software in which one can estimate this random walk variance from rate data, I found that the variances ranged from 0.05-0.6 ps^2/s. For Johannes Boehm looked at radiometer data from CONT02 and found random walk variances of 0.8 ps^2/s (Wettzell), 0.5 ps^2/s (Kokee), and 0.3 ps^2/s (Onsala).

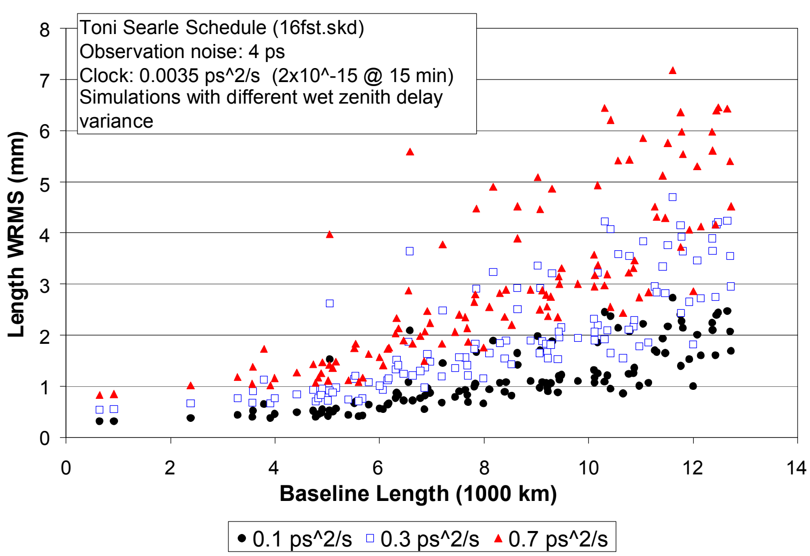

Figure 3. Sensititivity of baseline length repeatability to the wet troposphere random walk variance.

In the next set of simulations, the random walk clock variance was varied. Reducing the clock variance from 0.3 ps^2/s to 0.0036 ps^2/s improves the repeatabilities by about 0.05 ppb.

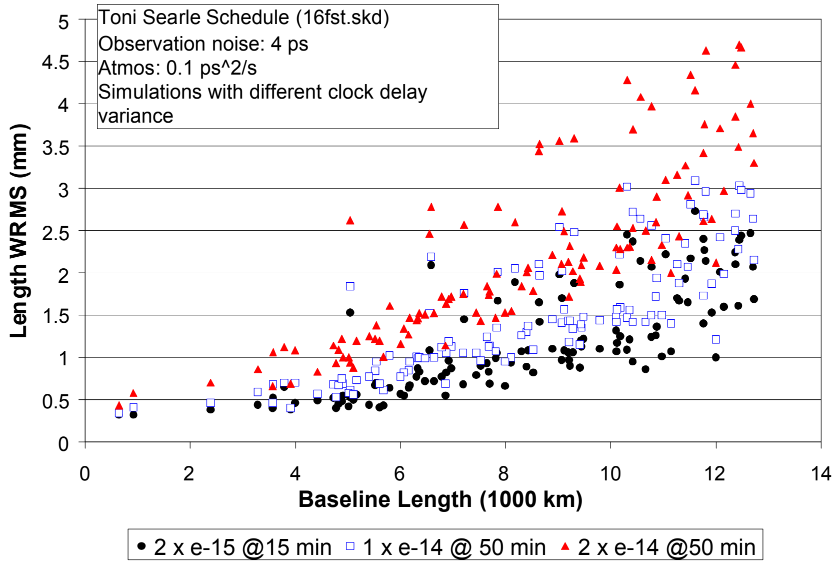

Figure 4. Sensititivity of length repeatability to clock variance. Random walk clock variances were varied from 0.0036 ps^2/s ($2x10^{-15}$ @ 15 min), 0.3 ps^2/s (10^{-14} @ 50 min), and 1.2 ps^2/s ($2x10^{-14}$ @ 50 min).

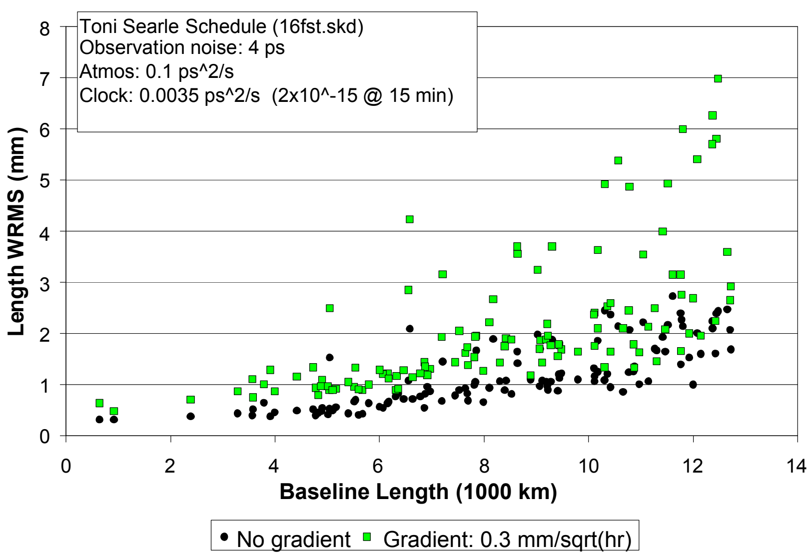

Figure 5. Effect of a random walk gradient.

In the last simulation a gradient was simulated with a random walk variance for each component (N-S and E-W) of 0.3 mm/sqrt(hr). This was the value used by Bar-Sever et al. (1997) for estimation of GPS gradients. It is roughly the value we are using for estimation of gradients in SOLVE. Figure 5 shows that the effect of the gradient is significant and most significant for the group of baselines with repeatabilities that consistently lie above the other baselines. These baselines involve the site L106B-70 in the Antarctic that must have poor connection with the rest of the network.