# IVS Memorandum 2006-015v02

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# “Simulation Studies at Goddard”

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Memo: CONT05 test of simulated wet zenith and clock delays
Added tests for 8 and 16 station simulation schedules
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**Current simulation**

For this test, what I wanted to do was to run the CONT05 sessions with only simulated clock and atmosphere delays and see what the baseline length repeatabilities looked like. 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.

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

The random walk variances were 0.1 $ps^2$/sec for the atmosphere and 0.3 $ps^2$/sec for the clock. I also added 15 ps of "correlator noise" to the observation uncertainty. Runs I did with the SOLVK Kalman filter software years ago typically gave atmosphere variances of around 0.1 $ps^2$/sec. The random walk variance for the clock corresponds to an Allan standard deviation of $10^{-14}$ @ 50 min.

In Figure 1, the baseline length repeatabilities are shown for CONT05 using the simulated data. Two cases are shown, one with atmosphere + clocks and the other with only the atmosphere data. For comparison I included Figure 2 showing the observed repeatabilities for CONT05. One can see that the level of repeatability is similar between observed and simulated cases. Although one can say that the repeatability is at the same level, you can't say that the source of the error that produces these two sets of repeatabilities is the same. (But maybe as a proxy for the real atmosphere it isn't bad?) For instance, if I compared the input atmospheric delay series with the wet zenith delay estimate I would certainly see differences corresponding to errors in the estimation method. These residual differences appear in the baseline length scatter. If I had used a courser estimation setup than 20 min atmos/60 min clocks, the larger residuals would have produced larger length scatter.

**Simulation schedules**

We generated several simulation schedules with SKED. Station position solutions were run for these schedules. For the 8-station schedules, the simulation database was run 20 times; for the 16 station schedule, 10 repetitions (with different random number seeding) were run. The atmosphere and clock parametrizations were the same as above for the CONT05 tests. Baseline length repeatabilities are shown in Figures 3-4.

1) 8-station network: Fortleza, Westford, Gilcreek, Hobart, Svetloe, HartRao, Nyales20

a) same antenna characteristics as current (256 Mbps)

b) VLBI2010 characteristics (X/S SEFD = 1800, slew rate 5 deg/sec, 256 Mbps)

The repeatabilities for these simulations appear to be reasonably comparable.

2) 16-station network: 8 stations from 1) + O'Higgins, Tigoconc, Pietown, Kokee, DSS45, Seshan25, Urumqi, MALI (GPS site ) with VLBI210 characteristics as in 1b)

Going from 8 stations to 16 stations doesn't change the level of repeatabilities much although I would need to check the baselines to identify stations that are producing the largest baseline scatter.

**Future work**

1) Test other atmosphere/clock model routines. I need to check routines I have for integrated random walk and gauss-markov processes (similar to those described by Joerg Wresnik and Johannes Boehm)

2) Generate simulated data that is not based on the same model as the SOLVE estimation strategy. (e.g., azimuthally asymmetry, turbulence, etc.)

3) Test atmosphere/clock models with sked simulation schedules using networks of VLBI2010 antennas. Try different VLBI2010 characteristics (slew rates, data rates, SEFD, number of stations, etc.)

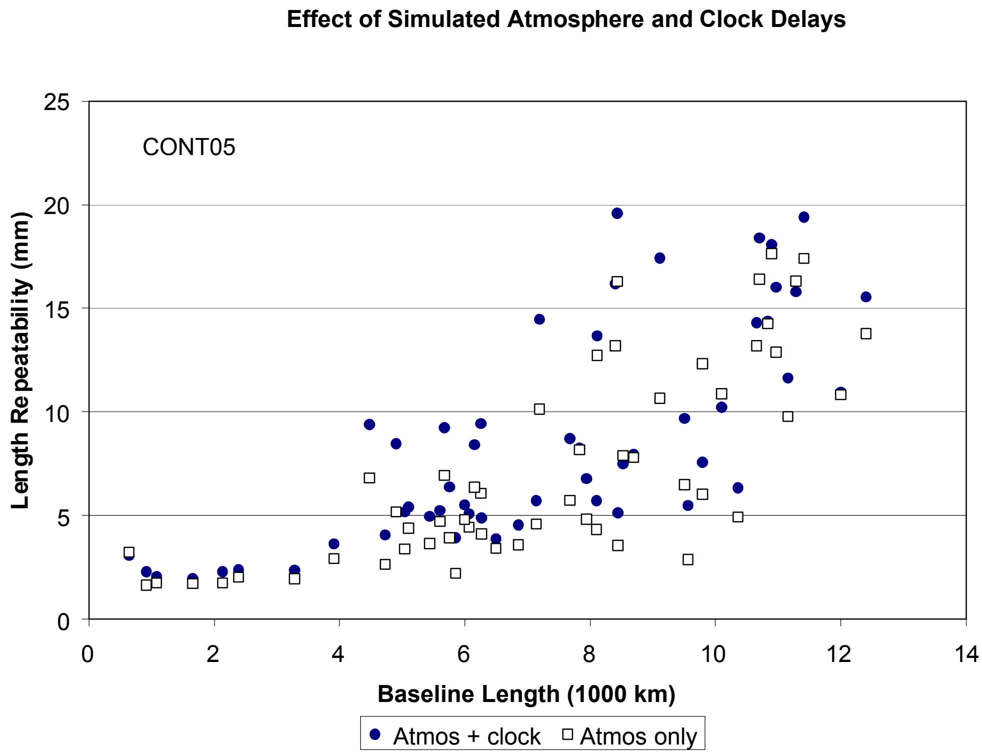


Figure 1.

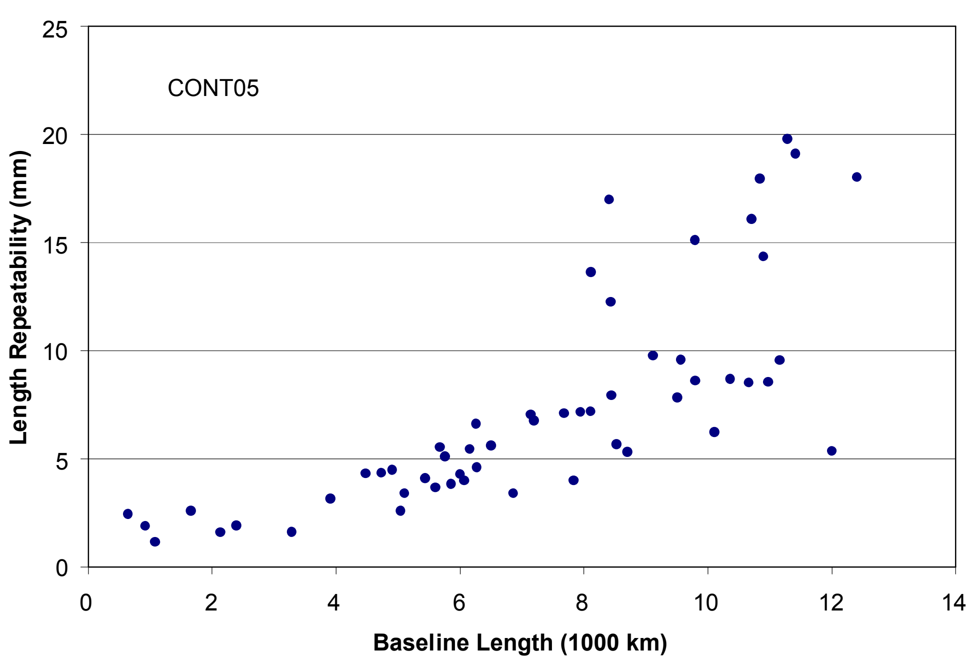


Figure 2.

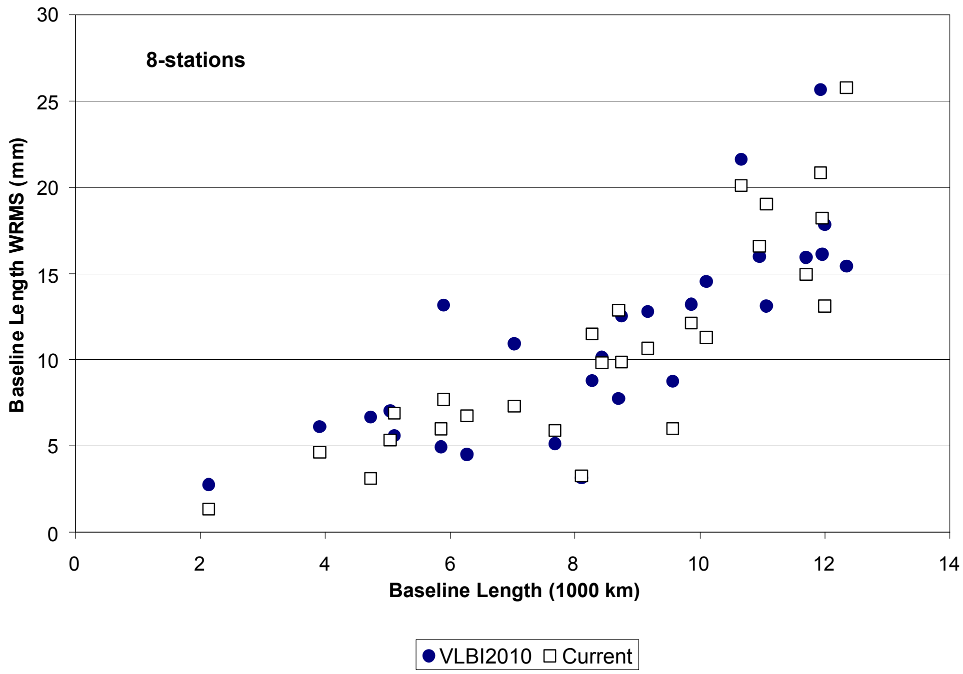


Figure 3.

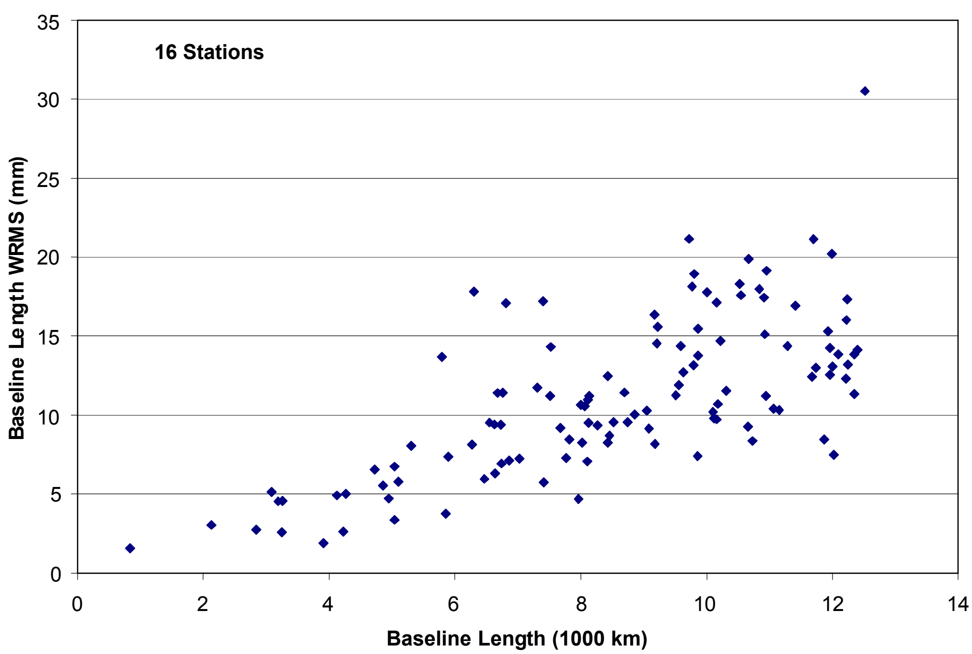


Figure 4.