NEXT GENERATION GLOBAL GEODETIC NETWORKS for GGOS

NG³N

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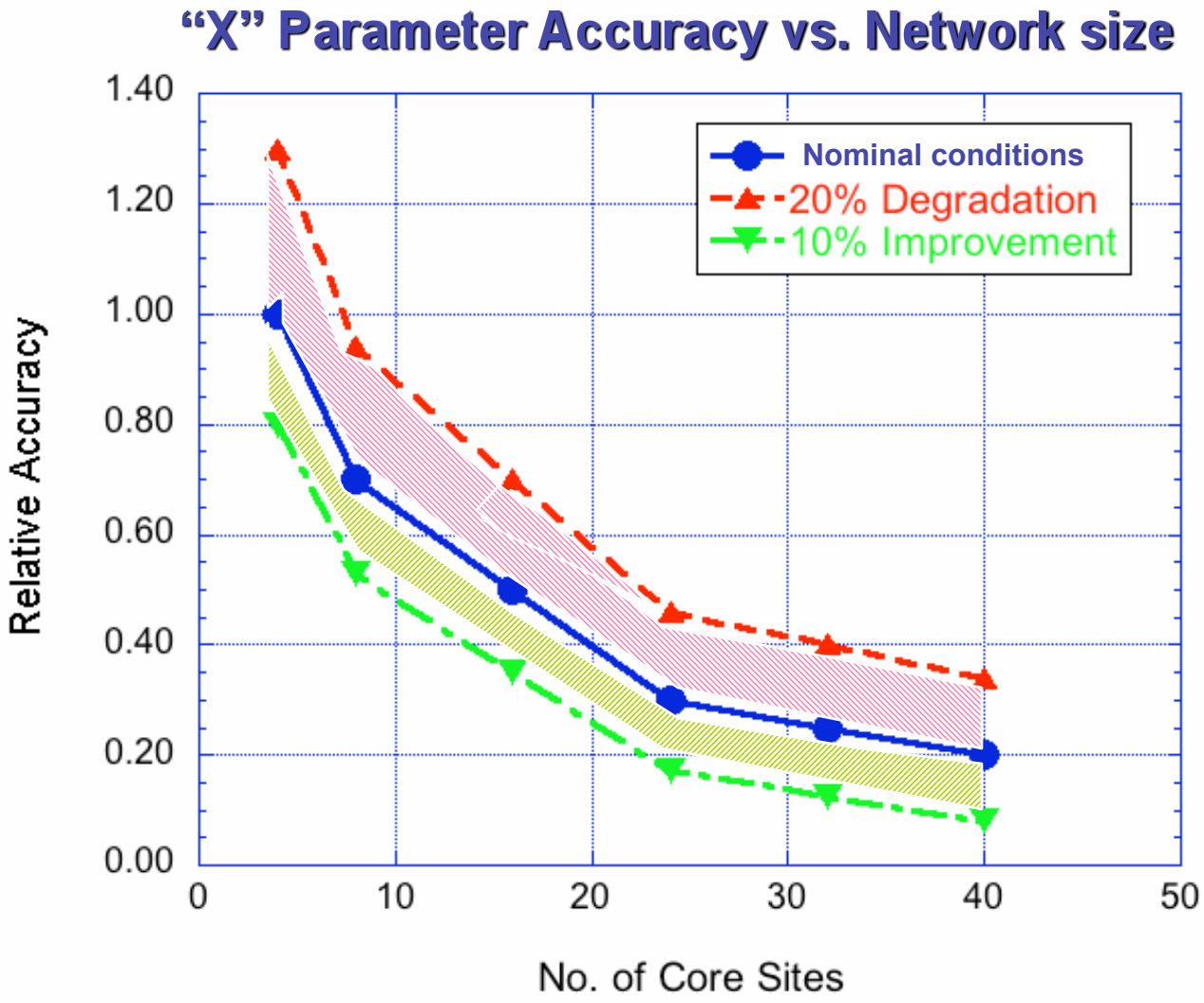
NG^{3}N Design

- SLR and VLBI optimal combination (first step):
  - ✓ Simulation of SLR and VLBI data for 2004 from four networks of 8, 16, 24 and 32 sites
  - ✓ System performance conforms with NGSLR and VLBI2010
  - ✓ **Simulation of a 1-year period with SLR and VLBI data (eventually to be extended to ~ 6 years)**
  - – Inclusion of GNSS, etc. later, in a future step

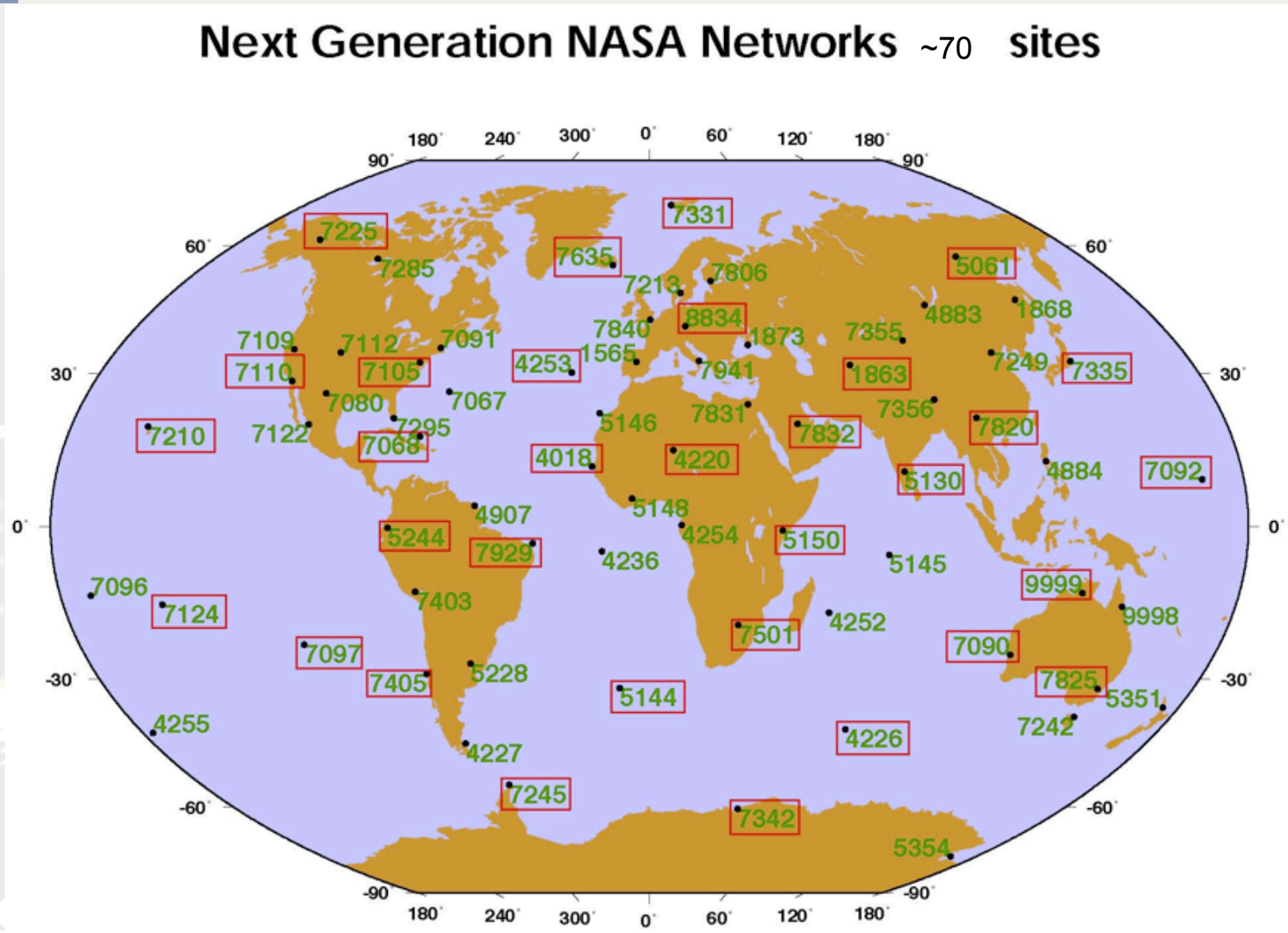
The NG³N Simulation Goal:

<1 mm epoch position and < 0.1 mm/y secular variations



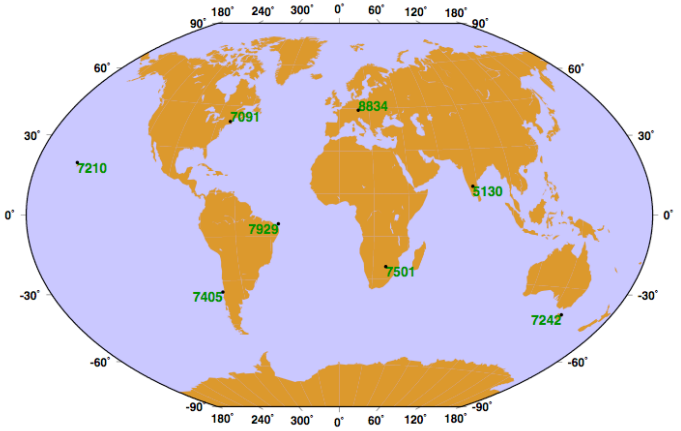
"X": Origin, Scale, EOP, their rates, etc.

Maximal Overlapping SLR-VLBI Network (**32**)

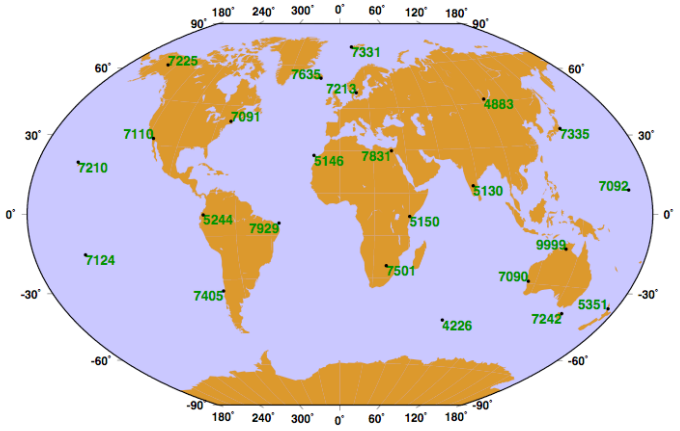


Network variants (8 ⇒ 32)

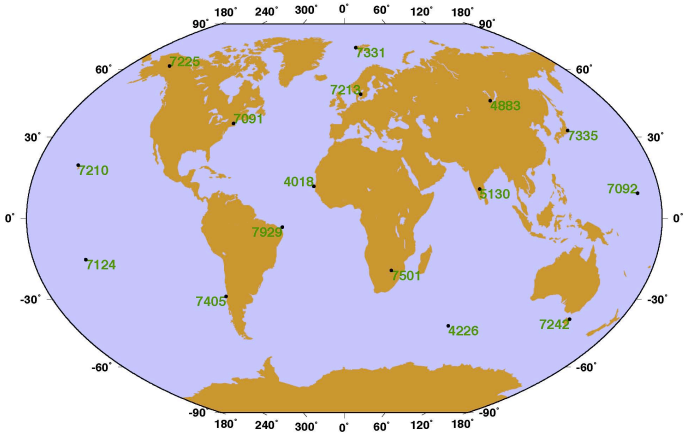
Next Generation NASA Networks 08 sites



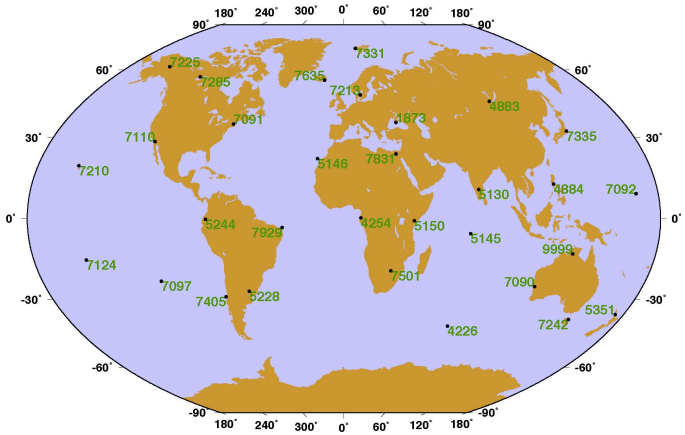
Next Generation NASA Networks 24 sites



Next Generation NASA Networks 16 sites



Next Generation NASA Networks 32 sites



One-year SLR & VLBI Simulation

- Primarily a test to verify the simulation process end-to-end
- Four networks with 8, 16, 24 and 32 sites
- Only site positions and EOP were estimated from one year of data
- The calibrated error covariance is projected on 7 TRF parameters
- Making the assumption that errors across years are uncorrelated, we use the one year estimates to project the accuracy of these parameters for different time spans of data (6, 13 and 16 years)

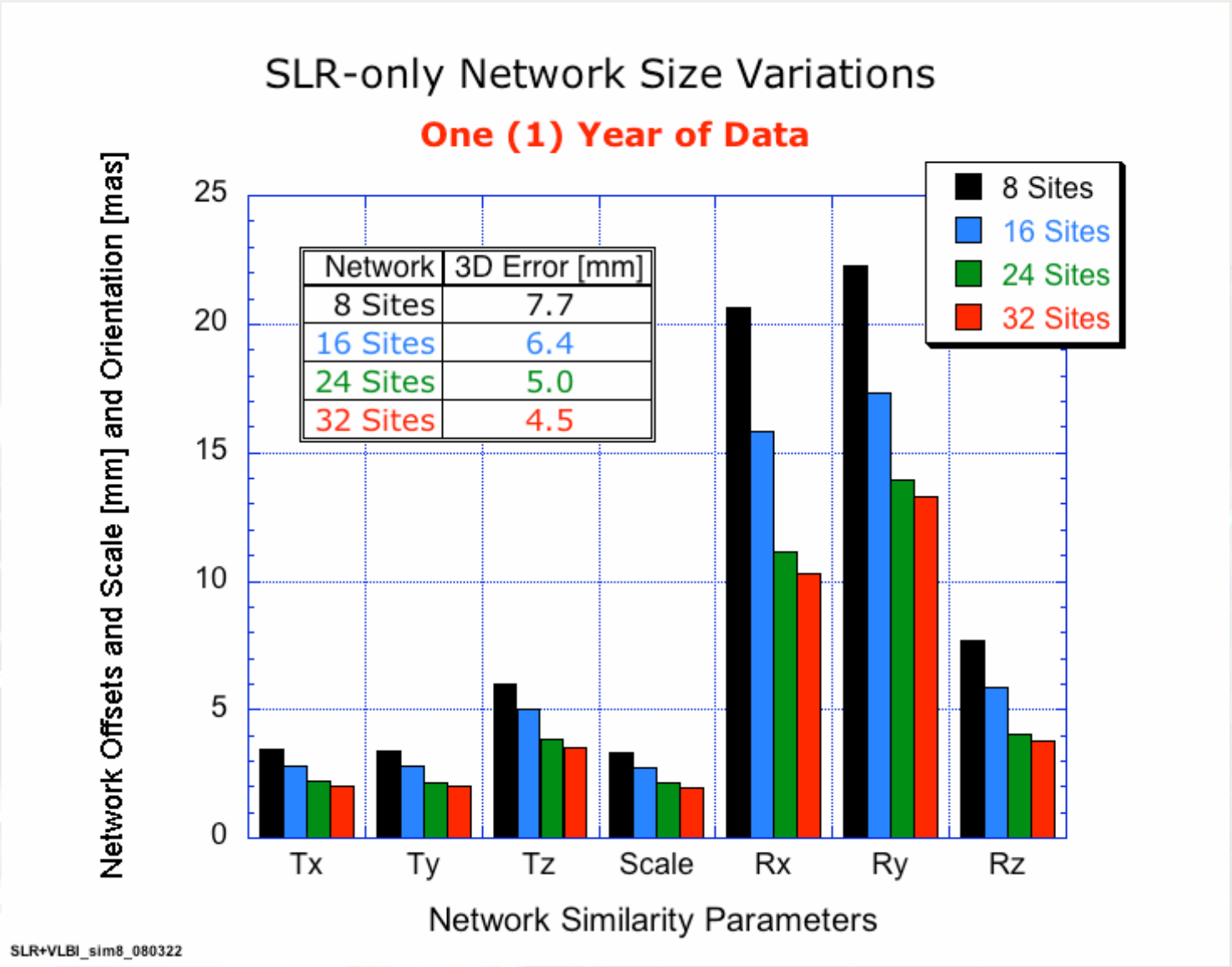
Background Models

- Different geophysical models common to both techniques were used between the data simulation and reduction steps, to introduce “commission errors” to account for our incomplete knowledge of the real system Earth

- The simulated data were generated with consistent geophysical models (where applicable) for SLR and VLBI, e.g. gravity-- static and temporal, tides, loading, atmosphere, etc.

- The parameter recovery uses models different from those used in generating the data, the difference being commensurate with the expected errors in these models (a best guess, e.g. GGM02 vs. EIGEN-GRACE01)

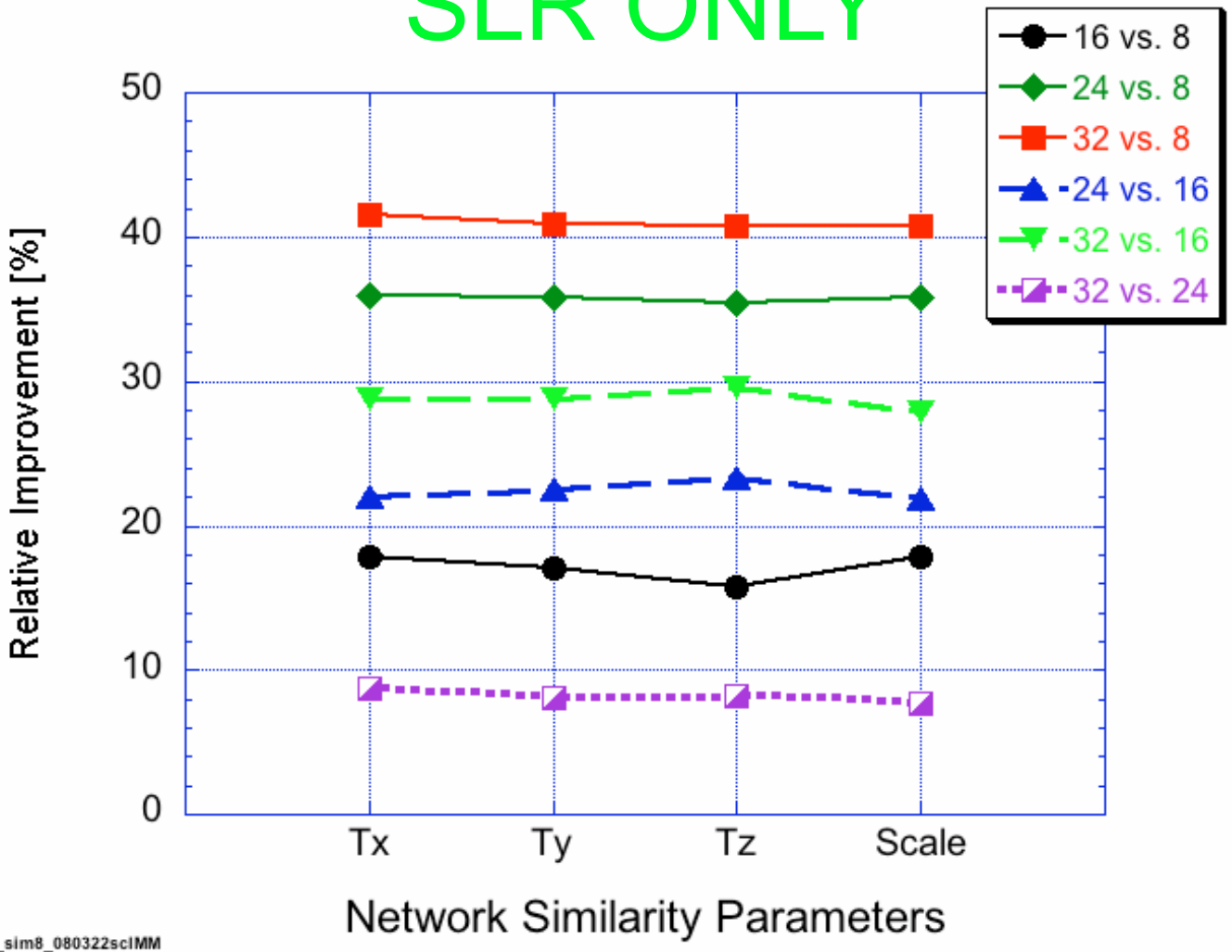
One-year Simulation Results



One-year Simulation Results

Origin & Scale

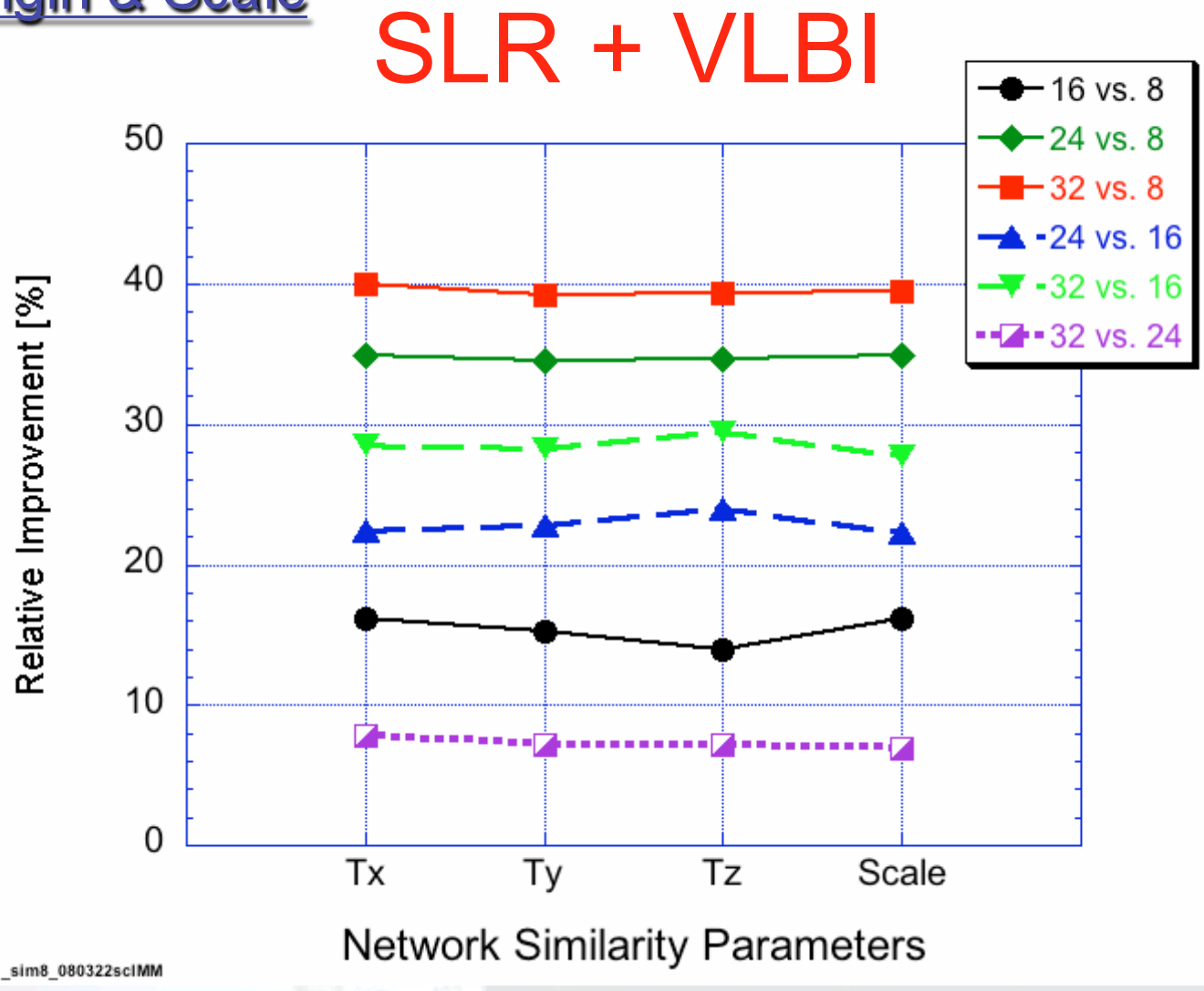
SLR ONLY



SLR+VLBI_sim8_080322sclMM

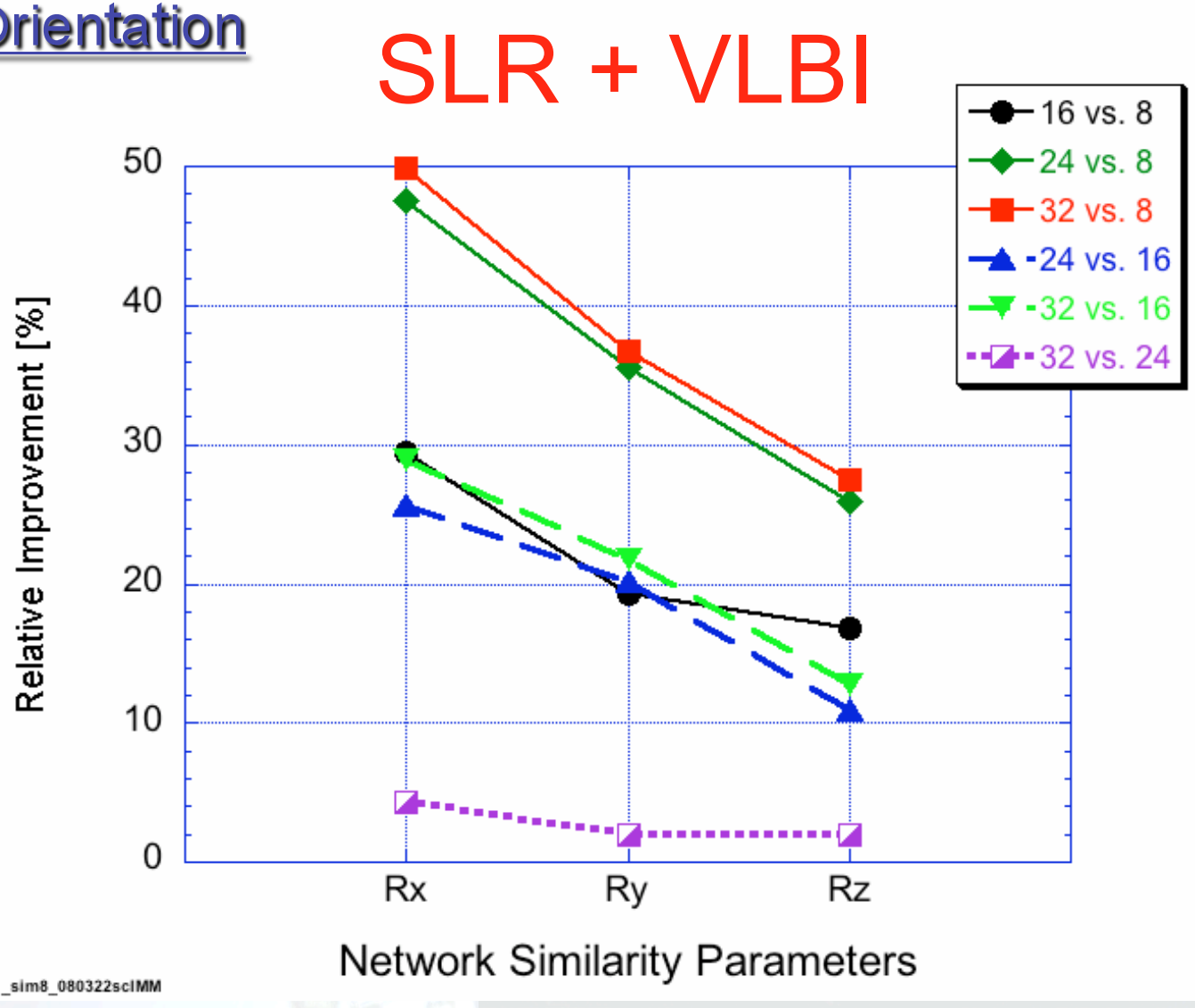
One-year Simulation Results

Origin & Scale



One-year Simulation Results

Orientation

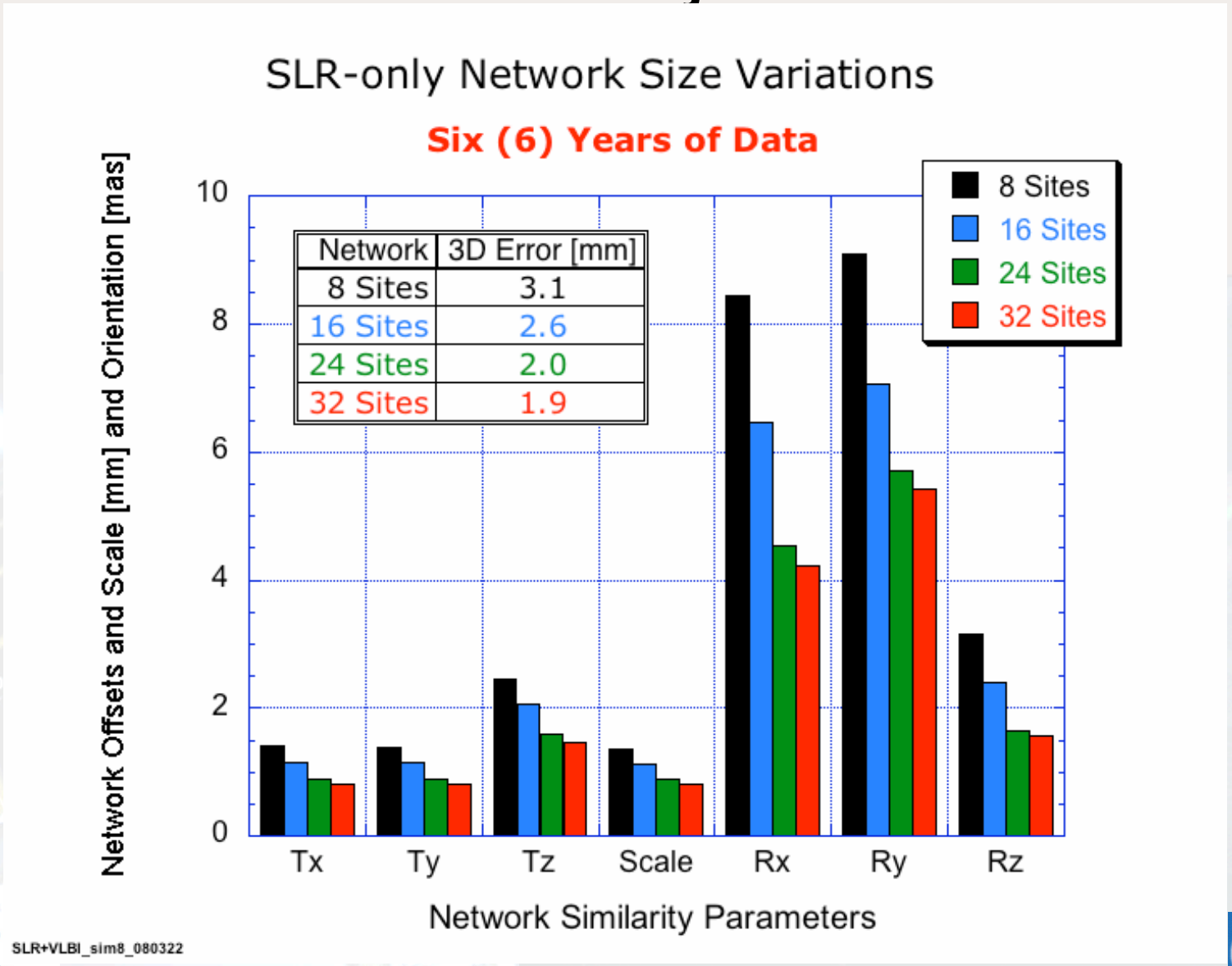


One-year Simulation Results

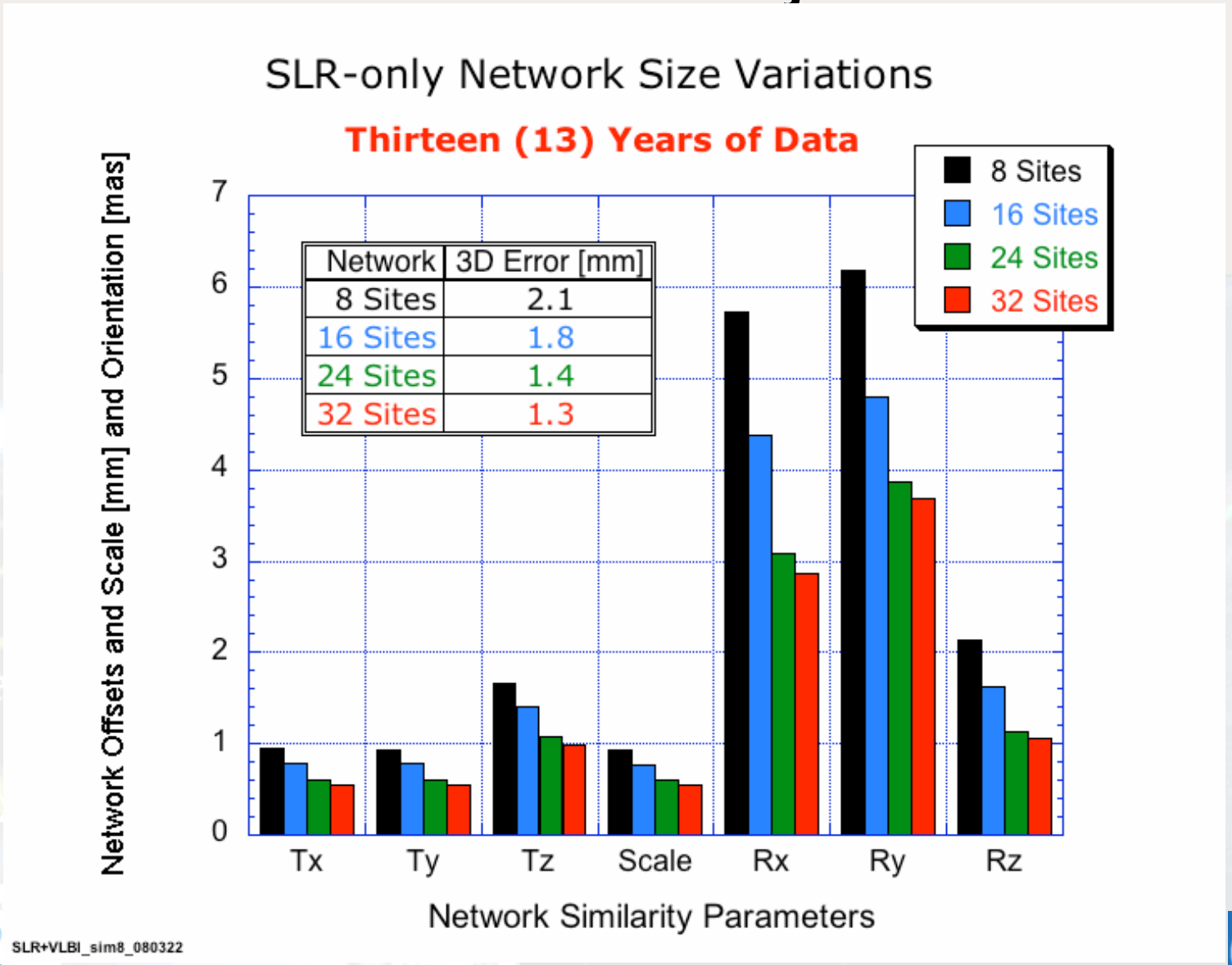
Transformation Component	8 vs. 16		16 vs. 24		24 vs. 32	
	ΔC [mm/ppb/mas]	σ_C [mm/ppb/mas]	ΔC [mm/ppb/mas]	σ_C [mm/ppb/mas]	ΔC [mm/ppb/mas]	σ_C [mm/ppb/mas]
T_X	-5.90	± 15.48	-12.04	± 0.98	-15.38	± 0.65
T_Y	23.07	15.57	21.69	0.98	34.18	0.65
T_Z	15.43	15.63	5.46	0.97	3.95	0.64
D_S	0.90	2.43	-0.05	0.15	-0.16	0.10
R_X	0.80	0.62	-2.22	0.04	-4.40	0.03
R_Y	0.69	0.63	-2.30	0.04	-4.41	0.03
R_Z	-0.91	0.59	-0.30	0.04	-0.27	0.03

X, Y, Z RMS	31.4	23.2	28.0	0.8	3.9	1.0	1.6	3.3	0.9

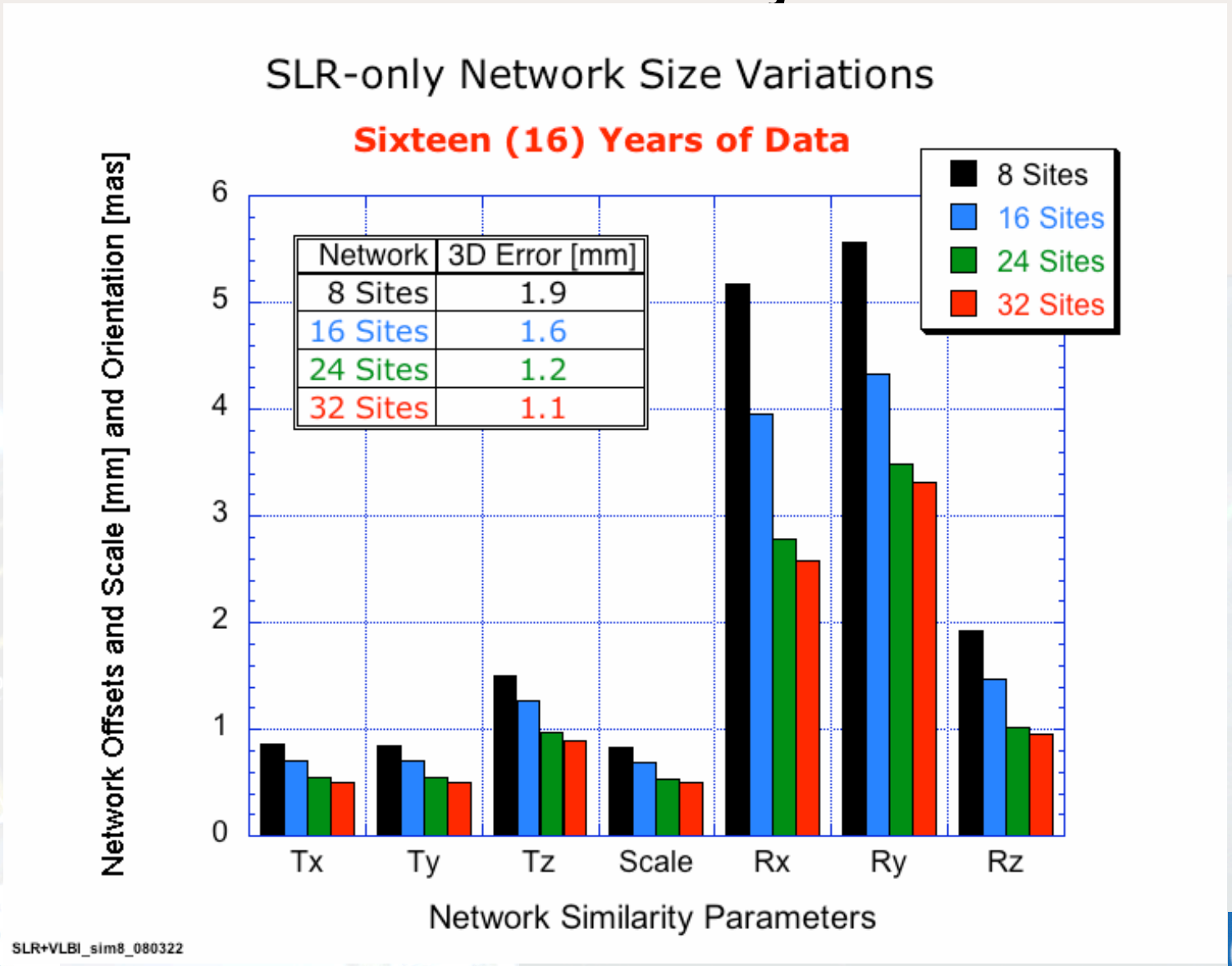
Six Year Projection



Thirteen Year Projection



Sixteen Year Projection



One-year Simulation Results

- The simulation validates the real world experience with 8 sites
- The biggest improvement is seen when going from 8 to 16 sites
- The largest impact of an 8 site addition in the origin is seen when going from 16 to 24 sites (~22%), and the least, from 24 to 32 (~8%)
- When VLBI is added, improvement in orientation levels at 24 sites with ~20% improvement vs. the 16 sites, but only a ~2% when going to 32 sites
- Results for a 13 year time span (corresponds to ITRF2005) show a 4- or 5-fold improvement compared to what we estimate for ITRF2005
- A projection for a 16 year time span (ITRF2009?) shows that a 32 site network approaches the GGOS goal of accuracy in the origin and scale

NG^{3}N Simulation Issues:

- Present design based on two component techniques (SLR & VLBI)
- Looking only at optimal network size with constrained system performance and background model quality, **perfect site-ties**
- Current focus is on “TRF” quality: origin, scale and orientation
- Next step will investigate the temporal variations of the TRF parameters
- Solutions will be repeated with the addition of local ties, weighting them with various scenarios that simulate real cases as well as extreme cases
- We will use the 16 site network to investigate the effect of choosing alternate sites on the results (varying the uniformity of the network)

Summary

- Origin and scale marginally controlled by a 24 site network; when extended to 32 sites though, it approaches GGOS goals (1 mm)
- Orientation seems to be less dependent on the size of the network and the extension from 24 to 32 sites does not improve the results significantly enough to justify the expense
- The effect of additional techniques on the quality of the TRF remains to be assessed
- Need to develop scenarios of “degradation” and “improvement” of nominal design parameters

Future Work

- We may have to consider *improvement of our models, analysis techniques and our space segment* (e.g. SLR targets) to improve TRF accuracy while keeping a reasonable network size

- Our simulation process will now run on a faster CPU to allow a quick turn-around of future cases and by May, we expect access to the Columbia grid cluster

- As we improve our turn-around time we plan to investigate scenarios with additional parameters varied (more satellites, different orbits, etc.)