GGOS Network Scoping Simulations

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GGOS ITRF Accuracy Goal

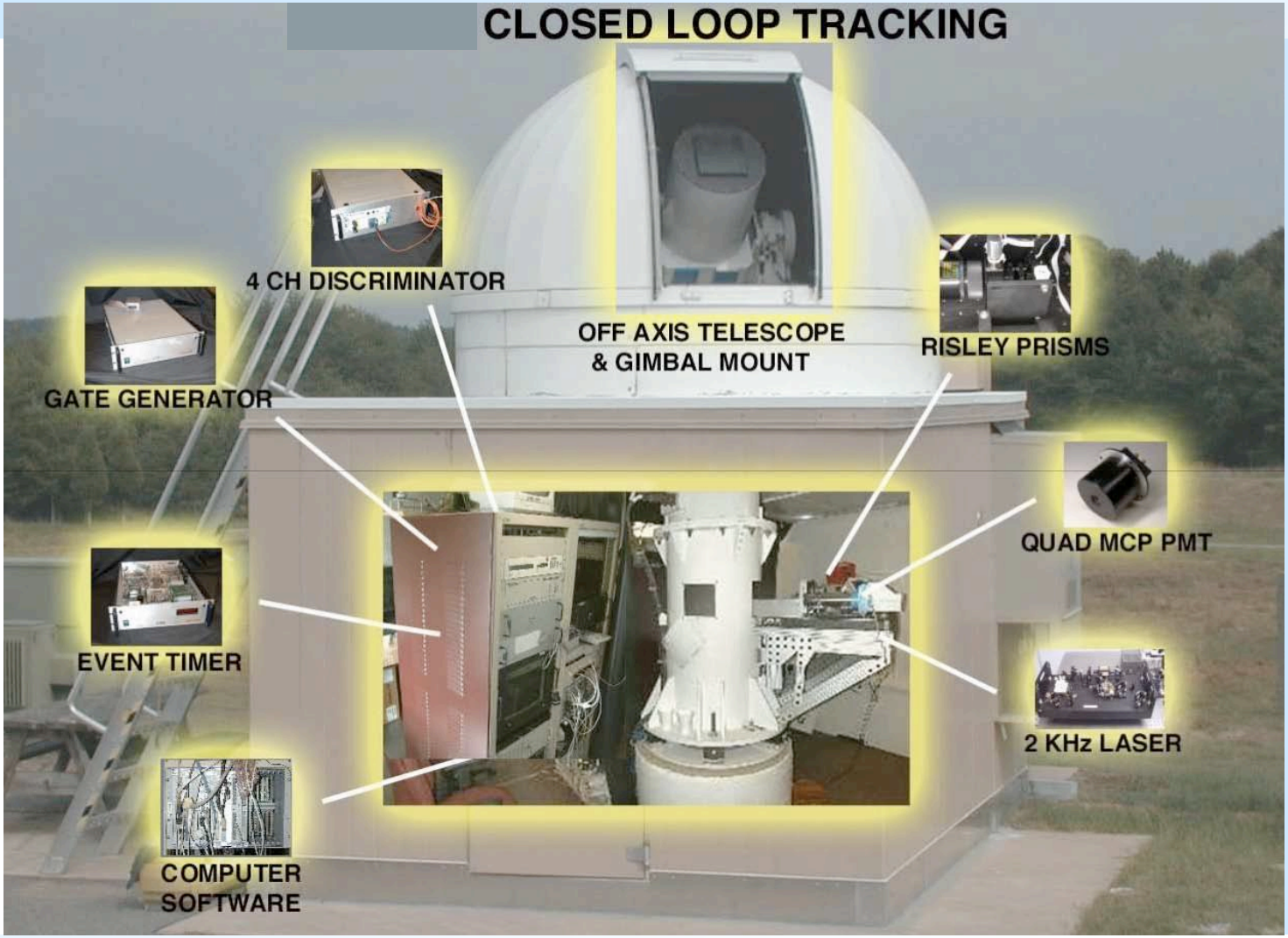
- **Future ITRF* should exhibit consistently and reliably accuracy and stability at the level of:**

<1 mm in epoch position, and

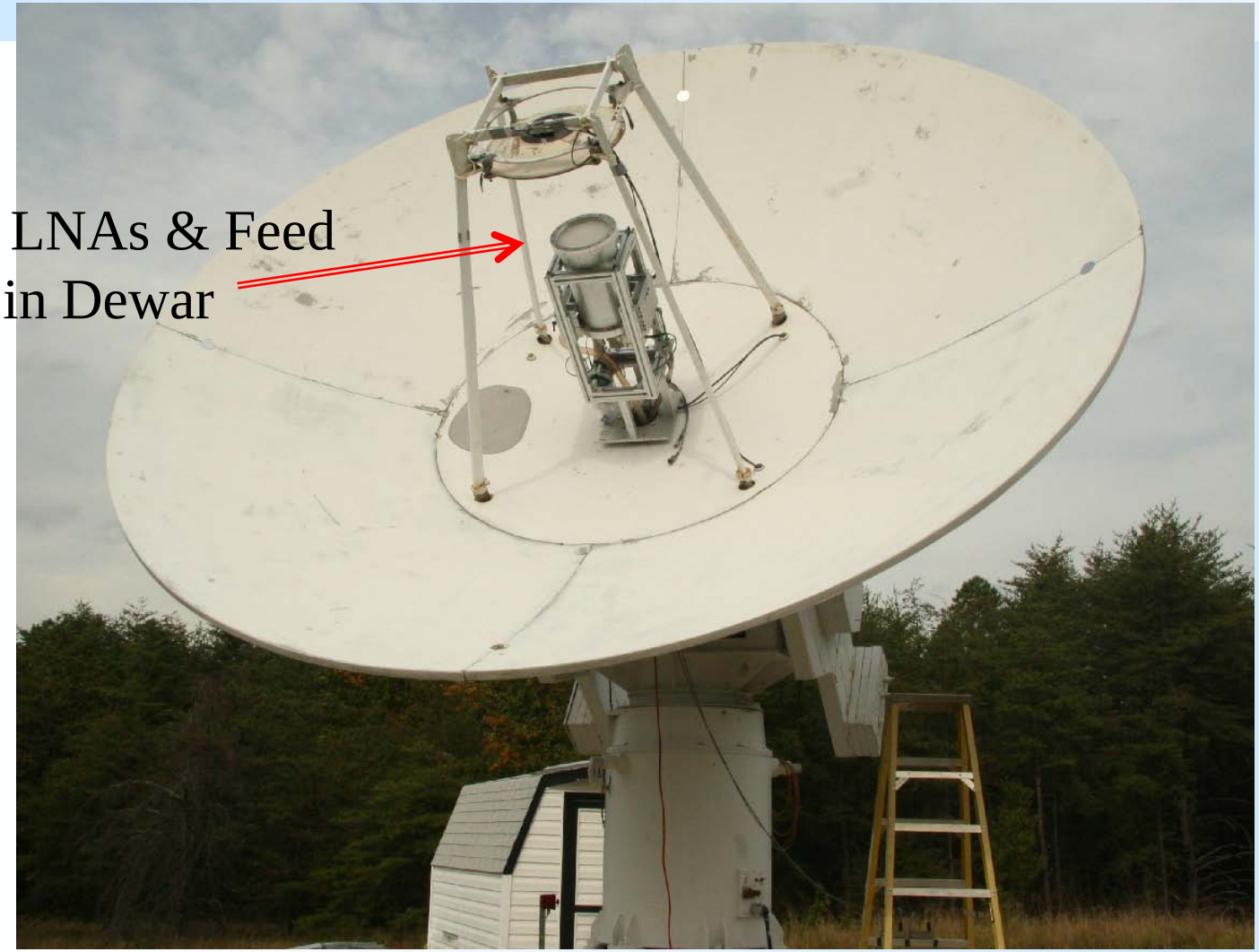
< 0.1 mm/y in secular change

***Current performance: ~ 10 mm and ~ 1 mm/y**

Future SLR station (NGSLR)

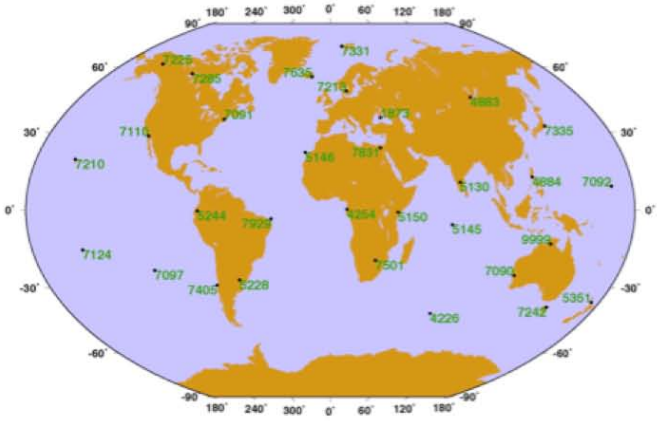


MV-3 5M Antenna @ GGAO

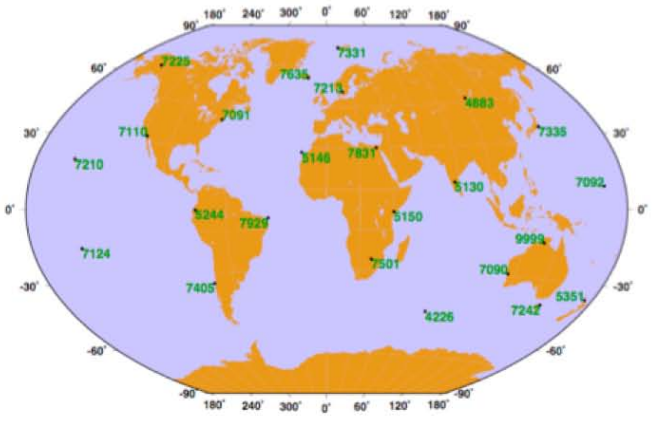


Network variants (32 ⇒ 8)

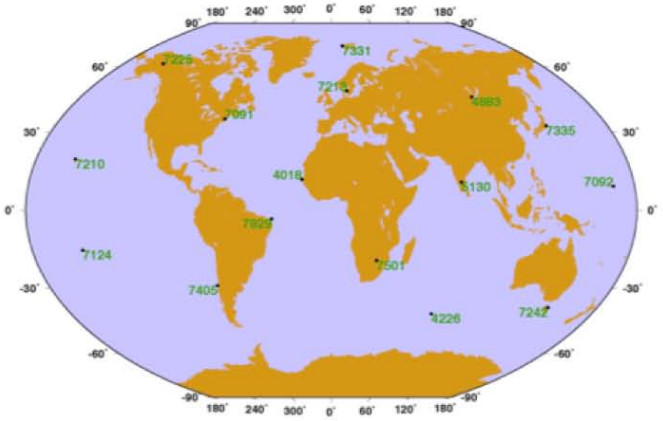
Next Generation NASA Networks 32 sites



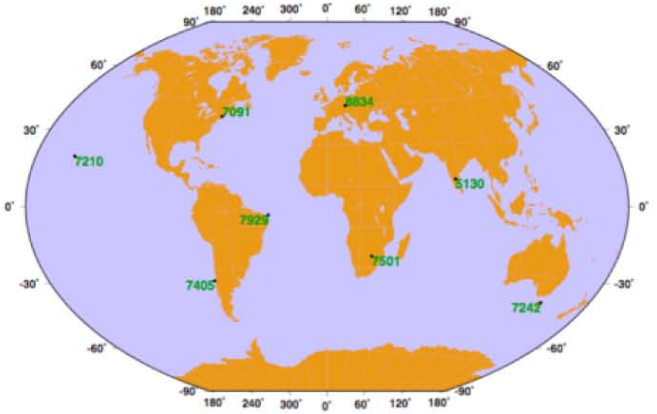
Next Generation NASA Networks 24 sites



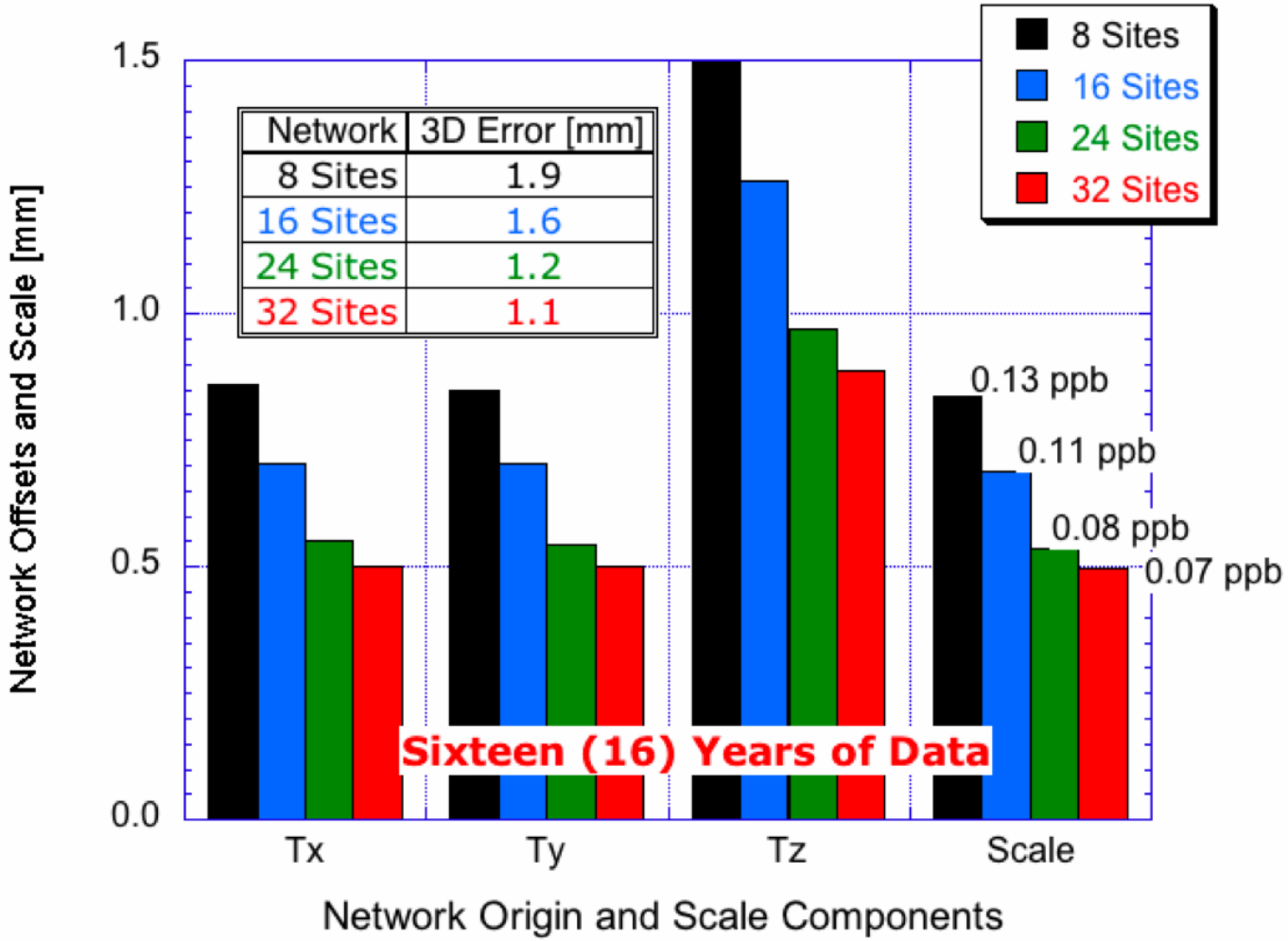
Next Generation NASA Networks 16 sites



Next Generation NASA Networks 08 sites

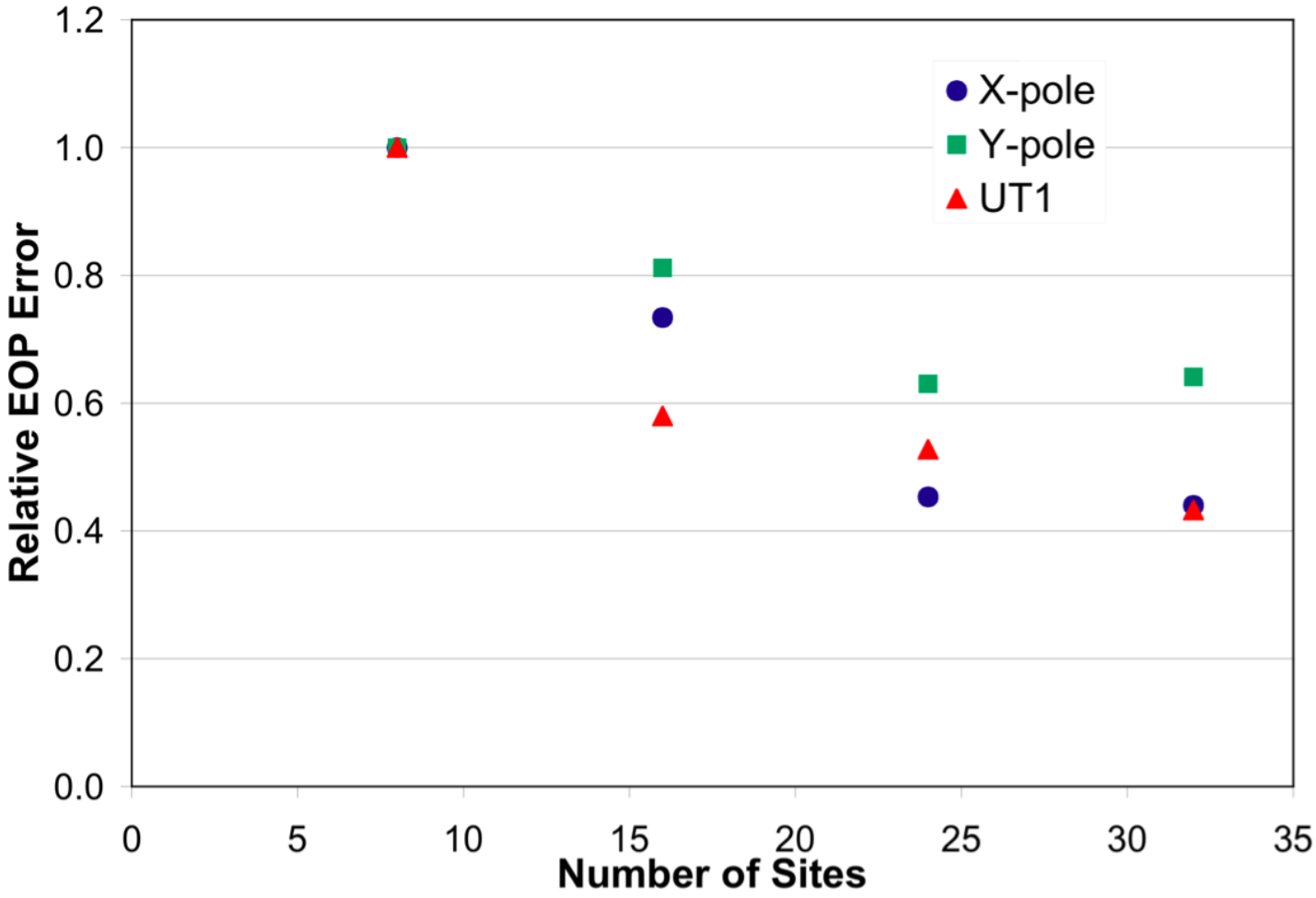


Simulation Results



SLR+VLBI_sim8_090222

One-year Simulation Results



Summary

- Origin and scale marginally controlled by a 24 site network; when extended to 32 sites, it approaches GGOS goals (1 mm)
- Orientation seems to be less dependent on the size of the network
- 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

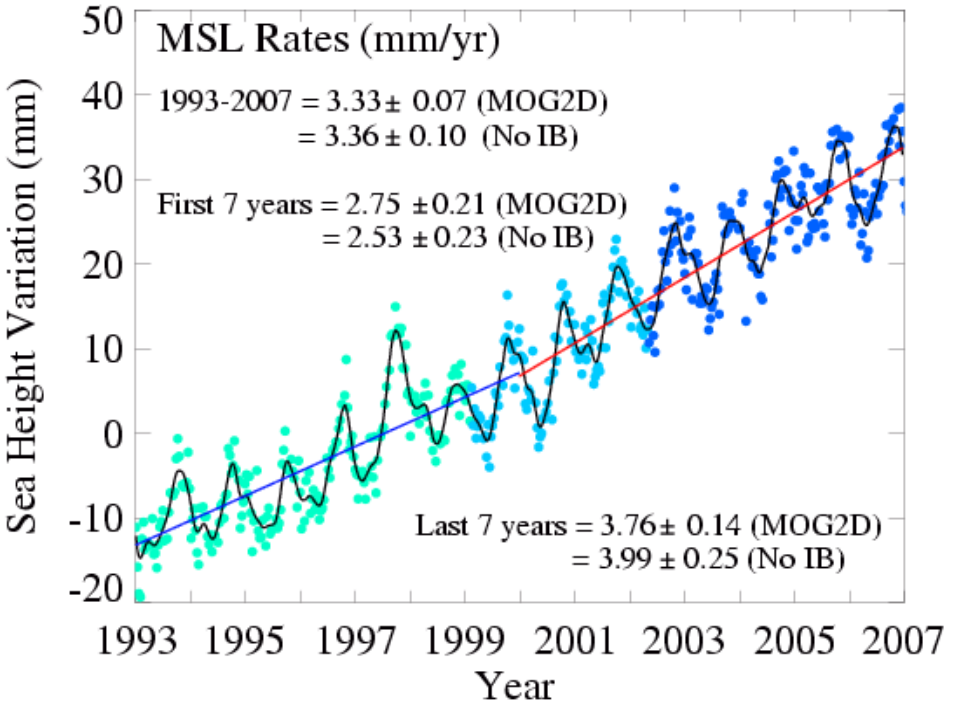
Future Work

- **Additional simulation studies will be carried out to:**
  - Determine the optimum and minimum size and geometry of the required global network, with associated tradeoff scenarios for incomplete deployments;
  - Provide input into the recommended selection of NASA and collaborative network stations, including tradeoffs of using existing versus new sites;
  - Understand the impact of likely phased deployment of new stations;
  - Understand the impact of vector tie errors between different observing systems at each station;
  - Study the possible benefit that could be provided by a space-based implementation
  - Determine the benefit resulting from adding corner cube reflector arrays on GNSS satellites for SLR tracking; and
  - Quantify the anticipated degradation in ability to determine the ITRF if the network is not modernized (i.e., if next generation systems are not used).

Additional Slides

Why 1 mm / 0.1 mm/yr ?

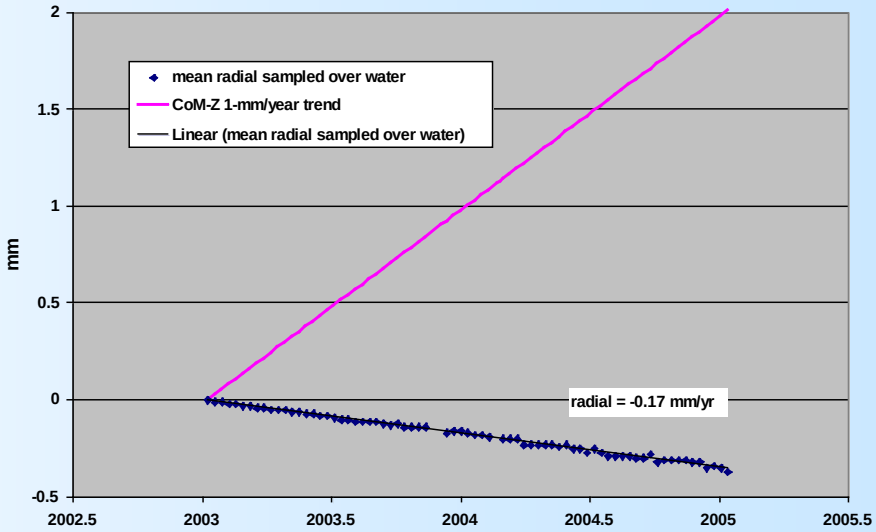
ITRF2005: 3.3 +/- 0.07 mm/yr



Beckley et al. (2007), *GRL, Fig 4*

For every 1 mm/yr Z-trend in the TRF origin, sea-level rates are affected by ~ 0.2 mm/yr

Lemoine et al. (2008), EGU2008-A-11368



Multiple techniques to solve the puzzle

- **High precision geodesy is very challenging**
  - **0.1 mm/yr stability required for sea level monitoring**
- **Fundamentally different observations with unique capabilities**
- **Together provide redundancy, cross validation and increased accuracy for TRF**
- **Strength from improvement of techniques and integration of techniques**

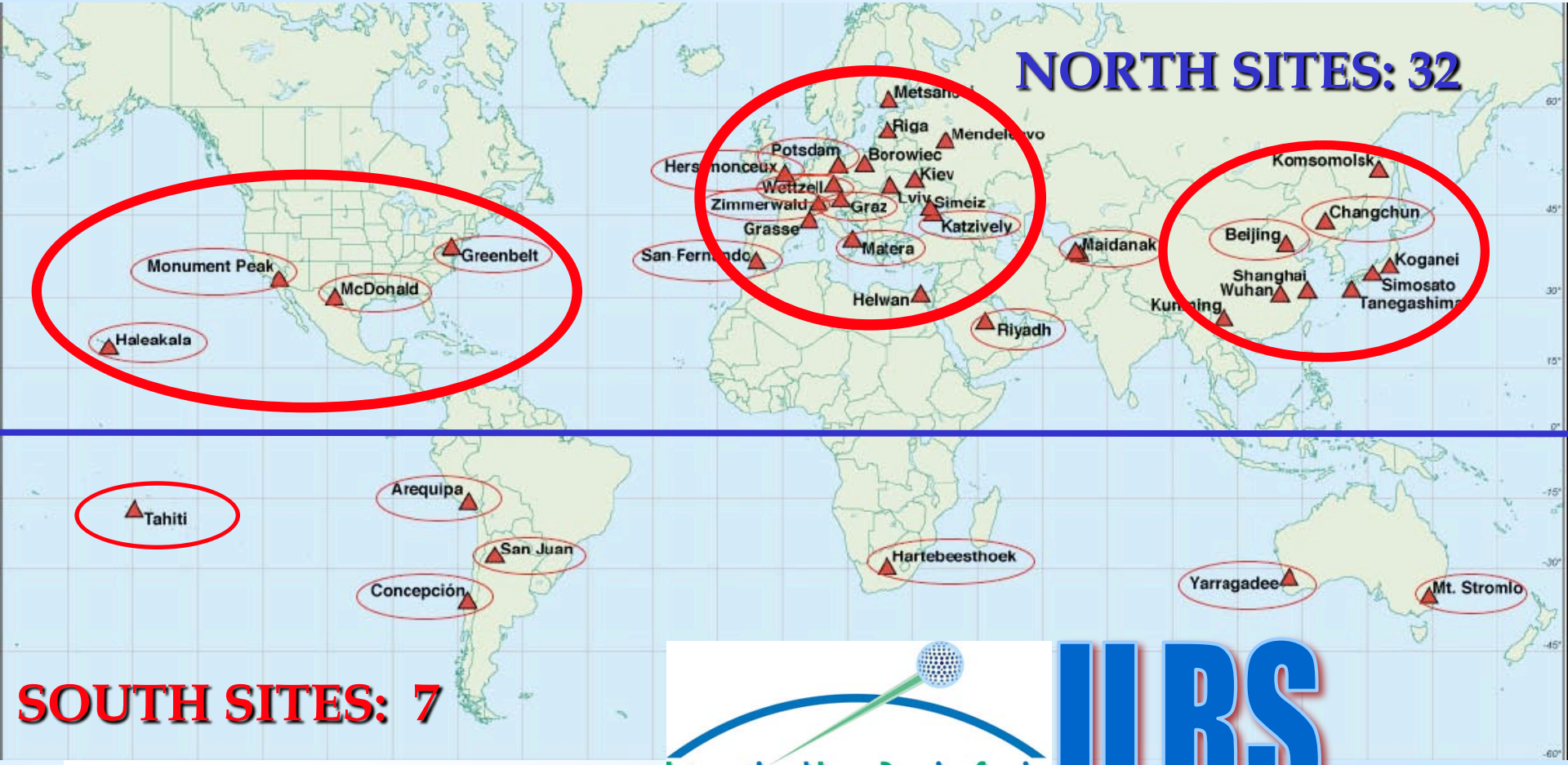
- Fundamental prerequisite:
  Well-distributed, co-located network with accurate ties

Technique Signal Source Obs. Type	**VLBI** Microwave Quasars Time difference	**SLR** Optical Satellite Two-way range	**GPS** Microwave Satellites Carrier phase
Celestial Frame UT1	**Yes**	No	No
Scale	**Yes**	**Yes**	Yes
Geocenter	No	**Yes**	Yes
Geographic Density	No	No	**Yes**
Real-time	No	No	**Yes**
Decadal Stability	**Yes**	**Yes**	Yes

Present Networks

- Space techniques are **indispensable** for the development of the terrestrial reference frame and for geodetic metrology
- The current state-of-the-art does not meet science requirements due to **poor area coverage** and **aging equipment**
- To meet the stringent future requirements (e.g. GGOS), we need to **design a new network** and deploy **modern hardware systems**

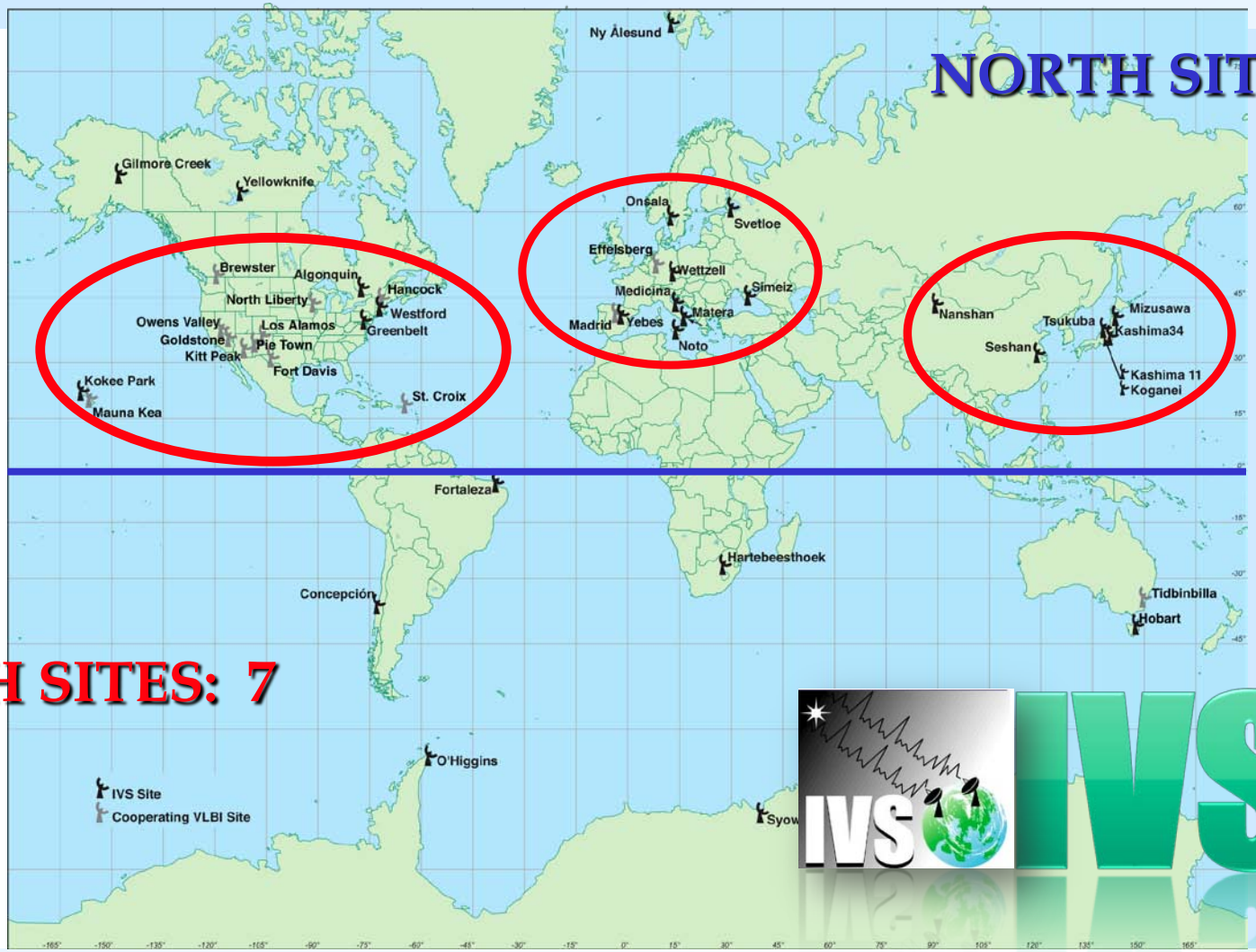
The ILRS Network



International Laser Ranging Service

ILRS

The IVS Network



Selected SLR Stations Around the World

Future Space Geodetic Network