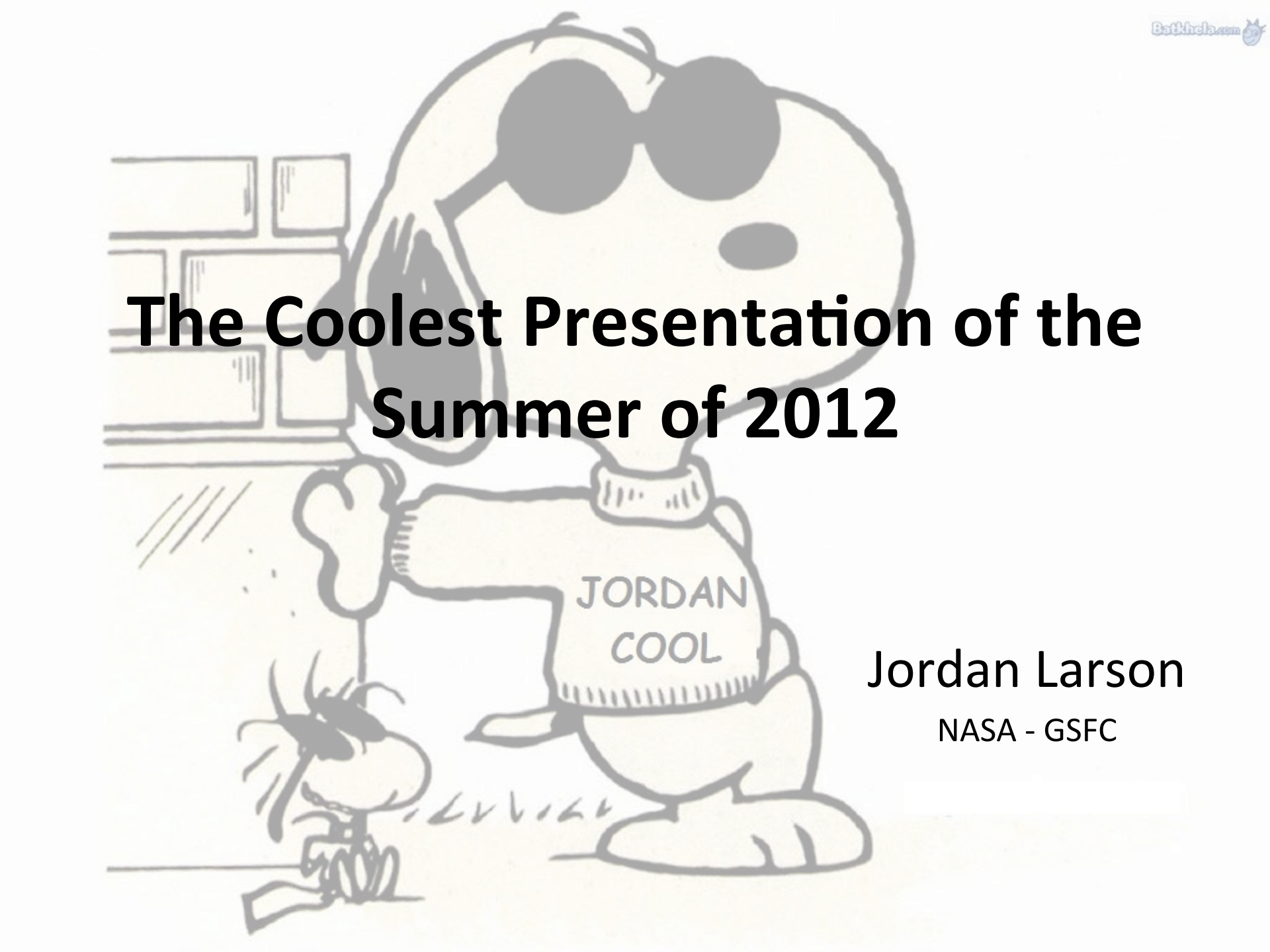
Jordan Larson Presents



The Coolest Presentation of the Summer of 2012

Jordan Larson

NASA - GSFC

Overview

- Time Series Analysis of SLR Station Coordinates
  - An investigation into the addition of STARLETTE and STELLA into the LAGEOS 1 & 2 standard solution
- Ground Tie Residuals
  - Find discrepancy between reference frame solutions for different techniques at a colocation site and the survey taken at the site.

Time Series Analysis of SLR Station Coordinates

- Historically, the SLR contribution to the ITRF has only been based on LAGEOS 1 & 2.
- With improvements in modeling especially gravity modeling, we were interested in the effects of adding STARLETTE and STELLA to the satellites used in the solution.

LAGEOS 1 & 2

- Aluminum-covered brass spheres
- Diameter of 60 cm
- Masses of 400 and 411 kg,
- Covered with 426 cube-corner retro-reflectors
- They have no on-board sensors or electronics
- Orbit - 5860 km and 5620 km
- Eccentricity – 0.0045 and 0.0135
- Well above Low Earth Orbit
- Well below Geostationary orbit
- Orbital inclinations of 109.8° and 52.6°

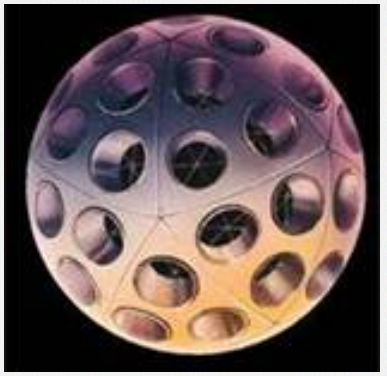
LAGEOS 1

LAGEOS 2

STARLETTE & STELLA

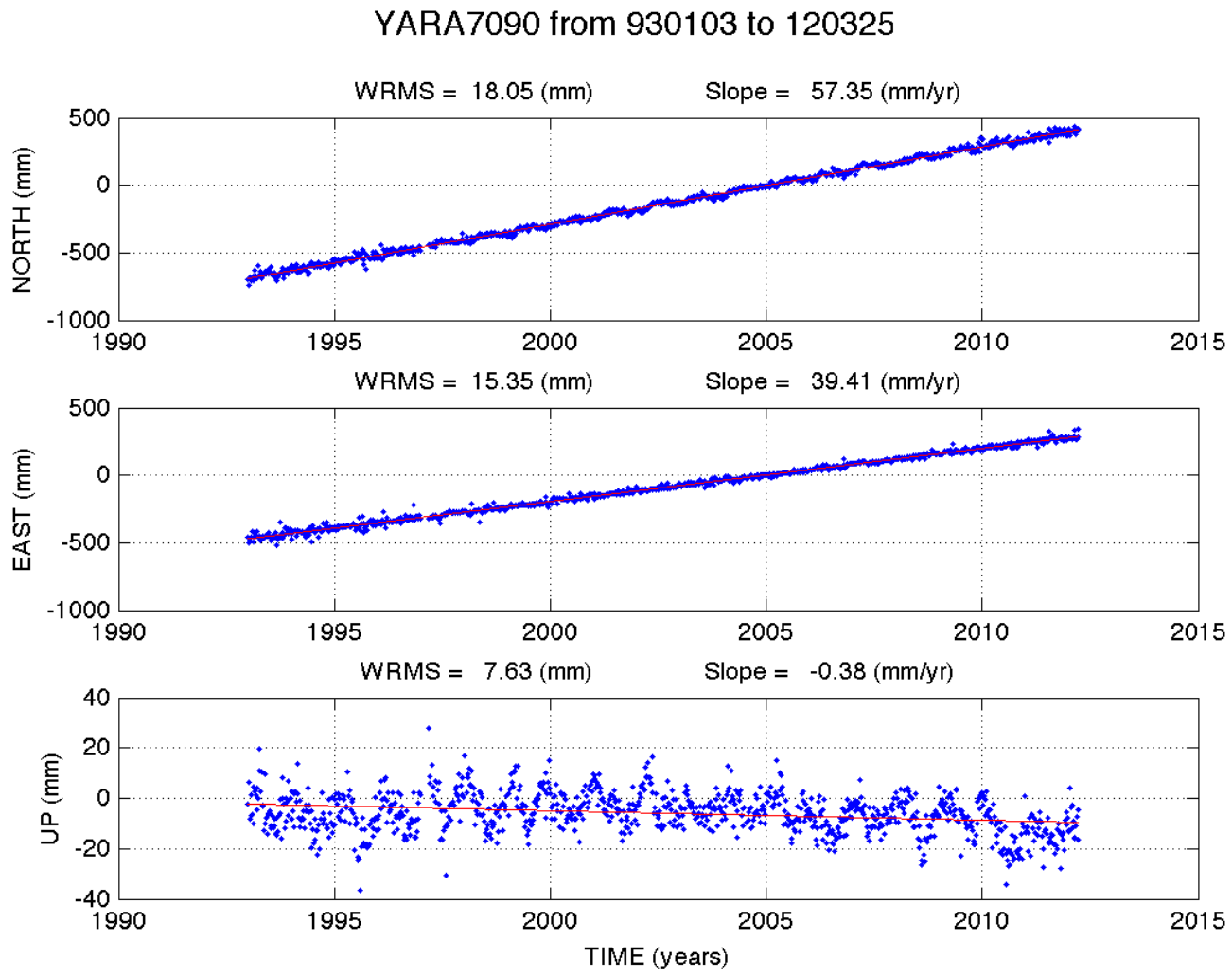
- Primarily used for gravity field determination
- Diameter of 24 cm
- Masses of 47 and 48 kg (10% of LAGEOS)
- Covered with 60 cube-corner retro-reflectors (14% of LAGEOS)
- Perigee - 800 km (14 % of LAGEOS)
- Eccentricity – 0.0206
- Low Earth Orbit
- Orbital inclinations of 49.83° and 98.6°

STARLETTE

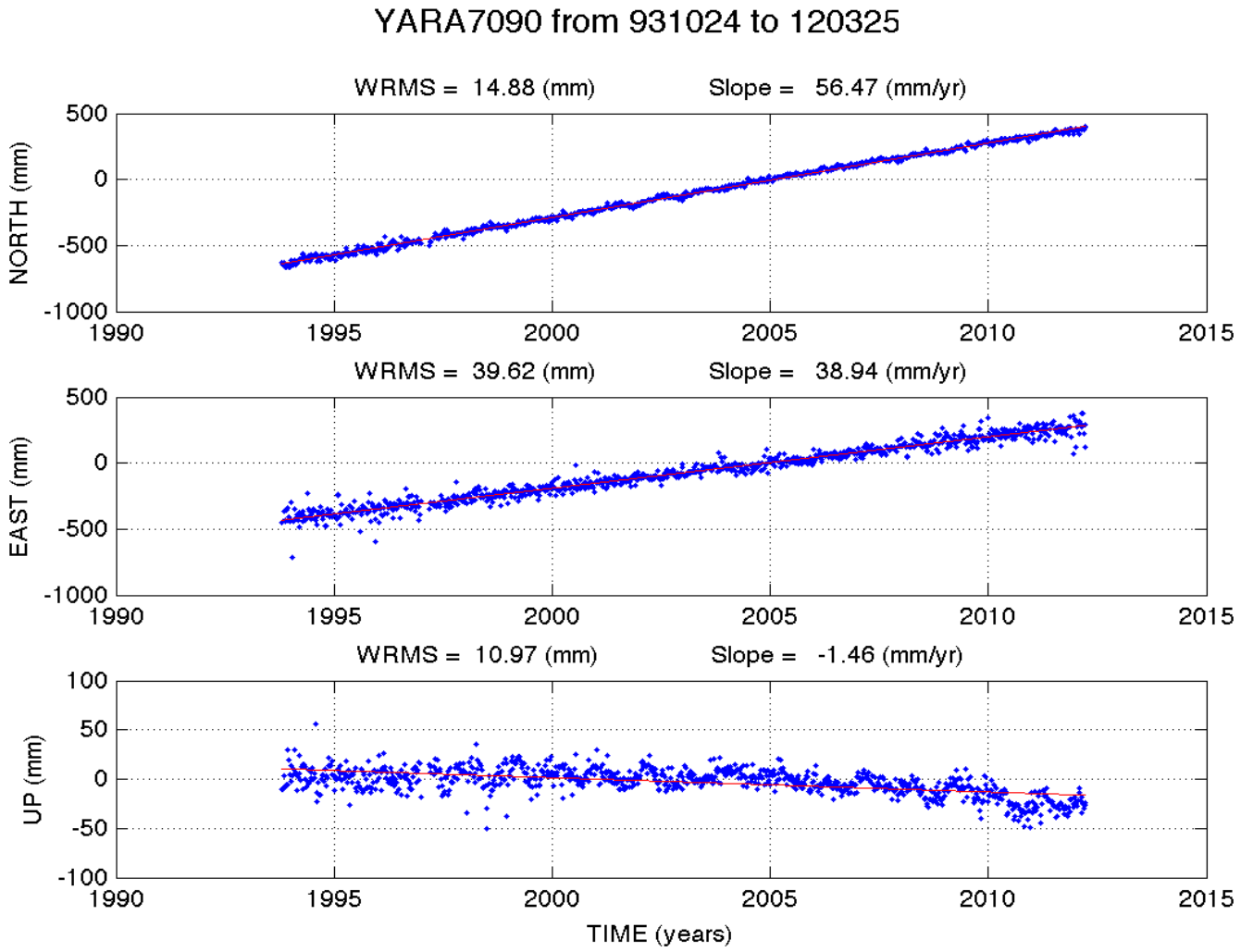


STELLA

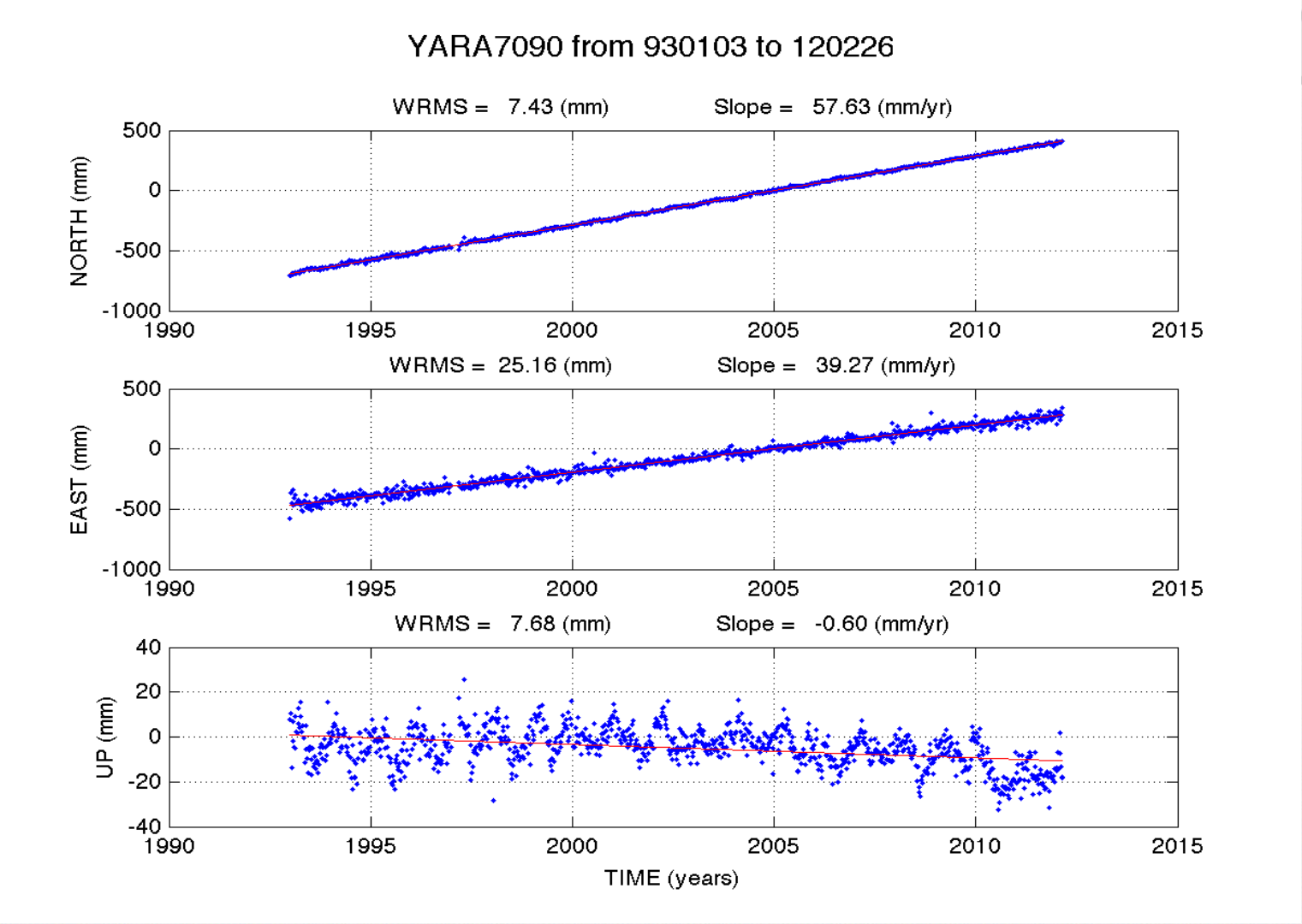
(LAGEOS 1 & 2)


YARA7090 from 930103 to 120325
WRMS = 18.05 (mm)
Slope = 57.35 (mm/yr)
NORTH (mm)
WRMS = 15.35 (mm)
Slope = 39.41 (mm/yr)
EAST (mm)
WRMS = 7.63 (mm)
Slope = -0.38 (mm/yr)
UP (mm)
TIME (years)

(STARLETTE & STELLA)



(LAGEOS 1&2, STARLETTE, and STELLA)



General Statistics

Satellites	Type	#of Stations	Ave East-WRMS	Ave North-WRMS	Ave Up-WRMS
LAGEOS 1 & 2	1	22	16.97	10.87	12.13
	2	16	17.45	13.83	14.26
	3	8	9.68	7.58	8.11
STARLETTE, STELLA	1	21	36.78	19.04	14.97
	2	16	32.41	20.11	16.45
	3	8	19.6	13.12	10.91
LAGEOS 1 & 2 STARLETTE, and STELLA	1	23	17.75	11.24	11.69
	2	16	18.44	14.17	14.53
	3	11	10.53	8.16	7.16

Time Series Conclusions

- Since the WRMS of fit does not significantly improve with the addition of STARLETTE and STELLA we cannot definitively say that 4 satellites are better than 2.
- We also can see that the weighting schemes for a station's type in the GEODYNE program may need to be reexamined since type 3 stations that had >2 years of observations had the lowest WRMS overall.

Ground Tie Residuals

- Looked at ground tie vectors between SLR, GPS, and DORIS for ITRF2008, SLRF2008, DPOD2008, and IGS08.
- Compared with survey ground ties computed at a specific time during the history of the station's occupation.
- Computed only those ground ties for which the stations' coordinates were valid at the time of the survey.

Table of SLR-GPS (ITRF2008)

Code	Code	East	North	Up	Vector
GRAS	7835	1.3	-3.6	-5.6	1.3
GRAS	7845	-1.1	-1.0	-0.6	-0.9
METZ	7806	-2.4	-2.3	-7.7	5.7
METS	7806	-2.3	-3.2	-10.8	7.3
GRAZ	7839	1.4	-0.6	-5.9	-2.2
BOR1	7811	-1.5	3.4	-16.6	-1.0
MATE	7941	-3.7	-4.7	-1.6	3.6
KOSG	8833	1.6	-1.9	-0.7	2.5
POTS	7836	2.7	-0.2	6.8	-2.7
WTZZ	8834	-1.3	-4.2	7.6	-0.2
BJFS	7249	0.6	2.2	5.9	-2.5
WUHN	7231	-8.5	-31.4	-3.7	-4.0
SHAO	7837	4.5	-5.0	-20.3	-3.1
KSMV	7335	4.6	8.6	70.3	14.1
KGNI	7308	-1.9	-6.0	34.8	-0.4
KGNI	7328	-5.5	-8.2	67.4	-16.0
HRAO	7501	-2.2	2.6	3.5	2.9
HARB	7501	-8.4	-0.8	6.3	7.9
MDO1	7080	5.4	-7.5	25.4	2.7
MDO1	7850	2.1	0.8	21.5	-2.8
GODE	7105	-3.2	1.2	-6.1	0.4
CONZ	7405	1.4	-4.6	6.9	-5.2
AREQ	7403	3.9	-6.9	9.8	3.0
STR2	7849	1.2	-2.4	-7.6	-1.8
STR1	7849	4.1	0.1	3.9	-0.8
THTI	7124	-2.4	-6.9	17.9	-8.4

- The ENU discrepancies are in the ties' coordinate discrepancies.
- The Vector discrepancy is in the length of the two ties.
- All measurements are in mm.

Table of SLR-GPS (SLRF2008-IGS08)

Code	Code	East	North	Up	Vector
GRAS	7835	1.3	-3.6	-5.6	1.3
GRAS	7845	-1.1	-1.2	-0.6	-0.9
METZ	7806	-2.4	-2.3	-7.7	5.7
METS	7806	-2.3	-3.2	-10.8	7.3
MATE	7941	0.2	-3.9	-4.1	3.7
HERS	7840	0.1	-4.4	-8.2	-1.9
HERT	7840	-1.6	-1.3	-1.0	-1.4
BJFS	7249	0.6	2.2	5.9	-2.5
WUHN	7231	-7.4	-32.6	-8.7	-2.8
SHAO	7837	4.5	-5.0	-20.3	-3.1
HARB	7501	-4.6	-0.1	4.9	4.2
GODE	7105	-3.2	1.2	-6.1	0.4
MONP	7110	3.2	-2.5	5.7	-1.6
CONZ	7405	1.4	-4.6	6.9	-5.2
YAR1	7090	3.3	-1.9	14.4	-3.7
YARR	7090	3.7	-2.2	21.2	-4.3
THTI	7124	-2.4	-6.9	17.9	-8.4

Discrepancy (mm)	Percentage
< 6	81
6 - 10	12
> 10	8

- All measurements are in mm.
- We see that the list is smaller, but that all vector lengths are under 10 mm and most are under

Comments on Z. Altamini's Results

- In a paper on the ITRF2008, Z. Altamini presents results on the ties between SLR, DORIS, and VLBI with the GPS stations at colocation sites.
- He presents 44 matches for SLR-GPS while we only obtained 26 matches.
- For these matches our discrepancies are equal
- Upon further inspection we found that for many of the survey ties he interpolated or extrapolated to the survey epoch and computed a ground tie

Statistics Comparison

ITRF2008 statistics

Discrepancy (mm)	Percentage
< 6	81
6 - 10	12
> 10	8

Z. Altamini ITRF2008 statistics

Discrepancy (mm)	Percentage
< 6	43
6 - 10	29
> 10	28

SLRF-IGS08 statistics

Discrepancy (mm)	Percentage
< 6	88
6 - 10	12
> 10	0

Note: Similar statistics for DORIS – GPS ground ties as well

Ground Tie Conclusions

- It seems that in future solution sets the time intervals and the coordinates of stations gets better defined over tighter time spans
- When comparing the SLRF with the GPS-ITRF2008 we do get more matches (38), and these further agree with Z. Altamini.
- However, in order to tie these sites together there needs to be surveys done once the sites are operational.

Further Development

- Write a script that compares the ground ties computed by a time series solution and the survey ground tie
- Investigate if these solutions give better or worse residuals than the reference solutions

Questions?