16th International Workshop on Laser Ranging

Poznań, Poland, 13 - 17 October 2008

"SLR - the next generation"

Determination of the SLR station coordinates and velocities on the basis of laser observations of low satellites

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Astrogeodynamical Observatory Borowiec

Satellites Parameters

	AJISAI	STARLETTE	STELLA
Sponsor	JAXA (JAPAN)	CNES (FRANCE)	CNES (FRANCE)
Launch date	August 12 1986	February 6 1975	September 26 1993
ID number	8606101	7501001	9306102
TECHNICAL AND PHYSICAL PARAMETERS			
Number of retroreflectors	1436	60	60
Shape	sphere	sphere	sphere
Diameter [cm]	214	24	24
Centre of mass correction [mm]	1010	75	75
Mass [kg]	685	47.25	48
CSA [m^2]	3.5968	0.0452	0.0452
CSA/Mass [m^2/kg]	0.00525	0.00096	0.00094
ORBITAL PARAMETERS OF THE SATELLITES			
Inclination	50.0°	49.8°	98.6°
Eccentricity	0.001	0.02	0.002
Perigee [km]	1480	810	800
Period [min.]	116	104	101

AJISAI

STARLETTE
STELLA

Program GEODYN II

Main models and parameters:

- Earth gravity field: EIGEN-GRACE02S 45x45 (Ajisai) 65x65 (Starlette/Stella)
- Earth and ocean tide model: EGM96
- Polar motion: IERS C04
- Arc length: 14 days for Ajisai, 10 days for Starlette/Stella
- Stations coordinates and stations velocities: ITRF2005
- Tropospheric refraction: Marini/Murray model.

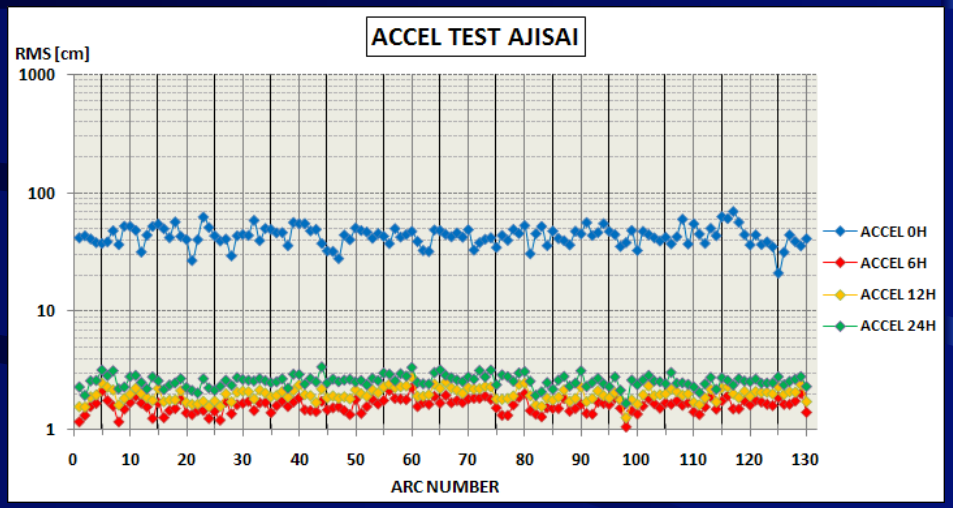
Main models and parameters:

- satellite state vector
- station geocentric coordinates transformated to station topocentric coordinates (Borkowski procedure)
- acceleration parameters along-track, cross-track and radial at 6 and 12 hours intervals

ACCEL Test

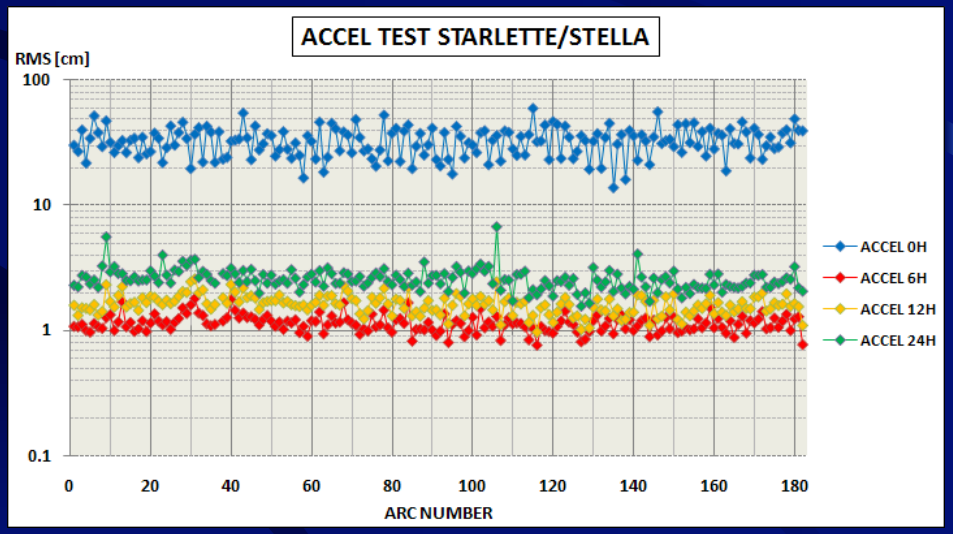
AJISAI

ACCEL	RMS
6H	1.61 cm
12H	1.98 cm
24H	2.56 cm
0H	44.05 cm



STARLETTE STELLA

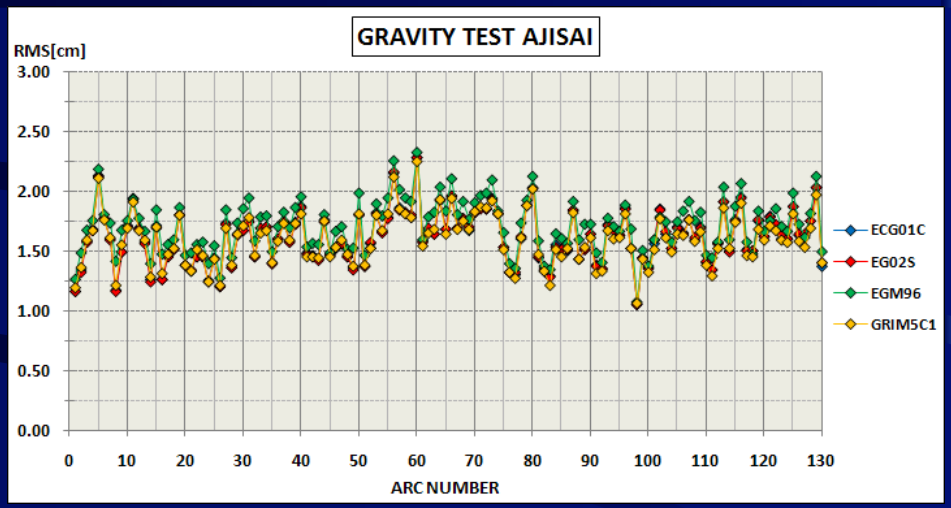
ACCEL	RMS
6H	1.15 cm
12H	1.63 cm
24H	2.62 cm
0H	32.84 cm



Gravity Test

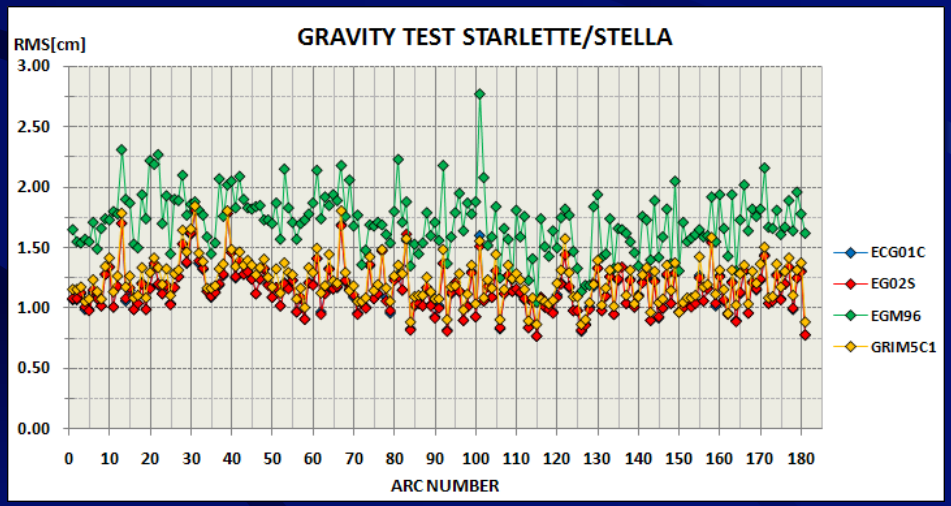
AJISAI

MODEL	RMS
ECG01C	1.61 cm
EG02S	1.61 cm
EGM96	1.72 cm
GRIM5C1	1.60 cm



STARLETTE STELLA

MODEL	RMS
ECG01C	1.15 cm
EG02S	1.15 cm
EGM96	1.71 cm
GRIM5C1	1.22 cm



Orbit Determination

- data from the 14 SLR stations collected in the period from January 1, 2001 to December 25, 2005

	Stacja	ID Number
1	McDonald	70802419
2	Yarragadee	70900513
3	Greenbelt	71050725
4	Monument Peak	71100411
5	Haleakala	72102313
6	Zimmerwald	78106801
7	Borowiec	78113802
8	Mount Stromlo	78259001
9	Grasse SLR	78353102
10	Potsdam	78365801
11	Graz	78393402
12	Herstmonceux	78403501
13	Mount Stromlo	78498001
14	Wettzell	88341001

	LAGEOS [Schillak, 2008]*	AJISAI	STARLETTE/ STELLA
Arc Length	1 month	14 days	10 days
Data	5 years 1999-2003	5 years 2001-2005	5 years 2001-2005
Reference Frame	ITRF2005	ITRF2005	ITRF2005
Mean Number of Normal Points	7847	3633	2201
RMS	1.47 cm	1.61 cm (A6H) 1.98 cm (A12H)	1.15 cm (A6H) 1.63 cm (A12H)
ACCEL Intervals	5 days	6 hours 12 hours	6 hours 12 hours
DRAG	NO	15 hours	12 hours

Schillak, S., *The comparison of the reference frames ITRF2000 and ITRF2005 in the determination SLR station positions and velocities*, European Geosciences Union, General Assembly 2008, Vienna, Austria, April 13-18, 2008.

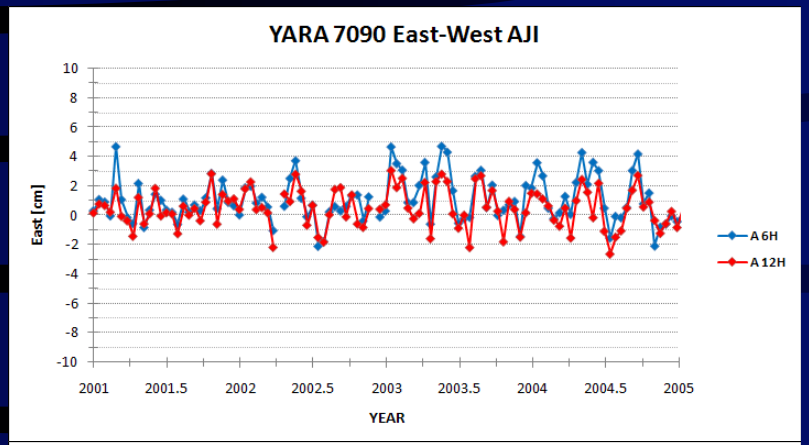
The positions and velocities of four SLR stations were determined:

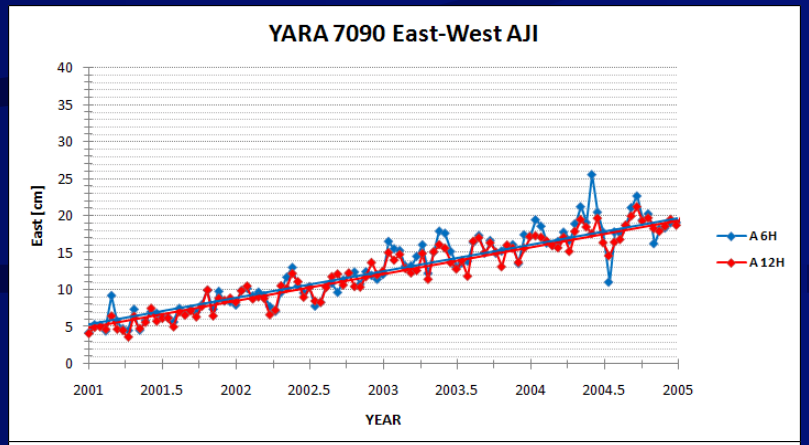
Graz (7839)

Greenbelt (7105)

Herstmonceux (7840)

Yarragadee (7090)


YARA 7090 East-West AJI
East [cm]
YEAR
A 6H
A 12H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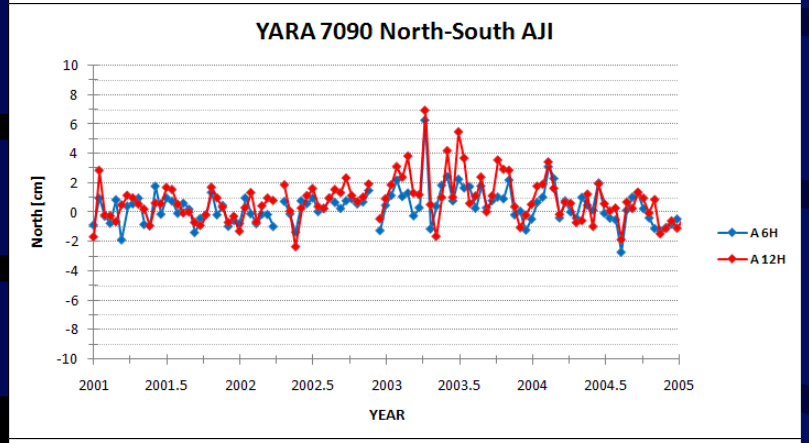
East [cm]
YEAR
A 6H
A 12H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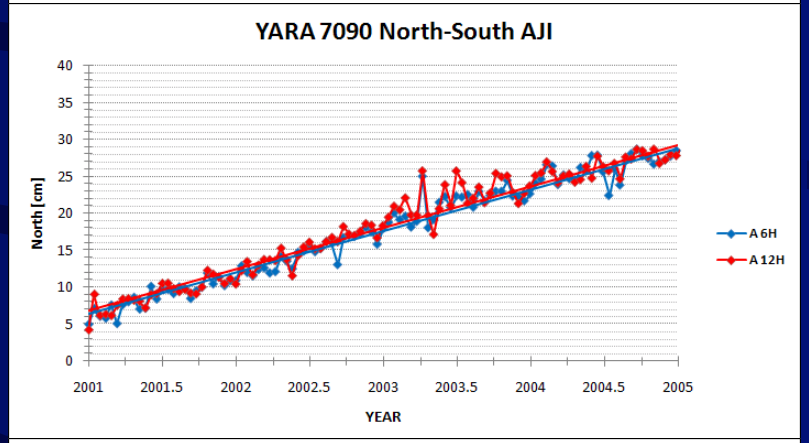
North [cm]
YEAR
A 6H
A 12H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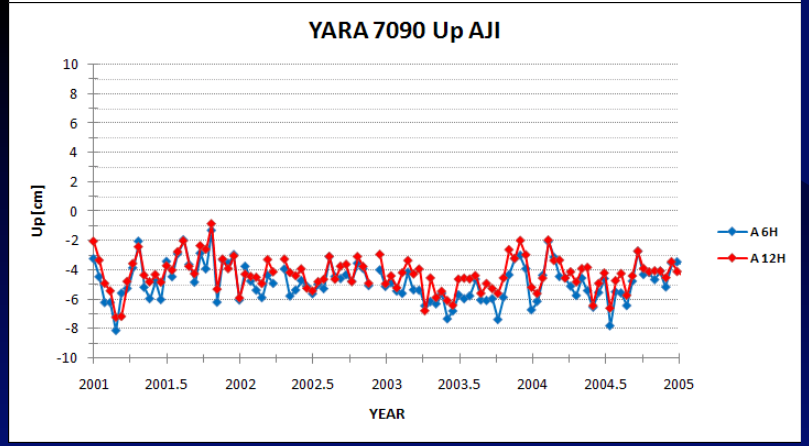
North [cm]
YEAR
A 6H
A 12H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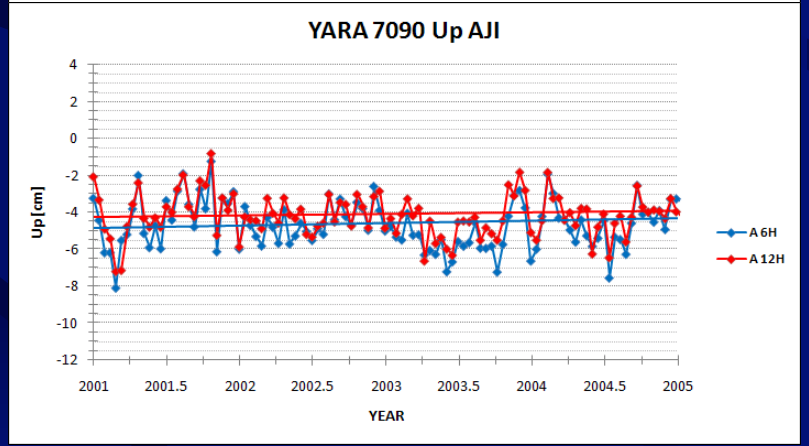
Up [cm]
YEAR
A 6H
A 12H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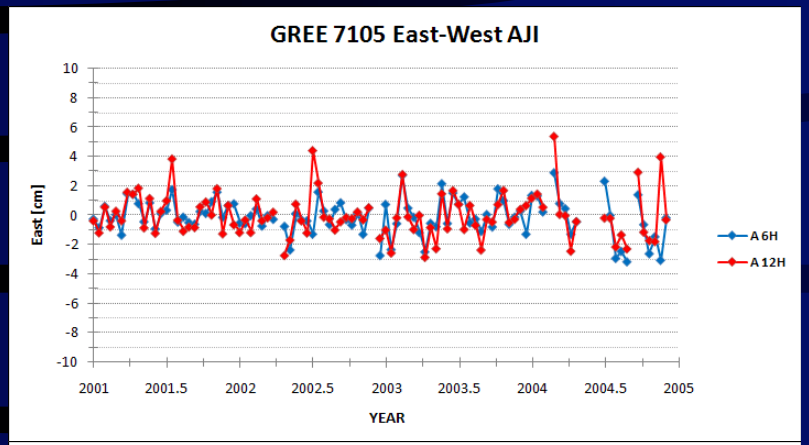
Up [cm]
YEAR
A 6H
A 12H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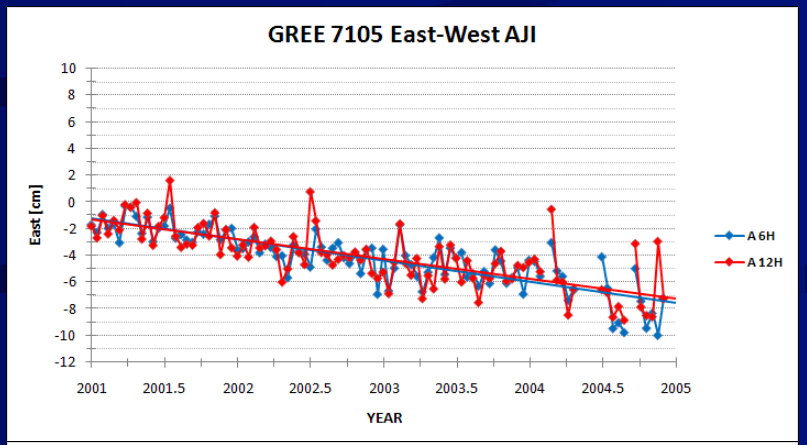
East [cm]
YEAR
A 6H
A 12H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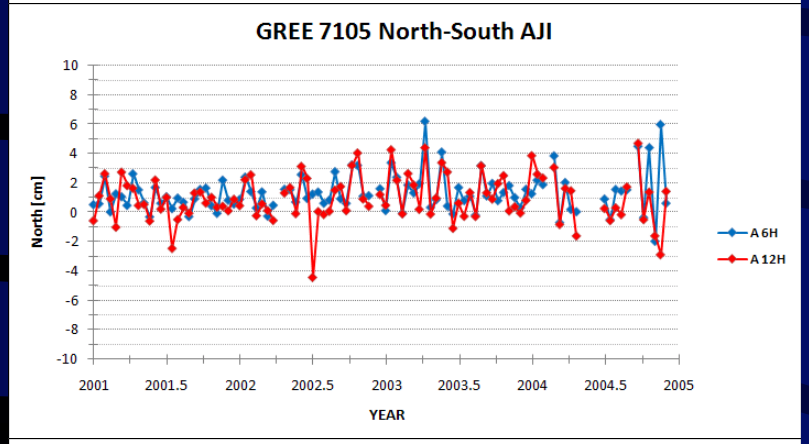
East [cm]
YEAR
A 6H
A 12H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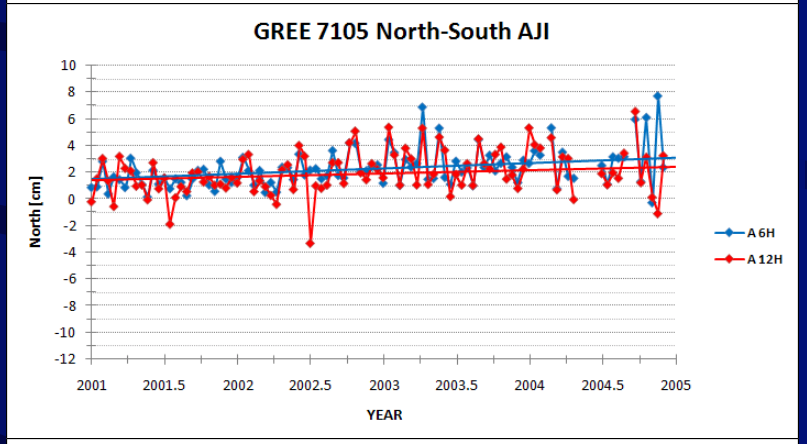
North [cm]
YEAR
A 6H
A 12H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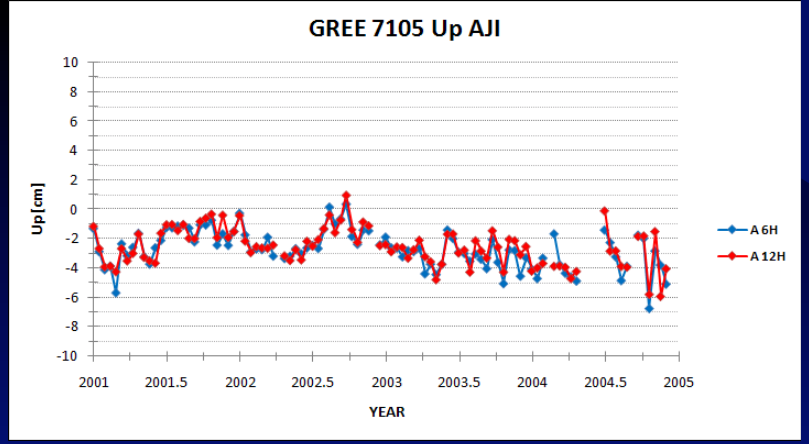
North [cm]
YEAR
A 6H
A 12H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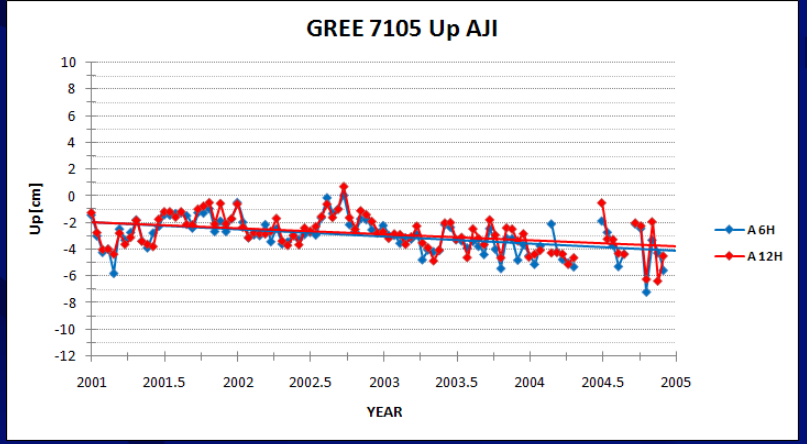
Up [cm]
YEAR
A 6H
A 12H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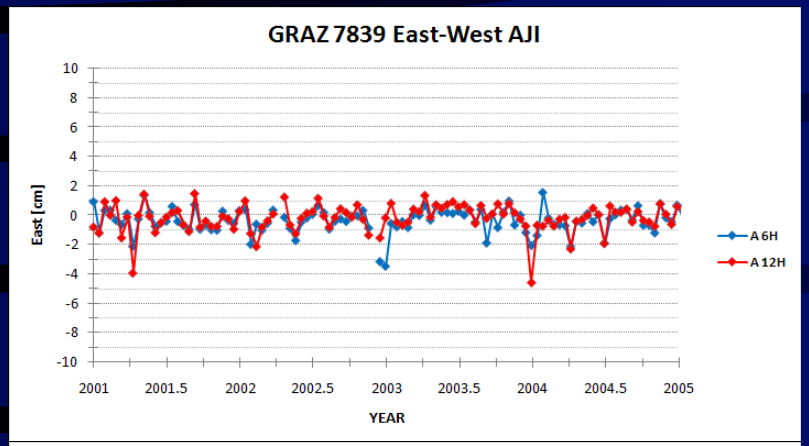
Up [cm]
YEAR
A 6H
A 12H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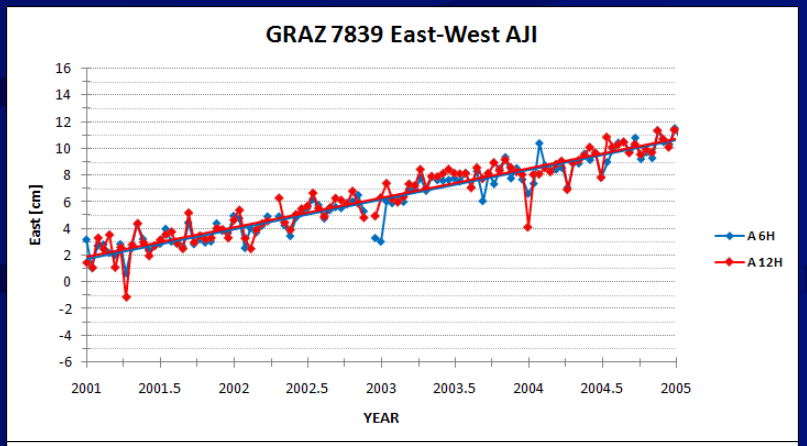
East [cm]
YEAR
A 6H
A 12H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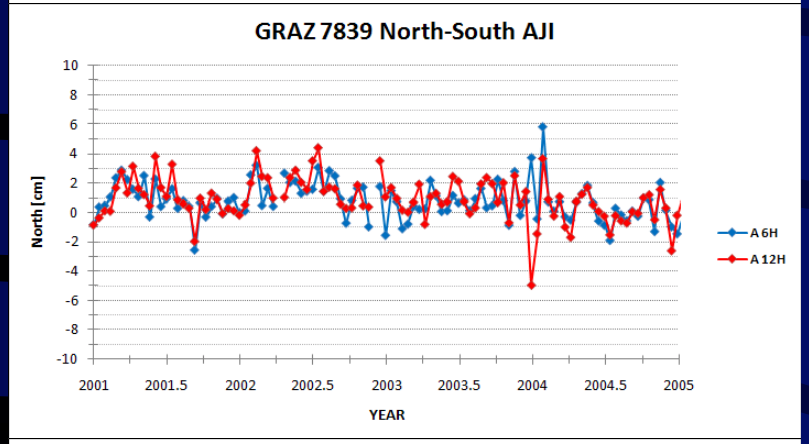
East [cm]
YEAR
A 6H
A 12H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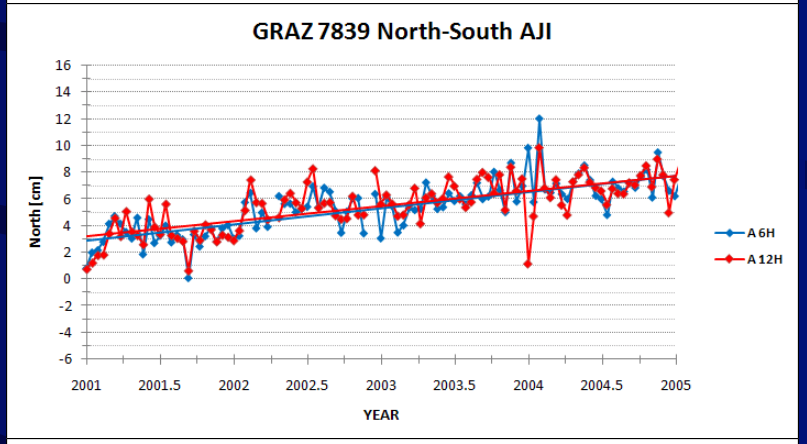
North [cm]
YEAR
A 6H
A 12H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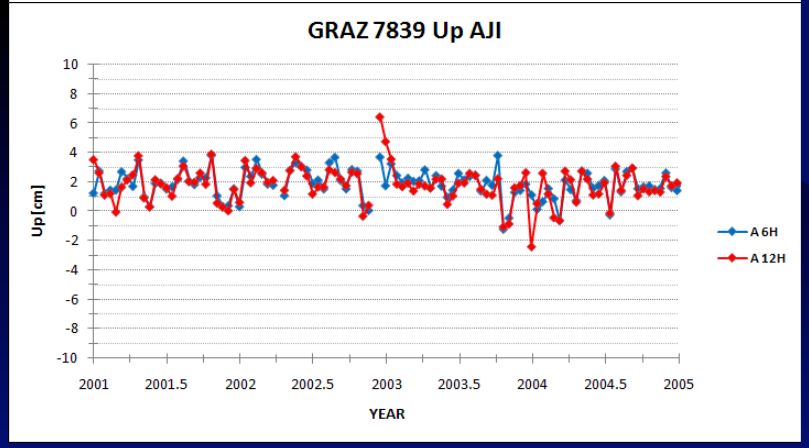
North [cm]
YEAR
A 6H
A 12H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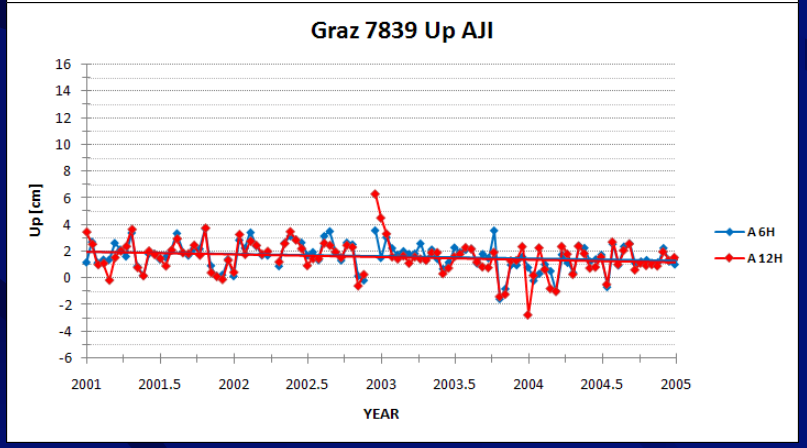
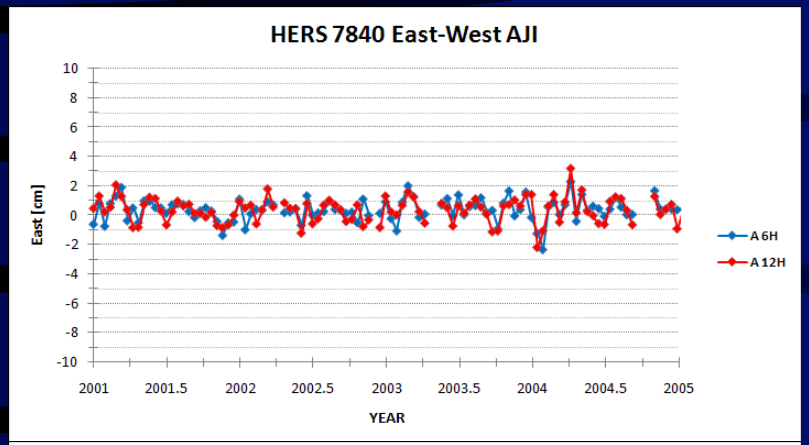
Up [cm]
YEAR
A 6H
A 12H


Graz 7839 Up AJI
Up [cm]
YEAR
A 6H
A 12H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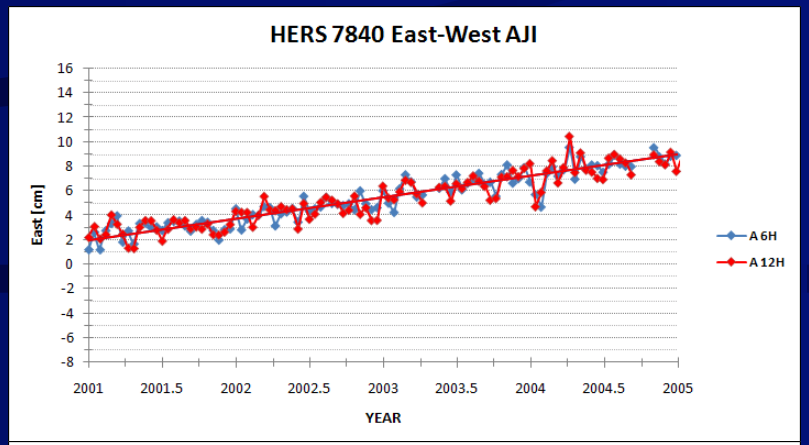
East [cm]
YEAR
A 6H
A 12H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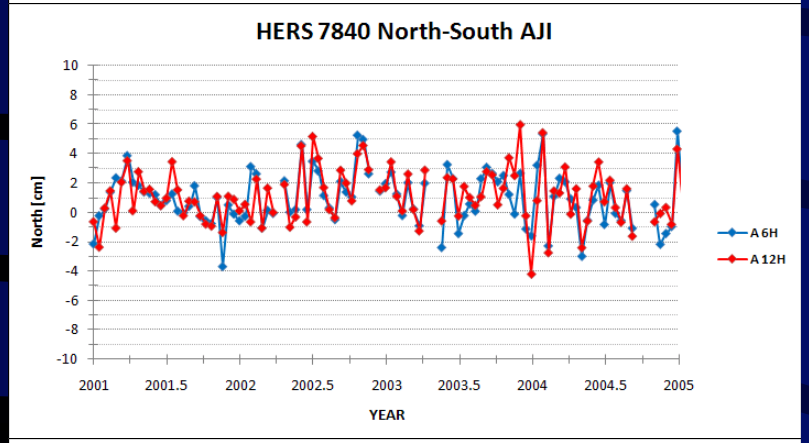
East [cm]
YEAR
A 6H
A 12H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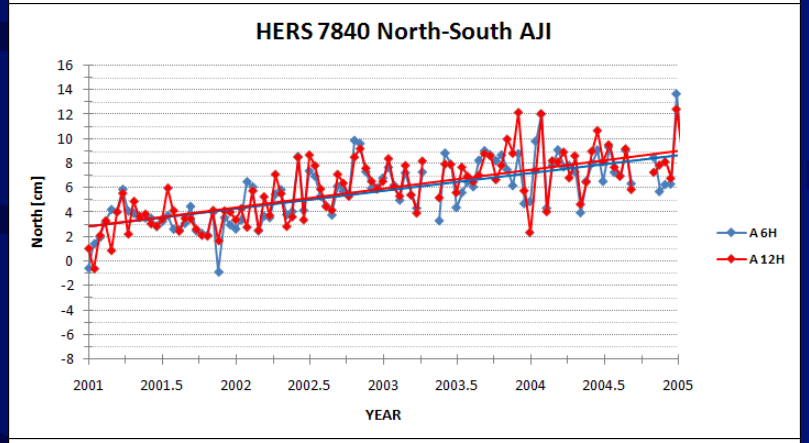
North [cm]
YEAR
A 6H
A 12H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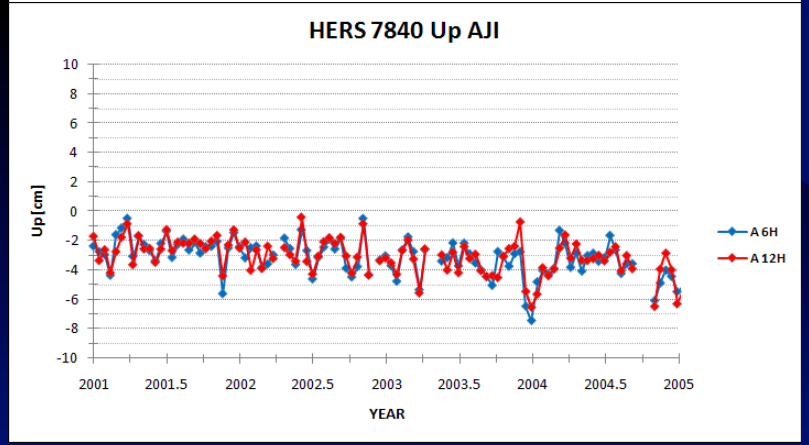
North [cm]
YEAR
A 6H
A 12H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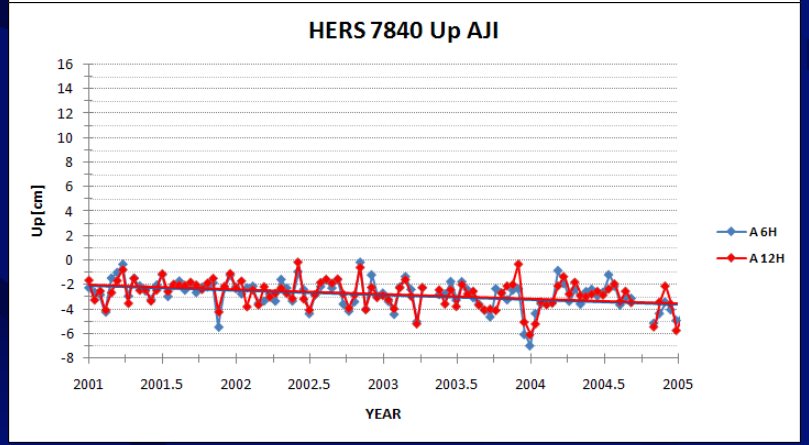
Up [cm]
YEAR
A 6H
A 12H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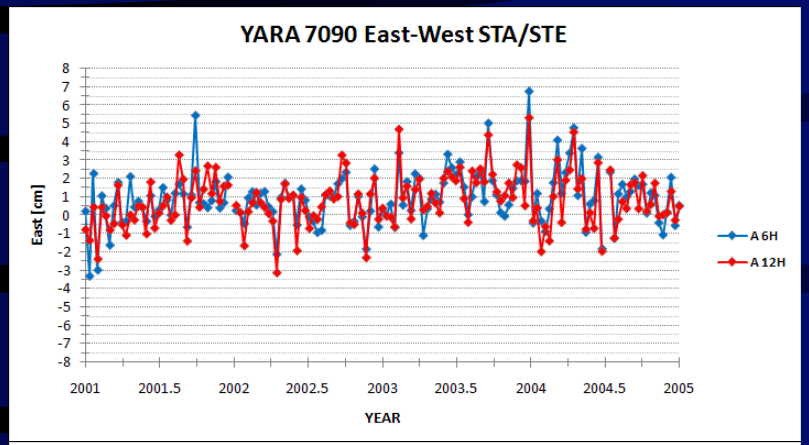
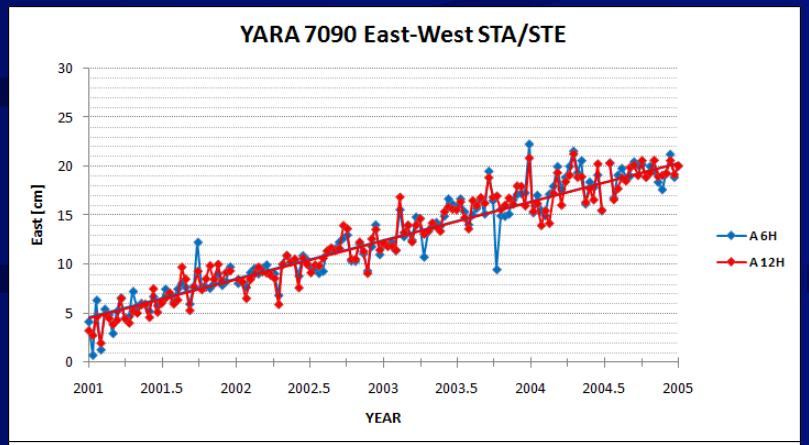
Up [cm]
YEAR
A 6H
A 12H


YARA 7090 East-West STA/STE
East [cm]
YEAR
A 6H
A 12H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East [cm]
YEAR
A 6H
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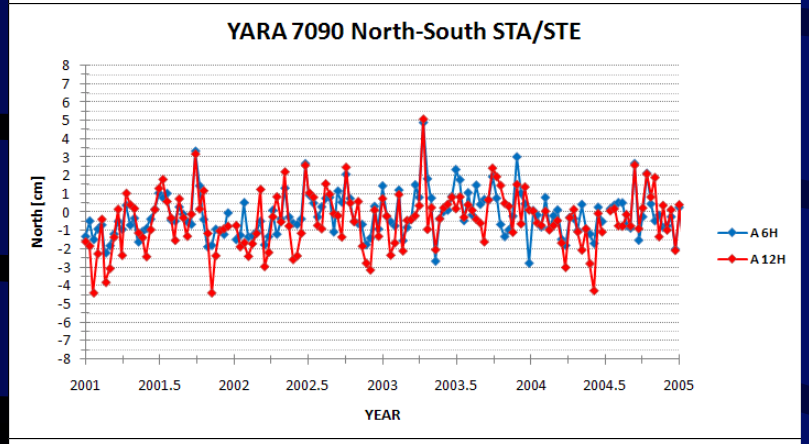
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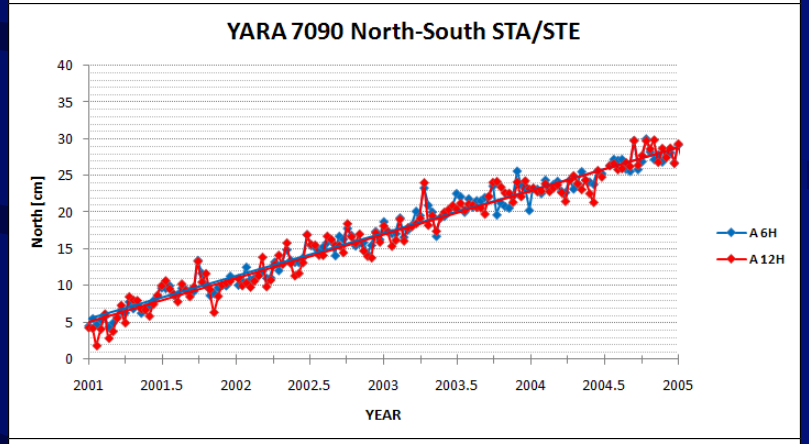
North [cm]
YEAR
A 6H
A 12H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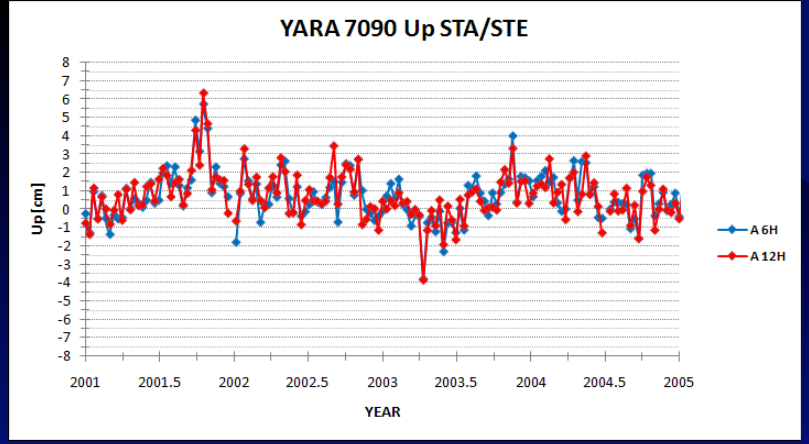
North [cm]
YEAR
A 6H
A 12H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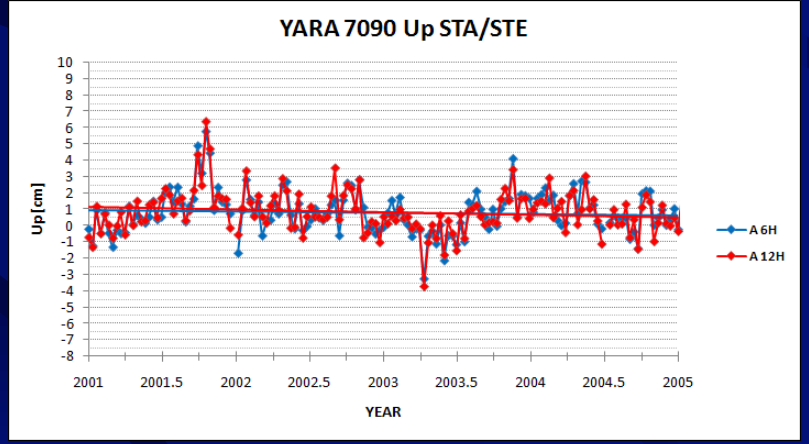
Up [cm]
YEAR
A 6H
A 12H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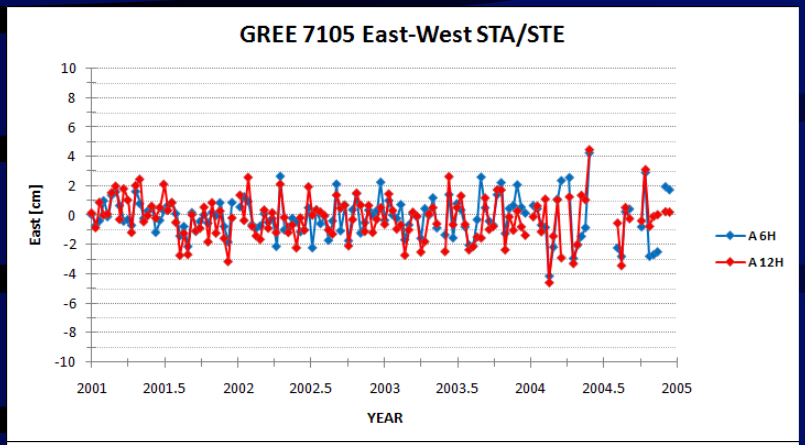
Up [cm]
YEAR
A 6H
A 12H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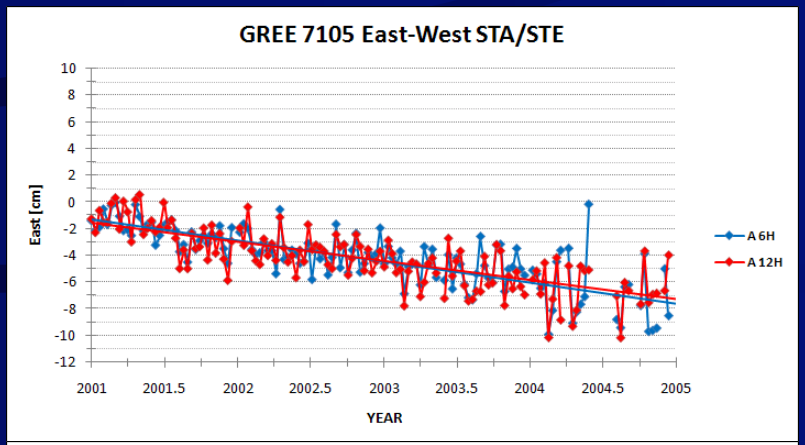
East [cm]
YEAR
A 6H
A 12H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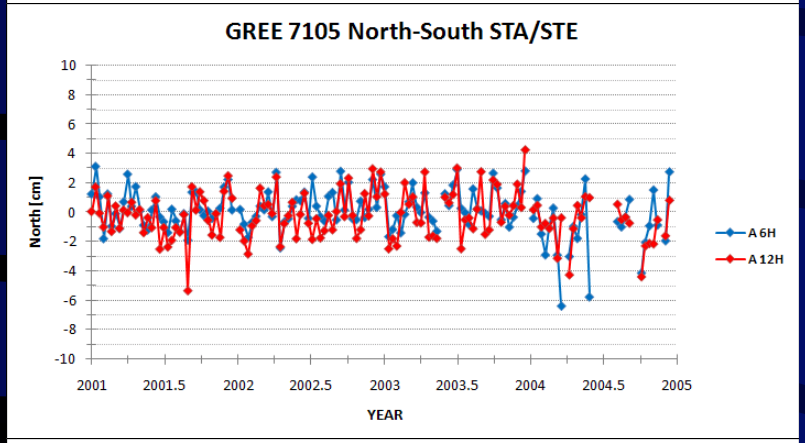
East [cm]
YEAR
A 6H
A 12H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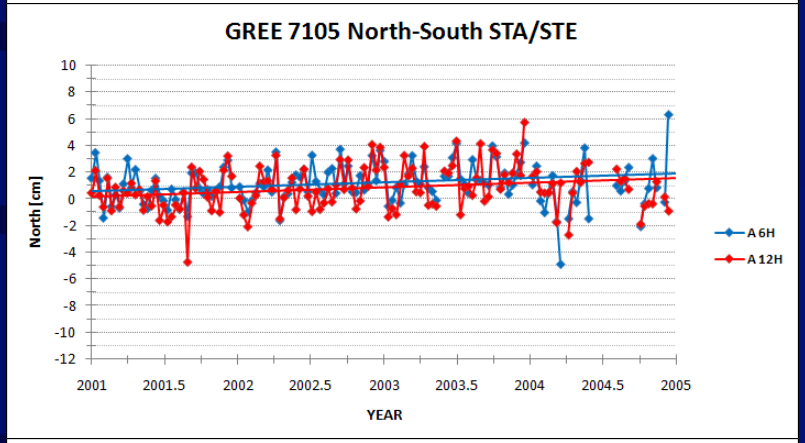
North [cm]
YEAR
A 6H
A 12H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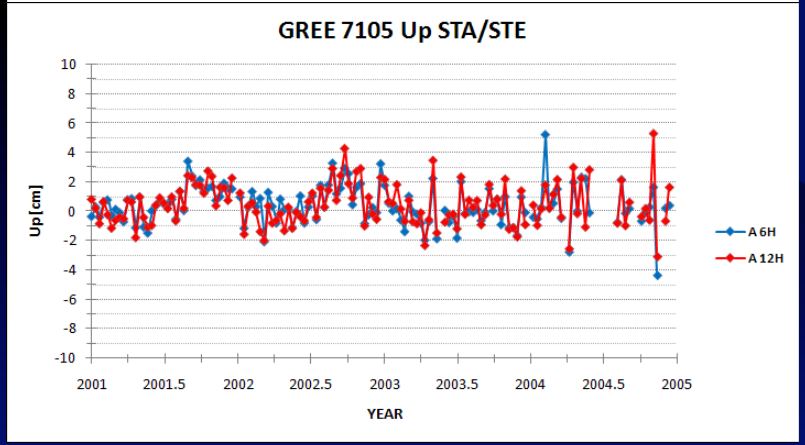
North [cm]
YEAR
A 6H
A 12H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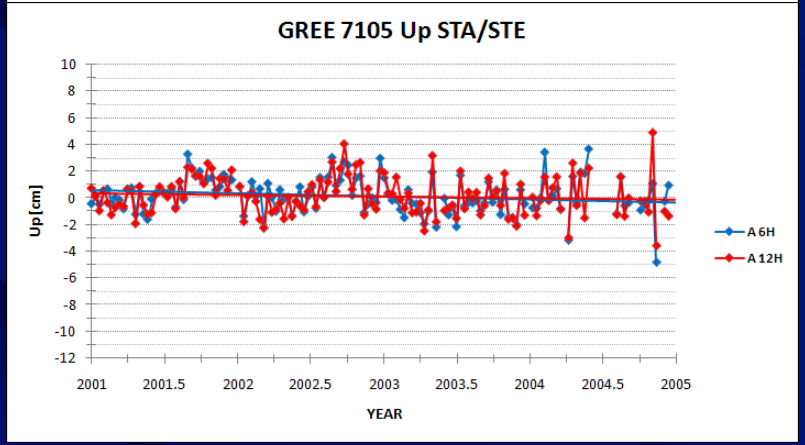
Up [cm]
YEAR
A 6H
A 12H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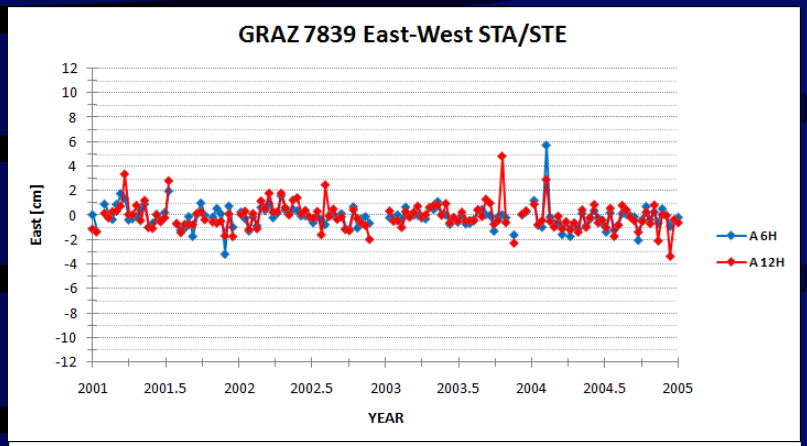
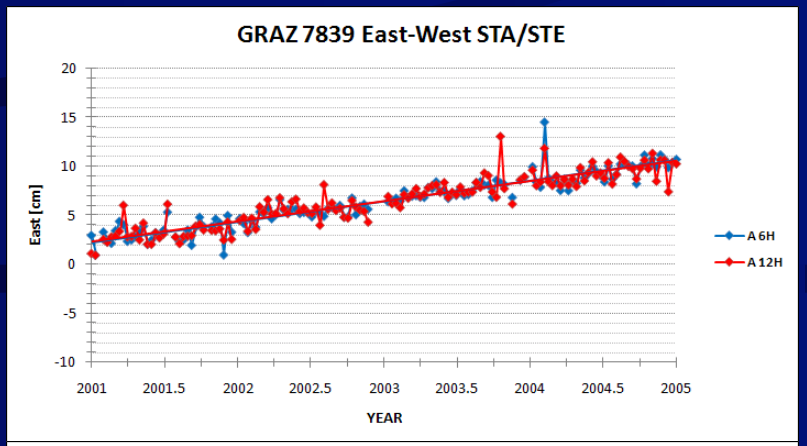
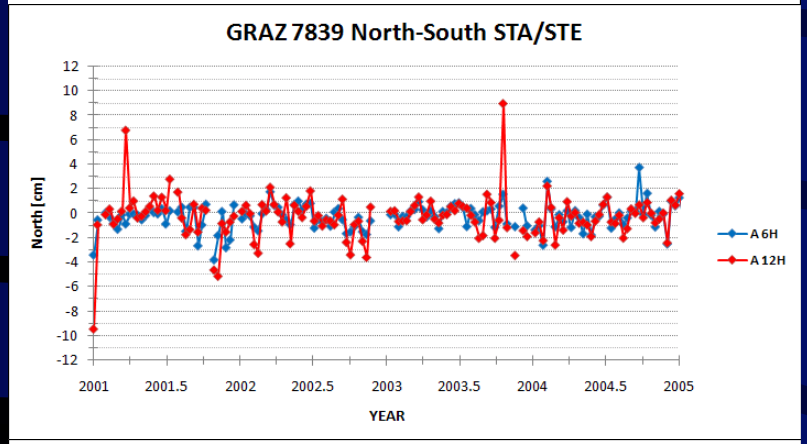
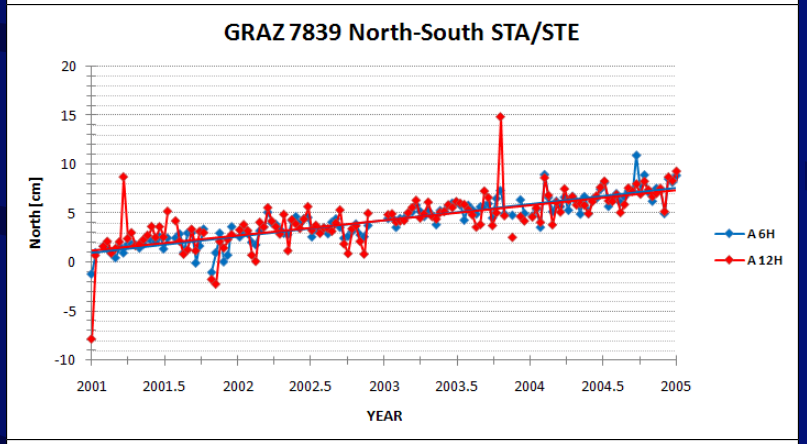
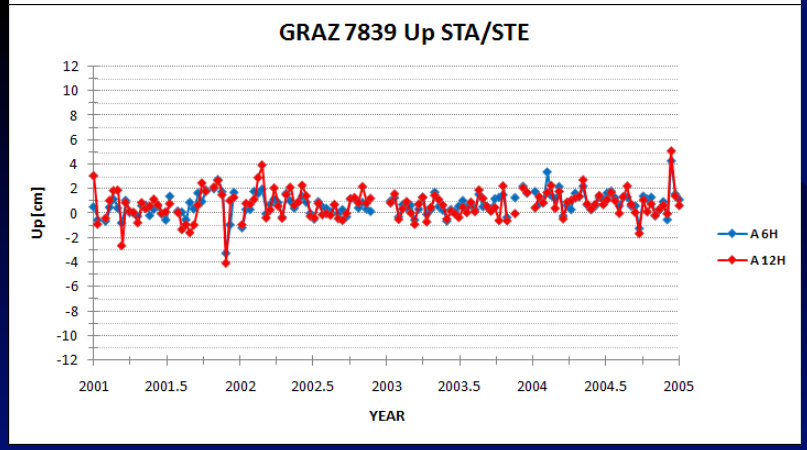
Up [cm]
YEAR
A 6H
A 12H

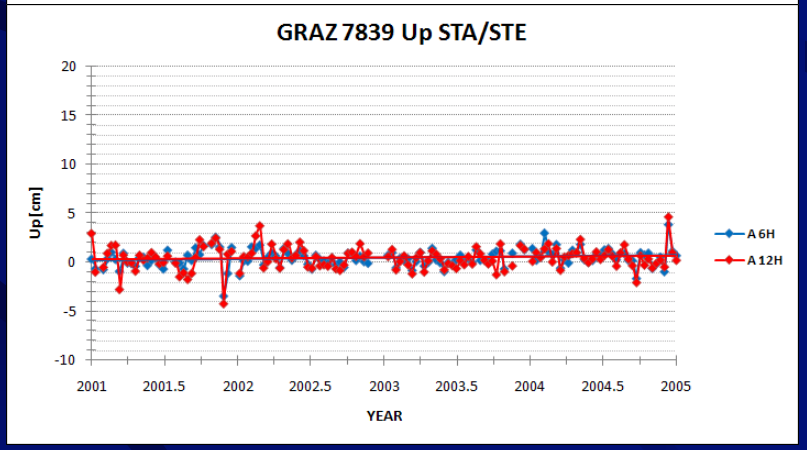

GRAZ 7839 East-West STA/STE
East [cm]
YEAR
A 6H
A 12H

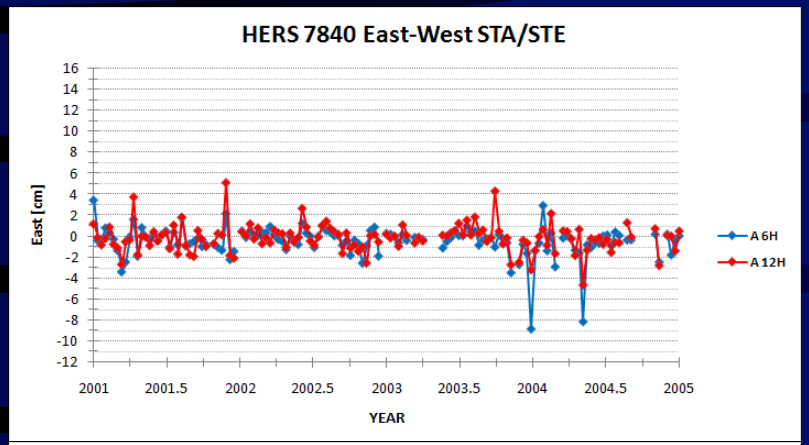

GRAZ 7839 East-West STA/STE
East [cm]
YEAR
A 6H
A 12H

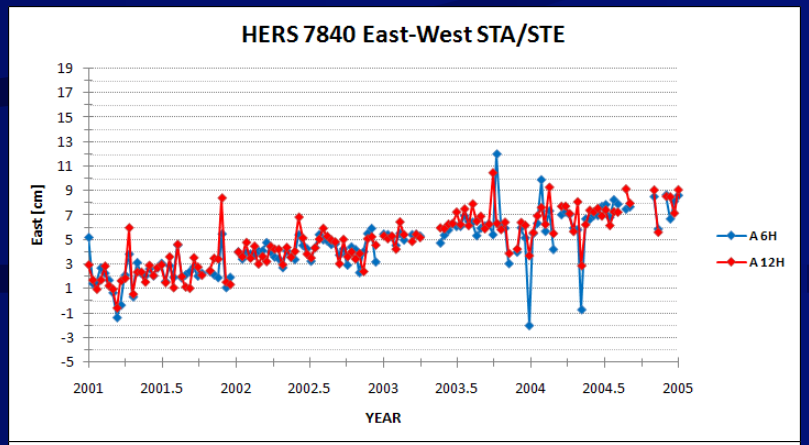

GRAZ 7839 North-South STA/STE
North [cm]
YEAR
A 6H
A 12H

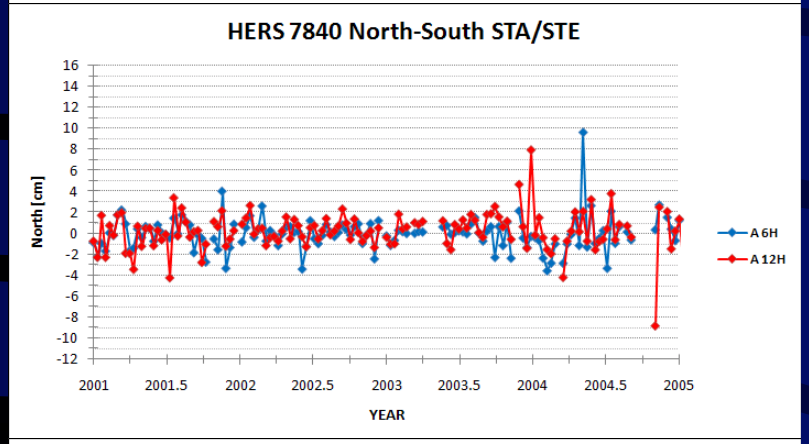

GRAZ 7839 North-South STA/STE
North [cm]
YEAR
A 6H
A 12H

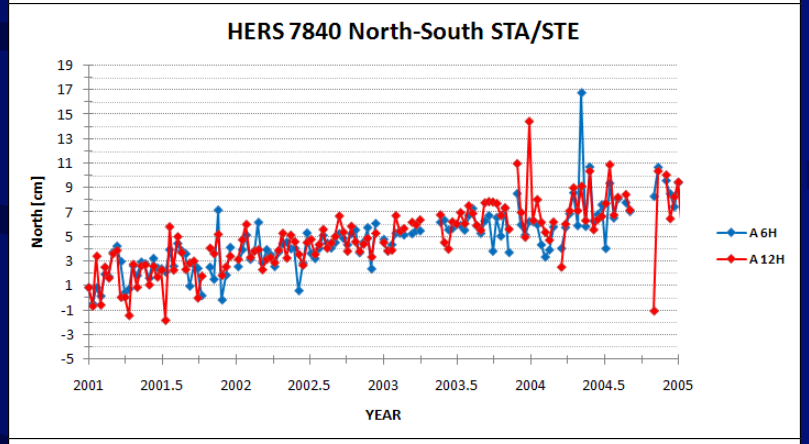

GRAZ 7839 Up STA/STE
Up [cm]
YEAR
A 6H
A 12H

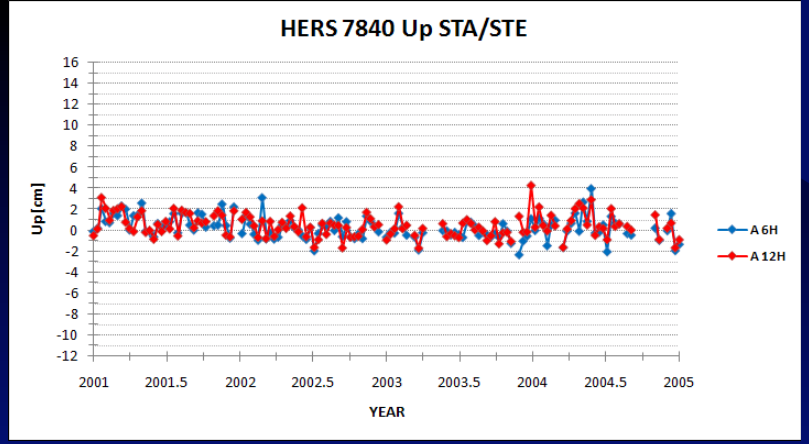

GRAZ 7839 Up STA/STE
Up [cm]
YEAR
A 6H
A 12H

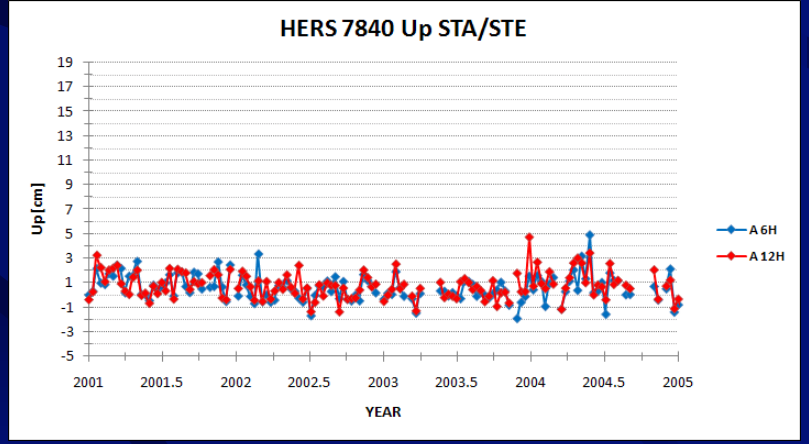

HERS 7840 East-West STA/STE
East [cm]
YEAR
A 6H
A 12H


HERS 7840 East-West STA/STE
East [cm]
YEAR
A 6H
A 12H


HERS 7840 North-South STA/STE
North [cm]
YEAR
A 6H
A 12H

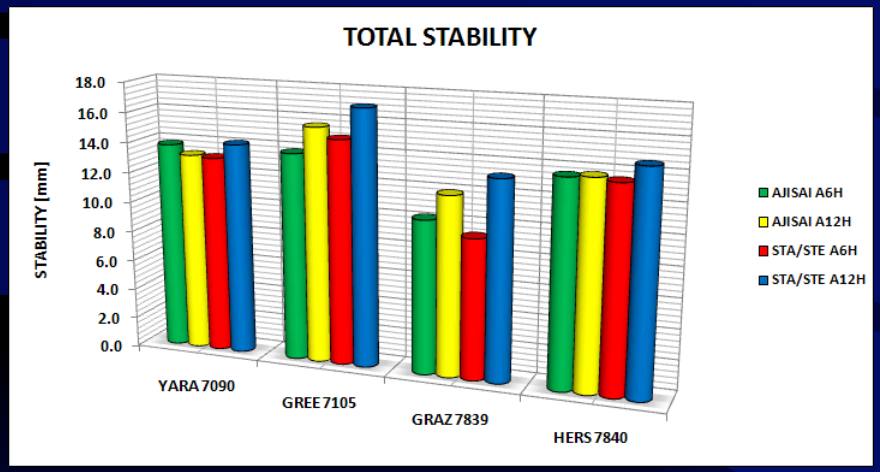

HERS 7840 North-South STA/STE
North [cm]
YEAR
A 6H
A 12H


HERS 7840 Up STA/STE
Up [cm]
YEAR
A 6H
A 12H

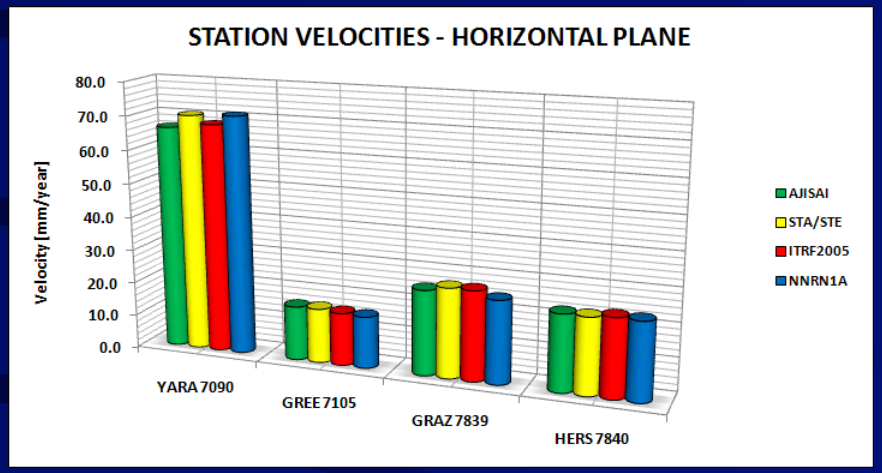

HERS 7840 Up STA/STE
Up [cm]
YEAR
A 6H
A 12H

Station Stabilities and Velocities

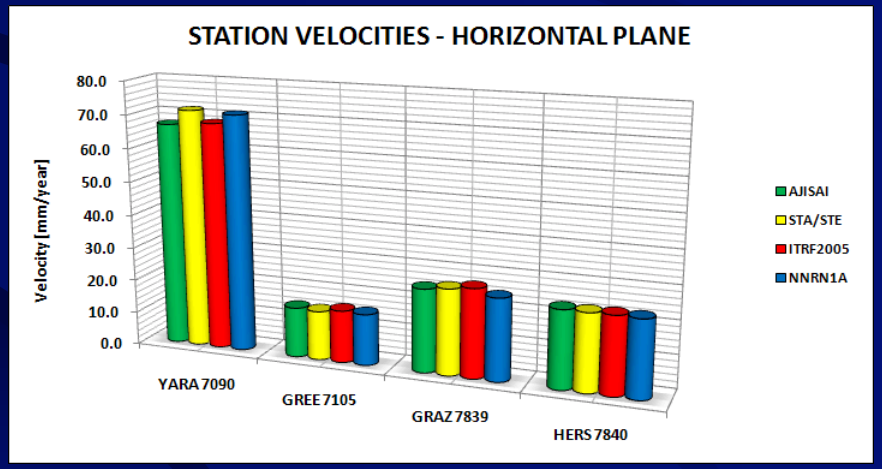
STATION TOTAL STABILITY



V2D - ACCEL 6H SOLUTION



V2D - ACCEL 12H SOLUTION



Summary and Conclusions

- the RMS on the level 1.61-2.56 cm for Ajisai and 1.15-2.62 cm for Sta/Ste
- the total stability of the station coordinates on the level 10.2-15.6 mm for Ajisai and 9.3-17.0 mm for Sta/Ste
- the station velocities (V2D) are in good agreement with ITRF2005 and geological model NNR-NUVEL1A
- the problem of LEO is too less observations
- the lack of SLR station on the Southern Hemisphere
- the new gravity field model (GOCE mission)
- *"SLR - the next generation"* - the future may belong to LEO

Acknowledgements

- the author wishes to thank the NASA geodesy group for consent to use of GEODYN-II orbital program,
- and to thank all ILRS stations and data centers for their continuous efforts to provide high-quality global SLR data for this work.

Thank you
for your attention
and nice stay in Poznan !