Poster #3071

Precise Orbit Determination and Measurement Bias Analysis for Starlette with SLR of the Korean SLR Station "DAEDEOK-73592601"

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Abstract

Korea Astronomy and Space Science Institute (KASI) has developed the first Satellite Laser Ranging (SLR) station of Korea, "DAEDEOK-73592601". The DAEK station has been provided SLR normal point (NP) data to International Laser Ranging Service (ILRS) data centers since August 2013 and became an active station in April 2014. As a new active ILRS stations, quality assessment of SLR NPs from DAEK station are required. In this study, precise orbit determination (POD) for Starlette and measurement bias analysis of ILRS stations are performed for quality check of DAEK SLR NPs. The NASA/GSFC GEODYN II software is used for POD and a weekly-based strategy is applied to process SLR NPs from January, 2013 to July, 2014 from 27 ILRS global stations. For air drag coefficients and empirical acceleration parameters estimation, 8h-based strategy is applied. For orbit quality assessment, post-fit residuals for total periods are investigated. For measurement bias estimation, quick orbital analysis from pass-by-pass approach is utilized. For Starlette, the mean RMS of post-fit residuals is 0.96 cm and the mean range bias and bias stability of DAEK stations are -1 mm and 34.8 mm, respectively.

Precise Orbit Determination

- **Precise Orbit Determination (POD) System and POD Strategy**
  - H/W : Workstation with Intel Xeon E5645@2.40GHz (64bit Linux OS)
  - NASA/GSFC GEODYN II system configuration

Model/Parameter	Description
Reference Frame	
Reference system	Inertial reference system
Precession/nutation	IAU2000
Polar motion	C04 IERS
Station coordinates	SLRF2008
Numerical Integration	Cowell's method
Step size	60 s
Arc length	7 days
Dynamic Model	
Earth geo-potential	GGM-2C (90 by 90)
Planetary ephemeris	JPL DE-403
Earth tide	IERS convention 2003
Ocean tide	GOT00.2
Dynamic polar motion	Applied
Relativistic effect	Applied
Atmospheric density	MSIS-86
Solar radiation	Box-wing macro
Earth Albedo pressure	Applied
Empirical acceleration	Radial, along and cross-track
Measurement Model	
Observations	30s SLR normal points
Tropospheric delay	Mendes and Pavlis
Estimation Parameters	Position and velocity of satellite

Category	Specification
Sponsor	CNES (France)
Applications	Gravity field & POD
Launch date	February 6, 1975
LRA diameter	24 cm
NP bin size (s)	30
Orbit	Circular
Inclination (deg)	49.83
Eccentricity	0.0206
Perigee (km)	812
Period (min)	104
Weight (kg)	47

< Starlette with 60 corner cubes >

- Measurement data : NPs from 27 ILRS stations, 2013 (Q1/Q2/Q3/Q4), 2014 (Q1/Q2)

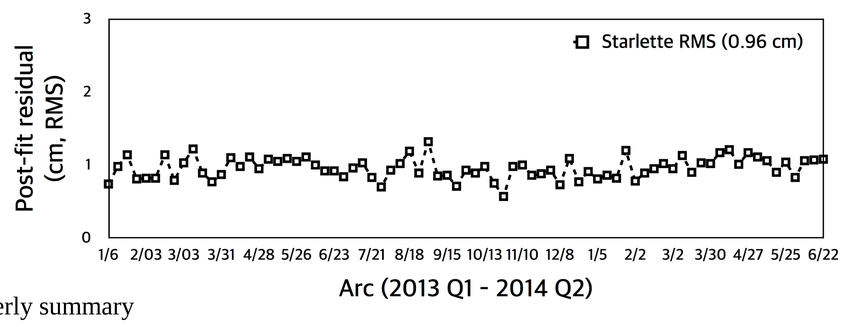
Station #	Station Location	Station #	Station Location
1824	Golosiiv	7501	Hartebeesthoek
1873	Simeiz	7810	Zimmerwald
1884	Riga	7820	Kunming
1888	Svetloe	7821	Shanghai
1890	Badary	7824	San Fernando
7080	McDonald	7825	Mt. Stromlo
7090	Yarragadee	7838	Simosato
7105	Greenbelt	7839	Graz
7110	Monument Peak	7840	Herstmonceux
7124	Tahiti	7841	Potsdam
7237	Changchun	7845	Grasse
7249	Beijing	7941	Matera
7359	Daedeok	8834	Wettzell
7406	San Juan		

- 77 weeks, 124,555 NPs
- **Estimation Strategy : 8h-based** air drag coefficients and empirical acceleration parameters
- **The center of mass for Starlette : 78 mm** [5]
- Measurement bias : quick orbital analysis (pass-by-pass)
- Outlier for range bias statistics < |100mm|

Precise Orbit Determination Results

- **Post-fit Residuals**
  - Mean root mean square (RMS) value : 0.96 cm (better than previous studies [1, 2, 3, 4])
  - DAEK station : **0.73 cm**

Research	Post-fit residual (cm, RMS)	Arc Length	Gravity	Drag	Accel
Lejba et al. (2007)	1.30	10 day	60X60	24h	6h
Jeon et al. (2011)	1.93	7 day	90X90, 180X180	8h	7day
Lejba & Schillak (2011)	1.87	10 day	75X75	12h	6h/12h
Jagoda & Ruhkowska (2013)	2.40	7 day	2159X2159	7day	7day



- Quarterly summary

	2013 Q1	2013 Q2	2013 Q3	2013 Q4	2014 Q1	2014 Q2
Mean RMS (cm)	0.93	1.02	0.93	0.87	0.94	0.96
# NP	17,813	21,914	21,008	19,009	23880	20931

Measurement Bias Analysis

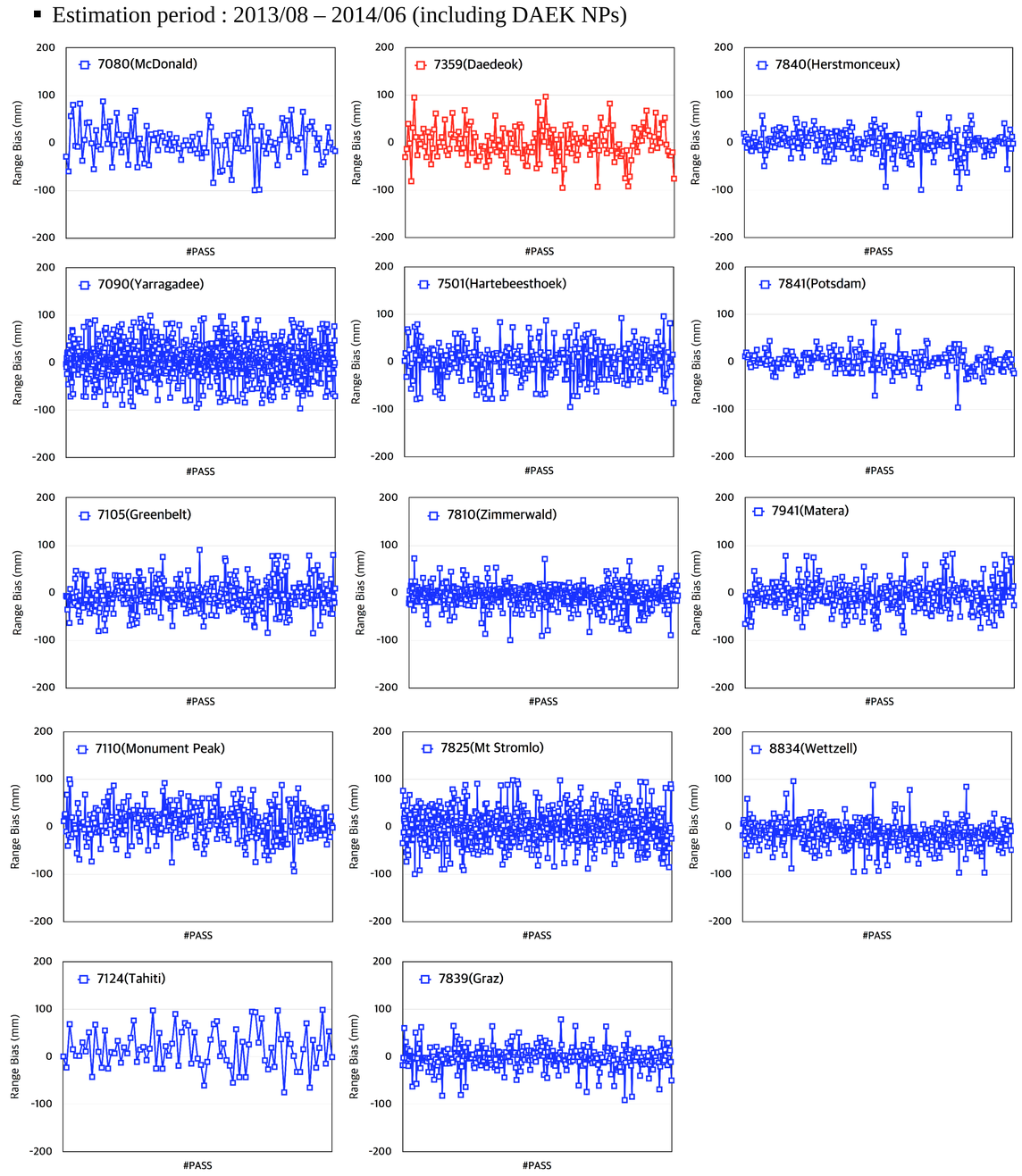
- **Korean SLR Station DAEDEOK-73592601**
  - General information

Item	Information
Station ID	7359
Code	DAEK
Site	Daejeon, Korea
Status	Active
SOD	73592601

  - Status of the DAEK station

SOD	Start date	End date	Status
73592601	2014-0411	active	Validated
73592601	-	2014-04-11	Quarantine

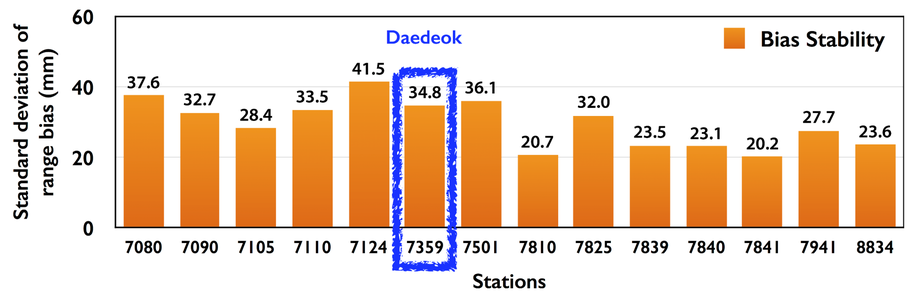
- **Measurement Bias Estimation**
  - Estimation period : 2013/08 – 2014/06 (including DAEK NPs)



< Range bias of ILRS stations by pass >

- **Stability Analysis Measurement Bias**
  - Mean bias and stability (standard deviation) of stations

Station #	Mean (mm)	Std. dev. (mm)	#Pass	Station #	Mean (mm)	Std. dev. (mm)	#Pass
7080	1.2	37.6	119	7810	-4.7	20.7	647
7090	6.0	32.7	1057	7825	0.3	32.0	777
7105	-6.2	28.4	417	7839	-1.7	23.5	335
7110	9.1	33.5	330	7840	0.4	23.1	283
7124	17.2	41.5	86	7841	2.4	20.2	232
7359	**-1.4**	**34.8**	**178**	7941	-4.7	27.7	387
7501	2.4	36.1	301	8834	-14.6	23.6	520



Conclusions and Future Works

- **Conclusions**
  - Precise orbit determination for Starlette using 27 ILRS stations including DAEK
    - Post-fit residuals (Total) : 0.96 cm (RMS)
    - Post-fit residuals (DAEK) : 0.73 cm (RMS)
  - Measurement bias analysis
    - Mean range bias of DAEK station : -1.4 mm
    - Range bias stability of DAEK station : 34.8 mm
- **Future Works**
  - Continuous POD works for Starlette using SLR NPs from ILRS stations including DAEK
  - Long term bias stability analysis of DAEK using Starlette SLR NPs

References

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