13-Po35

Satellite Laser Ranging at the Shimosato Hydrographic Observatory

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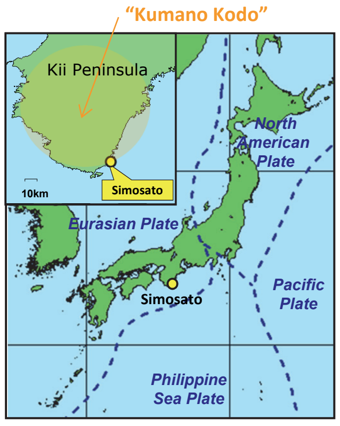
Introduction

The Shimosato Hydrographic Observatory (SHO), central Japan, has been carrying out Satellite Laser Ranging (SLR) observation for AJISAI, LAGEOS-1, LAGEOS-2 and other geodetic and earth observation satellites since 1982. More than 33,000 passes have been obtained as of Sep. 31, 2013.

Through the SLR observation, the precise position of Japan has been determined on the international reference frame such as ITRF. Based on this, we determined the transformation parameters from the Tokyo Datum to the world geodetic system. Furthermore, we have detected the intraplate deformation caused by the subduction of the Philippine Sea Plate off Shimosato in the interseismic phase and the coseismic crustal movements associated with the 2004 off the Kii Peninsula earthquake (Mw 7.5) and the 2011 off Tohoku earthquake (Mw 9.0).

In this poster, we summarize the SLR observation at Simosato over 30 years.



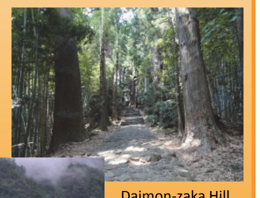
Location of Simosato

Shimosato Hydrographic Observatory

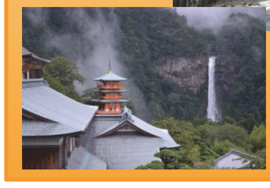
World Heritage "Kumano Kodo"

In July 2004, the Kumano Kodo pilgrimage routes and its religious treasures were registered as a UNESCO World Heritage site as "The Sacred Sites and Pilgrimage Routes in the Kii Mountains Range.".

Simosato is located in the Kumano Kodo area.



Daimon-zaka Hill (Kumano Kodo)

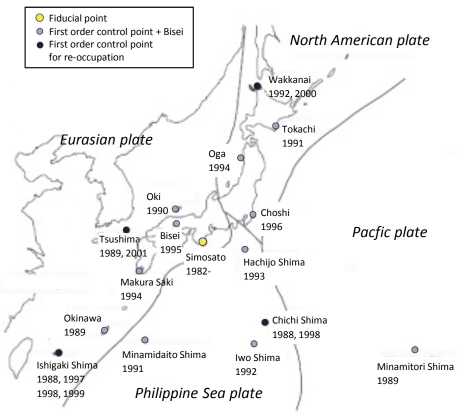


Three-tiered tower and Nachi Falls

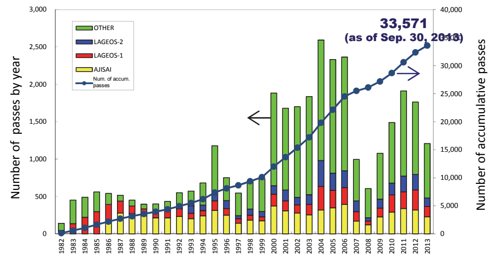
History of Shimosato Hydrographic Observatory (SHO) and SLR observations

- 1954 Established the Shimosato Hydrographic Observatory and started geomagnetic observation
- 1959 Started astronomical observation, mainly lunar occultation
- 1978 Transferred geomagnetic observation to Hachijo-jima island, 300 km south of Tokyo, due to the opening of electrical trains near the observatory
- 1982 Started SLR observation
- 1983 Revealed the difference between the world geodetic system and the Tokyo Datum; Japanese Island was mis-located 465 m southeast on earth.
- 1987-2001 Conducted campaign SLR observations at off-lying islands and coastal areas of Japan by using a transportable SLR system
- 1995 Installed GPS antenna/receiver and started continuous GPS observation
- 1998 Joined ILRS
- 1999 Achieved 10,000 passes of SLR
- 2005 Achieved 20,000 passes of SLR
- 2007-2009 Replaced SLR observation system
- 2008 Discontinued lunar occultation
- 2011 Registered GPS station as an IGS station (SMST)
- 2011 Achieved 30,000 passes of SLR
- 2012 30th anniversary of SLR observation

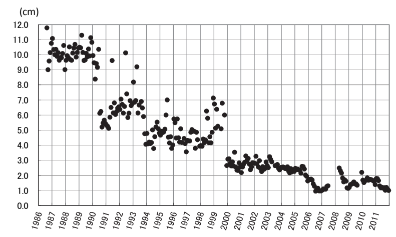
Transportable SLR system



Simosato and campaign SLR observation sites



Number of passes at Simosato station (1982-2013)



Monthly average of Ajisai normal point rms

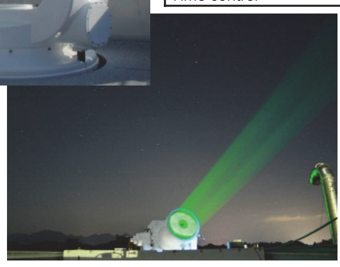
Replacement of the observation system in 2007-2009

The SLR observation equipment except the mount of the telescope was replaced from 2007 to 2009 due to aging. The specification is as the table below.

Principal Specifications of SLR Systems

		Old system (1982~2007)	New system (Dec. 2009~now)
Laser	Wave length	532nm	
Laser	Pulse width	＜100ps	＜20ps
Laser	Output energy (per pulse)	120mJ	60mJ
Laser	Repetition rate	4Hz	5Hz
Telescope	Optical type	Cassegrain	Nathmyth
Telescope	Transmitter/Receiver diameter	Transmitter：17cm Receiver：60cm	75cm (common use)
Receiver		PMT at the back of telescope	PMT in the observation room
Flight time counter		Time interval counter (resolution：4ps)	Event timer (resolution：1ps)
Time control		GPS and cesium oscillator	

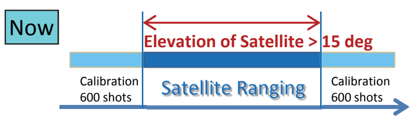
Old and new telescopes

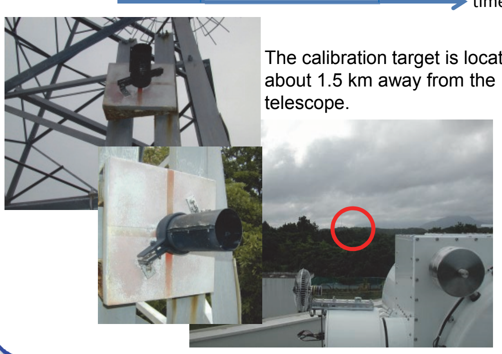


Operation

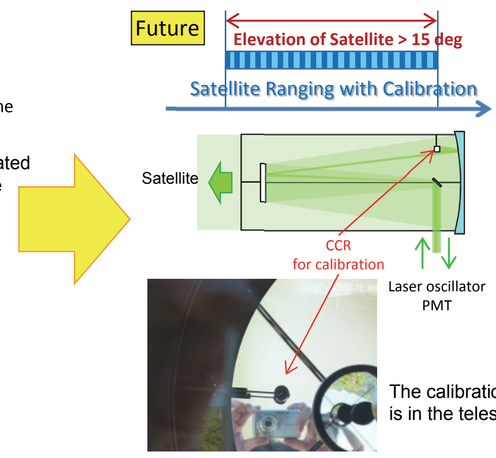
Installation of a calibration target in the telescope (under examination)

We have used a calibration target on a power line tower, which is located about 1.5 km away from the observatory. To develop calibration accuracy, we are considering the introduction of a calibration target mounted in the telescope. This will enable us to make calibrations while we conduct ranging measurements. The examination is being conducted.





The calibration target is located about 1.5 km away from the telescope.



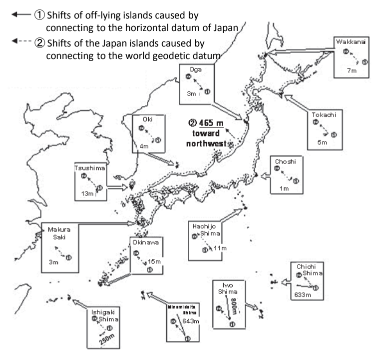
The calibration target is in the telescope.

Major results

1. Transition from the Tokyo Datum to the World Geodetic System

The SLR observation at Simosato revealed that the position of Simosato on the Tokyo Datum was incorrect by 465 m toward southeast relative to the world geodetic system.

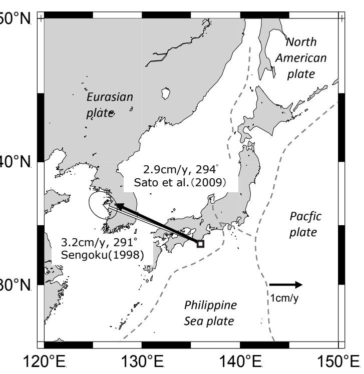
Furthermore, the SLR campaign observations at off-lying islands and coastal areas of Japan detected that the errors of optical and astronomical surveys.



2. Intraplate movement at Simosato

The intraplate velocities at Simosato within the Eurasian plate was estimated from Ajisai SLR data for 8 years from 1986 to 1994 (Sengoku, 1998) and LAGEOS SLR data for 10 years from 1995 to 2004 (Sato et al., 2009).

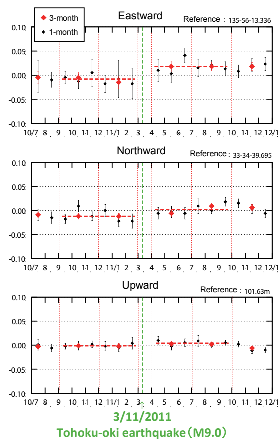
Simosato is moving at a rate of about 3 cm/year toward west-northwest. This is caused by the subduction of the Philippine Sea plate off Simosato and helps us understand the strength of interplate coupling which will induce large earthquakes in the future.



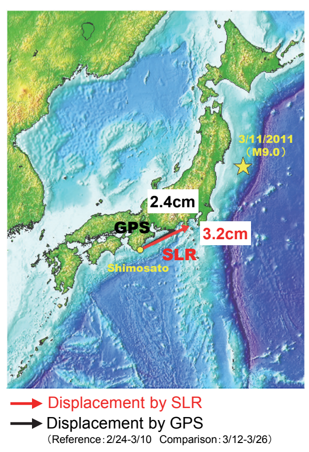
3. Coseismic displacement associated with the 2011 Tohoku-oki earthquake

On March 11, 2011, a huge interplate earthquake with magnitude of 9.0 occurred off northeastern Japan, causing devastating damage mainly to the Pacific coast of northeastern Japan.

Although Simosato is located about 800 km away from the epicenter, coseismic displacement of about 3 cm toward east-northeast was detected by SLR observation before and after the event. This is consistent with the result of GPS measurements.



Time series of the estimated positions of Simosato SLR from July 1, 2010 to December 31, 2011



Horizontal co-seismic displacement associated with the 2011 Tohoku-oki earthquake (M9.0)