

The SLR monitoring crustal movement in South America

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ABSTRACT

The M8.8 Chilean earthquake of February 27, 2010 caused a large surface displacement near its epicenter. Satellite Laser Ranging (SLR) station 7405, cooperatively operated by Germany and Chile about 130 km from the epicenter was affected by the earthquake. Another SLR station, No. 7406, operated jointly by the National Astronomical Observatories of the Chinese Academy of Sciences and San Juan University of Argentina, was about 600 km from the epicenter. Combining the observations of these two SLR stations with global SLR station observations, we calculate the geocentric coordinates of the two stations based on ITRF2000. The results show that the coordinates of the two stations have changed by varying degrees. SLR-7405 moved substantially towards the southwest with displacements of about 3.11, 0.52 and 0.49 m in X, Y, Z directions; the corresponding displacements for SLR-7406 are about 0.02, 0.03 and 0.02 m. The follow-up analysis showed that SLR-7405 station is still influenced by the subsequent medium earthquakes close to it during 2010-2011.

1 Introduction

In South America, there are several SLR stations. One of them is SLR station co-operated between German and Chile in Concepción City, and the equipment number is 7405 in the ILRS network. Northeast of the 7405 about 700 km, where is the Observatory of San Juan University of Argentina, there is another joint establishment of the SLR stations by National Astronomical Observatories of China and San Juan University, and its number is 7406 in the ILRS network.

The magnitude 8.8 quake struck near Maule of Chile on Feb. 27, 2010. It caused the movement of the entire city of Concepción by ~3-meter to the west, major damage and a tsunami near the epicenter at the same time. SLR-7405 ($\varphi = -36^{\circ}.843$, $\lambda = -73^{\circ}.025$) is about 80km from epicenter ($\varphi = -36^{\circ}.122$, $\lambda = -72^{\circ}.898$) of Chile M8.8 earthquake, it was struck by the major earthquake and was fully operational again near May 2010. SLR-7406 ($\varphi = -31^{\circ}.509$, $\lambda = -68^{\circ}.623$) is about 650km from the epicenter, its observation was not interrupted by the earthquake. The distance between SLR-7405 and SLR-7406 is about 716km. Utilizing the observations of these two SLR stations with global SLR observations, we calculate the geocentric coordinates of the two stations.

2 Data Analysis

The Lageos-1 laser-ranging satellite was designed especially for geodynamic research and is also one of the preferred satellites for the global SLR network. Therefore, observations from of Lageos-1 are abundant as well as highly precise. We selected Lageos-1 data supported by all the SLR stations (<http://ilrs.gsfc.nasa.gov/>). Methods of accurately determining the orbit of Lageos-1 are undertaken based on similar sets of input parameters (Yin Z.Q., et al, 2011). The reference frame, measurement and force models basically follow the IERS conventions. After analysis of the observations after the M8.8 Chilean earthquake of 2010, station SLR-7405 was determined to have moved 3.11, 0.52 and 0.49 m in X/Y/Z directions, while station SLR-7406 moved about 0.02, 0.03 and 0.02 m. After that, there still are many subsequent earthquakes during the last year. Taking concepcion as a center, we select the earthquakes $M > 6$ in 1000 km radius, some of them are listed in Table 1. The station coordinates of SLR-7405 are also calculated, and the result is showed in Figure 1.

Table 1 Subsequent earthquake near Concepción after Chile 2010 earthquake

Year	Mon	Day	TIME	LAT	LONG	DEP	MAG	DIST
2010	07	14	08 32 21.49	-38.07	-73.31	22	6.6	138
2010	09	09	07 28 01.72	-37.03	-73.41	16	6.2	40
2011	01	02	20 20 17.69	-38.37	-73.35	24	7.1	171
2011	02	11	20 05 30.79	-36.47	-73.12	27	6.8	41
2011	02	11	23 39 21.31	-37.20	-73.20	15	6.0	42
2011	02	12	01 17 01.41	-37.02	-72.95	16	6.1	21
2011	02	13	10 35 06.74	-36.65	-73.18	17	6.0	25
2011	02	14	03 40 09.92	-35.38	-72.83	21	6.6	163

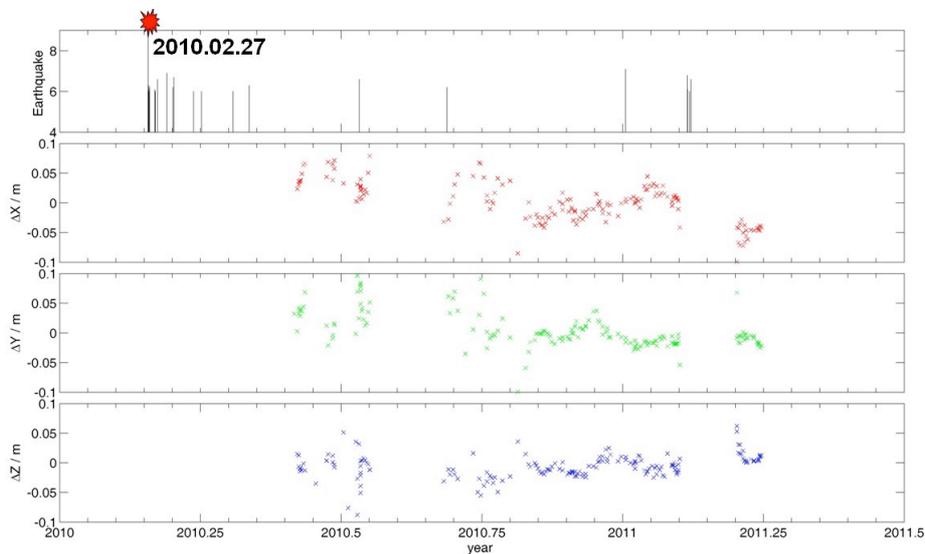


Figure 1 the earthquake sequence and coordinate of Concepción (7405) after the Chilean 2010 earthquake

3 Conclusions

Combining the observations of these two SLR stations with global SLR observations, we calculate the geocentric coordinates of the two stations based on ITRF2000. The results show that the coordinates of the two stations have changed by varying degrees. SLR-7405 moved substantially towards the southwest with displacements of about 3.11, 0.52 and 0.49 m in X, Y, Z directions; the corresponding displacements for SLR-7406 are about 0.02, 0.03 and 0.02 m, respectively. The continual analysis about the two stations showed that concepcion station is still affected by the subsequent earthquakes close to it. For example, the measurable movement of concepcion station might cause by the frequent earthquakes about 20-40 km away during February 11-13, 2011 (see Figure 1), the systematic displacement is about 2 cm on SLR-7405 station. San Juan station 7406, separated from station 7405 by about 700 km, did not show the obvious movement during these bunch of earthquakes periods. This solution, as an independent result derived from SLR observations, could provide an essential external check for other positioning techniques such as GPS.

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References

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