Impact of ambiguity resolution and LEO configuration on geocenter motion determination using ground and spaceborne GPS observations

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1. Overview This contribution conveys a discussion on the impact of integer ambiguity resolution and low Earth orbiter (LEO) configuration on the GPS-derived geocenter coordinate (GCC) estimates. A combined zero-difference processing of the ground observations from 98 global stations and the spaceborne observations from 4 LEOs is conducted. Benefited from ambiguity resolution in the double-difference mode between ground stations and one LEO, the formal errors of GCC estimates are reduced by 69.4%, 69.4% and 55.0%, and the standard deviations (STD) of GCC time series are reduced by 52.5%, 37.8% and 20.3% for the X, Y and Z components, respectively. After adding 4 LEOs into ground network, the formal errors of GCC parameters are reduced by 77.8%, 78.2% and 50.5%, and the STD of GCC time series are reduced by 44.4%, 31.7% and 57.5% for the X, Y and Z components, respectively. Concerning the Z component, the correlation with the B1C empirical parameter is reduced from 0.69 to 0.41, and the 5th and 7th draconitic harmonics are mitigated by 67.0% and 73.5%, respectively.

2. Method A total of 98 global GPS stations were selected from the IGS tracking network (Johnston et al. 2017). Therein, 57 core stations that contributed to the realization of IGb14 frame (Rebischung and Schmid 2016) were used for the datum definition by applying the No-Net-Translation (NNT) and No-Net-Rotation (NNR) constraints, while the positions of the remaining stations were freely estimated. Two typical LEO missions, namely the Gravity Recovery and Climate Experiment Follow-on (GRACE-FO) and Sentinel-3, were used. All the processing work within this study was done using the GSTAR software (Shi et al. 2023). The IAR was implemented at the DD level by forming the baselines between ground stations as well as between LEOs and ground stations. No baseline between LEOs was taken into consideration for the IAR.

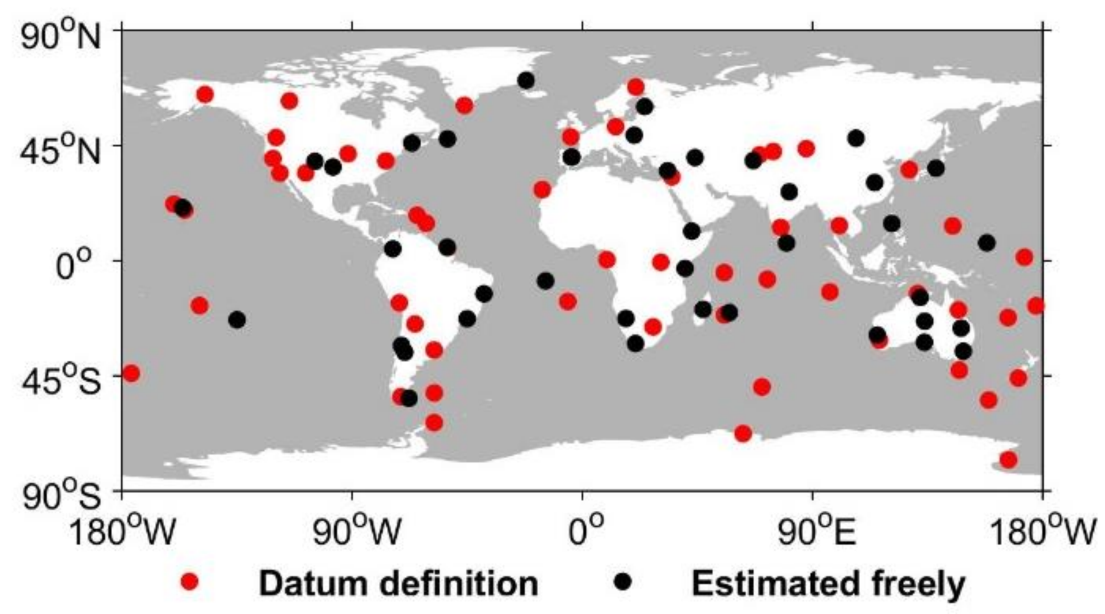

Fig. 1 Distribution of global GPS stations.

3. Impact of ambiguity resolution

Table 1 Differences between the analyzed solutions

Solution	Description
G-Float	only ground stations, not fixing ambiguities
G-Fixed	only ground stations, fixing ambiguities
GL-Float	ground stations and one LEO, not fixing ambiguities
GL-Fixed-G	ground stations and one LEO, fixing ambiguities for only ground stations
GL-Fixed-GL	ground stations and one LEO, fixing ambiguities for ground stations and LEO

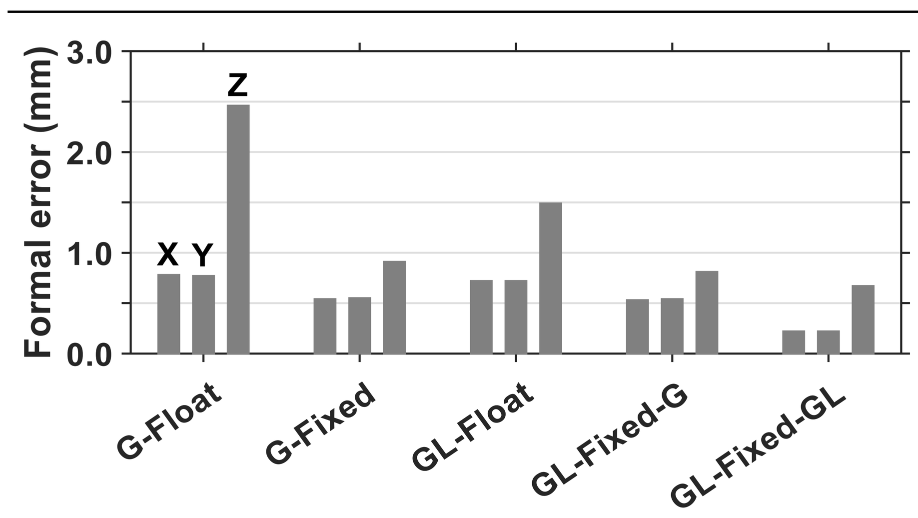

Fig. 2 Mean values of GCC formal errors estimated under various ambiguity resolution strategies

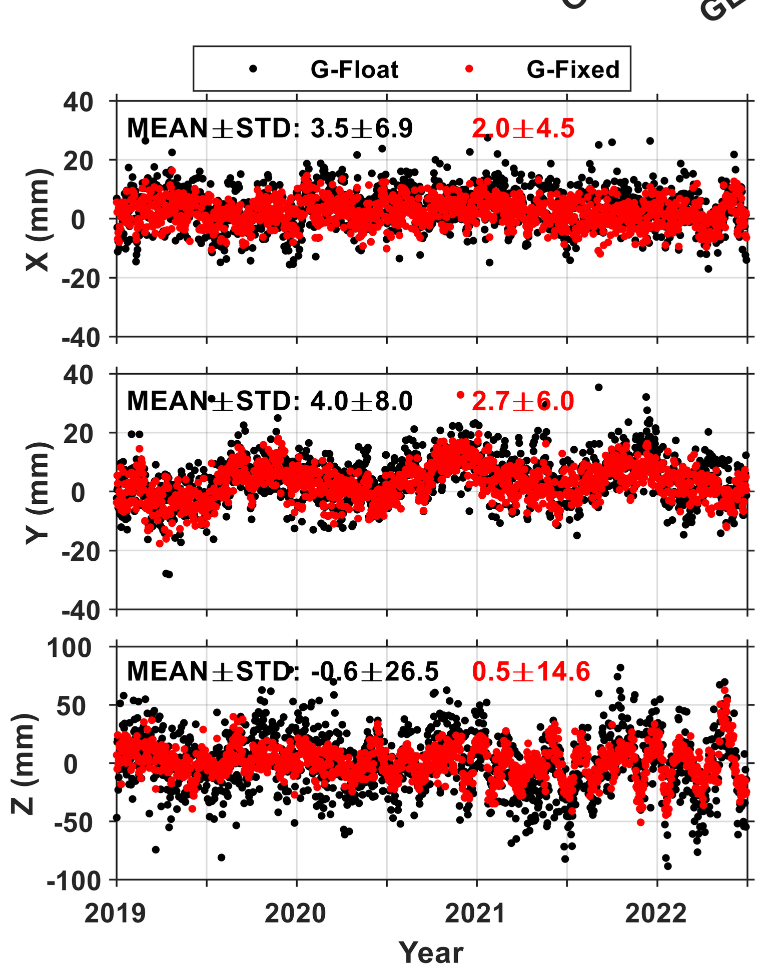

Fig. 3 GCC time series derived from ground station solutions

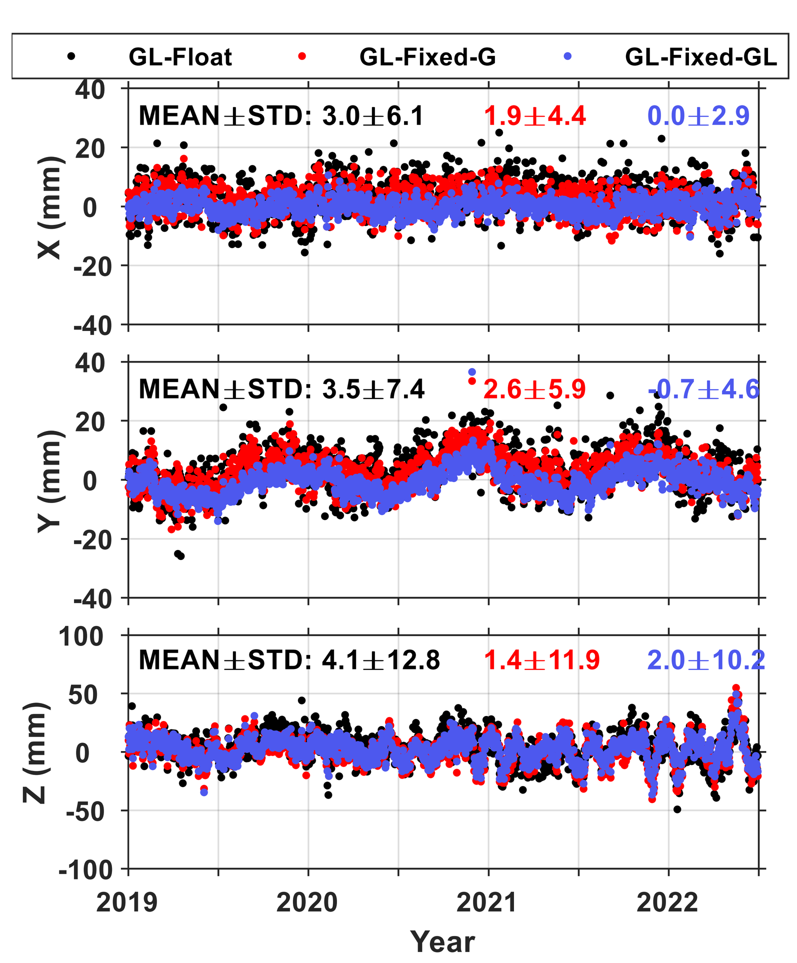

Fig. 4 GCC time series derived from ground station + LEO solutions

5. Impact of LEO configuration

Table 2 The analyzed solutions differing in LEO configurations

Solution	Observation source
G	only ground stations
GL-GFC	ground stations and the GRACE-C satellite
GL-S3A	ground stations and the Sentinel-3A satellite
GL-GFC+GFD	ground stations and the two GRACE satellites
GL-S3A+S3B	ground stations and the two Sentinel-3 satellites
GL-GFC+S3A	ground stations, GRACE-C and Sentinel-3A satellites
GL-4LEO	ground stations and all the 4 LEOs

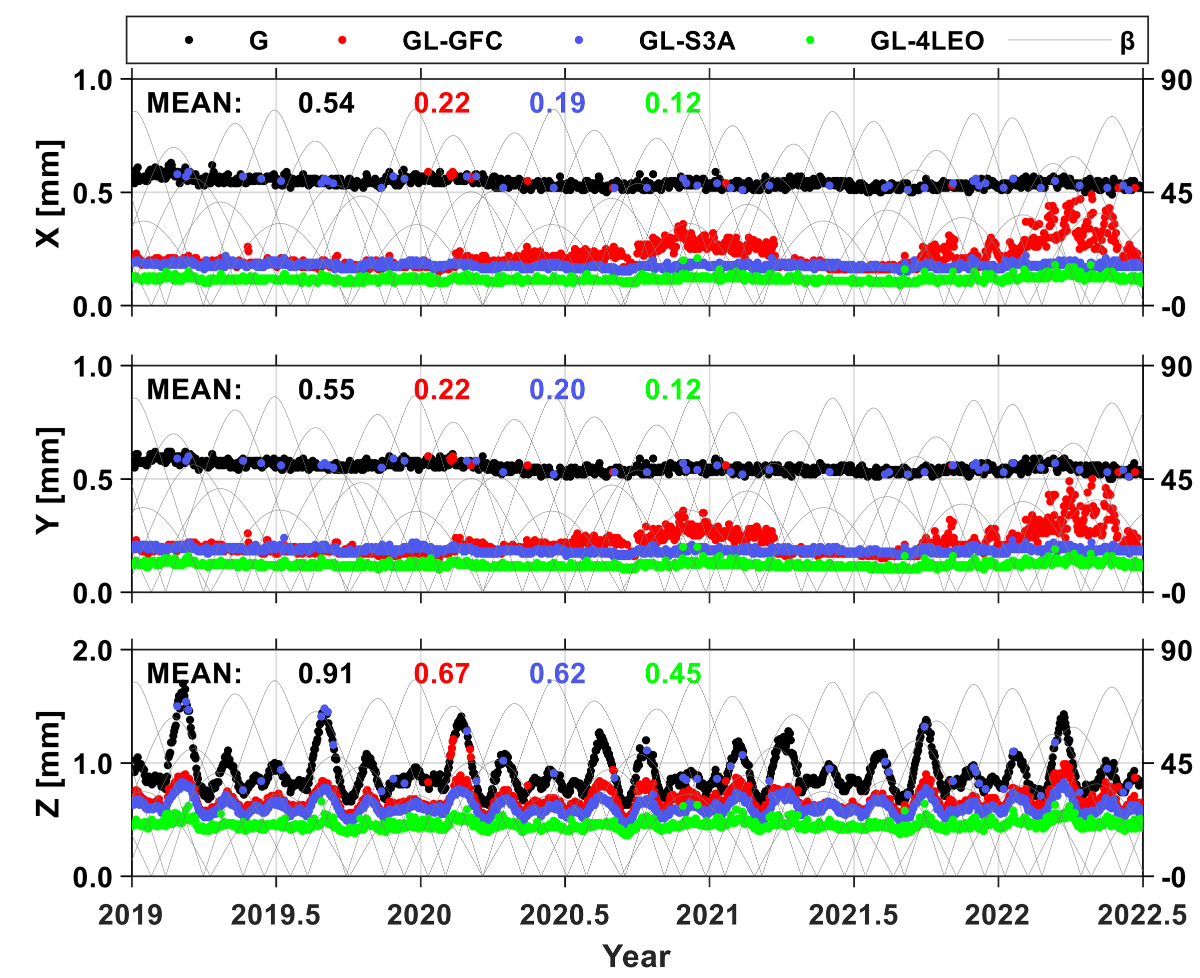

Fig. 5 Formal errors of GCC parameters as a function of the absolute value of the Sun elevation angle above the orbital plane (|β|)

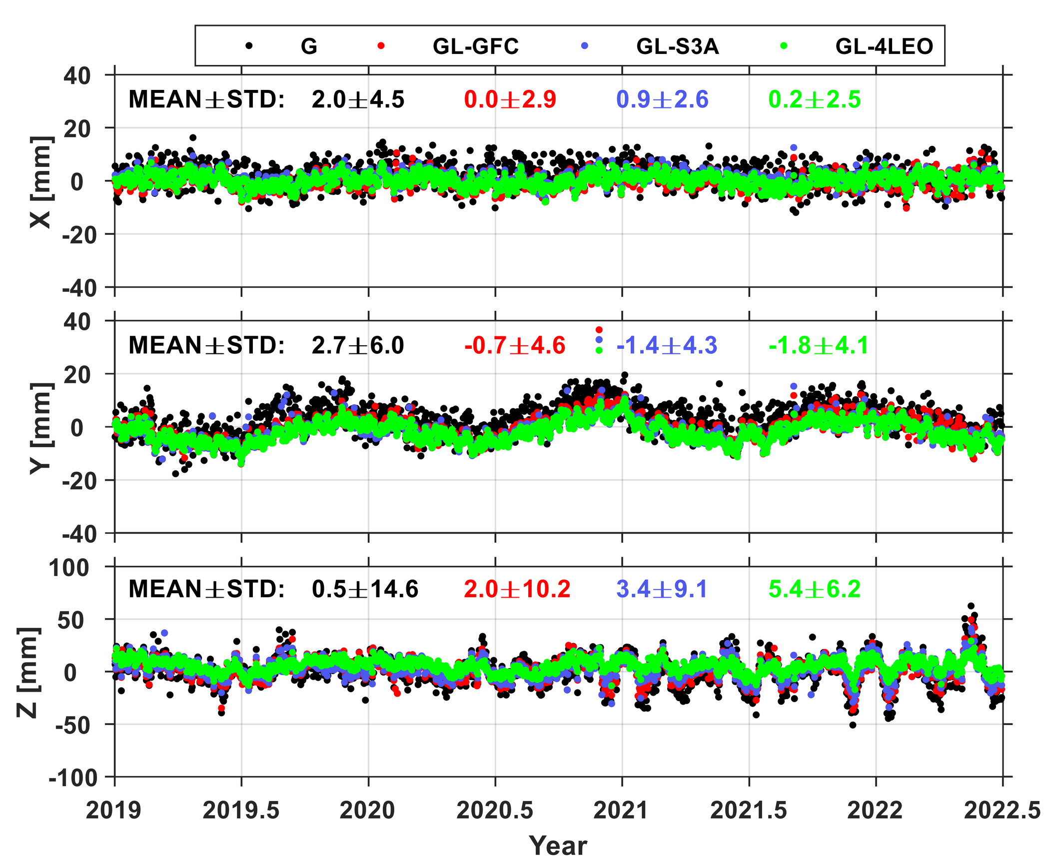

Fig. 6 GCC time series derived from different LEO configurations

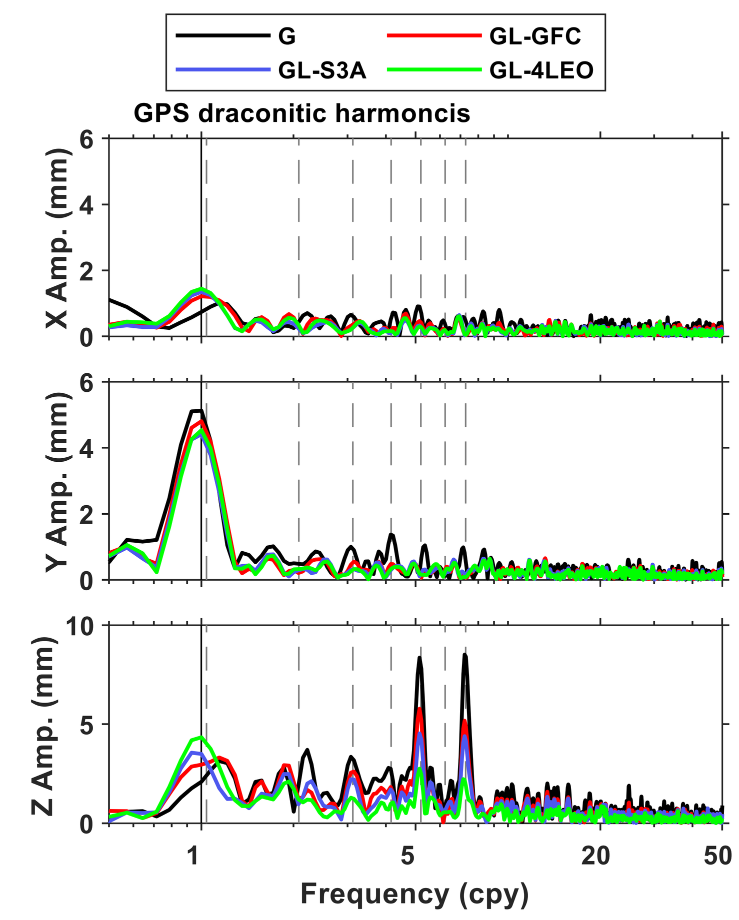

Fig. 7 Amplitude spectra of GCC time series

6. Comparison to external results

Table 3 Amplitudes and phases of the annual

Solution	Time span	Amplitude (mm)			Phase (deg)		
		X	Y	Z	X	Y	Z
G	2019.0-2022.5	0.8	5.2	2.4	38	311	331
GL-GFC	2019.0-2022.5	1.3	4.8	3.5	43	329	342
GL-S3A	2019.0-2022.5	1.4	4.4	3.9	40	328	15
GL-4LEO	2019.0-2022.5	1.5	4.5	4.6	40	330	6
GPS-4LEO (Männel and Rothacher 2017)	2010.0–2014.0	3.2	4.0	5.9	62	291	85
SLR-LAGEOS (Zajdel et al. 2021)	2017.0-2020.0	2.5	1.9	4.4	49	302	32

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