Report on the Analysis of the Asia Pacific Regional Geodetic Project (APRGP) GPS Campaign 2021

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Geoscience Australia acknowledges the traditional custodians of the country where this work was undertaken. We also acknowledge the support provided by individuals and communities to access the country, especially in remote and rural Australia.

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Executive Summary

The annual Asia Pacific Regional Geodetic Project (APRGP) GPS campaign is an activity of the Geodetic Reference Frame Working Group (WG) of the Regional Committee of United Nations Global Geospatial Information Management for Asia and the Pacific (UN-GGIM-AP). This document describes the data analysis of the APRGP GPS campaign undertaken between the 12th and 19nd of September 2021. Campaign GPS data collected at 102 sites in twelve countries across the Asia Pacific region were processed using version 5.2 of the Bernese GNSS Software in a regional network together with selected IGS (International GNSS Service) sites. The GPS solution was constrained to the ITRF2014 reference frame by adopting IGS14 coordinates on selected IGS reference sites and using the final IGS earth orientation parameters and satellite ephemerides products. The average of the root mean square repeatability of the station coordinates for the campaign was 2.0 mm, 2.4 mm and 6.4 mm in north, east and up components of station position respectively.

Introduction

The annual Asia Pacific Regional Geodetic Project (APRGP) GPS campaign is an activity of the Geodetic Reference Frame Working Group (WG) of the Regional Committee of United Nations Global Geospatial Information Management for Asia and the Pacific (UN-GGIM-AP). The WG continues to undertake an annual GPS campaign activity as some member countries are unable to participate in the Asia Pacific Reference Frame (APREF) project but have an ongoing requirement for geodetic positioning relative to a stable global/regional reference network. One of the roles of the WG is to create and maintain a densely realised and accurate geodetic framework, coordinate regional cooperation in geodesy amongst national agencies, and to build and improve the regional geodetic infrastructure. The APRGP is where UN-GGIM-AP member agencies contribute GPS data to the WG. GPS data from the APRGP are available for all participant member countries for local and global scientific research and local applications. The composite GPS data set is subsequently analysed by the WG to provide estimates of station coordinates in the International Terrestrial Reference Frame (ITRF). The results of the APRGP are also supplied by the WG to the official ITRF product centre to densify the ITRF in the Asia Pacific region. This document overviews the data analysis of APRGP GPS campaign undertaken in 2021.

The document is organised as follows. The data set of the campaign is described first. The data processing scheme is detailed thereafter, followed by the results of processing including the repeatability RMS (root mean square) of the station coordinates, and the final computed station coordinates.

GPS Data Set

The 2021 GPS campaign was undertaken from 12 to 19 September 2021 inclusive (day of year 255 to 261). Data were contributed by twelve countries across the region, including Bhutan, Brunei, Hong Kong (China), India, Malaysia, Mongolia, Myanmar, Philippines, Singapore, Tonga and Vietnam. Note that Hong Kong (China), India and Philippines are also contributing Continuous GPS (CGPS) data to the APREF project. Figure 1 shows the distribution of the APRGP 2021 campaign stations along with the APREF stations and IGS stations, blue circles are APRGP campaign sites, and black triangles are APREF stations.

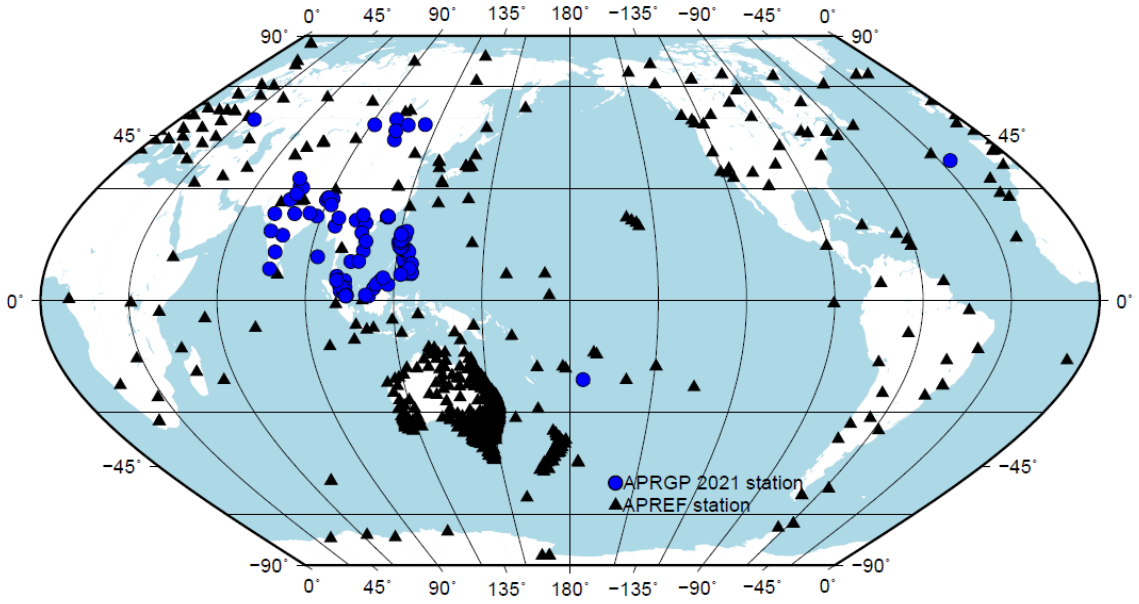

Figure 1 APRGP stations in the APRGP 2021 GPS campaign analysis along with the APREF stations and IGS stations, blue circles are APRGP campaign sites, and black triangles are APREF stations.

Data Processing Scheme

Analysis of the GPS observations was undertaken using the Bernese GNSS software V5.2. The Bernese GNSS software conforms to the IERS2010 conventions (Gérard and Brian, 2010). In order to tie the APRGP network to the ITRF2014 reference frame (Altamimi et al., 2016), the campaign data was processed along with the available data from IGS sites located around the Asia-Pacific region and APREF stations. For the details of APREF project, see http://www.ga.gov.au/scientific-topics/positioning-navigation/geodesy/asia-pacific-reference-frame.

An overview of the processing strategy is as follows:

- IGS final precise GPS satellite ephemeris and Earth rotation parameters were used for the daily data processing to generate daily normal equations.
- Site displacement due to ocean tidal loading for all stations were corrected by using the FES2004 model (Lyard et al., 2006).
- Antenna phase centre variations were taken into consideration using consistent, absolute IGS models of both receiver and satellite antenna phase centres (Schmid et al., 2007).
- Dual frequency carrier phase and code data were used with an elevation cut off angle of 7° and elevation-dependent weighting. Code measurements were only used for receiver clock synchronisation. Pre-processing used a sampling rate of 30 seconds; a sampling rate of three minutes was used for other processing.
- Carrier phase pre-processing was conducted on a baseline by baseline mode using triple differences. The observations with small pieces and the observations suspected to be corrupted by a cycle slip were marked. Subsequent processing did not use the marked observations. Different linear combinations of L1 and L2 cycle slips were fixed if possible. New ambiguity parameters were introduced if cycle slips could not be fixed reliably or if significant gaps in the observations where present. In addition, a data screening step in a baseline by baseline mode was performed based on weighted post-fit residuals and outliers were marked and removed from further processing.
- A priori dry tropospheric delay computed from a standard atmosphere was mapped with the Dry Global Mapping Function (GMF) (Böhm et al., 2006). For the wet component, continuous piecewise linear troposphere parameters were estimated in 1-hour intervals without any a priori model using the wet Vienna Mapping Function (VMF) and the ionosphere-free combination observations.
- After the pre-processing, ionosphere maps were estimated using the geometry-free linear combination. The vertical electron content was modelled with a single-layer model in a solar geomagnetic reference frame. The height of the single layer was 450 km above the Earth's surface. The previously estimated ionosphere maps were introduced as a priori ionosphere information and, in addition, stochastic ionosphere parameters were set up to support the Quasi Ionospheric Free (QIF) ambiguity resolution strategy (Dach et al., 2015).
- Ambiguity resolution was attempted on all baselines within the network in a baseline by baseline model using Melbourne-Wüebbena strategy for baselines up to 6000 km; the QIF approach was used for baselines up to 2000 km; and the phase-based wide-lane/narrow-lane method for baselines up to 200 km; and direct L1/L2 method for baselines up to 20 km. The QIF strategy is based on the ionospheric free linear combination, but also incorporates the estimation of an ionospheric parameter for each epoch to account for the residual ionospheric biases, details can be found in Dach et al. (2015).

- The daily normal equations were generated and combined into a campaign solution. As part of this process the daily solutions were compared with the combined solution and the resulting differences were analysed for the presence of outliers and the daily repeatability.

Results

The daily repeatability root mean square (RMS) of the station coordinates, an estimate of the day-to-day scatter of coordinate components about a weighted epoch mean, was used to assess the quality of the final epoch solution and as a measure of internal precision. Table 1 lists the daily repeatability (RMS) of the station coordinates. The average of the repeatability (i.e. RMS) of the station coordinates for the campaign was 2.0 mm, 2.4 mm and 6.4 mm in north, east and up components, respectively. Note that there is no solutions for the following sites due to data quality issues: DEOT from Bhutan, GET2 from Malaysia, PBGU from Philippines, SNPT and SNSC from Singapore, T002 and TGPU from Tonga.

Table 1 Daily repeatability RMS for the APRGP 2021 GPS campaign stations.

Station	Country	North (mm)	East (mm)	Up (mm)
BUMT	Bhutan	1.4	2.6	9.1
DGPL	Bhutan	1.4	1.6	6.2
KANG	Bhutan	2.0	2.6	5.7
PHUN	Bhutan	1.6	2.8	8.9
THIM	Bhutan	1.7	2.3	8.2
TSGG	Bhutan	3.3	2.6	6.2
WNGD	Bhutan	2.0	1.9	5.2
HKKT	Hong Kong (China)	2.2	2.1	8.2
HKLT	Hong Kong (China)	1.8	2.8	7.1
HKQT	Hong Kong (China)	1.0	3.3	10.9
HKSC	Hong Kong (China)	1.7	3.4	12.3
HKSL	Hong Kong (China)	2.0	2.6	6.5
HKST	Hong Kong (China)	2.3	2.3	7.3
KYC1	Hong Kong (China)	1.8	3.1	5.6
T430	Hong Kong (China)	2.3	1.1	5.0
1891	India	2.0	4.1	11.3
5185	India	1.7	3.0	14.1
DEHD	India	2.6	1.7	3.6
GCP_	India	1.7	2.9	3.7
JABA	India	2.1	3.4	9.6
JAIP	India	1.3	2.0	8.2
KGDC	India	1.9	3.8	12.5
KOLK	India	1.2	1.8	9.0
NAGR	India	3.2	1.6	10.6

Station	Country	North (mm)	East (mm)	Up (mm)
PALM	India	2.6	3.5	9.4
PTBL	India	1.8	3.4	8.9
PUNE	India	1.4	1.8	5.5
RANC	India	1.7	4.0	13.7
SHIL	India	3.2	2.5	6.2
TRIV	India	2.1	3.8	5.6
AMAN	Malaysia	2.1	2.5	7.6
ARAU	Malaysia	1.8	3.5	11.9
BEHR	Malaysia	1.2	5.4	7.9
BIN1	Malaysia	3.2	1.7	13.2
GMUS	Malaysia	1.8	3.6	8.8
GRIK	Malaysia	2.2	3.5	5.9
JHJY	Malaysia	2.3	3.8	9.9
KUAL	Malaysia	2.0	3.3	9.1
LAB1	Malaysia	1.7	9.5	9.5
MIRI	Malaysia	2.3	2.9	12.4
MTAW	Malaysia	0.2	2.2	2.6
PDIC	Malaysia	2.0	3.4	4.8
PEKN	Malaysia	2.1	2.8	6.5
SEG1	Malaysia	1.9	3.1	9.5
TLOH	Malaysia	1.9	1.3	11.1
UMAS	Malaysia	2.5	2.1	5.9
UMSS	Malaysia	0.2	2.2	2.5
USMP	Malaysia	1.8	2.4	12.1
DOA1	Mongolia	1.8	1.3	4.5
HOA1	Mongolia	1.2	1.7	2.9
HUV1	Mongolia	1.8	0.9	5.2
OMA1	Mongolia	0.7	1.3	4.0
OVA1	Mongolia	0.9	1.0	3.4
UB01	Mongolia	1.7	1.0	4.0
1233	Myanmar	1.0	2.5	10.1
POL1	Myanmar	0.4	3.4	9.2
PBAT	Philippines	1.8	2.1	10.6
PBOG	Philippines	1.3	1.7	5.0
PCB2	Philippines	2.1	2.0	4.1
PCDN	Philippines	1.2	2.2	12.3

Station	Country	North (mm)	East (mm)	Up (mm)
PCEB	Philippines	2.8	2.2	12.3
PCOT	Philippines	1.8	1.4	7.2
PCRT	Philippines	1.8	1.9	3.3
PDAV	Philippines	1.7	2.0	2.7
PDDN	Philippines	1.7	2.2	4.0
PDUM	Philippines	2.0	2.3	4.8
PFLO	Philippines	1.8	2.1	7.3
PGM2	Philippines	2.3	1.6	5.9
PILC	Philippines	2.2	3.5	7.1
PILN	Philippines	1.0	1.7	5.4
PMAS	Philippines	1.9	2.1	5.1
PMOG	Philippines	3.8	3.0	8.7
PMRV	Philippines	1.0	2.0	0.6
PMSC	Philippines	2.3	1.4	5.2
PNAG	Philippines	1.9	3.1	4.8
PSJN	Philippines	1.5	1.1	6.2
PSRG	Philippines	2.7	3.5	5.9
PSTC	Philippines	3.1	1.4	9.9
PSTN	Philippines	1.5	2.1	6.0
PSUR	Philippines	2.7	3.6	9.2
PTAG	Philippines	1.9	2.9	6.9
PTGO	Philippines	0.1	1.8	2.5
PTGY	Philippines	2.2	1.8	4.6
PTLC	Philippines	1.6	1.5	3.8
PURD	Philippines	1.0	1.6	5.9
PVIG	Philippines	1.3	1.9	11.2
PZAM	Philippines	2.1	2.3	9.5
SLYG	Singapore	1.5	3.7	6.1
SNUS	Singapore	2.0	3.2	8.1
SNYU	Singapore	3.4	2.5	6.8
SRPT	Singapore	1.9	4.1	7.2
SSMK	Singapore	1.6	3.6	8.6
SSTS	Singapore	0.9	3.6	7.1
T00B	Tonga	1.4	2.9	6.8
DIEB	Vietnam	1.6	4.9	8.5
DSON	Vietnam	2.0	4.5	7.9

Station	Country	North (mm)	East (mm)	Up (mm)
EAHL	Vietnam	2.0	2.8	6.4
HGIA	Vietnam	1.5	3.8	4.9
HTIE	Vietnam	2.1	3.4	6.7
KANH	Vietnam	1.4	3.5	9.1
QNAM	Vietnam	1.3	3.0	8.8
VUNT	Vietnam	2.6	4.3	6.6

The final computed Cartesian and geodetic coordinates (ITRF2014, GRS80 ellipsoid) are listed in Table 2 and Table 3, respectively, along with their formal error estimates. These estimates provide an indication of the quality of the measurements; they only characterise the internal precision of positioning performance and should not be taken as realistic estimates of position accuracy. More realistic estimates of station positioning uncertainty are provided by the RMS statistics given in Table 1. Note that the listed coordinates are at the mean epoch of the measurements in the ITRF2014 reference frame, and only for the campaign sites, the weekly coordinates of other CGPS stations of APREF project can be found in http://www.ga.gov.au/scientific-topics/positioning-navigation/geodesy/asia-pacific-reference-frame . The solutions in Solution Independent Exchange (SINEX) format can be found in the ftp link: ftp://ftp.ga.gov.au/geodesy-outgoing/apref/APRGP/. There is no solution for the stations from Brunei due to data quality issues.

Table 2 The final computed Cartesian coordinates in ITRF2014 at the mean epoch of the measurements, i.e. @2021.707 (in decimal year).

Station	X (m)	1 std (m)	Y (m)	1 std (m)	Z (m)	1 std (m)
1233	-634106.7679	0.0003	5968827.7154	0.0007	2149806.5783	0.0003
1891	1255391.6088	0.0004	5343000.8361	0.0012	3238812.3105	0.0007
5185	1748671.1085	0.0005	5598210.6064	0.0013	2498202.5980	0.0006
AMAN	-2332692.0654	0.0004	5934767.9969	0.0010	135097.2004	0.0003
ARAU	-1131052.0330	0.0006	6236311.6666	0.0017	711747.9399	0.0004
BEHR	-1270756.8922	0.0005	6236377.8737	0.0013	416063.8499	0.0003
BIN1	-2497850.3308	0.0005	5857731.5850	0.0011	358111.8408	0.0003
BUMT	-71428.9490	0.0003	5661326.3507	0.0010	2933192.7594	0.0006
DEHD	1140604.4723	0.0002	5391407.0254	0.0005	3201808.1511	0.0004
DGPL	4325.7695	0.0002	5691433.4102	0.0007	2872268.9954	0.0004
DIEB	-1336847.2798	0.0004	5787979.2372	0.0010	2315717.0632	0.0004
DOA1	-1772383.0782	0.0003	3884842.2180	0.0004	4722955.5698	0.0004
DSON	-1724386.9315	0.0006	5714538.8202	0.0012	2239949.3865	0.0005
EAHL	-1940045.8380	0.0005	5967333.3145	0.0010	1895525.3065	0.0004
GMUS	-1317445.3966	0.0005	6217407.6321	0.0013	537097.9743	0.0003
GRIK	-1225760.9062	0.0005	6230325.9122	0.0014	600544.0523	0.0003
HGIA	-1518217.0522	0.0007	5682319.4999	0.0015	2459169.4023	0.0007
HKKT	-2405144.6116	0.0005	5385195.0159	0.0008	2420032.2969	0.0004
HKLT	-2399063.4494	0.0003	5389237.6108	0.0005	2417326.8148	0.0003
HKQT	-2421568.5994	0.0007	5384910.3210	0.0011	2404264.1523	0.0006
HKSC	-2414267.6277	0.0005	5386768.7425	0.0008	2407459.7851	0.0004
HKSL	-2393383.1317	0.0004	5393860.9363	0.0006	2412592.1671	0.0003
HKST	-2417143.5910	0.0004	5382345.2520	0.0007	2415036.7082	0.0004
HOA1	-124480.6757	0.0002	4274103.0177	0.0005	4718553.5540	0.0005
HTIE	-1566049.4585	0.0006	6076067.8828	0.0016	1140478.3891	0.0003
HUV1	-730630.8708	0.0003	4074608.0658	0.0007	4837618.4255	0.0007
JABA	1028191.0482	0.0005	5775380.6915	0.0017	2496125.1784	0.0007
JAIP	1396816.9061	0.0003	5514751.1323	0.0006	2875200.8361	0.0004
JHJY	-1520490.4075	0.0004	6191944.3852	0.0012	169912.6449	0.0003
KANG	-150882.0266	0.0002	5671995.7725	0.0007	2907343.0072	0.0004
KANH	-1700737.5581	0.0004	5821573.0827	0.0008	1967522.4740	0.0004

Station	X (m)	1 std (m)	Y (m)	1 std (m)	Z (m)	1 std (m)
KGDC	1332847.0930	0.0005	6073840.0265	0.0014	1417538.8420	0.0005
KOLK	169179.7914	0.0025	5891004.8318	0.0115	2430555.0413	0.0047
KUAL	-1443668.6570	0.0005	6184650.1125	0.0013	587309.8290	0.0003
KYC1	-2408855.9658	0.0004	5391042.9880	0.0007	2403590.8852	0.0004
LAB1	-2708735.6340	0.0046	5744698.3646	0.0074	583318.7130	0.0017
MIRI	-2586925.5720	0.0006	5809853.2440	0.0012	482986.8267	0.0003
MTAW	-2974552.9102	0.0022	5622305.9266	0.0034	470932.3375	0.0009
NAGR	1396171.4932	0.0004	5181845.7031	0.0008	3435721.2678	0.0006
OMA1	-1148361.7959	0.0003	4482078.5438	0.0006	4377422.5436	0.0006
OVA1	-977156.8503	0.0002	4308800.7221	0.0005	4587095.4868	0.0004
PALM	1252182.9398	0.0005	5463690.0180	0.0015	3033294.7371	0.0009
PBAT	-3082933.5035	0.0005	5224292.1934	0.0009	1964073.7400	0.0004
PBOG	-3499087.8795	0.0003	5191752.5136	0.0005	1214049.9884	0.0002
PCB2	-3161494.9133	0.0005	5274362.8383	0.0007	1687745.6143	0.0003
PCDN	-3088458.5125	0.0005	5255341.0998	0.0007	1870978.2396	0.0003
PCEB	-3499372.6142	0.0007	5209601.9213	0.0010	1134905.1085	0.0003
PCOT	-3561309.0521	0.0006	5231065.2577	0.0009	794050.1494	0.0004
PCRT	-3504293.6234	0.0005	5220264.5294	0.0007	1068957.8878	0.0003
PDAV	-3688320.1612	0.0004	5143554.7258	0.0005	786028.7130	0.0002
PDDN	-3698127.2967	0.0005	5130740.7620	0.0007	822545.2907	0.0003
PDIC	-1304198.1160	0.0005	6237114.2762	0.0012	279242.6962	0.0003
PDUM	-3455857.4325	0.0006	5261024.5530	0.0007	1026318.8258	0.0003
PEKN	-1474284.9573	0.0005	6193341.5199	0.0013	385958.5768	0.0003
PFLO	-3127779.9985	0.0005	5310053.4662	0.0008	1638299.4838	0.0003
PGM2	-3290628.6421	0.0005	5245351.3654	0.0007	1524422.2544	0.0003
PHUN	60145.8076	0.0003	5694448.5564	0.0008	2863591.2273	0.0004
PILC	-3372132.9341	0.0006	5282112.8047	0.0008	1183262.8389	0.0003
PILN	-3219618.7206	0.0005	5178601.7179	0.0008	1864088.4400	0.0003
PMAS	-3450753.0304	0.0006	5188376.7412	0.0008	1357309.2529	0.0004
PMOG	-3274635.9466	0.0007	5269089.7780	0.0010	1476547.3658	0.0004
PMRV	-3134714.2191	0.0012	5323767.3314	0.0019	1579758.3329	0.0006
PMSC	-3068374.5059	0.0003	5325915.1728	0.0004	1697541.4176	0.0002
PNAG	-3394666.2300	0.0005	5187872.3840	0.0006	1492904.9106	0.0003

Station	X (m)	1 std (m)	Y (m)	1 std (m)	Z (m)	1 std (m)
POL1	-666918.1308	0.0004	5878675.9792	0.0013	2377399.8577	0.0005
PSJN	-3228520.3508	0.0005	5287794.8281	0.0007	1510623.8146	0.0003
PSRG	-3478357.1898	0.0006	5152038.4636	0.0008	1423144.4494	0.0003
PSTC	-3222394.2038	0.0006	5276124.9630	0.0008	1563214.8314	0.0003
PSTN	-3219843.9568	0.0005	5124937.7597	0.0007	2005414.5495	0.0004
PSUR	-3649682.9894	0.0006	5117857.9089	0.0009	1077577.7849	0.0003
PTAG	-3184318.5722	0.0006	5291065.5842	0.0009	1590418.2784	0.0003
PTBL	-298530.6081	0.0002	6240614.9366	0.0007	1278761.8252	0.0003
PTGO	-3596112.0039	0.0013	5182802.6373	0.0024	939355.0930	0.0006
PTGY	-3181284.7708	0.0005	5307488.5913	0.0008	1543919.7151	0.0003
PTLC	-3128650.4390	0.0003	5292970.9449	0.0005	1690799.4420	0.0002
PUNE	1679352.3776	0.0003	5811229.8753	0.0008	2017151.6426	0.0004
PURD	-3119484.8941	0.0006	5279888.9398	0.0009	1747197.1183	0.0004
PVIG	-3074264.8444	0.0004	5248848.6043	0.0006	1911809.7562	0.0003
PZAM	-3361516.2011	0.0007	5365985.9544	0.0012	764311.8705	0.0004
QNAM	-1939181.9815	0.0005	5824574.8973	0.0010	1724681.8665	0.0005
RANC	478231.7357	0.0003	5839998.1194	0.0012	2512209.1731	0.0007
SEG1	-1404378.4439	0.0005	6215518.6495	0.0013	274837.3222	0.0003
SHIL	-189399.2821	0.0003	5755480.2889	0.0011	2736393.1398	0.0006
SLYG	-1539524.8370	0.0003	6187725.8719	0.0008	151763.8532	0.0003
SNUS	-1518383.3359	0.0003	6193172.5728	0.0007	142897.1342	0.0002
SNYU	-1508025.9301	0.0008	6195576.1057	0.0022	148798.1912	0.0006
SRPT	-1519249.6637	0.0004	6192544.7094	0.0010	159623.9982	0.0003
SSMK	-1518411.4249	0.0004	6193330.4644	0.0012	133831.2688	0.0003
SSTS	-1504600.3285	0.0004	6196616.3633	0.0011	137086.1964	0.0003
T00B	-5933921.4215	0.0008	-482004.0375	0.0003	-2280909.9436	0.0004
T430	-2411015.9420	0.0005	5380265.4807	0.0010	2425132.4557	0.0004
THIM	36547.6789	0.0003	5664531.3253	0.0010	2926613.4854	0.0006
TLOH	-1369260.5224	0.0295	6217732.0841	0.0509	381198.0068	0.0156
TRIV	1422704.9948	0.0003	6147290.9619	0.0007	928074.6325	0.0002
TSGG	-150915.0304	0.0004	5672006.2238	0.0015	2907305.3320	0.0008
UB01	-1245727.5010	0.0003	4097907.9986	0.0006	4711968.0308	0.0006
UMAS	-2225109.3846	0.0006	5975252.5230	0.0013	162341.0478	0.0004

Station	X (m)	1 std (m)	Y (m)	1 std (m)	Z (m)	1 std (m)
UMSS	-2791752.4142	0.0025	5695647.4525	0.0038	666580.5208	0.0009
USMP	-1135919.7804	0.0006	6248058.3917	0.0018	591589.4228	0.0004
VUNT	-1849587.1886	0.0006	5995310.0361	0.0014	1143318.5691	0.0005
WNGD	2192.7787	0.0003	5662375.9339	0.0008	2930000.1218	0.0005

Table 3 The final computed Geodetic coordinates in ITRF2014 at the mean epoch of the measurements, i.e. @2021.707 (in decimal year).

Station	LONGITUDE (DMS)			1 std (m)	LATITUDE (DMS)			1 std (m)	ELLIPSOID HEIGHT (m)	1 std (m)
1233	96	3	50.94689	0.0003	19	49	40.13675	0.0002	92.4782	0.0008
1891	76	46	39.42974	0.0004	30	42	50.13584	0.0003	284.8044	0.0014
5185	72	39	11.34886	0.0004	23	12	38.97866	0.0003	20.2601	0.0014
AMAN	111	27	27.25797	0.0003	1	13	18.69069	0.0003	52.2184	0.0010
ARAU	100	16	47.06366	0.0004	6	27	0.56377	0.0004	17.9961	0.0017
BEHR	101	31	1.97468	0.0004	3	45	55.32883	0.0003	68.6917	0.0013
BIN1	113	5	39.62352	0.0003	3	14	25.13909	0.0003	58.9816	0.0011
BUMT	90	43	22.30478	0.0003	27	32	40.95281	0.0003	2873.5545	0.0012
DEHD	78	3	16.76832	0.0002	30	19	28.38361	0.0002	648.7074	0.0006
DGPL	89	57	23.22863	0.0002	26	56	0.80926	0.0002	1357.5428	0.0007
DIEB	103	0	19.85921	0.0003	21	25	39.95690	0.0003	463.7893	0.0011
DOA1	114	31	26.08634	0.0002	48	4	28.00313	0.0003	731.7167	0.0006
DSON	106	47	29.10047	0.0004	20	41	45.86144	0.0003	1.6026	0.0013
EAHL	108	12	5.27910	0.0003	13	12	54.76426	0.0003	642.2763	0.0011
GCP_	78	33	15.35106	0.0003	17	24	9.45013	0.0003	421.1004	0.0010
GMUS	101	57	49.67207	0.0004	4	51	46.70364	0.0003	125.9613	0.0013
GRIK	101	7	49.00252	0.0004	5	26	20.44003	0.0003	149.1721	0.0014
HGIA	104	57	32.44803	0.0004	22	49	39.13866	0.0004	107.9447	0.0017
HKKT	114	3	59.66051	0.0003	22	26	41.65357	0.0003	34.5489	0.0009
HKLT	113	59	47.87056	0.0002	22	25	5.27463	0.0002	125.9020	0.0006
HKQT	114	12	47.60362	0.0003	22	17	27.71818	0.0003	5.1508	0.0013
HKSC	114	8	28.30273	0.0003	22	19	19.81126	0.0003	20.2067	0.0010
HKSL	113	55	40.75926	0.0002	22	22	19.20911	0.0002	95.2717	0.0007
HKST	114	11	3.29640	0.0002	22	23	42.96620	0.0002	258.6999	0.0008
HOA1	91	40	5.64056	0.0002	48	0	31.57617	0.0003	1378.6764	0.0007

Station	LONGITUDE (DMS)			1 std (m)	LATITUDE (DMS)			1 std (m)	ELLIPSOID HEIGHT (m)	1 std (m)
HTIE	104	27	10.41550	0.0004	10	22	10.35786	0.0004	-4.9232	0.0017
HUV1	100	9	57.06527	0.0003	49	38	9.81253	0.0003	1243.4475	0.0009
JABA	79	54	19.41791	0.0004	23	11	21.20768	0.0004	329.0440	0.0019
JAIP	75	47	11.83310	0.0002	26	58	3.03974	0.0002	426.1265	0.0007
JHJY	103	47	47.52730	0.0004	1	32	12.51300	0.0003	39.1677	0.0013
KANG	91	31	25.60252	0.0002	27	17	12.93085	0.0002	1823.4206	0.0008
KANH	106	17	7.46045	0.0003	18	5	12.74132	0.0003	-13.7880	0.0009
KGDC	77	37	23.36417	0.0004	12	55	31.27419	0.0003	810.4941	0.0014
KOLK	88	21	18.04793	0.0024	22	32	53.08000	0.0020	-51.6996	0.0123
KUAL	103	8	20.93961	0.0004	5	19	7.99732	0.0003	55.0397	0.0013
KYC1	114	4	34.73037	0.0003	22	17	2.58138	0.0003	116.3458	0.0009
LAB1	115	14	41.20088	0.0020	5	16	57.50493	0.0014	57.2524	0.0085
MIRI	114	0	6.28873	0.0004	4	22	19.55730	0.0003	62.3584	0.0012
MTAW	117	52	53.94589	0.0009	4	15	45.97955	0.0008	72.8479	0.0039
NAGR	74	55	14.13287	0.0003	32	48	8.47295	0.0003	307.2257	0.0010
OMA1	104	22	14.62599	0.0003	43	36	19.30021	0.0003	1416.5304	0.0008
OVA1	102	46	39.02675	0.0002	46	15	59.73675	0.0003	1816.9423	0.0006
PALM	77	5	30.19712	0.0004	28	34	52.04709	0.0004	166.4846	0.0017
PBAT	120	32	43.78129	0.0003	18	3	14.05344	0.0003	51.7350	0.0010
PBOG	123	58	43.70391	0.0002	11	2	46.67640	0.0002	88.5250	0.0006
PCB2	120	56	19.70365	0.0003	15	26	45.80186	0.0003	78.7234	0.0008
PCDN	120	26	30.83748	0.0003	17	10	16.93094	0.0003	55.3329	0.0008
PCEB	123	53	23.59248	0.0003	10	19	5.18741	0.0003	126.9362	0.0012
PCOT	124	14	49.31731	0.0003	7	11	58.57271	0.0003	86.1723	0.0011
PCRT	123	52	22.55757	0.0003	9	42	45.87546	0.0003	76.5003	0.0009
PDAV	125	38	36.25023	0.0002	7	7	35.36370	0.0002	96.7556	0.0006
PDDN	125	46	59.70044	0.0003	7	27	33.75711	0.0003	90.5574	0.0008
PDIC	101	48	37.93038	0.0004	2	31	34.23086	0.0003	31.1715	0.0013
PDUM	123	18	0.28038	0.0003	9	19	18.62546	0.0003	88.3872	0.0009
PEKN	103	23	22.90093	0.0004	3	29	33.34718	0.0003	26.0019	0.0013
PFLO	120	29	57.67757	0.0003	14	58	58.56025	0.0003	90.7673	0.0009
PGM2	122	6	6.37550	0.0003	13	55	12.47792	0.0003	65.9226	0.0009

Station	LONGITUDE (DMS)			1 std (m)	LATITUDE (DMS)			1 std (m)	ELLIPSOID HEIGHT (m)	1 std (m)
PHUN	89	23	41.47439	0.0003	26	51	0.44212	0.0003	403.4283	0.0009
PILC	122	33	15.87027	0.0003	10	45	46.38397	0.0003	71.4546	0.0010
PILN	121	52	11.53662	0.0003	17	6	21.79872	0.0003	115.4504	0.0009
PMAS	123	37	39.36168	0.0003	12	22	8.03384	0.0003	80.1516	0.0010
PMOG	121	51	36.50585	0.0003	13	28	29.11391	0.0003	62.8281	0.0012
PMRV	120	29	24.77813	0.0005	14	26	9.59680	0.0005	59.2498	0.0022
PMSC	119	56	49.81776	0.0002	15	32	16.70385	0.0002	57.2644	0.0005
PNAG	123	11	54.92413	0.0002	13	37	36.53253	0.0002	73.1204	0.0007
POL1	96	28	20.50257	0.0003	22	1	31.24682	0.0003	1026.4886	0.0013
PSJN	121	24	23.77376	0.0003	13	47	30.03938	0.0003	66.6164	0.0009
PSRG	124	1	29.77033	0.0003	12	58	44.01482	0.0003	64.8491	0.0010
PSTC	121	24	52.22121	0.0003	14	16	53.93887	0.0003	62.4626	0.0010
PSTN	122	8	23.67057	0.0003	18	26	49.98710	0.0003	42.4919	0.0009
PSUR	125	29	37.30412	0.0003	9	47	30.52457	0.0003	80.2282	0.0010
PTAG	121	2	26.74883	0.0003	14	32	7.59152	0.0003	86.6509	0.0010
PTBL	92	44	19.51762	0.0002	11	38	35.23330	0.0002	1.2671	0.0007
PTGO	124	45	18.10454	0.0008	8	31	33.32333	0.0006	91.5533	0.0026
PTGY	120	56	17.81719	0.0003	14	6	1.02633	0.0003	715.4885	0.0009
PTLC	120	35	13.68800	0.0002	15	28	28.58157	0.0002	112.3128	0.0005
PUNE	73	52	53.59040	0.0003	18	33	27.60162	0.0002	494.3599	0.0009
PURD	120	34	32.20131	0.0003	16	0	15.10655	0.0003	82.5297	0.0011
PVIG	120	21	27.43765	0.0002	17	33	28.65789	0.0002	41.8434	0.0007
PZAM	122	3	54.15367	0.0003	6	55	43.13716	0.0003	84.2290	0.0014
QNAM	108	24	51.13218	0.0003	15	47	34.22873	0.0003	3.3121	0.0011
RANC	85	19	6.78108	0.0004	23	20	46.80158	0.0003	578.3059	0.0014
SEG1	102	43	55.28394	0.0004	2	29	10.67364	0.0003	28.5293	0.0013
SHIL	91	53	5.23973	0.0003	25	33	56.85260	0.0003	1496.6312	0.0012
SLYG	103	58	18.03803	0.0003	1	22	21.44527	0.0003	50.4918	0.0008
SNUS	103	46	31.86164	0.0002	1	17	32.68560	0.0002	62.7209	0.0008
SNYU	103	40	47.94542	0.0006	1	20	44.84627	0.0006	75.5713	0.0023
SRPT	103	47	3.91699	0.0003	1	26	37.41733	0.0003	58.7527	0.0010
SSMK	103	46	31.52796	0.0004	1	12	37.48552	0.0003	24.7269	0.0012

Station	LONGITUDE (DMS)			1 std (m)	LATITUDE (DMS)			1 std (m)	ELLIPSOID HEIGHT (m)	1 std (m)
SSTS	103	38	52.32359	0.0003	1	14	23.48887	0.0003	12.8712	0.0012
T00B	-17	-21	-22.10597	0.0003	-21	-5	-30.77254	0.0003	57.3959	0.0009
T430	114	8	17.54316	0.0003	22	29	40.98741	0.0003	41.3032	0.0011
THIM	89	37	49.19347	0.0003	27	28	48.37135	0.0003	2381.7809	0.0012
TLOH	102	25	9.72110	0.0209	3	26	58.01666	0.0131	56.9363	0.0557
TRIV	76	58	8.80347	0.0002	8	25	22.62182	0.0002	-17.9126	0.0007
TSGG	91	31	26.79176	0.0004	27	17	11.67472	0.0004	1816.2137	0.0017
UB01	106	54	31.69533	0.0003	47	55	16.82484	0.0003	1277.8780	0.0007
UMAS	110	25	28.92741	0.0004	1	28	5.91048	0.0004	51.3570	0.0014
UMSS	116	6	43.32212	0.0011	6	2	21.23271	0.0008	76.3515	0.0044
USMP	100	18	14.54450	0.0004	5	21	28.03052	0.0004	19.7970	0.0019
VUNT	107	8	43.04912	0.0004	10	23	44.27266	0.0004	5.5398	0.0015
WNGD	89	58	40.12310	0.0003	27	31	0.01410	0.0003	1929.3822	0.0009

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