



GOVERNMENT IMPLEMENTING AGENCY
AGENCY FOR LAND ADMINISTRATION AND
MANAGEMENT, GEODESY AND
CARTOGRAPHY

United Nations International Meeting on the Applications of Global Navigation Satellite Systems **VIENNA INTERNATIONAL CENTRE**

VIENNA, AUSTRIA,
5 - 9 DECEMBER 2022

GPS, GNSS based Online Data Processing System “MONPOS”

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Senior Officer of GNSS
ZOLZAYA. Lkhamsuren





1. CORS network - Continuously Operating Reference Station

Regulation, technical framework

Fundamental Geodetic Network

2. System Application

- Environment
- National Geodetic network development (Online Processing System based PPP technique)
- Velocity
- RTK service (surveying field)
- Real time monitoring of position

MONPOS.GAZAR.GOV.MN

ГАЗАР ЗОХИОН БАЙГУУЛАЛТ ГЕОДЕЗИ, ЗУРАГ ЗҮЙН ГАЗАР



Guideline to establish GPS CORS, Ministry of MCUD, 2011, order № 131

Requirements of CORS monument and its preparation

- <http://kb.unavco.org/kb/article/procedures-for-setting-a-cors-monument-600.html>
- <http://kb.unavco.org/kb/file.php?id=504>

Technical requirements of CORS environment (soil, ionosphere, approvals of local governor)

Technical qualification and limits

Antenna

- <http://kb.unavco.org/kb/article/choke-ring-antenna-calibrations-311.html>
- <http://kb.unavco.org/kb/file.php?id=136>

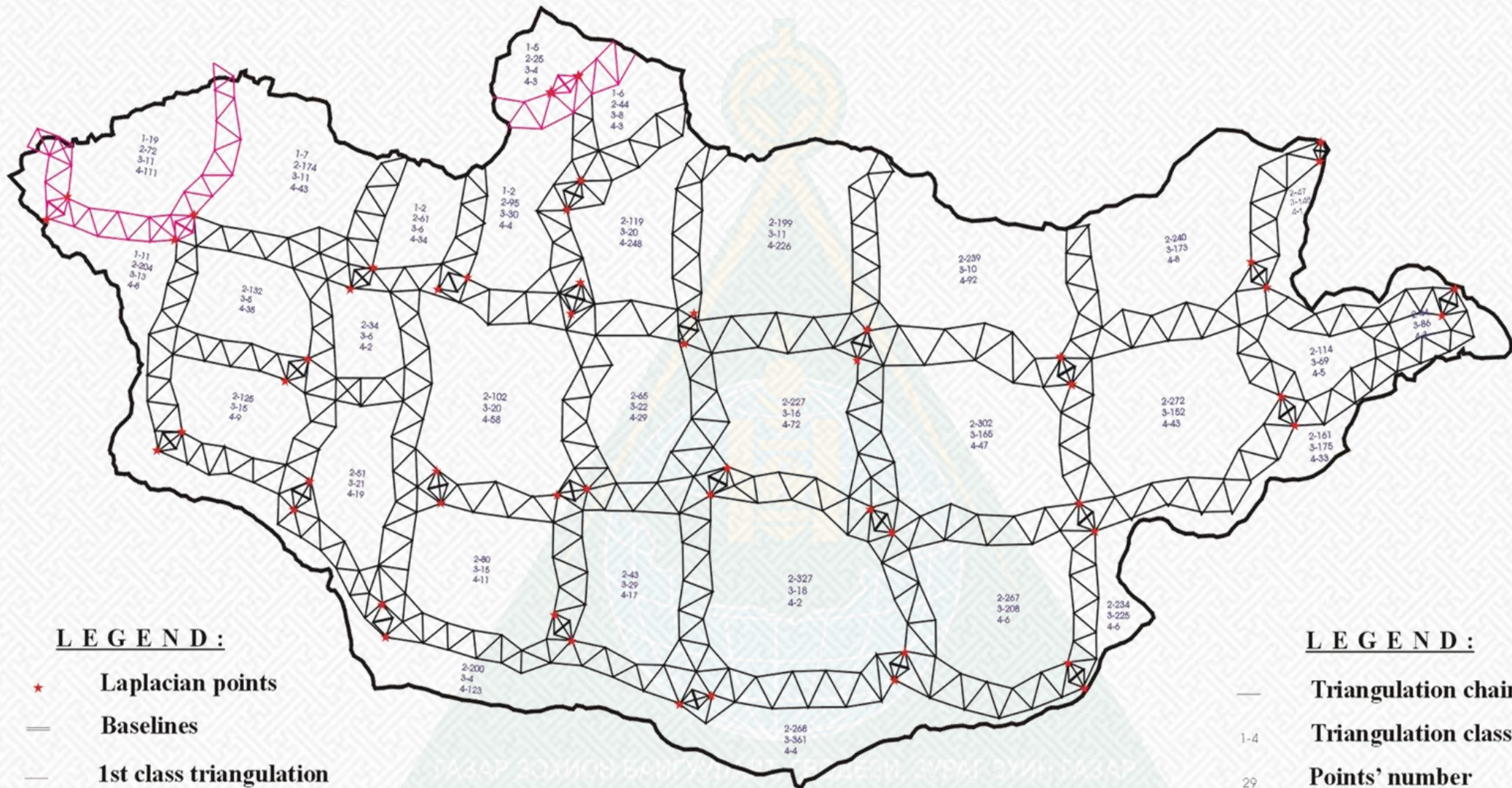
Receiver

- <http://kb.unavco.org/kb/article/gnss-receiver-and-antenna-power-compatibilities-492.html>
- <http://kb.unavco.org/kb/article/gps-receiver-and-antenna-testing-report-for-suominet-2000-51.html>

CORS products (data format, naming, storage, security)

- <https://www.unavco.org/data/gps-gnss/gps-gnss.html>

TRIANGULATION NETWORK of MONGOLIA



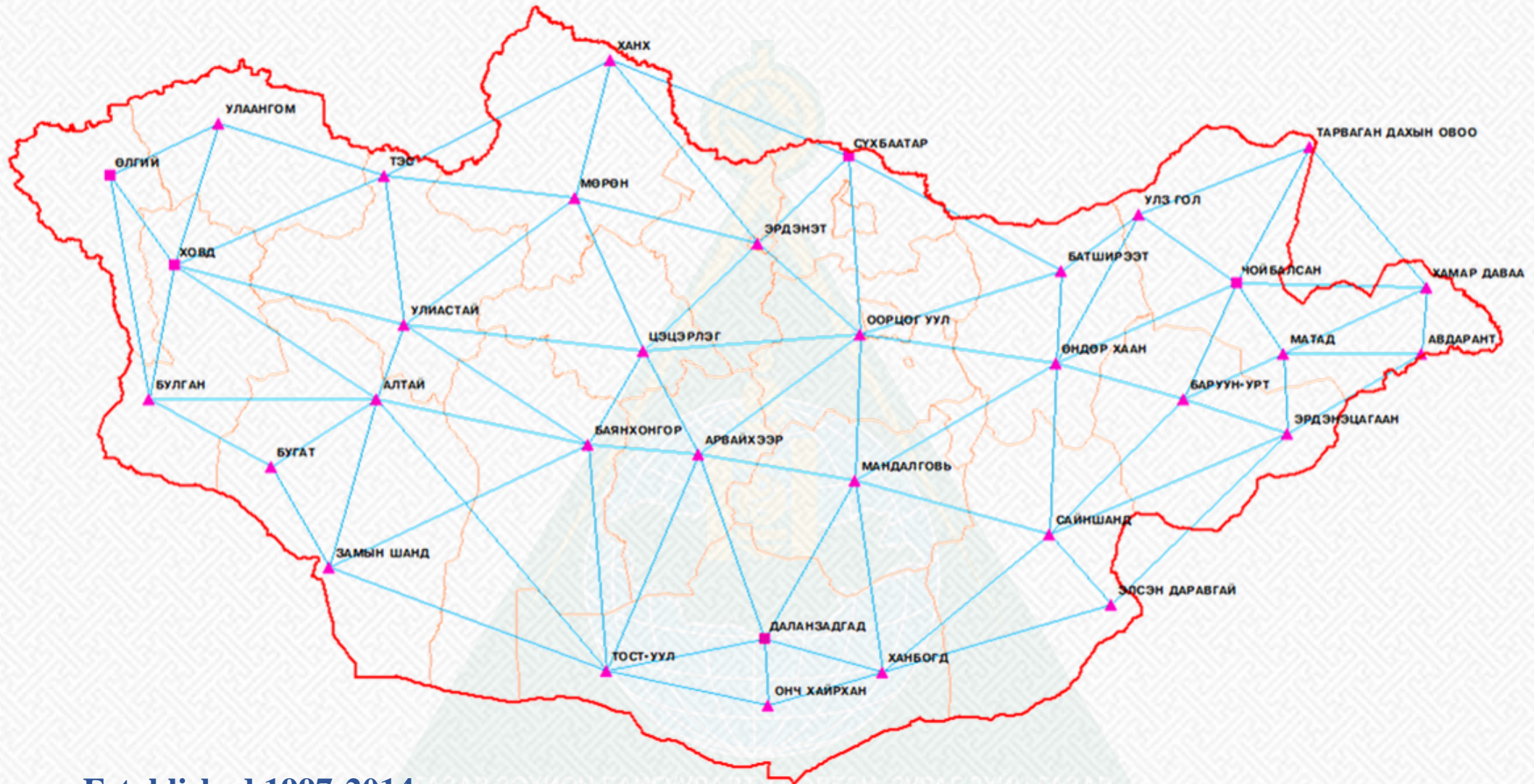
LEGEND :

- ★ Laplacian points
- Baselines
- 1st class triangulation

LEGEND :

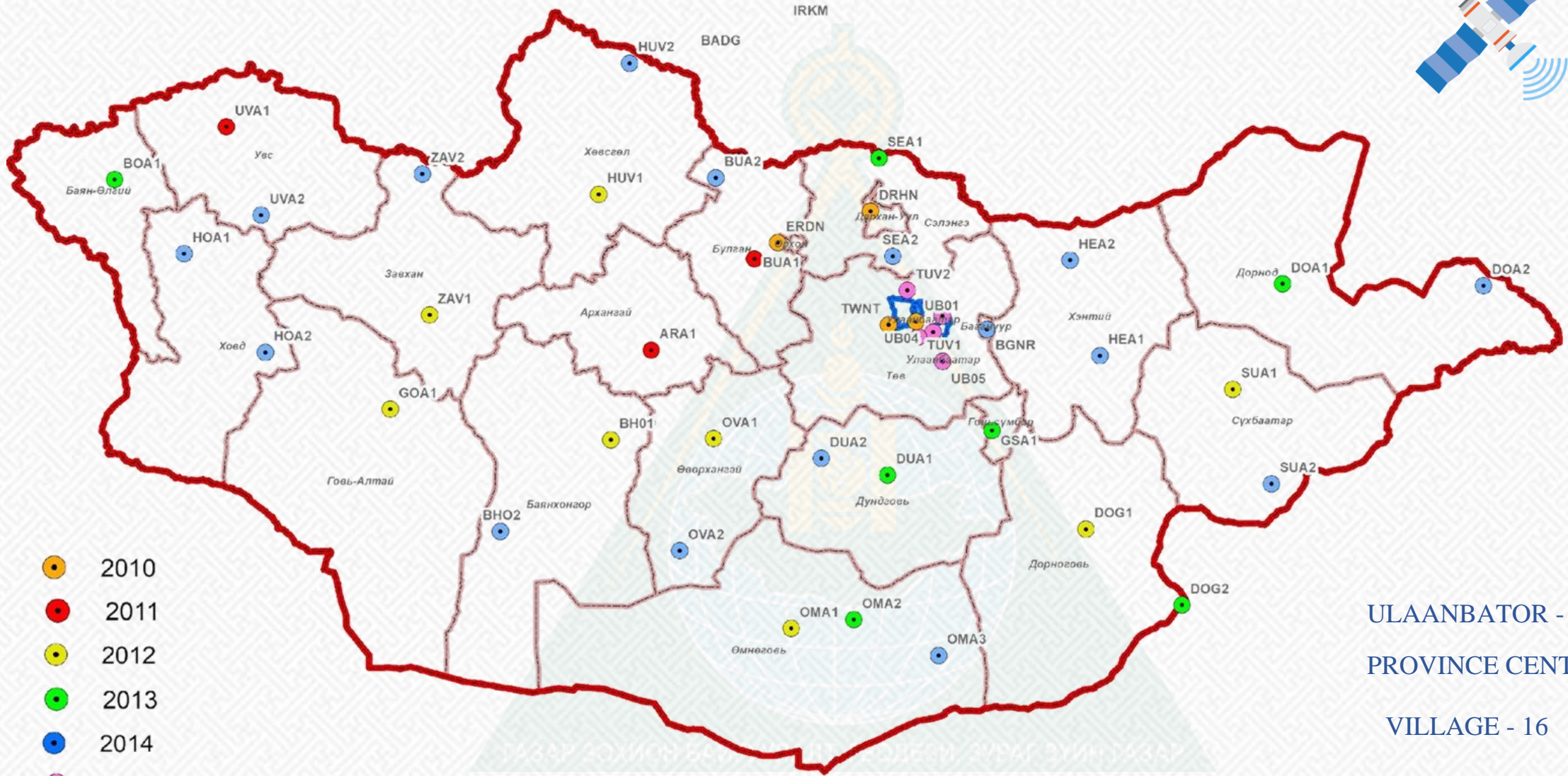
- Triangulation chain
- 1-4 Triangulation classes
- 29 Points' number

GPS GENERAL NETWORK of MONGOLIA



Established 1997-2014

The network classification of general, sub, mapping . Totally 3500 point



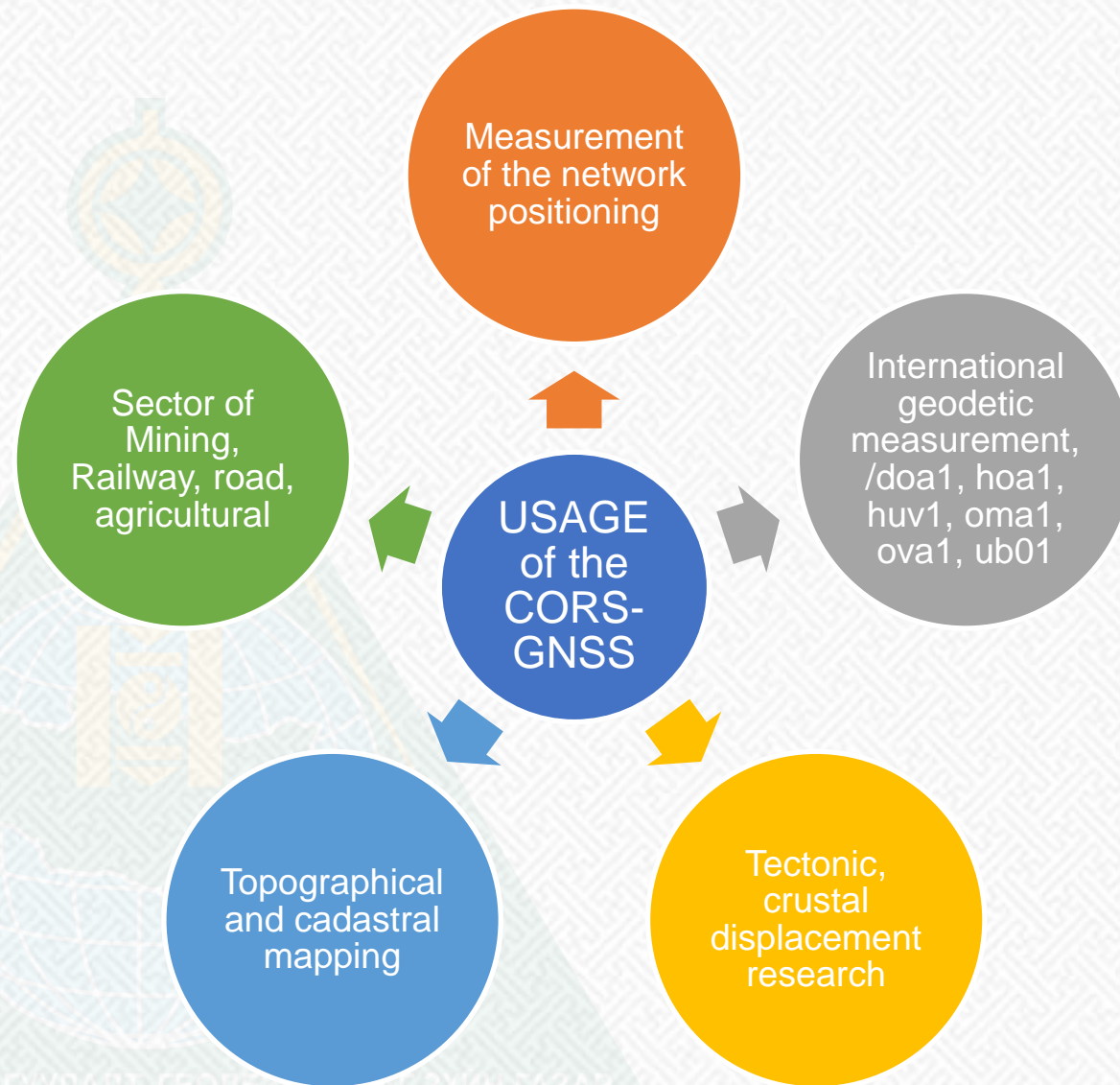
- 2010
- 2011
- 2012
- 2013
- 2014
- 2017

ULAANBATOR - 6
 PROVINCE CENTER - 21
 VILLAGE - 16

GNSS- CORS Application



1. Monument
2. On the Building



Velocity calculation/Epoch transformation



CORS ITRF2008.2005 Coordinate Comparison (ZAV1)

EPOCH	AUSPOS ITRF2014@epoch			GAMIT ITRF2014@epoch			dx	dy	dz
1/3/2015	-512176.526	4267410.314	4699017.313	-512176.527	4267410.307	4699017.312	0.001	0.007	0.001
1/3/2016	-512176.556	4267410.317	4699017.311	-512176.559	4267410.301	4699017.310	0.003	0.016	0.001
1/3/2017	-512176.587	4267410.317	4699017.311	-512176.590	4267410.304	4699017.312	0.003	0.013	-0.001
1/3/2018	-512176.618	4267410.321	4699017.309	-512176.625	4267410.306	4699017.316	0.007	0.015	-0.007
1/3/2019	-512176.651	4267410.324	4699017.305	-512176.641	4267410.296	4699017.290	-0.010	0.028	0.015
EPOCH	AUSPOS ITRF2008@epoch			GAMIT ITRF2008@epoch			dx	dy	dz
1/3/2015	-512176.525	4267410.317	4699017.316	-512176.5274	4267410.321	4699017.319	0.003	-0.005	-0.003
1/3/2016	-512176.555	4267410.320	4699017.314	-512176.5572	4267410.319	4699017.318	0.003	0.000	-0.004
1/3/2017	-512176.586	4267410.320	4699017.314	-512176.5888	4267410.322	4699017.315	0.003	-0.002	-0.002
1/3/2018	-512176.617	4267410.324	4699017.312	-512176.6171	4267410.325	4699017.316	0.001	-0.001	-0.004
1/3/2019	-512176.650	4267410.327	4699017.308	-512176.6477	4267410.325	4699017.312	-0.002	0.002	-0.004
EPOCH	CANADA ITRF2014@epoch			GAMIT ITRF2014@epoch			dx	dy	dz
1/3/2017	-512176.588	4267410.315	4699017.310	-512176.590	4267410.304	4699017.312	0.002	0.011	-0.002
1/3/2018	-512176.619	4267410.322	4699017.315	-512176.625	4267410.306	4699017.316	0.006	0.016	-0.001
1/3/2019	-512176.651	4267410.323	4699017.309	-512176.641	4267410.296	4699017.290	-0.010	0.027	0.020
EPOCH	CANADA ITRF2008@epoch			GAMIT ITRF2008@epoch			dx	dy	dz
1/3/2015	-512176.519	4267410.308	4699017.309	-512176.5274	4267410.321	4699017.319	0.008	-0.013	-0.010
1/3/2016	-512176.551	4267410.313	4699017.307	-512176.5572	4267410.319	4699017.318	0.006	-0.006	-0.011

#	Site	X (m)	Y (m)	Z (m)	vX (m/yr)	vY (m/yr)	vZ (m/yr)	Epoch
+REFERENCE_FRAME IGS08								
	BOA1_GPS	3288.12223	4197450.46715	4788430.37706	-0.02815	-0.00057	0.00051	2005.00
	ZAV1_GPS	-512176.22080	4267410.32653	4699017.35011	-0.03007	-0.00039	-0.00290	2005.00
	ZAV2_GPS	-458186.29043	4108620.24407	4842463.45994	-0.02646	0.00234	-0.00446	2005.00
	BHO2_GPS	-682421.51919	4483166.60788	4473369.62915	-0.02964	0.00123	-0.00571	2005.00
	OVA1_GPS	-977156.36008	4308800.74727	4587095.57416	-0.02972	-0.00127	-0.00510	2005.00
	OMA1_GPS	-1148361.26959	4482078.61841	4377422.61451	-0.03105	-0.00447	-0.00354	2005.00
	BUA1_GPS	-984543.69875	4091936.82657	4777922.21864	-0.02814	-0.00069	-0.00517	2005.00
	SEA1_GPS	-1140135.15738	3925546.52919	4880360.86513	-0.02867	-0.00159	-0.00539	2005.00
	UBO1_GPS	-1245727.08333	4097907.96320	4711968.10104	-0.02356	0.00081	-0.00689	2005.00
	GSA1_GPS	-1391414.48706	4185665.10237	4593318.16902	-0.02973	-0.00265	-0.00655	2005.00
	DOG2_GPS	-1720960.81763	4284249.88679	4387086.14338	-0.03108	-0.00463	-0.00762	2005.00
	SUA1_GPS	-1733071.50643	4026927.95757	4618414.64133	-0.03004	-0.00479	-0.00705	2005.00

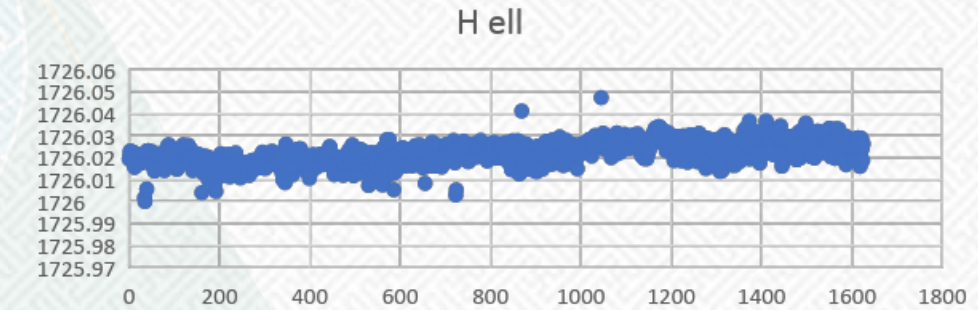
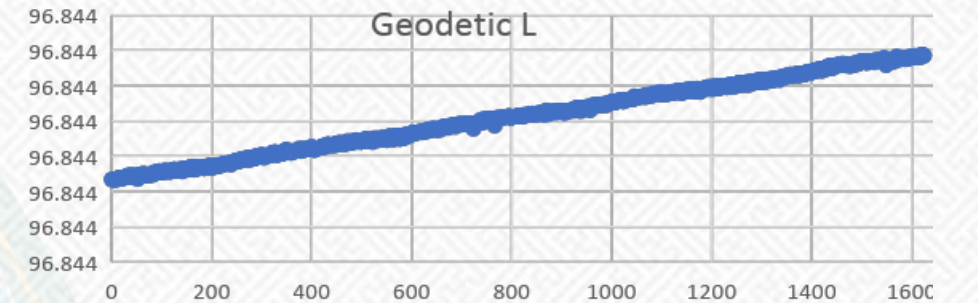
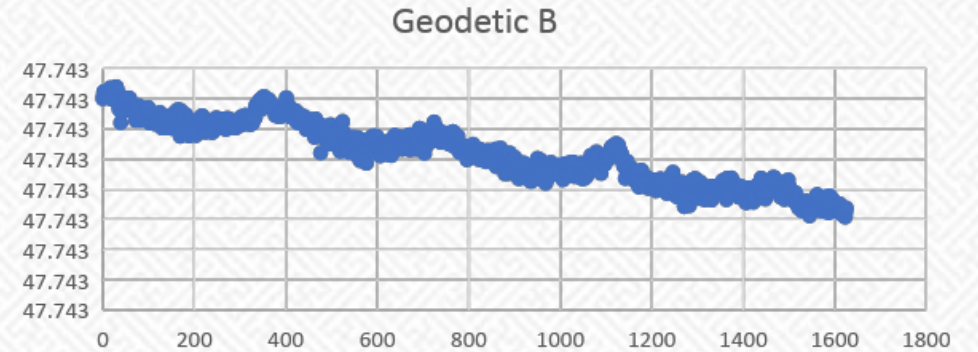
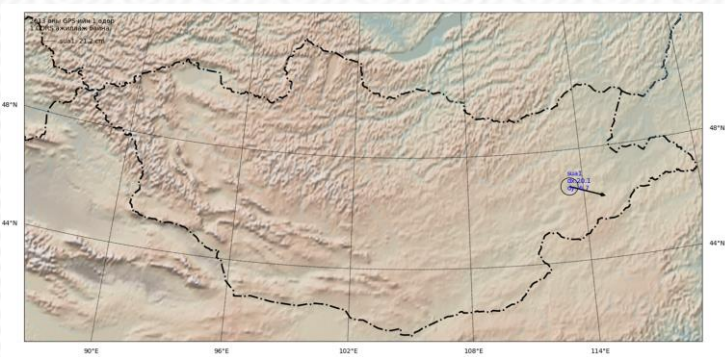
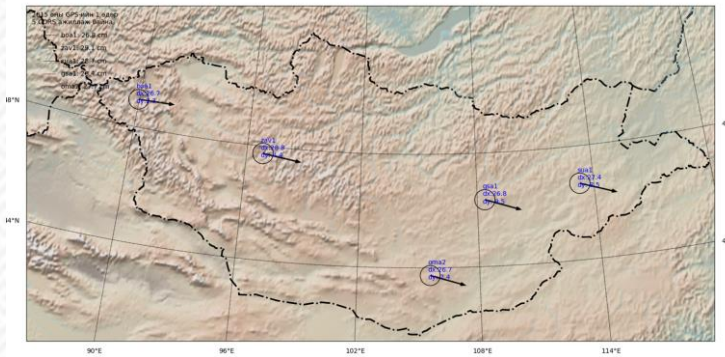


Plate motion monitoring

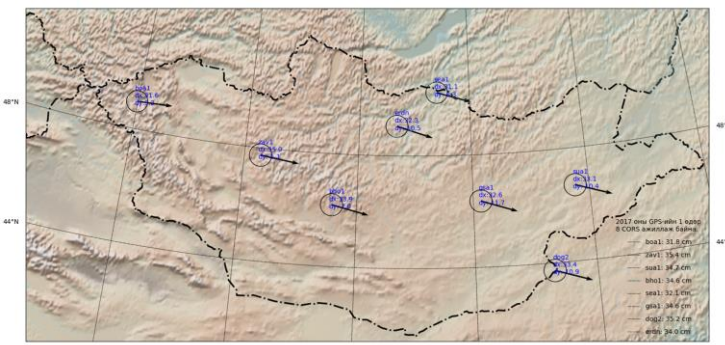
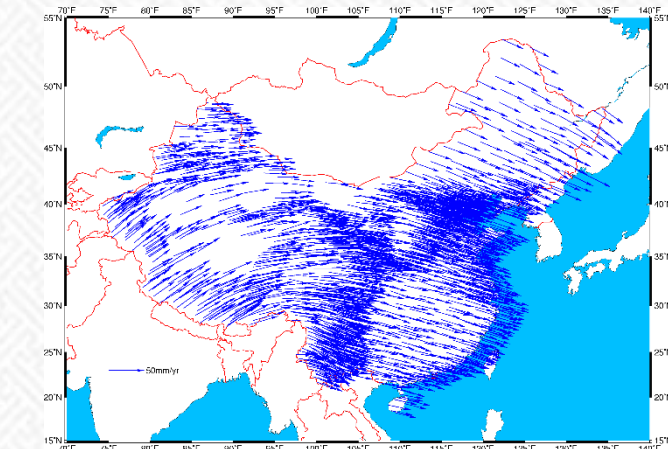


SUA1 21.2cm

2013-2015

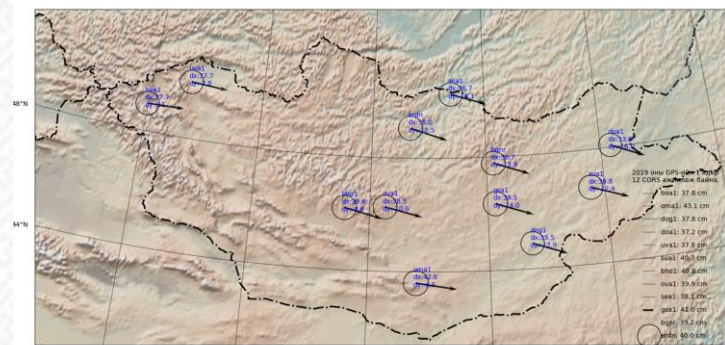


SUA1 28.7 cm
ZAV1 29.1 cm
BOA1 26.8 cm
GSA1 28.4 cm

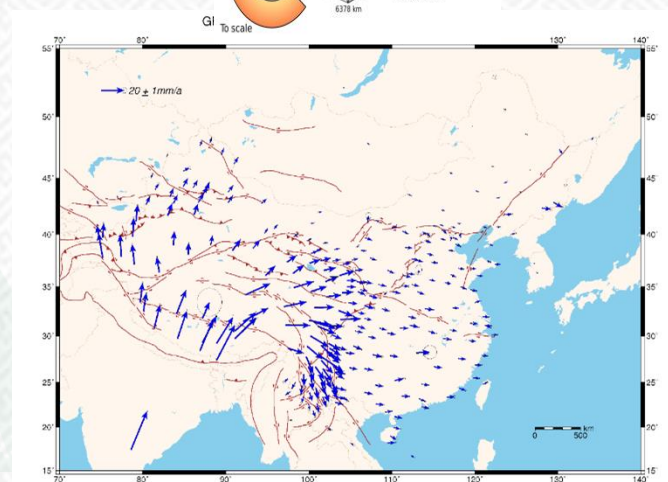
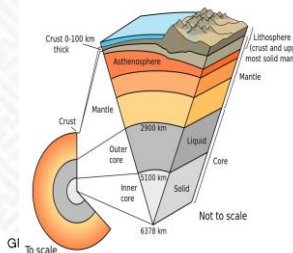


SUA1 34.2 cm
ZAV1 35.4 cm
BOA1 31.8 cm
GSA1 34.6 cm

2017-2019



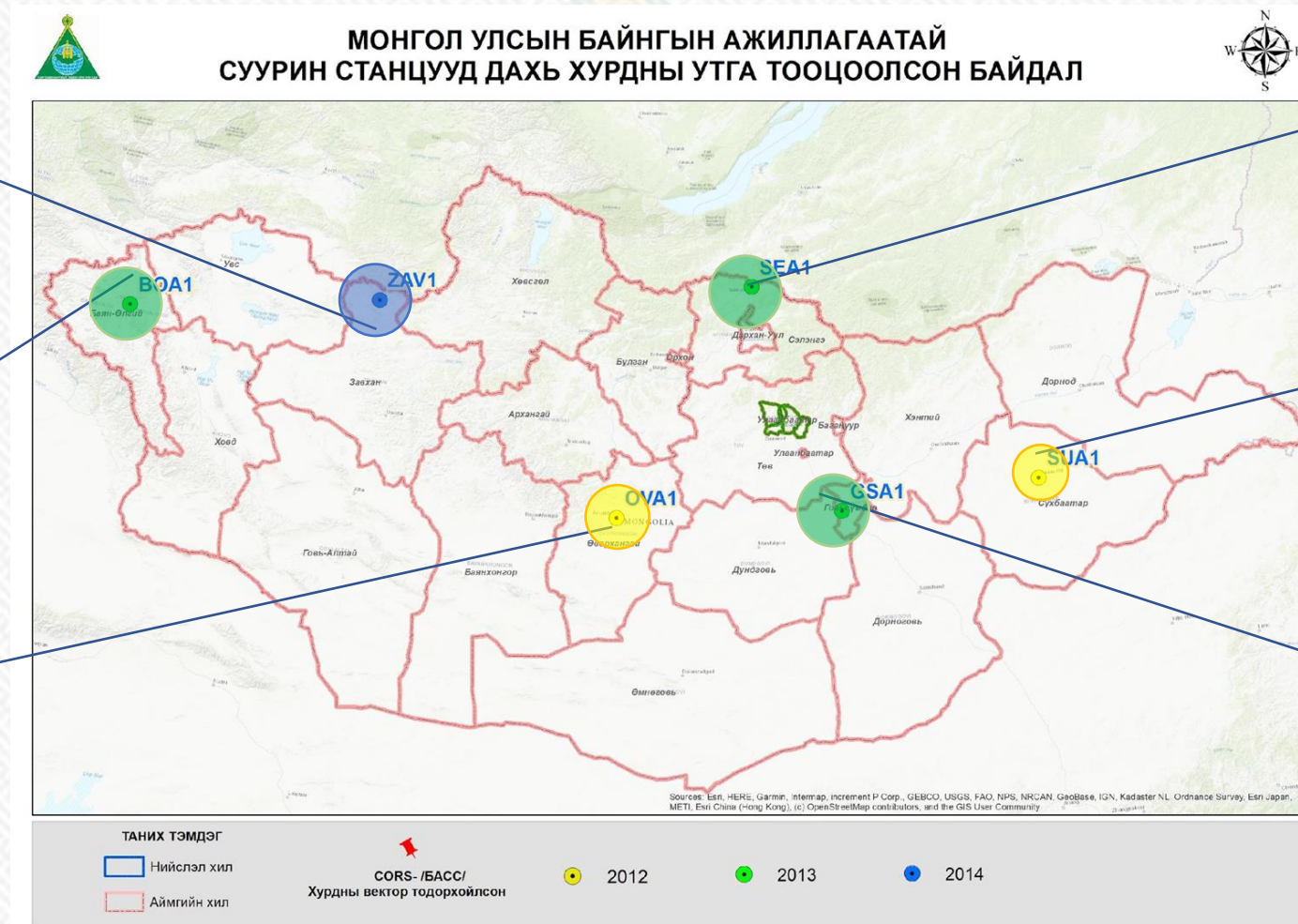
SUA1 40.7 cm
DOG1 37.8 cm
BOA1 37.8 cm
GSA1 41.0 cm



Stations of meets the requirement IGS



ALAMGAC director general's decree **No.116** velocity vector velocity- GNSS CORS date by **2022.06.06**



ZAV1
X= -30.26 mm/year
Y= 1.25 mm/year
Z= -1.09 mm/year

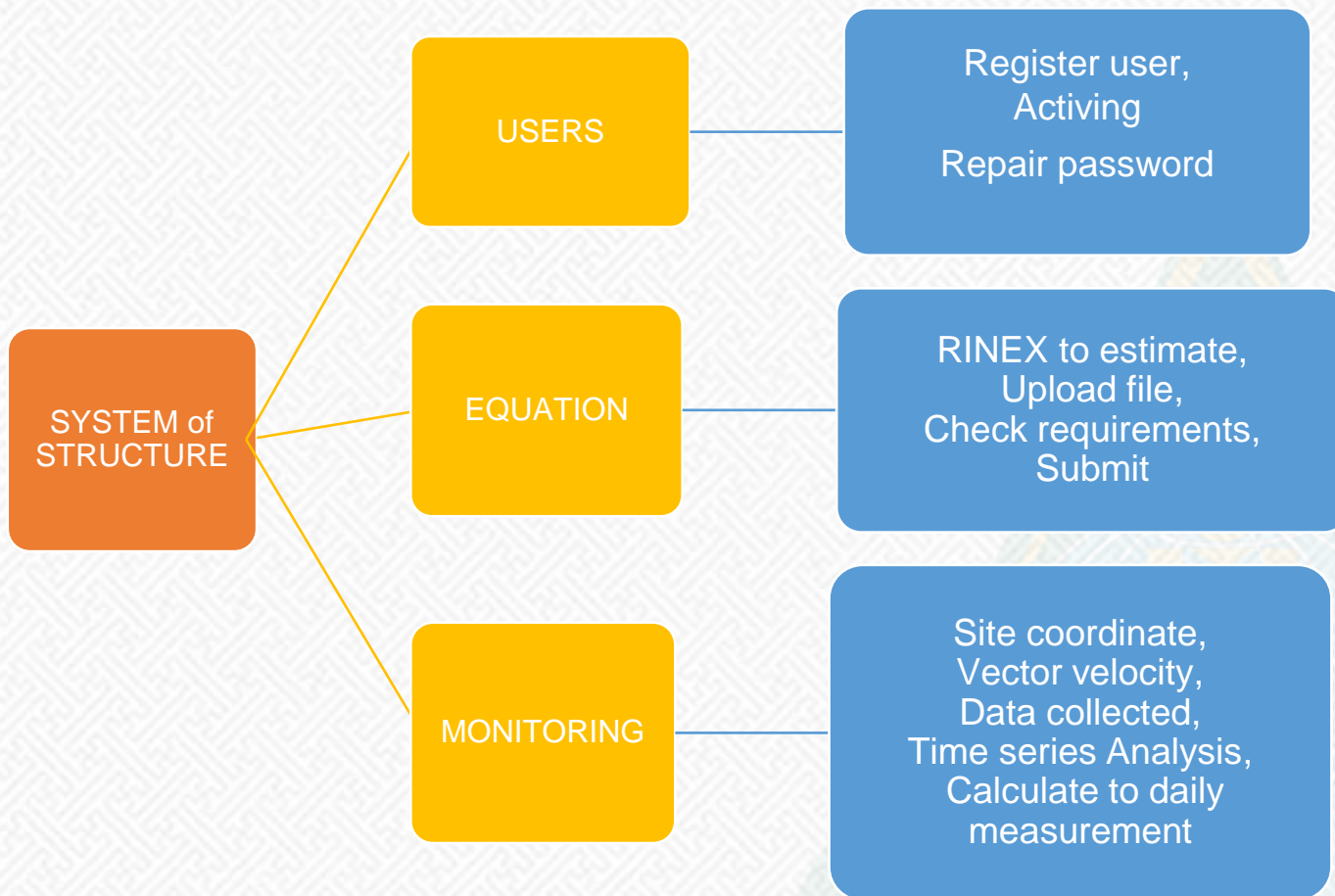
BOA1
X= -28.1 mm/year
Y= 1.2 mm/year
Z= -2.5 mm/year

OVA1
X= -29.97 mm/year
Y= 0.2 mm/year
Z= -3.95 mm/year

SEA1
X= -28.88 mm/year
Y= -0.89 mm/year
Z= -4.51 mm/year

SUA1
X= -22.78 mm/year
Y= -20.34 mm/year
Z= -6.54 mm/year

GSA1
X= -29.98 mm/year
Y= -1.9 mm/year
Z= -5.73 mm/year



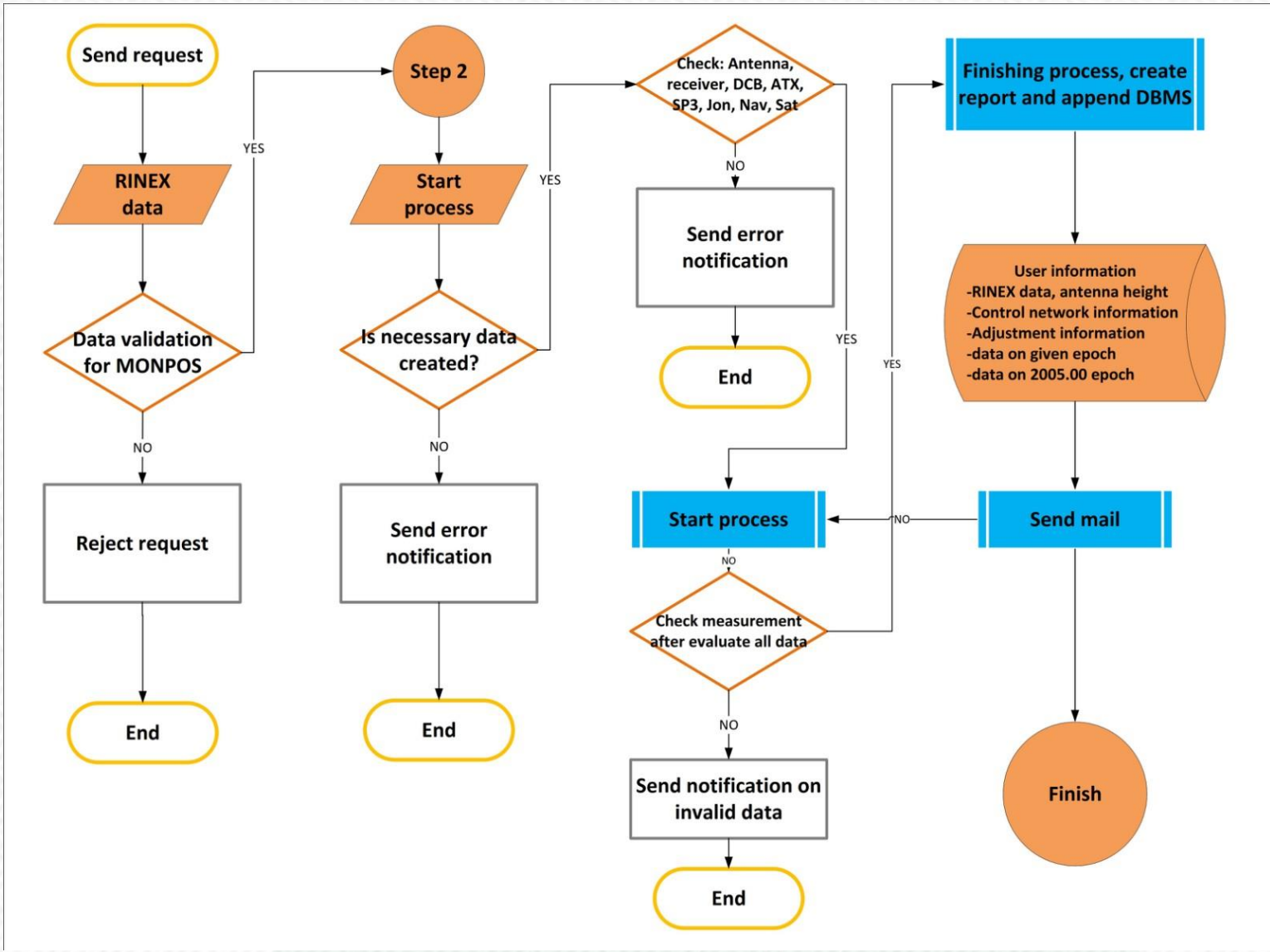
Program Environment

FORMAT	USED TECHNOLOGY	HAVE LICENSE?
Used Framework	Leaflet4, Django	OPEN SOURCE
Language of Program	JavaScript, Python	OPEN SOURCE
Web Server	Apache server	OPEN SOURCE
Database	PostgreSQL, PostGIS	OPEN SOURCE

Data Workflow Diagram



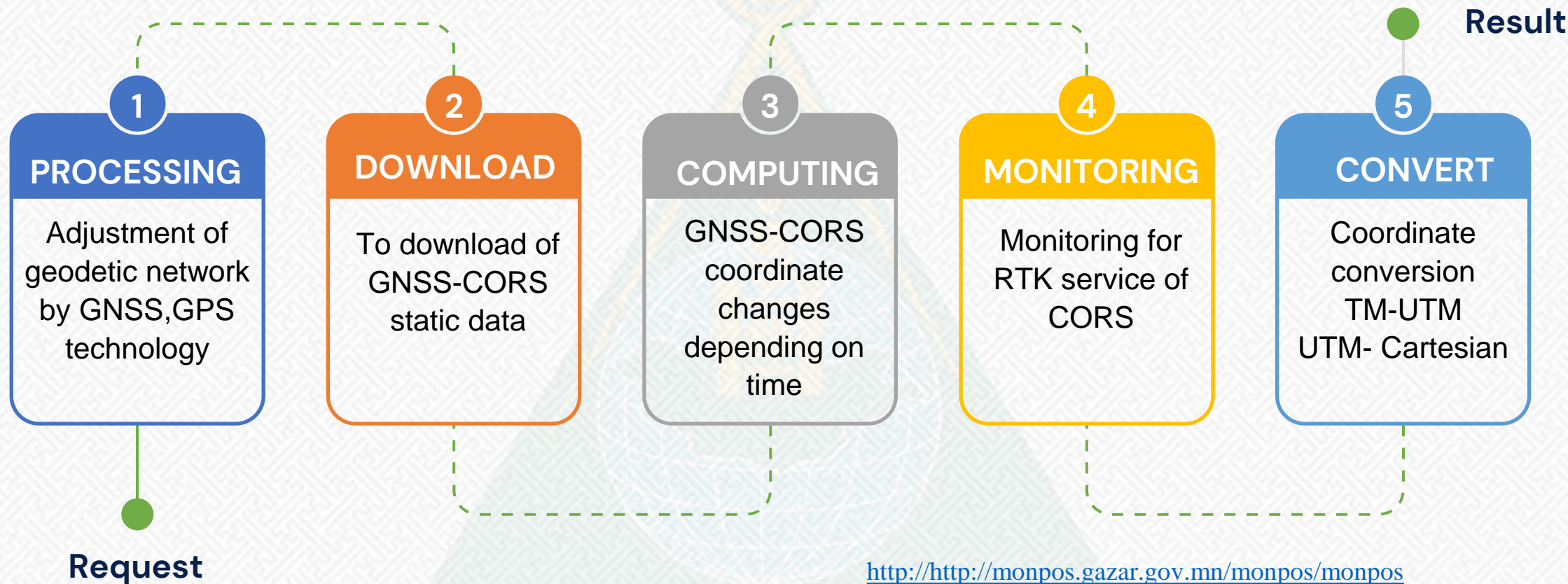
MONPOS



MONPOS SERVICES



Free based online services that are independent of time and space



<http://monpos.gazar.gov.mn/monpos/monpos>
<http://monpos.gazar.gov.mn/download/>
<http://monpos.gazar.gov.mn/>
<http://geocalc.gazar.gov.mn/>



1. How to Insert, Submit and Receive of RINEX data to adjustment

ГАЗАР ЗОХИОН БАЙГУУЛАЛТ, ГЕОДЕЗИ, ЗУРАГ ЗҮЙН ГАЗАР | ЗАСГИЙН ГАЗРЫН ХЭРЭГЖҮҮЛЭГЧ АГЕНТЛАГ

Баримт бичгүүд ▾

["MONPOS" GNSS-ИЙН ОНЛАЙН БОЛОВСРУУЛАЛТЫН СИСТЕМ](#)

Home / Өгөгдөл хуулах »

GNSS-ийн сүлжээний статик өгөгдөл илгээх

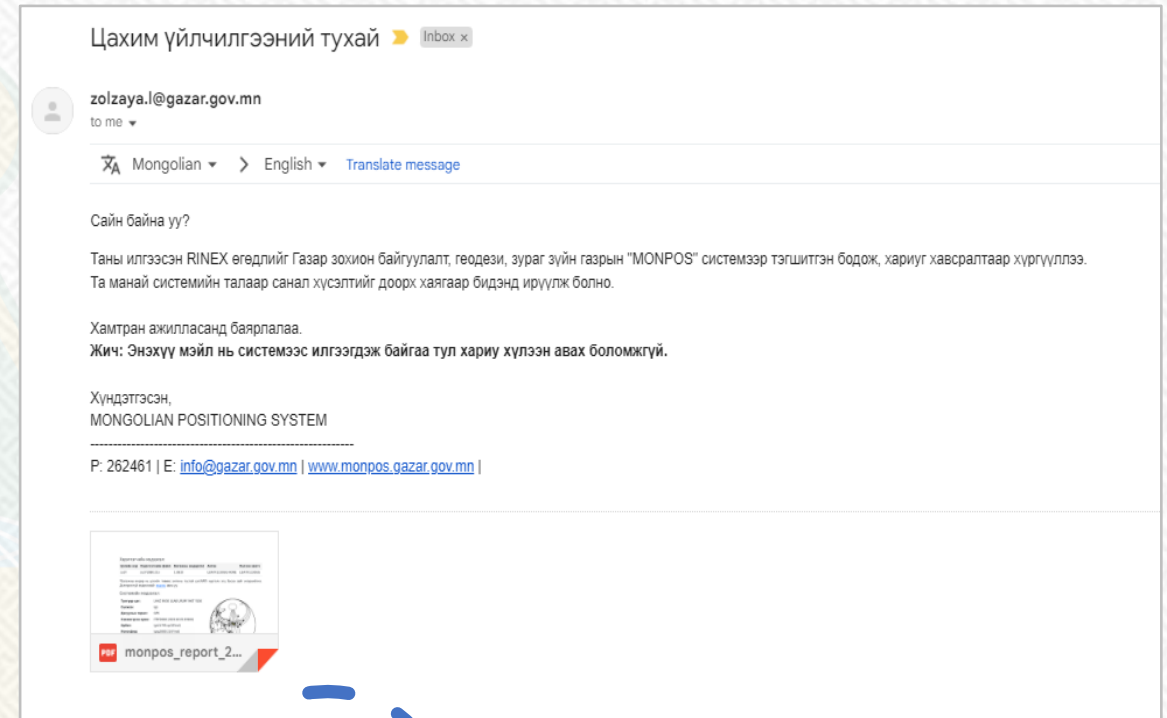
Rinex файл:

Choose Files

Сүлжээний төрөл:

IGS network
 MGL network

Filename	Height (m)	Receiver type	Receiver SN	Antenna type	Antenna SN
su372880.21o	1.8920	LEIATX1230GG	182800	LEIATX1230GG I	182800



The system is configured to automatically check the following conditions from the input file:

File name:

Height (m):

Receiver type:

Receiver SN:

Antenna type:

Antenna SN:



After about 10 minutes, the system will automatically email to user a response to the measurement equation (.pdf*) file.



1. AUSPOS

2.OPUS

3. MONPOS

3 Computed Coordinates, ITRF2014

All coordinates are based on the IGS realisation of the ITRF2014 reference frame. All the given ITRF2014 coordinates refer to a mean epoch of the site observation data. All coordinates refer to the Ground Mark.

3.1 Cartesian, ITRF2014

Station	X (m)	Y (m)	Z (m)	ITRF2014 @
SU37	-993525.239	4315429.413	4577090.334	15/10/2021
AIRA	-3530185.909	4118797.178	3344036.668	15/10/2021
CHUM	1228950.333	4508080.002	4327868.530	15/10/2021
GAMG	-3191608.004	4096899.771	3691839.190	15/10/2021
JFNG	-2279829.137	5004706.441	3219777.371	15/10/2021
LHAZ	-106942.222	5549269.748	3139215.240	15/10/2021
NOVM	452260.662	3635877.604	5203453.323	15/10/2021
NRIL	64536.816	2253782.918	5946363.509	15/10/2021
PDL2	1239970.904	4530790.163	4302578.874	15/10/2021
SUWN	-3062023.343	4055447.788	3841818.109	15/10/2021
TASH	1695944.753	4487138.675	4190140.760	15/10/2021
URUM	193030.112	4606851.270	4393311.512	15/10/2021
YAKT	-1914999.309	2308241.442	5610225.472	15/10/2021

3.2 Geodetic, GRS80 Ellipsoid, ITRF2014

Geoid-ellipsoidal separations, in this section, are computed using a spherical harmonic synthesis of the global EGM2008 geoid. More information on the EGM2008 geoid can be found at <http://earth-info.nga.mil/GandG/wgs84/gravitymod/egm2008/>.

Station	Latitude (DMS)	Longitude (DMS)	Ellipsoidal Height (m)	Derived Above Geoid Height (m)
SU37	46 08 19.28820	102 57 54.27772	1591.421	1636.174
AIRA	31 49 26.61115	130 35 58.54980	314.631	282.775
CHUM	42 59 54.60554	74 45 03.97533	716.327	759.317
GAMG	35 35 24.25225	127 55 10.78317	927.955	900.287
JFNG	30 30 56.03226	114 29 27.68023	71.301	84.711
LHAZ	29 39 26.40372	91 06 14.52055	3624.612	3659.303
NOVM	55 01 49.80320	82 54 34.18002	150.069	186.300
NRIL	69 21 42.59873	88 21 35.24443	47.938	62.032
PDL2	42 40 47.17472	74 41 39.37461	1714.206	1754.272
SUWN	37 16 31.84653	127 03 15.28799	82.254	58.788
TASH	41 19 40.97931	69 17 44.05788	439.699	483.269
URUM	43 48 28.61979	87 36 02.42089	858.842	922.221
YAKT	62 01 51.44939	129 40 49.11317	103.389	108.855

opus <opus@ngs.noaa.gov>
to me

FILE: su372880.21o OP1852930301870

NGS OPUS SOLUTION REPORT
=====

All computed coordinate accuracies are listed as peak-to-peak values.
For additional information: <https://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: zolzavamust@gmail.com DATE: May 19, 2022
RINEX FILE: su372881.21o TIME: 03:19:58 UTC

SOFTWARE: page5 2008.25 master270 180321 START: 2021/10/15 11:08:00
EPHEMERIS: igs21795.eph [precise] STOP: 2021/10/15 23:07:00
NAV FILE: brdc2880.21n OBS USED: 24977 / 25179 : 99%
ANT NAME: LEIATX1230GG NONE # FIXED ANTS: 99 / 101 : 98%
ARP HEIGHT: 1.8920 OVERALL RMS: 0.010(m)

REF FRAME: NAD_83(2011)(EPOCH:2010.0000) ITRF2014 (EPOCH:2021.7883)

X: -993523.869(m) 0.001(m) -993525.241(m) 0.001(m)
Y: 4315428.178(m) 0.018(m) 4315429.417(m) 0.018(m)
Z: 4577089.302(m) 0.019(m) 4577090.349(m) 0.019(m)

LAT: 46 8 19.30130 0.004(m) 46 8 19.28843 0.004(m)
E LON: 102 57 54.21935 0.004(m) 102 57 54.27774 0.004(m)
W LON: 257 2 5.78065 0.004(m) 257 2 5.72226 0.004(m)
EL HGT: 1599.599(m) 0.025(m) 1591.435(m) 0.025(m)
ORTHO HGT: [No NGS Geoid Model Available.]

UTM COORDINATES STATE PLANE COORDINATES
UTM (Zone 48) *** NOTE ***
Northing (Y) [meters] 5111470.507 Please manually select
Easting (X) [meters] 342825.391 SPC zone.
Convergence [degrees] -1.46753058
Point Scale 0.99990399
Combined Factor 0.99985458

US NATIONAL GRID DESIGNATOR: 48TUS4282511471(NAD 83)

BASE STATIONS USED
PID DESIGNATION LATITUDE LONGITUDE DISTANCE(m)
IRKJ 883101.5
BADG 828351.8
NOVM 1715830.7

NEAREST NGS PUBLISHED CONTROL POINT
AA5094 NPT N203311.140 W2150828.883 4741503.2

This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

Mongolian Positioning System
Т. Хэрэглэгчийн илгээсэн өгөгдөл:

N#	Цэгийн нэр	File	Phase Height(m)	Receiver Model (IGS)	Antenna Model (IGS)
1.	su37	su372880.21o	1.8920	LEIATX1230GG	LEIATX1230GG NONE

*Багажы өндөр нь цэгийн төвөөс антены тусгай цэг(ARP) хүртэлх эгц босоо зайг илэрхийлнэ. Дэлгэрэнгүй мэдээллийг [эндээс](#) авна уу.

2. Сүлжээний тодорхойлолт:

Тулгуур цэг:	NVSK ULAB URUM YAKT YSSK
Сүлжээ:	IGS
Дагуулын төрөл:	GPS
Хэмжигдсэн эрин:	ITRF2008 (20211015115900)
Орбит:	igs21795.sp3(Final)
Ионосфер:	igsg2880.21n(Final)
Навигаци:	[brdc2880.21n]

Зураг 1. Сүлжээний схем

4. ITRF2008 солбицол (20211015115900 эринд):

4.1. Картезиан солбицол

Цэгийн нэр	X(m)	Y(m)	Z(m)
su37	-993525.23521	4315429.41477	4577090.35974

Бүх солбицол IGS-ийн ITRF2008 системд хэмжилт хийсэн хугацааны дундаж эринд бодогдсон.

5. 2005 оны 01 дүгээр сарын 01-ны өдрийн ITRF2008 солбицол:

5.2. Картезиан солбицол

Цэгийн нэр	X(m)	Y(m)	Z(m)
su37	-993524.7353	4315429.4379	4577090.4458

Газрын харилцаа, геодези, зураг зүйн газрын даргын 2014 оны А/112 дугаар тушаалыг үндэслэн Монгол Улсын GNSS-ийн байнгын ажиллагаатай BOA1, ZAV1, OVA1, SEA1, SUA1, GSA1 станцын вектор хурдны мэдээллээр шилжүүлэв.

5.3. Геодезийн солбицол

Цэгийн нэр	B(dms)	L(dms)	H(WGS84,m)	H(Ортометр, m)
su37	46 8 19.29278	102 57 54.25458	1591.44056	1635.10039

Үйлдвэрлэлд ашиглаж буй програмын хангамжийн алгоритмуудээс хамааран хөрвүүлэлтийн үр дүн өөр өөр гарч байгаа тул картезиан солбицлыг ашиглах, бусад тохиолдолд манай компанийн веб хуудасны цахим [уйлчилгаа](#)г ашиглаж хэвсхийг зөвлөж байна. [Дэлгэрэнгүй](#)



2. Download the all data RINEX of collected site.

Статик өгөгдөл татах

1 2 3 4 5 6 7 8 9 10 11 12 **13** 14 15

CORS: UB03

Installed: 2012 001 00 00 00 - 2050 205 00 00 00

Receiver: TRIMBLE NETR9

Antenna: TRM59900.00 SCIS

Орчны зургууд:



ЗУРАГ ЗАСАХ

RINEX өгөгдөл татах:

ub032440.22d.Z

TATAХ

CORS: UB04

Installed: 2012 001 00 00 00 - 2050 001 00 00 00

Receiver: TRIMBLE NETR9

Antenna: TRM59900.00 SCIS

Орчны зургууд:



ЗУРАГ ЗАСАХ

RINEX өгөгдөл татах:

ub043400.22d.Z

TATAХ

CORS: UB05

Installed: 2012 001 00 00 00 - 2050 001 00 00 00

Receiver: TRIMBLE NETR9

Antenna: TRM59900.00 SCIS

Орчны зургууд:



ЗУРАГ ЗАСАХ

RINEX өгөгдөл татах:

ub053400.22d.Z

ub053400.22d.Z

ub053390.22d.Z

ub053380.22d.Z

ub053370.22d.Z

ub053360.22d.Z

ub053350.22d.Z

ub053340.22d.Z

ub053330.22d.Z

ub053320.22d.Z

ub053310.22d.Z

ub053300.22d.Z

ub053290.22d.Z

ub053280.22d.Z

ub053270.22d.Z

ub053260.22d.Z

ub053250.22d.Z

ub053240.22d.Z

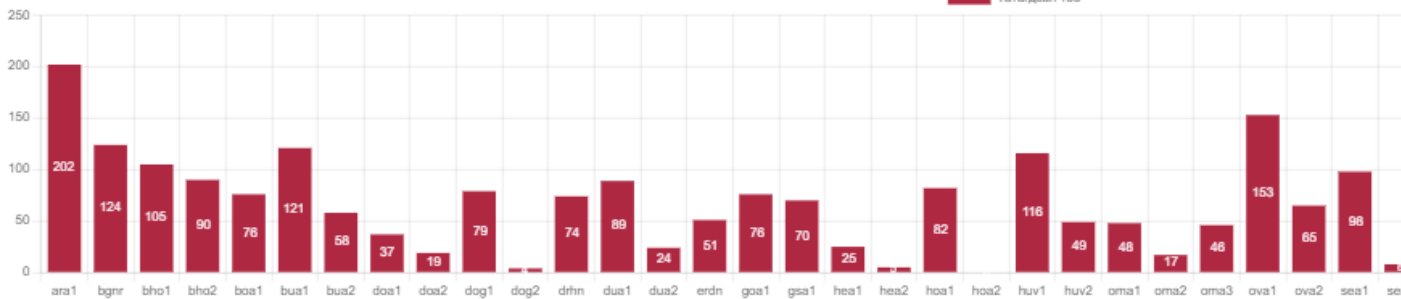
ub053230.22d.Z

ub053220.22d.Z

ub053210.22d.Z

— Татагдсан тоо:

■ Татагдсан тоо

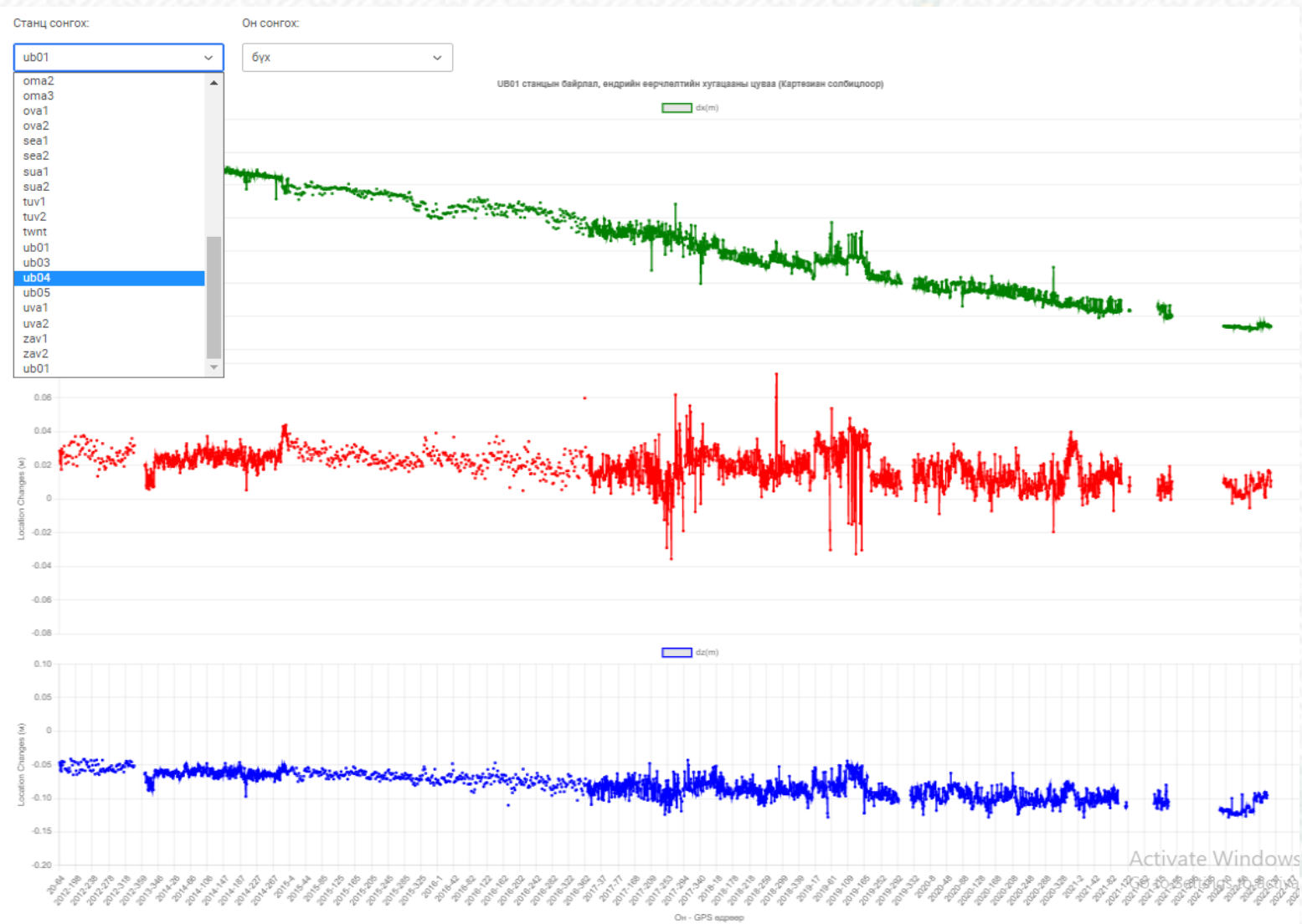


Since installed in 43 stations collected all databases in the virtual server. Available all data download by GPS days .



3. Monitoring to difference of coordinate (X,Y,Z) of the all GNSS-CORS

DAILY CHANGES IN POSITION



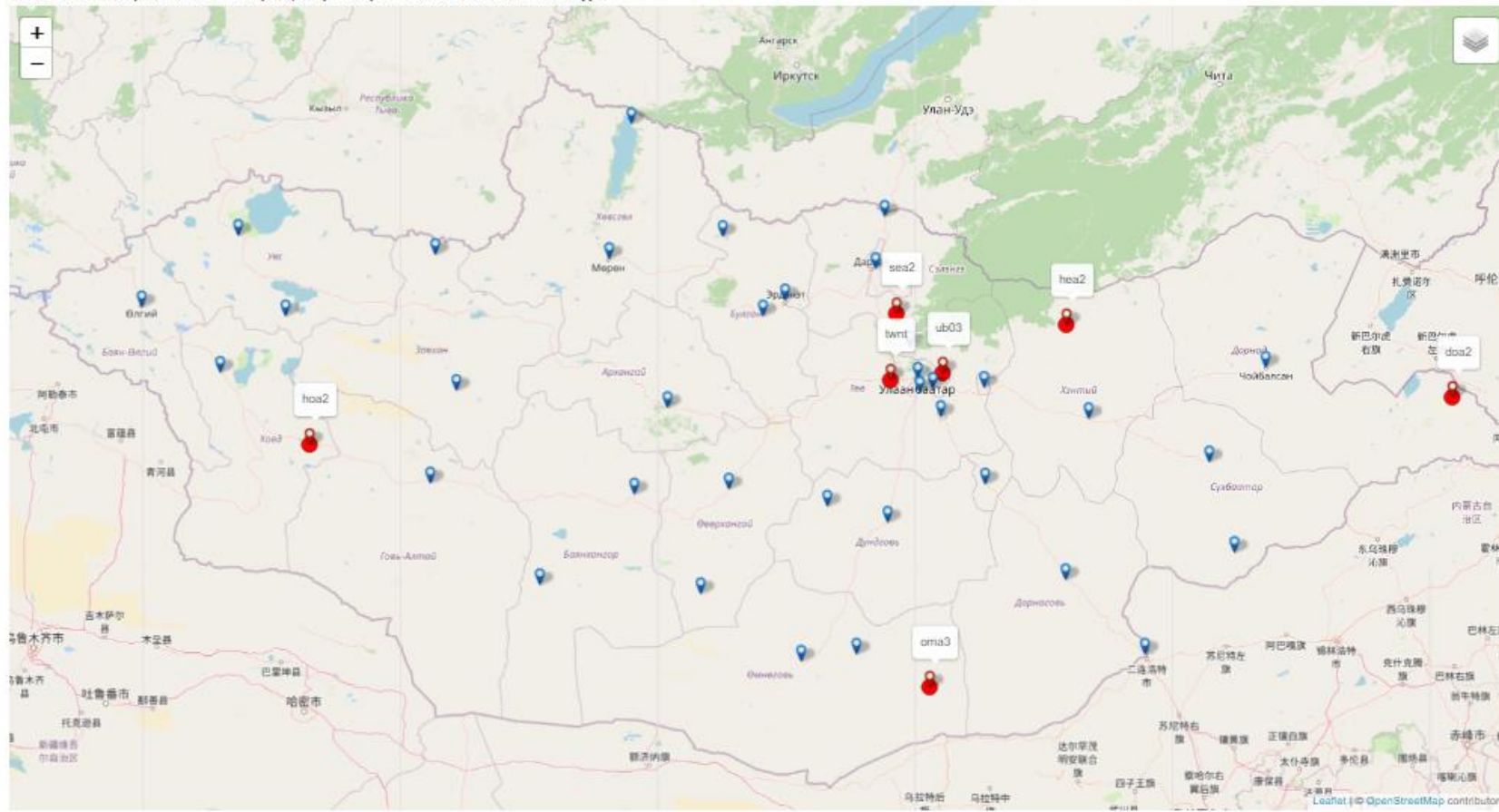
The MonPOS Processing System Analysis tool displays a graphic of all sites via time series analysis of positional and leveling differences.



4. Monitoring Real Time Kinematik /RTK/ CORS



Одоо холболт тасарсан CORS-ийн байрлал, дээр нь дарж холбогдох мэдээллийг авна уу.



RTK- NORMAL TRANSMISSION



BROKEN or MALFUNCTION

Холболт тасарсан:

№	CORS	Хэзээ тасарсан	Хариуцагч байгууллага	Хариуцагч мэргэжилтэн	Утас
1.	hea2	2022-03-05 08:03	Хэнтий аймгийн Батширээт сумын даамал	Н.Болор-Эрдэнэ	88028878
4.	hea2	2022-03-05 08:03	Ховд аймгийн Дарга сумын даамал	Д.Ившинхорол	86533386
-	-	-	-	-	-



5.Coordinate system converter



Солбицол хөрвүүлэх (гараар)
УТГА ОРУУЛАХ

Солбицлын систем:*
Cartesian

X(m)
-1283275.846148

Y(m)
4074608.088925

Z(m)
4700918.664696

Хөрвүүлэх

ҮР ДҮН

Солбицлын систем:*
UTM

Бүс:*
48

Оронгийн нарийвчлал (.):*
3

5311417.034

685358.839

*The coordinate conversion tool
between coordinate systems
used in Mongolia.*



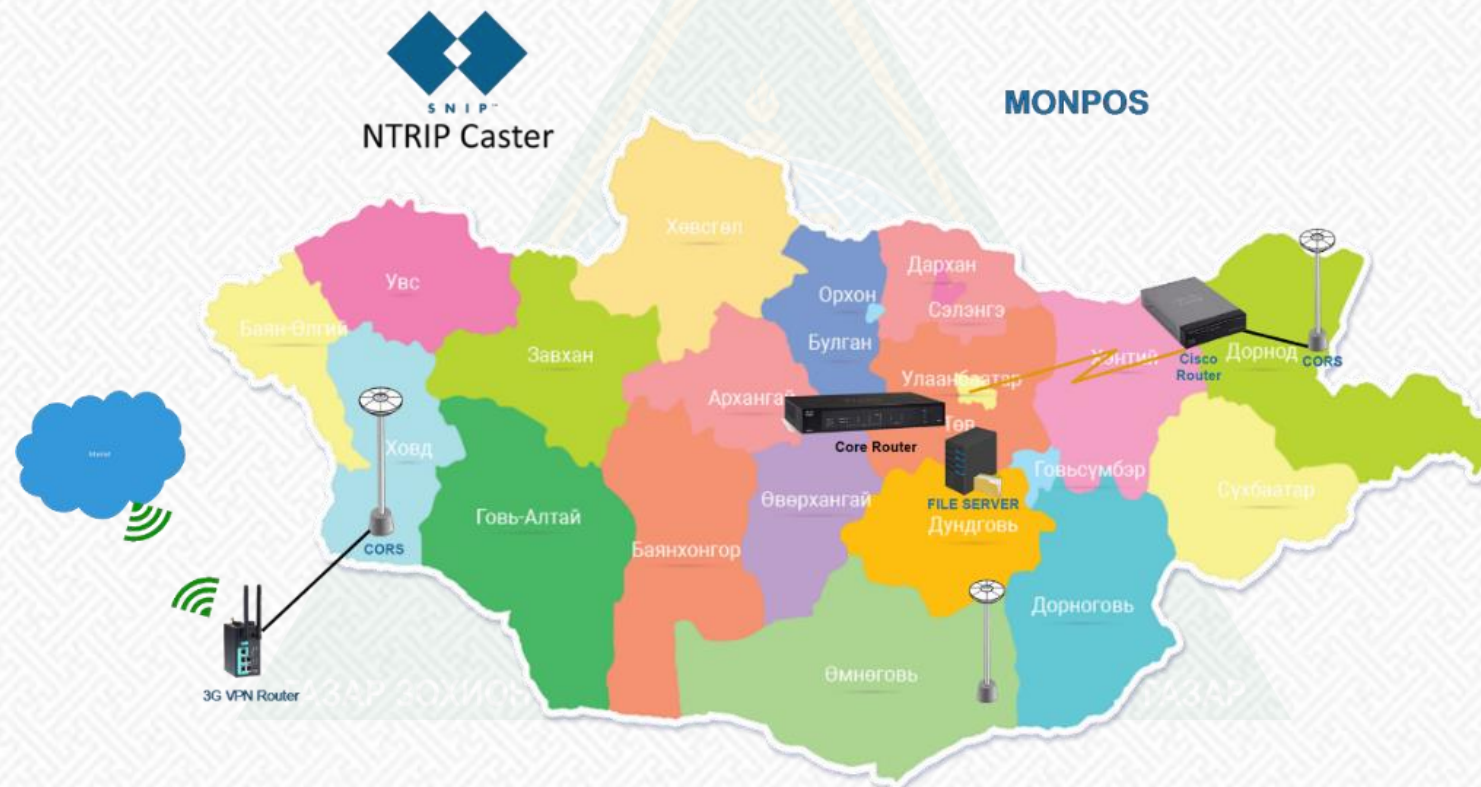
<http://geocalc.gazar.gov.mn/>



Future plan

CORS network enhancement

- To move full UNIX system
- Upgrade some stations hardware to support other GNSS system (Galileo, Beidou, QZSS)
- To establish new stations in required area.
- To increase and improve human resource.
- To adjust CORS network data in ITRF2020 epoch /after approval of Government resolution/.





ЗАСГИЙН ГАЗРЫН ХЭРЭГЖҮҮЛЭГЧ АГЕНТЛАГ
ГАЗАР ЗОХИОН БАЙГУУЛАЛТ,
ГЕОДЕЗИ, ЗУРАГ ЗҮЙН ГАЗАР



**Thanks for
attention**

