

“GNSS CORS network and its application in Mongolia”

Geodesy and Cartography Department, ALAMGC



МОНГОЛ УЛСЫН
ЗАСГИЙН ГАЗАР

GOVERNMENT OF MONGOLIA
AGENCY FOR LAND ADMINISTRATION
AND MANAGEMENT, GEODESY AND
CARTOGRAPHY



Content

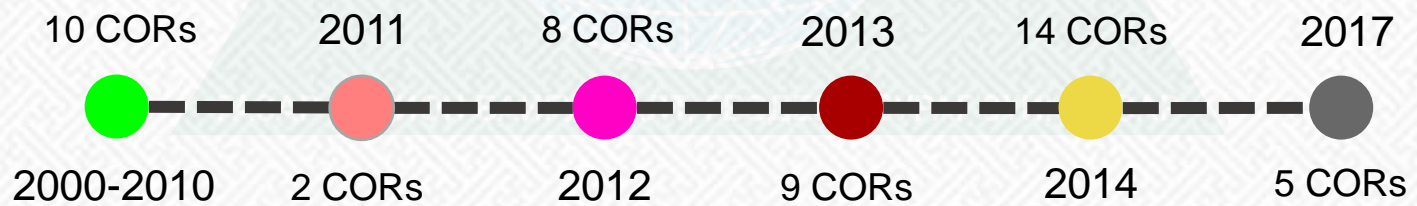
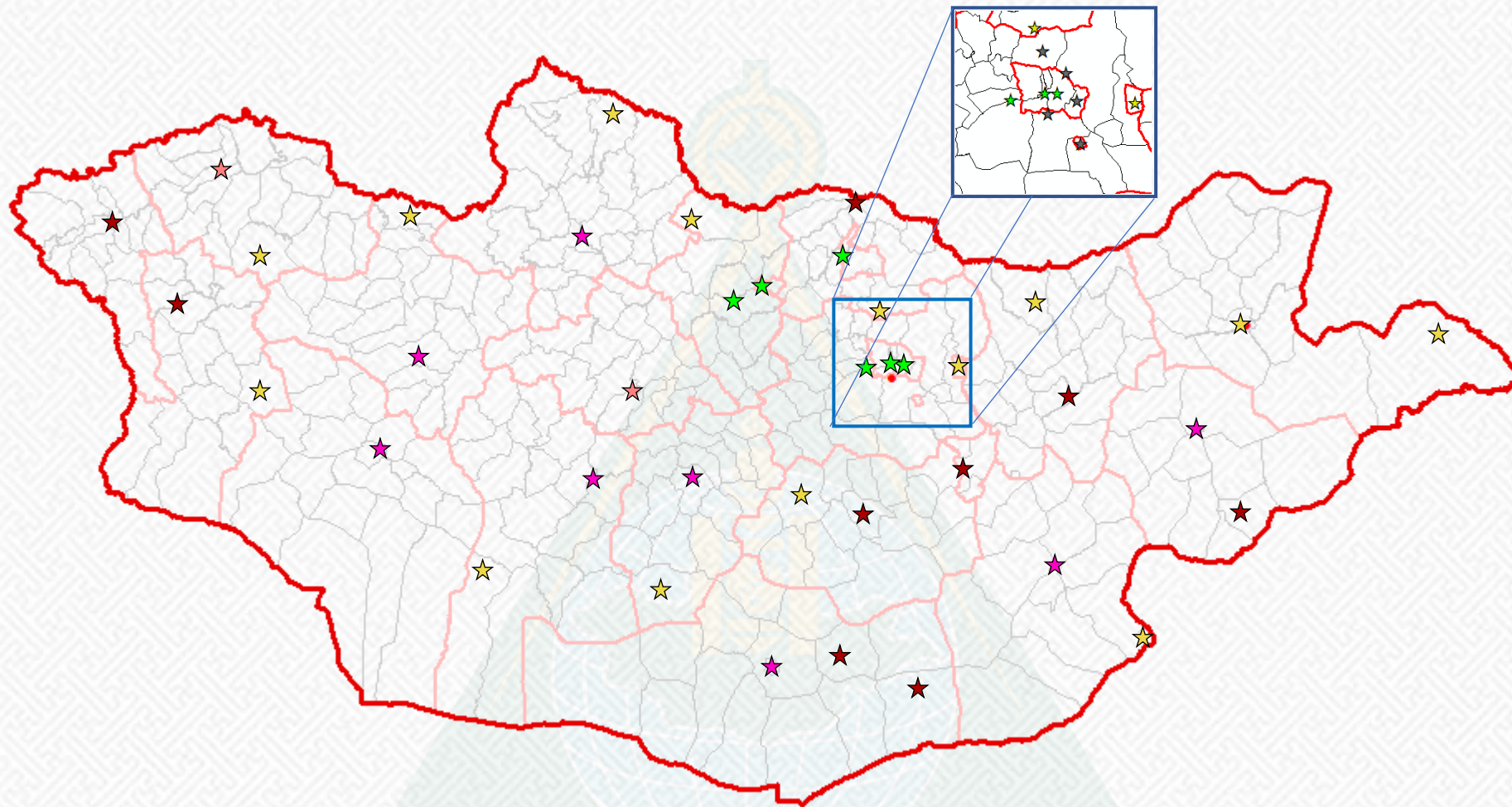
1. CORS network (MONPOS) brief introduction

- Current status
- Regulation, technical framework
- Infrastructure capacity /software, hardware, data transmission/

2. Application

- Environment
- National Geodetic network develop (online processing system based PPP technique)
- Velocity
- Plate motion monitoring
- RTK service (surveying field)
- Real time monitor for hazard

Current status of CORS





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

Requirements CORS monument and its preparation:

Procedures for Setting a CORS Monument by NGS

- <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 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

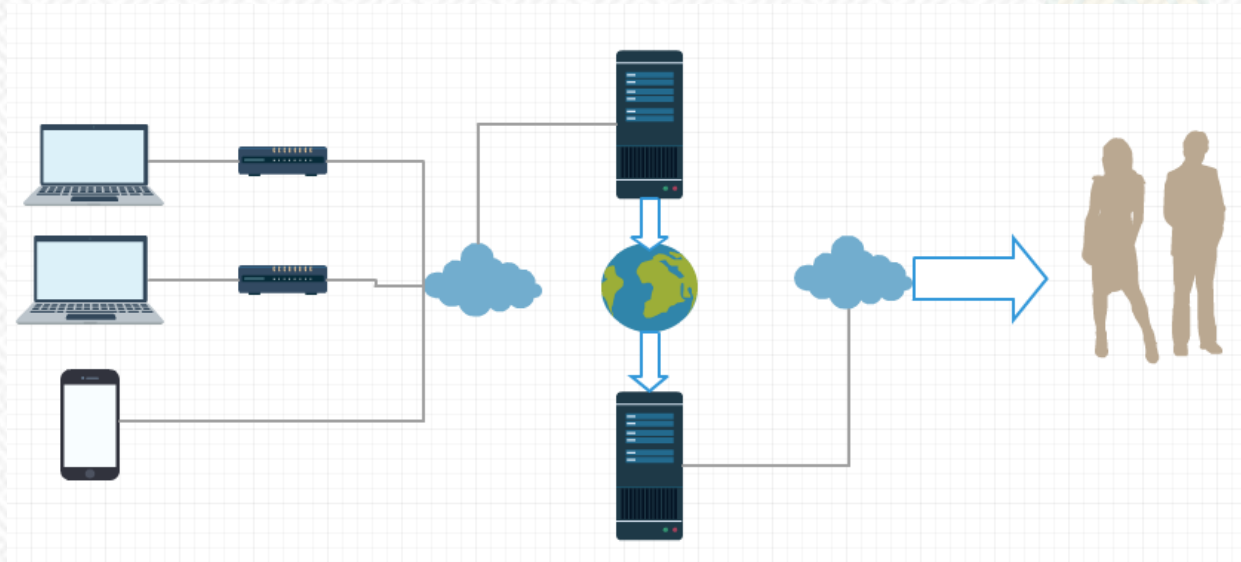
- <http://kb.unavco.org/kb/article/gnss-receiver-and-antenna-power-compatibilities-492.html>
- <http://kb.unavco.org/kb/article/gps-receiver-and-antenna-testing-report-for-suominet-2000-51.html>

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

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



MONPOS system architecture



1. Web server (LAMP, apache, IIS)
2. Host (Ubuntu server 14.06)
3. FTP server (Proftpd tool)
4. Mail server (smtp tool)
5. Data server (MONPOS SOPAC, CDDIS, WUHN)





Hardware/network architecture

FTP Push

Server Number: 1

Server Address: 66.181.168.80

Username: cors

Password:

Verify Password:

Delay: 0 Minutes

Remote Directory: /dog2

Path Style: Flat

Rename: No

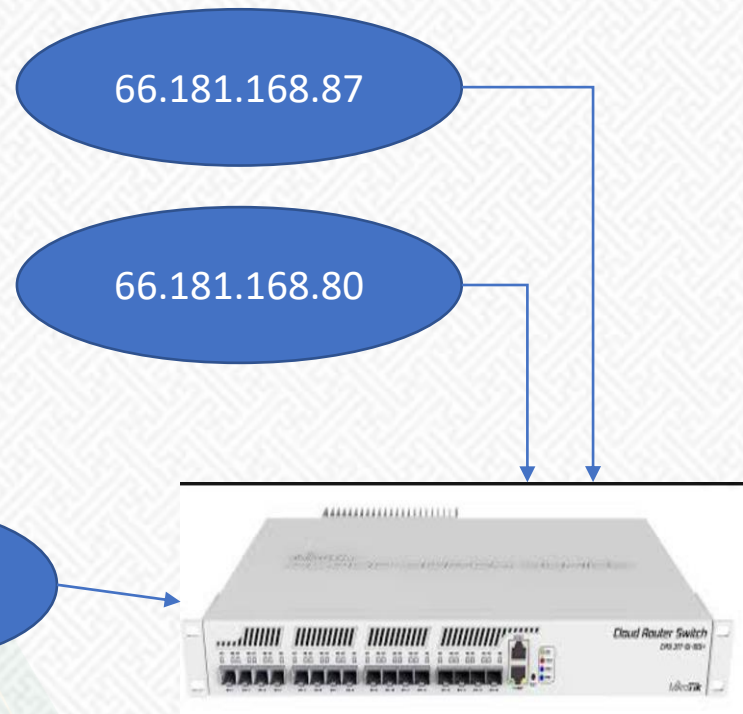
Transfer mode: Passive with fallback to active

OK Cancel Test

Bad login

FTP Push Log

Time	Status	Local File Name
2019-07-08T00:00:00Z	Disabled	/Internal/201907/BGNR188aA.T02
2019-07-07T00:00:00Z	Disabled	/Internal/201907/BGNR187aA.T02
2019-07-06T00:00:00Z	Disabled	/Internal/201907/BGNR186aA.T02
2019-07-05T00:00:00Z	Disabled	/Internal/201907/BGNR185aA.T02
2019-07-04T13:12:08Z	OK	/Internal/BGNR185a.T02
2019-07-04T03:35:42Z	OK	/Internal/BGNR184a.T02
2019-07-04T03:20:17Z	Couldn't send file	/Internal/BGNR184a.T02
2019-07-04T03:04:50Z	Couldn't send file	/Internal/BGNR184a.T02
2019-07-04T02:49:25Z	Couldn't send file	/Internal/BGNR184a.T02
2019-07-04T02:34:00Z	Couldn't send file	/Internal/BGNR184a.T02





Realtime kinematic

Static

Энэ оны байдраар улсын хэмжээнд 43 станц, 298 өдрийн сүлжээний хэмжилт хийхээс: (Дэлгэрэнгүй харах)

ГАЗАР ЗОХИОН БАЙГУУЛАЛТ,
ГЕОДЕЗИ, ЗУРАГ ЗҮЙН ГАЗАР

ЗАСГИЙН ГАЗРЫН
ХЭРГЭЖҮҮЛЭГЧ АГЕНТЛАГ

Сайн байна уу? Зочин
Нэвтрэх

GNSS-ийн ДЭД БҮТЦИЙН ЦАХИМ СИСТЕМҮҮД

- [Monpos](#)
- [MonStatic](#)
- [MonRTK](#)
- [MonGeoCalc](#)
- [MonGeoid](#)

СИСТЕМИЙН ХАНДАЛТ +

- [Санал хүсэлт илгээх](#)

Газар зохион байгуулалт, геодези, зурагзүйн газрын сүлжээнд холбогдсон GNSS-ийн байнгын ажиллагаатай станц (CORS)-ын мэдээлэл

Энэ оны байдраар улсын хэмжээнд 43 станц 250 өдрийн сүлжээний хэмжилт хийхээс: (Дэлгэрэнгүй харах)

Бодит агшны засвар (RTK) дамжуулж байгаа-(39)

uva2, sea2, oma3, huv2, hea2, dua2, zav2, ara1, bgnr, bho1, bho2, boa1, bua1, bua2, doa1, dog1, drhn, dua1, erdn, goa1, gsa1, hea1, hoa1, huv1, oma2, ova1, ova2, sea1, sua1, sua2, twnt, uva1, ub01, zav1, tuv1, doa2, tuv2, ub03, ub04.

Холболт тасарсан4

№	CORS	Хэзээ тасарсан	Хариуцагч байгууллага	Хариуцагч мэргэжилтэн	Утас
1.	dog2	023401, 2021-08-03	Дорноговь аймаг ГХБХБГ	Х.Энхбат	94080202
2.	hoa2	043301, 2020-06-16	Ховд аймаг ГХБХБГ	Р.Цэцэгмаа	89099958
3.	oma1	103201, 2021-09-07	Өмнөговь аймаг ГХБХБГ	О.Хатанбаатар	88046669
4.	ub05	090902, 2021-09-08	Газар зохион байгуулалт, геодези, зурагзүйн газар	Н.Төгөлдөрбаяр	262461

Засвартай0

№	CORS	Хэзээ тасарсан	Хариуцагч байгууллага	Хариуцагч мэргэжилтэн	Утас
---	------	----------------	-----------------------	-----------------------	------

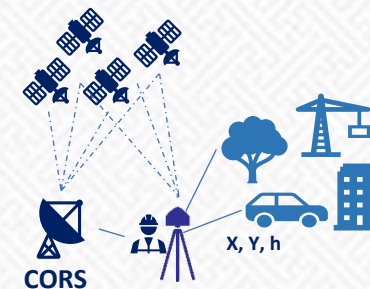
Дооо холболт тасарсан 4 CORS-ийн байрлал, дээр нь дарж холбогдох мэдээллийг авна уу.

<http://monpos.gazar.gov.mn/monpos>
<http://monpos.gazar.gov.mn/monstatic>
<http://monpos.gazar.gov.mn/monrtk>

№	CORS	Ажилласан өдөр	Ашиглалт	Хариуцагч байгууллага
1.	sua2	296	99%	Сүхбаатар аймаг ГХБХБГ
2.	ub03	296	99%	Газар зохион байгуулалт, геодези, зурагзүйн газар
3.	dua1	296	99%	Дундговь аймаг ГХБХБГ
4.	uva2	296	99%	Увс аймаг ГХБХБГ
5.	drhn	296	99%	Дархан-Уул аймаг ГХБХБГ
6.	doa2	296	99%	Дорнод аймаг ГХБХБГ
7.	ub05	296	99%	Газар зохион байгуулалт, геодези, зурагзүйн газар
8.	boa1	296	99%	Баян-Өлгий аймаг ГХБХБГ
9.	ova2	296	99%	Өвөрхангай аймаг ГХБХБГ
10.	oma2	296	99%	Өмнөговь аймаг ГХБХБГ
11.	erdn	295	98%	Орхон аймаг ГХБХБГ
12.	doa1	294	98%	Дорнод аймаг ГХБХБГ
13.	dua2	294	98%	Дундговь аймаг ГХБХБГ
14.	ara1	293	98%	Архангай аймаг ГХБХБГ
15.	oma1	293	98%	Өмнөговь аймаг ГХБХБГ
16.	buа2	292	97%	Булган аймаг ГХБХБГ
17.	ub04	292	97%	Газар зохион байгуулалт, геодези, зурагзүйн газар
18.	ova1	291	97%	Өвөрхангай аймаг ГХБХБГ
19.	oma3	289	96%	Өмнөговь аймаг ГХБХБГ
20.	bho2	289	96%	Баянхонгор аймаг ГХБХБГ
21.	buа1	287	96%	Булган аймаг ГХБХБГ
22.	tuv1	287	96%	Газар зохион байгуулалт, геодези, зурагзүйн газар
23.	sua1	287	96%	Сүхбаатар аймаг ГХБХБГ
24.	ub01	287	96%	ГЗБГЗЗГ ГЗЗХ
25.	bgnr	287	96%	ГЗБГЗЗГ ГЗЗХ
26.	zav2	287	96%	Завхан аймаг ГХБХБГ
27.	sea1	287	96%	Сэлэнгэ аймаг ГХБХБГ
28.	huv1	286	95%	Хөвсгөл аймаг ГХБХБГ
29.	tuv2	283	94%	Газар зохион байгуулалт, геодези, зурагзүйн газар
30.	bho1	283	94%	Баянхонгор аймаг ГХБХБГ
31.	dog1	282	94%	Дорноговь аймаг ГХБХБГ
32.	zav1	281	94%	Завхан аймаг ГХБХБГ
33.	uva1	280	93%	Увс аймаг ГХБХБГ
34.	hoa1	279	93%	Ховд аймаг ГХБХБГ
35.	goa1	278	93%	Говь-Алтай аймаг ГХБХБГ
36.	sea2	268	89%	Сэлэнгэ аймаг ГХБХБГ
37.	hea2	262	87%	Хэнтий аймаг ГХБХБГ
38.	huv2	248	83%	Хөвсгөл аймаг ГХБХБГ
39.	hea1	245	82%	Хэнтий аймаг ГХБХБГ
40.	dog2	171	57%	Дорноговь аймаг ГХБХБГ
41.	gsa1	161	54%	Говьсүмбэр аймаг ГХБХБГ
42.	hoa2	0	0%	Ховд аймаг ГХБХБГ
43.	twnt	0	0%	ГЗБГЗЗГ ГЗЗХ



2. Application



Environment analysis



RINEX data analyzed before the post processing

指标项	参考值	说明
dar	≥85%	数据有效率, 反映数据可用性与完好性, 数值越大表明质量越好。
mp1	<0.5m	L1 载波上多路径效应对伪距和相位的综合影响, 反映基准站周围干扰源的影响程度, 数值越小表明质量越好。
mp2	<0.5m	L2 载波上多路径效应对伪距和相位的综合影响, 反映基准站周围干扰源的影响程度, 数值越小表明质量越好。
sn1	>4db-Hz	L1 载波信噪比, 反映接收机品质、伪距和相位观测数据质量, 数值越大表明质量越好。
sn2	>64db-Hz	L2 载波信噪比, 反映接收机品质、伪距和相位观测数据质量, 数值越大表明质量越好。
o/spls	>200	观测值和周跳比, 能直接反映出数据的周跳情况反映载波相位观测值的跳变情况, 数值越大则出现的周跳越少, 数据质量越好。

"Standards for Satellite Navigation and Positioning Base Station Network Service Management System" (GB/T 35768-2017) and the "Global Navigation Satellite System Continuous Operation Base Station Network Technical Specification" (CH/T 2011-2012)

Table 1 Best/Poor 5 stations (Multipath MP1, MP2)

Site	Total	>85%	mp1<0.5	mp2<0.5	sn1>40db	sn1>30db	spls>200
zav2	146	100	100	100	100	100	100
zav1	1672	100	100	100	100	100	100
sua2	46	100	100	100	100	100	98
ova2	361	100	100	100	100	100	100
gsa1	1779	100	100	100	100	100	100
huv1	252	100	31	0	100	100	100
oma1	649	100	14	0	100	100	100
erdn	896	100	8	4	100	100	100
drhn	14	100	7	100	100	100	100
dua2	28	100	0	0	100	100	57

Table 2 Signal to Noise Ratio impact

Site	Total	>85%	mp1<0.5	mp2<0.5	sn1>40db	sn1>30db	spls>200
zav2	146	100	100	100	100	100	100
zav1	1672	100	100	100	100	100	100
ova2	361	100	100	100	100	100	100
gsa1	1779	100	100	100	100	100	100
dog1	598	100	100	100	100	100	100
dua2	28	100	0	0	100	100	57
huv1	252	100	31	0	100	100	100
goa1	379	97	70	4	99	100	74
twnt	709	100	99	99	98	98	96
sea1	1610	97	75	79	97	98	100

Table 3 Signal их, бара 5 CORS

Site	Total	>85%	mp1<0.5	mp2<0.5	sn1>40db	sn1>30db	spls>200
zav2	146	100	100	100	100	100	100
zav1	1672	100	100	100	100	100	100
ova2	361	100	100	100	100	100	100
gsa1	1779	100	100	100	100	100	100
dog1	598	100	100	100	100	100	100
huv1	252	100	31	0	100	100	100
sua2	46	100	100	100	100	100	98
twnt	709	100	99	99	98	98	96
goa1	379	97	70	4	99	100	74
dua2	28	100	0	0	100	100	57

Velocity calculation/Epoch transformation



Comparison between ITRF2008 and 2005 of CORS (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
	OVAL_GPS	-977156.36008	4308800.74727	4587095.57416	-0.02972	-0.00127	-0.00510	2005.00
	OMAL_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
	GSAL_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

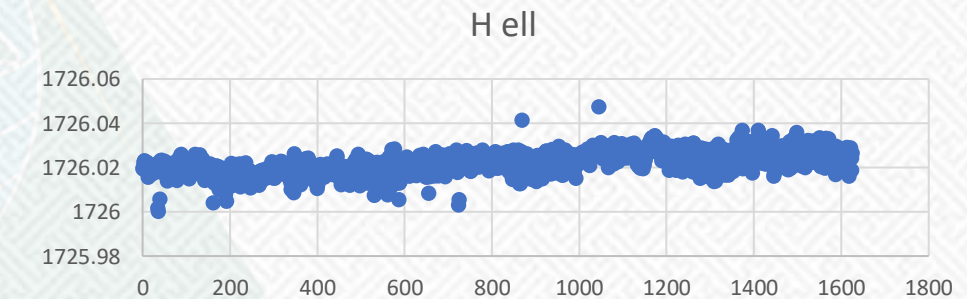
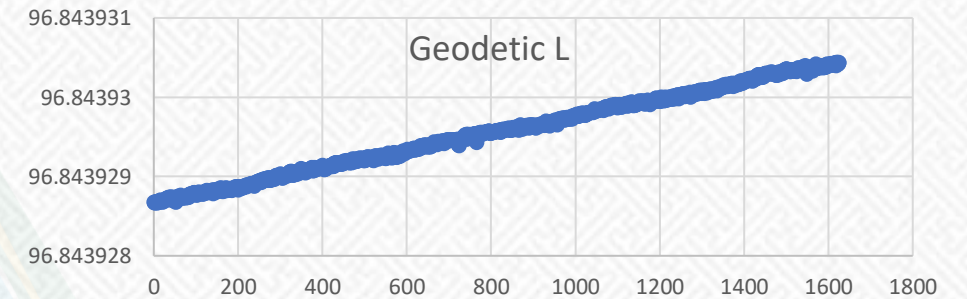
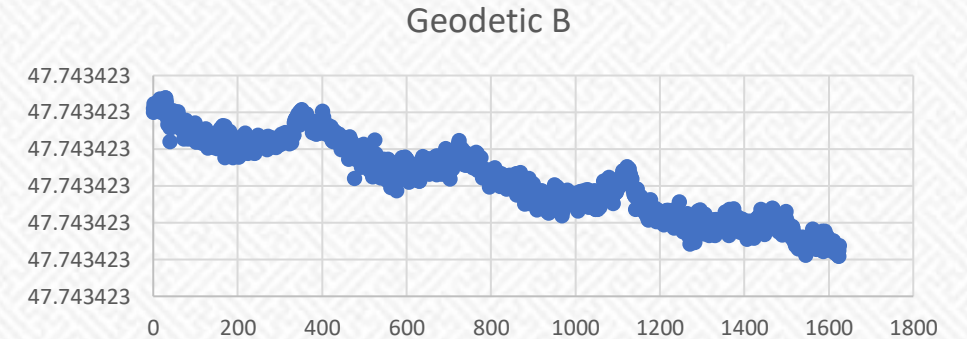
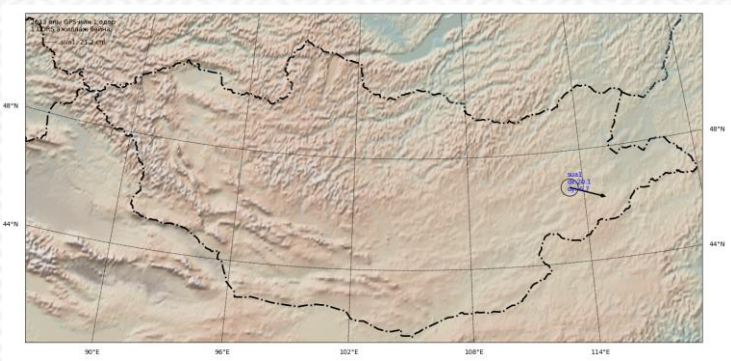
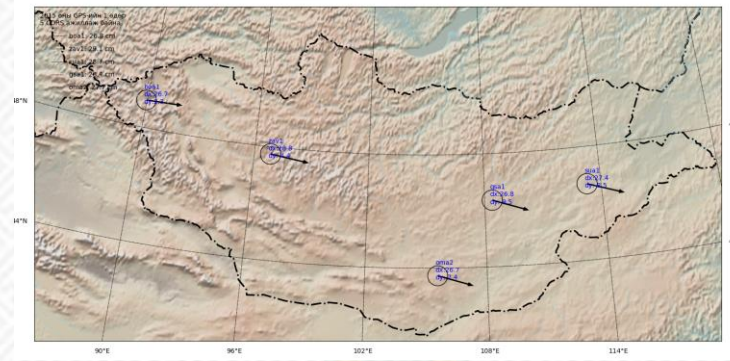


Plate motion monitoring

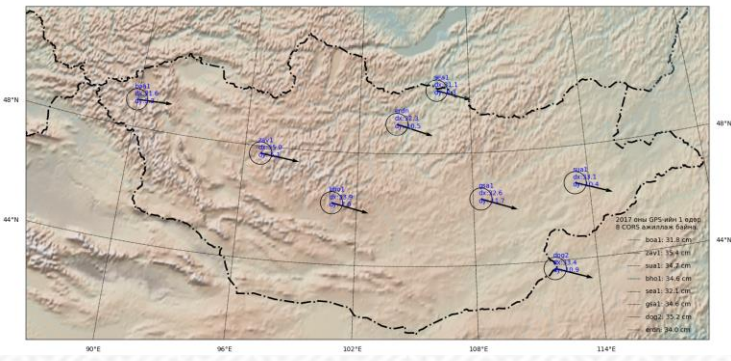
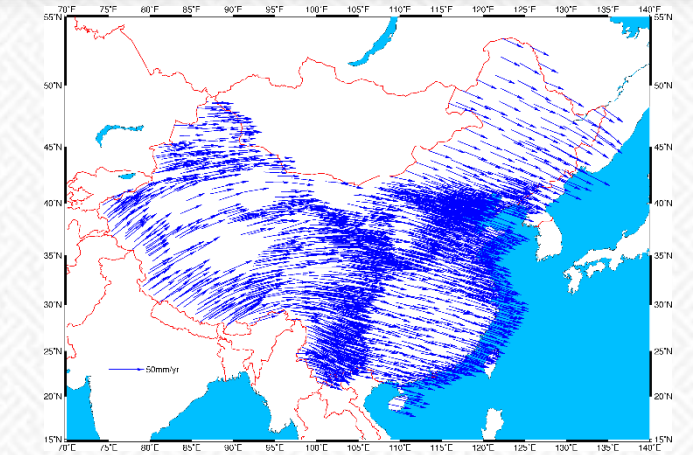


SUA1 21.2cm

2013-2015

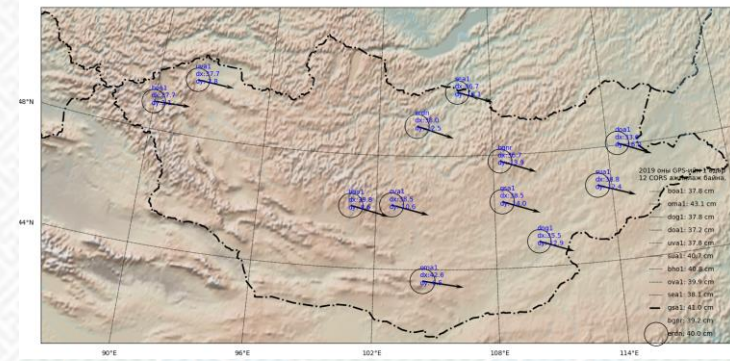


SUA1 28.7 cm
ZAV1 29.1 cm
BOA1 26.8 cm
GSA1 28.4 cm

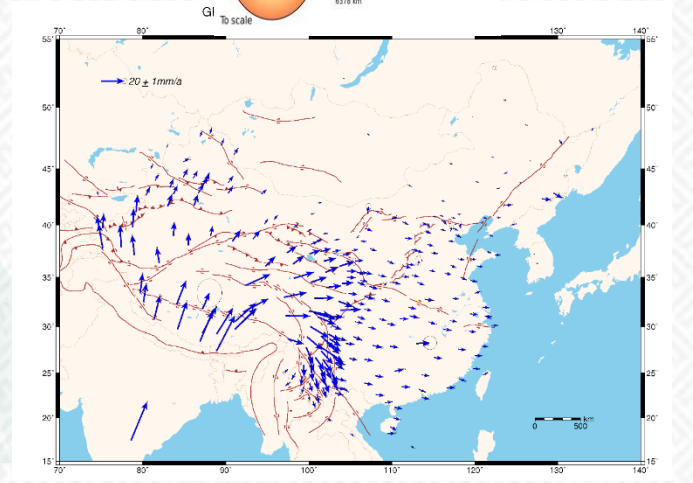
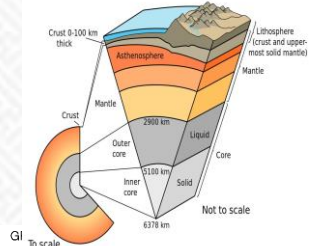


SUA1 34.2 cm
ZAV1 35.4 cm
BOA1 31.8 cm
GSA1 34.6 cm

2017-2019

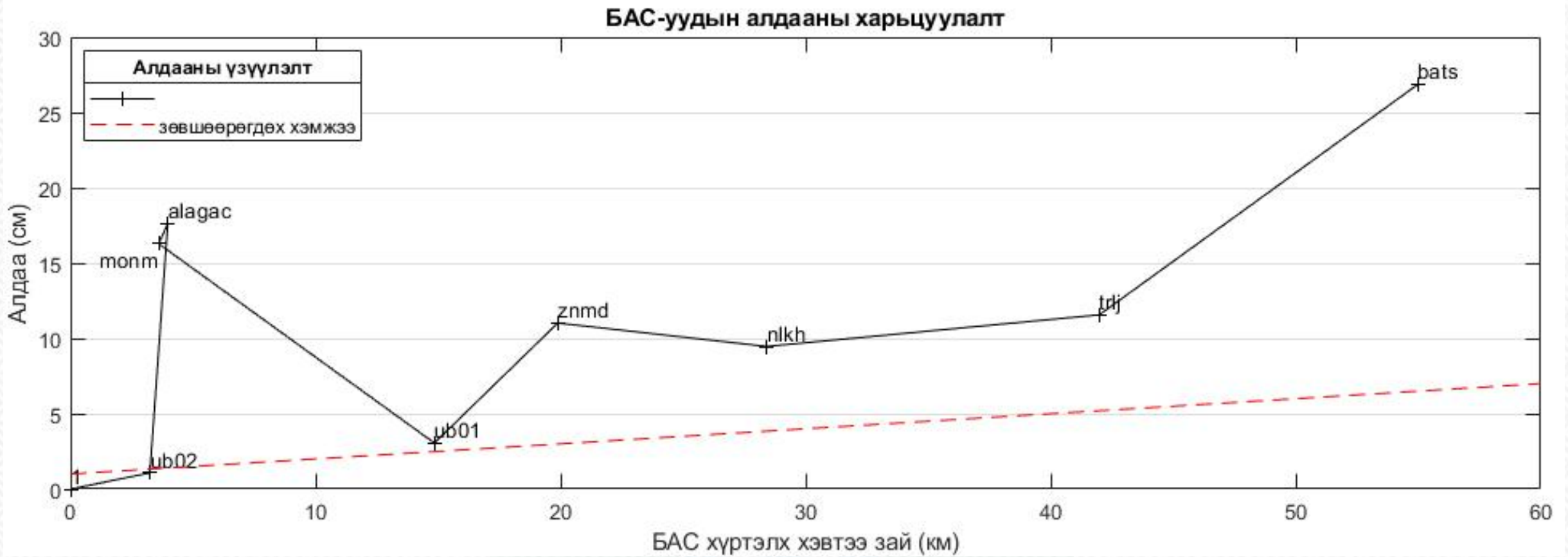


SUA1 40.7 cm
DOG1 37.8 cm
BOA1 37.8 cm
GSA1 41.0 cm





Realtime monitoring of CORS network



Online services (www.monpos.gazar.gov.mn)



RINEX файлын тоо: Тулгуур CORS-г сонгох:

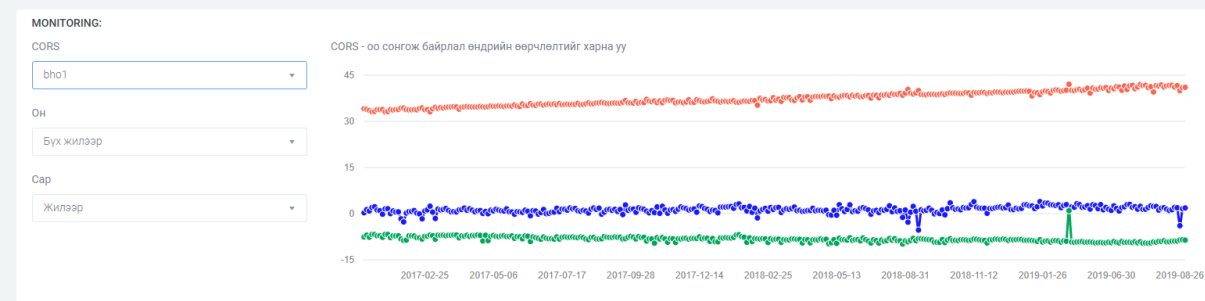
RINEX файл: No file chosen Багажны өндөр /метр/ Хүлээн авагчийн төрөл GNSS -ийн антены төрөл

e-mail хаяг Нэмэлт системийг сонгоно уу: Glonass Galileo Beidou

Таны GNSS-ийн өгөгдөл нь:

1. Статик горимд хэмжигдсэн байх
2. Хамгийн багадаа 2 ба түүнээс дээш цагийн өгөгдөл байх
3. Геодезийн сүлжээний шаардлага хангасан хос долгионы хүлээн авагчаар хэмжсэн байх
4. RINEX форматаар байх
5. IGS-ийн файл дугаарлалтын стандартад заасны дагуу нэрлэгдсэн байх

XXXXDDDS.YYc
 - XXXX – Хэмжсэн цэгийн нэр
 - DDD-Жилийн өдөр (GPS-ийн өдөр, 001-365)
 - S-хэмжсэн хугацааны урт (0-9, a-Z)
 - YY-хэмжилт хийсэн оны сүүлийн 2 орон (2018 үед 18)Жишээ нь: gunt2170.18c



2. RTK service in surveying field



CORS' RTK data service radius is within 35 km

SNIP, the simple NTRIP Caster (wPRO 3)

File Edit SetUp Reports Misc Help

Status Caster and Clients Serial Streams Relay Streams Pushed-In Streams Pushed-Out Streams Raw TCP/IP Nearest AVL

MountPt	buu1	sea1_mgl	bgnr_mgl	ub01_mgl	sua1	huv1
UpTime	02:35:20 Up(28/28)	02:35:20 Up(29/28)	02:35:19 Up(30/28)	02:35:19 Up(26/28)	02:35:19 Up(29/28)	02:35:19 Up(29/28)
Input	2,393 MB	2,686 MB	2,428 MB	2,738 MB	2,478 MB	2,451 MB
Output	384,06 KB	0 Bytes	0 Bytes	7,710 MB	0 Bytes	0 Bytes
Clients	0 / 25 [R]	0 / 91 [R]	0 / 9 [R]	5 / 1 945 [R]	0 / 0 [R]	0 / 1 [R]

Reserved MountPts (40/42)

- ✓ sea1_mgl [H] (28th/679)
- ✓ sea2_mgl [H] (28th/604)
- ✓ sua1 [H] (28th/813)
- ✓ sua2 [H] (47th/163)
- ✓ tuv1 [H] (30th/627)
- ✓ tuv2_mgl [H] (24th/968)
- ✓ twnt_test [H] (2nd/8 995)
- ✓ ub01_mgl [H] (28th/744)
- ✓ ub03 [H] (12th/1 121)
- ✓ ub04_mgl [H] (27th/1 560)
- ✓ ub05 [H] (8th/499)

Incoming NTRIP Servers [Push-In]

- Allow Connection
- Start As Parsed
- Start As Logged

Status Report Show Logs List MountPts

Set Up... Add... Sort by...

Filter Log Types Streams Log Threshold Show Sums Word Wrap Auto Save

Major Client Events

- C30821 On STATUS at 5a 11:04:44
- C30823 Off ?? 66.181.161.36 at 5a 11:05:30 (2n)
- C30824 On STATUS at 5a 11:05:43
- rover Off twnt_test at 5a 11:06:03 (up 02:17 min)
- rover Off ub01_mgl at 5a 11:06:11 (up 05:57 min)

Major Base Station Events

- UP dua2_mgl at 5a 09:00:04
- BD drhn_mgl at 5a 09:04:27 (time ~09:04 min)
- UP drhn_mgl at 5a 09:04:27
- DW dog1 at 5a 09:22:06 (online ~35:35 min)
- UP dog1 at 5a 09:22:06
- DW ub03 at 5a 09:40:02 (online ~1D 07:55)
- UP ub03 at 5a 09:46:18

Tables: 1 166, Banned Connections: 0/0

Listening, Reading at 13,56 KB/sec, (total 613,928 MB sent), Have 49 current clients, UpTime: 8 Days 21:27 (HH:MM)



1-р сайт:

dx (m): dy(m): Цаг (HH:MM:SS):

0.0035 0.0000 07:42:27.000

2-р сайт:

dx (m): dy(m): Цаг (HH:MM:SS):

0.0034 0.0000 07:42:28.000

3-р сайт:

dx (m): dy(m): Цаг (HH:MM:SS):

0.0042 0.0034 07:42:29.000

4-р сайт:

dx (m): dy(m): Цаг (HH:MM:SS):

0.0047 0.0046 07:42:30.000

5-р сайт:

dx (m): dy(m): Цаг (HH:MM:SS):

0.0045 0.0034 19:52:13.000

6-р сайт:

dx (m): dy(m): Цаг (HH:MM:SS):

0.0045 0.0040 07:42:31.000

7-р сайт:

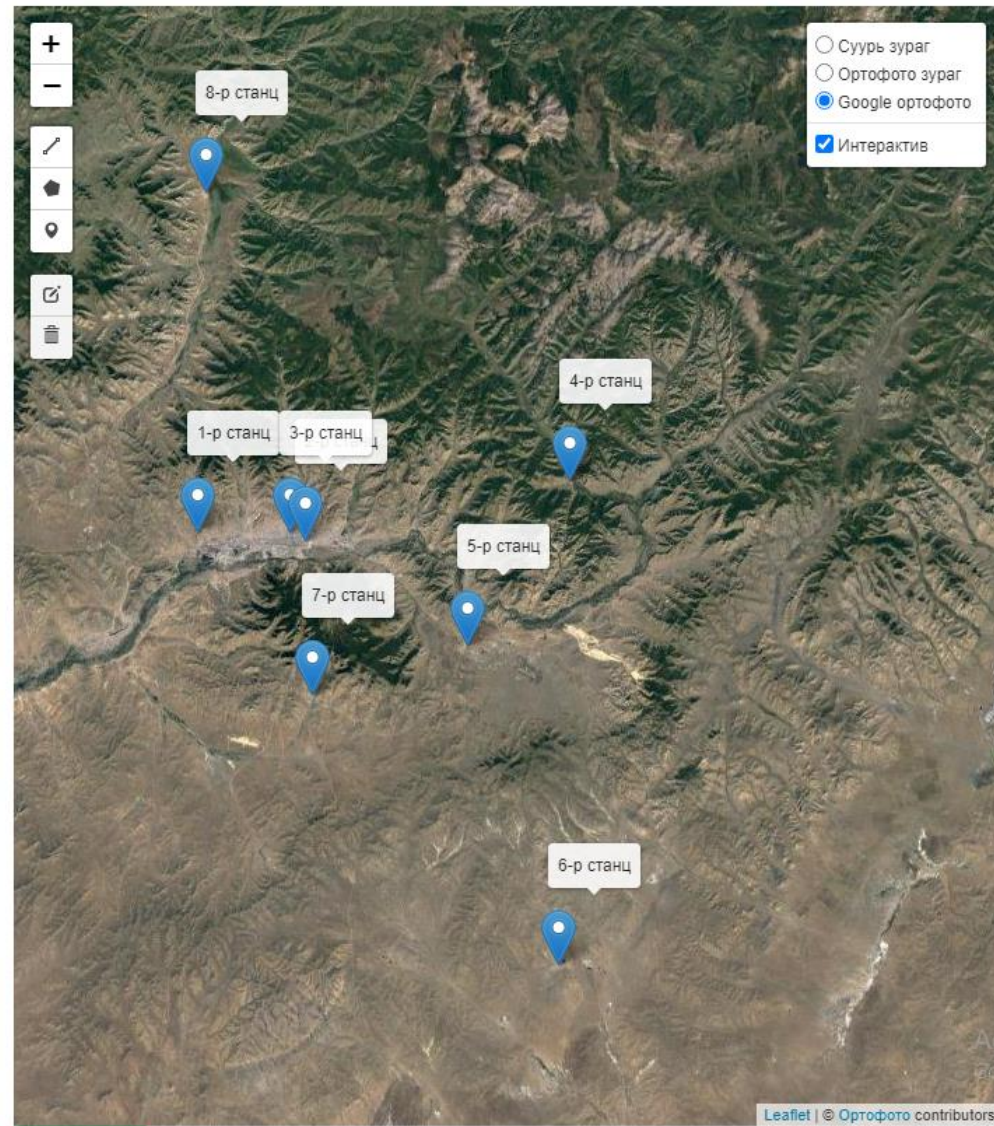
dx (m): dy(m): Цаг (HH:MM:SS):

0.0045 0.0034 07:42:32.000

8-р сайт:

dx (m): dy(m): Цаг (HH:MM:SS):

0.0045 0.0040 07:42:33.000

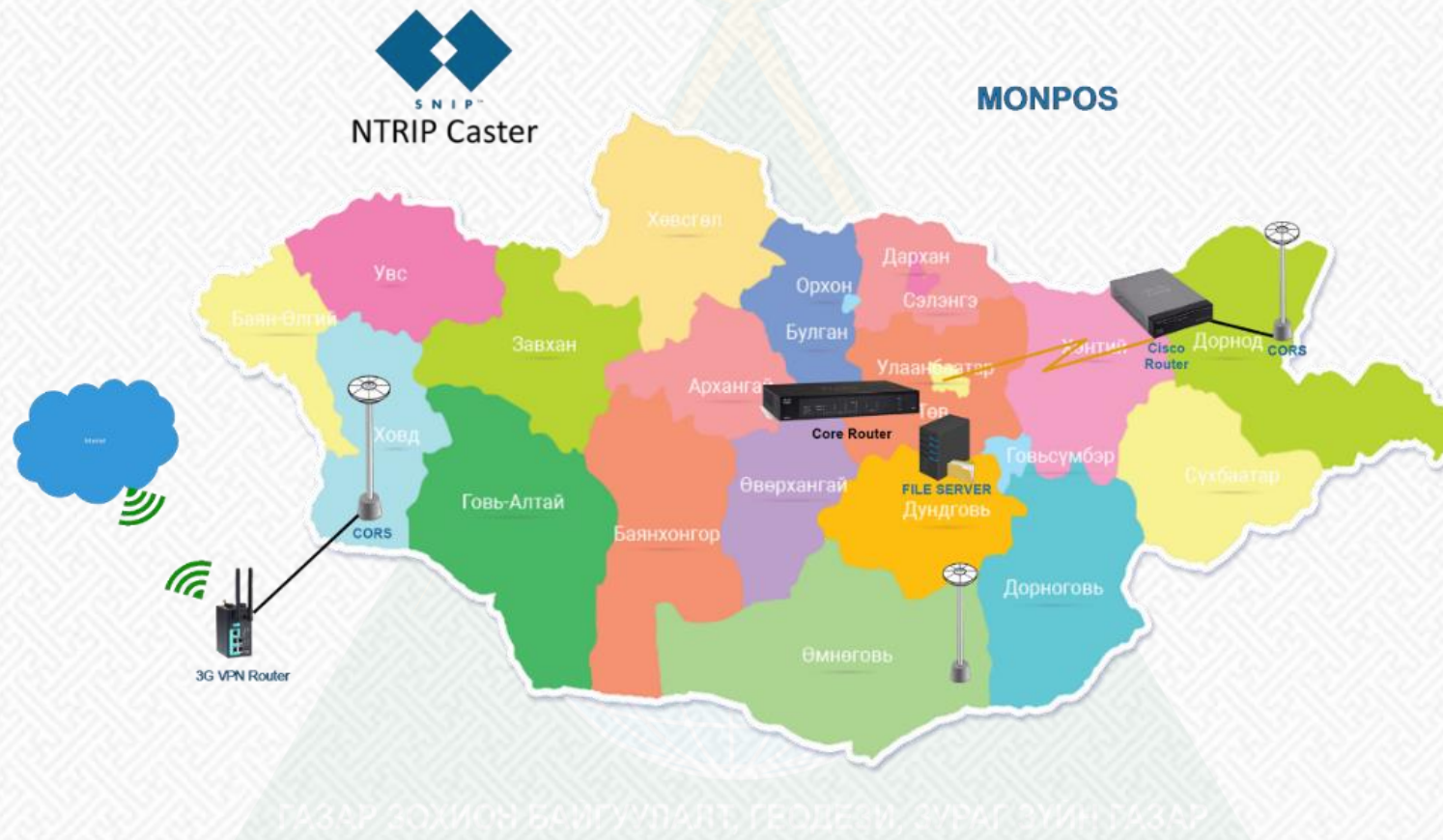


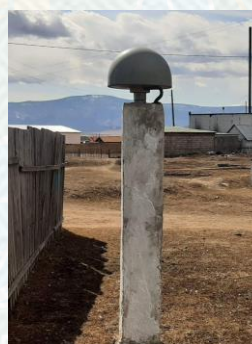
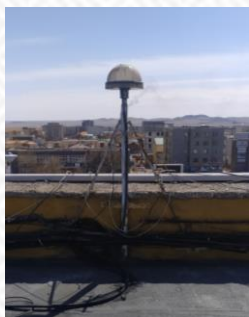


In Future

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.







GOVERNMENT OF MONGOLIA
AGENCY FOR LAND ADMINISTRATION AND
MANAGEMENT, GEODESY AND CARTOGRAPHY



**Thank you for
your attention
Q/A**

