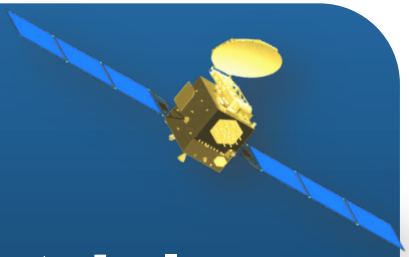

Study on updating BDS Terrestrial Reference Frame using BDS Observations

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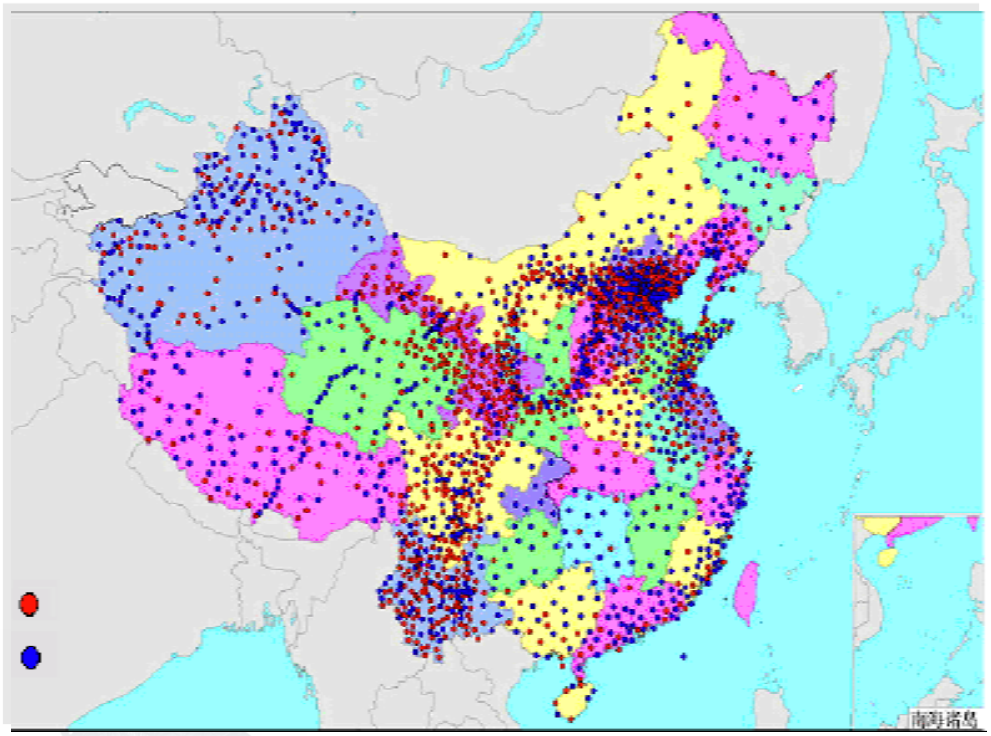
November, 2014

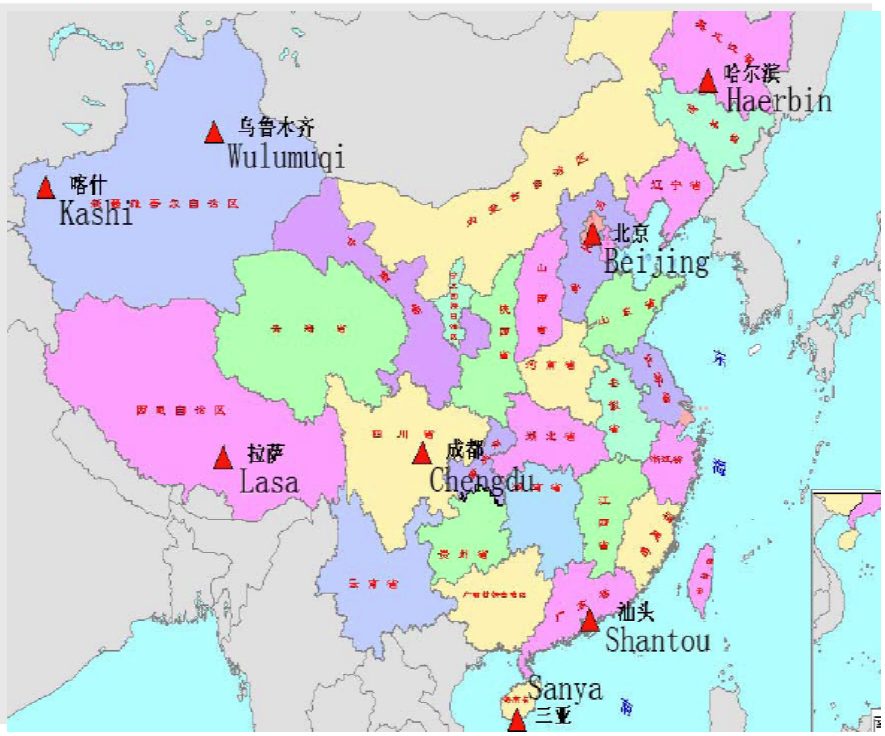
Overview

1. Background
2. BDS/GPS reference stations
3. Align the BDS/GPS reference stations to ITRF 2008
4. Updating of BDS Terrestrial Reference Frame using BDS observations
5. PCO and PCV Calibration for BDS/GPS receivers
6. Summary

1.Background

- CGCS 2000 and CGS (2012) are realized using only GPS data

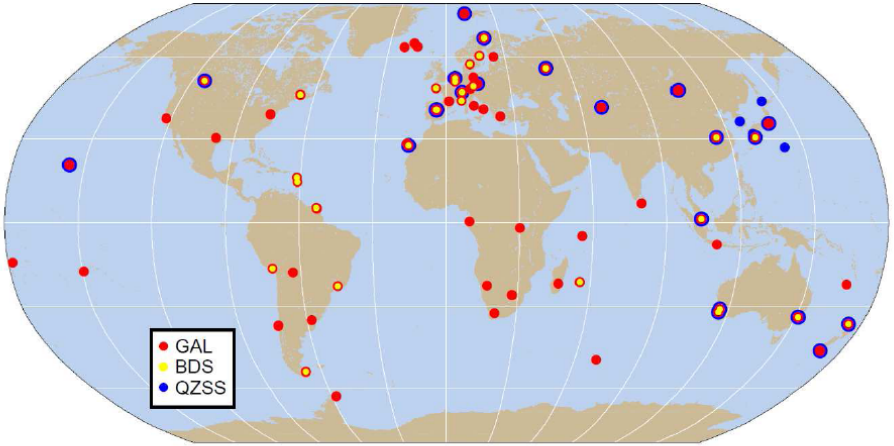




Could it be updated using BDS observations?

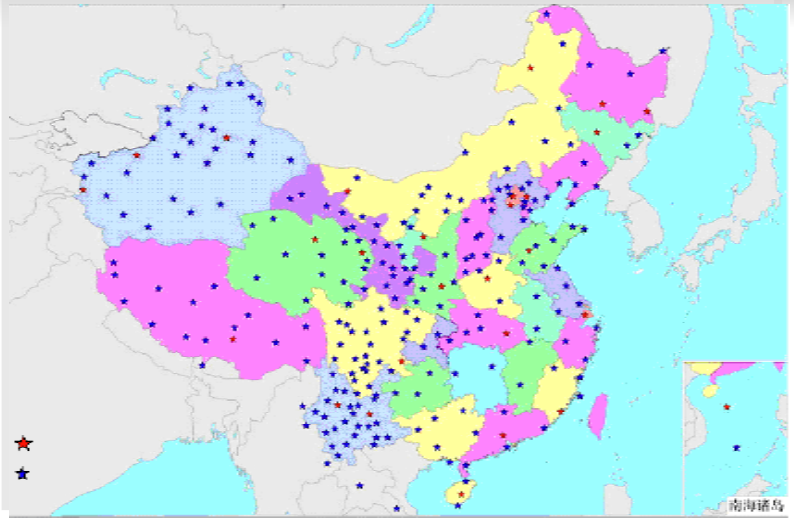
(WEI Ziqing, Compass Geodetic System, 2012, ICG-7)
(YANG Yuanxi, Updates of CGCS 2000, 2010, ICG-15)

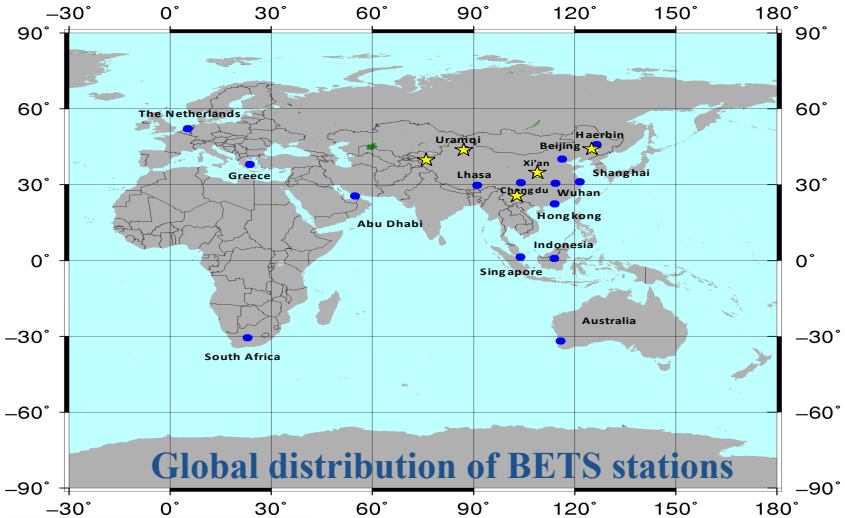
2.BDS/GPS reference stations

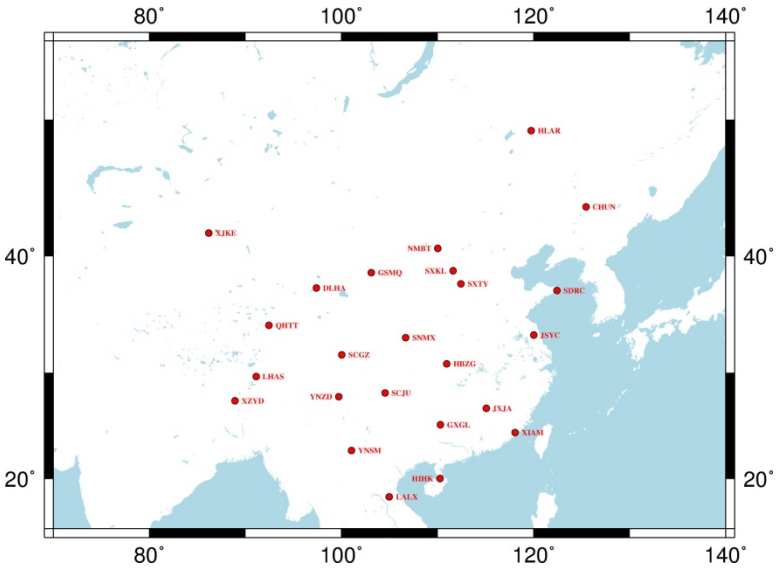


~90 Stations (Sep. 2013)

ftp://cddis.gsfc.nasa.gov/pub/gps/data/campaign/mgex/

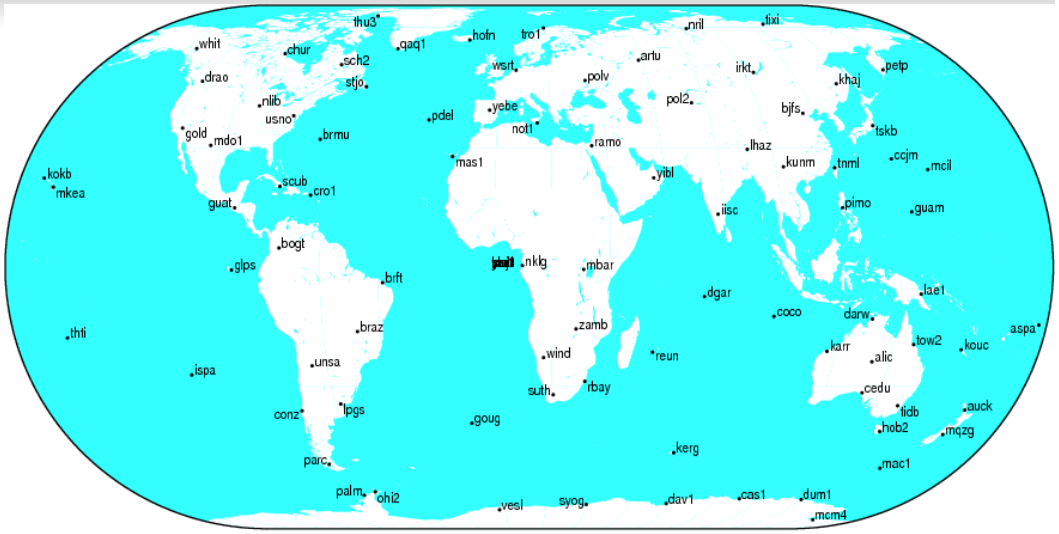




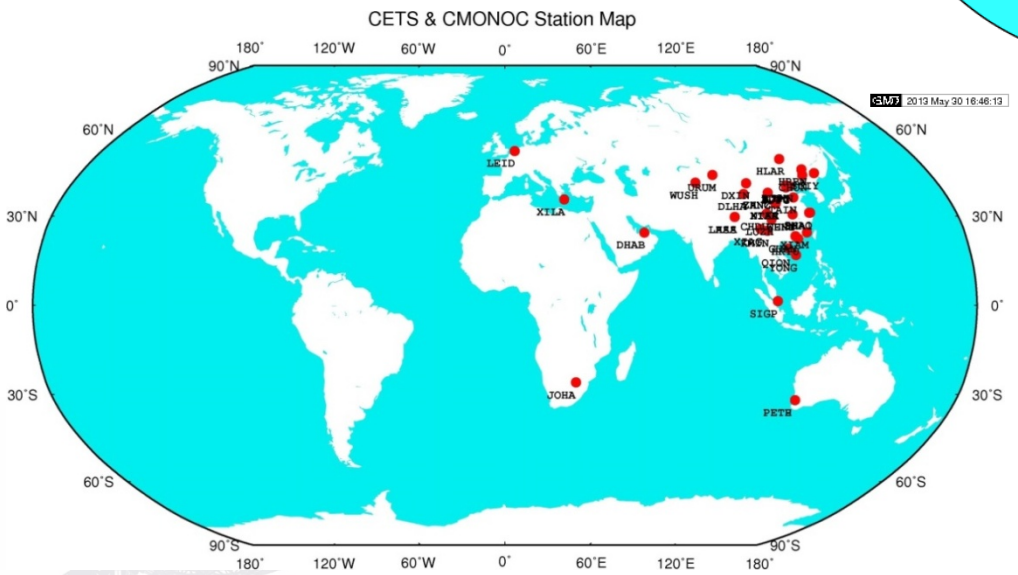


23 CMONOC GPS/BDS stations

3. Align BDS/GPS stations to ITRF 2008

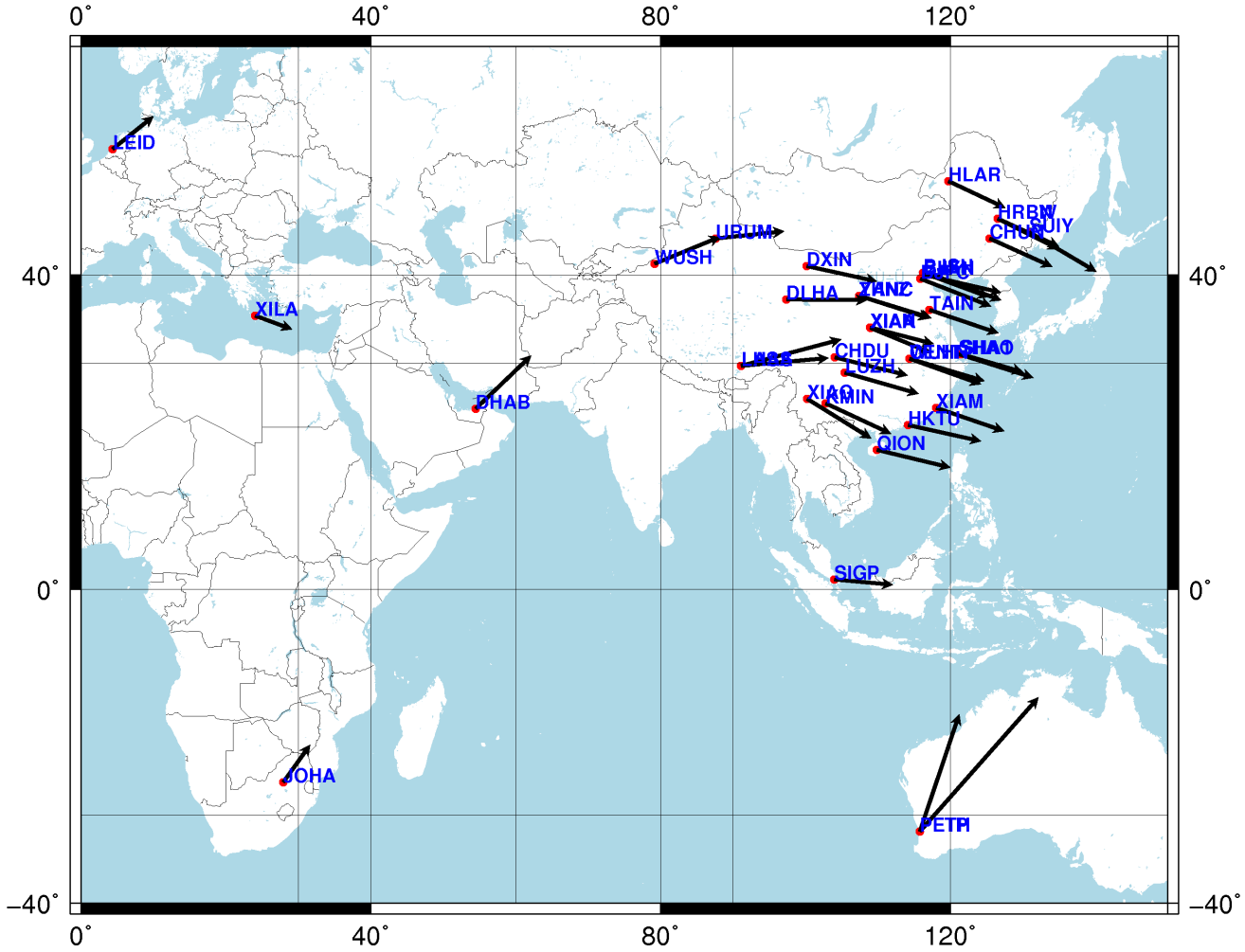


Distribution of Igb08 central station



Global distribution of BETS and CMONOC stations

2. Align BDS/GPS stations to ITRF 2008



Horizontal velocity field of CMONOC and BETS stations

3. Align BDS/GPS stations to ITRF 2008

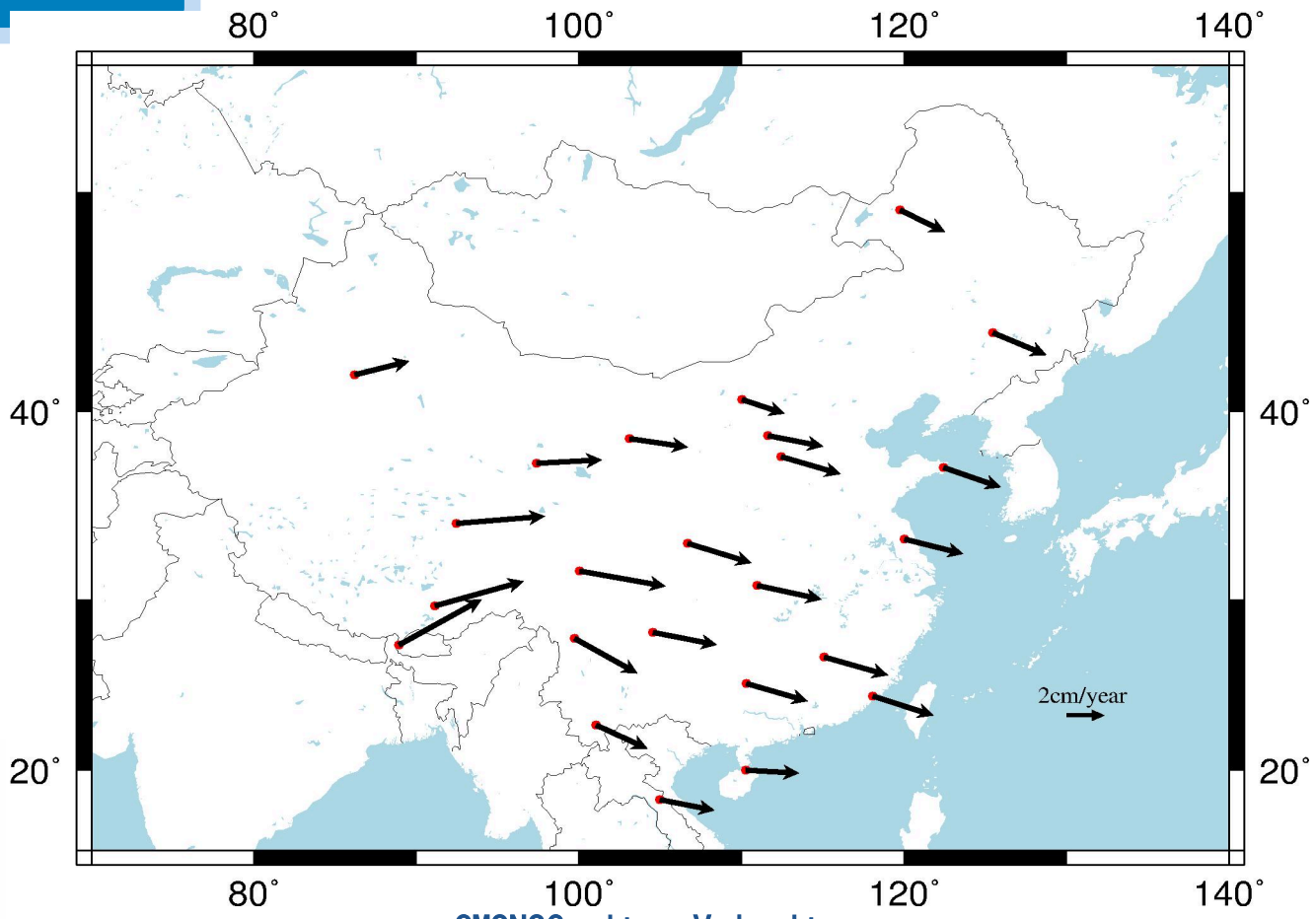
Precision Analysis

Site	Velocity (mm/yr)			Velocity RMS(mm/yr)			Position RMS(mm)			Source
	North	East	Up	North	East	Up	North	East	Up	
BJF1	-8.4	36.2	-6.9	0.18	0.20	0.46	2.30	2.65	6.03	CETS
BJFS	-13.0	33.2	4.0	0.14	0.14	0.37	1.97	1.96	5.11	CMONOC
LUZH	-9.9	34.6	3.4	0.13	0.15	0.49	1.73	2.08	6.77	CMONOC
NTSC	-26.2	46.0	-0.6	1.33	2.32	3.13	3.17	5.51	7.45	CETS
PETH	54.9	18.4	18.2	0.40	0.71	1.45	2.40	4.23	8.68	CETS
PFTP	62.8	55.4	-21.5	1.43	1.88	5.77	4.61	6.03	18.53	CETS
QION	-8.3	34.4	4.4	0.18	0.29	0.73	2.47	3.89	9.92	CMONOC
SHA1	-8.5	29.1	-4.3	0.44	0.62	1.64	2.18	3.10	8.19	CETS
SHAO	-11.1	35.0	-1.2	0.30	0.41	0.95	2.18	2.98	6.90	CMONOC
SIGP	-2.5	27.5	-18.8	0.67	1.44	2.58	4.55	9.81	17.63	CETS
SUIY	-18.6	31.4	-0.4	0.18	0.22	0.60	2.34	2.81	7.87	CMONOC
TAIN	-10.9	32.2	1.0	0.15	0.17	0.46	2.09	2.28	6.33	CMONOC
URUM	3.4	32.0	3.2	0.30	0.29	0.95	2.34	2.32	7.48	CMONOC
WUHN	-10.5	35.0	-3.7	0.18	0.22	0.62	2.23	2.69	7.56	CMONOC
WUSH	12.7	30.8	2.8	0.14	0.13	0.40	1.88	1.76	5.25	CMONOC
XIAA	-11.6	28.1	49.2	0.19	0.16	1.13	2.53	2.10	14.85	CMONOC
XIAG	-18.7	30.1	7.5	0.30	0.41	0.73	4.06	5.55	9.83	CMONOC
XIAM	-10.9	31.8	16.7	0.18	0.29	1.13	2.47	3.93	15.61	CMONOC
XIAN	-7.7	29.8	1.4	0.26	0.30	0.85	1.76	2.00	5.65	CMONOC
XILA	-6.4	17.3	-30.9	1.73	2.27	5.47	2.17	2.84	6.84	CETS
YANC	-10.5	32.8	5.0	0.13	0.14	0.38	1.87	1.94	5.33	CMONOC
ZHNZ	-10.4	33.7	4.3	0.24	0.27	0.80	1.80	2.00	5.90	CMONOC

Sites	Velocity RMS(mm/yr)		Position RMS(mm)	
	Horizontal	Vertical	Horizontal	Vertical
BETS sits (in China)	0.3	0.8	2.4	7.4
BETS all sites	0.5	1.3	3.0	8.9
BETS/CMONOC	0.3	0.9	2.5	7.7

3. Align BDS/GPS stations to ITRF 2008

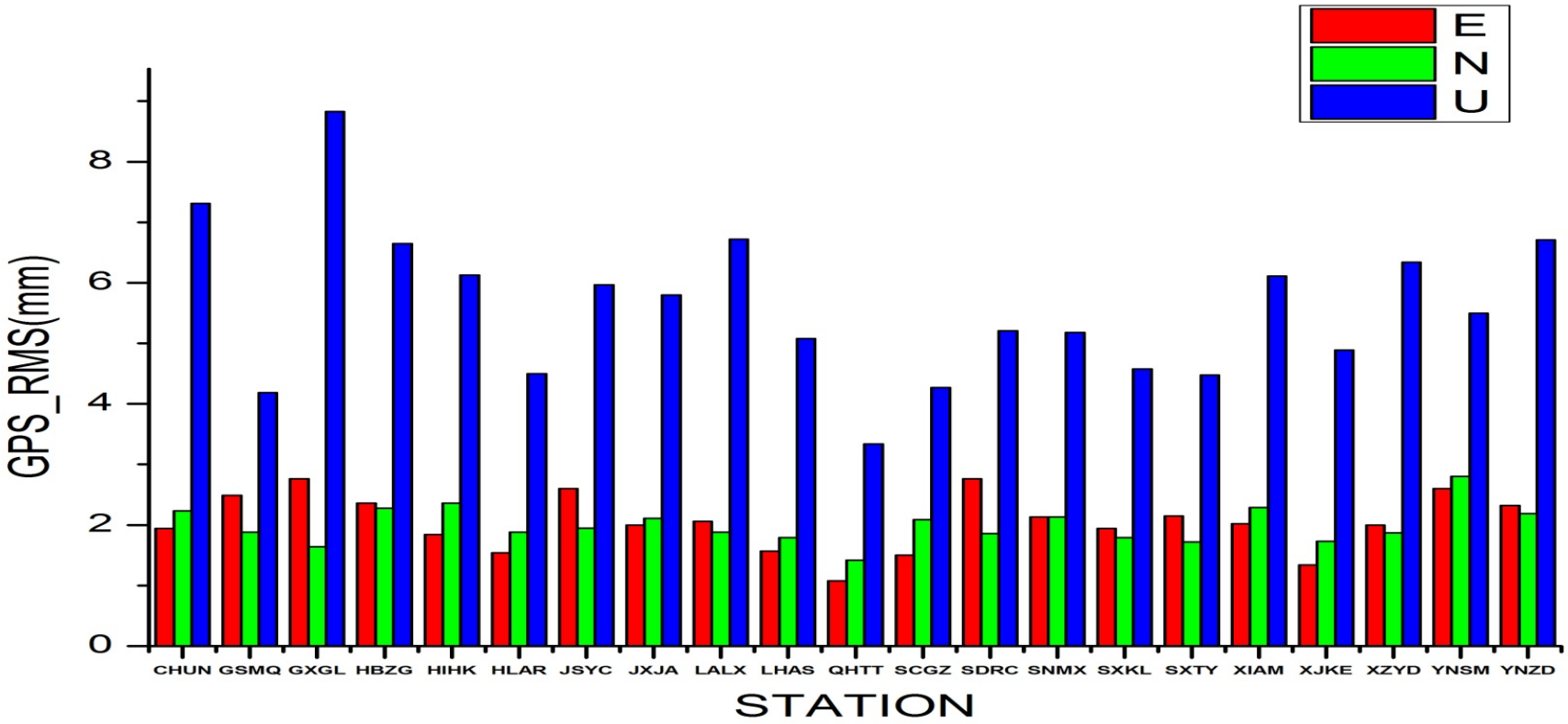
Precision Analysis



CMONOC sites Velocity
From day 31 of year 2011 to day 291 0f year 2014,
about 3 years and 260 days

3. Align BDS/GPS stations to ITRF 2008

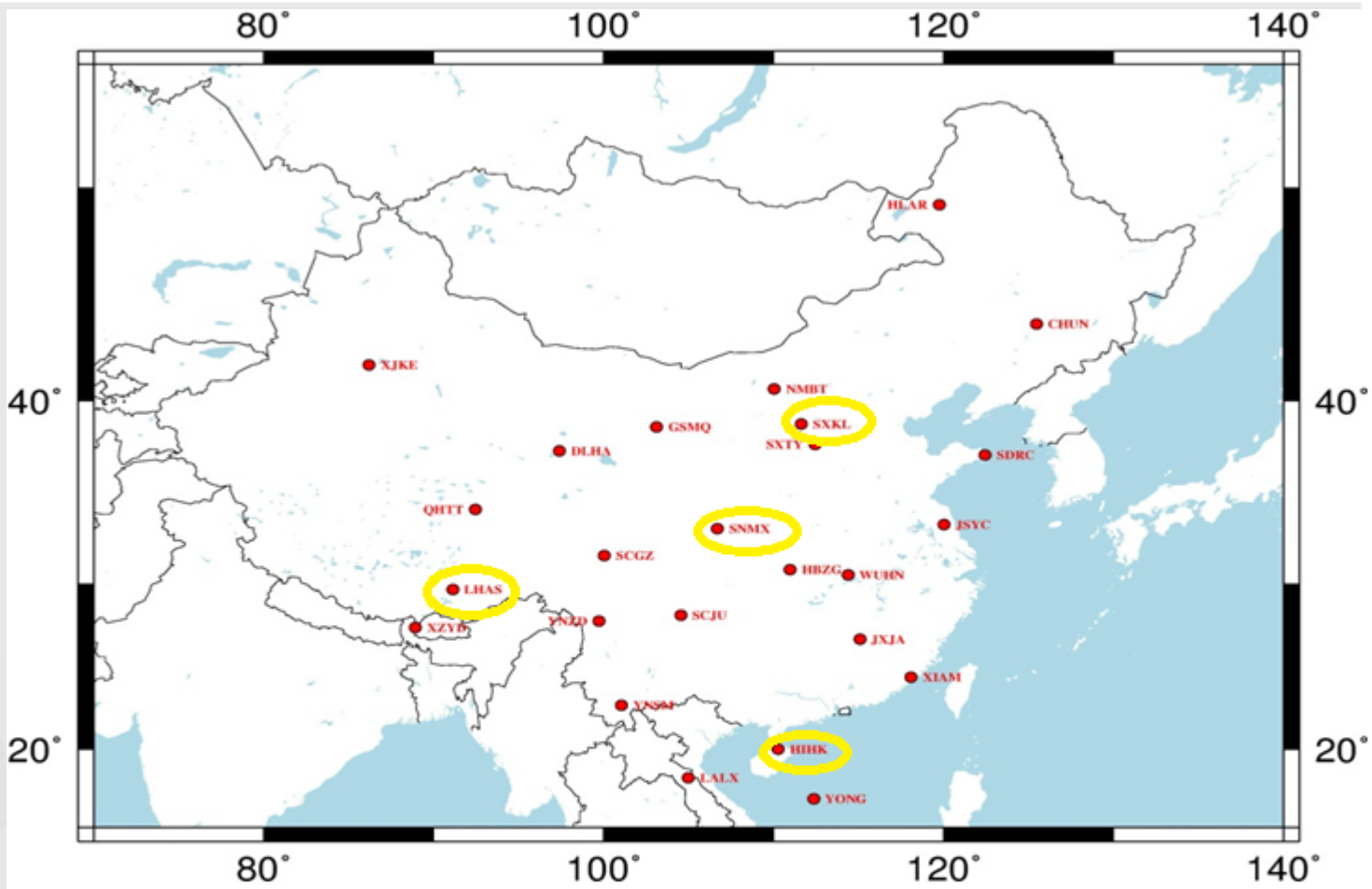
Precision Analysis



CMONOC sites time series RMS
From day 31 of year 2011 to day 291 Of year 2014,
about 3.years and 260 days

4.Update BDS Terrestrial Reference Frame using BDS observations

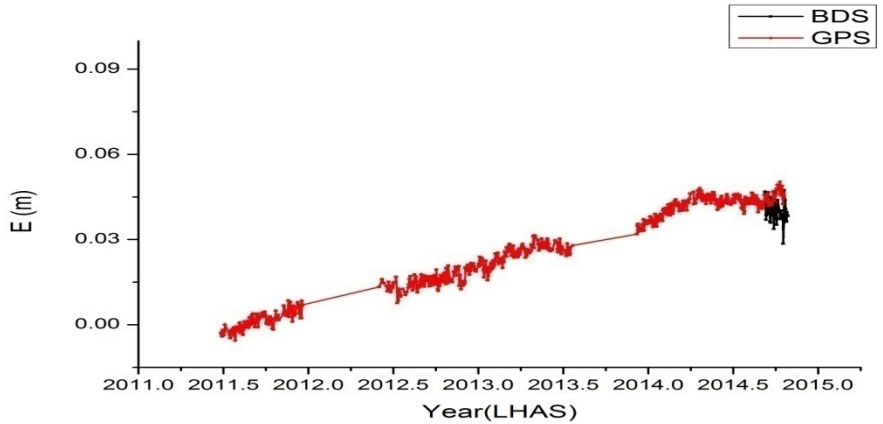
Simulation Study

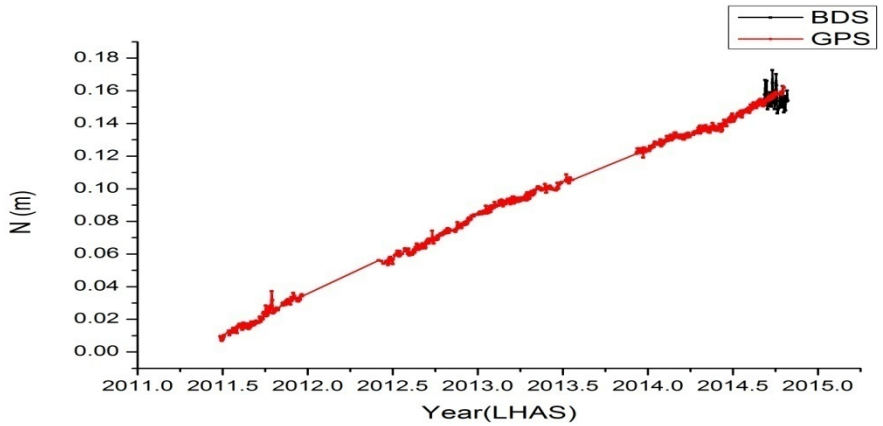


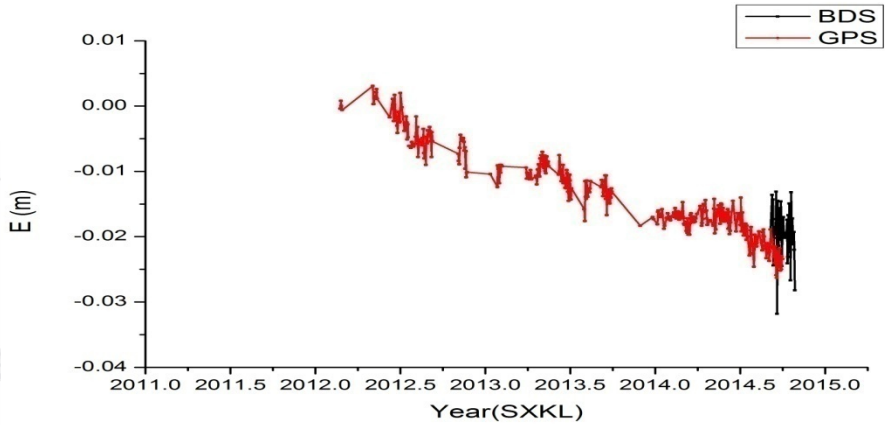
4.Update BDS Terrestrial Reference Frame using BDS observations

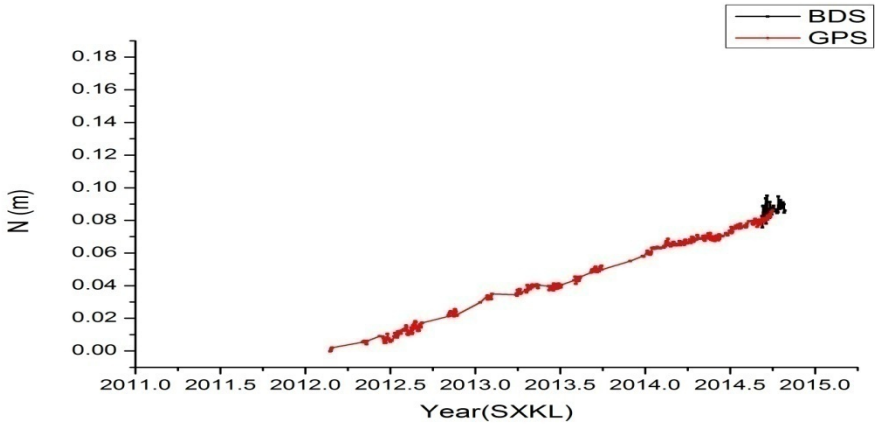
Simulation Study

Small jump : the PCV of BDS used is the same with GPS
Bigger noise : the Ambiguity fixing methold not applied.



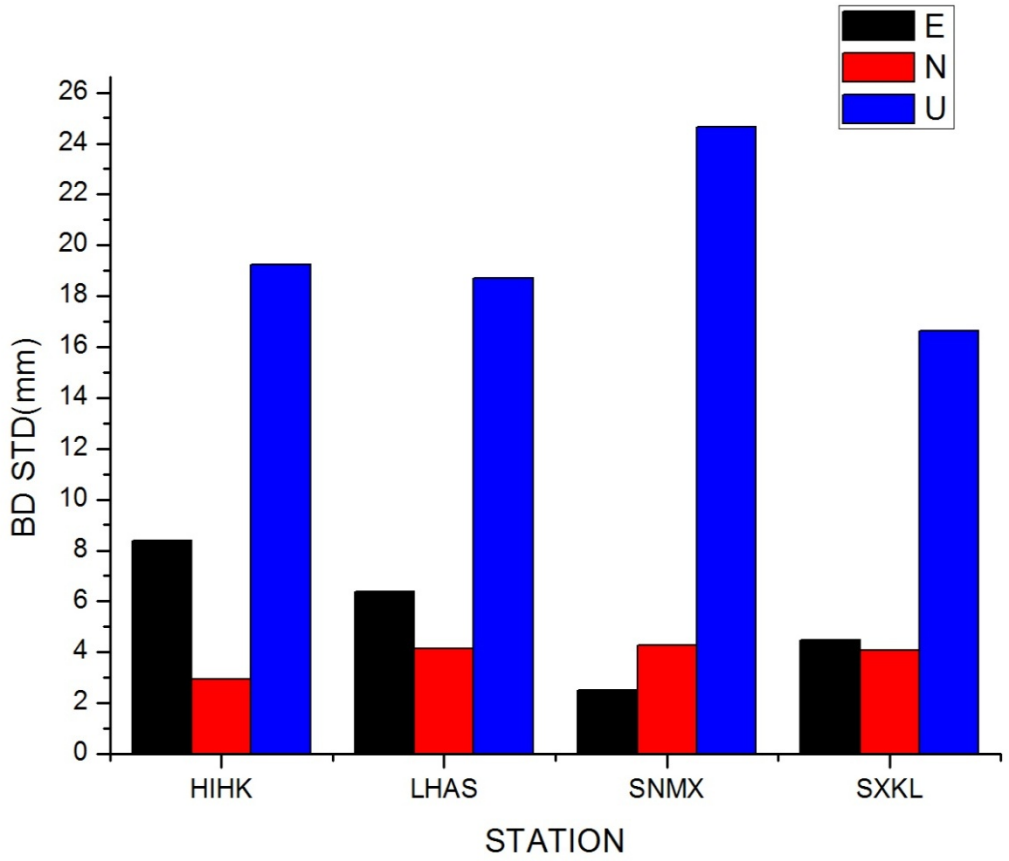






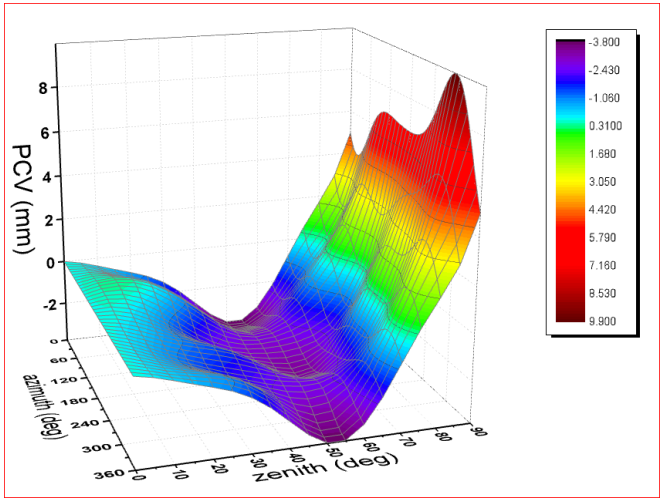
4.Update BDS Terrestrial Reference Frame using BDS observations

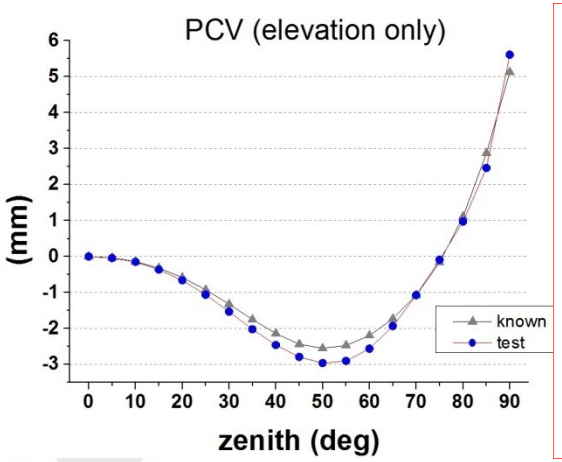
Simulation Study

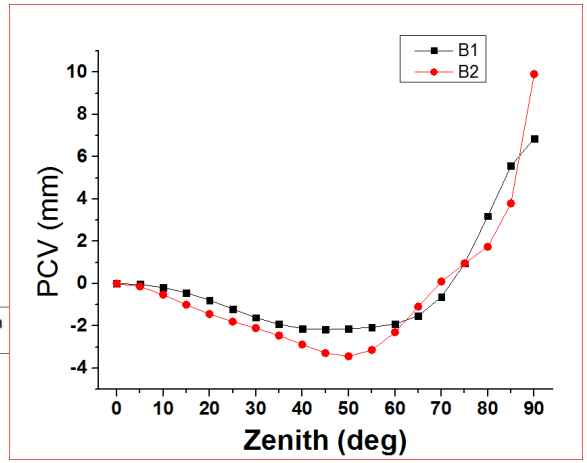


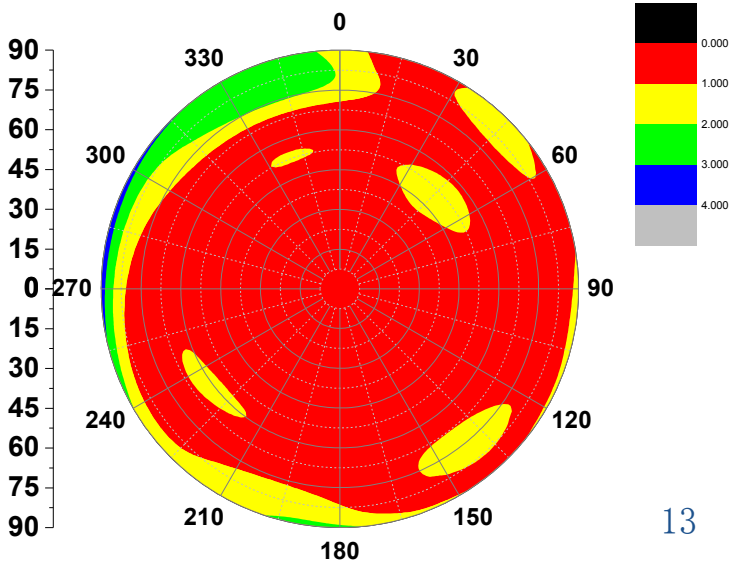
Horizontal position acuraccy of CMONOC test four staion is about 4-8mm
the PCV of BDS used is the same with GPS
the Ambiguity fixing methold not applied.

5. PCO and PCV Calibration for BDS/ GPS receivers









6.Summary

- BDS Terrestrial Reference Frame was realized using GPS observations and is closely aligned to ITRF2008. The position and velocity were obtained using local tie. The accuracy is about 1cm and 2mm/y (see Wei, 2012 in ICG-6);
- BDS started to provide regional service in 2012. There are more 80 BDS/GPS stations around the word. The data could be used to translate the reference information from ITRF2008 to BDS monitoring stations.
- Simulation study shows that using the BDS observation can update the BDS terrestrial Reference Frame at the accuracy of 1 cm and 2mm/y. The accuracy could be improved, when the accurate absolute PCO/ PCV model and ambiguity fixing method are applied.


Thank You !