



UPDATING THE THAI COORDINATE REFERENCE FRAME TO ITRF2005 USING GPS MEASUREMENTS: OBSERVATION ON A DIVERSION BETWEEN ITRF2000 AND ITRF2005 IN SOUTHEAST ASIA REGION

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Introduction

- Thai geodetic network has been regularly observed with GPS since 1994 thru several collaborative projects such as GEODYSSEA, SEAMERGES and RTSD-Delft.
- Previous realisations of Thai coordinate reference frame were tied to the global ITRF at epochs 1994, 1996 and 2000.
- After the occurrence of the 9.2 Mw Sumatra-Andaman earthquake on the 26th December 2004, horizontal displacements were evident at different magnitudes in many SE Asia countries.



Introduction

- Thai geodetic network has been co-seismically displaced and subsequently undergoing a decreasing (post-seismic) deformation at the centimetre to decimetre level that will continue for many years.
- Royal Thai Survey Department (RTSD) has been carrying out multiple GPS field campaigns to monitor the post-seismic displacements.
- This paper will analyse the GPS observations obtained from the RTSD GPS campaigns up to the end of 2008.



GPS campaign observations & other used data

- This study focuses on the zero-order Thai geodetic network, using GPS data from the GPS stations of the RTSD, which has been regularly measured since 1994.
- The complete zero-order Thai geodetic network was re-measured in February, July and October of 2005, in April, July and Nov of 2006, in May and Nov of 2007 and again in Nov 2008.
- Data from 30 IGS stations
- JPL precise orbits, information of time, polar motion and earth orientation

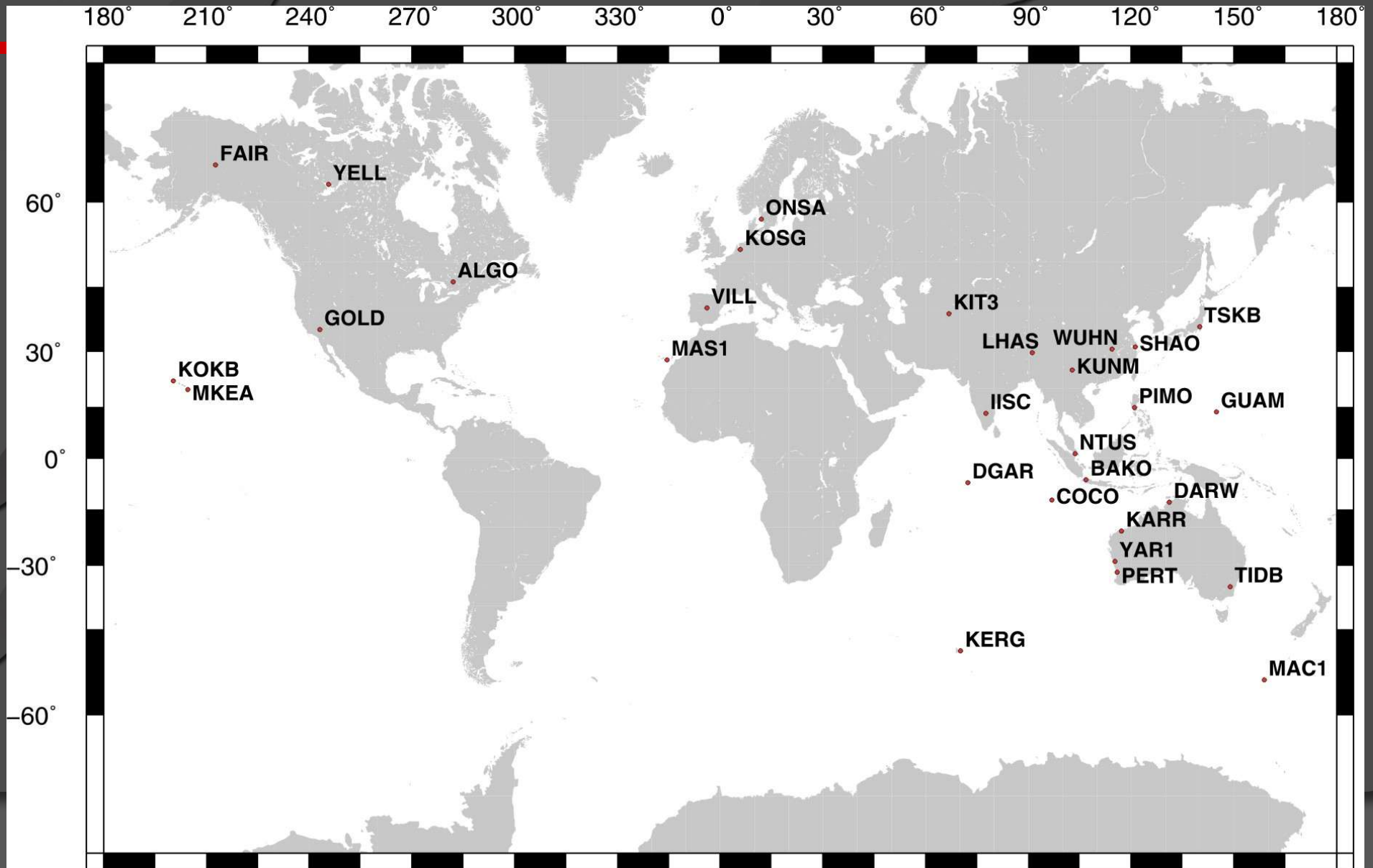


Overview of the geodetic network points in Thailand





IGS stations used for mapping





GPS data processing strategy

- Precise Point Positioning (PPP) technique is selected as a processing strategy in this study .
- All GPS data were uniformly processed with the GIPSY-OASIS II software developed by the Jet Propulsion Laboratory (JPL).
- GPS data were processed in daily batches with the PPP strategy.
- The daily ambiguity-fixed solutions were combined into 7-day campaign averaged solutions using 7-parameter Helmert transformations.



GPS data processing strategy

- In order to condense the results and to facilitate the detection and down weighting of outliers, the overall repeatability statistics of the 7-day combination solution were used to scale the formal errors in their variance-covariance (VCV) matrices.
- The median algorithm was applied to detect and remove outliers prior to the computation of final coordinate repeatabilities.



Coordinate
repeatabilities
for each GPS
point obtained
from the
processing of
Nov 2008
campaign

Station	Daily repeatabilities		
	North (mm)	East (mm)	Height (mm)
UTHA	1.1	1.2	4.1
SRIS	0.7	1.6	5.2
OTRI	0.8	0.7	3.7
BANH	1.0	1.3	7.6
CHON	1.7	2.1	4.5
PHUK	0.8	1.5	8.8
PAT2	1.2	1.5	5.7
NKPH	0.6	1.8	4.7
UDON	0.4	0.7	4.8
LOEI	0.9	1.1	2.1
CHAI	0.7	1.3	2.6
HUAH	1.3	1.4	4.5
MSTK	1.3	1.6	7.4
NKTM	1.6	1.9	5.6
MHSN	0.5	1.2	6.8
CHRI	1.0	1.4	7.3
CHTB	3.1	2.3	6.4
KCNB	2.1	2.8	14.3



Mapping campaign-averaged solutions into ITRF2000 & 2005

- Due to the widespread deformation, a local or national reference frame cannot be used to present the latest coordinates and displacements.
- IGS GPS stations need to be included, so that the positioning results can be given in the global ITRF solution.
- It should be noted that the computation of accurate ITRF coordinates (including ITRF2005) in SE Asia is not straightforward.



Mapping campaign-averaged solutions into ITRF2000 & 2005

- Under the influence of the mega earthquake in 2004, from 2005 onwards the stations NTUS, IISC, HYDE, BAKO, COCO, KUNM, WUHN, SHAO can no longer be used in ITRF realizations of GPS coordinates in SE Asia.
- For SE Asia, the zero-difference GIPSY software appears more robust as both additional regional and global IGS data can be easily added and simultaneously solved for.



Example of accurate mapping results into ITRF2000 & 2005 for the Nov 2008 campaign

Solution in	Overall IGS stations RMS			No. of IGS stations used
	North (mm)	East (mm)	Height (mm)	
ITRF2000	2.4	2.6	9.8	9
ITRF2005	2.5	2.1	7.1	15

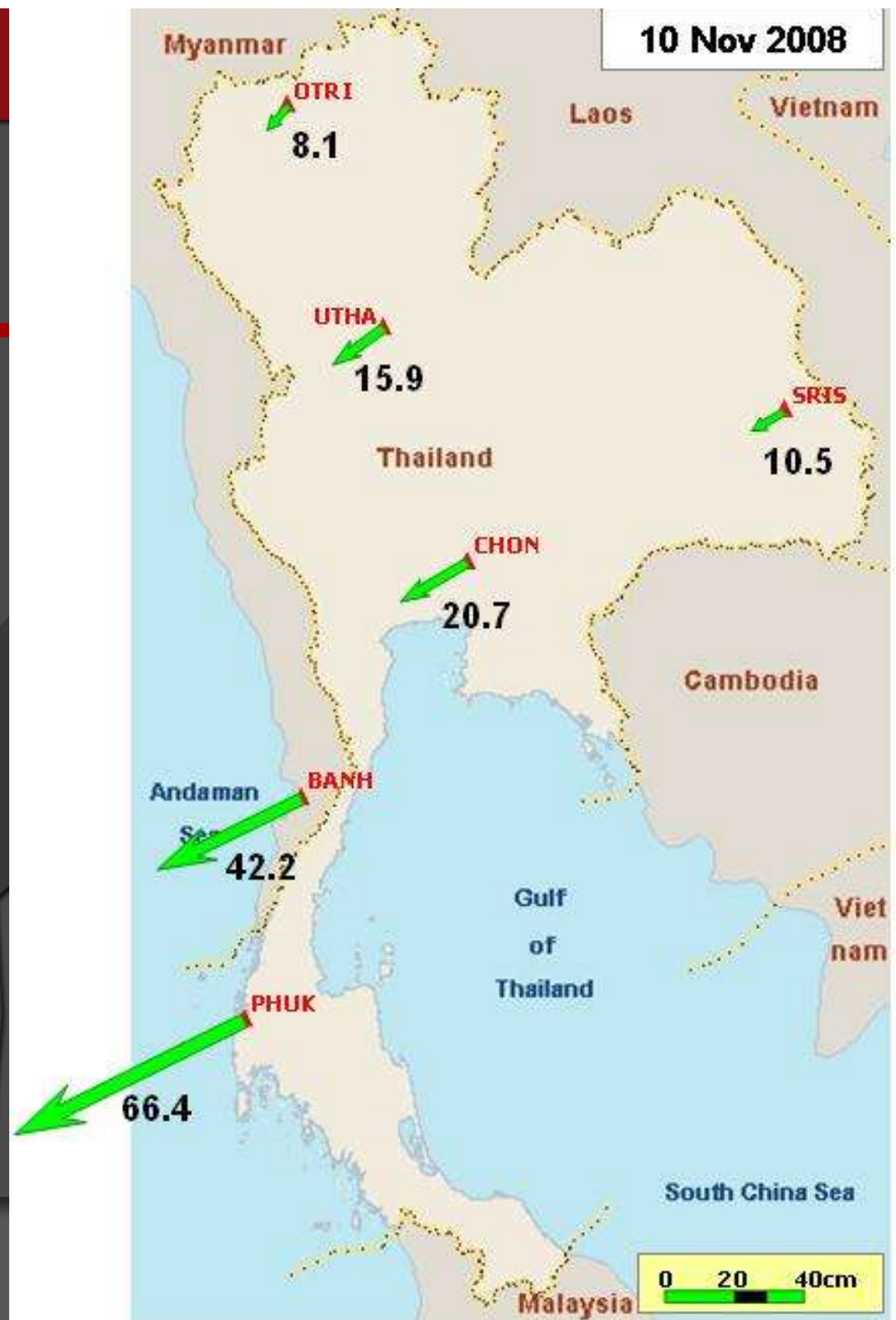


Mapping campaign-averaged solutions into ITRF2000 & 2005

- It is important to note that there is a difference in the definition of the ITRF2000 and 2005 solutions.
- Thus, the ITRF2000 and ITRF2005 coordinates (and hence also station velocities) are not compatible and should not be mixed in GPS solution analyses.



Horizontal total displacements due to the Sumatra-Andaman and Nias earthquakes at each zero-order Thai geodetic network site up to Nov 2008



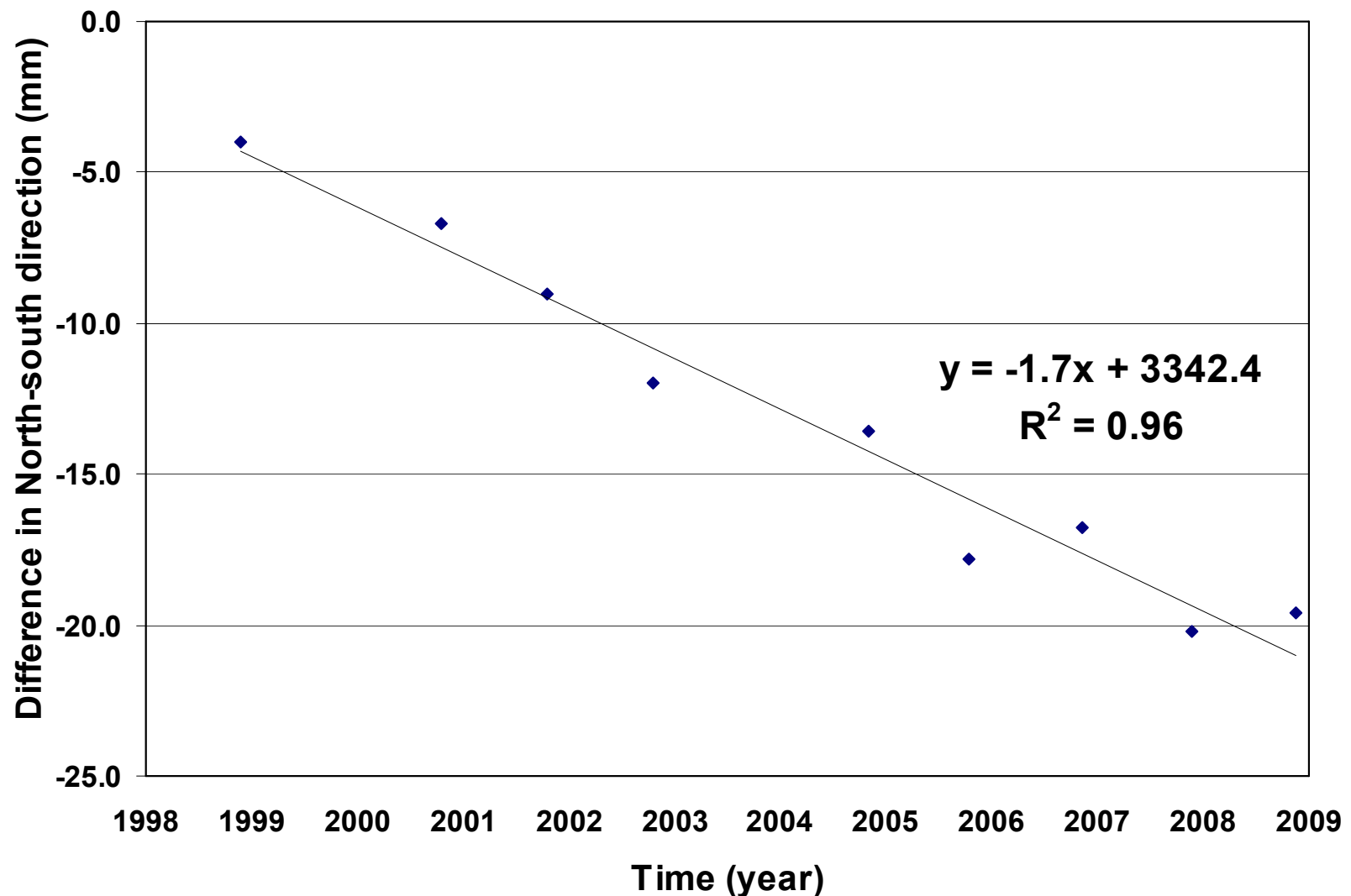


Observation on diversion btw ITRF2000 & 2005 in SE Asia region

- To compare the differences between ITRF2000 and ITRF2005 coordinate solutions, 3 Thai geodetic network points (PHUK, CHON and OTRI) and 2 IGS stations located in SE Asia region (NTUS in Singapore, BAKO in Indonesia) were selected.
- The differences are then computed at different epochs between 1998 and 2008.
- Only differences in north and east components are presented in the following figure.



Best fitted linear trend to the average N-S offsets btw ITRF2000 & 2005 btw 1998 & 2008





Concluding Remarks

- ~ 4 yrs after the Sumatra-Andaman earthquake, it results in the horizontal displacements ranging from 66.4 cm in the south (PHUK), 20.7 cm in the centre (CHON), 10.5 cm in the north-east (SRIS), to 8.1 cm in the north (OTRI) of Thailand.
- It is expected that post-seismic motions in Thailand will continue well into the next decade.
- It was also found that there is a significant diversion between ITRF2000 and ITRF2005 coordinate solutions in the north-south direction at a rate of 1.7 mm/yr within SE Asia region.



Thank you for your attention!