Report on the Asia Pacific Reference Frame (APREF) project

Guorong Hu

Australian Government
Geoscience Australia

POSITIONING AUSTRALIA

UN-GGIM-AP

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Report on the Asia Pacific Reference
Frame (APREF) Project

G. Hu, M. Jia and J. Dawson

Introduction

- **APREF project** - a collaboration of the Geodetic Reference Frame Working Group of the UN-GGIM-AP (formerly PCGIAP) and the Reference Frame Sub-Commission 1.3e (SC1.3e) of the IAG.

- APREF mandated by UNRCC Resolution

- Endorsed by the UNOOSA, FIG and IGS

- Call for participation on 1 March 2010

  - ❖ UN-GGIM-AP: the United Nations Global Geospatial Information Management for Asia and the Pacific
  - ❖ IAG: the International Association of Geodesy
  - ❖ PCGIAP: the Permanent Committee for GIS Infrastructure for Asia and the Pacific
  - ❖ UNRCC: United Nations Regional Cartographic Conferences
  - ❖ UNOOSA: United Nations Office for Outer Space Affairs

CALL FOR PARTICIPATION
IN THE ASIA-PACIFIC REFERENCE FRAME
(APREF) PROJECT

COORDINATED BY
Working Group 1 of the Permanent Committee for GIS Infrastructure for Asia and the Pacific (PCGIAP) under the auspices of the United Nations Regional Cartographic Conference (UNRCC)

IN COOPERATION WITH THE
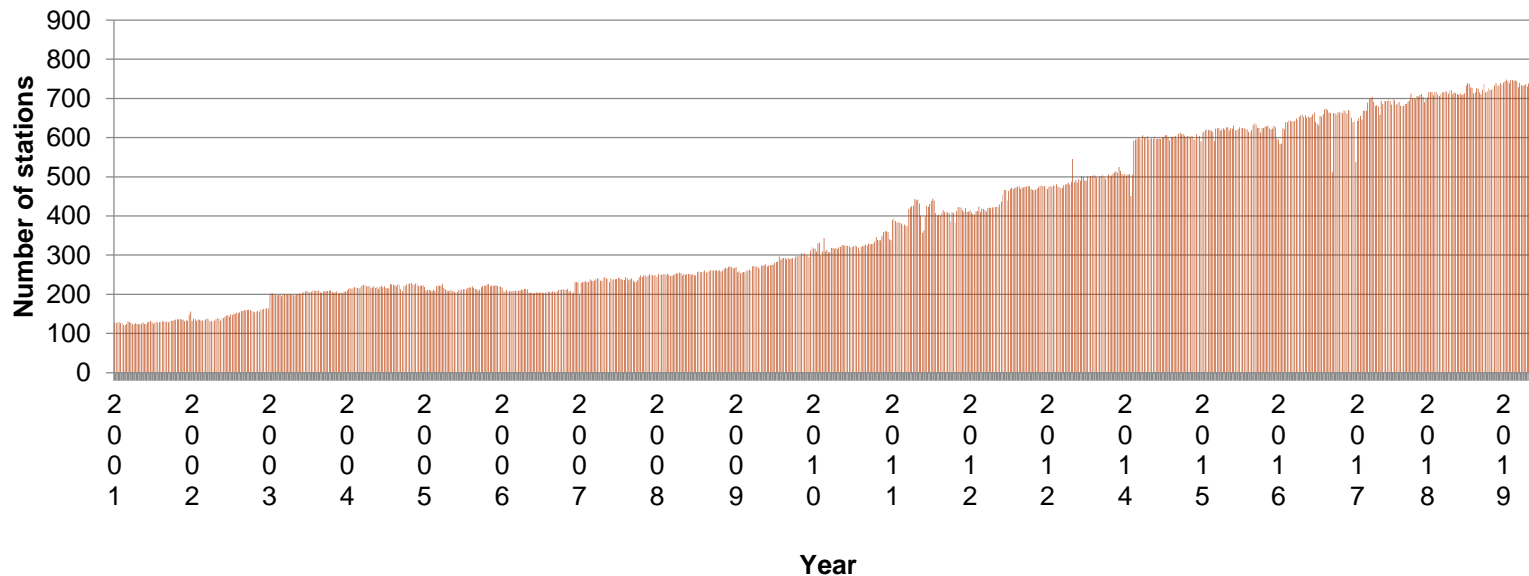International Association of Geodesy (IAG)

The benefits of APREF project

➢ Densification of ITRF in Asia and the Pacific region

➢ Access and link to the ITRF for all kinds of applications

➢ Contribute to the realization of the national datum and future datum modernization

➢ Monitoring the performance of the CORS network

➢ Create and maintain an accurate and densely realised geodetic framework, based on continuous observation and analysis of GNSS data

➢ Providing an opportunity and a forum towards improving the regional geodetic infrastructure

The status and development of APREF project

➢ **Data from the following 28 countries and regions:**
Afghanistan, Alaska USA, American Samoa, Australia, Brunei, Cook Islands, Federated States of Micronesia, Fiji, French Polynesia, Guam USA, Hawaii USA, Hong Kong China, Indonesia, Iran, Iraq, Japan, Kazakhstan, Kiribati, Macau China, Malaysia, Marshall Islands, Mongolia, Nauru, New Zealand, Northern Mariana Islands, Papua New Guinea, Philippines, Samoa, Solomon Islands, Tonga, Tuvalu, Vanuatu

➢ **16 national agencies participating**

The status and development of APREF project
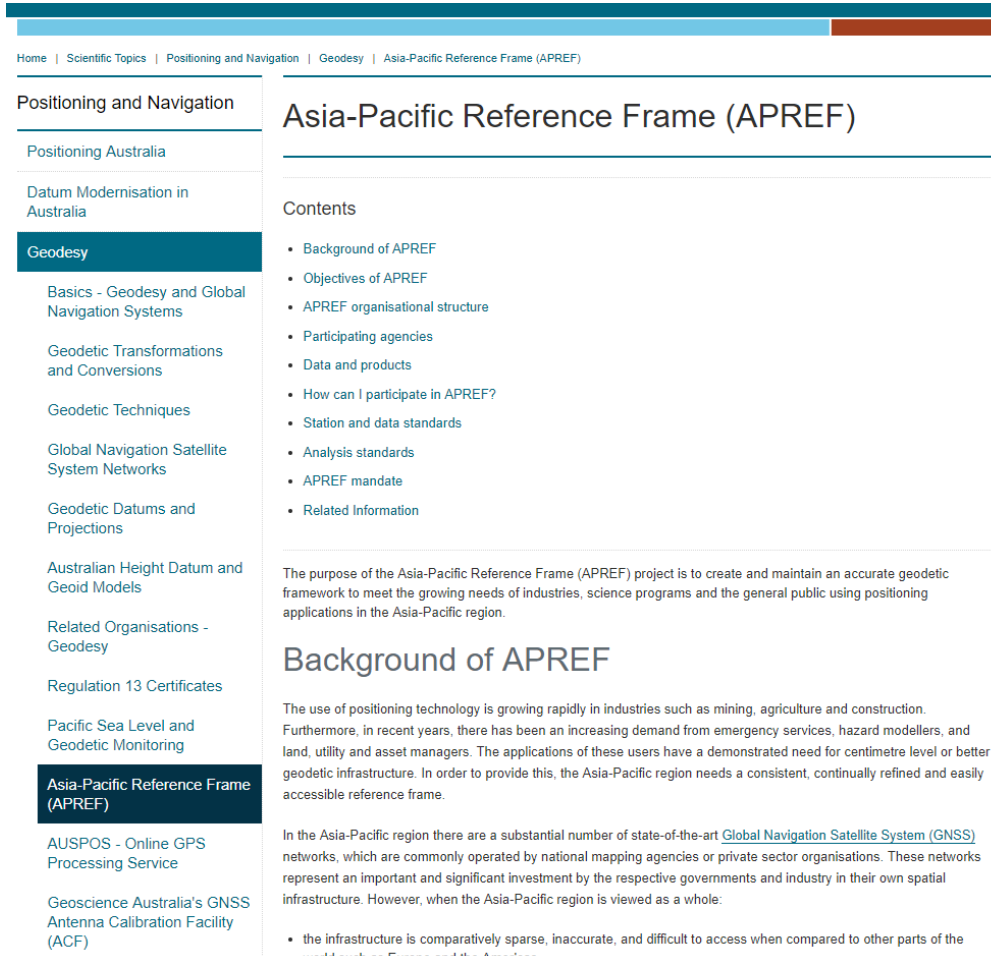
- ➢ ~ 630 Asia Pacific CORS stations now available

- ➢ ~ 800 stations routinely analysed including IGS stations

The APREF website

➢ http://www.ga.gov.au/scientific-topics/positioning-navigation/geodesy/asia-pacific-reference-frame

APREF data access

➢ APREF data is available from ftp://ftp.ga.gov.au/geodesy-outgoing/gnss/data/daily/

➢ Meta data of APREF stations: ftp://ftp.ga.gov.au/geodesy-outgoing/gnss/logs/

➢ **Highlight:** importance of keeping updating meta data of CORS sites

➢ Or GA's new GNSS data repository user interface https://data.gnss.ga.gov.au/search/ and

➢ Site manager https://gnss-site-manager.geodesy.ga.gov.au/

➢ Two key components of meta data: **antenna type and antenna height**

APREF products and position time series

➢ Weekly APREF combined solutions
ftp://ftp.ga.gov.au/geodesy-outgoing/gnss/solutions/apref/

➢ GA's weekly solutions: ftp://ftp.ga.gov.au/geodesy-outgoing/gnss/solutions/final/weekly/

➢ CORS site position time series:
http://192.104.43.25/status/solutions/analysis.html

➢ Awareness of **reference epoch** of the estimated position

Analysis standards of the APREF CORS network

➢ **use scientific software packages (e.g., Bernese, GAMIT, GIPSY)**

➢ **conform to the IERS 2010 conventions**

➢ **contribute solutions in the SINEX format**

➢ **adopt IGS absolute antenna calibration PCVs (igs14.atx)**

➢ **IGS final products**

➢ **IGS14 core sites as reference frame (igs14.snx)**

❑ **IGS14**: the latest realization of ITRF2014 in a series of IGS core GNSS reference stations aligning IGS products to ITRF2014

How the APREF link to the ITRF

Geoscience Australia (AUS)
IGG CAS (IGG)
Victoria DSE (VIC)

Independent
SINEX
Solutions (Bernese and
other GPS software)

ITRF2014 (IGS14)
(IGS14.snx,
soln.snx)

CATREF
software

APREF
combined
Solution (coordinates and velocities)
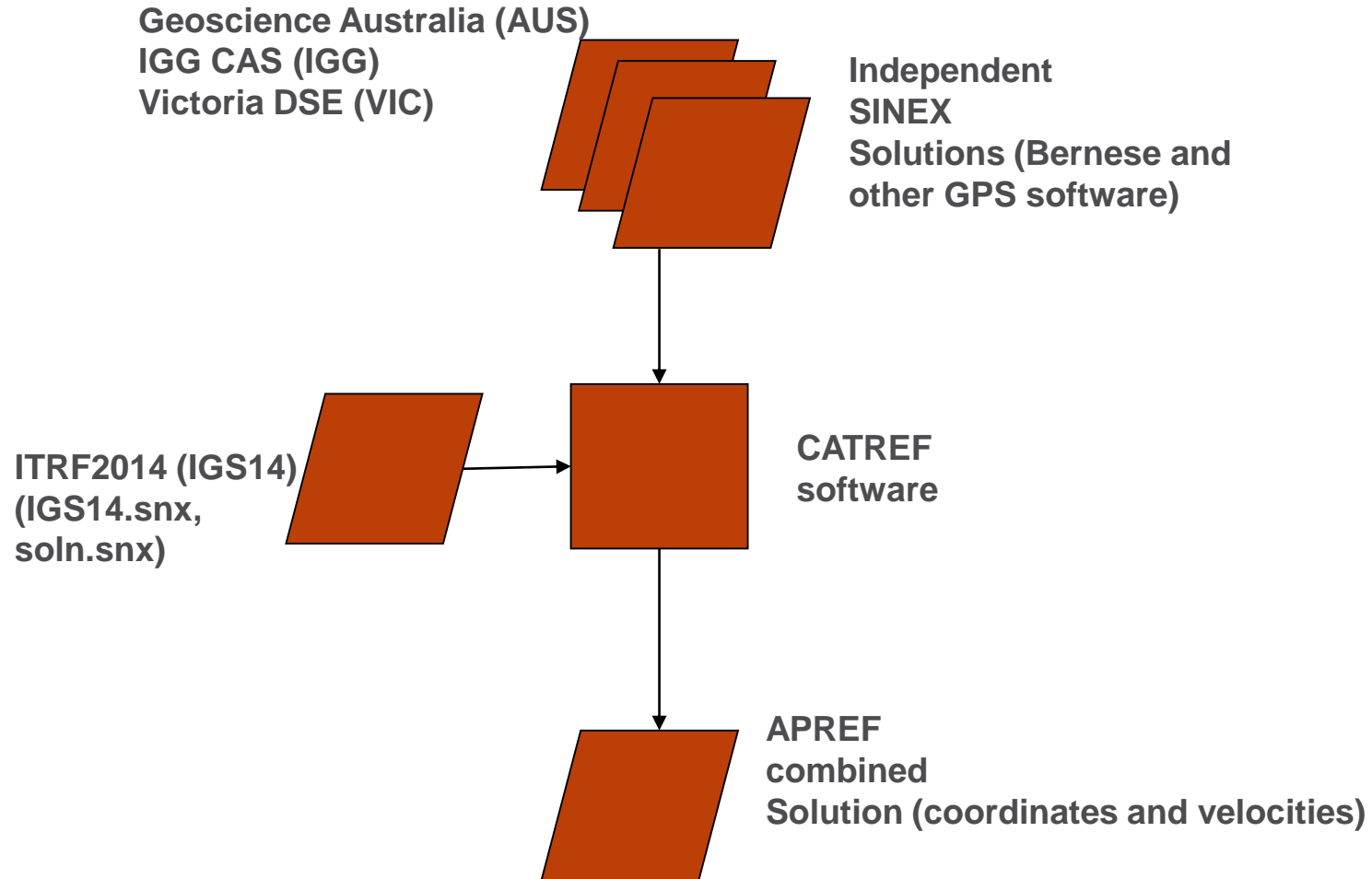
How the APREF link to the ITRF

The current realization of the APREF actually is a set of CORS sites with:
➢ precisely determined ITRF2014 coordinates; and
➢ reliable velocities (position time series > 2.5 yrs)
➢ output from the combination of long term position time series
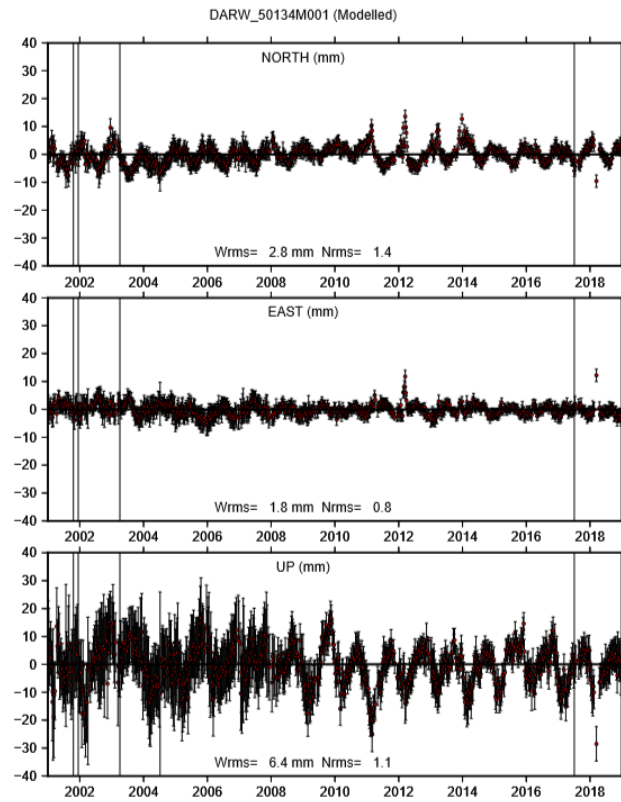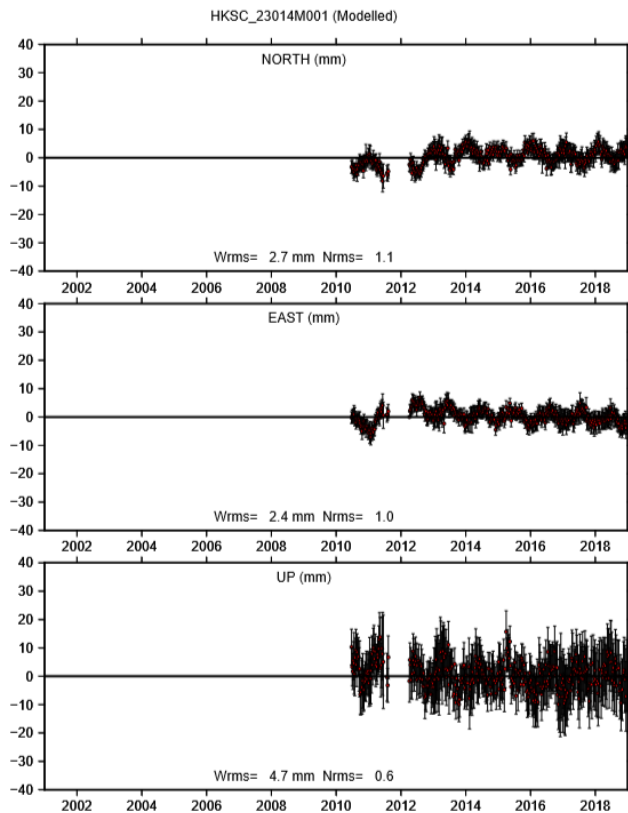
Accuracy assessment of weekly position solutions

The comparison of the LACs solutions with the published IGS weekly solutions for common IGS stations for the GPS week 1939.

| Solutions of LACs	Number of common IGS stations	Weighted RMS (mm)			Standard deviation (mm)		
		North	East	Up	North	East	Up
AUS	162	0.6	0.9	1.7	0.5	0.7	1.1
CUT	23	1.1	0.8	3.4	0.9	0.9	3.6
VIC	30	1.2	1.1	3.5	1.3	1.3	4.4
IGG	135	1.0	1.2	1.9	1.2	1.7	2.9

Accuracy assessment of weekly position solutions

➢ Repeatability of GA's weekly solutions

Horizontal: 1-4 mm
Vertical: 4-8 mm
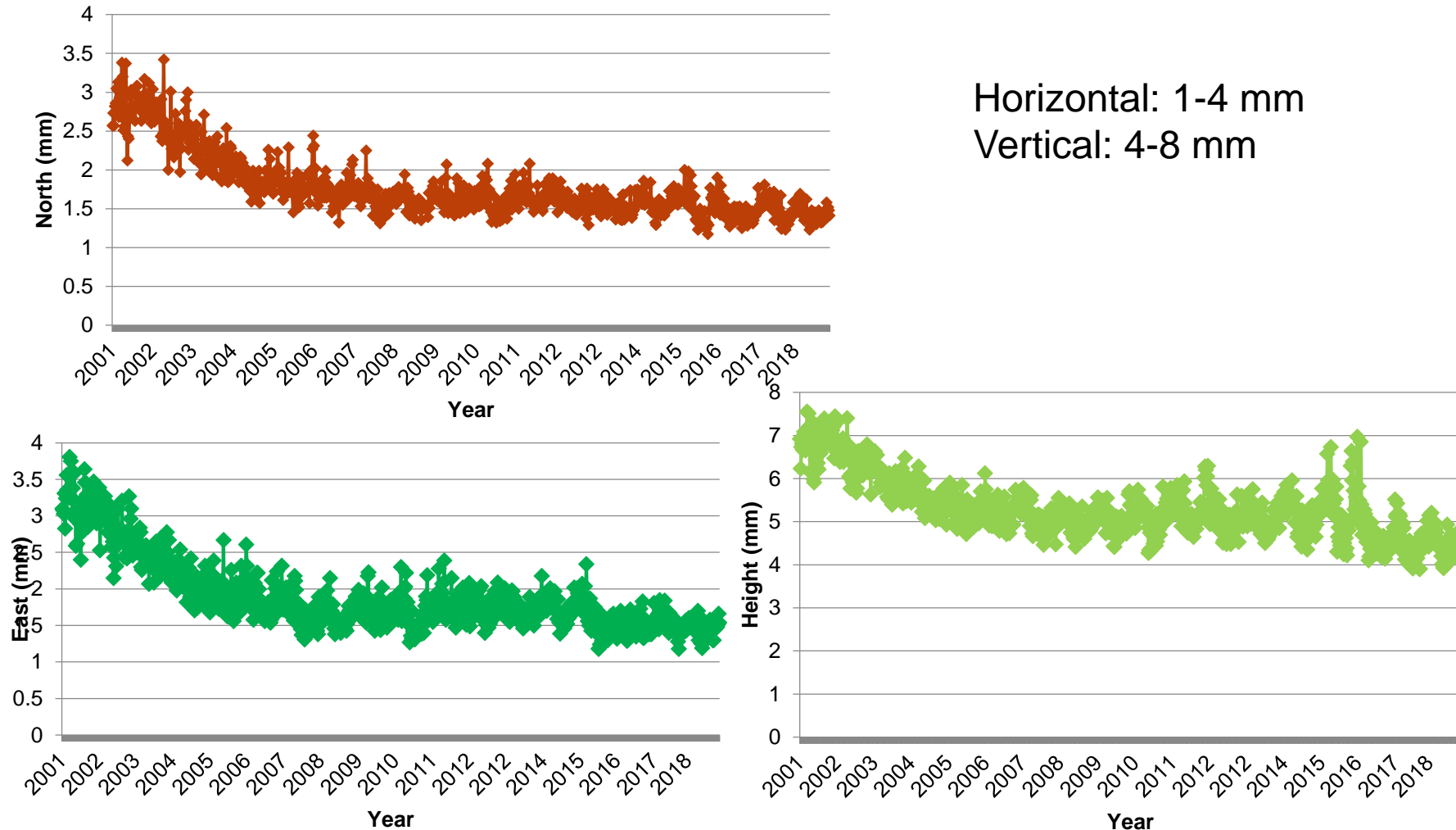
APREF application case study: estimated velocity field for Asia and the Pacific region
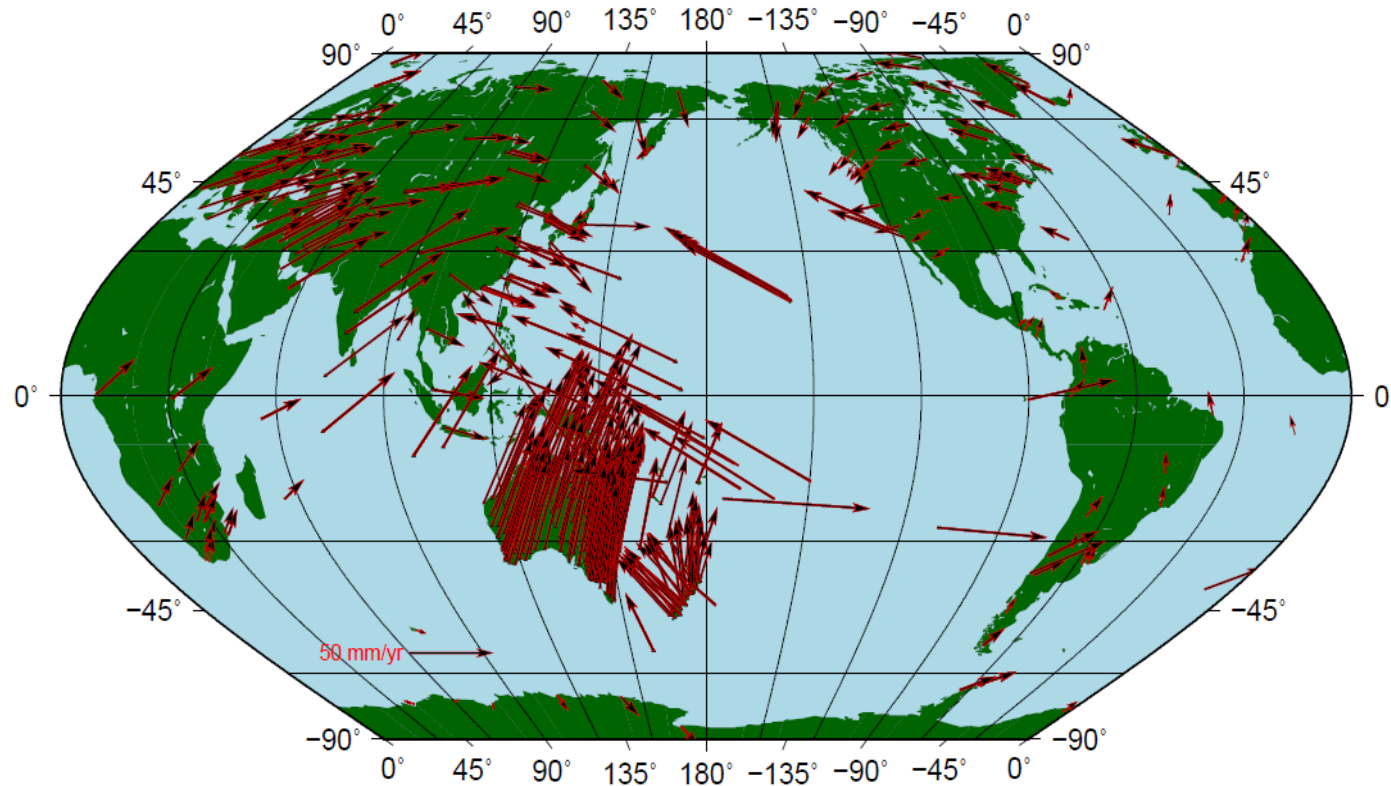
# Accuracy assessment of derived APREF velocity field

➢ The statistics of the velocity differences between the derived APREF solutions and IGS solutions for the common 173 stations.

Velocity Component	Minimum (mm/yr)	Maximum (mm/yr)	Mean (mm/yr)	STD (mm/yr)
North	-1.10	1.17	0.02	0.29
East	-0.15	2.00	0.01	0.32
Vertical	-1.78	1.85	0.08	0.54

APREF application case study: CORS site monitoring

NGS/Iraq Station ISBA event : data quality affected by some type of jamming since DOY 168/2011 (IGSSTATION mailing list – IGSSTATION – 4510)
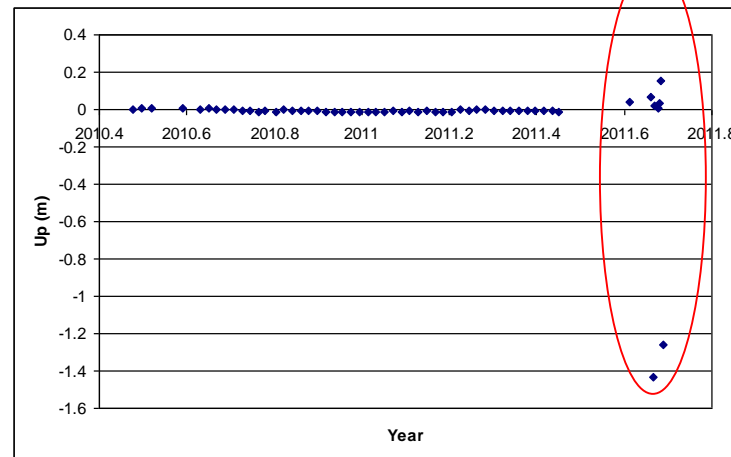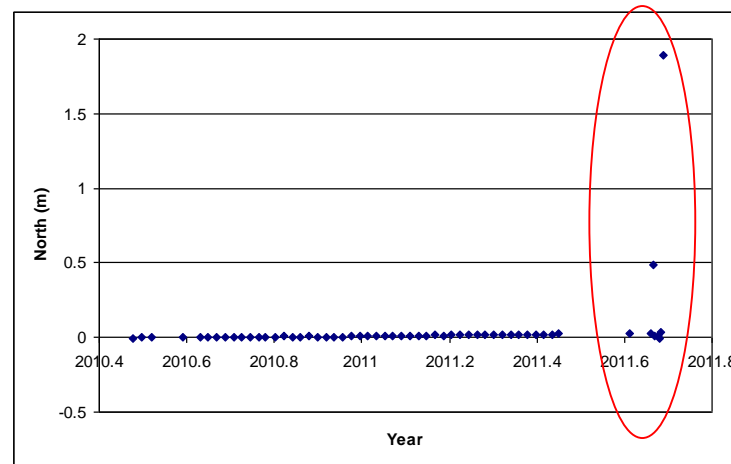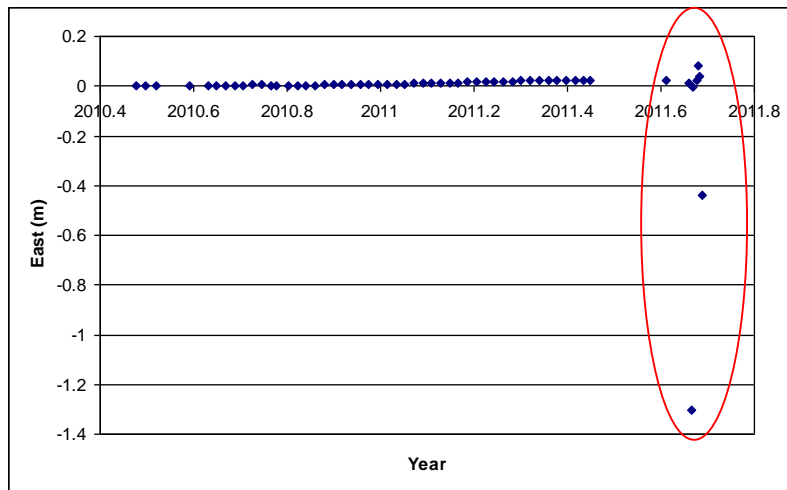
APREF application case study: interesting findings

➢ Statistics of average uncertainty of the estimated velocity in terms of monument types.

|	Monument types					
	Class A			Class B		
Number of stations	206			377		
Average uncertainty of the estimated velocity (mm/yr)	North	East	Up	North	East	Up
	0.04	0.03	0.19	0.07	0.06	0.29

Class A:
Geodetic standards

Class B:
non-geodetic standards

APREF application case study: Australia

➤ All Australia CORS sites from GA and state governments contributed to the APREF

➤ 28 IGS14 core stations maintained by GA

IGS core sites
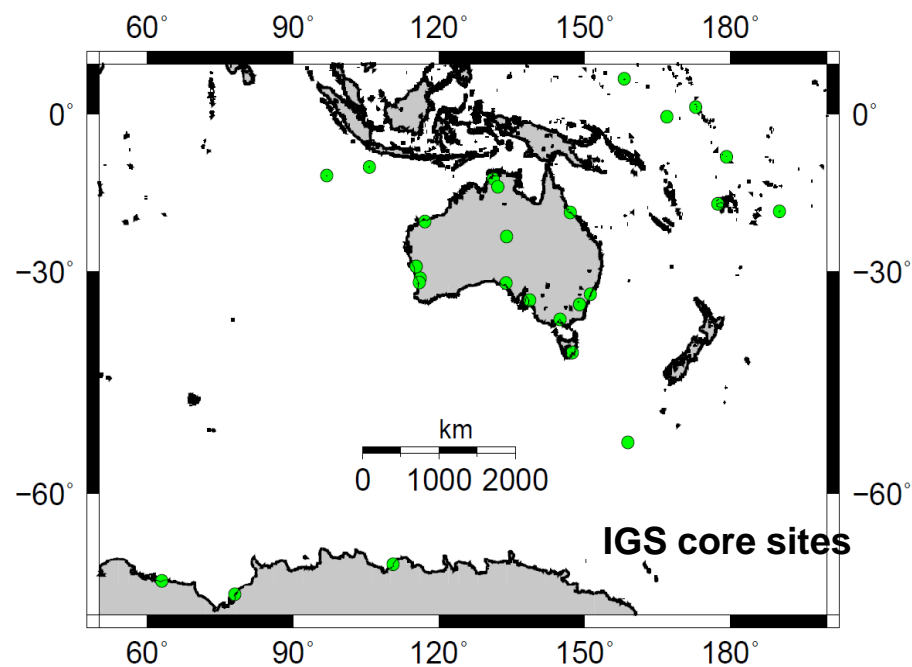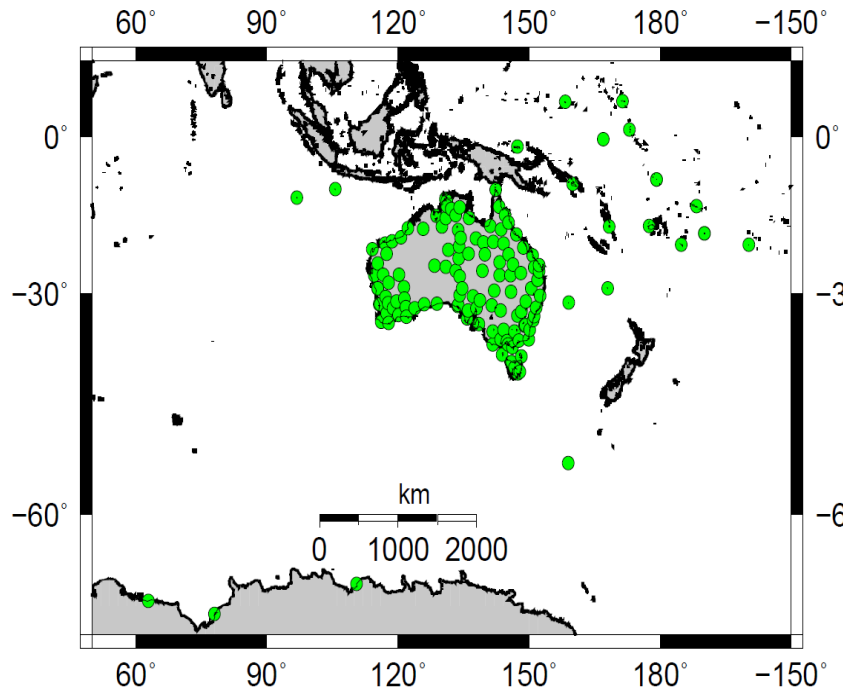
APREF application case study: Australia

➢ Australia's GDA2020 RVS (recognized value for standards) values derived from the combined APREF solutions

➢ 109 AFN stations aligned to IGS14, including positions at epoch of 2020.0 and velocities
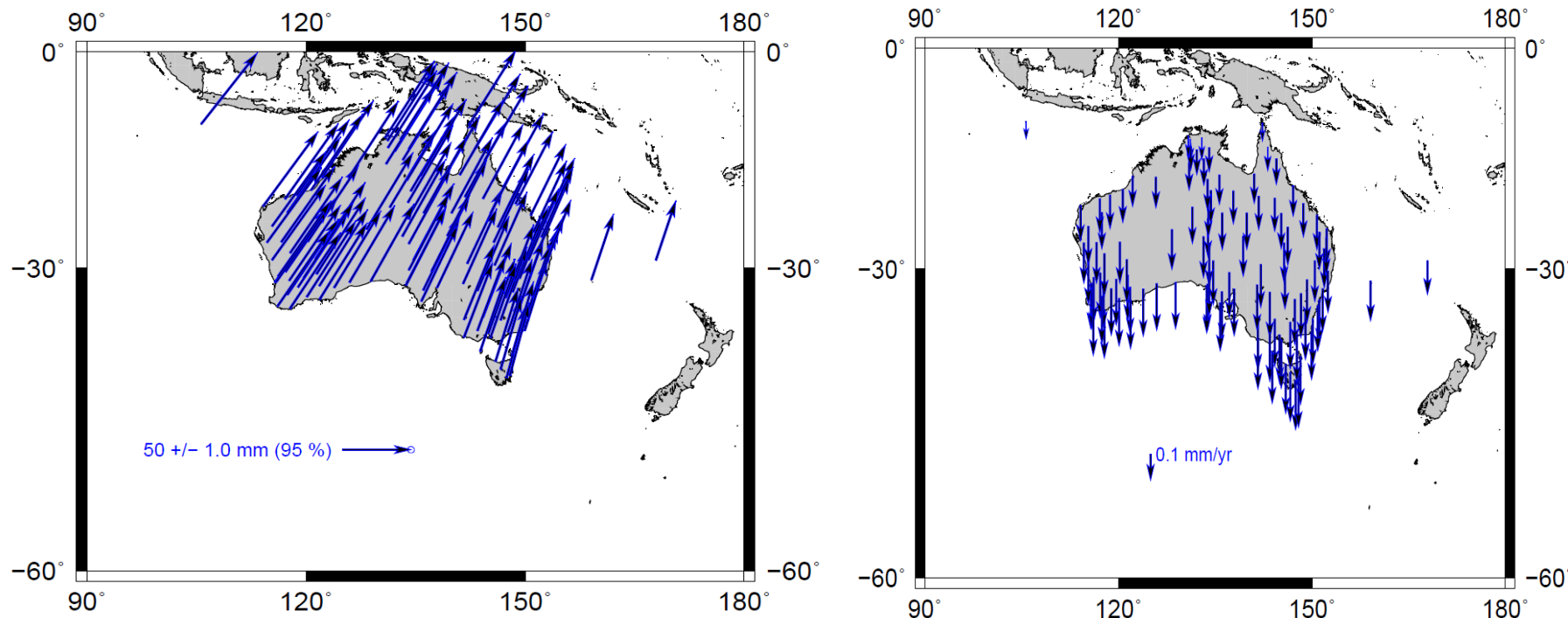
APREF application case study: Australia

➤ CORS station performance monitoring, BEE2 in QLD

Annual APRGP GNSS campaign

➢ WG1 of UN-GGIM-AP organizes annual APRGP GNSS campaign

➢ Aim for those countries who are unable to join APREF project but want to link the national datum to the ITRF
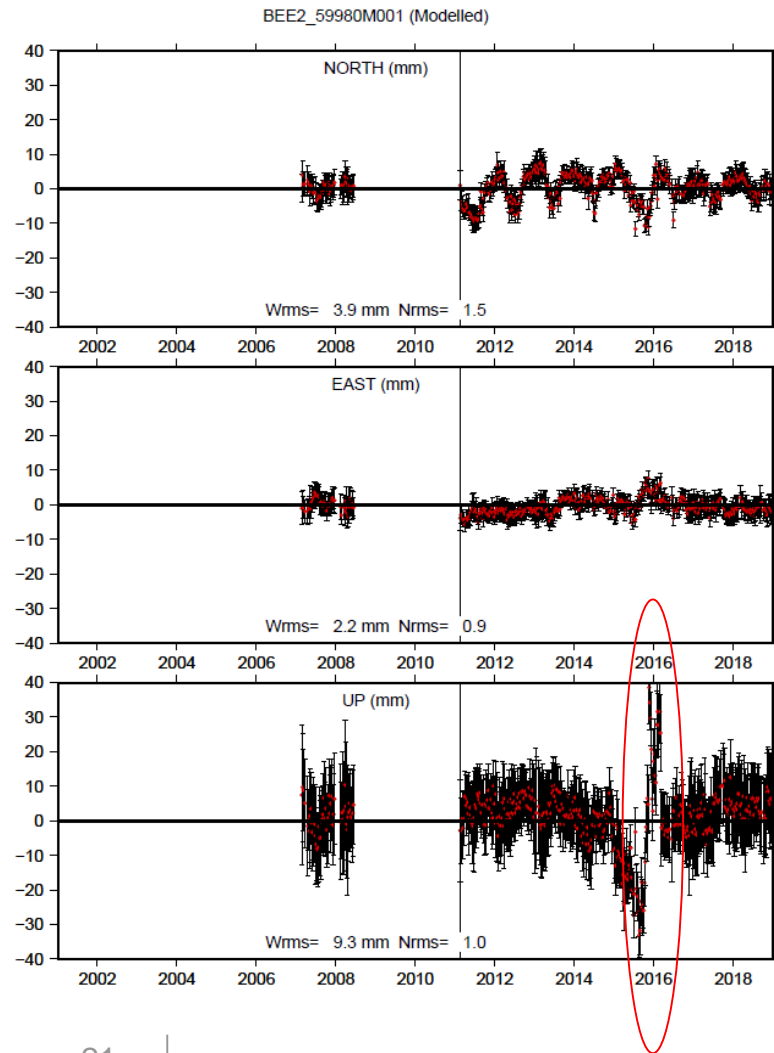
➢ 23th APRGP GNSS 2019 campaign: 15 Sept. – 22 Sept. 2019

➢ As of 28 Oct 2019, the following 12 countries contributed data to the APRGP 2019 campaign: Armenia, Bangladesh, Bhutan, Brunei, Cambodia, Indonesia, Japan, Lao, Myanmar, Singapore, Tonga, Vietnam

➢ All data and analysis reports are available from the link:
ftp://ftp.ga.gov.au/geodesy-outgoing/apref/APRGP/

Report on the Analysis of the Asia Pacific Regional Geodetic Project (APRGP) GPS Campaign 2016

Report on the Analysis of the Asia Pacific Regional Geodetic Project (APRGP) GPS Campaign 2017

Report on the Analysis of the Asia Pacific Regional Geodetic Project (APRGP) GPS Campaign 2018

Australia (Geoscience Australia) 2019

Concluding remarks

➤ The APREF solutions are more accurate and denser than any previous estimate – of great benefit for maintaining the reference frame in Asia and the Pacific region

➤ The APREF is a testing platform before a CORS site contributing to the IGS network in Asia and the Pacific region

➤ APREF data and products are contributing to the WG on Regional Dense Velocity Fields of the IAG

➤ APREF is contributing AUSPOS – a free online GPS data processing service

➤ APREF will contribute to the ATRF for Australia datum modernisation

➤ APREF data and products are the basis of all kinds of applications

Concluding remarks

➢ Challenges

- Issues remain regarding free and open access to data for many Asia-Pacific countries

- APREF door is still open for the member countries

- Routine analysis moving to RINEX v3 and multi-GNSS

- Quality control of APREF data and products

- APRGP data sets from some countries NOT meet RINEX standards, which may need technical training under the capacity building program of UN-GGIM-AP

- Need to identify additional analysis centres

  - limited redundancy with only 3 analysis groups

  - GSI (Japan) is joining LACs

Thank you

Phone: +61 2 6249 9884
Web: www.ga.gov.au
Email: guorong.hu@ga.gov.au
Address: Cnr Jerrabomberra Avenue and Hindmarsh Drive, Symonston ACT 2609
Postal Address: GPO Box 378, Canberra ACT 2601