Australian Government
Geoscience Australia

An Update on the Asia Pacific Reference Frame (APREF)

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Introduction

The APREF is a collaboration of the Geodetic Reference Framework for Sustainable Development Working Group of the United Nations Global Geospatial Information Management for Asia and the Pacific (UN-GGIM-AP), and the Reference Frame Sub-Commission 1.3e (SC1.3e) of the International Association of Geodesy (IAG). The broad objectives of APREF are to improve the definition, realization and maintenance of the regional geodetic framework in support of both scientific and regional geospatial activities by densifying the ITRF in the Asia and Pacific region. This poster details the current status of APREF, routine analysis and combination strategy, and presents the results of the velocity field determined from the APREF solution.

Status and development of APREF GNSS CORS network

As of the writing time, the APREF is archiving the CORS data from 28 countries in the Asia Pacific region. There are about 16 national agencies participating the APREF project. Currently, there are around 490 CORS stations available from the region. The distributions of the APREF stations are plotted in the Figure 1. The number of the stations of APREF is also plotted as the function of the year as shown in Figure 2, which also includes about 132 IGS core stations for linking the APREF to the ITRF2008. It can be seen the quickly increasing of the number of the stations in recent years. While it is the most dense GNSS CORS network currently available for the Asia and Pacific region, it also is an inhomogeneous network both in spatial and in temporal sense.

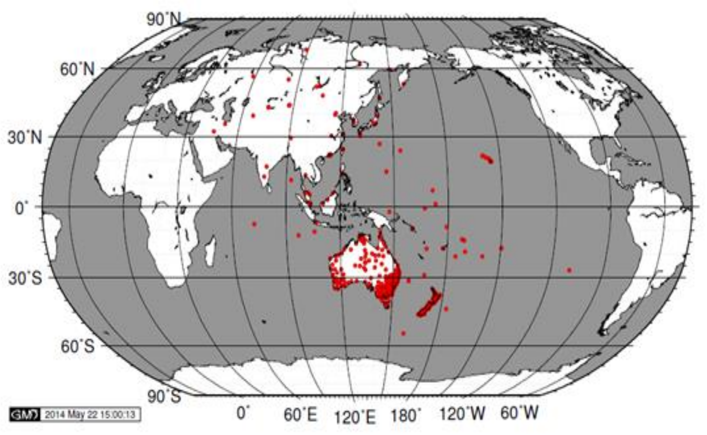


Figure 1: The ARPEF GNSS CORS network.

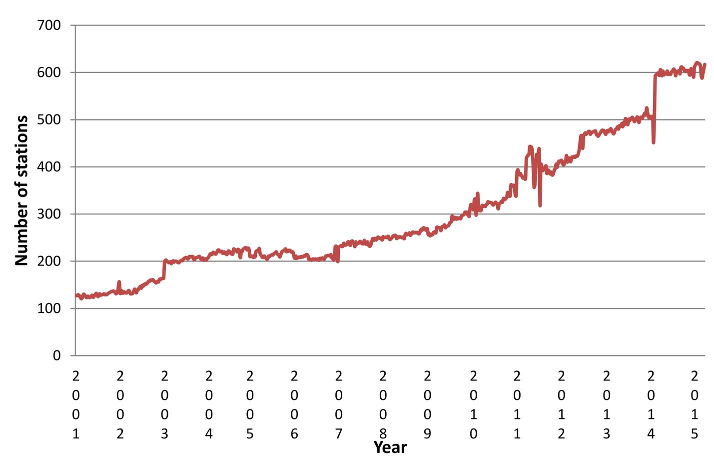


Figure 2: Number of the APREF CORS sites versus time.

Routine analysis and combination strategy

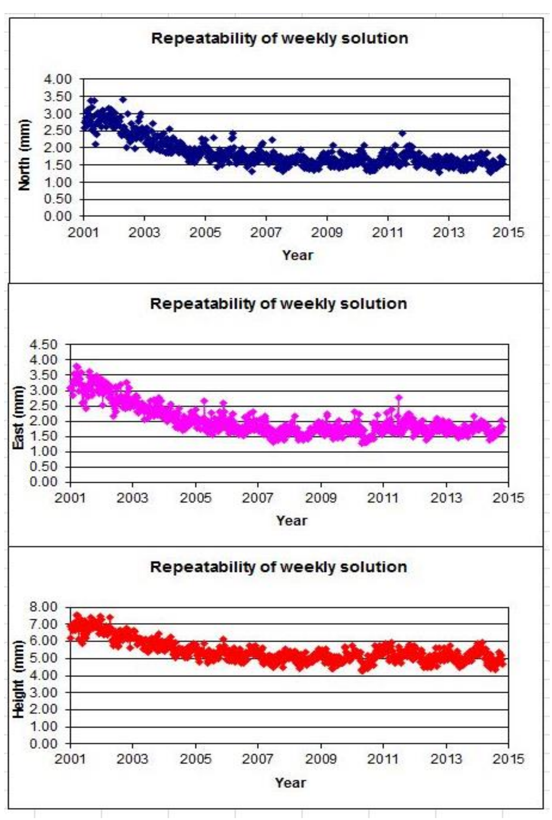


Figure 3: Weekly repeatability RMS of position solutions versus time.

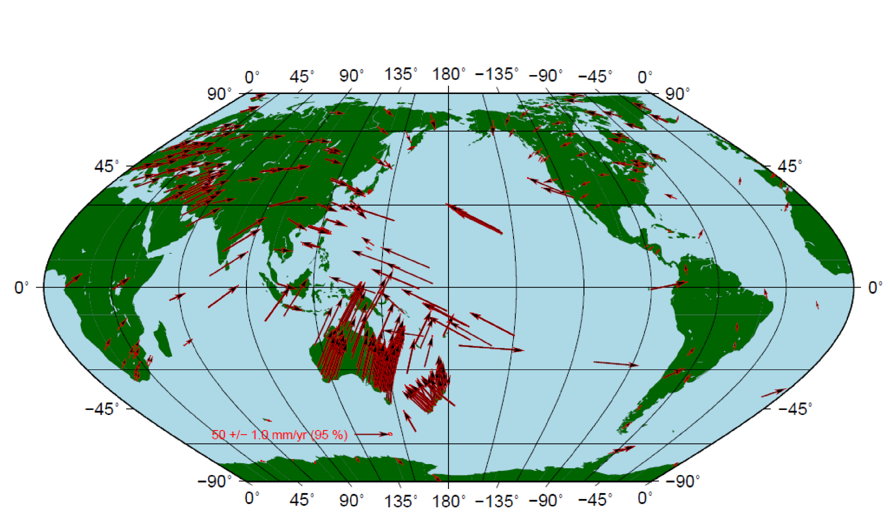
The APREF Central Bureau (CB), currently hosted by Geoscience Australia, is responsible for the daily management of APREF. The CB acts as liaison between station operators and analysis centers, providing the necessary station configuration metadata while also ensuring data meets the requirements of the analysis. At the CB the station information, antenna and receiver types in RINEX header are compared to the log files and corrected if necessary in order to guarantee consistency of the station information for further data analysis. However, with the number of stations growing, the need for shorter data latencies and the growing number of applications, the management of the APREF has become a challenge. Although guidelines exist for station equipment, operation and data flow, in practice different institutes use different practices. It is anticipated and encourage CORS operators to follow IGS guidelines in terms of operation of the station and handling of metadata.

Currently, APREF data are processed by four Local Analysis Centers (LACs). A state-of-the-art GPS processing strategy was applied, and was based on the IERS Conventions and the IGS guidelines, with the satellite orbits and clocks as well as the Earth orientation parameters are fixed to the final IGS products. The absolute antenna phase centre variation (PCV) corrections for satellites and receivers were used.

The daily solutions are generated in SINEX (Solution INdependent EXchange) format. Data cleaning has been done also by rejecting solutions with incorrect metadata. The daily final solutions are then combined into a weekly solution that is aligned to the IGS08. The weekly combined solutions are generated with Bernese software on the daily normal equations level. The stations are removed from the weekly combined solutions based on the residuals of the seven-parameter Helmert similarity transformation between daily and weekly solutions. The threshold of the residuals are set up below 10 mm and 20 mm for horizontal and vertical components, respectively. The daily coordinate repeatabilities are between 2 and 4 mm for the north and east horizontal components, respectively, and 4-8 mm for the vertical component, as shown in Figure 3.

APREF Position and Velocity Solutions

The weekly combined solutions are rigorously stacked using the CATREF software package from Institut Géographique National (IGN) to obtain the new regularized station coordinates and secular velocities as well as station position time series for the APREF CORS network. The velocity field for the Asia-Pacific region along with the IGS core stations is plotted in Figure 4. APREF products include Asia-Pacific station coordinates and velocities at higher densities than those currently provided by the IGS. The weekly SINEX files and updated ITRF coordinate, velocity solutions and coordinate time series are published on the APREF website (http://www.ga.gov.au/scientific-topics/positioning-navigation/geodesy/asia-pacific-reference-frame). A representative example of the positon time series of the CORS site at Hobart (HOB2) is shown in Figure 5, after outlier and linear trend removal.



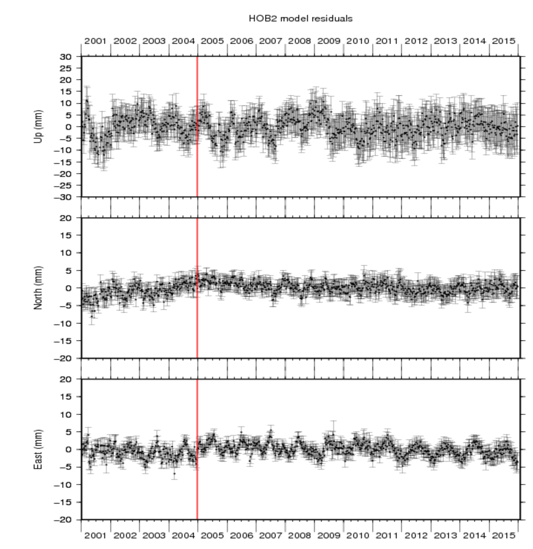


Figure 4: The velocity field for the APREF CORS network. **Figure 5:** The position time series of the CORS site at Hobart (HOB2).

Case study: intraplate velocities for the rigid Australian plate derived from the APREF solutions

To obtain the intraplate velocities, the velocity field of the APREF stations with respect to the rigid Australian plate can be determined by subtracting the common motion of the sites due to the Australian plate motion. The estimated Australian plate ITRF2008 rotation pole parameters based on the above APREF solutions were used in the calculation. The determined residual horizontal velocities for Australian Regional GNSS network (ARGN) and AuScope stations are plotted in Figure 6. Figure 7 shows a Gaussian distribution centred on a zero-mean residual velocity for the ARGN and AuScope stations.

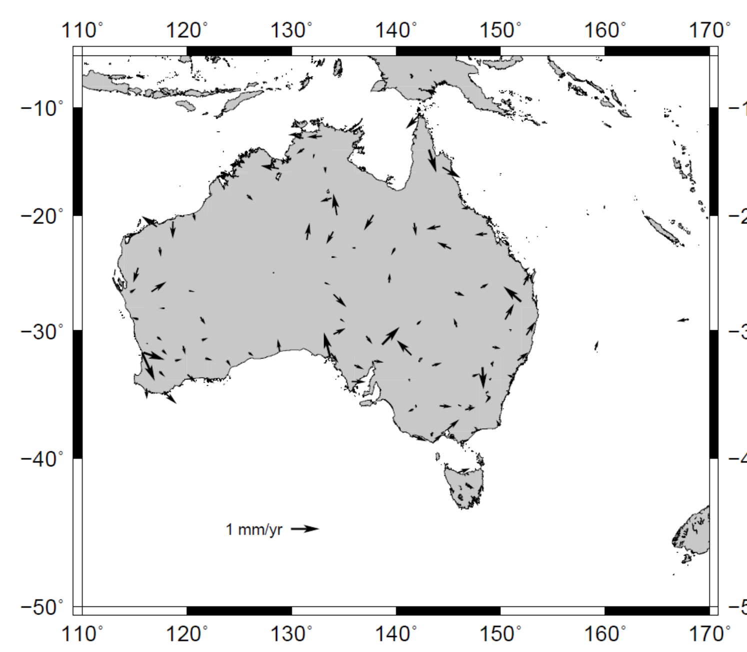


Figure 6: The horizontal velocity field relative to the Australian plate for the ARGN and AuScope sites.

Concluding remarks

The APREF CORS network is a voluntary network consisting of more than 490 permanent tracking stations which covers the Asia and Pacific region and its surroundings. APREF potentially supports multi-disciplinary applications ranging from surveying, geodynamics research, sea level monitoring to numerical weather prediction. The weekly SINEX files updated ITRF coordinate and velocity solutions where available are published on the Geoscience Australia's ftp website. These solutions are considered as the most accurate and up-to-date source of the APREF coordinates and velocities for the APREF stations. Furthermore, the APREF project provides site specific velocities of a network at higher densities than those provided by the IGS network.

We are continuing to pursue improved models, better approaches, and improving the process of detection of discontinuities of the position time series, to maintain and improve APREF products and we are contributing our solutions to the Working Group on Regional Dense Velocity Fields of the International Association of Geodesy Subcommision 1.3. Through this invaluable feedback and cross checking is further improving the performance of our results.

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