

PROCEEDINGS
of the
SECOND WORKSHOP
on
REGIONAL GEODETIC NETWORK
Ho Chi Minh City - Vietnam
July 12th - 13th 1999

**Working Group 1 - Regional Geodetic Network
of the
Permanent Committee on GIS Infrastructure for Asia and the Pacific**



Hosted by General Department of Land Administration of Vietnam

PROCEEDINGS
of the
SECOND WORKSHOP
on
REGIONAL GEODETIC NETWORK
Ho Chi Minh City - Vietnam
July 12th - 13th 1999

**Working Group 1 - Regional Geodetic Network
of the
Permanent Committee on GIS Infrastructure for Asia and the Pacific**

Published by
Vietnam Research Institute of Land Administration (VIRILA)
in Association with
the Australian Surveying and Land Information Group (AUSLIG)

**The Permanent Committee on GIS Infrastructure for Asia and the
Pacific**

Working Group 1 – Regional Geodetic Network

Acknowledgements

The PCGIAP Regional Geodetic Network Working Group gratefully acknowledges:

- The Vietnam General Department of Land Administration and its Deputy Director General, Prof. Dr. Sc. Dang Hung Vo, for arranging and hosting the 1999 Regional Geodetic Network Workshop in Ho Chi Minh City.

- The Australian Department of Industry, Science and Resources for its support through the Technology Diffusion Program.

Welcome to the Workshop on the Regional Geodetic Network for Asia & the Pacific

Distinguished guests,
Ladies and Gentlemen,

At the outset, let me thank you for visiting Vietnam in accordance with the planned schedule of the PCGIAP Working Group 1 workshop. On behalf of the leaders of General Department of Land Administration, Government of Vietnam, it is my privilege and pleasure to welcome all of you to the Workshop on the Regional Geodetic Network for Asia and the Pacific.

Supported by UN, The Permanent Committee on GIS Infrastructure for Asia and the Pacific was established 6 years ago in Kuala Lumpur. In several activities of PCGIAP the Working Group 1 has got a large cooperation of the countries in Asia and the Pacific to set up the unified geodetic system. Up to now the WG1 has organized 2 campaigns on the regional geodetic network. The network in 1998 campaign is larger than in 1997 campaign, and of course for the future it must be larger and larger.

This workshop will be focused on data processing of the regional geodetic network implemented in 1998. In this occasion we can have interesting discussions on scientific and technological and also practical aspects. In this workshop there will be some country reports on local geodetic networks. We are looking forward to sharing and exchanging experiences with the colleagues from different countries in the region on the using of the regional geodetic network to modernization of local geodetic networks. We do hope in this workshop the Working Group 1 will have joint activities in some new topics such as: the movement of the continentals, the raise of the sea level, the modern tectonics, the deformation of the Earth's crust and etc.

In Vietnam the construction of the National Geodetic Network was started in 1959. Up to 1994 the whole country was covered by the conventional geodetic network of I and II orders triangulation or traverse or GPS (single frequency). During the period 1995 – 1997 the "0" order GPS network was established with more than 100 points covering throughout land and sea territories of Vietnam. From 1997 to 1999 all the data of conventional and "0" order geodetic networks has been processed and linked to the regional geodetic network. At the end of this year the new geodetic system VN99 of Vietnam will applied for next century.

While the social-economic system of Vietnam is being under the process of the modernisation and industrialisation, the unified geo-database plays an important role in development of country. The WG1 workshop held in Vietnam shows that Vietnam is now rapidly approaching and participating in the global and regional activities.

The regional geodetic network has been established as the cooperation policies of the related countries in Asia and the Pacific region. In the modern time, the regional

cooperation has been played the crucial role in the development of global cooperation. The event of the regional geodetic network gives us opportunities to find regional solutions for the natural resources management, environmental protection.

Being the host of this workshop, I encourage all of you to actively participate in the discussions and share experiences between us in order to find our understandings and our operations. I do believe that after this workshop we will own more experiences to support us in settlement of the technical challenges facing in the upgrading step of the regional geodetic network.

Finally, I would like to once again congratulate all your presence here today and wish you all the best for a successful workshop with valuable conclusions. May I now be honorable to declare the workshop open.

HCMC, July 12, 1999

Prof. Dr. Sc. Dang Hung Vo

**Viet Nam General Department
of Land Administration**

Contents

<u>Presentation / Paper</u>	<u>Presenter</u>	<u>Page</u>
Acknowledgement		2
Welcome to the Workshop	Dang Hung Vo (Vietnam)	3
Contents		5
Executive Summary	John Manning (Australia)	7
Workshop Outcomes		8
Workshop Program		11
Workshop Attendees		13
Photograph of Attendees		17
List of people in the photograph		18
Report on the Permanent Committee on GIS Infrastructure for Asia and the Pacific for the Geodesy Workshop.	Bob Irwin (Australia)	19
Report on activities of working Group 1 Regional Geodetic Network.	John Manning (Australia)	25
APRGP98 Observation Campaign Overview	Geoff Luton, John Dawson, and Ramesh Govind (Australia)	35
Analysis of APRGP98 GPS data set by GSI	Shigeru Matsuzaka (Japan)	38
Asia-Pacific Regional Geodetic Project 1998. Global Positioning System (GPS) – Solutions.	Ramesh Govind, John Dawson, Geoff Luton (Australia)	46
Data Processing and Analysis of the APRGP98 GPS Campaign	Cheng P, Li XY, Wang Q, Chen JY (China)	53
GPS Data Analysis for APRG97 and APRG98 Campaigns	Cheng Zongyi, Zhu Wenyao, (China)	67
GPS Results for APRGP98	Cecep Subarya (Indonesia)	77
GPS Results for APRGP98	Samad Abu (Malaysia)	79

<u>Presentation / Paper</u>	<u>Presenter</u>	<u>Page</u>
Asia-Pacific Regional Geodetic Project 1998. Satellite Laser Ranging Solutions	Ramesh Govind, John Dawson, Geoff Luton (Australia)	84
Asia-Pacific Regional Geodetic Project 1998. Doppler Orbitography Range Integrated by Satellite (DORIS) Solutions.	Ramesh Govind, John Dawson, Geoff Luton (Australia)	89
Solutions of the VLBI experiments of Asian-Pacific Space Geodynamics Program	Guangli Wang, Jinling Li, Zhihan Qian, Shuhua Ye (China)	95
Unification of Vertical Datums with Application to Asia and the Pacific	Hossein Nahavandchi (Iran)	105
The Status of Vietnam Geodetic Network and a Proposal for Indochina Region	Dang Hung Vo, Tran Bach Giang (Vietnam)	113
Surveying and Mapping Activities of Nepal	Tirtha Pradhananga (Nepal)	122
Present Situation of National Geodetic Network in Mongolia	Byaruuzana Erdenebaatar (Mongolia)	127
Asia Pacific Regional Geodetic Project (APRGP) Expansion of APRGP to all Pacific Group Member Countries	Paserio Samisoni (Fiji)	132
Status Report on Geodetic Activities of Papua New Guinea	Robert Rosa (Papua New Guinea)	136
Current Status : Permanent GPS Network of Malaysia	Samad Abu (Malaysia)	140
Status of Existing Geodetic Networks of Iran	Farokh Tavakoli (Iran)	144
Transformation from Local to Regional Datum	John Manning (Australia)	146
Strategy for Computation of Transformation Parameters from Local Datums to Regional Datum	Farokh Tavakoli (Iran)	149
Brief Presentation in the Regional Geodetic Network Workshop 1999	Boukong Sougnatti (Lao)	155
Report to IUGG on Geodetic Network in SE Asia 1995-99	John Manning (Australia) Junyong Chen (China)	159

Executive Summary

The General Department of Land Administration, Vietnam hosted a Regional Geodetic Network Workshop in Ho Chi Minh City on 12th & 13th July 1999 on behalf of the Working Group 1 of the Permanent Committee on GIS Infrastructure for Asia and the Pacific.

Representatives from thirteen member countries attended the workshop. The workshop welcomed and encouraged the participation of Mongolia and Nepal in future campaigns, as both these countries requested assistance in applying GPS technology in their countries. Member countries were encouraged to respond and assist wherever possible.

Results from the Asia Pacific Regional Geodetic Project 1998 (APRGP98) campaign were presented thus concluding the core component of the project. This will form the basis for transformation of individual country geodetic networks to the ITRF reference frame,

The workshop reviewed the results from the previous 1997 campaign and developed a strategy for the combination of these individual GPS solutions using SINEX files and their subsequent integration with the 1998 campaign results. The APRGP98 observational data set will now be available for other regional scientific researchers.

The APRGP98 was assessed as being very successful with increased interest and level of participation by member countries; the increased number of stations in the campaign; the excellent results produced from GPS, SLR and DORIS observations; and the contribution to the densification of the ITRF in the Asia Pacific region.

Plans were developed for the next regional observation campaign in October 1999, with a results workshop to be hosted by Mongolia in Ulaanbaatar in August 2000. The aim of this campaign (APRGP99) is to expand the number of key geodetic sites occupied in individual countries and to undertake GPS connections to sea level at established tide gauges. Additionally it will also incorporate data from all permanent GPS, VLBI, SLR and DORIS to further densify the regional ITRF.

The workshop thanked the General Department of Land Administration, Vietnam for hosting such an important workshop, their generous hospitality and friendship in a magnificent venue.

J Manning

Deputy Chairman

Working Group 1

4 August 1999

Workshop Outcomes

Outcomes from discussions during the Workshop are summarised as:

1. *Completion of APRGP97 Campaign Computations:*

- SINEX files to AUSLIG by end of July 1999.
- Australia, China (State Bureau of Surveying and Mapping), China (Shanghai Observatory), Japan, Indonesia and Malaysia,
- Combined GPS solutions.
- Combined all techniques solution.
- Complete all computation for APRGP97 before APRGP99 (October 1999) commences.

2. *Completion of APRGP98 Campaign Computations:*

- SINEX files to AUSLIG by end of August 1999.
- Australia, China (State Bureau of Surveying and Mapping), China (Shanghai Observatory), Japan, Indonesia and Malaysia,
- Combined GPS solutions.
- Combined all techniques solution.
- Complete all computation for APRGP98 before APRGP99 (October 1999) commences.

3. *Publication of results*

Following combination of results an official set of coordinates for APRGP97 and APRGP98 will be prepared for distribution to member countries.

4. *1999 regional campaign*

A sub committee was established to plan the APRGP99 observation campaign:

- Committee members are Australia (coordinator), Fiji, Iran, Japan, and Vietnam.
- Committee to address the following criteria:
- Focus on the "Empty Zones" – Russia, China, India, etc and the "Pacific Group" for densification.
- Committee members to encourage and coordinate participation in APRGP99 by PCGIAP members in sub regions:
- Fiji – Pacific Islands sub-region members.
- Iran – West Asia sub-region members.
- Japan – permanent trackers in Pacific Islands sub-region.

- Vietnam – Indo-China sub-region members.
- Focus on site selection for connection to a universal height datum – GPS observations at tide gauge benchmarks and leveled benchmarks
- APSG5 and APSG6 VLBI campaign – 1st November and 8th November 1999 being coordinated by Shanghai Observatory.
- GPS campaign from 0hr, Sunday 31 October 1999 to 0hr Wednesday 10th November 1999.
- SLR and DORIS data for the whole month of October will be required. WPLTN to coordinate the SLR campaign

5. *Permanent Network of Base Stations*

Establish a list of all continuous GPS receivers in the region together with contact agencies and data availability eg. Pacific, Nepal, etc.

- Fiji to look at situation in Pacific sub-group,
- Nepal to investigate US and Italian campaigns in Nepal (and Absolute Gravity),
- Japan to advise of location of their receivers in Pacific (including proposed sites) with aim of making data available during APRGP99.
- Make information available on PCGIAP web site

6. *GPS Observations Specifications*

A sub committee was established comprising Australia, China (State Bureau of Surveying and Mapping), Japan and Malaysia to develop standards for the 1999 campaign including:

- Antenna descriptions.
- Antenna heights.
- Station IDs.
- RINEX headers conformity.
- Data transfer medium – ftp, CD-ROM, Zip, Floppy – in preferred order.
- Specifications for RINEX conversion software.

7. *Classification of networks*

Indonesia to provide a position paper on Accuracy Classification and Standards of coordinates. Interpretation of "Zero Order", "First Order" and "Second Order" in the context of the APRGP results.

8. *Development of Transformation parameters.*

Member countries to consider the optimum precision datum transformation proposals of Iran and Australia for implementation after achieving an adequate densification of ITRF points within individual geodetic networks. APRGP99 planning committee to also consider transformation requirements in site selection process.

9. Absolute Gravity Network

A subcommittee was established comprising Australia, Indonesia, Iran, Japan, Malaysia and Vietnam to develop a proposal for a regional Absolute Gravity Observation Campaign to connect relative gravity networks to gravity reference frames

10. Regional Geoid

A sub committee was established comprising Iran and Vietnam to study the terrestrial (relative) gravity data input data into the EGM96 – identifying weaknesses and developing a work plan for further observational requirements leading to an improved regional geoid.

11. Regional Geoid School

The Workshop supported the arrangements for an International Geoid School to be held in Malaysia in 2000, and strongly encourages member countries to attend. It also encourages the planning and hosting of Tropical Schools of Geodesy with specific reference to a school on GPS.

12. Electronic communications

The need for enhanced communication between WG1 members was identified.

- AUSLIG to further develop the Working Group web site with diagrams and meta data, and
- establish an email List Server with mailing addresses for all WG1 members and APRGP campaign participants.

Workshop programme
Ho Chi Minh City 12th-13th July 1999

Monday 12th July 1999

9:00	Welcome	Vietnam/ Dang Hung Vo
9:10	Role of PCGIAP/Report	Australia/Manning
9:40	APRGP98 Campaign Overview	Australia/Luton
10:00	GPS Results for APRGP98	Japan/Matsuzaka
10:30	Coffee break	
11:00	GPS Results for APRGP98	Australia/Govind
11:30	Discussion	
11:40	GPS Results for APRGP98	China/Pengfei Cheng
12:00	Lunch	
13:30	GPS Results for APRGP98	China/Cheng Zongyi
13:50	GPS Results for APRGP98	Indonesia/Cecep
14:10	GPS Results for APRGP98	Malaysia/Samad Abu
14:30	Discussion	
	Other results from APRGP98	
15:00	SLR/DORIS	Australia/Govind
15:30	VLBI	China/Jinling Li
15:50	Discussion	
16:00	Coffee break	
16:30	Links to local datums	Australia/Govind
17:00	Planning for the 1999 campaign	Australia/Manning

Tuesday 13th July 1999

8:30	planning for the 1999 campaign (continued)	Australia/Luton
	Country report	
9:30	Status of Vietnam Geodetic network and Indochina	Tran Bach Giang
10:00	Nepal	Pradhananga
10:15	Mongolia	Byarruuzana
10:30	Pacific	Fiji/Samisoni
10:45	Coffee break	
11:15	PNG	Rosa

11:30	Readjustment and transformations of Geodetic Network	Iran/tavakoli Australia/Manning
11:45	Malaysia	Samad
12:00	Lunch	
12:30	IAG Sub Commission Report	Australia/Manning
14:00	Discussion	
14:30	APRGP99 and connection to other GPS campaign	Australia/Govind
15:00	Report and Recommendations to PCGIAP	Indonesia/Manning
15:30	Coffee break	
16:00	Workshop summary	Vietnam & Australia
17:00	Close	Vietnam/Dang Hung Vo

Workshop Attendees

<u>No.</u>	<u>Country and Name</u>	<u>Agency and address</u>
Australia		
1	John Manning	Australian Surveying and Land Information Group (AUSLIG) Tel.: +61-2-62014352 Fax.: +61-2-62014366 Email: JohnManning@auslig.gov.au
2	Geoffrey Luton	Australian Surveying and Land Information Group (AUSLIG) Tel.: +61-2-62014345 Fax.: +61-2-62014366 Email: GeoffLuton@auslig.gov.au
3	Ramesh Govind	Australian Surveying and Land Information Group (AUSLIG) Tel.: +61-2-62014371 Fax.: +61-2-62014366 Email: GeoffLuton@auslig.gov.au
Cambodia		
4	Ith Sotha	Geographic Department, Ministry of Land Management, Urbanization and Construction Tel.: +855-23-722301 Fax.: +855-23-430138
5	Chin Chharom	Environmental Technical Advisory Programme, United Nations Development Programme Tel.: +855-23-725007 Fax.: +85-23-216982 Email: chharom@writeme.com
China		
6	Jinling Li	Shanghai Astronomical Observatory, Chinese Academy of Sciences Tel.: +86-21-64876589 Fax.: +86-21-64384618 Email: jll@center.shao.ac.cn
7	Cheng Zongyi	Shanghai Astronomical Observatory, Chinese Academy of Sciences Tel.: +86-21-64386191 Fax.: +86-21-64384618 Email: czyi@center.shao.ac.cn
8	Pengfei Cheng	Institute of Modern Geodesy, Chinese Academy of Surveying and Mapping Tel.: +86-10-68212277, +86-10-68212254 Fax.: +86-10-68218654 Email: pfcheng@public.bta.net.cn

Iran

- 9 Farokh Tavakoli Surveying and Geodetic Department, National
Cartographic Center of Iran
Tel.: +98-21-6001090
Fax.: +98-21-6001971
Email: ncc_iran@rose.ipm.ac.ir

Indonesia

- 10 Cecep Subarya Geodetic Division, BAKOSURTANAL (The National
Coordination Agency for Surveys and Mapping)
Tel.: +62-21-8757329, +62-21-8754654
Fax.: +62-21-8753289, +62-21-8754654
Email: geodesi@indo.net.id

Hong Kong, China

- 11 Simon Chi-wo Kwok Geodetic Survey Section, Survey and Mapping Office,
Lands Department
Tel.: +852-22313489
Fax.: +852-21160778
Email: Indslsg@landsd.gcn.gov.hk

Fiji

- 12 Paserio Samisoni Ministry of Lands and Mineral Resources
Tel.: +679-211405
Fax.: +679-304037
Email: psamisoni@lands.gov.fj

Japan

- 13 Shigeru Matsuzaka Geographical Survey Institute
Email: shigeru@gsi-mc.go.jp
Tel : 81.298.644832
81.298.642655

Laos

- 14 Kongkham Sourigna Technical Science Division, National Geographic
Department
Tel.: +856-20-517353
Fax.: +856-21-214915
Email: ngdsc@pan-laos.net.la
- 15 Manisay Thongchanh Planning Division, National Geographic Department
Tel.: +856-21-218468
Fax.: +856-21-214915
Email: ngdsc@pan-laos.net.la
- 16 Bounkong Sougnatti Survey Division, National Geographic Department
Tel./Fax.: +856-21-213662
Fax.: +856-21-214915
Email: ngdsc@pan-laos.net.la

Malaysia

- 17 Samad Bin Haji Abu Geodesy Section, Geodetic Survey Division, Department of Survey and Mapping (JUPEM)
Tel.: +60-3-2929930
Fax.: +60-3-2934084
Email: samadabu@jupem.gov.my

Mongolia

- 18 Byaruuzana Erdenebaatar State Administration of Geodesy and Cartography
Tel.: +976-1-320783
Fax.: +976-1-322683
Email: aersurmap@mongol.net

Nepal

- 19 Tirtha B. Pradhananga Topographical Survey Branch, Survey Department
Tel.: +977-1-482393, +977-1-482338
Fax.: +977-1-496216, +977-1-482957
Email: geosurvey@mos.com.np

Papua New Guinea

- 20 Robert Rosa National Mapping Bureau, Department of Lands
Tel.: +675-3276466
Fax. : +675-3276460
Email: natmap@datec.com.pg

Vietnam

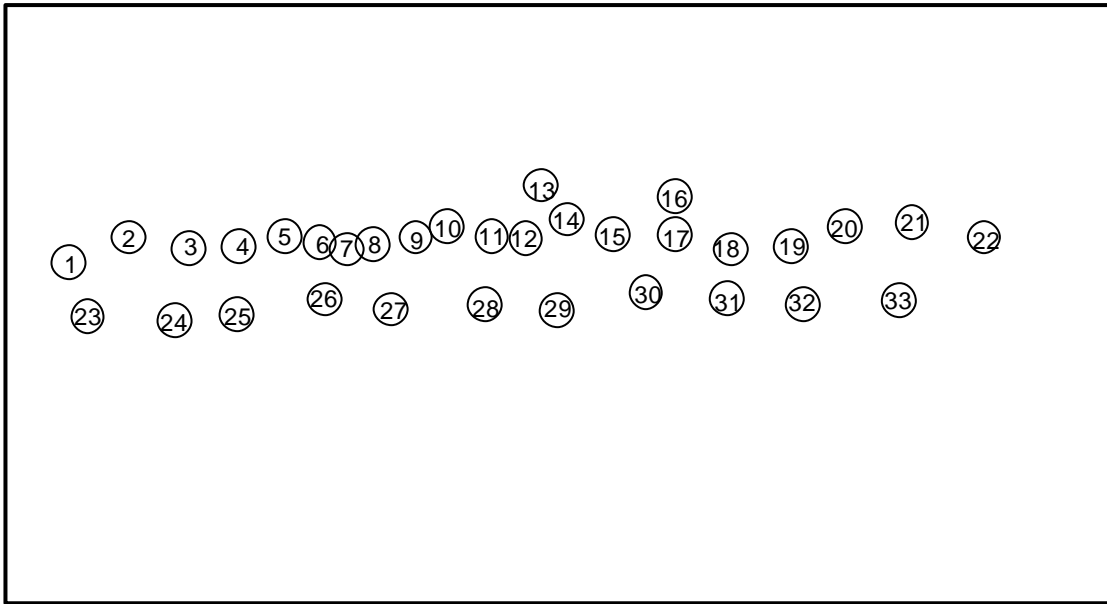
- 21 Dang Hung Vo General Department of Land Administration of Vietnam (GDLA)
Tel.: +84-4-8344066
Email : vo.gdla@hn.vnn.vn
- 22 Nguyen Bich Tuyen Import-Export and Consultancy Company – GDLA
23 Vu Hoang Anh Tel.: +84-4-8355722
24 Dinh Hong Phong Email : maptech.imecosum@fpt.vn
- 25 Tran Bach Giang Surveying and Mapping Department – GDLA
26 Phan Ngoc Mai Tel.: +84-4-8357893
- 27 Nguyen Kim Son Science - International Relation Dept. - GDLA
28 Le Kim Son Tel.: +84-4-8357910
- 29 Le Minh Vietnam Research Institute of Land Administration
30 Tran Dinh Lu Tel.: +84-4-7561156
31 Ha Minh Hoa Email : proj2.cplar@hn.vnn.vn
32 Dang Thai Son
33 Nguyen Thi Tuyet
34 Trinh Huu Lien
- 35 Le Quy Thuc Tel.: +84-4-7731276

36	Le Dinh Ai	Air Photography and Topographical Survey
37	Tran Dinh Luat	Company Tel.: +84-4-8351665
38	Nguyen Van Duc	Cadastre and Engineering Company
39	Hoang Hung	Tel.: +84-8-7415222
40	Tran Van Bang	
41	Vo Thanh Viet	
42	Vu Ngoc Bui	
43	Tran Dinh Au	Maritime Survey Center
44	Chu Van Quyen	Tel.: +84-8-8257084
45	Hoang Ngoc Thanh	Housing and Map Control Center - HCM Cty
46	Nguyen Quoc Dung	Tel.: +84-8-8399659
47	Le Van Hung	Technical college - Ho Chi Minh City
48	Le Van Trung	Tel.: +84-8-8293657
49	Dao Xuan Loc	
50	Tran Trong Duc	
51	Le Trung Chon	
52	Nguyen Tan Loc	
53	Le Tien Thuan	
54	Le Hoang Son	
55	Trinh Anh Co	Geodesy-Cartography-Remote sensing Association Tel.: +84-4-7731276

PHOTOGRAPH



LIST OF PEOPLE IN THE PHOTOGRAPH



No.	Name	No.	Name
1	Dinh Hong Phong	18	Ith Sotha
2	Pengfei Cheng	19	ThongChanh Manisay
3	Le Trung Chon	20	Paserio Samisoni
4	Le Minh	21	Geoffrey Luton
5	Jinling Li	22	Trinh Huu Lien
6	Trinh Anh Co	23	Ramesh Govind
7	Shigeru Matsuzaka	24	Ha Minh Hoa
8	Le Van Trung	25	Le Van Hung
9	Robert Rosa	26	Tirtha Pradhananga
10	Farokh Tavakoli	27	Le Quy Thuc
11	Nguyen Huu Chinh	28	Nguyen Bich Tuyen
12	Tran Dinh Lu	29	Dang Hung Vo
13	Simon Chi-wo Kwok	30	John Manning
14	Erdenebaatar Byaruuzana	31	Cecep Subarya
15	Tran Bach Giang	32	Kongkham Sourigna
16	Nguyen Kim Son	33	Le Kim Son
17	Vu Hoang Anh		

Report on the permanent committee on GIS Infrastructure for Asia and the Pacific for the Geodesy workshop

Bob Irwin
PCGIAP Executive Officer

Background

The Permanent Committee on GIS Infrastructure for Asia and the Pacific (PCGIAP) was established by the United Nations Regional Cartographic Conference for Asia and the Pacific (UNRCC-AP) at its triennial meeting in Beijing, May 1994. PCGIAP operates under, and reports to, the UNRCC-AP.

There are 55 member nations of the PCGIAP as defined by the United Nations. The countries span a wide part of the globe from Iran and Armenia in the west to French Polynesia in the east; from the Russian Federation and Japan in the north to New Zealand and Australia in the south.

Membership comprises directorates of national survey and mapping organisations and equivalent national agencies of the nations from Asia and the Pacific. Each nation nominates a single representative but may invite experts as advisers.

PCGIAP meets annually and has an Executive Board of representatives from 10 key member nations with projects being carried out by working groups. The Board comprises:

<u>President</u>	Dato' Abdul Majid Bin Mohamed, Director General, Department of Survey and Mapping, Malaysia
<u>Vice-President</u>	Prof. Yang Kai, Deputy Director General, National Bureau of Surveying and Mapping, China
<u>Secretary</u>	Mr. Drew Clarke, Head of Division, Analytical and Mapping Division, Department of Industry, Science and Tourism, Australia
<u>Members</u>	LtGEN A.K.Ahuja, Surveyor General, Survey of India, India
	Mr. Rudolf W. Matindas, Head of Center for Mapping, Indonesia
	Mr. Saeid Noori Bushehri, Head of GIS Department, National Cartographic Center, Iran
	Mr. Motoyuki Kidokoro, Director General, Geographical Survey Institute, Japan
	Mr. Kim Won-Ik, Director General, National Geographic Institute, S Korea
	COL Nukool Ratanakarn, Royal Thai Survey, Thailand.
	BGEN, Liberato Manuel, Administrator, Department of Environment and Natural Resources, The Philippines

Aims and Objectives

The aims of PCGIAP are to:

maximise the economic, social and environmental benefits of geographic information in accordance with Agenda 21 by providing a forum for the 55 members nations from the Asia and the Pacific region to cooperate in the development of the Asia-Pacific Spatial Data Infrastructure (APSDI) and contribute

to the development of the global infrastructure.

The objectives of PCGIAP are to:

- a. Develop guidelines for the nature of legislative and administrative procedures and orders appropriate to the acquisition and sharing of spatial data.
- b. Define the nature of a regional geographic information infrastructure that each country in the region can make available to meet regional mapping requirements as they relate to global mapping requirements, principally consisting of a regional geodetic framework, topographic features and geographic names.
- c. Define a framework for the documentation of the status of fundamental data sets and key agencies in each member nation, and for the exchange of such information.
- d. Design a strategy for the development of a regional geodetic framework and topographic data bases as the basis for regional GIS activity.
- e. Prepare guidelines and strategies to assist member nations in the development of digital cadastral data bases and where necessary for the implementation of cadastral reforms to meet individual member nation needs.
- f. Determine the need for research, training and technology exchange in relation to the beneficial impact of geographic information on the social, economic and environmental objectives of member nations of Asia and the Pacific region.

Current Activities

This following summarises the current activities of the Permanent Committee on GIS Infrastructure for Asia and the Pacific (PCGIAP).

Definition of the regional spatial data infrastructure

PCGIAP has produced "PCGIAP Publication 1 – A Definition of the Asia-Pacific Spatial Data Infrastructure (APSDI)". This document defines the regional infrastructure, its components, the benefits it will provide, its links with Agenda 21, and its role in the evolution of the global spatial data infrastructure (GSDI). PCGIAP Publication 1 can be found on the PCGIAP Web site. The Committee welcomes comment on Publication 1.

Annual meeting of PCGIAP

PCGIAP held its 1999 annual meeting in Beijing from 19-22 April 1999. PCGIAP working groups reported to the Committee which discussed and analysed their progress and workplans. A report on the meeting will be distributed by China and placed on the PCGIAP web site by the Australian Secretariat. Main outcomes from the meeting and other items follow.

Working Group 1 - Regional Geodetic Network

WG1 has three main projects:

1. Regional precise geodetic network
2. Linkages from local to regional horizontal geodetic datum
3. Regional vertical datum.

The following points summarise progress and future activities of WG1:

- Significant progress has been made by WG1 with the regional horizontal and vertical datums as well as the work for the regional geodetic network project.
- Two successful PCGIAP regional geodesy field campaigns have been conducted; a space geodesy campaign in 1997 and a GPS campaign in 1998.
- A PCGIAP geodesy workshop was held in Canberra July 1998 and the present one is being hosted by Vietnam in July 1999. The workshops provide a technical forum for presentation of results of the regional campaigns, transfer of technology and to prepare for future cooperative projects.
- A third regional geodetic campaign is being arranged for October 1999 to extend the GPS connections to the geodetic networks in individual countries unable to participate in the 1998 campaign, such as the Pacific nations, and to enhance the connection of local vertical datums to sea level.
- A similar technical workshop is scheduled in mid-2000 to address the results of the 1999 campaign for development of transformation parameters and vertical datum unification strategies.
- The definition of the regional horizontal datum is now complete with the agreement by PCGIAP in Beijing that the ITRF reference frame and GRS80 ellipsoid will be used as the regional horizontal datum.
- It was also agreed that the values from the 1997 campaign should be used as the interim datum points for key permanent sites pending the development of site velocities in future campaigns.

Working Group 2 - Regional Fundamental Data

WG 2 is undertaking four projects within its workplan:

1. Policy for Sharing Fundamental Data

- A draft policy for the sharing of fundamental data and guidelines on the custodianship of fundamental data have been developed.

2. Develop Fundamental Datasets

WG2, which is chaired by Australia, is addressing the development of regional fundamental datasets through a number of avenues, including:

- cooperation with The University of Melbourne to undertake research into spatial data infrastructures and to determine the extent and quality of fundamental spatial data that exists in PCGIAP member countries;
- investigation and testing of existing regional fundamental spatial datasets as a guide, in particular to the way administrative boundaries have been dealt with in Europe, for example;
- Aligning the technical specification for APSDI with the project specification for Global Mapping.

3. Develop Network of APSDI Data Nodes

- WG2 developing the rationale and functions of a data node.
- WG2 is analysing the establishment and operation of the data nodes and technical issues such as proposed architecture.

4. Develop Regional GIS Application Demonstrations

Initial investigation has occurred regarding the use of current small scale GIS datasets as application demonstrations.

Development Needs Taskforce

PCGIAP is determining a program of GIS related development needs across the Asia and the Pacific region and is carrying this out through its Development Needs Taskforce. The following points outline progress and future work plans of the Taskforce:

- The Taskforce Committee comprises Malaysia, Japan, Iran and Australia, each leading the Taskforce workplan in a sub-region of the Asia and the Pacific.
- Prior to identifying development needs of members, and recommending programs and funding options to address those needs, the Taskforce is collecting and analysing institutional and program information about the 55 member country agencies. The collection phase is being achieved through a questionnaire, and a combination of workshops and face-to-face meetings between Taskforce representatives and member countries.
- Input from the 55 members will be collated and analysed for a single report. A small number of projects will be identified which have maximum impact on development of member NSDIs (and hence the APSDI and in turn the GSDI).
- The projects will then be scoped for implementation. The objective is to have projects that support development in a large number of member countries.

Cadastral

Main outcome from discussions on cadastral matters in Beijing:

- there was insufficient support to establish a PCGIAP cadastral working group.

Given the strong interest of FIG Commission 7, the meeting agreed that at the next UNRCC-AP and PCGIAP meeting early in 2000, Commission 7 be invited to convene a technical seminar on the cadastre. As well, Commission 7 will be invited to prepare a paper detailing a proposed workplan for a PCGIAP cadastral working group which addresses resourcing and implementation. Formation of a PCGIAP cadastral working group will be considered by the Committee after this technical seminar.

PCGIAP will be represented by its President at the UN/FIG Bathurst Workshop and Melbourne International Conference in October 1999 on the cadastre. The President will report back to the next PCGIAP meeting on outcomes of communication with FIG Commission 7 and also the Bathurst/Melbourne meetings.

Australia gave strong support to the formation of a cadastral working group but no country volunteered to take responsibility for any work in that regard. Hong Kong however agreed to manage preparation up to UNRCC-AP on PCGIAP cadastral issues with support from

the Secretariat.

Some of the key issues discussed at the Beijing meeting included:

1. Definition of cadastre. (Many different perspectives including GIS, land registration, land tax, land use, ownership etc.). No country offered to coordinate the production of a definition.
2. Cadastre is not a regional issue. Rather, it is an issue of regional significance.
3. In many countries, there is no national cadastre. Responsibility is at the state/province/local level of government.
4. Land rights including inherent rights in customary land.
5. The role of the PCGIAP in facilitating or supporting the strengthening of institutional arrangements for national cadastres.

PCGIAP Contact Details

For further information on PCGIAP contact the PCGIAP Executive Officer or visit the PCGIAP web site.

Bob Irwin

PCGIAP Executive Officer

PO Box 2

BELCONNEN ACT 2616 AUSTRALIA

Tel: + 61 2 6201 4267 Fax: + 61 2 6201 4366

Email: BobIrwin@auslig.gov.au

URL: <http://www.permcom.apgis.gov.au/>

Permanent Committee on GIS Infrastructure
for Asia and the Pacific

• **HISTORY**

- Beijing meeting of UNRCC-AP - May 1994
- PCGIAP meetings: Kuala Lumpur July 1995
Sydney October 1996
Bangkok February 1997
Tehran March 1998
Beijing April 1999

• **MEMBERSHIP**

55 Member Nations

Geodesy Workshop - Ho Chi Minh City, 12-14 July 1999



Permanent Committee on GIS Infrastructure
for Asia and the Pacific

• **AIMS**

.... maximise the economic, social and environmental benefits of geographic information in accordance with Agenda 21

.... develop the Asia-Pacific Spatial Data Infrastructure (APSDI) and contribute to the development of the global infrastructure

Geodesy Workshop - Ho Chi Minh City, 12-14 July 1999



Permanent Committee on GIS Infrastructure
for Asia and the Pacific

• **OBJECTIVES**

- define regional infrastructure
- develop regional geodetic framework
- arrangements for sharing spatial data
- define fundamental datasets and nodes
- assist in SDI development
- research, training and technology exchange

Meeting the Objectives will satisfy the Aims

Geodesy Workshop - Ho Chi Minh City, 12-14 July 1999



Permanent Committee on GIS Infrastructure
for Asia and the Pacific

• **STRUCTURE**

Operational Structure:

- Executive/Secretariat
- Regional Geodesy
- Regional Fundamental Data
- Development Needs

The above groups carry out their workplans to meet the Objectives of PCGIAP

Geodesy Workshop - Ho Chi Minh City, 12-14 July 1999



Permanent Committee on GIS Infrastructure
for Asia and the Pacific

• **ACHIEVEMENTS**

- Publication No.1 defining APSDI
- geodetic network project
- principles for sharing data in the region
- addressing SDI development needs
- relationship with UNRCC-AP
- role in global infrastructure model
- linkage with Agenda 21

Geodesy Workshop - Ho Chi Minh City, 12-14 July 1999



REPORT ON ACTIVITIES OF WORKING GROUP 1 REGIONAL GEODETIC NETWORK

John Manning
Vice Chairman
Working Group 1

Introduction

Regional cooperation in Geodesy at the national level is coordinated through the Regional Geodetic Network Working Group of the Permanent Committee for GIS Infrastructure in the Asia and the Pacific region (PCGIAP). This group sees the benefits of working together in regional geodesy and sharing information. It recognises that no individual country has all the answers and respects that each has its own circumstances to consider in building a united regional framework.

Background

The Permanent Committee on GIS Infrastructure for Asia and the Pacific (PCGIAP) was established by the United Nations Regional Cartographic Conference for Asia and the Pacific (UNRCC-AP) at its triennial meeting in Beijing, May 1994. PCGIAP operates under, and reports to, the UNRCC-AP.

Membership of PCGIAP comprises directorates of 55 national survey and mapping organisations and equivalent national agencies of the nations from Asia and the Pacific. Each nation nominates a single representative but may invite experts as advisers.

The aims of the PCGIAP are to:

Maximise the economic, social and environmental benefits of geographic, by providing a forum for the members nations from the Asia and the Pacific region to cooperate in the development of the Asia-Pacific Spatial Data Infrastructure as a contribution to the development of the global infrastructure.

Two of the key PCGIAP objectives are to :

- Design a strategy for the development of a regional geodetic framework and topographic databases as the basis for regional GIS activity.
- Determine the need for research, training and technology exchange in relation to the beneficial impact of geographic information on the social, economic and environmental objectives of member nations of Asia and the Pacific region.

The establishment of a Geodesy Working Group was approved at the initial meeting of the PCGIAP in Kuala Lumpur in 1995. The current terms of reference for the Working Group are given in Attachment 1.

The primary role of the PCGIAP working group is to facilitate a single regional datum and provide a linkage of compatible geodetic datums to a regional datum. This is fundamental to the development of an Asia Pacific Spatial Data Infrastructure which requires that:

- A reference regional datum be established, and
- Transformation values are to be determined between the regional datum and the local geodetic datums of the individual countries.

These then permit a homogeneous spatial data set to be readily assembled from national spatial data sets based on local datums.

The reason for the establishment of a Regional Geodetic Network was to provide a common datum for all nations in the Asia Pacific region and to densify the global distribution of ITRF points. Connections to individual geodetic datums can facilitate the delivery of national data to a homogeneous regional spatial data base by individual countries by the use of transformation parameters for those countries whose datum is not already in ITRF. To develop these transformations the individual datums need to be well defined and have sufficient common stations in both individual and regional systems to determine datum transformations.

Since the individual datums within the Asia and Pacific Region differ from country to country, some countries may need assistance to perform the datum transformation. This assistance ranges from GPS equipment, survey expertise, datum definition to the definition of datum transformation parameters.

The issue of connecting local sea level based height datums through a universal vertical datum and a related regional geoid also remains to be addressed. Enhanced linkages need to be formed between national Geodetic bodies represented by the PCGIAP and scientific bodies such as those represented by the Asia Pacific Space Geodynamics Group. This will enable geodetic networks to eventually take advantage of information gathered on differential tectonic movement of the landmasses in applying geodetic datums.

Working Group activities 96-99

At the inaugural business meeting of the Working Group in 1996 in Sydney a number of project responsibilities were identified and a program of regional geodetic activities endorsed. The initial goal of the Geodesy Working Group was to establish a precise regional geodetic network as a high-level reference framework, covering the Asia and the Pacific Region, from Central Asia to the Western Pacific.

Another area of activity identified was the investigation of techniques, which can be used to transform national spatial data into a single spatial data set in the region.

Additionally the Working Group has been gathering information on geodetic datums in individual countries used within the region. This information on existing geodetic datums for all countries in the UN Cartographic region of Asia and the Pacific is shown on the PCGIAP Web site, www.percom.apgis.gov.au with a feedback mechanism to amend any incorrect, or out of date, entries.

Asia Pacific Regional Geodetic Project (APRGP' 97).

One of the core projects of the Working Group has been the establishment of a precise Regional Geodetic Network. In October 1997 an Asia Pacific Regional Geodetic Project (ARGP97) was initiated to gather data for an overarching geodetic framework of permanent stations as the basis for the integration of national geodetic datums. In the ARGP97 observation campaign a number of techniques were employed:

- GPS
- DORIS
- SLR,
- VLBI

The GPS data acquired by participating countries during this campaign was assembled in Australia, and distributed on CD-ROM for immediate use by Asia Pacific member

countries. The non-IGS GPS sites are shown in Figure 1 below.

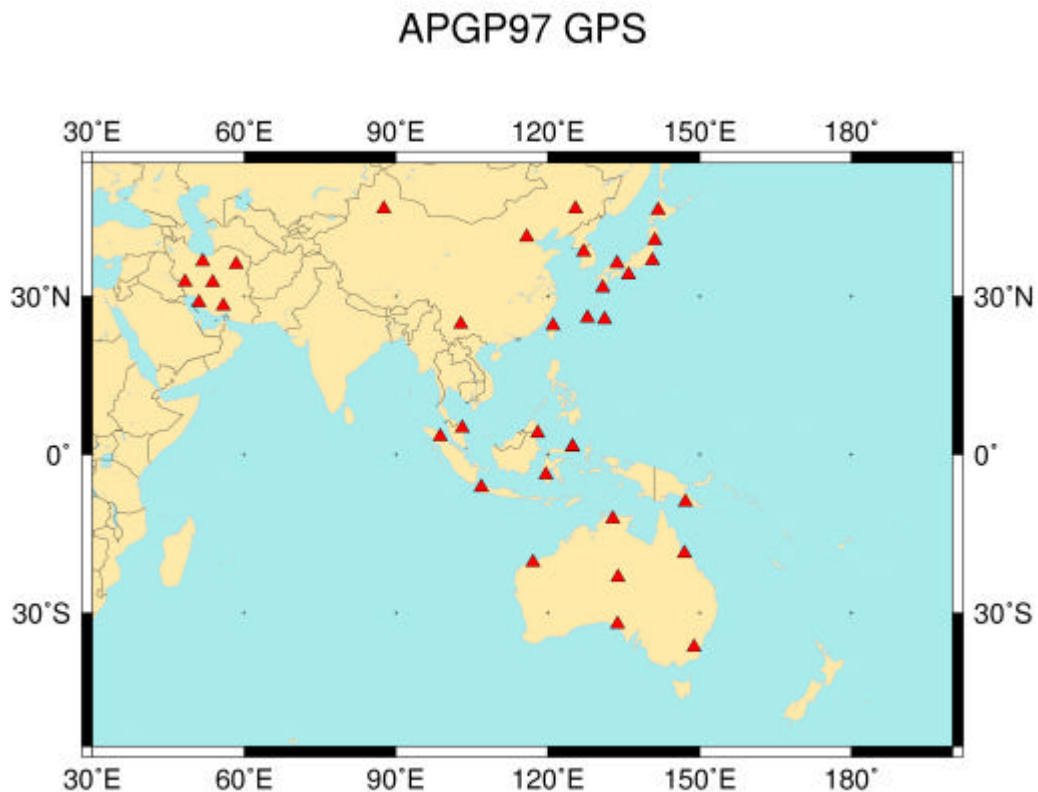


Figure 1 Non-IGS GPS sites occupied during ARGP97

The first PCGIAP Regional Geodetic Workshop

A results workshop was subsequently hosted by AUSLIG in Canberra 2-4th July 1998 to conclude the core component of the project, leading to the finalisation of a set of results. Representatives from ten member countries of the PCGIAP attended the workshop, and presented results from the 1997 campaign. Proceedings of the Workshop were published by AUSLIG and are available through APSG and PCGIAP web sites. Following the meeting the observational data set was then made available to other regional scientific researchers.

Four countries independently presented GPS results from processing the APRGP97 data set:

- Indonesia (GAMIT)
- Japan (GAMIT)
- China (GAMIT)
- Australia (MicroCosm)

The results presented showed good agreement and demonstrated a significant achievement in technology for those involved. It was noted that Malaysia and Iran are also close to also establishing high precision GPS processing capability in their analysis centres whilst smaller countries such as Vietnam and PNG were working with receiver

manufacturers proprietary software such as PRISM.

The workshop examined the options for definition of a regional geodetic datum in a global setting and recommended use of an interim combined GPS solution in ITRF, pending further work on an integrated solution of all techniques utilising ground ties at collocated sites. The APRGP97 campaign produced significant results, but also achieved a degree of technology transfer for participating members in the development of a regional capability for high level processing of GPS data. Further the workshop considered the ongoing need for a strategy to link individual vertical datums, such as

- Land locked countries
- isolated island
- chart datums,
- as well as scientific sea level determinations.

It recommended the concept of a unified vertical datum using data stored in earth centred Cartesian coordinates or related to an ellipsoid such as the GRS80 ellipsoid in the ITRF system.

Asia Pacific Regional Geodetic Project (APRGP' 98).

At the Canberra workshop plans were developed for the implementation of an expanded observational campaign in November 1998 (APRGP98). A cooperative strategy was developed with the GEODYSSSEA project for a common observational campaign and sharing of data from key sites.

A second APRGP field campaign was then held in November 1998 at the same time as the GEODYSSSEA98 campaign. Participation in the campaign included GPS epoch occupation of a number of sites on national Geodetic networks. Seventeen nations were able to participate and

GPS observations from some 92 sites in addition to the existing IGS sites were achieved. The GPS data (except from four sites in India) was collated by AUSLIG and distributed on CD ROMs to all countries for processing, analysis and presentation of results. A VLBI campaign was again arranged by China (Shanghai Observatory) through APSG cooperation and SLR observations (through WPLTN) with DORIS participation through CNES. The non-IGS GPS sites observed during the campaign are shown in Figure 2 below.

APGP98 GPS

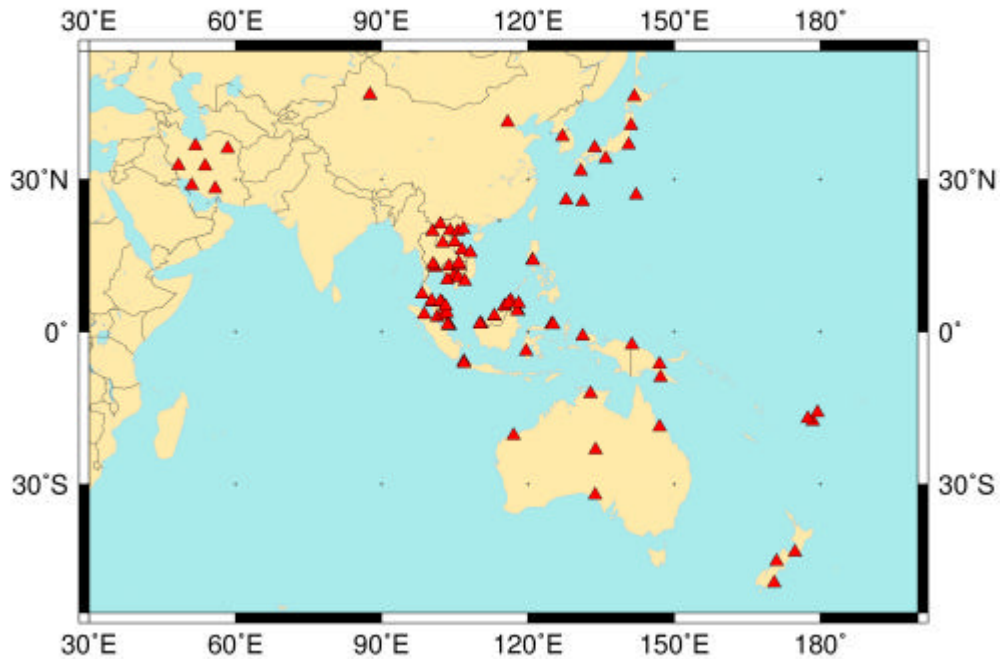


Figure 2 : Non-IGS GPS sites occupied during ARGP98

The Second PCGIAP Regional Geodetic Workshop

The ARGP98 results computed by individual countries will be presented at this workshop and a strategy for a combined solution developed.

5th PCGIAP Meeting April 1999

At the 5th Meeting of PCGIAP in Beijing 19-23 April 1999 the working group met and reviewed progress with activities. Drawing on the results from the APRGP campaigns, it reached a number of conclusions to set the general directions of the Working Group activities until the 6th Committee meeting is held in the year 2000. These are:

1. That the reference frame for geodetic applications in the Asia and the Pacific be the International Terrestrial Reference Frame (ITRF) and that the GRS80 ellipsoid be used for horizontal computation within that reference frame.
2. That the horizontal coordinates determined from the APRGP campaigns in ITRF are to be used as the interim datum points pending the determination/verification of the horizontal velocities at those stations.
3. That a regional geodetic campaign be undertaken in October 1999 to extend the GPS connections to the geodetic networks in individual countries, unable to participate in APRGP98 such as the Pacific nations, and to enhance the connection of local vertical datums to sea level.

4. That the concept of a universal ellipsoidal vertical datum be further investigated as a means of connecting individual vertical datums across the region.
5. That the PCGIAP endorses a proposal by Mongolia to hold a regional Technical Geodesy Workshop in Ulaanbaatar in the year 2000 to conclude the APRGP99 campaign.
6. That further research be undertaken on the development of options for transformation parameters for consideration by the working group following presentation of results from the Technical Workshop in Mongolia
7. That the Working Group on Regional Geodetic Network encourages the greater participation of the Pacific Island nations in the Working Group and resolves to look for ways of providing support and technology transfer to the countries in the Pacific sub region.

The PCGIAP subsequently endorsed the following resolution and recommendation from the Working Group at the plenary meeting

Resolution: Regional Datum

Recognising the need for a uniform geodetic control system across the Asia and the Pacific region, the PCGIAP resolves that :

The ITRF system and the GRS80 ellipsoid be adopted as the fundamental datum parameters for regional applications.

Recommendation : Geodesy Technical workshop

Recognising the benefits arising from Geodesy Technical Workshops of the APRGP campaigns and the invitation by Mongolia to host such a meeting in UllanBaatar in mid 2000. The PCGIAP recommends that:

The Geodesy meeting to be held in Mongolia becomes an endorsed PCGIAP Technical Workshop.

And further

PCGIAP encourages all members to send Geodesy technical representatives to the meeting in Mongolia.

Workplans

The following work plans for the Working Group for the next 12 months were approved as:

Project 1. Regional Precise Geodetic Network - Coordinator Australia

The aim of this project is to establish positional values, within a global reference frame, for a fundamental network of permanent geodetic stations across the Asia and the Pacific region. This project will additionally develop strategies for incorporating additional permanent stations. It will provide the basis for monitoring the positional movement of these geodetic stations on an ongoing basis using all geodetic techniques including VLBI and GLONASS. The processed solutions developed from the data will be delivered to IERS as a regional contribution to the global reference frame. These SINEX solutions will be submitted to IGS and ILRS, made available to member countries of the Permanent

Committee and referenced on the PCGIAP Geodesy Networks Web page.

Details of permanent stations, organisations responsible for operation, and access to data will be published and maintained on the PCGIAP Geodesy Networks Web page.

Workplan Summary

Action	Responsibility	Target Date	Progress
1. Finalise APRGP98 collection and distribution of GPS data	Australia,	30 April 1999	Completed
2. Individual countries process and present results for combined solution	Participating members,	12/13 th July 1999	Completed
3. Arrange Technical Workshop for presentation of results from APRGP98	Vietnam	12/13 th July 1999	Completed
4. Prepare strategies to maintain precise reference framework and further develop the regional network of permanent sites	Australia,	12/13 th July 1999	For workshop discussion
5. Publish proceedings of Technical workshop and enhance directory of permanent network sites, and details of access to data, on WWW	Australia, Vietnam	September 1999	In hand
6. Monitor development of GLONASS and present strategy for using GLONASS global base station observations for Working Group consideration	Russia	12/13 th July 1999	Incomplete. Re-assess after IGEX workshop at ION meeting September 1999
7. Investigate regional capability for ongoing VLBI for WG1 discussion and submission to the Permanent Committee	Japan	12/13 th July 1999	China to arrange ongoing annual VLBI campaigns

Project 2. Linkages from Local to Regional Horizontal Geodetic Datum Co-ordinator - Australia

The APRGP campaigns from Project 1 will provide the key reference geodetic network for the region. Beyond this primary reference framework the objective of Project 2 is to link national Geodetic datums together, so that all spatial information from individual countries can be readily assembled into a unified regional spatial data infrastructure for GIS purposes.

Field GPS campaigns will assist in linking individual networks to the regional datum. These field observations from both permanent base stations, and epoch sites on local geodetic points, will be processed in terms of the regional reference frame and the results compared to the values from local geodetic networks. Initially, indicative block shifts for each country will be compiled.

This will allow the development of appropriate transformation parameters to be determined for the conversion of spatial data from individual country databases to a

regional spatial data infrastructure. Member countries are encouraged to publish transformation values and to post computational parameters to the PCIAP Geodetic Networks home page.

Where appropriate, the precise regional points established in ITRF from the core APRGP campaigns could subsequently be used to constrain a geodetic readjustment of the local terrestrial network.

Workplan summary

Action	Responsibility	Target	Progress
1. Develop observation campaign strategy and workplan for APRGP99	Australia	August 1999	Draft prepared for discussion
2. Arrange epoch campaign to link with international projects in the region	Australia,	October 1999	In hand
3. Undertake processing of APRGP98 observation campaign	Australia, in parallel with other countries	Sequentially from April 1999	Initial processing completed. Integration required
4. Prepare papers on strategy for computation of transformation parameters	Australia, China, Iran	12/13 July 1999	Papers prepared for consideration
5. Individual countries readjust geodetic network to regional points	Individual countries	UNRCCAP 2000	Ongoing
6. Individual countries publish results, post to WWW	Individual countries	UNRCCAP 2000	Ongoing

Project 3. Regional Vertical Datum Coordinators: Japan and Australia

The Asia and the Pacific region has a wide variety of landforms, isolated islands, and water bodies. Digital spatial data includes various digital terrain models, local sea level land datums, and unique hydrographic chart datums. To establish a regional spatial data infrastructure across the region there is a need to be able to combine the various individual height datums.

The objective of the project is to develop a strategy, for the most appropriate regional vertical datum, to be applied to the Asia and the Pacific region. This will involve investigating the most appropriate approach to an optimal seamless geoid and the concept of adopting a reference ellipsoid to link individual datums to a regional datum. Consideration of the relationship between a regional geoid and the national/local vertical datums in use in the region is an important element in this project.

Workplan summary

Action	Responsibility	Target	Progress
1. Prepare discussion papers on aspects of vertical datum for consideration as possible approaches for establishing a regional vertical datum	Japan, Australia, China	12/13 th July 1999	For discussion at Workshop
2. Represent the WG on IAG Special Study Groups on sea level. Prepare progress reports to WG	Vietnam	Ongoing	Commission X sub commission on SE Asia reformed. Report presented to IAG

Attachment 1

Terms of Reference of Working Group on Regional Geodetic Network

Objectives: To assist the Permanent Committee in the development and maintenance of a regional geodetic infrastructure as the basis for a regional GIS.

Structure: Membership will be open to representatives from each member country of the Permanent Committee.

Operation: The business of the Working Group will be carried out under the chairmanship of a person appointed to the position by the Permanent Committee at each three yearly UNRCCP meeting.

Within the Working Group, vice chairpersons and coordinators of major projects will be nominated as appropriate. These elected persons will form the executive of the Working Group.

The chairman with concurrence of the working group may invite observers to meetings to provide specialist advice on specific issues. Observers may speak on specific issues when invited, but input will normally be through the national member.

The business of the group will be undertaken in a workplan that describes individual project milestones and completion dates and identifies responsibilities associated with these activities.

The forward workplan will be subject to endorsement/approval by the Executive Board subsequent to each meeting.

Reporting: A report from the working group will be prepared for each Executive Board Meeting. The report should address action on all issues referred to the Group, progress on current workplan and suggestions for forward work programs.

Issues:

Determine the optimum geodetic infrastructure necessary to support a regional GIS.
Research and document the general status of national geodetic networks within each

member nation.

Determine and implement appropriate transformation strategies to integrate local datums into regional datums by developing transformation parameters for individual countries so that spatial data can be made available in a homogeneous regional data set.

Support activities leading to the development of a regional vertical datum.

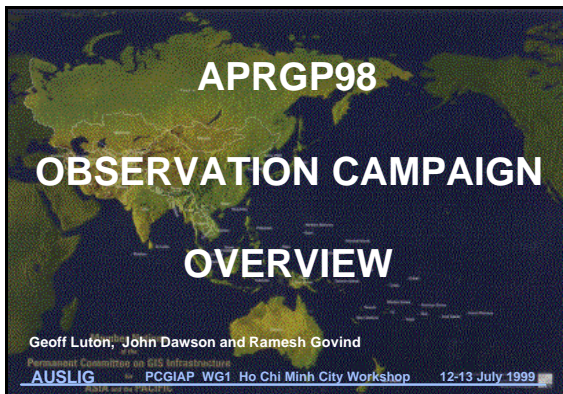
Maintain a schedule outlining the individual activities, milestones, responsibilities, and completion dates associated with the above activities.

Each member makes available and also takes advantage, where appropriate, of opportunities for the exchange of personnel to contribute toward training and education and to improve regional cooperation in Geodesy.

That the Working Group through the Permanent Committee liaise with the International Union of Geodesy and Geophysics (IUGG) and other such bodies for the utilisation of advanced space technology (VLBI, SLR, etc) to facilitate the integration of the GPS networks within the region.

ARPGP98 Observation Campaign Overview

Geoff Luton, John Dawson
and Ramesh Govind
Australia



ARPGP98 Campaign Design

- Densification of precise regional geodetic network
- Links to local datum network sites for derivation of datum transformations
- Links to vertical datums

AUSLIG PCGIAP WG1 Ho Chi Minh City Workshop 12-13 July 1999

Observation Techniques

- VLBI - coordination by Shanghai Observatory
- SLR
- DORIS
- GPS - coordination by AUSLIG
- Absolute gravity - no observations

AUSLIG PCGIAP WG1 Ho Chi Minh City Workshop 12-13 July 1999

Campaign Observation Periods

- VLBI - two 24 hour observation sessions
 - APSG3 6 November 1998
 - APSG4 13 November 1998
- SLR - one month during November 1998
- DORIS - one month during November 1998
- GPS - GPS part week 984 and week 985 (19th to 28th November)
Concurrent with GEODYSSSEA 19th to 24th

AUSLIG PCGIAP WG1 Ho Chi Minh City Workshop 12-13 July 1999

Number of Participating Sites

- VLBI - 6
- SLR - » 26
- DORIS - » 36
- GPS - 92 regional
30+ regional IGS

AUSLIG PCGIAP WG1 Ho Chi Minh City Workshop 12-13 July 1999

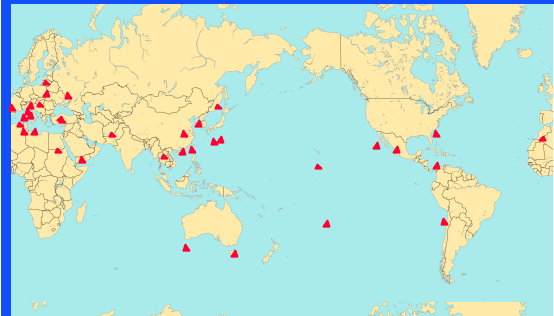
Participating Countries - GPS

Country	No. of sites
● Australia	5
● Cambodia	6
● China	3
● Fiji	3
● Hong Kong (China)	1
● Indonesia	7
● Iran	6
● Japan	9
● Lao	7
● Malaysia	25
● New Zealand	3
● Papua New Guinea	3
● Philippines	2
● Singapore	3
● South Korea	1
● Thailand	4
● Vietnam	4
17 Countries	92 sites

AUSLIG PCGIAP WG1 Ho Chi Minh City Workshop 12-13 July 1999

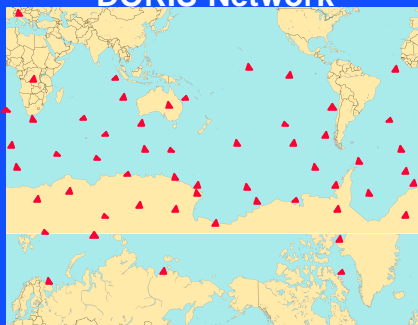


ILRS Network



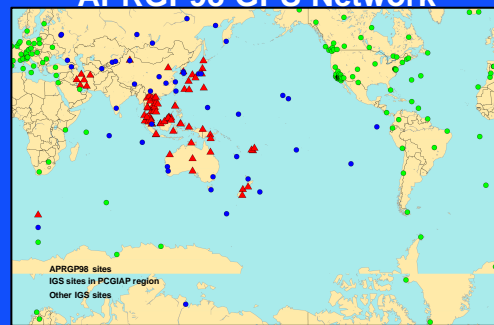
AUSLIG PCGIAP WG1 Ho Chi Minh City Workshop 12-13 July 1999

DORIS Network



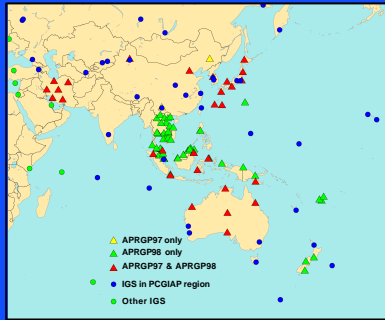
AUSLIG PCGIAP WG1 Ho Chi Minh City Workshop 12-13 July 1999

APRGP98 GPS Network



AUSLIG PCGIAP WG1 Ho Chi Minh City Workshop 12-13 July 1999

APRGP 97/98 GPS Networks



AUSLIG PCGIAP WG1 Ho Chi Minh City Workshop 12-13 July 1999

APRGP98 GPS Data Assembly

- Regional raw or RINEX data supplied to AUSLIG
 - ◆ FTP
 - ◆ Attached files to email
 - ◆ CD-ROM/diskettes via post/courier
- Raw data converted to RINEX
- CD-ROM copies of RINEX data prepared and distributed by AUSLIG

AUSLIG PCGIAP WG1 Ho Chi Minh City Workshop 12-13 July 1999

APRGP98 Data Availability

- GPS data on CD-ROM from AUSLIG
 - ◆ Distributed to 9 participating countries
- Proposal for GPS data to be lodged with APSG data centre and made available to non-PCGIAP users
- SLR data & VLBI results on line at CDDIS
- DORIS data available from CNES on request

AUSLIG PCGIAP WG1 Ho Chi Minh City Workshop 12-13 July 1999

Outcomes

- Increased number of participating countries and sites
- Improved precise ITRF coordinates for regional geodetic network
- A 2nd single epoch snapshot
- Initial values for site velocities
- Densification of regional network
- Links to sites in local datums enabling derivation of datum transformations
- Links to vertical datum (tide gauge sites)

AUSLIG PCGIAP WG1 Ho Chi Minh City Workshop 12-13 July 1999

Analysis of APRGP98 GPS data set by GSI

Shigeru Matsuzaka, Akiko Yamada and
Shoichi Matsumura
Geographical Survey Institute (GSI),
Japan

Abstract

Positions of 88 campaign sites were estimated by GAMIT and GLOBK software. With a few exceptions final positional rms are better than a few mm.

Data set

Data from 88 campaign sites with 37 IGS stations were processed for days 323 through 332, 1998(Figure 1), prepared and supplied in a CD-ROM by AUSLIG.

Computation Strategy

Firstly, GPS data were processed using GAMIT ver. 9.81 for each day and for each cluster. GLOBK ver. 5.02 was employed to combine the clusters and get the final solution.

GAMIT processing

Campaign sites were divided into 8 clusters with appropriate IGS stations as the maximum number of stations handled by GSI's GAMIT is limited (Table 1). Initial values for the analysis were calculated by an analysis with 1 iteration. Final solution was obtained by 0 iteration. Constraints were 1.0m for IGS points and 100.0m for campaign sites.

In the calculation, satellite positions were also estimated and tropospheric zenith delay was approximated by a piece-wise linear function every 2 hours. Phase characteristics of GPS antenna was corrected by IGS_01 and NGS values.

Detailed setup for the analysis is in Table 2.

GLOBK processing

To get the global solution, cluster solutions were combined with the SIO's global solution. Station constraint was 1.0cm for 48 IGS stations, which constitute ITRF96 frame.

For the final combined solution at epoch 1998.8830, see Table 3. **** shows sigma could not be computed (or too large).

Conclusions

Positions of most campaign sites were determined better than last year's results. Combination with SIO global network apparently worked for the better. Several stations show no rms in the final solution which was reduced to an epoch, whereas daily solutions indicate no large errors. The reason is that for those stations the data were not available for 1/2 of the campaign period and running GLOBK over the available data period would give us reasonable sigmas.

For the future analysis, velocities of the sites will be estimated quite accurately using this year's (1999) and past campaign data.

References

Massachusetts Institute of Technology, Scripps Institution of Oceanography, Documentation for the GAMIT GPS Analysis Software, Release 9.6, 1997. and GLOBK Documentation, version 4.1, 1997.

Working Group 1 – Regional Geodetic Network of the Permanent Committee on GIS Infrastructure for Asia and the Pacific, Proceedings of the Workshop on Regional Geodetic Network, 2-4 July 1998 Canberra, Australia, 1998.

Figure 1. GPS sites for GAMIT processing

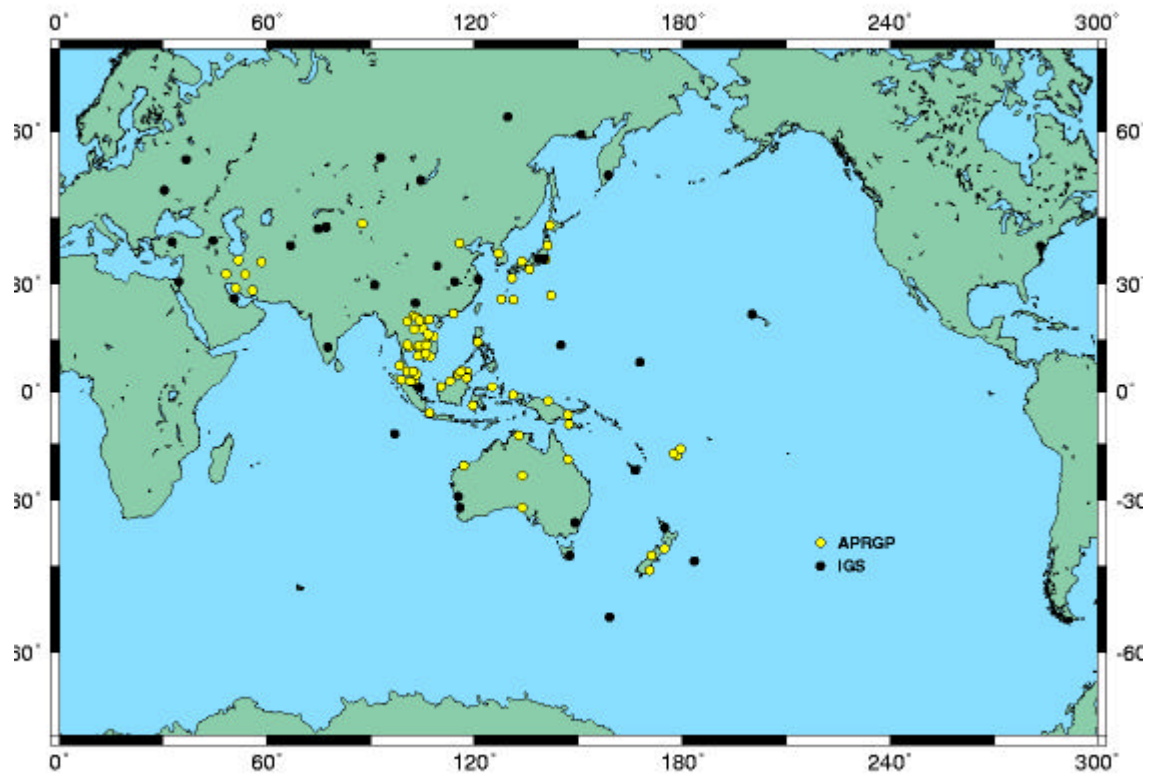


Table 1. Clusters for GAMIT processing

CLUSTER	A	B	C	D		E	F	G	H
APRGP	LADA	BEIJ	0029	PHON	SIHA	MMA8	ALIC	OUSD	SUVA
Site	MARI	SUWN	0073	SAMN	QT04	RP01	BAKO	HOKI	VANU
	NILO	URMQ	0745	HOUA	PHUK	TAWA	CEDU	WGTN	VITI
	REIH	URUM	0746	QT01	DOP5	T012	JAB1		
	ROSE		2001	QT02	TGET	D001	KARR		
	YAS1		2003	VIEN	DOP4	TKIN	LAE1		
			2004	LAKX	KUAL	D005	MORE		
			3009	PHUT	DOP3	MSAN	PARE		
			6006	CTY3	DOP1	MLAB	PBIT		
			BEIJ	KHON	TKLA	MTAW	PDAY		
				STUE	SAMP	D004	TOW2		
				SIEM	SMU1	TKUC	VANI		
				CHUL	TG75	T030	PSOR		
				RTSD	CCBS	MKUC			
				CHON	DOP2	PDAY			
				LAND	P075	BAKO			
				PENH	SVAY	LABG			
						P075			
IGS	Bahr	Sele	guam	ntus		Guam	Coco	auck	auck
Site	Glsv	Pol2	irkt	kunm		Ntus	Guam	chat	chat
	Kit3	Usna	mag0	iisc		Wuhn	Hob2	hob2	kokb
	Ankr	lisc	petp	wuhn		Shao	Kwj1	tid2	kwj1
	Nssp	Kstu	shao			Kunm	Noum	mac1	noum
	Pol2	Lhas	tskb			Coco	Pert	noum	
	Ramo	Irkt	usud				Tid2		
	Sele	Kunm	wuhn				Yar1		
	Usna	Xian	xian						
	Zwen	Wuhn	yaka						
		Shao							
		Uram							

Table 2. Session Table for GAMIT processing

Processing Agency = GSI

Station Number = *

Satellite Number = *

Station Constraint = Y ; Y/N

Satellite Constraint = Y ; Y/N (next two lines are free-format but 'all' must be present)

all a e i n w M rad1 rad2 rad3 rad4 rad5 rad6 rad7 rad8 rad9;

10000.0 10000.0 10000.0 10000.0 10000.0 10000.0 0.001 0.001 0.001 0.001 0.001

0.001 0.001 0.001 0.001

Type of Analysis = 0-ITER ; PREFIT / QUICK / 0-ITER/1-ITER/2-ITER

Data Status = RAW ; RAW/CLN

Final ARC = YES
Choice of Observable = LC_HELP ; L1_SINGLE/L1&L2/L1_ONLY/L2_ONLY/LC_ONLY/
; L1,L2_INDEPEND./LC_HELP
Choice of Experiment = RELAX. ; BASELINE/RELAX./ORBIT

Measurement Error = 10.0 mm + 0.00 ppm
Ionospheric Constraints = 0.0 mm + 8.00 ppm
Zenith Delay Estimation = YES ; YES/NO
Number Zen = 13 ; number of zenith-delay parameters
Zenith Constraints = 0.50 ; zenith-delay a priori constraint in meters (default 0.5)
Zenith Model = PWL ; PWL (piecewise linear)/CON (step)
Zenith Variation = 0.02 100. ; zenith-delay variation, tau in meters/sqrt(hr), hrs (default .02 100.)
Ambiguity resolution WL = 0.15 0.15 1000. 10. 1000. ; FIXDRV, SOLVE > 9.26 defaults (last entry is max baseline)
Ambiguity resolution NL = 0.15 0.15 1000. 10. 1000. ; FIXDRV, SOLVE > 9.26 defaults
Reference System for ARC = IGS92 ; WGS84/WGS72/MERIT/IGS92(default)
Yaw Model = YES ; YES/NO default = YES
Radiation Model for ARC = BERNE
Inertial frame = J2000

Notes:

PREFIT : Prefit manipulations including cleaning (no solution)
QUICK : Quick solution
0-ITERATION : Full solution with good prior station coordinates and orbits
1-ITERATION : Full solution with approximate prior station coordinates
2-ITERATION : Full solution with approximate prior station coordinates and orbits
Data Status : RAW for automatic editing with AUTCLN; CLN (CLEAN) for no editing

Optional controls:

Inertial frame = J2000 ; B1950/J2000 (default = B1950)
Initial ARC = YES ; YES/NO default = NO for BASELINE/KIINEMATIC, YES for RELAX/ORBIT
Final ARC ; YES/NO default = YES
Radiation Model for ARC ; SPHRC/BERNE/SRDYB/SVBDY default = BERNE
Reference System for ARC ; WGS72/WGS84/MERIT/IGS92 (default = IGS92)
Tabular interval for ARC ; 900. seconds (new default), 1350. seconds (old default)
Stepsize for ARC ; 75. seconds (new default), 168.75 seconds (old default)
Earth Rotation ; Diurnal/Semidirunal terms: Binary coded: 1=pole 2=UT1 default=3
Estimate EOP ; Binary coded: 1 wob 2 ut1 4 wob rate 8 ut1 rate
Wobble Constraint = 3. 0.3 ; Default 3. (arcsec) 0.3 (arcsec/day)
UT1 Constraint = 0.00002 0.02 ; Default .00002 (sec) 0.02 (sec/day)
Number Zen = 13 ; number of zenith-delay parameters (default 1)
Zenith Constraints = 0.50 ; zenith-delay a priori constraint in meters (default 0.5)
Zenith Model = PWL ; PWL (piecewise linear)/CON (step)
Zenith Variation = 0.02 100. ; zenith-delay variation, tau in meters/sqrt(hr), hrs (default .02 100.)
Tropospheric Constraints = NO ; YES/NO (spatial constraint)
Antenna Model = ELEV ; NONE/ELEV/AZEL default = NONE
Tide Model ; Binary coded: 1 earth 2 freq-dep 4 pole 8 ocean default = 1
Yaw Model ; YES/NO default = YES
Clean Option ; SINCLN/AUTCLN(default)/DBLCLN

AUTCLN Command File ; Filename; default none (use default options)
 Edit AUTCLN Command File ; YES/NO; default = NO
 Iteration = XFILES ; CFILES / XFILES (default)
 Ambiguity resolution WL ; default = 0.15 0.15 1000. 10.
 Ambiguity resolution NL ; default = 0.15 0.15 1000. 10.
 Type of Biases : IMPLICIT (default for quick), EXPLICIT (default for full)
 H-file solutions ; ALL ; LOOSE-ONLY
 Select Epochs ; Enter start and stop epoch number (applies only to SOLVE)
 Export Orbits ; YES/NO default = NO
 Orbit id ; 4-char code read only if Export Orbits = YES
 Orbit Format = SP3 ; SP1/SP3 (NGS Standard Products)
 Orbit organization ; 3-char code read only if Export Orbits = YES
 Reference System for Orbit = ITR96 ; ITR92/ITR91/ITR90/WGS84/MERIT (for SP3 header)
 Delete all input C-files ; YES/NO default = NO
 Delete MODEL input C-files ; YES/NO default = NO
 Delete SINCLN input C-files ; YES/NO default = NO
 Delete DBLCLN input C-files ; YES/NO default = NO
 Delete AUTCLN input C-files ; YES/NO default = NO
 Update T/L files ; T_AND_L (default), T_ONLY, L_ONLY, NONE
 (Applies only to update for full solution after quick)
 SOLVE-only = NO ; YES/NO default = NO
 X-compress = YES ; Uncompress/compress X-files default = NO
 SCANDD control ; FULL (default), FIRST, BOTH, IFBAD, NONE
 Run CTOX = YES ; Make clean X-files from C-files default = NO

Table 3. ITRF96 coordinates at 1998.883

Site	X	Y	Z	dX	dY	dZ
0029	-3862395.5092	3105010.5295	4001962.4125	0.0015	0.0014	0.0013
0073	-3591893.3734	3758832.9256	3682342.8500	0.0016	0.0015	0.0013
0745	-3512919.4392	4524558.2087	2795882.4739	0.0014	0.0015	0.0010
0746	-3786805.5578	4311845.8324	2774485.1476	0.0013	0.0014	0.0010
2001	-3642148.5560	2861482.2362	4370365.6556	0.0016	0.0015	0.0015
2003	-4488925.8241	3483902.9209	2887743.1782	0.0018	0.0017	0.0012
2004	-3565271.3203	4118973.2471	3306293.3910	0.0015	0.0016	0.0011
3009	-3997615.4135	3276762.6553	3724230.5250	0.0013	0.0011	0.0011
6006	-3822373.3725	3699359.8887	3507585.8179	0.0012	0.0012	0.0010
ALBH	-2341332.8971	-3539049.5124	4745791.3607	0.0012	0.0014	0.0015
ALGO	918129.4792	-4346071.2354	4561977.8212	0.0008	0.0008	0.0007
ALIC	-4052051.9274	4212836.1061	-2545105.7533	0.0025	0.0026	0.0015
AMC2	-1248596.0953	-4819428.2346	3976506.0239	0.0013	0.0016	0.0013
ANKR	4121948.5803	2652187.9517	4069023.6812	0.0027	0.0024	0.0024
AOML	9 82296.7925	-5664607.2196	2752614.4717	0.0016	0.0024	0.0013
ARAU	-1131051.8065	6236311.7433	711748.1587	0.0068	0.0097	0.0027
AREQ	1942826.7521	-5804070.2433	-1796893.9565	0.0010	0.0010	0.0008
ASC1	6118526.0671	-1572344.7070	-876451.1702	0.0053	0.0047	0.0017
AUCK	-5105681.0643	461564.0376	-3782181.7094	0.0017	0.0015	0.0012
BAHR	3633909.0096	4425275.5028	2799861.3162	0.0015	0.0017	0.0011
BAKO	-1836969.0006	6065617.1656	-716257.7988	0.0016	0.0022	0.0008
BEIJ	-2148743.8819	4426641.2907	4044655.9382	0.0008	0.0010	0.0009
BINT	-2495021.2760	5858781.6185	360450.7240	0.0021	0.0032	0.0009
BOGT	1744399.0952	-6116037.7545	512731.6303	0.0041	0.0069	0.0016
BRMU	2304703.5726	-4874817.1779	3395186.9020	0.0008	0.0009	0.0007
CAS1	-901776.1709	2409383.3907	-5816748.4365	0.0021	0.0021	0.0030
CCBS	-1538174.7856	6188130.2844	148379.5216	0.0033	0.0065	0.0012
CEDU	-3753472.3393	3912741.0052	-3347960.7915	0.0013	0.0013	0.0010
CHAT	-4590670.9751	-275482.9324	-4404596.7506	0.0019	0.0016	0.0016
CHON	-1190208.2732	6097682.7588	1438406.3144	*****	*****	*****
CHUL	-1132728.3146	6092488.3431	1504562.0385	0.0027	0.0049	0.0017
COCO	-741950.0904	6190961.6411	-1337768.5045	0.0017	0.0025	0.0010
CRO1	2607771.1831	-5488076.7518	1932767.6932	0.0029	0.0047	0.0019
CTY3	-1916790.9985	5822974.9562	1754668.7883	0.0040	0.0060	0.0022
D001	-2702793.0640	5747549.3886	583412.6895	0.0021	0.0028	0.0009
D004	-2984273.5990	5617687.2785	469697.2105	0.0022	0.0028	0.0009
D005	-2827033.5722	5673602.9816	705604.6287	0.0022	0.0030	0.0009
DAV1	486854.5536	2285099.2855	-5914955.7059	0.0009	0.0008	0.0010
DGAR	1916269.6996	6029977.3531	-801720.1358	0.0038	0.0052	0.0014
DOP1	-1263943.4383	6242702.9554	334310.4383	*****	*****	*****
DOP2	-1500246.2447	6197397.9712	152195.8659	*****	*****	*****
DOP3	-1391259.0474	6212965.4812	382801.3331	*****	*****	*****
DOP4	-1353514.1669	6196995.4819	666524.9894	*****	*****	*****
DOP5	-1143197.9677	6237895.1397	677621.3019	*****	*****	*****
DRAO	-2059164.7059	-3621108.3929	4814432.3671	0.0008	0.0008	0.0008
EISL	-1884951.6351	-5357595.9259	-2892890.5328	0.0035	0.0044	0.0026
ELAT	4555028.8160	3180067.2562	3123164.3239	0.0030	0.0025	0.0020
FAIR	-2281621.4673	-1453595.7949	5756961.9014	0.0008	0.0008	0.0009
FORT	4985386.6375	-3954998.5864	-428426.4740	0.0010	0.0010	0.0008
GALA	-33796.0176	-6377522.6517	-82120.8926	0.0054	0.0080	0.0022
GLSV	3512889.0833	2068979.7995	4888903.1337	0.0011	0.0010	0.0012
GOL2	-2353614.1975	-4641385.3717	3676976.4398	0.0008	0.0008	0.0008
GUAM	-5071312.7858	3568363.5127	1488904.3211	0.0009	0.0008	0.0006
HARK	5084625.3000	2670366.2648	-2768494.5322	0.0009	0.0009	0.0008
HOB2	-3950071.4443	2522415.1946	-4311638.2926	0.0007	0.0007	0.0006
HOKI	-4635697.0015	735523.1692	-4304158.6735	0.0022	0.0019	0.0018
HOUA	-1084448.8616	5887162.2572	2195042.9803	0.0024	0.0040	0.0018
HRAO	5085352.4902	2668395.7131	-2768731.6702	0.0028	0.0023	0.0016
IISC	1337936.7392	6070317.1023	1427876.5693	0.0022	0.0033	0.0013
IRKT	-968332.2295	3794425.4167	5018167.7401	0.0007	0.0007	0.0007
JAB1	-4236442.8889	4559929.5930	-1388624.5433	0.0057	0.0058	0.0023
JPLM	-2493304.2440	-4655215.4168	3565497.4028	0.0015	0.0017	0.0013
KARR	-2713832.3599	5303935.1101	-2269514.9270	0.0014	0.0020	0.0010

KELY	1575559.2526	-1941827.9265	5848076.5037	0.0014	0.0015	0.0024
KERG	1406337.3352	3918161.1007	-4816167.3870	0.0009	0.0009	0.0009
KHON	-1689963.9142	5951481.6569	1545756.3183	0.0025	0.0044	0.0015
KINA	-2785188.8132	5700556.6867	651770.7049	0.0021	0.0027	0.0009
KIT3	1944945.3131	4556652.2214	4004325.9798	0.0008	0.0008	0.0008
KOKB	-5543838.1244	-2054587.1379	2387809.7631	0.0009	0.0009	0.0008
KOSG	3899225.2352	396731.8524	5015078.3622	0.0008	0.0008	0.0008
KOUR	3839591.4263	-5059567.5409	579956.9441	0.0010	0.0010	0.0008
KSTU	-174281.7633	3571333.0275	5264196.0456	0.0011	0.0014	0.0016
KUAL	-1443668.1851	6184650.1406	587309.9591	0.0029	0.0058	0.0012
KUAN	-1469474.1863	6192002.2164	423675.2171	0.0030	0.0062	0.0012
KUNM	-1281255.3814	5640745.4483	2682879.7720	0.0012	0.0019	0.0011
KWJ1	-6160880.9644	1339883.0923	960810.5142	0.0009	0.0009	0.0007
LABG	-1836967.2874	6065621.6794	-716219.2841	0.0016	0.0025	0.0008
LADA	3151871.9072	4654363.3586	3005669.3058	0.0016	0.0019	0.0013
LAE1	-5312857.0464	3451108.0180	-736322.8086	0.0020	0.0018	0.0007
LAKX	-1567312.5754	5855889.6313	1978061.4495	0.0022	0.0039	0.0016
LAND	-1608477.0341	6039324.1807	1268553.6835	*****	*****	*****
LHAS	-106937.7485	5549269.5842	3139215.7800	0.0008	0.0009	0.0007
LPGS	2780102.9761	-4437418.8777	-3629404.5891	0.0032	0.0040	0.0029
MAC1	-3464038.5438	1334172.7870	-5169224.2955	0.0008	0.0008	0.0008
MAD2	4849202.4570	-360329.0765	4114913.1312	0.0008	0.0008	0.0008
MAGO	-2825810.1836	1581232.9374	5477005.5089	0.0013	0.0012	0.0014
MALI	4865366.4712	4110737.4889	-331121.6980	0.0010	0.0010	0.0008
MARI	3205584.5067	4075347.1097	3705004.7645	0.0014	0.0016	0.0013
MAS1	5439192.2660	-1522055.5913	2953454.7395	0.0009	0.0009	0.0007
MAW1	1111287.1669	2168911.2634	-5874493.6148	0.0025	0.0029	0.0061
MCM4	-1311703.2380	310815.0622	-6213255.0946	0.0016	0.0017	0.0033
MKEA	-5464105.0989	-2495166.7730	2148290.9899	0.0054	0.0036	0.0024
MKUC	-2200986.1293	5983687.1578	180479.6867	0.0020	0.0030	0.0008
MLAB	-2708733.1380	5744690.9253	583321.4246	0.0021	0.0028	0.0009
MMA8	-3177117.9770	5293321.2060	1597132.9944	0.0022	0.0028	0.0010
MORE	-5288524.5903	3409956.1502	-1038575.0963	0.0019	0.0017	0.0007
MSAN	-2990750.4182	5596338.0810	644936.6541	0.0022	0.0028	0.0009
MTAW	-2974552.4746	5622306.1716	470932.6386	0.0022	0.0028	0.0009
NILO	3582731.9569	4026235.5148	3399695.7110	0.0016	0.0018	0.0013
NOUM	-5739971.5848	1387563.6311	-2402123.4841	0.0016	0.0013	0.0009
NRC1	1112777.3031	-4341475.8213	4522955.7734	0.0011	0.0015	0.0014
NSSP	3478646.8030	3418805.7685	4097987.1419	0.0016	0.0017	0.0015
NTUS	-1508022.7304	6195576.6837	148799.4670	0.0021	0.0037	0.0009
NYA1	1202433.9441	252632.2525	6237772.5237	0.0016	0.0015	0.0036
NYAL	1202430.6206	252626.6697	6237767.5184	0.0009	0.0009	0.0010
ONSA	3370658.6472	711877.0595	5349786.8812	0.0007	0.0008	0.0008
OUSD	-4387888.5797	733420.9401	-4555178.5342	0.0019	0.0017	0.0016
P075	-2408855.2473	5391043.2202	2403591.1180	0.0014	0.0020	0.0010
PARE	-3147782.6561	5529856.7739	-439535.5626	0.0017	0.0021	0.0008
PBIT	-3674851.2963	5210705.1064	159398.6834	0.0022	0.0025	0.0008
PDAY	-1841390.7001	6069118.9473	-672984.8845	0.0017	0.0026	0.0009
PENH	-1608754.6428	6038688.1737	1271254.5475	0.0025	0.0047	0.0014
PERT	-2368687.0694	4881316.5341	-3341796.0823	0.0007	0.0008	0.0006
PETP	-3576239.7694	1401003.4679	5075177.5016	0.0016	0.0013	0.0017
PHON	-1243325.3269	5798971.2532	2342488.9092	0.0023	0.0037	0.0018
PHUK	-912741.8971	6253870.4040	855385.4029	*****	*****	*****
PHUT	-1736467.2930	5861984.6182	1812076.4026	0.0024	0.0041	0.0016
POL2	1239971.5411	4530790.0812	4302578.7832	0.0010	0.0012	0.0010
POTS	3800689.7579	882077.3009	5028791.2592	0.0007	0.0008	0.0008
PRDS	-1659602.8671	-3676725.7551	4925493.5972	0.0012	0.0014	0.0015
PSOR	-4204738.1908	4795031.9561	-97013.0657	0.0027	0.0027	0.0008
QT01	-1339427.1836	5788402.7022	2313168.9175	0.0273	0.0350	0.0120
QT02	-1724394.2887	5714553.7082	2239923.5526	0.0022	0.0037	0.0016
QT04	-1843711.8714	5998027.5983	1138672.7531	0.0027	0.0051	0.0014
RAMO	4514722.0008	3133507.7735	3228024.5957	0.0023	0.0023	0.0017
REIH	3509963.7372	4347105.4961	3066072.1904	0.0016	0.0019	0.0013
REYK	2587384.4612	-1043033.4930	5716563.9781	0.0015	0.0015	0.0022
ROSE	3185578.8536	4356094.3736	3390474.9451	0.0014	0.0017	0.0013
RP01	-3184192.2859	5291065.9123	1590599.1666	0.0021	0.0028	0.0010
RTSD	-1129962.1806	6092333.4168	1507233.0105	0.0027	0.0051	0.0018

SAMN	-1451207.6082	5801837.9607	2211983.0074	0.0022	0.0037	0.0017
SAMP	-964465.0175	6291997.2248	400195.8855	0.0032	0.0062	0.0013
SANT	1769693.3806	-5044574.1602	-3468321.0471	0.0010	0.0009	0.0009
SCH2	1448636.8866	-3385243.6532	5191046.9568	0.0012	0.0014	0.0017
SELE	1046790.7856	4540257.0748	4342920.7608	0.0010	0.0013	0.0012
SHAO	-2831733.3188	4675666.0243	3275369.4943	0.0007	0.0007	0.0006
SIEM	-1481813.4490	6025851.6353	1469486.6457	0.0025	0.0044	0.0015
SIHA	-1466153.4671	6095949.2196	1166708.1413	0.0026	0.0048	0.0014
SMU1	-1531685.1865	6189736.2414	148233.2192	0.0033	0.0066	0.0012
STJO	2612631.2066	-3426807.0176	4686757.8089	0.0013	0.0014	0.0015
STUE	-1706562.2206	5962886.4273	1482541.1777	0.0025	0.0045	0.0015
SUTH	5041274.8059	1916054.0268	-3397076.0573	0.0031	0.0025	0.0019
SUVA	-6060677.0845	166617.3319	-1973761.6450	0.0067	0.0069	0.0034
SUWN	-3062022.7072	4055448.0805	3841818.3213	0.0009	0.0010	0.0009
SVAY	-1703381.9963	6023545.6304	1218999.5047	0.0026	0.0049	0.0014
T012	-2496815.4799	5858477.2443	355737.7104	0.0020	0.0029	0.0009
T030	-2203525.8154	5982977.7670	175363.8076	0.0019	0.0030	0.0008
TAEJ	-3120422.9710	4086355.4342	3761769.5956	0.0020	0.0022	0.0019
TAWA	-2984278.9454	5617684.1030	469695.7510	0.0021	0.0026	0.0009
TG75	-1532153.6402	6189689.5266	146655.2784	0.0057	0.0099	0.0016
TGET	-1329733.0676	6199766.6323	687129.5603	*****	*****	*****
THU1	538981.3924	-1388714.7900	6181005.1296	0.0007	0.0007	0.0009
TID2	-4460996.2025	2682557.0688	-3674443.6131	0.0008	0.0007	0.0006
TKIN	-2790190.3353	5697101.1191	660474.5489	0.0021	0.0029	0.0009
TKLA	-1254411.5880	6244432.4112	336712.3506	*****	*****	*****
TKUC	-2224775.5461	5975001.0365	175039.3493	0.0019	0.0029	0.0008
TOW2	-5054582.7769	3275504.4286	-2091539.6172	0.0019	0.0016	0.0009
TRO1	2102928.5920	721619.4082	5958196.1967	0.0013	0.0014	0.0024
TSKB	-3957199.2280	3310199.6796	3737711.6834	0.0008	0.0008	0.0007
TTAW	-2974504.0254	5622478.6613	469019.0876	0.0022	0.0028	0.0009
URMQ	193030.8235	4606851.3367	4393311.4329	0.0009	0.0015	0.0013
URUM	193030.8228	4606851.3215	4393311.4183	0.0009	0.0015	0.0013
USNA	1160668.8432	-4826883.1748	3990863.0254	0.0483	0.0443	0.0388
USUD	-3855262.9935	3427432.5293	3741020.3457	0.0011	0.0010	0.0009
VANI	-4972631.1820	3983209.0100	-296767.0708	0.0019	0.0018	0.0007
VANU	-6119100.8818	62728.3072	-1792699.8533	0.0074	0.0076	0.0037
VIEN	-1314797.6284	5923043.6469	1961129.5762	0.0024	0.0040	0.0017
VITI	-6073527.5924	276502.0282	-1921630.3011	0.0066	0.0067	0.0033
WES2	1492233.3619	-4458089.4772	4296046.0036	0.0008	0.0008	0.0007
WGTN	-4777269.3944	434270.0336	-4189484.6032	0.0029	0.0025	0.0022
WHIT	-2218337.8400	-2201205.1078	5543057.5752	0.0012	0.0012	0.0018
WSRT	3828735.9788	443304.8701	5064884.6467	0.0014	0.0013	0.0016
WTZR	4075580.6667	931853.7001	4801568.0552	0.0007	0.0007	0.0007
WUHN	-2267749.2212	5009154.3254	3221290.7427	0.0008	0.0011	0.0008
XIAN	-1735212.5624	4976840.1089	3580538.3488	0.0009	0.0012	0.0009
YAKA	-1915023.2826	2308213.2394	5610224.9747	0.0013	0.0013	0.0018
YAKZ	-1915023.2859	2308213.2347	5610224.9740	0.0013	0.0012	0.0017
YAR1	-2389025.6300	5043316.8837	-3078530.6478	0.0007	0.0008	0.0006
YAS1	2726445.1108	4442816.4890	3665092.3267	0.0013	0.0015	0.0013
YELL	-1224452.5303	-2689216.1075	5633638.2745	0.0008	0.0007	0.0009
ZWEN	2886325.5147	2155998.4294	5245816.1431	0.0007	0.0007	0.0007

ASIA-PACIFIC REGIONAL GEODETIC PROJECT 1998. Global Positioning System (GPS) – Solutions.

Ramesh Govind, John Dawson and Geoff
Luton
Australian Surveying and Land Information
Group
Canberra, Australia

1. Data

Figure 1 shows the global distribution of IGS and APRGP98 GPS stations.

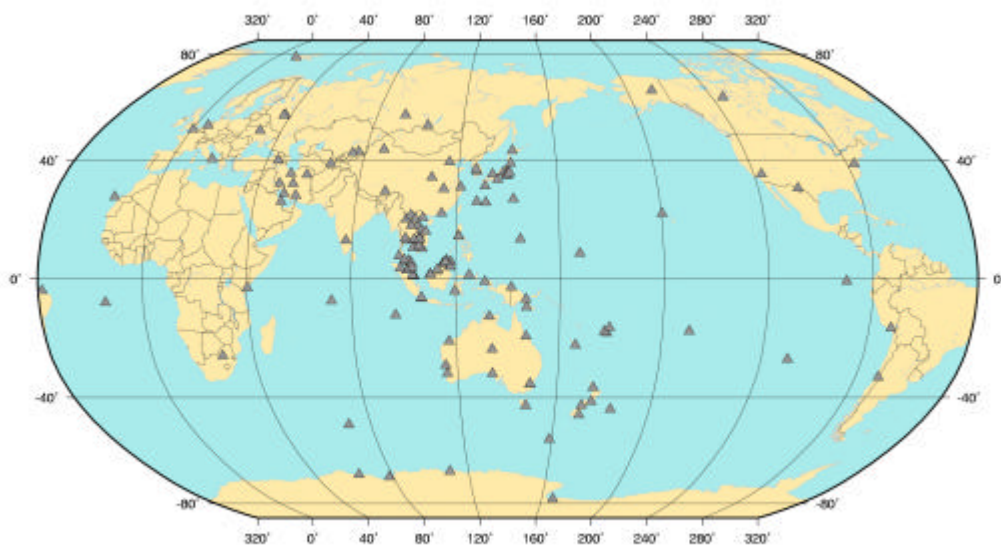


Figure 1: Distribution of IGS and APRGP98 GPS stations.

2. GPS Computation Procedure / Computation Standards

The AUSLIG data processing procedure is the full implementation of the IERS Conventions 1996 (McCarthy, 1996).

Ten days of GPS solutions were computed using ~38 IGS GPS stations distributed globally. Six regional solutions were computed, for convenience these regional solutions were separated into the following station sets:

- Iran and China;
- Cambodia, Vietnam, Thailand and Laos;
- Malaysia;
- Singapore, Hong Kong, Philippines and Indonesia;
- Japan; and
- Australia, Papua New Guinea and Fiji;

Measurement Modelling

OBSERVABLE	Carrier phase Pseudo-range for receiver clocks only 20° Elevation cut-off 30 second sampling rate
IONOSPHERE	Ionosphere corrected L1 double difference
TROPOSPHERE	Modified Hopfield

Orbit Modelling

Earth's Gravitational (Static) Potential Model	JGM-3 – degree and order 12
Solid Earth Tides (Dynamic) Potential	Love Model
Ocean Tide (Dynamic) Potential	Christodoulidis
Third Body Perturbations	Sun, Moon and Planets Values for physical constants – AU, Moon/Earth mass ratio, GM (moon, sun and planets) from JPL DE403 Planetary Ephemeris.
Direct Solar Radiation Pressure	ROCK
Centre of Mass Correction / Attitude	Observation Correction applied

Station Position Modelling / Reference Frame

Precession	IAU76/IERS96
Nutation	IAU80/IERS96 (including epsilon and psi corrections)
Sine terms added to accumulated precession and nutation in Right Ascension	As in IERS TN 21, p. 21
Geodesic Nutation	As in IERS TN 21, p.37
Polar Motion	Bulletin B – apriori
Earth Rotation (UT1)	Bulletin B – apriori
Daily and Sub-daily tidal corrections to X,Y and UT1	Applied
Plate Motion	ITRF96
Planetary and Lunar Ephemeris	JPL DE403
Station Displacement – Solid earth Tide Loading	Williamson and Diamante (1972) + Wahr (1980) for the frequency dependent elastic response of the Earth's fluid interior
Station Displacement – Ocean Tide Loading	Scherneck (1991)
Station Displacement – Pole Tide	Applied as a default
Station Displacement – Atmospheric Loading	NIL
Reference Frame –	ITRF96

3. Estimated Parameters

For a one 24 hour arc, the following global and arc parameters were estimated.

Global:

- Station Coordinates
- Daily UT [A1-UT1] and pole.

Arc Parameters:

- State vector for all satellites
- One Solar Radiation Pressure scale factor
- Y-Bias – constant, once per revolution sine and cosine of the period.
- Ambiguities/Cycle slips (Ambiguities estimated as real numbers)
- Troposphere every 2 hours per station

4. Results

Table 2. RMS differences (m) between AUSLIG orbit and IGS final product.

GPSWEEK	X	Y	Z	Radial	Along	Cross
09844:	0.227	0.214	0.217	0.094	0.274	0.246
09845:	0.265	0.250	0.240	0.086	0.316	0.289
09846:	0.224	0.210	0.197	0.081	0.251	0.251
09850:	0.193	0.216	0.182	0.061	0.228	0.247
09851:	0.289	0.245	0.247	0.100	0.324	0.300
09852:	0.224	0.234	0.230	0.098	0.275	0.270
09853:	0.221	0.228	0.241	0.097	0.271	0.275
09854:	0.176	0.180	0.189	0.075	0.222	0.209
09855:	0.204	0.186	0.187	0.077	0.232	0.227
09856:	0.201	0.175	0.190	0.074	0.224	0.226

Table 3. Station coordinate difference between AUSLIG SSC and ITRF96.

ID	dX(mm)	dY(mm)	dZ(mm)	dE(mm)	dN(mm)	dU(mm)
AREQ	2.8	18.3	-0.9	8.4	-5.5	-15.5
CAS1	-9.3	2.9	-12.3	7.7	0.5	13.7
CHAT	-9.4	3.1	3.3	-3.7	8.7	4.3
COCO	-7.1	8.9	7.8	6.0	9.6	7.8
DAV1	8.2	5.1	-18.4	-6.9	-0.4	19.6
DGAR	30.4	21.1	-0.4	-22.5	3.3	29.1
EISL	1.7	28.7	8.3	-8.0	-5.2	-28.4
FAIR	-2.8	-1.5	5.6	-0.2	-0.5	6.4
FORT	-1.8	10.7	2.5	7.3	1.9	-8.3
GALA	-9.3	-30.6	-0.8	-9.2	-0.4	30.6
GODE	-4.2	-6.5	7.9	-5.5	2.7	9.2
GOLD	5.2	1.9	-2.9	3.8	0.0	-5.0
GUAM	4.5	1.1	0.6	-3.5	1.3	-2.9
HERS	3.3	1.3	6.6	1.3	1.6	7.2
HOB2	-1.9	-0.3	7.6	1.2	6.5	-4.1

HRAO	24.3	-25.7	1.3	-34.0	5.3	8.1
IRKT	0.5	-1.7	-3.7	-0.1	-0.9	-4.0
KERG	8.7	1.7	-0.7	-7.6	3.0	3.5
KOKB	5.3	2.5	-1.4	-0.5	1.0	-6.0
KWJ1	10.8	17.2	-8.0	-19.1	-6.8	-8.1
LHAS	0.7	-4.0	7.6	-0.7	8.6	0.3
MAC1	-8.6	-9.4	1.0	11.9	4.4	1.9
MALI	11.7	8.4	-2.6	-1.2	-1.8	14.5
MAS1	7.2	-16.1	20.3	-13.5	12.7	19.4
MATE	-6.8	0.5	0.7	2.4	4.7	-4.3
MDO1	4.0	-5.7	1.2	5.3	-1.3	4.6
NOUM	-7.0	-0.3	8.8	1.9	10.7	2.9
NTUS	-0.7	28.4	-2.4	-6.1	-3.1	27.6
NYAL	-7.1	1.6	-25.4	3.1	1.6	-26.2
SANT	4.0	4.5	-5.9	5.2	-6.5	0.8
SHAO	-0.3	0.5	1.3	0.0	0.8	1.2
TIDB	-3.7	3.4	2.7	-1.0	5.1	2.5
TSKB	0.0	-6.1	-8.2	4.7	-4.3	-8.0
WUHN	2.7	-22.9	-7.0	7.0	5.1	-22.5
YAR1	-12.9	11.0	-2.7	6.9	5.2	14.8
YELL	5.1	1.6	-5.5	4.0	0.6	-6.6
RMS	8.9	12.7	8.0	9.4	5.1	13.8

5. Summary

The AUSLIG Orbit matches the IGS final product at the 7-10cm in the radial direction. The AUSLIG global SSC compared to the NCL (IGS-GNAAC) matches at 9,5,14 mm rms (E,N,U). The daily coordinate repeatability is 13,5,21 mm (E,N,U). Overall the ten day solution has a < 1cm horizontal accuracy and ~ 1cm vertical accuracy.

This APRGP is excellent data set that is making important contributions towards reference frame densification in the region. Station velocities to be computed soon and third campaign will make valuable contribution to this process. The estimate coordinates are given in Appendix A.

Appendix A Final coordinates APRGP98 (ITRF96 @1998.90).

STATION	ITRF96-X	ITRF96-Y	ITRF96-Z
GOLD	-2353614.206	-4641385.381	3676976.429
YELL	-1224452.534	-2689216.114	5633638.262
FAIR	-2281621.472	-1453595.799	5756961.883
KOKB	-5543838.134	-2054587.141	2387809.744
GUAM	-5071312.791	3568363.521	1488904.304
KWJ1	-6160880.967	1339883.103	960810.485
GODE	1130773.844	-4831253.584	3994200.397
MDO1	-1329998.695	-5328393.395	3236504.170
TIDB	-4460996.195	2682557.085	-3674443.634
HOB2	-3950071.435	2522415.209	-4311638.310
YAR1	-2389025.629	5043316.902	-3078530.665
TOW2	-5054582.743	3275504.419	-2091539.627
KARR	-2713832.340	5303935.101	-2269514.928
CEDU	-3753472.330	3912741.019	-3347960.811
ALIC	-4052051.924	4212836.115	-2545105.772
COCO	-741950.088	6190961.655	-1337768.514
AUCK	-5105681.055	461564.043	-3782181.723
JAB1	-4236442.880	4559929.585	-1388624.559
CHAT	-4590670.963	-275482.911	-4404596.762
NOUM	-5739971.570	1387563.639	-2402123.495
STR1	-4467102.430	2683039.441	-3666949.706
KOSG	3899225.236	396731.846	5015078.357
MATE	4641949.683	1393045.317	4133287.357
NYAL	1202430.618	252626.665	6237767.518
KIT3	1944945.305	4556652.227	4004325.972
IRKT	-968332.234	3794425.418	5018167.726
SELE	1046790.774	4540257.113	4342920.649
KSTU	-174281.769	3571333.026	5264196.026
POL2	1239971.540	4530790.072	4302578.768
MDVO	2844672.246	2161070.121	5266363.834
ZWEN	2886325.512	2155998.429	5245816.143
HERS	4033470.211	23672.793	4924301.237
SANT	1769693.387	-5044574.159	-3468321.059
AREQ	1942826.760	-5804070.255	-1796893.972
EISL	-1884951.632	-5357595.915	-2892890.546
FORT	4985386.641	-3954998.591	-428426.483
THTI	-5246415.222	-3077260.310	-1913842.435
ASC1	6118526.051	-1572344.732	-876451.173
GALA	-33796.022	-6377522.714	-82120.897
MAS1	5439192.256	-1522055.605	2953454.745
DGAR	1916269.722	6029977.381	-801720.151
MALI	4865366.454	4110737.478	-331121.702
HRAO	5085352.517	2668395.699	-2768731.676
USUD	-3855263.006	3427432.531	3741020.329
IISC	1337936.743	6070317.119	1427876.571
SHAO	-2831733.324	4675666.029	3275369.480
WUHN	-2267749.223	5009154.304	3221290.717
LHAS	-106937.749	5549269.589	3139215.776
NTUS	-1508022.733	6195576.708	148799.450
XIAN	-1735212.566	4976840.104	3580538.330
TAEJ	-3120422.980	4086355.440	3761769.592

TSKB	-3957199.242	3310199.685	3737711.669
BAHR	3633908.999	4425275.489	2799861.308
NSSP	3478646.800	3418805.767	4097987.136
GLSV	3512889.075	2068979.832	4888903.121
SUWN	-3062022.702	4055448.070	3841818.296
MCM4	-1311703.251	310815.089	-6213255.216
DAV1	486854.562	2285099.306	-5914955.726
CAS1	-901776.163	2409383.417	-5816748.473
MAC1	-3464038.540	1334172.798	-5169224.321
KERG	1406337.337	3918161.117	-4816167.393
MAW1	1111287.175	2168911.285	-5874493.626
PERT	-2368687.061	4881316.544	-3341796.094
SUVA	-6060677.126	166617.344	-1973761.673
VITI	-6073527.646	276502.045	-1921630.331
VANU	-6119100.918	62728.323	-1792699.875
P075	-2408855.282	5391043.255	2403591.125
CCBS	-1538174.830	6188130.345	148379.518
TG75	-1532153.704	6189689.566	146655.269
SMU1	-1531685.213	6189736.278	148233.213
HOUA	-1084448.866	5887162.305	2195042.992
KHON	-1689963.939	5951481.713	1545756.323
LAKX	-1567312.588	5855889.643	1978061.444
PHON	-1243325.324	5798971.252	2342488.893
PHUT	-1736467.311	5861984.667	1812076.408
SAMN	-1451207.624	5801838.027	2211983.029
VIEN	-1314797.636	5923043.672	1961129.571
CHON	-1190208.304	6097682.849	1438406.340
CHUL	-1132728.320	6092488.373	1504562.045
PHUK	-912741.900	6253870.441	855385.413
RTSD	-1129962.186	6092333.480	1507233.023
MMA8	-3177117.998	5293321.247	1597133.000
RP01	-3184192.330	5291065.961	1590599.177
HOKI	-4635696.991	735523.198	-4304158.688
OUSD	-4387888.610	733420.972	-4555178.588
WGTN	-4777269.377	434270.057	-4189484.607
CTY3	-1916791.065	5822975.156	1754668.839
QT02	-1724394.320	5714553.775	2239923.568
QT04	-1843711.900	5998027.698	1138672.760
BEIJ	-2148743.886	4426641.293	4044655.924
URMQ	193030.823	4606851.353	4393311.430
MORE	-5288519.291	3409952.726	-1038574.057
LAE1	-5312857.064	3451108.040	-736322.827
VANI	-4972630.009	3983208.077	-296767.020
TAWA	-2984278.954	5617684.116	469695.745
KUAL	-1443668.181	6184650.176	587309.956
ARAU	-1131051.806	6236311.760	711748.152
BINT	-2495021.305	5858781.690	360450.723
KINA	-2785188.826	5700556.715	651770.701
KUAN	-1469474.173	6192002.180	423675.210
D001	-2702793.079	5747549.415	583412.686
D004	-2984273.613	5617687.301	469697.205
D005	-2827033.593	5673602.981	705604.624
DOP1	-1263943.434	6242703.021	334310.452
DOP2	-1500246.231	6197397.989	152195.862
DOP3	-1391259.058	6212965.536	382801.338

DOP4	-1353514.176	6196995.577	666525.002
DOP5	-1143197.954	6237895.176	677621.311
MKUC	-2200986.126	5983687.159	180479.677
MLAB	-2708733.143	5744690.933	583321.417
MSAN	-2990750.419	5596338.092	644936.652
MTAW	-2974552.466	5622306.163	470932.627
T012	-2496815.506	5858477.290	355737.708
T030	-2203525.838	5982977.814	175363.802
TGET	-1329733.086	6199766.671	687129.564
TKIN	-2790190.350	5697101.144	660474.544
TKLA	-1254411.594	6244432.460	336712.362
TKUC	-2224775.562	5975001.079	175039.345
TTAW	-2974504.048	5622478.709	469019.084
BAKO	-1836969.010	6065617.221	-716257.807
LABG	-1836967.297	6065621.734	-716219.294
PSOR	-4204738.281	4795032.038	-97013.086
PARE	-3147782.661	5529856.785	-439535.576
SAMP	-964465.007	6291997.271	400195.885
PBIT	-3674851.369	5210705.173	159398.675
PDAY	-1841390.706	6069119.024	-672984.896
0029	-3862395.541	3105010.543	4001962.421
0073	-3591893.400	3758832.944	3682342.852
0745	-3512919.524	4524558.307	2795882.522
0746	-3786805.640	4311845.920	2774485.190
2001	-3642148.562	2861482.257	4370365.644
2003	-4488925.852	3483902.940	2887743.181
2004	-3565271.287	4118973.223	3306293.358
3009	-3997615.486	3276762.711	3724230.568
6006	-3822373.388	3699359.901	3507585.814
KGNI	-3941949.208	3368156.378	3702214.880
KSMV	-3997525.389	3276870.927	3724218.564
KTTY	-4000969.872	3375309.051	3632196.884
MUIR	-3976113.337	3377936.130	3656756.448
LADA	3151871.897	4654363.335	3005669.294
MARI	3205584.500	4075347.097	3705004.752
NILO	3582731.922	4026235.470	3399695.673
REIH	3509963.694	4347105.441	3066072.153
ROSE	3185578.845	4356094.359	3390474.934
YAS1	2726445.108	4442816.474	3665092.314
LAND	-1608477.057	6039324.282	1268553.699
PENH	-1608754.666	6038688.252	1271254.552
SIEM	-1481813.471	6025851.719	1469486.657
SIHA	-1466153.478	6095949.233	1166708.135
STUE	-1706562.242	5962886.465	1482541.176
SVAY	-1703382.021	6023545.699	1218999.513