Report of the

**Joint GCOS-WIGOS Workshop for the Pacific Small Island Developing States (SIDS)**

9-12 October 2017, Nadi, Fiji

# Key messages from the Joint GCOS-WIGOS Workshop for Pacific SIDS,

* Systematic observation of the Earth’s climate is a global common good that supports the implementation of the Paris Agreement, in the context of sustainable development and efforts to eradicate poverty.
* Many meteorological observations, made at high spatial and temporal density, support local forecasting and warning applications. These observations are a national responsibility contributing to national and regional needs with some additional global value.
* However, systematic upper air observations, made routinely by radiosondes under the WMO World Weather Watch (WWW) Programme, including the GCOS Upper Air Network (GUAN), support numerical weather prediction (NWP) leading to global benefits. These observations are used primarily for forecasting and climate applications at the international level, including climate reanalyses which form the basis of much of our understanding of climate and climate change; and
* Systematic upper air observations in the Pacific region, tend to have the highest measured impact, of all ground-based measurements, on the quality and accuracy of weather and climate analysis and prediction not only locally, but globally. The resulting products underpin weather and climate aspects of early warning systems as well as other climate-related services.
* Both the spatial density and observing frequency of the upper air network over the South Pacific region currently fall short of GCOS and WMO requirements. Due to the unique geography of the region – vast swathes of ocean surface with relative little land mass distributed over some 20 small island states with modest-size populations and correspondingly modest GDPs – systematic observation is particularly challenging in this region.
* The upper air network over the South Pacific therefore needs sustained international support.
* The workshop developed an outline for a *Pacific region observing network plan in support of the GCOS Implementation Plan and the* *Implementation Plan for the Evolution of Global Observing Systems (EGOS IP) t*o:
  + Strengthen regional and national meteorological networks to support adaptation actions and avert loss and damage;
  + Identify capacity building needs to ensure the sustainability of the networks;
  + Be used to support requests for finance from the operating entities of the financial mechanism under the Convention, the GCOS Cooperation Mechanism and other relevant funding sources.
* Support of the observing network in the region should be based on transparent processes and a commitment to free and open data sharing in accordance with WMO Resolutions 40 and 60 and the GCOS Monitoring Principles. The network should be designed to be, efficient, sustainable, it should meet agreed international standards as well as national requirements. Ensuring sustainability is of paramount importance, and the network plan must therefore also include the necessary elements of capacity development.
* The draft plan will be developed by GCOS and WMO in collaboration with Secretariat of the Pacific Regional Environmental Programme (SPREP), the Pacific Islands Communication and Infrastructure Panel (PICI), and Pacific Meteorological Council, and submitted to COP 24.

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**Joint Global Climate Observing System (GCOS) and WMO Integrated Observing System (WIGOS) Workshop for the Pacific Small Island Developing States**

# Introduction

This workshop was organised jointly by the Global Climate Observing System (GCOS), and the WMO Integrated Global Observing System (WIGOS) focusing on gaps in climate observation systems in Pacific island states. The meeting was hosted by the Government of Fiji through its Meteorological Service whose support was essential to the success of the meeting. The Secretariat of the Pacific Region Environment Programme (SPREP) provided logistical and technical support.

# Session I: Scope and Purpose of Workshop including Background Information on UNFCCC, GCOS and WIGOS

In 2016, the UNFCCC, in decision 19/CP.22, emphasized “*the need to maintain, strengthen and build capacities for climate observations*…” and SBSTA 45 “*noted the need for regional workshops, as identified by the GCOS 2016 implementation plan, […] and invited the GCOS to organize such workshops, taking into consideration the benefit of organizing these workshops in collaboration with relevant partners*”. SBSTA also highlighted the need for support in the LDCs and small island developing States.

For the first of these regional workshops a meeting was organised jointly by the Global Climate Observing System (GCOS), and the WMO Integrated Global Observing System (WIGOS) focusing on gaps in in the observing systems for weather and climate in Pacific island states. The workshop focussed initially on two areas: precipitation and upper air (radiosonde) measurements. Water is a primary resource and high quality and useful information on water needs to be made available on a free and easily accessible basis. Water (e.g. floods, extreme rainfall and droughts) has been identified as a major issue of concern for adaptation by parties in their submissions to the UNFCCC. Upper air measurements have been identified as the in-situ observations whose improvement would give most benefit to the models that underpin both numerical weather prediction and climate prediction and analysis - which will have local, regional and global benefits.

The workshop had the following goals:

* Develop an understanding by all parties of how improved local observations can contribute to climate analysis, weather forecasting and early warning systems
* Based on national priorities expressed by the participants, identify the most important cost-effective observational improvements and develop plans to implement these improvements to observations
* Advocate for improved data stewardship including open access to data products
* Identify funding opportunities
* Improve GCOS communication with international, regional and national stakeholders, especially in developing countries.
* The experience gained should be the basis for future regional workshops.

The agenda is attached in annex B.

The UNFCCC has an important interest in systematic observations of the climate system as expressed in article 5 of the convention, together with national reporting requirements in article 4. Adaptation and early warning systems together with the Global Stocktake are all important parts of the UNFCCC’s Paris Agreement and systematic observations play an important role in addressing all of these.

GCOS, established in 1992 and supported by WM0, aims to ensure that systematic observations are undertaken and that the results are made available to all users. It reviews the status of the climate system (GCOS 2015) and prepare Implementation plans (GCOS 2016) that are presented to the UNFCCC. These plans identify what needs to be monitored the Essential Climate Variables (ECV), and specific actions that should be undertaken to ensure the continuation and improvement of the global climate observing system.

WIGOS is an all-encompassing approach to the improvement and evolution of WMO and WMO co-sponsored observing systems in support of all WMO application areas, including their contributions to GCOS. It will foster the orderly evolution of the present WMO global observing systems, in particular the Global Observing System (GOS), the hydrological observing systems and the observing components of the Global Atmosphere Watch (GAW) and the Global Cryosphere Watch (GCW), into an integrated, comprehensive and coordinated system. It will satisfy, in a cost-effective and sustainable manner, the evolving observing requirements of WMO Members, while enhancing coordination of the WMO observing system with systems operated by international partners. Together with the WMO Information System (WIS), WIGOS will be the basis for the provision of accurate, reliable and timely weather, climate, water and related environmental observations and products by all Members and WMO Programmes, which will lead to improved service delivery.

# Session II: Observational Data Requirements for the Pacific

Observational requirements clearly depend on the applications areas they are addressing. Therefore, requirements for global observations may not meet all the local needs. GCOS provides requirements for 54 Essential Climate Variables (ECV). However, not all these need to be observed by each State. Some are provided by satellite observations, while ocean observations are often performed by international consortia.

Observations must be exchanged internationally in order for them to be used in climate and weather modelling at global and regional scales.

Precipitation observations are made locally and reported internationally. Figure 1 shows data for July 2017 received and processed by the Global Precipitation Climatology Centre (GPCC) by DWD under the auspices of the World Meteorological Organization (WMO). These show that, given the amount of ocean and land in the region, the density of observations appears to be consistent with other countries. However, a particular problem with observations of precipitation is the spatial inhomogeneity of the measured quantity, especially in mountainous terrain. As participants pointed out, a single site on a volcanic island may not be representative of the whole island.



Figure Data form the Global Precipitation Climatology Centre (GPCC) for July 2017

Upper air (radiosonde) observations are very important for global numerical weather predictions, both regionally and globally. The impact of these observations can reach planetary scale. ECMWF has thus stated that better upper air observations in the south Pacific are critical for extended range forecasts over Europe. Isolated radiosonde observations in the Pacific are routinely shown to have the highest impact of all observations on skill of global Numerical Weather Prediction (NWP) models.

# Session III: National Observing Capabilities and Needs

All the countries in the Pacific region have relatively small populations and land areas but have large areas of ocean in their exclusive economic zones (EEZ), (Table 2). It should be noted that even taking into account the EEZs will not cover all areas of the ocean, while the requirement for observations for global NWP and climate analysis remains in essence the same irrespective of national borders and EEZs.

Table 1 summarises the observations in the Pacific region. All the Pacific Island States noted a number of common issues:

* The large distances between islands and the remoteness of monitoring sites poses special challenges. Access to some islands by ship may be infrequent and time consuming.
* Communications between monitoring sites and Central Offices can be difficult without internet, telephone land lines or reliable electrical power.
* Costs of consumables can be prohibitive for small low-Gross Domestic GDP countries, and are often at a premium price owing to the low quantities being ordered and cost of shipping.
* Training and capacity building are important widespread needs. This covers all aspects of meteorological service provision from observations, maintenance and repair, to reporting and using data. Assistance is needed to ensure that procurements deliver high-quality, cost-effective equipment.

Table 1 Summary of Observing capabilities reported by countries, recorded in OSCAR and data exchanged

|  | Presentation | OSCAR | SYNOPS (OGIMET)  (8th – 9th October) | CLIMAT | Radiosonde |
| --- | --- | --- | --- | --- | --- |
| Fiji | 32 AWS  10 TB3 Rainfall stations  41 Rainfall stations (manual)  34 Manual synoptic/climate  4 Lightning stations  1 Wind Profiler,  1 Tidal,  3 Weather Radar  Hydrological Network  12 Stations for International Exchange | 50 Stations  → 22 GOS Stations  → 22 WHOS Stations  → 4 GCOS/GSN Stations  → 1 GCOS/GUAN Station (91680) | 16 stations (metadata)  8 stations (3 Hourly or better)  5 stations (zero obs)  No hourly reports | 5 Stations providing  monthly reports | 2 per day (62 August)  Timeliness good (<60mins)  Max Height 93% > 30hPa  (Jan – Aug 2017)  TEMP and BUFR |
| Cook Islands | 7 AWS  (Project to replace above with 10 new systems)  1 Upper-Air (No consumables) | 13 Stations  → 13 GOS Stations  → 4 GCOS/GSN Stations  → 1 GCOS/GUAN Station (91843) | 8 stations (metadata)  91831 (Hourly)  91843 (3 Hourly)  91844 (2 Hourly)  5 stations (zero obs) | GSN stations not reporting CLIMAT | Silent since Jan 2017  (No Consumables) |
| Federated States of Micronesia | 3 Weather Service Offices  2 SAWRS  21 COOP Stations  3 Upper-Air Stations | 27 Stations  → 27 GOS Stations  → 3 GCOS/GSN Stations  → 1 GCOS/GUAN Station (91334) | 14 stations (metadata)  4 (6 Hourly)  9 ( 1 to 3 obs)  1 stations – zero obs  No hourly/3hr’ly reports | 3 Stations providing  monthly reports | 2 per day (62 August)  Timeliness good (<70mins)  Max Height 89% > 30hPa  (Jan – Aug 2017)  TEMP and BUFR |
| Kiribati | 9 Stations | 16 Stations  → 14 GOS Stations  → 3 GCOS/GSN Stations  → 1 GCOS/GUAN Station (91610) | 8 stations (metadata)  2 stations (3 Hourly)  4 stations ( 1 – 3 obs)  2 stations (zero obs)  No hourly reports | GSN stations not reporting CLIMAT | 1 per day (30 August)  Timeliness good (<70mins)  Max Height 84% > 30hPa  (Jan – Aug 2017)  TEMP **No BUFR** |
| Marshall Islands | 7 Stations  22 drought monitoring stations  2 Radiosonde stations | 19 Stations  → 19 GOS Stations  → 2 GCOS/GSN Stations  → 1 GCOS/GUAN Station (91376) | 8 stations (metadata)  1 (6 Hourly)  4 ( 1 – 3 obs)  3 stations (zero obs)  No hourly reports | 2 Stations providing  monthly reports | 2 per day (62 August)  Timeliness good (<60mins)  Max Height 95% > 30hPa  (Jan – Aug 2017)  TEMP and BUFR |
| Nauru | Zero active stations | 4 Stations  → 4 GOS Stations  → 0 GCOS Stations |  |  |  |
| Niue | 1 Station | 3 Stations  → 3 GOS Stations  → 1 GCOS/GSN Stations | 1 stations (metadata)  91824 (3 obs)  No hourly reports | 1 Stations providing  monthly reports but not every month |  |
| Palau | 1 NWS Station  6 Coop Stations | 3 Stations  → 3 GOS Stations  → 1 GCOS/GSN Stations  → 1 GCOS/GUAN Station (91408) | 1 station (metadata)  1 (6 hr’ly or better)  No hourly reports | 1 Stations providing  monthly reports | 2 per day (62 August)  Timeliness good (<80mins)  Max Height 90% > 30hPa  (Jan – Aug 2017)  TEMP and BUFR |
| Papua New Guinea | 14 Manual Stations (3 closed)  22 Climate Stations  200 Rainfall Stations  6 AWS  2 Tide Gauges | 43 Stations  → 43 GOS Stations  → 3 GCOS/GSN Stations  → 1 GCOS/GUAN Station (92035) | 9 stations (metadata)  1 station (3 Hourly)  7 stations ( 1 – 3 obs)  1 stations (zero obs)  No hourly reports | 6-8 Stations providing  monthly reports | Silent since Feb 2013  (No Consumables)  (Hydrogen generator issues) |
| Samoa | 2 Manual Stations  13 Sites (AWS)  Wind Profiler and RASS  Tide Gauge | 17 Stations  → 17 GOS Stations  → No GCOS Stations | 10 stations (metadata)  8 stations (Hourly)  2 stations (3 Hourly)  No hourly reports | No CLIMAT but none are GSN. Apia is a RBCN |  |
| Solomon Islands | 6 Synoptic Stations  1 Upper-Air Station (stopped)  8 AWS  12 Auto-Rainguage  4 Lightning stations  5 Hydrometric Stations  3 Agro Met Stations | 9 Stations  → 9 GOS Stations  → 2 GCOS/GSN Stations  → 1 GCOS/GUAN Station (91517) | 7 stations (metadata)  4 stations (3 Hourly)  3 stations (4-5 obs)  No hourly reports | No CLIMAT reports | Silent since Oct 2011  (No Consumables)  All equipment is now questionable |
| Tonga | 8 Stations ( 7 Manual, 1 AWS)  Seismic Network | 9 Stations  → 9 GOS Stations  → 2 GCOS/GSN Stations | 5 stations (metadata)  3 stations (3 Hourly)  2 stations (6 Hourly)  No hourly reports | No CLIMAT reports |  |
| Tuvalu | 4 Manual  5 Rainfall (non operational)  1 Upper Air  1 Tide Guage  1 Lightning Detector  1 GPS positioning system  1 Seismic Station | 5 Stations  → 5 GOS Stations  → 2 GCOS/GSN Stations  → 1 GCOS/GUAN Station (91643) | 4 stations (metadata)  1 station (3 hr’ly )  3 stations (6 hr’ly)  No hourly reports | No CLIMAT reports | 1 per day (30 August)  Timeliness good (<80mins)  Max Height 90% > 30hPa  (Jan – Aug 2017)  TEMP **No BUFR** |
| Vanuatu | 8 Synoptic Stations  1 Upper-Air Station (Not working)  75 Rainfall Stations  4 Tidal Guages | 13 Stations  → 7 GOS Stations  → 6 AWS with no affiliation  → 2 GCOS/GSN Stations  → 1 GCOS/GUAN Station (91557) | 7 stations (metadata)  2 stations (3 hr’ly)  5 stations (2-4 obs)  No hourly reports | No CLIMAT reports | Silent since Apr 2016  (No Consumables)  Issues with Hydrogen Generator |

Table 2 Basic statistics for the Pacific Island States. with USA, and Japan added for comparison. Data form UN and World Bank.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Land Area | Area of EEZ | Population | GDP | GDP per km2 | Population Density including EEZ |
|  | *km2* | *million km2 including land area* | *thousands, UN Estimate for 2017* | *World Bank. 2016, US$* | *US$ per km2* | *km2 per person* |
| Cook Islands | 240 | 1.80 | 17 | 311 a | 0.00017 | 0.01 |
| Federated States of Micronesia | 702 | 3.00 | 106 | 322 | 0.00011 | 0.04 |
| Fiji | 18,274 | 1.30 | 906 | 4632 | 0.00360 | 0.70 |
| Kiribati | 811 | 3.44 | 116 | 166 | 0.00005 | 0.03 |
| Marshall Islands | 181 | 1.99 | 53 | 183 | 0.00009 | 0.03 |
| Nauru | 2 | 0.31 | 11 | 102 | 0.00033 | 0.04 |
| Niue | 26 | 0.39 | 2 | 10b | 0.00003 | 0.00 |
| Palau | 535 | 0.60 | 22 | 293 | 0.00048 | 0.04 |
| Papua New Guinea | 45,258 | 2.87 | 8,251 | 16929 | 0.00590 | 2.88 |
| Samoa | 283 | 0.13 | 196 | 786 | 0.00600 | 1.50 |
| Solomon Islands | 2,799 | 1.62 | 611 | 1202 | 0.00074 | 0.38 |
| Tonga | 72 | 0.66 | 108 | 395 | 0.00060 | 0.16 |
| Tuvalu | 3 | 0.75 | 11 | 34 | 0.00005 | 0.01 |
| Vanuatu | 12,300 | 0.68 | 276 | 774 | 0.00110 | 0.41 |
|  |  |  |  |  |  |  |
| Total above | **81,486** | **20** | **10,687** | **26,139** | **0.00130** | **0.55** |
|  |  |  |  |  |  |  |
| USA | **9,525,067** | **11.35** | **325,958** | **18,569,100** | **1.60** | **28.72** |
| Japan | **377,930** | **4.48** | **126,670** | **4,939,384** | **1.10** | **28.28** |

Notes: a data for 2014, b data for 2003

# Fiji

The Fiji Meteorological Service (FMS) is now under the Ministry of Disaster Management and Meteorological Service. It operates all the year around providing daily weather forecasting and warnings to Fiji, Cook Islands, Kiribati, Nauru, Niue, Tokelau, Tonga and Tuvalu. It is recognised as a WMO Regional Specialized Meteorological Centre. In Fiji there are networks of meteorological, rainfall and hydrological stations and weather radar. The site at Nadi Airport launches radiosondes twice daily. 12 stations report data internationally to the WMO WIS/GTS.

While Fiji has its own training needs, it also serves as a focal point for capacity building for the surrounding island states.

Transport to and from the smaller outlying islands adds to the difficulties of maintaining the observation system while deploying a reliable communications system is a priority.

# Cook Islands

The Cook Islands have an upper air station that launches radiosondes once a day. This was supported by the UK until the end of 2016. The precipitation measurements are not representative, as rainfall on different sides of the island is markedly different. They have experience with a voluntary observing system using cheap rainfall gauges situated at schools.

# Federated States of Micronesia

The Federated States of Micronesia Weather Services Offices (WSO) are built, operated and funded by the US National Oceanic and Atmospheric Administration (NOAA) National Weather Service (NWS) while the Government of the Federated States of Micronesia hires and employs the WSO staff.

There are three Weather Service Offices (METAR/SPECI) on Pohnpei, Chuuk and Yap, and two SAWRS Stations (METAR/SPECI that operate for 2hrs pre/post US Airlines flights) at Pohnpei and Kosrae Airports. There are also 27 COOP Stations. There are upper air soundings from all three WSOs, twice daily at 00Z and 12Z.

Installation and maintenance can be a problem due to remoteness of islands with both communication problems and travel issues.

# Kiribati

Of the nine meteorological stations 3 are silent and only 2 provide continuous hourly observations. Issues include the lack of resources for the maintenance and operation of equipment. Communications is also an issue and the use of existing internet links is being investigated.

Kiribati is looking for assistance with international tendering and donors to support the Kiribati Joint Implementation Plan for Climate Change and Disaster Risk Reduction which includes both the reactivation of existing meteorological stations and the establishment on new stations.

The upper-air station is supported by funds from the UK, managed through SPREP.

# Marshall Islands

Majuro National Weather Service first started in 1950. It operates under the US NOAA NWS and it’s contracted by the Government of Marshall Islands to provide weather products and services to citizens. The staff are employed by US NOAA NWS. US NOAA NWS has assigned the Weather Forecast Office in Guam (WFO Guam) and Weather Forecast Office in Honolulu (WFO Honolulu) to provide services and warnings for the North Pacific island states including the Marshall Islands.

The observations include surface stations, weather radar and an upper air station that operates twice daily.

There is a need for more observation sites in the outer islands to improve drought forecasting and monitoring. There also needs to be a sustainable and robust communication system for observation transmittal and for early warnings. Installation of Chatty Beetles[[1]](#footnote-1) in 5 to 8 other atolls is underway.

# Nauru

Currently there are no meteorological stations in Nauru. There are some limited observations made at the airport. Plans are being implemented to establish a Meteorological Office and to provide some equipment. Two officers are being trained in Nadi, Fiji.

# Niue

Hanan Airport is Niue’s only meteorological station. Daily weather forecasts are provided by Fiji Meteorological Service / RMSC Nadi but Niue produces its own three-day weather forecast. There are also rainfall and seismic observations.

# Palau

Due to cooperation between the US NOAA NOAA NWS and the Government of the Republic of Palau, the Palau Weather Service is 100% funded by the US Government and on the basis of a reimbursable funding. It employs a total of 13 staff.

There is a weather station at Koroor (which will move closer to the airport) and two Cooperative Stations measuring temperature and precipitation as well as three stations observing surf conditions.

Additional rain gauges are needed, and access to US NOAA NWS data, products and information should be improved.

# Papua New Guinea

Currently Papua New Guinea Weather Service has:

* 14 manual observation stations (3 recently closed).
* 22 climate stations and less than 200 rainfall stations.
* 6 AWS and 20 rainfall data loggers.
* 2 tide gauges (1 not operational).
* Hydrology network is under Ministry of Environment.

However, it is unclear how well these operate and there is a lack of stations in the Highlands region. The two upper air stations ceased operation in early 2015 due to lack of funds for consumables.

Currently the National Weather Service needs to be restructured and to receive an adequate budget to restore the silent stations and train staff. There needs to be an effective communication strategy to allow the transmission of information from the data loggers and AWS and to link to airport observations. Data records from manual stations need to be rescued and digitized. The capacity of the staff needs to be enhanced.

# Samoa

Samoa has 7 AWSs in addition to those at the airport. It has a weather forecasting capability using satellite data and effective communications for data transmission. It operates a multi-hazard early warning system with a smart phone app to distribute warnings.

It does not undertake upper air soundings but relies on data from the American Samoa’s upper air soundings, which is nearby.

# Solomon Islands

Currently the Solomon Islands Meteorological Service has

* Six (6) Surface Synoptic Observation Stations.
* One (1) Upper Air Stations (not operational).
* Eight (8) AWSs -1 mSTAR, 1 iSTAR, 4 SWoCK, 2 NDMO.
* Twelve (12) Automatic Rain Gauges (AEGs) and 4 yet to be installed.
* Three (3) Agro-Meteorology Stations (AGSs), funded and installed by the Taiwan Central Weather Bureau (CWB) but the data from these stations are not currently available to the Meteorological Service.
* HimawariiCast ground stations installed by Japan Meteorological Agency (JMA), funded by Japan International Cooperation Agency (JICA).

Issues include lack of expertise and resources. This has led to a lack of upper air observations due to the lack of consumables and maintenance, lack of maintenance and calibration to ensure data quality. Poor international procurement of meteorological instruments contributes to these issues.

There are also problems with timely data transmission. Finally, the use of Mercury substance with meteorological instruments needs to be phased out.

# Tonga

Since 2005 Tonga has been producing its own weather forecasts, previously these were done by Fiji. Tonga has 8 meteorological stations. It does not perform any upper air observations. Limits on resources mean that equipment is not inspected regularly and few spares are held.

# Tuvalu

The Tuvalu Metrological Office has:

* 4 manned synoptic stations including in the Capital, all operational.
* 5 rainfall stations, currently non-operational.
* 1 upper air program (1 observation per day 2300UTC).
* 1 tide gauge with tsunami warning system.
* Lightning detector.

The upper air station is supported by funds from the UK, managed through SPREP.

The increasing population results in an increase in both the vulnerability and exposure of people to natural hazards such as sea-level rise, increased variability of weather, climate, storm surges and coastal inundation.

There are severe problems with communications to the outlying islands where there is limited internet access, no mobile coverage, no television and no HF radios. There are

power and cabling issues for land phones lines and there is one radio station service (AM radio) with a limited transmission. The electricity supply is insufficient. Solutions could include Chatty Beetles and HF radios.

# Vanuatu

In Vanuatu there are:

* 8 synoptic stations and 3 are these are designated GCOS stations (91551,91555,91568)
* 75 rainfall stations/sites.
* 4 tidal gauges.
* 6 volcano monitoring stations.
* 3 broadband stations.

In addition, one upper air station, which has not been operational since September 2016 due to lack of funds.

There is limited expertise in maintenance and calibration of instruments (both manual and AWSs) and upper air stations. Capacity development to help improve the quality of the stations is needed.

Communications is an issue with a need for improved back-up communications tools (such as HF radios)

# Session IV: Regional Observing System Capabilities

In order to serve specifically the needs of global climate applications, two networks of observing stations have been established as GCOS Baseline Networks, mainly on the basis of existing GOS networks. These are:

* the GCOS Surface Network (GSN) (1023 stations as of April 2017).
* the GCOS Upper-Air Network (GUAN) (177 stations as of April 2017).

These networks form a minimum configuration required for global applications. Regional climatic needs can be much more extensive, and it is anticipated that such needs will be served by more dense networks on a regional basis, possibly with more extensive requirements for observing programmes and specifications.

Concerning the availability of surface observations for weather predictions and warning, the situation could be improved by simply ensuring the international exchange of hourly data. In many case this is a very low- or no- cost option with substantial benefits. However, most of the upper air observations in the region are funded externally with regional meteorological services unable to find and justify the funds needed for consumables and maintenance.



Figure 2 The GCOS Upper Air Network (GUAN)



Figure 3 The GCOS Surface Network (GSN). Number of months reporting July 2016-Jun 2017. (Red=12, Blue =5to 10, Green = 1, Grey =0)

# Session V: Gap Analysis and Mitigation Steps

Radiosondes are critical for climate reanalysis produced by Global NWP systems. Langland et al. (2011) show that local uncertainties in analysis are substantially larger in areas with no conventional (non-satellite) upper air observations. Isolated radiosonde stations have a large impact and twice daily soundings more so than a single daily sounding. This has implications for trend analysis, process understanding, adaptation and the Global Stocktake under the 2015 Paris Agreement.

For global NWP we should focus on improving surface pressure and upper air wind observations. These parameters are amongst the fundamental variables for NWP (the others are temperature and humidity) and both provide driving requirements for surface-based observing systems, since – as opposed to temperature or humidity - neither is currently measured from space.

Surface pressure is derived in experimental mode from total CO2 column measurements and satellite imagers provide horizontal wind components by feature tracking, but only for a single layer with no vertical resolution and limited height information. Wind observations are particularly important in the tropics.

The threshold requirement (given in WMO’s OSCAR database) is 500 km, which means that in principle every grid cell of 500 km x 500 km = 250,000 km2 should have a radiosonde station as a minimum. This may make sense for the continental landmasses: in Europe and over North America the design separation is 200 to 250 km. However, a 500 km resolution is unachievable in the Pacific.

A practical alternative would be to consider adopting a lower regional (Pacific) threshold resolution of 750 or 1000 km. Even 1000 km would be quite ambitious, given that the total surface area of the Pacific is about 165,000,000 km2, which would require on 165 radiosonde stations.

The ECMWF Deputy Director of Forecasts noted in September 2017 regarding the potential value of rehabilitating the upper air network over Papua New Guinea.

“Radiosondes in PNG can help capture the amplitude and phase of the MJO, and the Kelvin waves, and help predict when Rossby wave trains may be triggered from that area, and then propagate across the Pacific to N. America, and where they influence the mid-latitude storms tracks and ultimately the weather in Europe”

“Isolated radiosondes are individually much more valuable and bring much more benefit to forecast quality than observations in a dense network (benefit per station that is!)”

Therefore, it is proposed to design a network around a regional WMO Requirement for Global NWP. This would be a foundational activity with a significant impact on almost all weather and climate products. This would consider surface pressure and upper air winds provide for non-satellite observations. A slightly lower threshold resolution requirement that recommended by WMO could be considered due to unique geography of the South Pacific. Such a redesigned network would be ambitious but not impossible.

However, the meeting also noted that the current financing model (asking the WMO Members to fund this out of their NMHS budgets) will not be adequate for a redesigned Regional Basic Observing Network for the Pacific region. As noted in the previous section all upper air observations in the region, apart for Fiji, are funded by countries outside the region (e.g. USA and UK).

In addition to the plenary discussions on gaps analysis and mitigation steps, participants further discussed these in Groups. Group 1 comprised of participants from Cook Islands, Nauru, Niue, Tonga, Tuvalu and Vanuatu. Group 2 comprised of participants from Fiji, Papua New Guinea and Solomon Islands. Group 3 comprised of participants from the Federated States of Micronesia, Marshall Islands and Palau. Although participants are in Groups for the discussions, they help each other to identify gaps and mitigation steps for their respective countries as well as for regional and sub-regional perspectives. Summary of each country gaps and mitigation steps resulting from the Groups’ discussions are presented in Table 1 below.

**Table 1: Outcomes from Groups’ Discussions**

| **Countries** | **Gaps** | **Mitigation Steps** |
| --- | --- | --- |
| Cook Islands | Limited upper air station’s balloons and radiosondes. | Provide 350 grams balloons and radiosondes to measure temperature and wind speed and direction. |
| Limited coverage of observations around the country, especially on outer smaller islands. | Install 8 new AWSs. |
| Limited satellite dish to access, and limited computer hardware and software to process, meteorological satellite information. | Install new HimawariiCast ground station receiving equipment, and it includes satellite dish to access, and computer hardware and software to process meteorological satellite information. |
| No dedicated Global Telecommunication System (GTS) and lack of compliance with the WMO Information System (WIS) requirements with existing communication system. | Install dedicated GTS or equivalent with WIS specifications including computer hardware and software for storage and communication system to relay the data onto the GTS. |
| Fiji | Limited coverage of observations around the country, especially on outer smaller islands. | Install a new and additional upper air station and Global Atmospheric Watch (GAW) station on Rotuma island. |
| Time delayed for receiving, limited to no direct access to, data from some AWSs operating in Fiji. Data are transmitted from the AWSs to a satellite and from the satellite to ground stations in another country and from this country to Fiji via GTS. | Assess current situation and explore ways to allow the Fiji Meteorological Service to regular access data in near-real time from all AWSs operating in Fiji. |
| High costs and dependency on mobile telephone networks for collecting and transmitting meteorological data from AWSs to the Fiji Meteorological Service. | Assess current situation and explore complimentary or alternative low cost and back-up communication systems for collecting and transmitting meteorological data from AWSs to the Fiji Meteorological Service. |
| AWSs are installed at locations where main national telephone networks are not available. | Identify best potential communication systems to collect and transmit data from the AWSs to the NWS taking into consideration near real-time, easy and regular direct access to the data. |
| Staff members have very limited skill to maintain and calibrate electronic information technological based meteorological equipment, including AWS and related sensors. | Provide training and to also include AWSs and related sensors. |
| Limited equipment calibration facilities. Only one calibration laboratory and kit in the Pacific Region, operated by the Fiji Meteorological Service, but can only calibrate certain equipment and not all equipment. Also calibration is done on a yearly basis, based on project-based funding from JICA, but the cost of calibrating after end of project and on a needs basis might be too expensive for many NMHSs. | Assess the current situation and explore options to address the issues. |
| Limited capacity for auditing NMHSs compliance and reporting to ICAO Annex 3. | Organize training on auditing NMHSs for compliance with ICAO Annex 3. |
| Limited coordination to assist other Pacific islands’ NMHSs to comply with QMS especially ISO 9001: 2015. | Organize regional coordination mechanism to assist Pacific islands’ NMHSs to comply with QMS especially ISO 9001: 2015. |
| Limited coordination to assist other Pacific islands’ NMHSs on competency assessment for AMOs. | Organize regional coordination mechanism to assist Pacific islands’ NMHSs on competency assessment for AMOs. |
| AMDAR data are not integrated with synoptic, climate, upper air, satellite data, etc. | Integration of AMDAR data with synoptic, climate, upper air, satellite data, etc. |
|  | Limited integration of all hydro-meteorological data. | Advocacy of WIGOS at national level. |
| Reliance on projects and donor assistance for logistics, observations and operational support. | Advocacy at national level of the importance of NMHSs to climate change adaptation and disaster risk reduction. |
| Fiji does not have a Meteorology Bill. | Draft Meteorology Bill for Fiji. |
| Limited skills in project development and implementation. | Provide in-country training in project development and implementation. |
| Limited skills in leadership and management. | Provide in-country training in leadership and management. |
| Limited capacity in oceans’ observations. | Provide training on ocean-based observing systems. |
| Kiribati | 3 silent synoptic/surface stations due to lack of resources to replace obsolete equipment. | SPREP with support from the Finland-Pacific (FINPAC), project provided basic equipment for Bonriki and Cassidy airport stations. Provide basic meteorological equipment or AWS for the 2 remaining silent stations to measure wind speed and direction, atmospheric pressure, rainfall, air temperature, maximum temperature, minimum temperature, rainfall, humidity, salinity, water level, quality of water and soil temperature. |
| Staff members have limited skills in weather observations especially at international aerodromes. | Fiji Meteorological Service (FMS) with the support of JICA, WMO and Fiji Airways provided in-country training for staff members on Kirimati (2016) and Tarawa (2017). In addition to this, FMS with the support of JICA provided a regional training on basic weather observations. However, there is still a need for follow up in-country training especially to also assess the competency of the staff. |
| Staff members have very limited skill to maintain and calibrate electronic meteorological equipment, including AWS and related sensors. | FMS with support from JICA provided 2 regional trainings (2015 & 2016) on maintenance and calibration of meteorological electronic equipment. Continue the training and to also include AWSs and related sensors. |
| Limited resources for logistic and operation support due to limited support from the national government budgets. | Advocacy of the importance of NMHSs to climate change adaptation and disaster risk reduction. |
| Very limited spares for basic meteorological instrument including maximum temperature thermometer, minimum temperature thermometer, dry and wet bulb temperature thermometers. | Organize for a stock of spare thermometers. |
| Lack of planning for maintenance, calibration and replacement of equipment. | Develop an Operation, Monitoring and Develop maintenance plan for all equipment. |
| Limited equipment calibration facilities. Only one calibration laboratory and kit in the Pacific Region, operated by the Fiji Meteorological Service, but can only calibrate certain equipment and not all equipment. Also calibration is done on a yearly basis, based on project-based funding from JICA, but the cost of calibrating after end of project and on a needs basis might be too expensive for many NMHSs. | Develop a Memorandum of Understanding (MoU) with Fiji Meteorological Service on calibration of equipment. |
| Limited QMS especially ISO 9001: 2015 and Part 174 auditing, compliance and reporting. | Assist Kiribati Meteorological Service for regular auditing for compliance with ISO 9001:2015 and Part 174. |
| Limited capacity for auditing for compliance with ICAO Annex 3. | Organize training on auditing for compliance with ICAO Annex 3. |
| Kiribati does not have a Meteorology Bill. | Draft Meteorology Bill for Kiribati. |
| Limited skills in project development and implementation. | Provide in-country training in project development and implementation. |
| Limited skills in leadership and management. | Provide in-country training in leadership and management. |
| No dedicated GTS and lack of compliance with the WIS requirements with existing communication system. | Install dedicated GTS or equivalent with WIS specifications including computer hardware and software for storage and communication system to relay the data onto the GTS. |
| Nauru | Presently, Nauru neither has a Weather Office nor a weather/climate station. | The Secretariat of the Pacific Community (SPC) with support from the European Union (EU) funding, constructing a new building for the Emergency Services which will also house the Meteorological Office. SPREP with support from the FINPAC project provides basic and manual meteorological equipment for Nauru to measure wind speed and direction, air temperature, atmospheric pressure and rainfall. |
| No Office computer, communication system including internet, etc. | Install computer hardware and software for the Office when it is completed. |
| No dedicated GTS and lack of compliance with WIS requirements with existing communication system. | Install dedicated GTS or equivalent meeting the WIS requirements including computer hardware and software for storage and communication system to relay the data onto the GTS. |
| Limited skills and experiences in weather observations. | FMS with the support of JICA provided a regional training on basic weather observations and Nauru participated in this training. However, there is still a need for follow training especially in-country training once the Weather Office and weather/climate station are set up. |
| No skills and experiences in weather forecasting and services. | They need training in weather forecasting and services. |
| No skills and experiences in climate services. | They need training in climate services. |
| Niue | SPREP with support from the FINPAC project provided an AWS for Niue and it is installed at the international aerodrome, serving 3 purposes, namely, GCOS for climate services, Synoptic station for weather forecasting and warnings, and an aeronautical meteorological station for aviation. Currently the AWS is measuring wind speed and direction, atmospheric pressure, air temperature, minimum temperature and humidity, however it has not fully fulfil the GCOS, Synoptic and aeronautical meteorological, stations’ requirements. | For the aeronautical meteorological station’s requirements, there is a need to measure height of cloud bases and visibility. This will require a ceilometer and a visibility sensor to be added to the existing AWS. For the GCOS and climate services’ requirements there is a need to add on to the current AWS the sensors to measure soil temperature, soil moisture, grass minimum temperature, water quality, water level, water salinity and evaporation rate. Need HimawariiCast ground station receiving equipment. |
| Very limited spares for basic meteorological instrument including maximum temperature thermometer, minimum temperature thermometer, dry and wet bulb temperature thermometers. | Organize for a stock of spare thermometers. |
| Limited meteorological monitoring stations. | Weather and climate on eastern side is different from the western side of the island. Currently there is only 1 meteorological station on the island and there is a need for another station on the islands. |
| Limited skill in information and technology. | SPREP with support from the FINPAC project provided 2 regional training in information and technology but limited to weather forecasters and technicians from Fiji, Papua New Guinea, Solomon Islands, Tonga and Vanuatu. There is still a need to continue this training and include Niue. |
| Limited satellite dish to access, and limited computer hardware and software to process, meteorological satellite information. | Install new HimawariiCast ground station receiving equipment, and it includes satellite dish to access, and computer hardware and software to process meteorological satellite information. |
| Staff members have very limited skill to maintain and calibrate electronic information technological based meteorological equipment, including AWS and related sensors. | FMS with support from JICA provided 2 regional trainings (2015 & 2016) on maintenance and calibration of electronic meteorological equipment. Provide additional resources to continue the training and also include AWSs and related sensors. |
| Limited skills and experiences in weather observations. | FMS with the support of JICA provided a regional training on basic weather observations and Niue participated in this training. However, there is still a need for follow training especially in-country training and also to include Aeronautical Meteorological Observers (AMO) competency assessment. |
| Limited skills and experiences in weather forecasting and services. | Provide training in weather forecasting and services. |
| No dedicated GTS, no direct communication link to Melbourne MTN and lack of compliance with the WIS requirements with existing communication system. | Install dedicated GTS or equivalent, with direct link to Melbourne NTN, including computer hardware and software, and all compliance with the WIS specifications. |
| Papua New Guinea | New staff and limited skills in basic weather observations especially at international aerodromes. | Organize in-country training for new staff and other staff member in weather observations. |
| Majority of staff at Meteorological Station at international aerodromes are to regularly assessed and certified to AMOs requirements. | Organize in-country training in competency assessment of AMOs. |
| Currently new staff members undertake training in weather observations, however the training materials and the actual training of staff need to be reviewed for compliance with WMO BIP-MT in the area of weather observations. | Review and draft updated training curriculum for BIP-MT in the area of weather observations. |
| Need refresher training in weather forecasting. | Provide in-country training in weather forecasting especially on severe weather events other than tropical cyclones. |
| 2 upper air stations are not operating due to lack of resources and obsolete equipment. | Provide and install new equipment and other facilities including training to get the 2 upper air stations into operation again. |
| Time delayed for receiving, limited to no direct access to, data from AWSs operating in Papua New Guinea. Data are transmitted from the AWSs to a satellite and from the satellite to ground stations in another country and from this country to Papua New Guinea NWS via GTS. | Assess current situation and explore ways to allow the NWS to regular access data in near-real time from AWSs operating in Papua New Guinea. |
| High costs and dependency on mobile telephone networks for collecting and transmitting meteorological data from AWSs to the NMHSs. | Assess current situation and explore complimentary or alternative low cost and back-up communication systems for collecting and transmitting meteorological data from AWSs to the NMHSs. |
|  | AWSs are installed at locations where main national telephone networks are not available. | Identify best potential communication systems to collect and transmit data from the AWSs to the NWS taking into consideration near real-time, easy and regular direct access to the data. |
|  | Staff members have very limited skill to maintain and calibrate electronic information technological based meteorological equipment, including AWS and related sensors. | Provide training and to also include AWSs and related sensors. |
|  | Very limited spares for basic meteorological instrument including maximum temperature thermometer, minimum temperature thermometer, dry and wet bulb temperature thermometers. | Organize for a stock of spare thermometers. |
| Lack of planning for maintenance, calibration and replacement of equipment. | Develop an Operation, Monitoring and Maintenance Plan for all equipment. |
|  | Currently there is no legislation for meteorological services. | Draft Meteorology Bill for Papua New Guinea. |
|  | Limited equipment calibration facilities. Only one calibration laboratory and kit in the Pacific Region, operated by the Fiji Meteorological Service, but can only calibrate certain equipment and not all equipment. Also calibration is done on a yearly basis, based on project-based funding from JICA, but the cost of calibrating after end of project and on a needs basis might be too expensive for many NMHSs. | Install equipment calibration facilities for Papua New Guinea National Weather Service. |
|  | Limited QMS especially ISO 9001: 2015 and Part 174 auditing, compliance and reporting. | Assess Papua New Guinea National Weather Service QMS system especially ISO 9001” 2015 and Part 174, and provide recommendations for regular auditing. |
| Limited capacity for auditing NMHSs compliance and reporting to ICAO Annex 3. | Organize training on auditing NMHSs for compliance with ICAO Annex 3. |
| Limited resources for logistic and operation support due to limited support from the national government budgets. | Advocacy of the importance of NMHSs to climate change adaptation and disaster risk reduction. |
| Reliance on projects and donor assistance for logistics, observations and operational support. | Advocacy of the importance of NMHSs to climate change adaptation and disaster risk reduction. |
| Limited integration of all hydro-meteorological data. | Advocacy of WIGOS at national level. |
| Limited skills in project development and implementation. | Provide in-country training in project development and implementation. |
| Limited skills in leadership and management. | Provide in-country training in leadership and management. |
| Limited capacity in oceans’ observations. | Provide training on ocean-based observing systems. |
| Samoa | New staff and limited skills in basic weather observations especially at international aerodromes. | Organize in-country training for new staff and other staff member in weather observations. |
| Majority of staff at Meteorological Station at international aerodromes are to regularly assessed and certified to AMOs requirements. | Organize in-country training in competency assessment of AMOs. |
| Currently new staff members undertake training in weather observations, however the training materials and the actual training of staff need to be reviewed for compliance with WMO BIP-MT in the area of weather observations. | Review and draft updated training curriculum for BIP-MT in the area of weather observations. |
| Need refresher training in weather forecasting. | Provide in-country training in weather forecasting especially on severe weather events other than tropical cyclones. |
| Time delayed for receiving, limited to no direct access to, data from AWSs operating in Samoa. Data are transmitted from the AWSs to a satellite and from the satellite to ground stations in another country and from this country to Samoa Meteorological Service via GTS. | Assess current situation and explore ways to allow the NWS to regular access data in near-real time from AWSs operating in Samoa. |
| High costs and dependency on mobile telephone networks for collecting and transmitting meteorological data from AWSs to the NMHSs. | Assess current situation and explore complimentary or alternative low cost and back-up communication systems for collecting and transmitting meteorological data from AWSs to the NMHSs. |
| Staff members have very limited skill to maintain and calibrate electronic information technological based meteorological equipment, including AWS and related sensors. | Provide training and to also include AWSs and related sensors. |
| Very limited spares for basic meteorological instrument including maximum temperature thermometer, minimum temperature thermometer, dry and wet bulb temperature thermometers. | Organize for a stock of spare thermometers. |
| Lack of planning for maintenance, calibration and replacement of equipment. | Develop an Operation, Monitoring and Maintenance Plan for all equipment. |
|  | Currently there is no legislation for meteorological services. | Draft Meteorology Bill for Samoa. |
| Limited equipment calibration facilities. Only one calibration laboratory and kit in the Pacific Region, operated by the Fiji Meteorological Service, but can only calibrate certain equipment and not all equipment. Also calibration is done on a yearly basis, based on project-based funding from JICA, but the cost of calibrating after end of project and on a needs basis might be too expensive for many NMHSs. |  |
| Limited QMS especially ISO 9001: 2015 and Part 174 auditing, compliance and reporting. | Assess Samoa Meteorological Service QMS system especially ISO 9001: 2015 and Part 174, provide recommendations regular auditing. |
| Limited capacity for auditing NMHSs compliance and reporting to ICAO Annex 3. | Organize training on auditing NMHSs for compliance with ICAO Annex 3. |
| Limited resources for logistic and operation support due to limited support from the national government budgets. | Advocacy of the importance of NMHSs to climate change adaptation and disaster risk reduction. |
| Reliance on projects and donor assistance for logistics, observations and operational support. | Advocacy of the importance of NMHSs to climate change adaptation and disaster risk reduction. |
|  | Limited integration of all hydro-meteorological data. | Advocacy of WIGOS at national level. |
| Limited skills in project development and implementation. | Provide in-country training in project development and implementation. |
| Limited skills in leadership and management. | Provide in-country training in leadership and management. |
| Limited capacity in oceans’ observations. | Provide training on ocean-based observing systems. |
| Solomon Islands | 2 silent synoptic/surface stations due to lack of resources to replace obsolete equipment. | SPREP with support from the Finland-Pacific (FINPAC), project provided basic equipment for 1 station. Provide AWS for the remaining silent station to measure wind speed and direction, atmospheric pressure, rainfall, air temperature, maximum temperature, minimum temperature, rainfall, humidity, salinity, water level, quality of water and soil temperature. |
| Upper air station non-operational due to obsolete equipment and lack of resources. | Provide and install new equipment and other facilities including training to get the upper air station into operation again. |
| New staff and limited skills in basic weather observations especially at international aerodromes. | Organize in-country training for new staff and other staff member in weather observations. |
| Majority of staff at Meteorological Station at international aerodromes are to regularly assessed and certified to AMOs requirements. | Organize in-country training in competency assessment of AMOs. |
| Currently new staff members undertake training in weather observations, however the training materials and the actual training of staff need to be reviewed for compliance with WMO BIP-MT in the area of weather observations. | Review and draft updated training curriculum for BIP-MT in the area of weather observations. |
| Need refresher training in weather forecasting. | Provide in-country training in weather forecasting especially on severe weather events other than tropical cyclones. |
| Time delayed for receiving, limited to no direct access to, data from AWSs operating in Solomon Islands. Data are transmitted from the AWSs to a satellite and from the satellite to ground stations in another country and from this country to the Solomon Islands Meteorological Service via GTS. | Assess current situation and explore ways to allow the NWS to regular access data in near-real time from AWSs operating in the Solomon Islands. |
| Staff members have very limited skill to maintain and calibrate electronic information technological based meteorological equipment, including AWS and related sensors. | Provide training and to also include AWSs and related sensors. |
| Very limited spares for basic meteorological instrument including maximum temperature thermometer, minimum temperature thermometer, dry and wet bulb temperature thermometers. | Organize for a stock of spare thermometers. |
| Lack of planning for maintenance, calibration and replacement of equipment. | Develop an Operation, Monitoring and Maintenance Plan for all equipment. |
| Limited equipment calibration facilities. Only one calibration laboratory and kit in the Pacific Region, operated by the Fiji Meteorological Service, but can only calibrate certain equipment and not all equipment. Also calibration is done on a yearly basis, based on project-based funding from JICA, but the cost of calibrating after end of project and on a needs basis might be too expensive for many NMHSs. |  |
| Limited QMS especially ISO 9001: 2015 and Part 174 auditing, compliance and reporting. | Assess Samoa Meteorological Service QMS system especially ISO 9001: 2015 and Part 174, provide recommendations regular auditing. |
| Limited capacity for auditing NMHSs compliance and reporting to ICAO Annex 3. | Organize training on auditing NMHSs for compliance with ICAO Annex 3. |
| Limited resources for logistic and operation support due to limited support from the national government budgets. | Advocacy of the importance of NMHSs to climate change adaptation and disaster risk reduction. |
| Reliance on projects and donor assistance for logistics, observations and operational support. | Advocacy of the importance of NMHSs to climate change adaptation and disaster risk reduction. |
| Limited integration of all hydro-meteorological data. | Advocacy of WIGOS at national level. |
| Limited skills in project development and implementation. | Provide in-country training in project development and implementation. |
| Limited skills in leadership and management. | Provide in-country training in leadership and management. |
| Limited capacity in oceans’ observations. | Provide training on ocean-based observing systems. |
| Tuvalu | Limited coverage meteorological monitoring stations on the islands/atolls. | Install 6 new AWSs to measure wind speed and direction, humidity, atmospheric pressure, rainfall, evaporation, maximum temperature, air temperature, minimum temperature, soil temperature, soil moisture and salinity. |
| Staff members have very limited skill to maintain and calibrate electronic information technological based meteorological equipment, including AWS and related sensors. | FMS with support from JICA provided 2 regional trainings (2015 & 2016) on maintenance and calibration of electronic meteorological equipment. Provide resources to continue the training and to also include AWSs and related sensors. |
| Limited satellite dish access, and limited computer hardware and software to process, meteorological satellite information. | Install new HimawariiCast ground station receiving equipment, and it includes satellite dish to access, and computer hardware and software to process meteorological satellite information. |
| No dedicated GTS and lack of compliance with the WIS requirements with existing communication system. | Install dedicated GTS with WIS specifications including computer hardware and software for storage and communication system to relay the data onto the GTS. |
| Limited skill in information and technology. | SPREP with support from the FINPAC project provided 2 regional training in information and technology and limited to weather forecasters and technicians from Fiji, Papua New Guinea, Solomon Islands, Tonga and Vanuatu. There is still a need to continue this training and include Tuvalu. |
| Tonga | Staff members have very limited skill to maintain and calibrate electronic information technological based meteorological equipment, including AWS and related sensors. | FMS with support from JICA provided 2 regional trainings (2015 & 2016) on maintenance and calibration of electronic meteorological equipment. Provide resources to continue the training and to also include AWSs and related sensors. |
|  | Limited skill in information and technology. | SPREP with support from the FINPAC project provided 2 regional training in information and technology to limited number (2 per country) of weather forecasters and technicians from Fiji, Papua New Guinea, Solomon Islands, Tonga and Vanuatu. However, there is still a need to continue this training and to provide opportunity for other technicians to participate in such training. |
| Very limited spares for basic meteorological instrument including maximum temperature thermometer, minimum temperature thermometer, dry and wet bulb temperature thermometers. | Organize for a stock of spare thermometers. |
| Expanding oceanographic observation network. | Install 2 new stationary surface buoy stations to measure sea-temperature, wind speed and direction, and atmospheric pressure. |
| No dedicated GTS and lack of compliance with the WIS requirements with existing communication system. | Install dedicated GTS with WIS specifications including computer hardware and software for storage and communication system to relay the data onto the GTS. |
| Vanuatu | High Frequency (HF) radios are obsolete and need replacement with digital system. | Install 7 digital HF radio systems in the 7 Offices in the outer-islands. |
| The upper air station at Bauerfield international airport is non-operational due to obsolete equipment and lack of resources. | Provide and install new equipment and other facilities including training to get the upper air station into operation again. |
| Staff members have very limited skill to maintain and calibrate electronic information technological based meteorological equipment, including AWS and related sensors. | FMS with support from JICA provided 2 regional trainings (2015 & 2016) on maintenance and calibration of electronic meteorological equipment. Provide resources to continue the training and to also include AWSs and related sensors. |
| Limited skills in information and technology. | SPREP with support from the FINPAC project provided 2 regional training in information and technology to limited number (2 per country) of weather forecasters and technicians from Fiji, Papua New Guinea, Solomon Islands, Tonga and Vanuatu. However, there is still a need to continue this training and to provide opportunity for other technicians to participate in such training. |
| Limited base-line data and information of current status of Vanuatu national observing system. | Conduct assessment of Vanuatu national observing system. |
| Vanuatu has been sending it personnel to the FMS for BIP-MT in weather observations. | Assist Vanuatu to develop a training package in BIP-MT in weather observations to be delivered in-country. |
| No dedicated GTS and lack of compliance with the WIS requirements with existing communication system. | Install dedicated GTS or equivalent with WIS specifications including computer hardware and software for storage and communication system to relay the data onto the GTS. |
|  |  |  |

# Session VI: Workshop Deliverables and Next Steps

The meeting discussed issues surrounding improving the observational systems in the Pacific. The meeting concluded that:

* Systematic observation of the Earth’s climate is a global common good that supports the implementation of the Paris Agreement, in the context of sustainable development and efforts to eradicate poverty.
* Many meteorological observations, made at high spatial and temporal density, support local forecasting and warning applications. These observations are a national responsibility contributing to national and regional needs with some additional global value.
* However, systematic upper air observations, made routinely by radiosondes under the WMO World Weather Watch (WWW) Programme, including the GCOS Upper Air Network (GUAN), support numerical weather prediction (NWP) leading to global benefits. These observations are used primarily for forecasting and climate applications at the international level, including climate re-analyses which form the basis of much of our understanding of climate and climate change; and
* Systematic upper air observations in the Pacific region, tend to have the highest measured impact, of all ground-based measurements, on the quality and accuracy of weather and climate analysis and prediction not only locally, but globally. The resulting products underpin weather and climate aspects of early warning systems as well as other climate-related services.
* Both the spatial density and observing frequency of the upper air network over the South Pacific region currently fall short of GCOS and WMO requirements. Due to the unique geography of the region – vast swathes of ocean surface with relative little land mass distributed over some 20 small island states with modest-size populations and correspondingly modest GDPs – systematic observation is particularly challenging in this region.
* The upper air network over the South Pacific therefore needs sustained international support.
* The workshop developed an outline for a *Pacific region observing network plan in support of the GCOS Implementation Plan and the Implementation Plan for the Evolution of Global Observing Systems (EGOS IP) t*o:
  + Strengthen regional and national meteorological networks to support adaptation actions and avert loss and damage;
  + Identify capacity building needs to ensure the sustainability of the networks;
  + Be used to support requests for finance from the operating entities of the financial mechanism under the Convention, the GCOS Cooperation Mechanism and other relevant funding sources.
* Support of the observing network in the region should be based on transparent processes and a commitment to free and open data sharing in accordance with WMO Resolutions 40 and 60 and the GCOS Monitoring Principles. The network should be designed to be, efficient, sustainable, it should meet agreed international standards as well as national requirements. Ensuring sustainability is of paramount importance, and the network plan must therefore also include the necessary elements of capacity development.
* The draft plan will be developed by GCOS and WMO in collaboration with Secretariat of the Pacific Regional Environmental Programme (SPREP), the Pacific Islands Communication and Infrastructure Panel (PICI), and Pacific Meteorological Council, and submitted to COP 24.

Annex A contains the outline of the plan that will be further developed. Some issues in the region that need to be addressed were highlighted by the participants. These included:

* Communications: Many of the Pacific islands are remote and communications are not straightforward. Chatty Beetles provide one of a suitable option and their use should be encouraged.
* Transport: The distances involved and the need to use infrequent ships mean that remains and maintained are often delayed and equipment takes longer to be repaired. Additional expense is involved in addressing this.
* Precipitation is an important parameter both in mountainous islands where issues include flooding and drought, and atolls where drought and sea water intrusion are large concerns.
* Typical metrological stations do not reflect the variable nature of precipitation on many islands and simpler, cheaper voluntary observing systems should be considered to address some of these needs.
* Assistance in procurement to ensure cost-effective solutions are purchased that meet requirements specified by WMO is needed. A joint purchase of equipment and consumables for several countries is may be part of the solution.
* Training is needed and suitable facilities to do this are available in SPREP and Fiji Meteorological Service.

# Annex A – Outline Plan

**Pacific Region Observing Network Plan:**

**in Support of the GCOS and EGOS Implementation Plans (Simon)**

1. **Articulate requirement: how does it contribute to (JP, SE, TO, LPR)**
   1. Firstly, Global Climate needs – a global good
   2. Secondly, Early Warning Systems
2. **Link to quantitative requirements WMO RRR and GCOS ECV (SE, TO, LPR)**
   1. These are achievable and these are what the scientific community says are needed
3. **Alignment with PICI Panel strategy (PICI Panel, Pacific Met Desk)**
   1. How regional approach meets local plans, and other plans such as Region V plan, Pacific Met Plan
   2. Regional Partnerships
4. **Make a strong case for Basic Observing Needs observations as a global good (LPR)**
   1. Simple economic arguments, local funding makes no sense, present numbers, e.g. Look at GDP/km2 and UK Met Office studies
   2. Build case for long-term international support to ensure sustainability of radiosondes
5. **Explain gap between what is needed and what exists (TO, LPR – global aspects, Pacific Met Desk)**
   1. Country by country status,
   2. Also, national aspects
6. **Define an achievable and realistic end state (TO, LPR, SE, Pacific Met Desk)**
   1. Look at region and define a reasonable proposal for sites that are fundable.
   2. Buy in from national met offices
   3. Regional support of smaller Met offices, regional cooperation on maintenance, spares, training
   4. Define common standards and equipment, to have common spares and consumables (reduce costs etc.)
7. **Outline the necessary steps (Wilson, PACIFIC MET DESK, TO, All countries!)**
   1. Rehabilitation of existing stations
   2. Upgrade of telecommunications
   3. Installation of new stations as needed
   4. Integration with measurements from aircraft, ships and buoys (show that we are integrating other measurements as much as possible)
   5. Optimise integration of use of satellite data (particularly as there is so little land for monitoring)
   6. Build the necessary HR capacity: Staffing, Training Education. Consider regionally based training and expertise. Practical skills needed
   7. Equipment should match local personnel skills
   8. Consumables
   9. Regional quality management (Regional WIGOS Centre)
8. **Estimate Required Financial Resources (Wilson, PACIFIC MET DESK, TO, All countries!)**
9. **Sustainability (Arona)**
   1. How is this achieved – global responsibility
   2. National commitment
   3. Technical aspects (of network, maintenance, HR capacity etc.)
   4. Equipment should match local personnel skills
   5. Transparent procurement – a regional approach? – ISO?
10. **Possible management and procurement structures (PICI Panel)**

# Annex B – Agenda

**Monday, 9 October**

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| **Workshop Opening** Ceremony  Master of Ceremony (MC): Mr. Henry Taiki, WMO Secretariat | | |
| 08:30 – 09:00 | Registration |  |
| 09:00 – 09:10 | Welcome Quests and Opening Prayer |  |
| 09:10 – 09:20 | Statement on Behalf of the WMO Secretary-General | Mr. Lars Peter Riishojgaard, WMO Secretariat |
| 09:20 – 09:30 | Statement on Behalf of the GCOS Secretariat | Mr. Simon Eggleston, GCOS Secretariat |
| 09:30 – 09:40 | Statement on Behalf of the United Nations Framework Convention on Climate Change (UNFCCC) Secretariat | Ms. Joanna Post, UNFCCC Secretariat |
| 09:40 – 09:50 | Statement on Behalf of the Secretariat of the Pacific Regional Environment Programme (SPREP) | Ms. Siosinamele Lui, SPREP |
| 09:50 – 10:00 | Opening Address on Behalf of Fiji Government | Mr Ravind Kumar, Director of Fiji Meteorological Service and PR of Fiji with WMO |
| 10:00 – 10:30 | *Group Photo & Coffee / Tea Break* | |
| **Session I: Scope and Purpose of Workshop including Background Information on UNFCCC, GCOS and WIGOS**  (Chairperson: Mr. Ravind Kumar, Fiji) | | |
| 10:30 – 10:50 | Setting the Scene of the Workshop: Workshop Goals | Mr. Simon Eggleston, GCOS Secretariat; and Dr Lars Peter Riishojgaard, WMO Secretariat |
| 10:50 – 11:10 | UNFCCC Need for Systematic Observations | Ms. Joanna Post, UNFCCC Secretariat |
| 11:10 – 11:35 | GCOS Implementation Plan | Mr. Simon Eggleston, GCOS Secretariat |
| 11:35 – 12:00 | Introduction to WIGOS | Mr. Lars Peter Riishojgaard, WMO Secretariat |

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| 12:00 – 12:30 | Activities of Pacific Meteorological Council (PMC) and the Pacific Islands Communication and Infrastructure (PICI) Panel | Ms. Siosinamele Lui, SPREP; and Mr. Wilson Leguvaka, Chair of the PICI Panel |
| 12:30 – 14:00 | *Lunch Break* | |

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| **Session II: Observational Data Requirements for the Pacific**  (Chairperson: Mr. Arona Ngari, Cook Islands) | | |
| 14:00 – 14:30 | GCOS Essential Climate Variables and Implications for the Pacific SIDS | Dr. Simon Eggleston, GCOS Secretariat |
| 14:30 – 15:00 | The WMO Rolling Review of Requirements and the Observing System Capability Analysis and Review Tool (OSCAR)/Requirements Database | Dr. Lars Peter Riishojgaard, WMO Secretariat |
| 15:00 – 15:30 | WMO Regional Activities | Mr. Henry Taiki, WMO Secretariat |
| 15:30 – 16:00 | *Coffee / Tea Break* | |
| 16:00 – 16:30 | WMO Region V (South-West Pacific) Working Group on Infrastructure (RA-V WG-INFR) | Mr. Karl Monnik, Chair of RA-V WG-INFR |
| **Session III: National Observing Capabilities and Needs**  (Chairperson: Mr Henry Taiki, WMO Secretariat) | | |
| 16:30 - 16:50 | Fiji |  |
| 16:50 – 17:10 | Cook Islands |  |
| 18:00 – 20:00 | *Welcome Cocktail Reception @ Tanoa Nadi Hotel* | |

**Tuesday, 10 October**

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| 09:00 – 09:20 | Statement on behalf of UNFCCC Subsidiary Body for Scientific and Technological Advice (SBSTA) | Mr. Carlos Fuller, Chair of UNFCCC SBSTA. |
| **Session III: National Observing Capabilities and Needs Continued**  (Chairperson: Mr Henry Taiki, WMO Secretariat) | | |
| 09:20 – 09:40 | Federated States of Micronesia | Mr. Wilfred Nanpei |
| 09:40 – 10:00 | Kiribati | Mr. Kiaronga Iabeti |
| 10:00 – 10:20 | Marshall Islands | Mr. Nover Juria |
| 10:20 – 10:40 | Nauru | Mr. Barassi Botelanga |
| 10:40 – 11:00 | ***Coffee/Tea Break*** | |
| 11:00 – 11:20 | Niue | Mr. Robert Togiamana |
| 11:20 – 11:40 | Palau | Ms. Joyleen Tmatk |
| 11:40 – 12:00 | Papua New Guinea | Ms. Kisolel Posanau |
| 12:00 – 12:20 | Samoa | Mr. Eseese Ah Ken |
| 12:20 – 14:00 | ***Lunch Break*** | |
| 14:00 – 14:20 | Solomon Islands | Mr. Barnabas Tahunipue |
| 14:20 – 14:40 | Tonga | Mr. Selusalema Vite |
| 14:40 – 15:00 | Tuvalu | Mr. Tauala Katea |
| 15:00 – 15:20 | Vanuatu | Mr. Joe Stanley Mala |
| 15:20 – 16:00 | ***Coffee/Tea Break*** | |

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| **Session IV: Regional Observing System Capabilities**  (Chairperson: Dr. Simon Eggleston, GCOS Secretariat) | | |
| 16:00 – 16:20 | Overview of GCOS Network | Mr. Tim Oakley, WMO Secretariat |

**Wednesday, 11 October**

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| **Session V: Gap Analysis and Mitigation Steps**  (Chairperson: Ms. Joanna Post, UNFCCC Secretariat) | | |
| 09:00 – 09:10 | WMO Country Profile Database | Mr. Lars Peter Riishojgaard, WMO Secretariat |
| 09:10 – 09:30 | UNFCCC National Adaptation Plans | Ms. Joanna Post, UNFCCC Secretariat |
| 09:30 – 09:50 | WIGOS-Related Gaps in the Pacific Region | Mr. Lars Peter Riishojgaard, WMO Secretariat |
| 09:50 - 10:30 | Overview of GCOS Network / GCOS Essential Climate Variable - Related Gaps in the Pacific Region / Network performance - Precipitation data in support of climate monitoring / Network performance - Upper air data in support of climate monitoring | Mr. Tim Oakley, WMO Secretariat; and Dr. Simon Eggleston, GCOS Secretariat |
| 10:30 – 11:00 | *Coffee/Tea Break* | |
| 11:00 – 12:30 | Regional WIGOS/GCOS Plan | Plenary discussion |
| 12:30 – 14:00 | *Lunch Break* | |
| 14:00 – 15:30 | Possible Gap Mitigation Steps: Technical Elements | Breakout groups discussions |
| 15:30 – 16:00 | *Coffee/Tea Break* | |
| 16:00 – 16:30 | Groups’ presentations | Plenary discussion |
| 16:30 - 17:00 | Start discussion on workshop’s communication | Plenary discussion |

**Thursday 12 October**

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| **Session VI: Workshop Deliverables and Next Steps**  (Chairperson: Dr. Lars Peter Riishojgaard, WMO Secretariat) | | |
| 08:30 – 08:50 | Network performance - Upper air data in support of climate monitoring | Mr. Tim Oakley, GCOS Secretariat |
| 08:50 – 09:10 | Network performance - Precipitation data in support of climate monitoring | Mr. Simon Eggleston, GCOS Secretariat |
| 09:10 – 09:45 | Workshop Outcomes/Deliverables: Input to COP-23, WMO EC-70, RA-V-17, GCOS Collaboration Mechanism, … | Plenary |
| 09:45 – 10:00 | Introduction to breakout groups’ discussions | Plenary |
| 10:00 -12:30 | *Group Visit to Fiji Met Service* | |
| 12:30 – 14:00 | *Lunch Break* | |
| 14:00 – 15:00 | Breakout groups’ discussions | Breakout groups |
| 15:00 – 15:30 | *Coffee/Tea Break* | |
| 15:30 – 16:00 | Breakout groups’ presentations | Plenary |
| 16:00 - 16:30 | Reflection on breakout groups presentations & discussion on way forward | Plenary |
| 16:30 – 17:00 | Closing remarks |  |

# Annex C – Participants

**List of Participants**

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| **COUNTRY** | **NAMES** | **CONTACTS** |
| **Australia** | Mr Karl Monnik | [k.monnik@bom.gov.au](mailto:k.monnik@bom.gov.au) |
| **Cook Islands** | Mr Arona Ngari | [Arona.ngari@cookislands.gov.ck](mailto:Arona.ngari@cookislands.gov.ck) |
| **Federated States of Micronesia** | Mr Wilfred Nanpei | [Wilfred.nanpei@noaa.gov](mailto:Wilfred.nanpei@noaa.gov) |
| **Fiji** | Meleti Banimarama |  |
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|  | | |
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1. a portable Iridium satellite terminal that permits text-based alerts and messaging in remote locations, where communication options are limited. [↑](#footnote-ref-1)