AUSTRALIAN BUREAU OF METEOROLOGY - COUNTRY REPORT

Reporting on activities supporting Pacific Key Outcomes (PKOs) of the Pacific Islands Meteorological Strategy (PIMS) 2012-2021

This Report is presented to the Fourth Meeting of the Pacific Meteorological Council (PMC-4) held in Honiara from 14-17 August 2017

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1.0 Summary

This report outlines activities in which the Australian Bureau of Meteorology (the Bureau) is engaged in the Pacific Island Countries and Territories (PICTs) including:

- Aid-funded activities supported by the Australian Department of Foreign Affairs and Trade;
- Training activities carried out by the Bureau of Meteorology Training Centre;
- Information on the Australian contribution, through the Bureau, of guidance products from the Bureau National Operations Centre (BNOC) and the Darwin Regional Specialised Meteorological Centre (RSMC);
- The Bureau's role in hosting the WMO Regional Instrument Centre (RIC); and
- Activities the Bureau has supported directly through its core funding allocation and activities conducted under part cost-recovery arrangements.

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2.0 Aid-funded activities supported by the Australian Department of Foreign Affairs and Trade

2.1 Climate and Oceans Support Program in the Pacific – July 2012 to June 2018

The Climate and Oceans Support Program in the Pacific (COSPPac) is a component of Australia's contribution to minimising the impacts of climate variability and change in the Pacific and to meeting the Australian Government's climate change aid objectives. It has a total budget of approximately $39.3M for six years. The timeline of the program is 1 July 2012 to 30 June 2018. Initially the project had a budget of $A31.5M over four years. DFAT have since extended the project by two years to allow transition of COSPPac products and activities to relevant regional agencies.

The higher level shared development outcome that COSPPac is intended to contribute to is:

- Pacific Island countries have skills and information to adapt to climate variability and change contributing to sustainable livelihood.

The specific outcome for COSPPac is:

- Pacific Island NMHSs and other relevant in-country agencies understand and use climate, ocean and sea level products for the benefit of island communities and governments.

The work of COSPPac is structured (with accompanying activities) within four areas (sub-projects):

- Capacity Development and Communications (CD&C)
- Climate and Ocean Monitoring and Prediction (COMP) and
- Pacific Sea Level Monitoring (PSLM)
- Climate Data for the Environment (CliDE)

The Program is focused on the needs of Pacific 14 NMHSs, with Land and Survey Departments (L&SD) also important user stakeholders. COSPPac is implemented by the Australian Bureau of Meteorology (the Bureau), in partnership with Geoscience Australia (GA), the Pacific Community (SPC), and the Secretariat of the Pacific Regional Environment Programme (SPREP).

COSPPac contributes to regional priorities and aligns with the Pacific Islands Meteorological Strategy (PIMS) and the Pacific Roadmap for Strengthened Climate Services (PRSCS). COSPPac provided funding support through SPREP for the PIMS and PRSCS reviews and COSPPac staff were involved in a mid-term review of the PIMS in October 2016, and contributed to the implementation plan at the PIMS and PRSCS workshop in Nadi in May 2017.

As part of the Australian Government's performance assessment process, an Independent Progress Review (IPR) was commissioned in early 2014, the mid-point of the Program. The IPR has two purposes: to assess the progress of COSPPac against its design, including any modifications agreed to by its partners through Annual Work plans; and to consider how Australia can best support Pacific NMHSs after 2016. The Review stated that "The Program is highly effective in many different ways across 14 partner countries" and "The key Program stakeholders, Pacific Island NMHSs, consistently identified positive and substantial benefits in all areas of programming." It recommended that COSPPac products and services be transferred to regional partners where appropriate.

In response, COSPPac has been in active transition since 2015; staffing within the Bureau has been significantly reduced and recruitment and training of similar positions has taken place in Pacific Regional Organisation Partners as part of the transition process. During 2017-18 as products and services are transitioned the Bureau will be continuing to support the Pacific organisations in their first full year of running services operationally. The transition of a significant science and technology Program to its Pacific partners has not been undertaken on this scale before, the transition of products and services to the region is demonstration of the capacity building success of the program. There will also be opportunities to see how the services and structures fit with both DFAT's emerging Pacific climate change strategy and potential extension opportunities through alternative funding mechanisms, such as the Green Climate Fund.

3.0 Activities under the Pacific Public Sector Linkages Program (PPSLP) and the Government Partnership for Development (GPFD)

3.1. Quality Management System for Aviation Weather Services Project (Addresses PIMS PKO 1, 11)

The Objective of this project was to assist Pacific Island NMHSs to achieve certification to the International Organization for Standardization (ISO) 9001 Quality Management Standard) through a sustainable national internal audit regime for aviation weather services.

The project assisted counterpart organisations (PICs) to develop a quality management system (QMS) to meet the requirements of the International Civil Aviation Organization (ICAO) Annex 3 to the Convention on International Civil Aviation, Meteorological Services for International Air Navigation to deliver aviation weather services in conformity with the (ISO) 9000 series of quality assurance standards and in particular, the international ISO 9001 Quality Management Standard. (See Annex I, Attachment A for further details)

3.2 Training and implementing systems for participation by Pacific Island countries in open international exchange of meteorological information (Addresses all PIMS PKOs)

The key objective of the activity was to assist counterpart organisations to develop the capacity for full participation in WMO systems for transmitting and handling the weather, climate and environmental information that are vital for the sustainable economic development and mitigation of severe weather and natural disasters.

4.0. Contributions from the Bureau's core budgeted funds and through cost-recovery activities

The following contributions were made by the Bureau through its core budget, including providing staff time to carry out WMO and DFAT funded activities in the region:

- Following from the PNG National Weather Service evaluation in 2014, cooperation in meteorological matters has now been included as an area of cooperation in an Annex to the Memorandum of Understanding between Australia and PNG on cooperation in the transport sector (as meteorology falls within the Department of Transport in PNG). The Bureau and the NWS have been liaising with their respective transport agencies and DFAT to plan an initial two year activity under this arrangement, expected to commence in September 2017. The agreed budget for the activity allows for reciprocal visits, strategic planning, including of the observations network, training, and assistance with services for APEC in 2018.

4.1 Other externally funded activities under part cost recovery arrangements

A. Implementation of WMO Information System/ Table Driven Code Form (WIS/TDCF) (Addresses PIMS PKO 7)

The project was aimed at assisting NMHSs to be informed of what needs to be done to implement WIS/TDCF. A WIS Implementation Plan has been developed for WMO RA V countries, including the counterpart countries for this project. This plan is aimed at guiding RA V Members to implement WIS functionality in their identified data exchange centres and to become effective WIS users in a timely and harmonized manner, in order to participate in open international exchange of meteorological information (see Annex 1, Attachment B for further details).

B. Update on Fiji Integrated Meteorological Forecast System (FIMS) Upgrade (Addresses PIMS PKO 10)

FMS operates FIMS (an adaption of the Australian Integrated Forecast System, AIFS) at its Head Office in Nadi, Fiji. This system consists of two FMS AIFS servers and a storage system, which were upgraded in 2015. The upgrade consisted of a hardware upgrade and a move to the Linux operation system and updated applications to remain consistent with Bureau applications and support. The hardware had been previously replaced in 2008.5.0 Support under the WMO World Weather Watch Framework (see Annex 1, Attachment C for further details).

5.0 Support under the WMO World Weather Watch Framework

5.1 Guidance products (Addresses PIMS PKOs 1-6)

The Bureau's guidance products for the Pacific consist of a mixture of manual and NWP products, provided through public and Registered User web pages, by direct availability of model data where this has been organised, and also provided directly to the Severe Weather Forecasting and Disaster Risk Reduction Demonstration Project web site. These are provided by the Bureau National Operations Centre, Melbourne and RSMC Darwin. Following the commissioning of a new supercomputer, the Bureau has commenced a series of upgrades to the core numerical prediction products. (See Annex 1, Attachment D for more detail).

5.2 Melbourne WMO Regional Instrument Centre (RIC) (Addresses PIMS PKO 7)

The Melbourne RIC is a measurement and instrumentation laboratory. It maintains international traceable reference standards in Temperature, Humidity, Pressure, Solar Radiation, Rainfall and Ozone. The Melbourne RIC regularly calibrates reference instruments for the Bureau and RA V members. The RIC has provided technical advice, inter-comparisons and calibrations to RA V. This service has been utilised by Fiji and the Solomon Islands in the last 2 years. The RIC also hosts an annual visit by staff of BMKG Indonesia staff to the laboratory which provides them with upskilling of their experts, reference calibrations and the opportunity to strengthen ties in the region.

The Melbourne RIC has also provided metrology (measurement) training for RA V members and other government staff. Additionally, it provides instrument selection and siting advice and in the last two years has provided such advice to the Cook Islands, Fiji, Hong Kong, Indonesia and the Philippines.

In 2017 the Melbourne RIC undertook a solar instrument (pyrheliometer) inter-comparison at Tsuba Japan. This was a critical inter-comparison of RA-II and RA-V pyrheliometers timed to take place between international pyrheliometers comparisons at PMOD in Switzerland scheduled every 5 years.

Sea Level Monitoring

In late 2016 the Bureau completed construction of a new length calibration laboratory for sea-level monitoring. This state of the art facility replaces the calibration laboratory that has operated for the last 20 years at the National Tidal Unit in South Australia. Routine calibration of the primary sea level sensors, associated thermistors and levelling instrumentation continues to be undertaken on an 18 month cycle. In the next 12 months it is expected that the secondary sea level sensors will be added to this calibration schedule. The aim is to establish reliable into comparisons between the primary and secondary sea level sensors with the view to using the current secondary sensors in place of the primary. The secondary sensors are more reliable and robust and expected to provide as good or better sea level observation at lower cost.

The Bureau and Geosciences Australia are currently working to connect the sea level measurements to GNSS benchmarks on each island. This will enable reliable sea level observations relative to the geoid and ellipsoid for the Southwest Pacific.

The technical working group for the sea level project was reactivated this year and representatives from the Pacific Islands were instructed on developments in sea level measurement, quality control, siting and general metrology. A number of broader technical issues were discussed with both the island representatives and representatives of the data users .The Pacific Island staff also had a week-long training course in maintenance of the equipment.

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6.0 Education and Training Activities

6.1 Onsite and online training at the Bureau of Meteorology Training Centre (Addresses PIMS PKO 11)

Activity	Details
Pacific Island graduates on Graduate Diploma in Meteorology course (40 weeks, Jan-Nov)	2015 -1 student (Vanuatu) 2016 – no students completed 2017 – 2 students (Tonga)
BMTC hosted the 11th Southern Hemisphere Tropical Cyclone Workshop.	Held 5-9 October 2015. Fiji (2), and 1 each from Tuvalu, Solomon Islands, Vanuatu, Samoa, Fed. States for Micronesia, PNG, Cook Islands, Tonga, New Zealand
BMTC conducts monthly online "Regional Focus Group" meetings for RA-V as part of our activities as a Centre of Excellence in WMO-CGMS Virtual Laboratory in Satellite Meteorology, Education and Training program.	2015 -6 attendees over 6 meetings: Vanuatu (4), Solomon Islands (2) 2016 – 21 attendees over 12 meetings: ; Fiji (4), New Zealand (9), Solomon Islands (1), Tuvalu (1), Vanuatu (6) 2017 - 20 attendees over 7 meetings; Cook Islands (1), Fiji (3), Guam (2), New Zealand (3), Niue (1), Solomon Islands (3), Tonga (3), Tuvalu (2), Vanuatu (2)
Delivered Radar training in Melbourne (calibration and maintenance techniques) for a technician from Fiji.	1 attendee (Fiji), held 6 Sept – 22 Oct 2016
South Pacific Region 'Training Needs Review' meeting hosted by FMS on 19 February 2015	WMO, US NWS, COMET, FMS and Bureau stakeholders

ANNEX I - Attachments to Australian Country Paper to PMC-4

Quality Management System for Aviation Weather Services Project ANNEX I Attachment A

Objective: Achieving certification to the ISO 9001Quality Management Standard through a sustainable national internal audit regime for aviation weather services.

Brief description of project

The aim of the project was to assist counterpart organisations (PICs) to develop a quality management system (QMS) to meet the International Civil Aviation Organization (ICAO) *Annex 3 to the Convention on International Civil Aviation, Meteorological Services for International Air Navigation,* requirements to deliver their aviation weather services in conformity with the International Organization for Standardization (ISO) 9000 series of quality assurance standards and in particular, the international ISO 9001 Quality Management Standard .

The project was conducted in three stages. It commenced in November 2012 with an "in-region" five day internal auditor training course with two participants from each PIC (a total of 22), in Port Vila, Vanuatu. Participants were provided with an internationally recognised qualification as an internal Quality Management auditor.

The second stage involved inviting 20 PIC participants who had successfully completed the auditor training course (stage 1) to participate in real-time audits with the Bureau's experienced QM Section auditors. The participants were placed in 6 teams of 3 participants all from different Met Services and one team of two from Fiji. The mixed team approach enhanced the QM network throughout the SW Pacific and was a strategy to assist in ensuring the sustainability of QMSs throughout the Region. It also provided an ideal opportunity to consolidate their stage 1 workshop training in a practical environment and benchmark their audit techniques and performance as well as provide face-to-face guidance on issues they may have faced in developing and implementing their own QMS.

The third stage involved the selection of 12 participants who had successfully completed stages 1 and 2 to be provided with the opportunity to undertake Lead Auditor training. The training was conducted in Nadi, Fiji, in conjunction with Gary Management Systems Pty Ltd, an Australian Registered Training Organisation and the Bureau's Quality Assurance Unit. The Lead Auditor course is approved by the International Register of Certified Auditors (IRCA). All 12 participants successfully passed and have been awarded an internationally recognised Lead Auditor qualification.

Status of implementation to date and achievements

Stage 1 workshop has been completed and was very successful – this was supported by the very positive and extensive feedback from participants.

Stage 2 involved real-time practical QM auditor training conducted within the Bureau. Participant feedback was very positive and strongly endorsed the approach adopted.

Issues and proposed way forward

The Bureau continues to host the WMO Quality Management website on behalf of WMO. The website provides valuable information, resources and publications and tools for WMO Members on how to successfully implement a QMS.

The Bureau also manages a WMO Quality Management Forum on behalf of WMO. The purpose of the forum is to provide WMO Members with an opportunity to ask questions relating to the implementation of their QMS, source valuable QM resource material and advice on how to address any roadblocks that they may be experiencing. There are currently over 230 registered members.

Preliminary results on a survey conducted in 2016 by CAeM - WMO Region V on the status of implementation for Aeronautical Meteorology Service Providers (AMSPs) as to whether or not if their State/Territory had established a properly organized QMS for the provision of aeronautical meteorological service to international air navigation. It shows that 14 out of the 21 WMO Members listed had achieved certification of compliance or were in conformity with ISO 9001. Two advised they had a partial QMS in place and three advised they had no QMS in place. Two members did not respond. However, less than 50% had achieved certification of compliance by an external certification organization.

A recent survey circulated to Members of the Pacific Islands Aviation Weather Services panel (PIAWS) on the implementation of quality management approach in the Pacific Island Countries and Territories has shown that four out of the twelve respondents had achieved certification of compliance or were in conformity with ISO 9001. The mechanism used to establish this level of conformity was not provided. However, how it was established was not indicated. It is of note that two Members have achieved certification of compliance to ISO 9001 and one Member has achieved certification of compliance to ISO 9001:2015.

The challenge to implementing a QMS has been exacerbated by the upgrade to the new ISO 9001 Standard. There is now a need to be aware of, and to identify the new and enhanced requirements within ISO 9001:2015. It should also be noted that QM auditors are also required to upgrade their knowledge and skills to enable them to conduct effective audits against the new ISO 9001:2015 Standard.

WMO No.1100 – *Guide to the Implementation of a Quality Management System for National Meteorological and Hydrological Services* and other relevant services providers within an ISO 9001:2015 Quality Management Framework (Ed 2017).

This document written by Bryan Boase and Helen Tseros provides step by step guidance on how to implement a quality management system for NMHSs and other relevant service providers. The Guide has recently been updated to reflect the new requirements of ISO 9001:2015 and has a

wealth of resource material as well as tools that have proven very successful in providing tangible audit evidence that demonstrates that the requirements of ISO 9001:2015 have been met. The Guide is due for release in September 2017.

There is 'in-principle' endorsement for a proposal to conduct a training workshop for WMO Quality Management practitioners on the transition to the ISO 9001:2015 Quality Management Standard. The training workshop will primarily cover the elements provided in the update WMO Guide No.1100.

International exchange of meteorological information ANNEX I Attachment B

Training and implementing systems for participation by Pacific countries in open international exchange of meteorological information
19 countries participated in the training workshop, 29 April – 3 May 2013, including 12 Pacific partner countries and 7 other Member countries of WMO in the South-West Pacific region. Experts from Global Information System Centres (GISC) in Australia, China, Japan, Korea, WMO Secretariat and the Association of Hydro-Meteorological Equipment Industry (HMEI) contributed to the workshop by delivering speeches and lectures.

The aim of the activity is to assist counterpart organisations to fully participate in WMO systems for transmitting and handling the weather, climate and environmental information. This activity prepares partner countries to 1) adopt the new arrangements for the future free and open international exchange of weather and climate information and products through a more comprehensive information service known as the WMO Information System (WIS); and 2) to adopt the new data formats required to participate in the World Meteorological Organisation (WMO) coordinated international exchange of weather and climate related information, i.e. to migrate to Table Driven Code Form (TDCF) for the exchange of observed and predicted weather data and products.

To achieve this aim, a two-stage approach was adopted. In the first stage, a training workshop on WIS/TDCF was conducted in Melbourne to convey the concept and preparedness for WIS and TDCF in the counterpart organisations. In the second stage, an implementation plan was developed for each partner country in consultation with the counterpart organisation. On-site assistance was provided by the Applicant to implement the plan, so that the partner countries can take advantage of the services provided by the WIS, will be able to submit necessary metadata, to exchange their weather data in TDCF under the framework of the WMO WIS Core Network, and to receive and fully utilise the data made available in WIS. The free exchange of essential weather data supports the mitigation of severe weather events and natural disasters such as tropical cyclones, drought, storm surge and tsunami.

Support and upgrade of Fiji Integrated Meteorological Forecast System FIMS ANNEX I Attachment C

FMS operates the Australian Integrated Forecasting System (AIFS) at its Head Office in Nadi, Fiji, for the preparation of public and aviation forecasts and warnings. This system was first installed in 1998.

Since 1998, the FMS AIFS system and its underlying infrastructure—the Fijian Integrated Meteorological System (FIMS)—has been upgraded three times with the assistance of Bureau IT staff, once in 2004 and again in late 2008 and late 2015, on a cost-recovery basis.

The most recent upgrade migrated FMS mission-critical forecasting operations to a virtualised Linux cluster similar to that now used in Bureau Regional Offices. As part of the upgrade the Bureau provided updated software applications, databases, documentation and additional training.

The benefits to FMS of the upgrade included:

- reduced running costs, including power consumption and cooling;
- reduced hardware costs (by about 50 per cent) for equivalent or improved performance;
- a scalable architecture, whereby more servers and storage trays can be added over time;
- simplified system management and high availability through server virtualisation; and
- the ability to support both Linux and Windows servers in one cluster, through server virtualization.

During October 2015, two FMS Staff (one IT staff member and one forecaster) visited ABoM for the initial setup of the FMS systems in Melbourne. The FMS staff members reviewed and provide feedback on how well the setup matched FMS requirements. Following the review and further work, the applications and system configuration was transported to Nadi when an ABoM systems engineer visited. These visits were fully funded by the FMS AIFS Upgrade project.

Also in November 2015 2012 two BoM IT staff visited Fiji Met Service to conduct system audit for the Fiji AIFS Upgrade Project, assist with User Acceptance Testing and contribute to the upgrade the Fiji Met Service's operational forecasting system.

The upgraded system was commissioned in December 2015 and has been operating operationally ever since.

Two FMS IT Staff have been invited to attend training on supporting the AIFS system at ABoM in late August 2017.

Bureau's contribution of guidance products to PIC NMHSs ANNEX I Attachment D

Manual Analysis

A key product produced by RSMC Darwin is a suite of broad scale tropical analyses produced by forecasters in Darwin. Streamline analyses at gradient level and 200hPa are performed each day at 00UTC and 12UTC, supplemented by a MSLP analysis at 00UTC.

The Bureau (through the RSMC Darwin) continued to contribute regional NWP guidance and tropical climate monitoring products during the full demonstration phase of the SWFDDP in 2013, 2014 and 2015. Charts and NWP products are available on the RSMC Darwin web site, and a selection of regional NWP products is available directly to SWFDDP participating countries on the MetConnect Pacific web page, hosted by the Meteorological Service of New Zealand.

An upgrade in the Bureau's ACCESS model suite (APS2) was implemented in the first half of 2015, which delivered improved horizontal resolution (grid size decreased from 40km to 25km), improved assimilation of satellite data and improved model physics in the Bureau's global NWP model, ACCESS-G. Charts and forecast tracks are available from the Bureau's high-resolution ACCESS-TC model on the RSMC Darwin web page and work is in hand to allow access to ACCESS-TC track maps and bulletins via the Met Connect Pacific web site. Track bulletins from ACCESS-TC are sent directly to several south Pacific meteorological services to ingest into Bureau-developed forecasting software (TC Module) for use in tropical cyclone warning centre operations.

Apart from the above, the Bureau supported the SWFDDP through the provision of a Darwin RSMC representative on the Regional Subproject Management Team, representation on the RAV Tropical Cyclone Committee (Chair, Mike Bergin) and also on the overall SWFDP Steering Group.

Climate Diagnostics

RSMC Darwin provides a range of climate diagnostic information to stakeholders in the region, focused on key climate drivers in the tropics such as the El Nino-Southern Oscillation, Madden-Julian Oscillation, Indian Ocean Dipole and significant tropical waves. As well as a wealth of information on the Bureau website, RSMC Darwin climatologists produce a 'Weekly Tropical Climate Note' which discusses the current state of the climate as well as expectations for the next two to four weeks.

Numerical Weather Prediction

A wide range of Numerical Weather Prediction (NWP) products are provided to countries in the region from the ACCESS suite of models. Model fields are made available as GRIB2-format gridded products that can be ingested into local software systems or as pre-generated charts over the domain of interest. Coincident with a series of major upgrades in the Bureau's supercomputing capabilities, the Bureau's models are being upgraded. The ACCESS-Global and AUSWAVE models were upgraded from 40km resolution to 25 km in March 2016, with improved assimilation and use of new observational data types, and an upgrade to the 12 km ACCESS R was made in April 2016. Work has continued towards the next sequence of upgrades, including an operational

ensemble implementation of the ACCESS-Global model and resolution increases. Within the Australian domain, an upgrade of the ACCESS-City model (covering parts of Australia at 1.5 km resolution) has shown considerable improvement in the handling of convective regimes.

The Severe Weather Forecasting and Disaster Risk Reduction Demonstration Project (SWFDDP)

RSMC Darwin continues to be actively involved in the SWFDDP, which aims to improve the ability of NMHSs to forecast severe weather events as well as to improve guidance to NMHSs through feedback to modelling agencies and RSMCs. The current phase of the project is focused on the southwest Pacific, including Fiji, New Zealand, Samoa, Vanuatu and the Solomon Islands.

Currently, RSMC Darwin is providing a wide range of charts and NWP output to NMHSs participating in the project, as well as to the 'Metconnect Pacific' (Meteorological Service of New Zealand) web page which acts as a hub for guidance material being used in the region.

The Coastal Inundation Forecast Demonstration Project, Fiji Sub-project (CIFDP-F)

The WMO CIFDP-F sub-project is focused on the development of an efficient forecasting and warning system for coastal inundation in Fiji. The Bureau has been involved with this project since 2012, by providing technical advice and expertise for planning, system design and periodic stage reviews.

Support to Volcanic Ash Advisory Services

The Volcanic Ash Advisory Centres (VAACs) provide eruption detection and ash dispersion guidance for use by aviation forecasters in each State. VAAC Darwin covers the western Solomon Islands, PNG, and westwards to Indonesia, and VAAC Wellington covers the area to the east of that across the remainder of the south Pacific. Australia and New Zealand have worked hard to improve mutual back up arrangements across this region, which covers a large part of the Pacific 'Ring of Fire'. An ongoing issue in the region is the status of volcanic monitoring. ICAO requires States to monitor active or potentially active volcanoes, preferably instrumentally. Australia is actively discussing ways to improve operational monitoring arrangements in PNG.